Accelerator Division

SECTION A: TECHNICAL SPECIFICATION FOR LOT 1

GOVERNING THE CONTRACT FOR THE SUPPLY OF THE CONVENTIONAL MULTIPOLE WIGGLER MPW-80 FOR X-RAY ABSORPTION BEAMLINE AT THE ALBA SYNCHROTRON LIGHT LABORATORY

14th June 2007

1 Introduction and scope of work

1.0.1. ALBA is a new synchrotron radiation source being built at the site of the Centre Direccional in Cerdanyola del Vallès, nearby Barcelona, and will produce ultra-violet and X-ray beams of exceptional brightness. The facility will comprise a 3 GeV electron storage ring, injected from a ~100 MeV linac through a full energy booster synchrotron, and an initial complement of seven beam lines.

1.0.2. The facility will be constructed, owned and operated by the Consortium for the Construction, Equipment and Exploitation of a Synchrotron Light Laboratory (referred to simply as CELLS), a public administration consortium shared at 50% between Catalan and Spanish governments.

1.0.3. The conventional multipole wiggler being tendered will be installed at ALBA EXAFS beam line. The main parameters (Maximum field, K value, length and period) have been derived from user's requirements, and they are: a maximum flux between 2 and 20 keV through a vertical aperture of 250 μrad and a horizontal aperture of 1.5 mrad, for currents up to 400 mA, and; a maximum power into the monochromator: of 700 W in the ranges 0-7 keV, 7-20 keV and 20-50 keV.

1.0.4. To meet the requirement a so called reference design has been performed by CELLS. This reference design is a basis of these specifications. If required CELLS can provide this reference design to the tenders

1.0.5. According to the restricted power on the optical components, the wiggler has to be optimized for two different stored current regimes: 100 mA to 250 mA, and, 400 mA. For 100 mA to 250 mA, the K value should be K(1) = 13. For 400 mA, K(2) = 9.3. For the reference model used by CELLS, the first K value can be obtained at a gap of 12.6 with B(1) = 1.747 T, whilst the second is achievable at a gap of 18 mm and B(2) = 1.25 T.

1.1 Scope

1.1.1. The scope of the contract is to design, manufacture, testing, packing and delivery to the ALBA storage ring on the Centre Direccional site a conventional wiggler MPW-80 according to this technical specification.

1.1.2. The wiggler will be procured as a single turn-key system, subject to a performance specification. The supplier is responsible for meeting the requirements of this specification.

1.1.3. The supplier is also responsible for the detailed magnetic measurement of the device, and must provide all of the necessary test equipment and measuring instruments required to achieve this.

1.1.4. The supplier will be responsible for the factory acceptance test and transport to ALBA site. The wiggler should not suffer damage to the magnet structure, magnet materials, mechanical structure or drive system when exposed to ambient temperatures during transportation.

1.1.5. CELLS acceptance test on site as well as the commissioning with beam will be responsibility of CELLS.

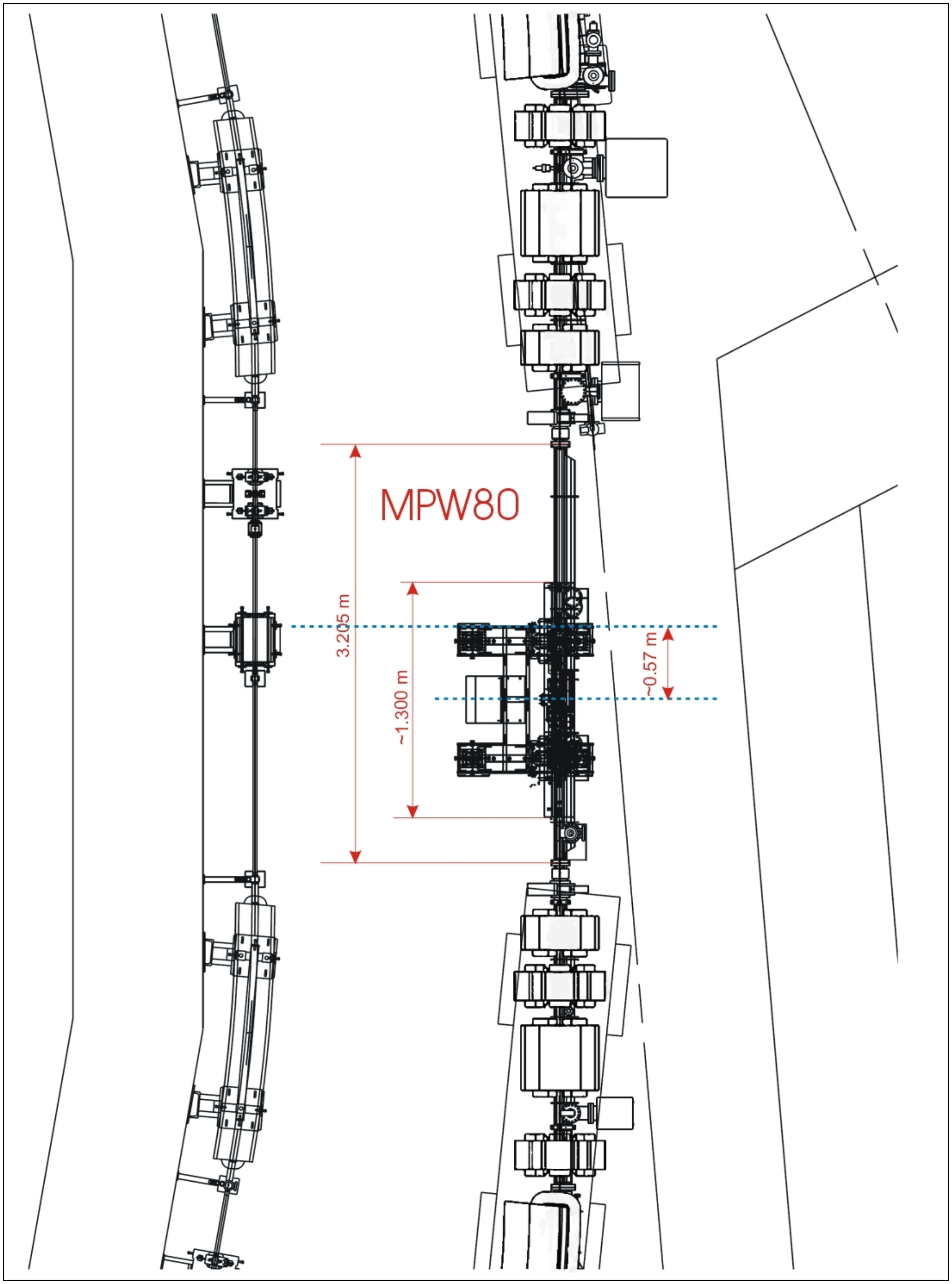


Figure 1a. Lay out of the multipole wiggler MPW80 in the straight section of the storage ring

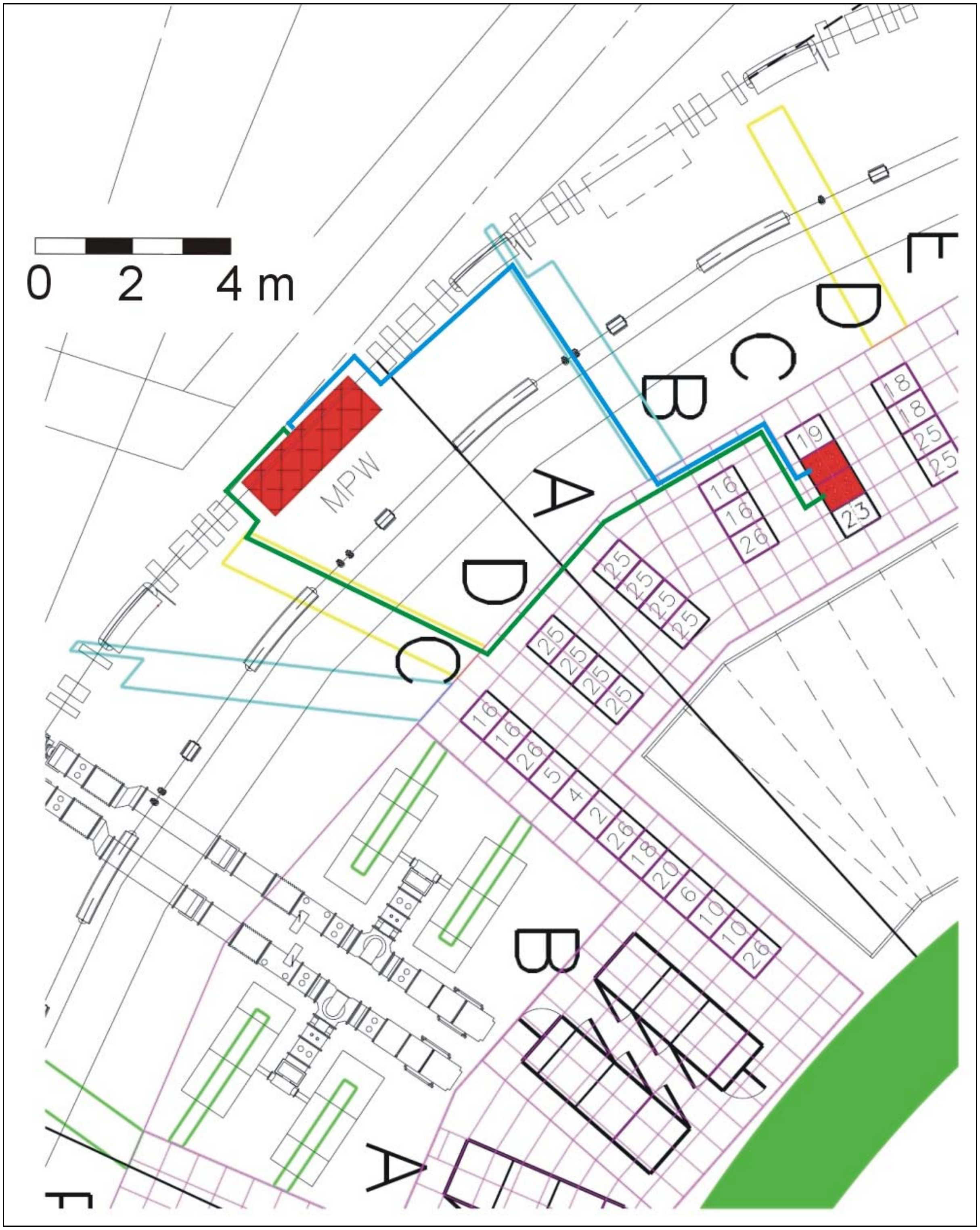


Figure 1b. Lay out of the service area where the control racks of MPW80 are placed. In blue we sketch the lay out of cables for control signals (~17 m) and in green the lay out of cables for power (~19 m).

