



2021_I

First proposal call for Nótoç beamline



GOBIERNO
DE ESPAÑA

MINISTERIO
DE CIENCIA, INNOVACIÓN
Y UNIVERSIDADES



UNIÓN EUROPEA

Fondo Europeo
de Desarrollo Regional
"Una manera de hacer Europa"

Nóτος Team



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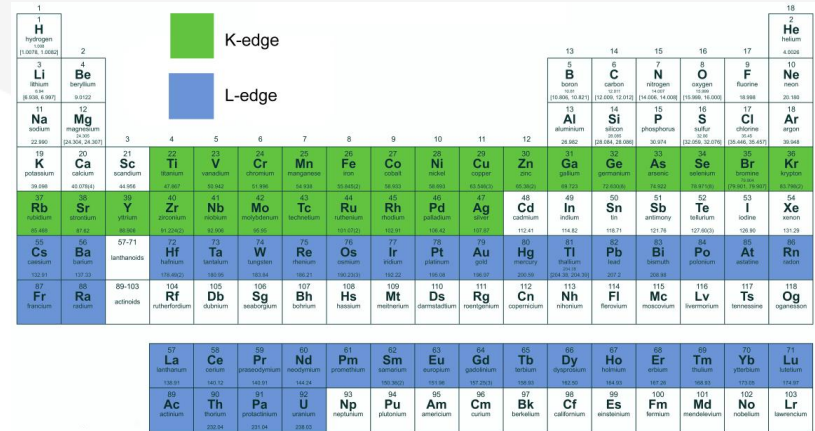


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Nóτος : description

Scientific case

- Hard X-ray beamline
- Multi-activities capabilities:
 - X-rays Absorption Spectroscopy (XAS)
 - X-Rays Diffraction (XRD)
 - metrology applications
- Study of the electronic structure, short (XAS) and long range order (XRD):
 - chemistry
 - catalysis
 - energy science
 - nanomaterial and condensed matter
 - environmental science
- Focused on *in situ* and *operando* measurements on heterogeneous catalysis and electrochemistry
- Tests and improvement of high precision mechanical components, performances of detector systems, carrying out new methodologies and concepts to improve beamline instruments