1.2 Suppliers Deliverables

1.2.1. **Equipment**	1 fully functioning conventional wiggler with associated controls, motors and encoders ready for installation at ALBA, according to this technical specification to CELLS site. Mechanical fasteners, supports, and fiducial points are included. Corrector coils are included as well.
1.2.2. **Cabling and connection box**	Design and manufacturing of cabling and connection box is included in the deliverables.
1.2.3. **Reports and Documentation** All documentation must be supplied in English unless otherwise agreed. All documents must be delivered both in hard copy and electronic format.	Detailed program for execution of the contract.
	Preliminary Design Review (PDR) documentation.
	Initial Quality Control Protocol.
	Monthly status reports.
	Final Design Review (FDR) documentation.
	Test plan: Factory and Site Acceptance Test Procedure(s).
	Factory and Site Acceptance Test Reports.
	Full support documentation for all items of equipment, including all installation, operation and maintenance manuals.
	A maintenance plan proposal
	Full set of drawings for all equipment supplied to CELLS.
	A list of recommended spare items and any spare parts included within the tender: the costs of such items must be clearly identified whether included in the tender or to be purchased separately.
	Safety report.
	Quality Assurance Documents for the completed device with copies of all specified material certificates, details of all quality control checks and intermediate test results.
1.2.4. **Control racks**	All control equipment should fit in two standard racks. The technical characteristics of the racks are described in Appendix. The location of these racks in the Service Area is sketched in Figure 1b above.

1.3 Components Supplied by CELLS

1.3.1. The following items will be provided by CELLS:

1.3.2. **TANGO control system**	A TANGO based control system will be provided by CELLS, and it will be installed and commissioned at manufacturer site.
1.3.3. **Power converters**	Power supplies to feed the correction coils.

1.3.4. CELLS reserves the right to recommend other particular components.

1.4 Components that may be supplied by CELLS

1.4.1. **Motors & encoders**	Motors and encoders have to be compatible with the Motor Controller selected by CELLS at due time. Hardware interface is described in the Appendix.

1.5 Timescales

1.5.1. Following the award of the contract, the design stage shall not exceed two calendar months in length unless mutually agreed in writing. A full design review must take place within this time period. The main project milestones are shown in Table 1.1 below. This table is indicative.

Milestone	Months after start of contract	Tentative date
Tender reply	-	10 July 2007
Start of contract	0	1 September 2007
PHASE I		
Kick-off meeting	0,5	
Preliminary Design Review (PDR)	0,5	15 September 2007
Final Design Review (FDR)	2	1 November 2007
PHASE II		
End of carriage production	10	1 July 2008
Magnetic blocks ready for assembly	10	1 July 2008
Factory acceptance tests	13	1 October 2008
Delivery and CELLS acceptance tests	14	1 November 2008

Table 1.1: Main Project milestones

1.5.2. The wiggler should be delivered 14 months after the placement of the contract.

1.5.3. Phase I will finish with the acceptance of the Final Design Report. The contents of which shall be agreed upon at the preliminary design review meeting. The Phase II can only start after the approval of the conceptual design report by CELLS. The procurement of long lead time items, which could have an influence upon the time schedule, should be discussed at the preliminary design review meeting.

1.6 Guarantee

1.6.1. The equipment shall be guaranteed for 24 months following the date of delivery, or 18 months from the date of final acceptance, whichever is the latest.

2 General conditions of the contract

2.1 Basis of the contract

2.1.1. The contract will be based on the following documents:

- This Technical specification.
- All other documents issued with this Technical Specification (Appendix).
- Any amendments to items 1 and 2 issued by CELLS during the tender period
- The Supplier's tender proposal

2.1.2. Strict compliance with these contract documents is required unless otherwise specifically agreed in writing.

2.2 Supplier's Responsibilities

2.2.1. The Supplier is responsible for meeting all the requirements of this specification and for all aspects of the performance of the device: magnetic, mechanical and electrical, as well as safety aspects, including testing and certification.

2.2.2. The Supplier will be responsible for the final design, the production methods and the correct performance of all the items that are supplied, irrespective of whether they have been chosen by the Supplier or suggested by CELLS. Any approval by CELLS of the design and components does not release the Supplier from his responsibilities in this respect.

2.2.3. The Supplier must provide all materials and any necessary tooling, jigs and fixtures required for the manufacture of the MPW80 wiggler. The supplier must also provide all test equipment and measuring instruments required to certify the performance of the device.

2.2.4. The Supplier is advised to work in close contact with CELLS at all stages of the contract in order to resolve any technical issues or problems that arise in the most timely and efficient manner.

2.3 Contract Management

2.3.1 Contract Engineer

2.3.1.1. At the start of the contract the Supplier shall assign an engineer (the Contract Engineer) who will be responsible for all reporting to, and contact with CELLS.

2.3.2 Programme and Progress Reports

2.3.2.1. Within one month of the commencement of the contract the Supplier must issue a detailed programme covering the design, manufacturing, installation and testing phases in sufficient detail to allow regular progress monitoring.

2.3.2.2. The programme should include at least:

- Start and finish dates of the work.
- Completion of detailed design.
- Material and purchased procurement items.
- Completed fabrication.
- Testing of major components.
- Recommended site visits by CELLS personnel.
- Shipment and delivery to CELLS.
- Finishing of contract.

2.3.2.3. Thereafter, and throughout the contract, the Contract Engineer shall supply a written report to CELLS every month detailing progress with respect to the programme. This report should contain as a minimum a list of activities and milestones achieved since the previous report, any delays or technical issues which are likely to affect the performance or the schedule and any proposals to address these delays or technical issues and an updated schedule and/or milestone list.

2.3.2.4. Where delays of more than two weeks against any milestone in the agreed program is anticipated the Supplier will both inform CELLS immediately in writing, and make available evidence of all corrective action being undertaken to mitigate the impact on the contract deliverables.

2.3.2.5. All reports and documentation needed for a smooth follow-up of the contract execution will be written in English, and should be delivered in electronic format.

2.3.3 Inspections

2.3.3.1. CELLS intend to carry out periodic and/or spot contract inspections at the Supplier's premises and where deemed necessary that of its subcontractors. Contract inspections will be concerned with all contract compliance issues including Programme, Quality and Performance. The supplier should allow the entrance in his company to CELLS employees.

2.3.3.2. In line with providing CELLS with a detailed programme the Supplier will propose a schedule of relevant evidence, physical and documentary, that will assist to demonstrate actual monthly progress at the Supplier's premises throughout all contract stages and status inline with programme milestones.

2.3.3.3. The supplier should include in the time schedule the recommended site visits by CELLS personnel.

2.3.4 Technical and Progress Meetings

2.3.4.1 Preliminary Design Review (PDR)

2.3.4.1.1. Within one month of the signature of the contract a Preliminary Design Review will be held with the Supplier at the CELLS site. At this review the Supplier will present their proposed design solution for the magnetic design, the mechanical support, girder design and holder design. CELLS and the Supplier must agree that the solution proposed is suitable and that it should proceed to a full design. The Supplier will also present a plan for the execution of the contract and a Quality Assurance plan.

2.3.4.1.2. An agreed set of minutes will be produced by the supplier following the PDR accurately recording the state of the design work as well as all agreements and actions.

2.3.4.2 Final Design Review (FDR)

2.3.4.2.1. CELLS and the Supplier must agree the final design at the Final Design Review meeting to be held at the CELLS site. At the Final Design Review the Supplier must present to CELLS the detailed final design, including:

- The magnetic and electrical design, reason for design choices and design calculations.
- The mechanical layout.
- An outline of maintenance, operating and hazard management documents.
- A complete list of components.
- The production drawings. This includes all piece and part drawings required for fabrication.
- Complete, dimensioned assembly and component drawings of the support structure.
- A detailed manufacturing and testing programme, with regular milestones to allow progress to be monitored.
- The inspections and test schedules, including the plan for factory tests.
- Full details of factory acceptance testing.

2.3.4.2.2. The Supplier must issue the Final Design Report detailing the proposed design, as well as a set of CAD drawings, two weeks in advance of the meeting to enable supervision by CELLS.

2.3.4.2.3. An agreed set of minutes will be produced following the FDR accurately recording whether all aspects of the design listed above have been completed, as well as all agreements and actions.

2.3.4.2.4. With the acceptance of the Final Design Report by CELLS the phase I of the contract is finished (see Table 1.1)

2.3.5 Approval Prior to Manufacture

2.3.5.1. Unless otherwise agreed in writing, CELLS must approve the final design report presented at the Final Design Review before the Supplier proceeds to ordering of any materials, components or equipment required to fulfil this contract. The procurement of long delivery items before the acceptance of the final design review is only possible with the written permission of CELLS.

2.3.6 Site Acceptance

2.3.6.1. It is a condition of contract finishing that all supporting documentation has been received and accepted by CELLS, in particular:

- Testing, certifications and inspections including material compositions, correction coils inspection sheets, magnet inspection sheet, magnet measurement data and magnetic field measurements.
- Hazard management.
- Maintenance and operating manuals.
- Quality Assurance documents.
- As-built mechanical and electrical drawings.

2.3.7 Approval before Delivery

2.3.7.1. Delivery to CELLS shall not commence until successful completion of all Factory Acceptance Tests and after written authorisation by CELLS.

2.3.8 Deviation from the Specification

2.3.8.1. During the construction, all proposed deviations from the final design report must be submitted to CELLS in writing; CELLS will give its approval or refusal also in writing.

2.4 Reliability and Maintenance

2.4.1. All equipment shall be manufactured in accordance with the best existing techniques and recognised good engineering practices available at the time of construction. All systems shall be designed and constructed for a long lifetime. Subassemblies shall be designed for repair rather than replacement. This point has to be addressed during the final design review meeting.

2.5 Norms and Standards

2.5.1. The system must comply with all harmonised European standards as well as details regarding the appropriate EMC regulations. A basic separation between power and signal cables should be provided.

2.6 Quality Assurance

2.6.1. The Supplier shall provide and implement a quality assurance program compliant with ISO-9001 for the design, manufacture and testing of all systems and equipment provided by them, which includes carrying out all relevant inspections and tests as detailed in Section 9.

2.6.2. No acceptance or approval by CELLS of any procedure or test result shall release the Supplier from his responsibility in fulfilling the terms of this contract.

2.7 Safety and Hazard Management

2.7.1. The Supplier shall carry out a safety assessment of the equipment (wiggler as well as power supplies and racks, etc.) and its operation. This shall be fully documented in the corresponding manuals. Any safety and risk assessments carried out as part of the CE marking shall be supplied to CELLS. CELLS will provide the supplier all clarifications on the CE marking conditions, if needed.

2.7.2. CELLS requires Suppliers to employ hazard management techniques to reduce the risk of personnel becoming injured as a result of interaction with their equipment. This has to be addressed in the operation manual mentioned in the deliverable documentation.

2.7.3. Consideration should be made of hazards that exist at all stages of the life of the equipment, including installation, commissioning, operation, maintenance, repair, decommissioning and disposal. The analysis should include hazards that may occur during fault conditions and should include all potentially hazardous materials. The hazard management system should:

- Identify hazards
- Reduce severity
- Mitigate likely hazards
- If possible, predict casualty rates.

2.7.4. A hazard database, identifying all hazards associated with the equipment, should be provided by the Supplier in outline at the Design Review, and in final form as part of Operation and maintenance manuals.

2.8 Drawings

2.8.0.1. The Supplier shall provide 2 (two) full sets of paper copies of the final functional mechanical and electrical drawings, on good quality (80 gram plus paper) punched and put in white 4 ring presentation binders not exceeding 75% full.

2.8.0.2. The Supplier shall also provide two full sets of electronic copies of the functional mechanical and electrical drawings on a CD or DVD.

2.8.0.3. The Supplier shall make drawings available as soon as possible throughout the term of the contract.

2.8.0.4. All labelling and documentation must be in English.

2.8.1 'As-Built' Drawings

2.8.1.1. Where deviations from the information or dimensions contained in the manufacturing drawings is authorised by CELLS during manufacture, the Supplier must note the changes. The supplier should update all drawings of the final design report according to the production.

2.9 Manuals

2.9.1. Detailed installation, operation and maintenance manuals shall be prepared for the system. Included in the manual shall be detailed assembly/disassembly and alignment instructions, routine maintenance requirements, fault diagnosis instructions, start-up and conditioning procedures. Supporting these requirements shall be appropriate mechanical and electrical schematic drawings and diagrams, and Process & Instrumentation diagrams.

2.9.2. The maintenance schedule shall include a description and justification for each operation, the conditions under which it must be performed and an estimate of the time required.

2.10 Delivery

2.10.1. The supplier is responsible for the transportation, and delivery of the wiggler at ALBA site. The supplier has to provide CELLS with detailed unloading instructions. Unloading is the responsibility of CELLS.

2.10.2. The Supplier shall ensure that all equipment within the extent of this supply is fully and satisfactorily protected during handling and transportation. Packing cases must be robust and suitable for lifting and transportation without damage. Internal packing must be adequate to prevent movement or vibration during transportation. The packing for the transportation to CELLS site has to be approved by CELLS.

2.10.3. Shock and tilt indicators must be fitted to reveal evidence of any mishandling between the Supplier's premises and CELLS.

2.10.4. Returnable packing will be considered on request. The collection and return of the packaging will be entirely the responsibility of the Supplier. CELLS reserves the right to use the package during a maximum of 12 months to store the wiggler before its installation into the ring.

2.10.5. The Supplier shall detail at tender the largest dimensions and weights of individual components to be delivered.

2.10.6. Individual items weighing more than 30 kg shall be provided with sufficient lifting hooks and/or be compatible with fork-lift trucks. If special lifting jigs are required, these shall be provided by the Supplier

3 Magnetic system

3.1 General

3.1.1. The wiggler magnet arrays will be designed so as to produce a sinusoidal variation of the vertical magnetic field (Bz) centred on the magnetic axis of the device. The first and final end sections in the array will have special arrangement, so as to produce an electron trajectory centred on the magnetic axis. Magic fingers can be used to reduce multipole components in field integral.

3.1.2. According to the restricted power on the optical components, the wiggler has to be optimized for two different stored current regimes: 100 mA to 250 mA, and, 400 mA. For 100 mA to 250 mA, the K value should be K(1) = 13. For 400 mA, K(2) = 9.3. For the reference model used by CELLS, the first K value can be obtained at a gap of 12.6 with B(1) = 1.747 T, whilst the second is achievable at a gap of 18 mm and B(2) = 1.25 T.

3.1.3. The wiggler should be mechanically conceived with the possibility of gap movement, i. e., like a planar undulator. It should be optimized to work at two gaps defined in paragraph 3.1.2 and it should have the possibility of changing the gap between experiments between these two values and above up to the maximum gap value.

3.1.4. To meet the requirement of the users, CELLS made a so called reference design (see paragraph 1.0.4). Because of the high field within the wiggler the design must be a hybrid one. CELLS has chosen a symmetric device because in this way, if the first integral is zero, the second integral is also zero. However, the proponent can propose a different magnetic design. In this case, the proponent should demonstrate that its design achieves the performances given in the next section.

3.1.5. Support mechanical design should be compliant with tolerances for mechanical magnitudes also given in section 3.4.

3.1.6. The storage ring tunnel is stabilized for a temperature of 23 ±0.1º C and magnetic measurements, both of magnetic blocks and of the final assembly, should be conducted at this temperature. The wiggler should meet the specifications in the temperature range of 23ºC ±0.5ºC.

3.2 Main parameters of the wiggler MPW80

3.2.1. According the reference design (see paragraph 1.0.4)., the gap corresponding to K1 will be used when current in the Storage Ring is 100 mA to 250 mA, and the gap corresponding to K2 will be used when current is 400 mA.

3.2.2. The main parameters of the wiggler and the dimensions of the magnetic blocks and poles, according to the reference design, are given in the following table 3.1 and 3.2

3.2.3. The magnetic field for the reference design can be described (g being the gap and λ being the period length) by:

$$B_0 = 4.39e^{\left(-6.6\left(\frac{g}{\lambda}\right)+4.44\left(\frac{g}{\lambda}\right)^2\right)}$$

3.2.4. The magnetic forces within the magnets, according the reference design, are roughly 50 kN for the gap correspondinf to K1 and 25.6 kN for the gap corresponding to K2

Field Direction	Vertical
Nominal peak on axis field, B_o *(gap 12.5 mm)*, K_1	1.74 T, K_1 = 12.976
Nominal peak on axis field, B_o *(gap 17.95 mm)*, K_2	1.25 T, K_2 = 9.328
Period length	80 mm
Number of pole pairs @ central section	25
Number of pole pairs @ edge sections	4
Pole length	13.4 mm
Magnetic block length	26.6 mm
Length of magnetic arrangement (not including end sections)	1027 mm
Length of magnetic arrangement (including end sections)	1198 mm
Magnetic length (including stray field > $5 \cdot 10^{-5}$ T)	1758 mm
Minimum magnetic gap, mm	12.5
Maximum magnetic gap, mm	>300
Transverse field homogeneity at all field levels	$\left|\Delta B_z / B_z\right| \leq 1\%$ at x = ± 20 mm
Material minimum coercitivity	12 kOe
Gap velocity	Not an issue for this application

Table 3.1: Main parameters of multipole wiggler MPW80

Magnitude	Value
Magnetic block width	109.6 mm
Magnetic block heigh	56.2 mm
Magnetic block thickness	26.6 mm
Pole width	75.2 mm
Pole heigh	43.3 mm
Pole thickness	13.4 mm
Pole chamfer side width	4 mm
Magnet block chamfer side width	5 mm
Ratio pole/period lengths	0.335

Table 3.2: Dimensions of the magnetic blocks and poles of the wiggler MPW80 according to the reference design.

3.3 Field Homogeneity.

3.3.1. The roll-off of field in horizontal plane should be less than 1% within ±10 mm.

3.4 Field Errors.

3.4.1. The variation of peak vertical magnetic field strength (B_z) between the individual poles must be less than ±1%. The maximum RMS horizontal component (B_x) must be less than ±0.1% of the peak vertical component within ±20 mm along the horizontal transversal axis.

3.4.2. Measurements shall be made of the first and second field integrals for B_z component. Allowance must be made for the effects of the fringe fields, and hence the integrals should be measured along the nominal longitudinal axis over a range of at least ±0.5 m from both ends of the device. The maximum values of these integrals for both components must satisfy the following requirements:

	expression	**After shimming**	**With correction coils**
First Field Integral	$\int_{-\infty}^{\infty} B(s)\,ds$	$\leq \pm 10^{-4}$ T·m	$\leq \pm 10 \cdot 10^{-6}$ T·m (vertical) $\leq \pm 50 \cdot 10^{-6}$ T·m (horizontal)
Second Field Integral	$\int_{-\infty}^{\infty} sB(s)ds$	$\leq \pm 10^{-4}$ T·m^2	$\leq \pm 80 \cdot 10^{-6}$ T·m^2 (vertical) $\leq \pm 150 \cdot 10^{-6}$ T·m^2 (horizontal)

Table 3.3: Maximum values of the first and second integral of the whole device in both transversal planes

3.4.3. These values must be met at all gaps in whole area $|\Delta x| < 20mm$ in order that the device could be operated without disturbing an electron beam already circulating in the storage ring. It is expected that to meet these requirements, correction coils will be required at both ends outside the device. In this case, the supplier should include in the tendering documentation a conceptual design of such correction coils and their specification, along with the currents needed in each correction coil circuit as a function of the gap.

3.4.4. The maximum length of the wiggler should be 1.3 m, as specified in section 4.1.2. Being the magnetic length of the device 1 m, the space left outside the device to fit the corrections coils is ca. 150 mm at each end.

3.4.5. Within the reference design, the proposed a scheme based on end sections made of two poles with 4 free parameters in order to minimize the field integrals. The supplier can propose and alternative scheme, but in this case this should be justified with simulations.

3.4.6. The supplier should detail the tolerances of the whole mechanical arrangement needed in order to fulfil the specifications given above.

3.4.7. The phase error of the device is not an issue, because it will be used as a wiggler, i. e., the interference pattern should not be improved. However, it may not be higher than 5º at minimum gap.

3.4.8. The maximum integrated first field errors off-axis in the device (‘multipole errors’) must satisfy the requirements for both normal and skew components given in Table 3.3 below. These specifications must be met at all gaps in area $|\Delta x| < 20mm$. The use of skew quadrupole correction coil can be considered if necessary.

MULTI-POLE COMPONENT	**1st INTEGRAL**
Normal Quadrupole	0.005 T
Skew Quadrupole	0.0005 T
Normal Sextupole	0.05 T/m
Skew Sextupole	0.005 T/m

Table 3.4: Maximum allowed integrated Multi-pole component values

3.5 Magnetic materials

3.5.1. Magnetic materials used to build the devices should approach as much as possible the performance of the theoretical material specified in the reference design: NdFeB magnetic material blocks, with a remanent field B_r = 1.4, a permeability of μ = 1.06 (easy axis) and μ = 1.17 (normal to easy axis). Although coercitivity is not used to model the wiggler for the conceptual design, a typical value of this magnitude is H_{cB} = 14/15 kOe (1100/1200 kA/m). Thus, the wiggler shall be capable of closure to minimum gap (12.5 mm), with no irreversible loss of magnetization of the magnet materials. The coercitivity of the magnet material shall be such as to prevent any loss of magnetization during assembly, over a temperature range up to 60ºC. The coercitivity should be big enough to prevent magnetic degradation because of radiation, allowing nominal performance of the wiggler when installed in the operating storage ring.

3.5.2. The permanent magnet blocks shall have been thermally stabilized at 60ºC or higher such that the residual induction B_r shall not experience irreversible loss in excess of 0.05% upon -10ºC to 60ºC temperature cycling. The magnet type and grade should be approved by CELLS.

3.5.3. The magnets shall be protected against any harmful corrosion for a period of 10 years, in 75% humidity, 30ºC environment.

3.5.4. The magnet blocks may be attached mechanically to the magnet keepers. The use of adhesives can be considered but should only be used after the explicit approval of CELLS. The mounting scheme must be approved by CELLS during the Final Design Review as outlined in Section 2.3.4.2 of these specifications.

3.5.5. No aqueous chemical processing is permitted on the magnet blocks. Vacuum deposited titanium nitride or tin is the preferred anticorrosion coating. If blocks are thus coated, and if they are to be adhesively bonded, the surface should not be chemically treated. The corrosion protection coating must be approved by CELLS during the Final Design Review.

3.5.6. Permanent magnet blocks shall be indelibly marked with serial numbers visible on each side and magnetization direction on the ends of the blocks. The serial numbers and magnetization directions shall be noted on a magnet array assembly drawing or table provided to CELLS. All magnet block measurement data shall be supplied to CELLS.

3.5.7. It is expected that the Supplier will order an excess number of magnet blocks [~ +20%], to facilitate sorting and to allow for breakage. These spare blocks shall be delivered to CELLS with the wiggler.

3.6 Request for Modification and Standardization

3.6.1. CELLS assumes that the different bidders manufactured already in the past a lot of high field wigglers and the bidders have a lot of knowledge and know how to build in high field wigglers. In order to get a cost effective solution CELLS ask the different bidders to make proposals for some modifications to use a so called standard design and meeting the specifications of CELLS.