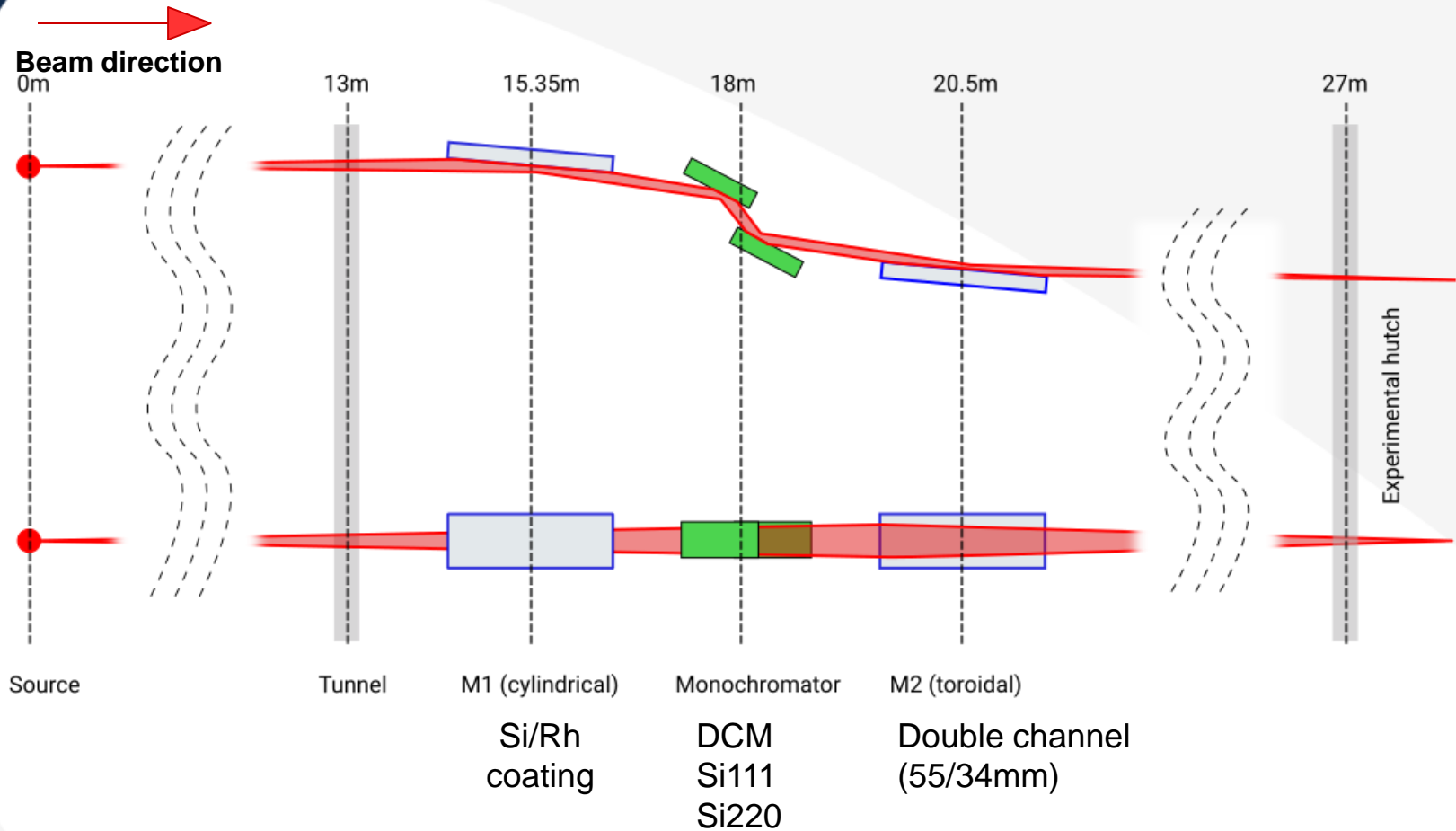


The periodic table shows absorption edges for various elements. The K-edge is highlighted in green, and the L-edge is highlighted in blue. The table includes element symbols, atomic numbers, and names.

Main features

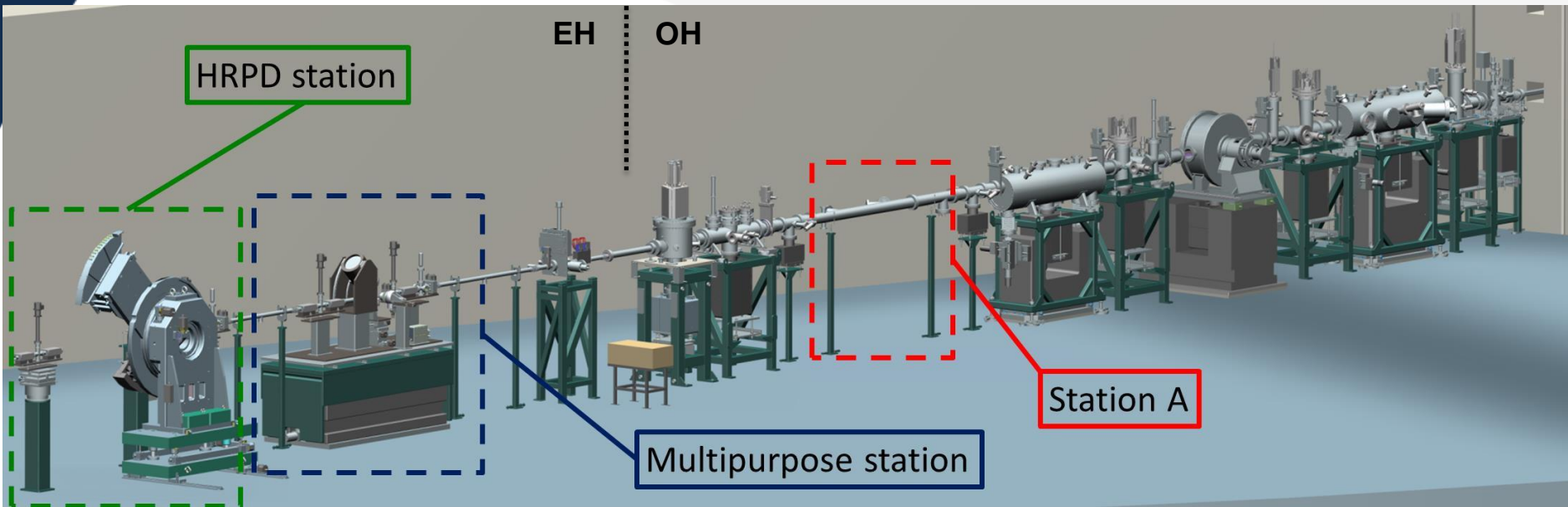
- Energy range **4.5 -30 keV**
- Minimum photon flux: **10¹¹(ph/s)**
- Harmonic rejection **<10⁻⁴ (Si111)**
- Spot properties on sample:
 - For the metrology station about 100x100 μm²
 - For the PD/XAS station: between 100 μm and 3 mm, in horizontal.
 - Vertically, it should be about 1 mm
 - Vertical collimation of the beam on sample better than 20 μrad FWHM.