4 Mechanical frame

4.1 Overview

4.1.1. The support structure provides the framework for holding the magnetic structure and mechanisms for longitudinal motion of both magnet rows. ALBA storage ring beampipe requires a “C” frame to permit wiggler installation only from the radially inward side of the storage ring (Figure 2).

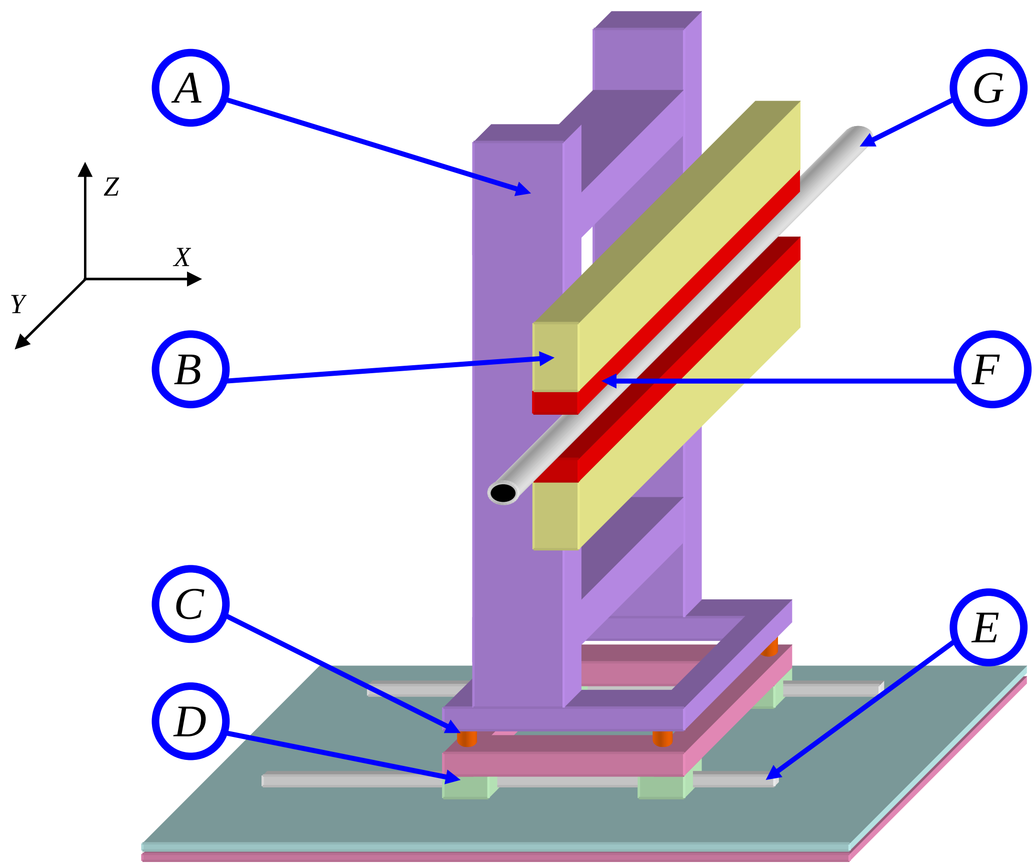


*Figure 2.- Sketch of the mechanical frame and coordinate axis used in the present document. The first comprises the **static support** (A, in violet) as well as the **movable girders** (B, in yellow). The mechanical frame has to be mounted on a **basis** (C, pink) allowing the alignment of the whole setup. The wiggler has to be mounted on **linear bearings** (D, green) sliding on **rails** (E, grey). A motor system should drive the motion of **magnetic arrays** (F, red) assembled on the movable girders. The magnetic arrays should move symmetrically with respect to the electron beam circulating inside the **vacuum chamber** (G, grey). The ALBA tunnel floor will be provided with a double layer pedestal of epoxy and stainless steel platform.*

4.1.2. The boundaries of the spatial envelope for the wiggler mechanical frame are given in table 4.1 below. No part of the Insertion Device shall extend outside these boundaries, except with the prior approval of CELLS. Maximum weight allowed is also presented in Table 4.1.

Table 4.1. *Physical boundaries of the device*

Magnitude	Values
Maximum length [mm]	1300
Maximum height[mm]	2500
Maximum width [mm]	1000
Maximum wheight [kN]	40

4.1.3. Wiggler mechanical frame should be designed and built in order to fulfil tolerances given in section 4.2. The movable girders shall be designed so they will not exhibit any long term thermally induced deformations which could cause variability in the magnetic field. The backing beam shall be stress relieved before final machining to ensure stability.

4.1.4. Wherever possible, materials used in the mechanical structure that are subject to corrosion shall be protected by anodizing, black oxiding or painting. Fiducial surfaces should be masked when painting adjacent areas. Colour to be used should be RAL 840HR 4001 (violet).

4.1.5. The completed magnet and support frame assembly shall be capable of being lifted by an overhead crane. Lifting eyes shall be provided for this purpose, and these eyes must be specified with a safety factor of four. Lifting eyes must meet European standards. Maximum weight is shown in Table 4.1.

4.1.6. Electrical grounding terminals shall be provided for the mechanical structure, and there shall be no ungrounded metallic parts of the assembly.

4.1.7. The Supplier shall provide a removable safety envelope for the moving parts, including drive component gears and chains. The purpose of this cover is to protect personnel from moving parts as stated in CE regulation and to provide dust protection. The covering material is to be transparent polycarbonate plastic. The cover may be supported by a metal frame or can be mounted off the static support of the wiggler.

4.2 Functional requirements

4.2.1. The magnet assemblies are attached to upper or lower movable girders by dovetails or squared fasteners, allowing virtual shimming through magnetic block displacement.

4.2.2. The movable girders shall move to change the magnetic field of the insertion device by changing the distance between the upper and lower beams. To this end, 4 motors should be used, allowing the operation in tapered mode. Maximum taper allowed should be 2 mm in 1 m length.

4.2.3. The mechanical frame shall keep the magnet assemblies centred around the electron beam, with roll, jaw and twist within specified limits independent of the magnetic forces expressed in Table 4.2 below.

Table 4.2. *Maximum forces applied to the magnetis arrangements.*

Magnitude	Boundary condition
Maximum vertical force on one array.	$F_z < 50\ kN$

4.2.4. A mechanical safety factor of at least 1.5 based on yield strength should be used for all mechanical designs. The magnet keeper backing beams should be designed so they will not exhibit any long term thermally induced deformations which could cause variability in the magnetic field. The backing beam shall be stress relieved before final machining to ensure stability.

4.2.5. The vacuum chamber will be supported independently of the wiggler frame which should be designed to be moved back to give access to the beampipe. CELLS will provide the profile and dimensions of the vacuum beampipe envelope during the design phase.

4.2.6. Wiggler MPW80 will not be operated in the undulator regime, i. e., from its output, only the smooth part of the spectrum (high energies) will be used. So, the mechanical tolerances are not a big issue in the design, because we are not interested in increase any interference pattern.

4.2.7. For this reason, we fix al the mechanical tolerances in the 0.2 mm range, except in the gap positioning system, where we demand 1 μm in resolution, in order to ensure good repetitivity in the case of working at different operational gaps.

4.2.8. To measure the gap, four lineal encoders should be used, placed on the static support and connected to each one of the ends of movable girders.

4.2.9. The number of limit switches at each end of movement should be 2, the first (interlock switch) will disable the motor acting on that axis and the second (safety switch) will be hardwired and cut off the power of the motor controller crate.

4.2.10. All deformations of mechanical frame in all directions should guarantee differences less than 0.1 mm between each magnetic arrays and the nominal axis of the device.

4.2.11. The maximum gap of the ID should be as large as possible, around 300 millimeters (mm). If possible, to produce a magnetic field less than 25 gauss.

4.2.12. The minimum gap of the ID should be 12.5 mm.

4.2.13. Mechanical hard stops have to be included in the design to ensure the protection of the vacuum chamber and the mechanical structure.

4.2.14. The support structure shall provide the necessary degrees of freedom to allow the ID to be properly aligned to the beam vacuum chamber.

4.3 Basis

4.3.1. A basis must be designed to accommodate wiggler frame and allow the movement by a pallet truck, and must have a floor clearance of 120 mm.

4.3.2. Electron beam height in the tunnel is 1.4 m above the tunnel floor. A standard correction level pedestal with a height of 60 mm should be taken into account.

4.3.3. The complete arrangement of support plus wiggler frame should be designed according to this reference. A sketch is shown in Figure 3.

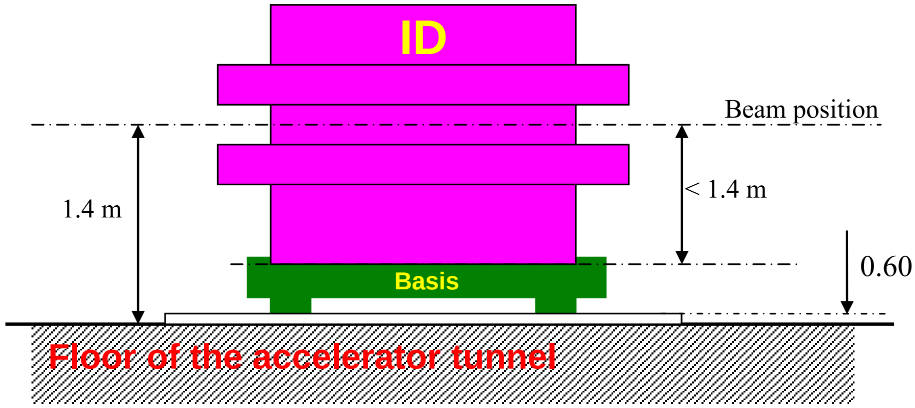


Figure 3. Sketch of the wiggler front-view.

4.3.4. The wiggler basis shall be designed to lay on linear bearings sliding on rails embedded in the tunnel floor, to allow the full wiggler be rolled back and forth into position and then mounted securely in its final position. The design of the rolling system should be proposed by the supplier. It should permit rolling the device without significant vibration and a repetitivity of 50 µm in the final position.

4.3.5. In addition to the linear bearings sliding on rails, the supplier should include bolt-on wheels to support and move the insertion device on the floor before its installation in the tunnel.

4.3.6. The basis shall provide kinematic adjustment in x, y and z axes. The resolution shall be such as to provide the alignment tolerances stated in the preceding section. The support structure must be designed to allow movement of ±15 mm in any direction and be capable of being positioned to within ±100 µm

4.3.7. The basis shall be designed such as to maintain independent adjustment of the different degrees of freedom in so far as is practical.

5 General mechanical requirements

5.1 Fasteners, Fittings and Water/Air

5.1.1. All equipment shall use non-magnetic fasteners, nuts and washers throughout. The standards of these components will be defined by CELLS during the design phase. If this is not possible, then each deviation from this should be approved by CELLS, detailing position, thread form, size, etc. The Supplier will be required to supply spare fasteners for each case of using non agreed fasteners, nuts or washers; the quantities are to be agreed with CELLS. All equipment shall use uniform tube for water, air, etc. throughout, if needed, the sizes to be defined by CELLS during the design phase.

5.2 Mountings and Stands

5.2.1. The Supplier will be responsible for providing a suitable floor-mounting structure to support all components. The support structure must be designed to allow movement of ±15 mm in any direction and be capable of being positioned to within ±0.1mm. All stands are to be painted and must be finished in RAL 840HR 4001 colour (violet).

5.3 Protection of Moving Parts

5.3.1. All moving parts must be protected and comply with the CE directives, and this must be carried out to CELLS satisfaction.

5.4 Acoustic noise

5.4.1. The level of acoustic noise for the equipment shall not exceed 35 dBA at 1 m. Note that CE certification requests to specify in the manual the level of noise.

5.5 Survey and Alignment

5.5.1. The concrete floor has a minimum horizontally level specification of: Horizontal ±1 mm/m; levelling ±15 mm.

5.5.2. To align the ALBA machine, we have opted for a 3-D free stationing approach. The tunnel will be fitted out with some reference points known in our Global Coordinate System. The wiggler will be aligned with respect to all these reference points. The alignment will be done by CELLS.

5.5.3. As it is impossible to target directly the sensitive part of the wiggler which is the magnetic axis, we have to refer it to external fiducial points. This process is called Fiducialization and the external points are called fiducial marks. These fiducial marks will receive the prism of our 3D measuring system.

5.5.4. In our case, a fiducial mark is a machined hole on a machined planar surface. The location and dimensions of this fiducial mark on the wiggler has to be determent during the design phase.

5.5.5. This hole will represent one precise point. The intersection between the planar surface and the axis of the cylinder defines one point.

5.5.6. Then, for alignment considerations the supplier has to:

- Fit out the wiggler with fiducials marks:
  - At least 4 fiducials. The exact number shall be approved by CELLS.
  - The fiducials shall be set on the rigid part of the frame, backwards the location of moving beams.
  - The wiggler shall be aligned from a single position of our 3D measuring system. The lines of sight from the instrument to all the fiducials have to be optimized.
- Provide the coordinates of the fiducial marks with respect to the magnetic axis:
  - The position of the fiducials with respect to the magnetic axis shall be given within the specification of 50µm in accordance with physicist requirements.

5.5.7. The location of the fiducial marks on the static support must be discussed and agreed between the Supplier and the CELLS during the Final Design Review.

6 Electrical distribution and systems specification

6.1 Introduction

6.1.1. The electrical system consists of control panels, racks, power distribution, cabling and wiring containment associated with the system.

6.1.2. All electric or electronic cables from the wiggler should go to an electrical junction box placed at the wiggler static support. The position of the junction box will be agreed between the Supplier and CELLS during the design period.

6.1.3. The racks for the operation of the wiggler will be installed in the Service Area of the ALBA building. The distance between the wiggler and the racks is roughly 20 m. The Supplier is responsible for all the cabling inside the wiggler and inside the racks. CELLS is responsible for the cabling between the wiggler (junction box) to the racks at the service area.

6.2 General Aspects

6.2.1. As mentioned in section 1.2, the Supplier has to provide two control racks, to be used temporary in the factory. Dimensions of each one are 2000 mm high x 612 mm wide x 800 mm deep. The detailed specification of the racks is given in the Appendix.

6.2.2. Equipment should be designed such that it will fit into the area without causing equipment and electrical access difficulties. Adequate space must be available around equipment and panels for safe working access for installation, commissioning and foreseeable maintenance activities.

6.2.3. Enclosures, racks etc shall have an aluminium nameplate on each rack module that shall include the following information (in 14 point size fonts). These shall include the following information:

- ALBA Equipment Tag number (details to be agreed)
- Supplier's name and address
- Enclosure or rack etc number as per designation on drawings and electrical schematics
- Input voltage and current ratings
- Gross weight of the unit
- Date of manufacture
- Blank space to write the TANGO address

6.3 Cabling

6.3.1. All cable and wiring must be LSOHFR (Low Smoke, Zero Halogen, Fire Retardant) unless specifically agreed otherwise, complying with IEC 60754-1 and IEC 60332. The oxygen index must be higher than 28 and acid gas emission less than 4% for the outer sheath. PVC compound must not be used.

6.4 Electrical Safety Issues

6.4.1. Electrical equipment shall be constructed in accordance with best practice and must conform to all applicable CE norms and standards. High voltage components, connectors, wiring terminations, etc. shall be physically separated from low voltage control circuits. Personnel shall not be exposed to high voltages while performing routine service on energised control circuits.

6.4.2. All equipment to go into the Service Area shall be housed in a standard 2000 x 612 x 800 mm HWD rack mount enclosure to IP2X. Enclosure covers shall only be removable with the use of tools. Following the removal of covers to allow access to the internal components, any high voltage conductor (greater than 25 V ac or 60 V dc) shall be shielded against contact to IP2X.

6.4.3. It is anticipated that electrical equipment will not require isolation before personnel access to the storage ring is permitted. To allow this, all electrical equipment must be shielded to IP2X.

6.5 Wiring and Earthing

6.5.1. Each rack module in the Service Area must include the facility to earth the module directly to the rack enclosure (see Appendix).

6.6 Subcontracts

6.6.1. Any electrical subcontracts used shall be familiar with CE electrical installation practices and standards and shall be subject to CELLS approval.

6.7 Thermal Environment

6.7.1. Electrical equipment racks will be located in the Service Area which will have raised floors into which cool air will be supplied. Air will be drawn up through the base of the rack for cooling purposes and exhausted from the top. The racks shall have a temperature stability of ±1 ºC during normal operation although this cannot be guaranteed. The air temperature within the Service Area is expected to be about 23ºC ±1ºC from floor up to 4 m. The Supplier shall ensure that the electrical equipment will operate within specification under the worse case foreseeable conditions.

6.7.2. All equipment shall be capable of operation in an ambient temperature range of 10ºC to 40ºC.The components shall be able to withstand a relative humidity range of 0% to 90% non-condensing.

6.8 Electrical Drawings

6.8.1. Electrical drawings shall be provided in standard format.

6.8.2. Full maintenance information shall be provided, sufficient to locate faults down to individual electronic component level, including but not limited to:

- System block diagram
- System cabling schedule
- Schematics for all units
- Control rack wiring diagrams or schedules
- Sub-assembly drawings including component layout and electrical schematics
- Setting up, calibration or configuration instructions, if required.

7 Control systems and interface

7.0.1. The wiggler will be operated remotely from the users within from the experimental hall.

7.0.2. CELLS will provide the control system. For information only, the software of the control system is described in the Appendix. The hardware and PLC should follow the guidelines given in Appendix.

7.0.3. The supplier should indicate in the tendering at which date the control system has to be implemented on his site.

7.0.4. The supplier should define and built a junction box, attached to the static support of the Insertion Device, as a clear hardware interface between the racks in the Service Area and the Insertion Device itself. This junction box is the physical limit of the Insertion Device from the point of view of the control system hardware.

7.0.5. Cabling between the junction box and the control rack in the service area is not included in the supply, and it will be CELLS responsibility. For the Factory Acceptance Tests, the Supplier should provide the temporal connections between the control rack and the junction box.

7.0.6. PLC's for equipment protection should be agreed with CELLS and programmed by the Supplier.

8 Installation requirements

8.0.1. The installation of wiggler at ALBA site is the responsibility of CELLS.

8.1 Health and Safety Considerations

8.1.1. Before installation commences the Supplier shall supply CELLS with a full risk register for the design and installation and method statements for the installation.

8.1.2. Operating, maintenance and installation instructions must be supplied with the equipment which, if followed, ensures compliance with all the relevant CELLS site regulations/guidelines.

8.1.3. Wiggler has movable parts, so these devices should comply with the CE specifications.

9 Quality assurance and testing

9.1 Quality Assurance Programme

9.1.1. The Supplier shall follow a quality assurance program compliant with ISO-9001 for the design, manufacture and testing of all systems and equipment provided by them.

9.1.2. The Supplier must provide a Quality Assurance document for the supplied equipment, certifying that it conforms to the specification and the supplied engineering drawings, and containing all material certificates, the results of all inspections and tests, and the procedures used.

9.2 General Arrangements for Tests

9.2.1. The tests at the factory and on-site must establish that all items of the manufactured equipment completely meet the performance requirements as described in this specification (see sections 3 and 4).

9.2.2. CELLS will have the right to observe all factory tests. The Supplier shall give at least 2 weeks notice of any test date to allow the necessary travel arrangements to be made.

9.2.3. Testing shall conform at all times to the local safety codes.

9.2.4. CELLS reserves the right to require additional or more extensive tests to be conducted in the event of marginal design or performance.

9.2.5. The Supplier shall formulate acceptance test procedures for all systems and will provide the facility and instrumentation to perform all relevant tests to ensure compliance with this specification.

9.2.6. Additionally, equipment that is free issued to the Supplier and that is incorporated with the design must be used during tests when appropriate. The acceptance test procedures shall include but not be limited to the testing procedures specifically outlined in this document, but also those necessary to prove compliance with this specification. Test procedures must include details of how the tests are set up and performed, and the criteria for acceptance/rejection. The supplier shall present a full Test Plan at the FDR. Included in the plan shall be detailed procedures for the tests, with a list of test equipment and the tolerances of the readings for the relevant parameters. These test procedures are subject to CELLS review and acceptance.

9.3 Factory Acceptance Tests

9.3.1. The following Factory Acceptance Tests must be completed successfully at the Supplier's premises before shipment. The factory tests must demonstrate all aspects of the control system, power supplies and the interlock electronics, with special attention given to

- Measurements of magnetic field maps of field components by means of suitable probes and methods. Measurements shall be made at central plane at the following gaps; 12.5, 14, 16, 20, 25, 50, and 100 mm (or maximum gap) and gap corresponding to K2. Field maps must consist of points at X = 0 to ±20mm, with a longitudinal point spacing of 0.5 mm and a horizontal point spacing of 2 mm.

- First and second field integral. Maps of field integrals should be done at central plane at the following gaps; 12.5, 14, 16, 20, 25, 50, and 100 mm (or maximum gap) and gap corresponding to K2. The transversal horizontal separation of integral measurements should be 1 mm.
- Integrated multipoles (normal and skew integrated quadrupoles and sextupoles)
- The results of the measurements must be analysed and compared directly to the specification of section 3. Measurement errors and reproducibility must also be evaluated by repeating the field map measurement at both minimum gap and gap corresponding to K2.

9.3.2 Within the tender documents the tenderer should provide the list of the tests which are normally foreseen for the factory acceptance test. The list should include mechanical tests to be done by the Supplier to guarantee the right performance from the mechanical point of view (functional system, deformation of magnetic beams, measurement of the accuracy of encoders, measurement of electrical system, etc).

9.4 Site Acceptance Tests

9.4.1. After delivery to CELLS, CELLS will carry out magnetic measurements of the first and second field integrals as well as phase error measurements to prove that the integrity of the device has been maintained.

9.4.2. For purpose of issuing the final payment, the acceptance of the device is defined as the successful completion of site acceptance tests to substantiate the compliance with this specification.

9.4.3. The site acceptance tests will probably not take place in the storage ring building.

9.5 Final Acceptance Tests

9.5.1. For purpose of warranty, the final acceptance of installation is defined as the successful completion of acceptance tests after installation in the storage ring to substantiate the compliance with this specification.

9.5.2. It will be a condition of final acceptance that the Contractor must have provided to the satisfaction of CELLS, full documentation as noted throughout this specification, to cover all systems embodied within this contract.

10 Tendering

10.1 Pre-tender Clarifications

10.1.1. If interested Suppliers do not fully understand the requirements and implications of the specification or some doubt exists as to its interpretation then they should contact CELLS to obtain clarification.