Nóτος : Optical layout



- M1 cylindrical dynamic meridional bent mirror for collimation
- Fixed exit Double Crystal Monochromator
- M2 toroidal dynamic meridional bent mirror for focusing

Three Experimental End stations

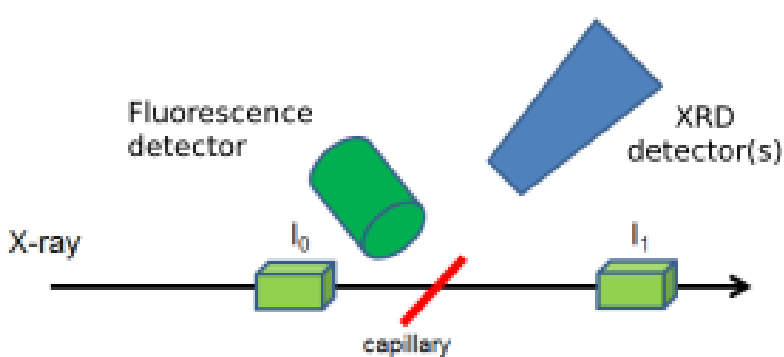
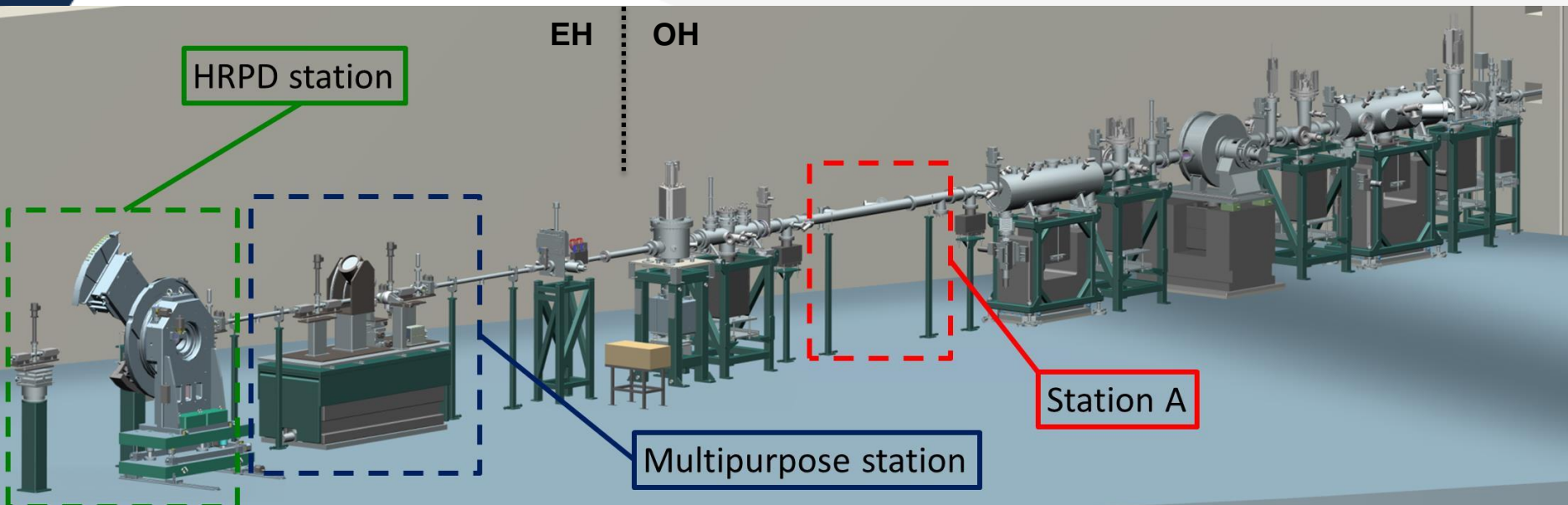