10.1.2. Enquiries of a technical nature should be directed to:

Dr J. Campmany
Email: campmany@cells.es
Telephone: +34 93 592 43 44

10.1.3. Enquiries of a contractual nature should be directed to

Mariano Sazatornil
Administrative Division Head
Email : alba.concursos@cells.es
Telephone: +34 93 592 43 54

10.1.4. Postal address:

Projecte Sincrotró ALBA
Consorci per a la Construcció, Equipament i Explotació del Laboratori del Sincrotró (CELLS)
08193 Bellaterra – Cerdanyola del Vallès
Barcelona, Catalonia (Spain).

10.1.5. If such a clarification results in a modification of the specification or other tender documents then this information will be distributed to all interested Suppliers.

10.2 Tender Evaluation

10.2.1. CELLS will evaluate the bids taking into consideration the cost, the technical aspects, Management plan and delivery time along with proponent qualifications, post-production support, the proposal itself as well as any other factors that CELLS may consider appropriate to its evaluation, as detailed in the Folder of Administrative Clauses.

10.3 Information Required with the Tender

10.3.0.1. The Supplier shall provide with the tender documents sufficient information to allow an informed choice of Supplier, as detailed below. It is essential that this information, provided with the Invitation to Tender documents, accompanies the tender response. In the absence of this information the bid may be rejected as non-compliant.

10.3.0.2. In particular, the proposal should include:

10.3.1 General outline

- A table of contents of all presented material.
- A confirmation of acceptance, or otherwise, of every clause of the present specification.
- A Fabrication Plan, with an outline schedule, showing the principal design, ordering and manufacturing, testing, installation and commissioning phases of the principal components, along with a list of proposed milestones for design / progress verification.
- Responses to specific questions and assessments asked in this proposal (see for instance paragraphs 1.4, 3.1.4., 3.4.5, 3.6, 4.2.11, 4.3.4, 4.3.5 and 4.3.6). The proponent should clearly indicate any section that cannot be met in its entirety.
- A summary of any value-added services that can be provided.
- Proponent should include a minimum of two (2) reference or similar contracts, to include: company name, contact name, title and email or phone number. References should be provided for subcontractors or third party proponents of the work.

10.3.2 Management plan and proponent qualifications

- Details of the Quality control protocol that the Supplier will apply
- A list of previous similar or comparable projects, in size and scope, to enable CELLS to assess the Supplier's ability, experience, competence and reliability to accomplish the contract.
- List of proposed personnel, corresponding job and function, title and experience required to handle the works included in the contract.
- List of proposed work packages.
- Clear indication of the effort that CELLS has to dedicate to install the wiggler at the ALBA site, including the number of staff and the time to be spent.

10.3.3 Engineering and Manufacturing Information

- The preliminary design including: full description, and technical and economic justification.
- Basic details of the magnetic system including the holders, and methods for assembly and fixing etc.
- Details of proposed power converters for correctors and their ratings, if included in the deliverables.
- Outline proposal for the method of fiducializing the reference surfaces/holes to the magnetic axis.
- Details of equipment and infrastructure that will be used to carry out the factory acceptance tests.

10.3.4 Capital cost Breakdown

10.3.4.1. A breakdown of costs into the following categories:

- MPW80 construction and testing including deliverables specified in section1.2
- Cost of additional items listed in section 1.4 that may be included in the deliverables.
- Cost of essential spares to be supplied as part of the contract.

10.3.4.2. Costs should be provided in Euro (€), and should include insurances, permits, licenses, fees, miscellaneous charges and any additional cost that should be paid by CELLS. Taxes should be shown separately if applicable.

10.3.4.3. Payment schedule, invoice payment terms, and other relevant issues regarding payments should be clearly specified in the quotation.

10.3.5 Services and Running Costs

- Details on availability, costs and lead times of spares, and possible future obsolescence of any components.
- Additional equipment or facilities required.
- A breakdown of electrical power requirements, including UPS if needed.
- A maintenance schedule if needed.

10.3.6 Delivery and Installation

- Details of the proposed delivery arrangements.
- Description of any handling requirements during installation, testing and commissioning
- Details of the largest dimensions and weights of individual components to be installed

Accelerator Division

APPENDIX

TO THE

TECHNICAL SPECIFICATION FOR LOT 1

GOVERNING THE CONTRACT FOR THE SUPPLY OF THE CONVENTIONAL MULTIPOLE WIGGLER MPW-80 FOR X-RAY ABSORPTION BEAMLINE AT THE ALBA SYNCHROTRON LIGHT LABORATORY

Specification of :

Control System

Hardware guidelines

Control racks

14th of June 2007

Table of Contents

1. Control systems and interface

2.1. General

2.1.1. The insertion devices will be operated remotely.

2.1.2. Alba's control system is currently based on Suse Linux (currently Suse10.2, kernel 2.6). Alba will provide a Compact PCI and the operating system will be installed by Alba.

2.1.3. The IOC is connected to the Alba network (Ethernet 100BaseT or 1000BaseT). The preferred remote control link for eventual subsystems is Ethernet (this is the case for the motor controller). Other filed buses like RS485, RS232 and GPIB can be used under certain conditions.

2.1.4. Alba uses TANGO as a toolkit to build the control system, and therefore the devices will be remotely configured, monitored, and read from Tango device servers. TANGO has first been developed at the ESRF (Grenoble, France) and now it is a collaboration between four institutes (ESRF, Soleil located near Paris/France, Elettra at Trieste/Italy and ALBA.

2.1.5. Control system for motors will be written at Alba and provided to the supplier. It will be installed in the CPCI crate. Tango will not be needed for basic test in the factory.

2.1.6. The Bidder is responsible for the integration of the different subsystems (i.e. power supplies, eventual cryogenic and vacuum systems), interlocks, and temperatures.

2.1.7. The Bidder shall provide a well documented protocol for the remote control of the different subsystems. Example programs shall be included.

2.2. Hardware architecture

2.2.1. The following figure 17 shows the hardware architecture diagram for the ID control.

2.2.2. Alba will provide a Compact PCI and a motor controller with the necessary software for controls.

2.2.3. The supplier must define and implement signals and logic for interlocks to ensure correct and safe operation of the device. These shall be managed by PLC. The supplier is responsible for the design of the logic in the PLC. The supplier shall also provide fully documented source code and development tools to CELLS. The structure of the interlocks must be proposed by the supplier and agreed by CELLS. Choosing a solution without PLCs although is not preferred would be possible under certain conditions after agreement with CELLS. Technical reasons for the choice shall be documented.

2.2.4. Temperatures are read from a PLC. CELLS will inform the bidder about the preferred model of the PLC. The final choice shall be agreed with CELLS.

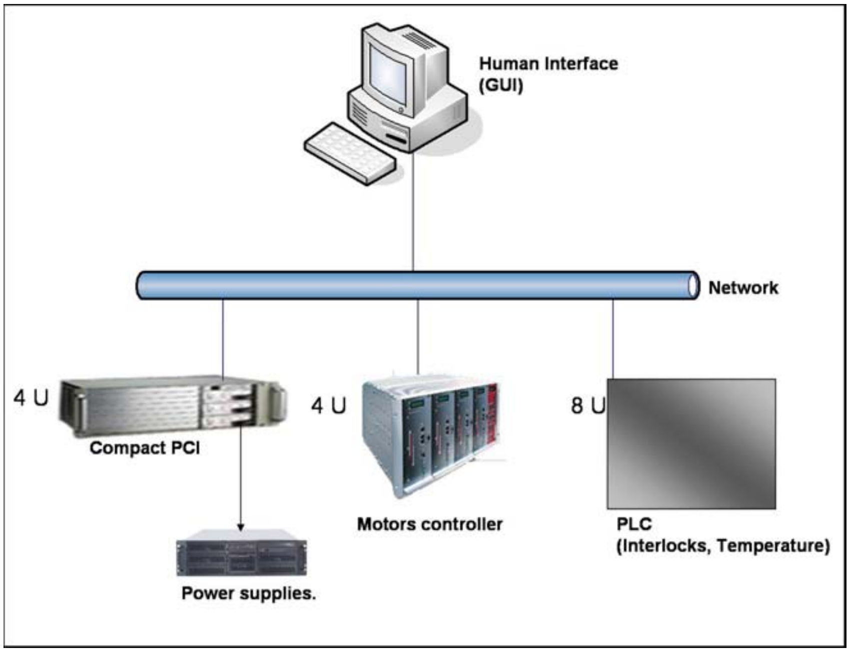


Figure 17. Proposed hardware architecture

2.2.5. IOCs, motor controller and PLC are connected to the network. Human–machine interfaces (monitor, control and archiver) will run in the control room and will access to IOCs through the network. For acceptance tests, the Human interface will run in a computer connected to the network (but not necessary in the control room).

2.2.6. The standards of connectors and signals shall be agreed during contract discussion.

2.2.7. The equipment will be installed in ALBA service area, in two racks, one dedicated to power units and the other dedicated to control. A sketch if given in figure 18.

2.2.8. Two racks (600 mm width, 800 mm depth) should be provided by the supplier for temporary installation in the factory. Racks will not be delivered to CELLS. Figure 18 shows an example.

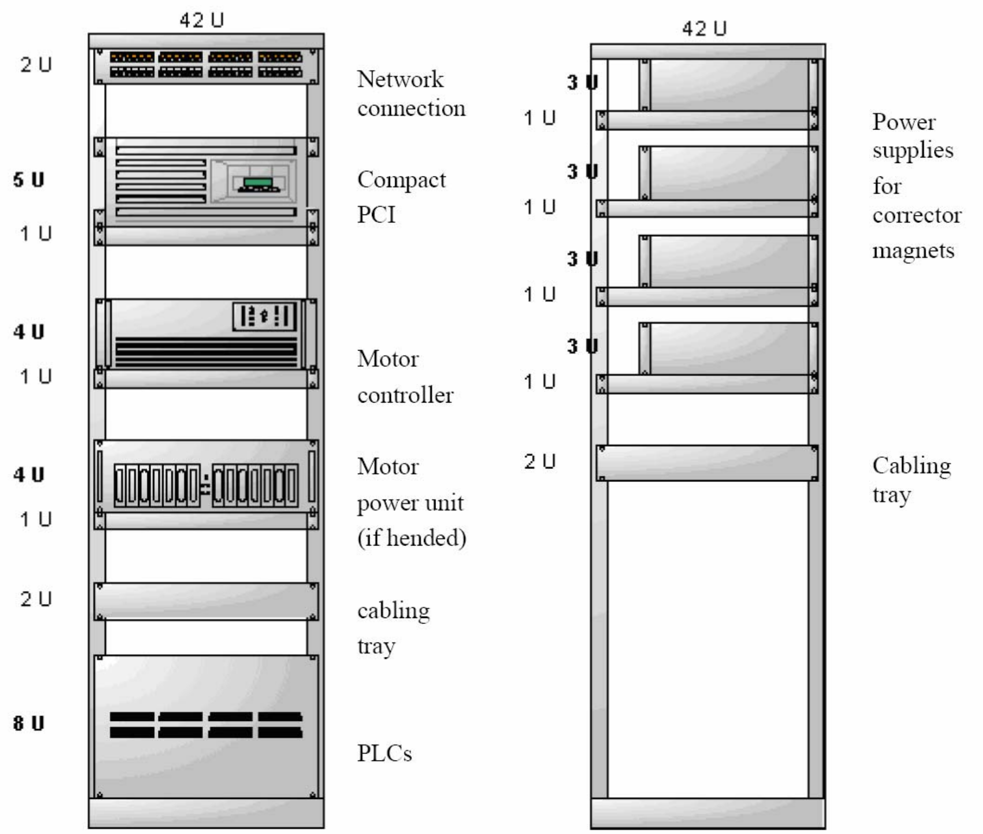


Figure 18. Sketch of control equipment location inside the racks

2.3. Software architecture

2.3.1. From the software point of view (see Figure19), the architecture is distributed, and the final system will be integrated in a Tango control system. As mentioned before (see 2.1.5), Tango will not be needed for basic test in the factory.

2.3.2. The wiggler will have a motor controller server for any axis. Alba will provide a standalone tool to control the motors.

2.3.3. The Power supplies will be controlled through a field bus. Alba will provide a standalone tool to control the power supplies.

2.3.4. The monitoring software of the interlocks has to be proposed by the supplier and agreed by CELLS.

2.3.5. The temperatures of critical locations have to be monitored. These monitors should be connected directly to the PLC. The supplier has to propose the number and location of monitors which is to be agreed with CELLS.

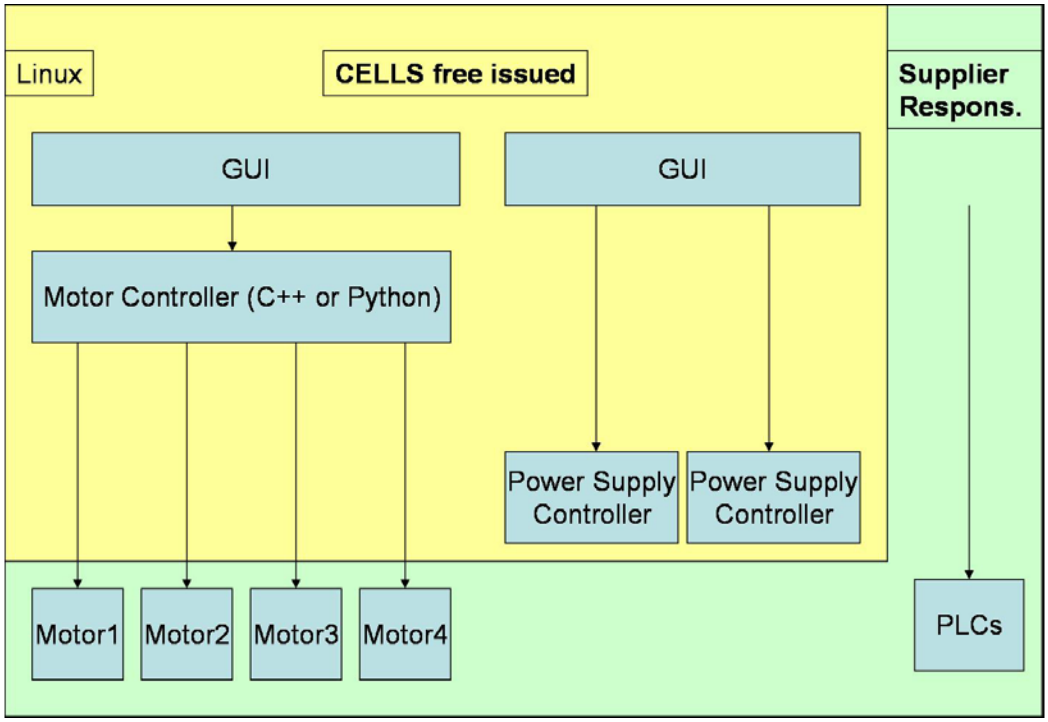


Figure 19: Proposed software architecture for factory test (in the case there are 4 motors).

Hardware standards

3.1. Motion control

Alba prefers 2 phases stepper motors. Motors used for motion control shall be compatible with the specifications given in this document. Any derivation from these standards must be explained and agreed with CELLS. In the case the supplier proposes other type of motors, drivers for motor control shall be also included in the offer. Motor drivers shall have an step-direction interface.

3.1.1. Motor phases and signals pinout.

The motor connection (including the limits switches) will be with metallic compatible ITT cannon 14-12 pin male. The following picture (Figure 20) shows the pin out of this connector, and an example is TNM OU 1400-12P1L. If a four phases motor is used, the phases will be connected in series or in parallel in agreement with the CELLS staff.

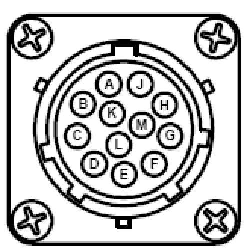
Connector	Pin	Signal	Description
	A	Home	Mechanical reference
	B	Phase A+	Motor power
	C	Phase A-	
	D	n/c	
	E	Phase B+	Motor power
	F	Phase B-	
	G	n/c	
	H	Limit switch+	Travel limit
	I	Limit switch-	
	J	Disable	Remote disable
	K	+5 V power	Auxiliary power supply
	L	GND	

Figure 20: Motor phases and signals pin out

CELLS has defined a color code for the motor cables.

Motor phases:

- phaseA+: yellow
- phaseA-: green
- phaseB+: white
- phaseB-: brown

Motor signals:

- GND: black
- Disable: pink
- Limit+: orange
- Limit-: blue
- Home: grey

- +VCC: red

The motor cable to the control system will be a shielded [2x(2x0.75 mm2)+(6x0.34 mm2)], and it will be provided by ALBA.

The motor controller could deliver a maximum power of 330 W, with a maximum current of 8 A and maximum voltage of 78 V.

3.1.2. Motor brake

A motor brake signal will be delivered by the motor controller. This signal is LVTTL.

3.1.3. Motor encoder pin out.

The relative encoders will be with a 15 pin sub-D male, with a pinout showed in the following picture (Figure 21).

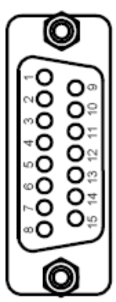
Connector	Pin	Signal		Type/Direction	Description
		Incremental	SSI		
	1	EncIn A+		RS422	Encoder Signal
	9	EncIn A-			
	2	EncIn B+		RS422	Encoder Signal
	10	EncIn B-			
	3	EncAux+	Data+	RS422	Auxiliary Encoder Signal
	11	EncAux-	Data-		
	4		CLK+	RS422	Clock SSI Interface
	12		CLK-		
	5			n/c	
	13			n/c	
	6			n/c	
	14	5V sense+			Sense signals
	7	5V sense-			
	15	+5 VDC power		power supply	Auxiliary Power Supply
	8	GND		power ground	

Figure 21. Enconder pinout

The signals for the encoder signals will be RS422 standard.

If an absolute encoder is used, only SSI protocol is supported. Other protocols have to be agreed with CELLS staff. The SSI protocol has a clock signal provided by the controller in pins 4 (CLK+) and 12 (CLK-), and the data signal will be in the pins 3 (DATA+) and 11 (DATA-). The signal levels are always RS422 standard.

The encoder cable to the control system will be a [4 (2x0.14 mm2)+(4x0.5 mm2)].

The preferred option is to receive digital signals from the encoder, but if the output is analogue, it shall be 1 Vpp differential. The supply voltage for the encoder shall be 5 V. The pinout shall be agreed with CELLS.

3.1.4. Limit switches.

The limit switches could be either dry-contacts, or active with a open drain output.

3.2. Signals.

Whenever possible, fast digital timing signals (electrical) interconnecting modules or devices should use LVTTL logic levels, capable of driving 50 Ohms cables with RC loads. Other logics like NIM or PECL will be also supported. The standard connector is a compatible with the Lemo Series 00 of contact type female.

Regarding optical signals, it will be supported the HFBR-1528 and HFBR-1414 (high speed) optical link outputs.

For analogue control signals 4-20 mA or ±10 V shall be used. As both signals have their advantages and disadvantages, the final selection shall be done in agreement with ALBA

For control, 24 VDC shall be used for digital signals (with unshielded twisted pairs ([2x0.5 mm2)]). The usage of 48 VDC or AC signals is not acceptable.

The preferred connectors are 50 Ohms BNC female connectors (panel or feed through) (with RG58 cables), or compatible with the Lemo Series 00 (with RG174 cable). High frequency signals will be connected with SMA (with RG223) or N connectors. Also screw clamp connectors, DB 9 or DB25 could be used. Other connectors like miniDIN or multipin Lemo compatible connectors have to be agreed with CELLS.

Application where maximum RF shielding and minim noise radiation is required, triax connectors and cables could be used. The triax connector (like triax BNC or any Lemo) has to be agreed with CELLS.

When video signals are transmitted, the connector will be 75 Ohms BNC female panel connectors (with RG59 cable).

Interlocks and controls should be designed to be failsafe.

1. A safe state shall be indicated by a closed contact sending +24 VDC signals.
2. An unsafe state shall be indicated by an open contact that blocks the +24 VDC.
3. On power failure, the system should indicate an unsafe state.

3.3. High voltage

The high voltage signals will be defined when the controller and pumps will be chosen by the vaccum group. The cable will be connected with something like the RG213 or the HTC-50-3-2 from Draka (up to 10 A).

3.4. CompactPCI/PCI

CompactPCI and PXI equipment shall be compatible with the specification PICMG 2.0 R3.0. All the equipment shall be 3U, although 6U boards could be used if necessary.

CompactPCI crates will be used in favour of PXI crates. The rear I/O will not be used in our systems.

The PCI (and the PCIe) bus will be also supported. The selection of PCI or cPCI systems will be decided for any specific application according to the needs.

3.5. NIM

All NIM bins will supply ± 6 VDC. The delivered power is 150 W.

3.6. Fieldbuses

For connecting any controller to the control system, ALBA prefers the following controller interfaces in the order given below:

1. TCP/IP over Ethernet
2. RS-232 / RS-422
3. GPIB

Other interfaces than the three interfaces listed above shall not be used.

3.7. Grounding

All connectors or connection points and internal cabling provided by the supplier shall be EMC compatible and mounted on metallic patch-panels. Those panels shall be electrically and mechanically connected to the equipment according to the EMC recommendations.

The equipment (girders or vacuum components) shall provide, either foot or top side, two holes, one M8 and the other M10, both 15 mm deep. The M8 hole shall contain the appropriated screw to fix a terminal spade, crimped with either a bared copper 29 mm^2 cable or a green/yellow jacket isolated copper 25 mm^2 cable according to the current country safety rules. This cable shall be connected directly to the ground (or on the cable tray ground) according to the current safety rules. The M10 hole shall contain the appropriated screw to fix a terminal spade, crimped with an EMC ground strap. This EMC ground strap shall be connected to the closest ground (or massif equipment connected to the ground eg Cable trays), to be ECM compatible. The EMC ground strap shall be copper laminated or braided but it shall be completely tinned to provide corrosion resistance. The EMC ground strap shall be 50x5 mm^2 or with a maximum length shorter than 13 times the width.

This electrical connections are required when the device are not electrically connected. If a girder and a magnet are electrically connected through the mechanical connections, they could be considered a single equipment, and any electrical connection is required between them.

2. Rack specifications

4.1. IP Protection

All the facility space is considered a safe environment. Due to this no IP protection will be requested for the cabinets.

4.2. Dimensions

The cabinet will handle standard 19’’ racks according to DIN 41494/IEC 297 (see Figure 22).

The dimensions of the cabinet should be 2000x600x800mm^3. It can be considered a slight variation in the height although it is required that 42U units of electronic equipment can be installed.