HRPD-XAS station in EH:
High Resolution PD measurements equipped with a two circles diffractometer and a 10-channel Ge(111) analyzer with the possibility to combine them with XAS measurements.

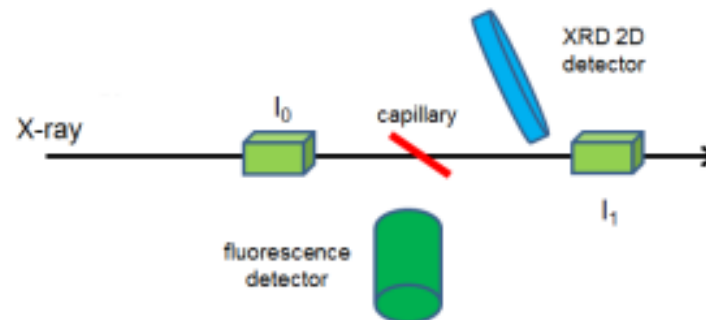
The **multipurpose station** in EH: XAS investigation in transmission and fluorescence mode, fast PD measurements, combination of PD and XAS experiments and metrology measurements.

Station A in OH: 2 m length free space suitable to test equipment for metrology activity

Three Experimental End stations

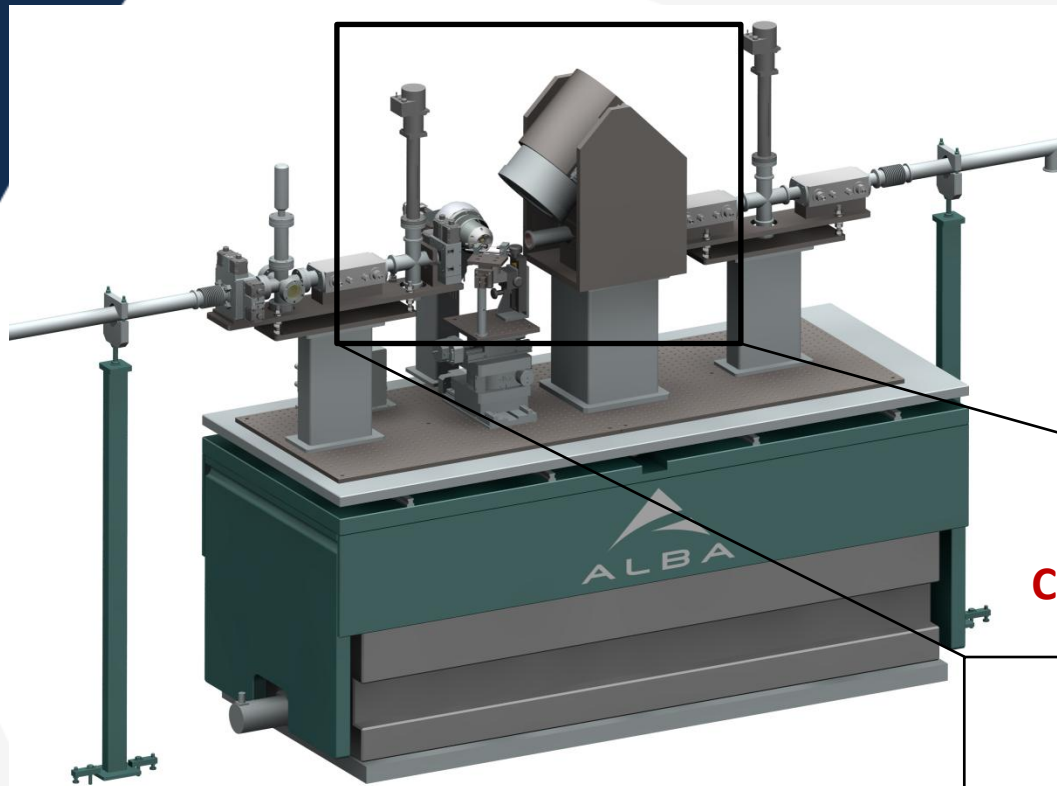


HRPD-XAS station in EH: High Resolution PD measurements equipped with a two circles diffractometer and a 10-channel Ge(111) analyzer with the possibility to combine them with XAS measurements.



The **multipurpose station** in OH: XAS investigation in transmission and fluorescence mode, fast PD measurements, combination of PD and XAS experiments and metrology measurements

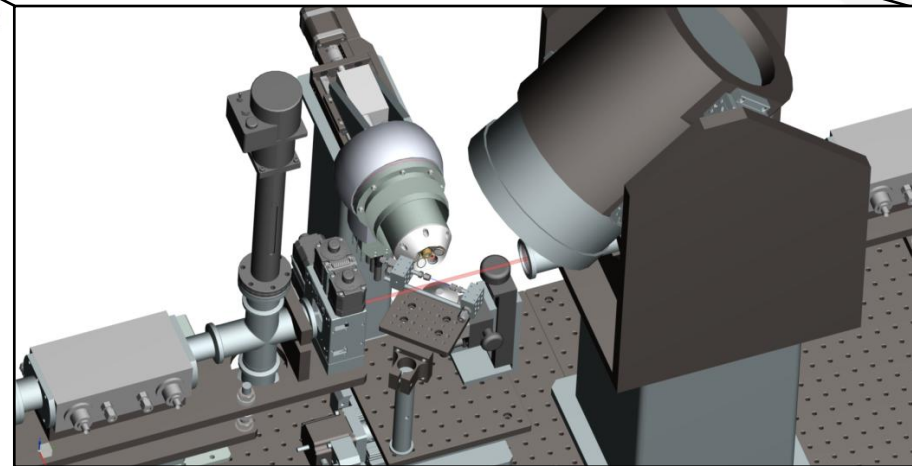
Multipurpose station



Requirements of the station:

- **Flexible** and **open space** for metrology activity and for XAS and PD experiments
- Define standard configuration for XAS and PD measurements