The cabinet will need to have supports in order to stand directly on the concrete floor and not on the false-floor of the facility. These supports shall be provided by the contractor. The external envelope of the ensemble shall be defined by the side walls of the rack (i.e. the supports shall not stick out). The total height of the false floor is 500mm. The cabinets and/or the support shall have some mechanism to balance the height of the feet so little irregularities of the floor could be compensated and the racks can be properly aligned.

The rack and its supports must be mechanically fixed to each other in order to guarantee safe operation. The method proposed shall guarantee that no mechanical interference arises between adjacent racks and allow for safe rack operation.

The eventually fixation of the racks to the floor shall allow for errors in the position of floor drilled holes of ±10 mm.

The supports shall be considered as an integral part of the rack. CELLS strongly prefers that the supports can be dismount from the racks. The contractor will have full responsibility on the functionality of the ensemble rack-support.

All the cabinets shall be supplied with eye holders. They will be used for the installation of the cabinets inside the facility using the crane that is available inside the facility.

4.3. Total Weight

The maximum weight of the rack including the installed electronically equipment 400 kg**.**

All the cabinets shall be supplied with four eye holders. They will be used for the installation of the cabinets inside the facility using a crane.

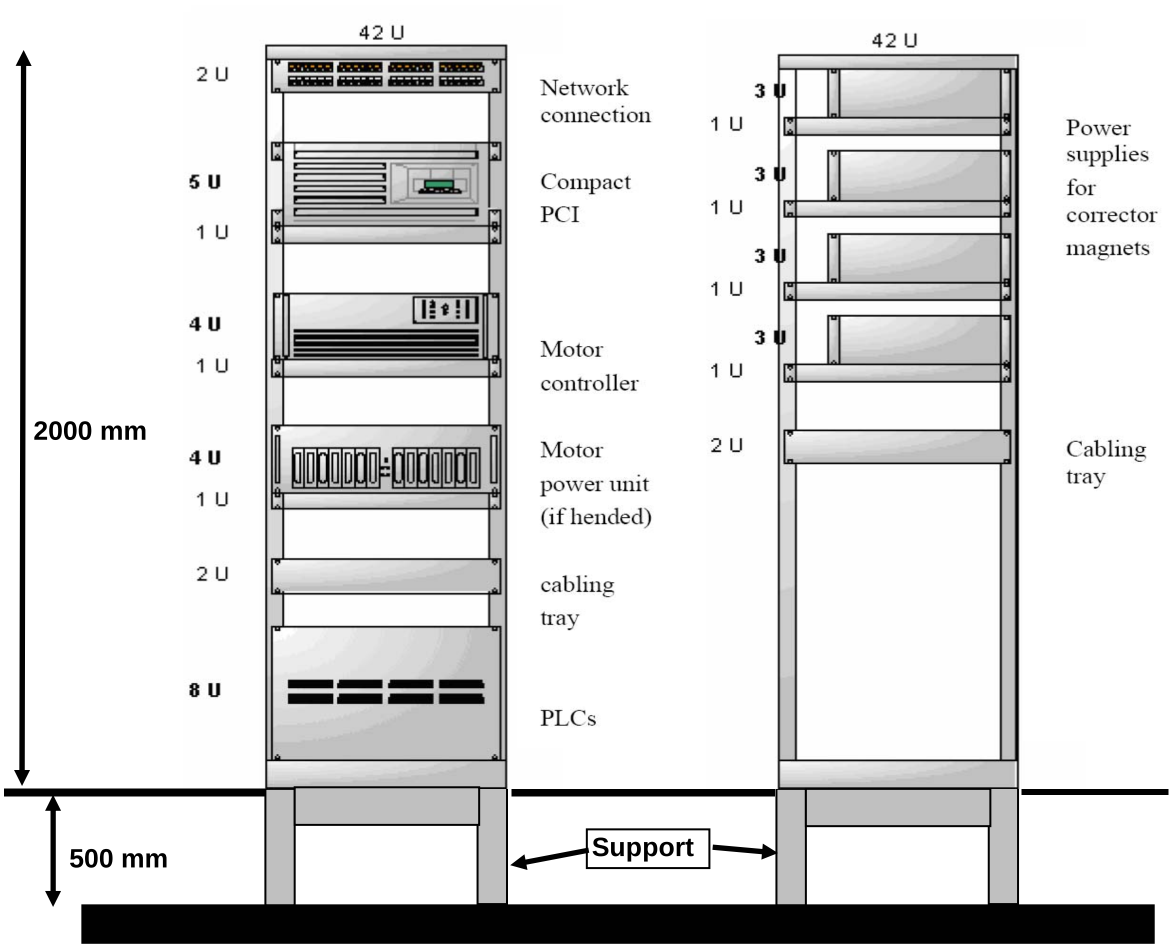


Figure 22. Lay out of the cabinets with the supports dedicated to ID control

4.4. Accessory Trays

There will be three types of fixing that will be used to handle the equipment inside the cabinet:

1. Slide Rails – Used for "light" 19'' standard equipment whose weight will not be bigger than 25kg. This support has to occupy a maximum of 1U in the cabinet and the vertical space that uses has to be available for the equipment.
2. Light Shelf – In this support it will be installed "light" non standard 19'' equipment. It has to support a maximum weight of 25kg.
3. Heavy Shelf – In this support will be installed the heavy equipment. It has to support a maximum weight of 75kg.

None of these accessories shall be telescopic.

4.5. Cable Routing

All the cables from the outside of the cabinet will enter through the bottom side of the cabinet to cable trays. Special brush accessories will be needed to ease the route of these cables. The general policy will be that the main cable routing will be done in the rear side (see Figures 23). In order to do this the equipment installed in the cabinet will be fixed as close as possible to the front door producing a valuable space for routing cables in the rear side. In order to fit the cable trays the distance between the two vertical axis (front and rear) shall be the distance most next to 450 mm without exceeding it. And the distance from the front axis to the door shall be 100mm. Finally the total length from the rear axis to the rear door will be 250 mm (see Figures 23).

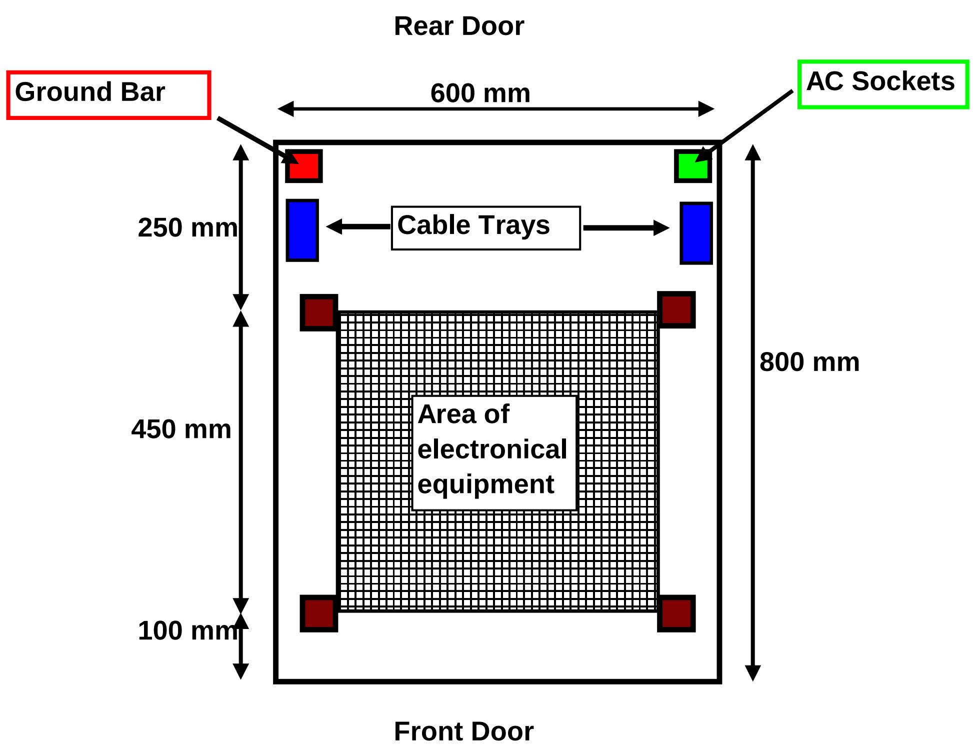


Figure 23. Rack layout.

In the rear side it has to be installed two vertical cable trays in order to route all the cables. The lengths of the trays have to be as large as possible.

In the front side the vertical cable management will be done using little cable hoops that have to be fixed in the front axis or in any part of the cabinet but not in the side panel. This cable hoop section has to be larger than 10 cm^2. Little plastic parts of very easy mounting will be preferred (no screw).

In some cases a horizontal cable distributor accessory is needed to route the cables from the equipments to this cable hoops.

Also it will be needed a cabling guide tray in order to route the cables from the front to the rear side. For every cable tray will be reserved a maximum space of 2U.

The contractor is invited to suggest any extra accessory that would improve the cable management inside the cabinet.

4.6. Doors and side covers.

The cabinets have to incorporate a door in the front and the rear side. It shall be used a glazed doors on the front and a steel door in the rear side. The doors should be equipped with a button for opening.

4.7. Fan System

In the case of the racks that will be installed with glass doors it will be needed to be installed a fan system in order to ventilate the cabinet. This system has to be installed in the top of the cabinet without occupying any U and without affecting the exit of the cables. The system has to be operated at 220V.

The preferred system would be a modular one with 1, 2 or 3 fans. Each fan should have a minimum flow rate of 120 m^3/h.

The contractor is invited to suggest any other solution that would improve the ventilation inside the cabinets that uses glazed doors.

4.8. Grounding System

All the electronically units of the cabinet shall be connected electrically to the general ground. In order to do this connection all necessary accessories shall be provided by the contractor. Moreover a standard M8 general ground connection of the cabinet shall be provided to connect the cabinet to the facility ground.

The cabinet has to provide also a general earth connection to the equipment. This connection has to be done from the bottom side. For doing this connection properly two connections of ground shall be possible: the first one is the direct contact of the equipment to the metallic axis of the cabinet, and the second one is using a ground bar that has to be installed vertically in the rear side next to the cable trays. This bar shall include some metric holes (preferably M6) in order to connect each individual equipment ground.

It is also necessary to have the possibility to shield individual cables to the cabinet (like shielding brackets). In this case one accessory have to be provided for connecting the shield of different control signal cables (Ø up to 15mm) directly to the cabinet.

4.9. Socket Strips

The AC distribution of the equipments has to be smartly connected using socket strips installed inside the cabinet in the rear side. These sockets should be installed vertically beside the right cable tray.

The sockets have to be standard Schuko connectors (DIN 49440) and the socket strip will need to be connected also in a standard Schuko connector. The total number of sockets inside a cabinet has to be greater or equal than 16. The maximum number of strips that have to be possible to be installed inside each cabinet has to be at least 24. The socket strips have preferably to have installed a thermal magnetic breaker and a main suppression noise filter. The sockets should not have a manual on/off switch and allow a connection of equipments up to 16A.

It has to be possible to distribute inside one cabinet two different AC sources (8 plugs each minimum).

At ALBA there are four different types of electrical supplies, which will be identified by colour codes. The contractor will receive the detailed information on the colours to be used for the sockets of each rack during the initial stages of contract execution. Each rack will receive a maximum of two different types of supply (i.e. colours for the sockets), among the total of FOUR types of supply (i.e. colours for sockets) existing at ALBA.

4.10. Units marks

In the front side of the cabinet has to be installed labels all along vertical axis that indicates the height in U units from 1(bottom) to 42U(up).