Concept design



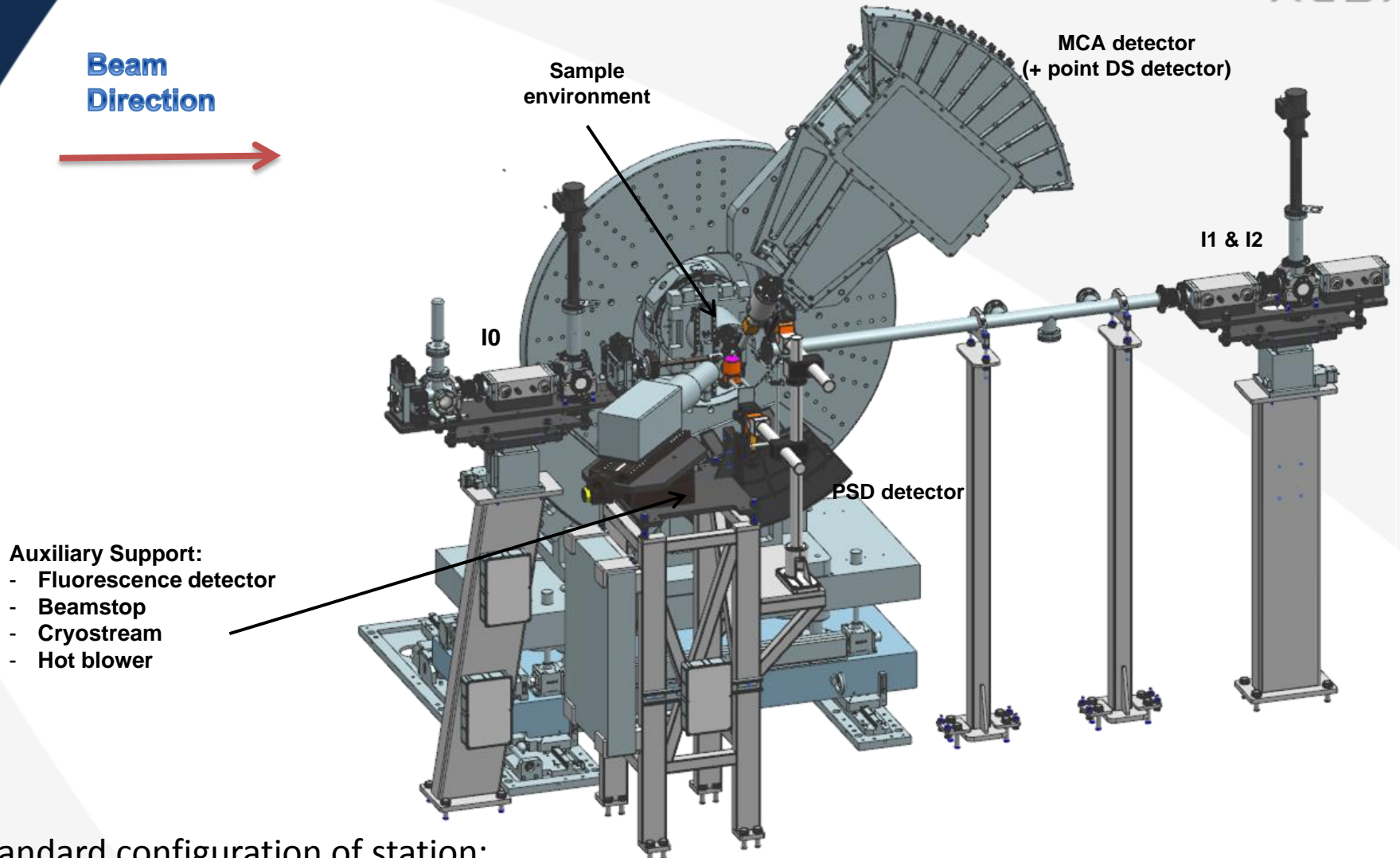
Standard configuration for XAS and PD:

- 3 ion chambers for XAS measurements in transmission
- Multi-channel SDD 90° with respect X-Rays beam
- 2D detector for PD measurements
- Motorized stage at sample position

Not available in 2021-I

Expected for September 2021

HRPD & XAS station



Standard configuration of station:

- **two circles diffractometer** and a 10-channels Ge(111) analyzer
- **Position sensitive detector** for PD
- **3 ion chambers** for XAS measurements in transmission

Capability of NOTOS for the call 2021-I



Optical performance

Energy range: 7-23 KeV

Energy resolution: $\Delta E/E < 5E^{-4}$ with Si(111)

Number of Photons on the sample: $> 5E+9$ ph/s at 20 keV (250 mA)

Beam size: horizontal 0.5 - 5 mm (defined by slits), vertical: down to 0.5 mm

Working geometry: PD: transmission, XAS: transmission

End station available: **HRPD-XAS**

Sample environment:

PD: capillary; XAS: cell for self-supported pellet for transmission measurement

Temperature of sample:

PD: Cryostream (100-450 K) and Hot Blower (RT to 950 °C); XAS (RT to 550 °C)

Only inert gas and 20%O₂/He will be available

Few days will be available in the next semester



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Scheduling of development

- Silicon Drift Detector for XAS: **July 2021**
- PSD detector for PXR: **September 2021**
- Focusing mirror M2 : **September 2021**
- Multipurpose endstation : **September 2021**
- Gas system for reactive gas: **November 2021**
- Capillary setup for operando experiment: **November 2021**

Optical performance

Energy range: 4.5-25 KeV

Energy resolution: $\Delta E/E < 2E^{-4}$ with Si(111)

Number of Photons on the sample: $> E^{+11}$ ph/s at 20 keV (250 mA)

Min. Beam size: 100 μm x 100 μm

Working geometry: PD: transmission, XAS: transmission & fluorescence

End station available: **HRPD&XAS + Multipurpose stations**

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<https://www.cells.es/en/beamlines/bl16-notos>

In the Autumn meeting to receive a feedback for experimental setup/reactive gas system will be organized

Time for questions/comments!












Νότος

2021_I

First proposal call for Νότος
beamline

(extra slides)








Reactive gas system for Nóτος

Gas (Purity and volume)	Proposed concentration	Condition requested by expert users			Connect or / Injection	Safety	Comments (dedicated gas line or not and installation inside or outside gas cabinet)
		$[c]_{max}$ during reaction	P_{range} (bar)	T_{max} (°C)			
H ₂	100%	100%	1 - 80	800	E		Dedicated Gas line (always available) / IN
CO ₂	100%	30%	1 - 80	950	C		Dedicated Gas line (always available) / OUT
O ₂ ^a	20%	20%	1 - 5	400	M		Dedicated Gas line (always available) / OUT
Synthetic air	100%	-	-	1000	B (?)		OUT
CO	100%	50%	1 - 50	450	E		Dedicated Gas line (always available) / IN
NH ₃ ^a	X% ^b	5-6%	1	450	M		OUT
N ₂ O ^a	20% (info requested for 40%)	20%	1 - 5	400	M		OUT
NO ^a	X% ^b	5%	1	450	M		OUT
NO ₂ (+21% O ₂) ^a	X% ^b	5000 ppm	1	450	M		OUT
N ₂	100%	50%	1 - 80	400	C		Ion Chamber, in Exp Hall
He	100%		1 - 80		C		Dedicated Gas line (always available) / OUT + Ion Chamber, in Exp Hall

^a All mixtures are diluted in He and if cylinders are acquired from Abelló-Linde the cylinder connector is always M

^b Always below the [highest percentage still considered inert](#) (data corroborated with Abelló-Linde) and considering limitations from manufacturer

Reactive gas system for Nóτος

Ar	100%		1 - 80	1000	C		Dedicated Gas line (always available) / OUT + Ion Chamber, in Exp Hall
Kr	100%				C		Ion Chamber , in Exp Hall
CH ₄	100%	50%	1 - 5	950	E	 	One dedicated shared line for all HCs / IN
Ethane	100%	50%	1 - 5	700	E	 	
Propane	100%	50%	1 - 5	700	E	 	
Butane	100%	-	-	-	E	 	
Ethylene	100%	-	-	-	E	  	
Propylene	100%	-	-	-	E	 	
Butadiene	100%	-	-	-	E	  	
*H ₂ S ^a	X% ^b	-	-	-	M		Dedicated Gas line / IN (another flammable could be used instead)
H ₂ O		-	1 - 20	950			Injection by means of: 1) Syringe pump (1 bar) 2) HPLC pump (likely up to 5-10 bar is reasonable) 3) Bubbler with Inert Gas
MeOH							
EtOH							
Other Alcohols							
Guaiacol & other oxygenated organic reactants		-	60	250			
Formic acid & other acids		-	20	?			
Organic comp (propane, benzene, toluene etc) <5000 ppm	<5000 ppm	<5000 ppm	1	500			

^a All mixtures are diluted in He and if cylinders are acquired from Abelló-Linde the cylinder connector is always M

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Reactive gas system for Nóτος

Total number of gas lines: 10

number	Gas type	Note	Connector type	Gas cabinet
2	Flammable	H ₂ + others flammables (flammable sensors, inside cabinet and close to dosing point)	E	Y
1	CO	Dedicated gas line, sensor	E	Y
1	H ₂ S	Optional. Another flammable gas can be used instead	M	Y
2	Inert	1 for He + <u>Ar</u> for internal calibration MS	C	N
1	CO ₂	Compatible with N ₂ O. Be able to use mixture if needed	C (U) or M	N
1	O ₂	O ₂ 20%, inert	M	N
2	Mixture	NO; NO ₂ ; NH ₃ , inert	M	N