Status and Operation of the ALBA RF System

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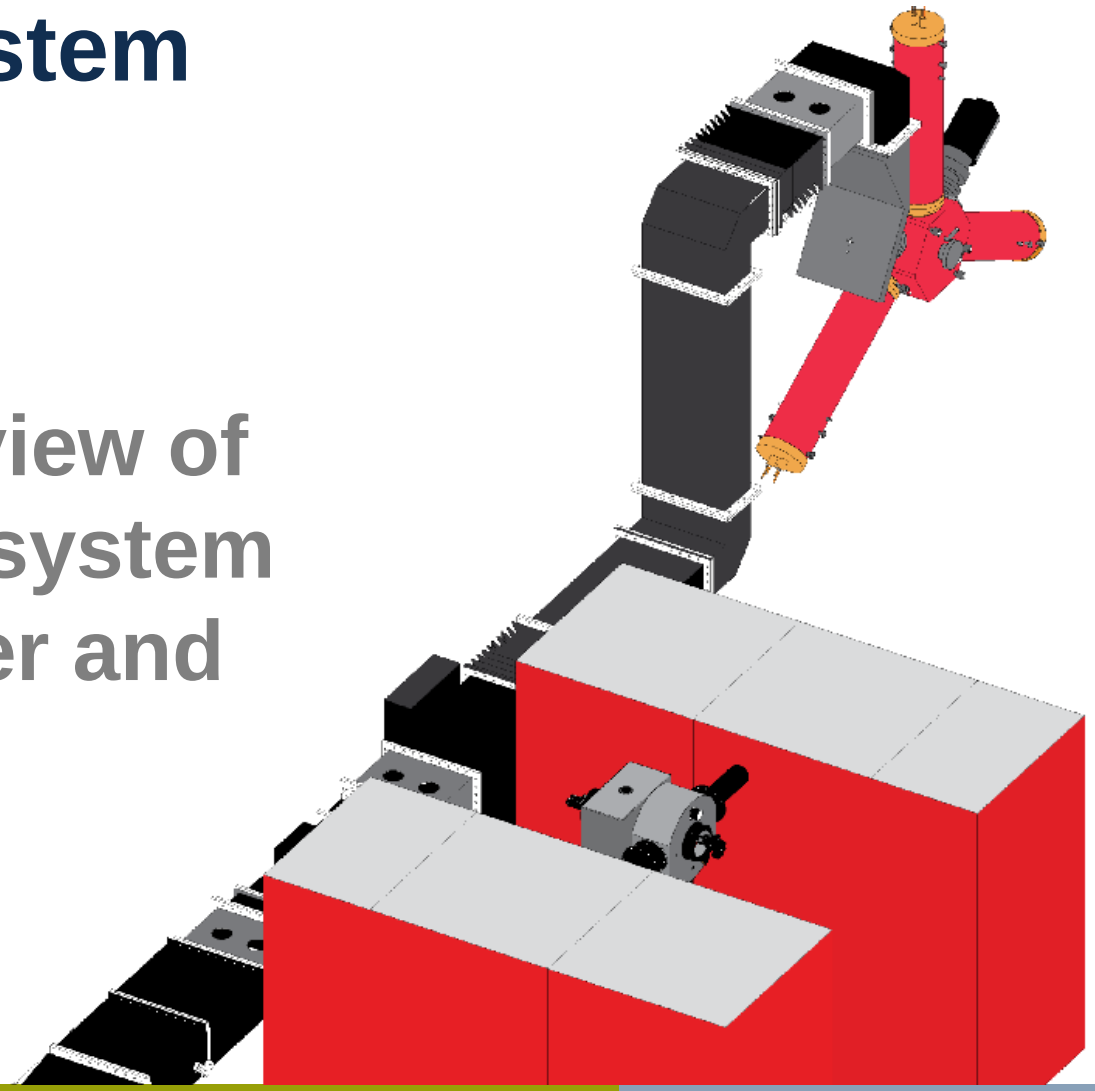
Contents

- Overview of the ALBA RF system
- Performance of the RF system
  - Statistics during users operation
  - Major incidents
- L3 L-4444C installation
- Other projects

ALBA RF system

General overview of the ALBA RF system for the Booster and Storage Ring



Some numbers

	STORAGE RING	BOOSTER (@ 3 GeV)
Frequency	499.654 MHz	
RF total Voltage	3600 kV ***2500 kV***	900 kV
Beam Current	250 mA ***110 mA top-up***	2 mA
Total Beam Power	540 kW ***120 kW***	1.3 kW
Losses (including IDs)	1300 keV/turn	627 keV/turn
Type of cavity	NC EU-Cav (DAMPY)	NC 5-cell
Number of cavities	6	1
RF Voltage per cavity	600 kV ***450 kV***	1000 kV
RF Power per cavity	150 kW ***56 kW***	35 kW
RF Transmitter	2 x 80 kW	1 x 80 kW
Synchrotron frequency	9.3 kHz	8.6 kHz

Nominal

Currently operating

ALBA RF System

- SR: 6 cavities
  - 2x80kW IOT amplifier combined
- Booster: PETRA 5 Cell cavity
  - 1x80kW IOT amplifier

Performance of the ALBA RF system

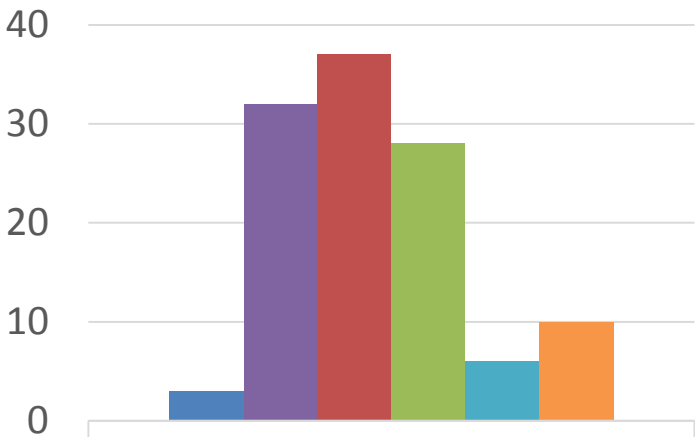
Interlock count

IOT hour count

Cavity arching

Damaged components

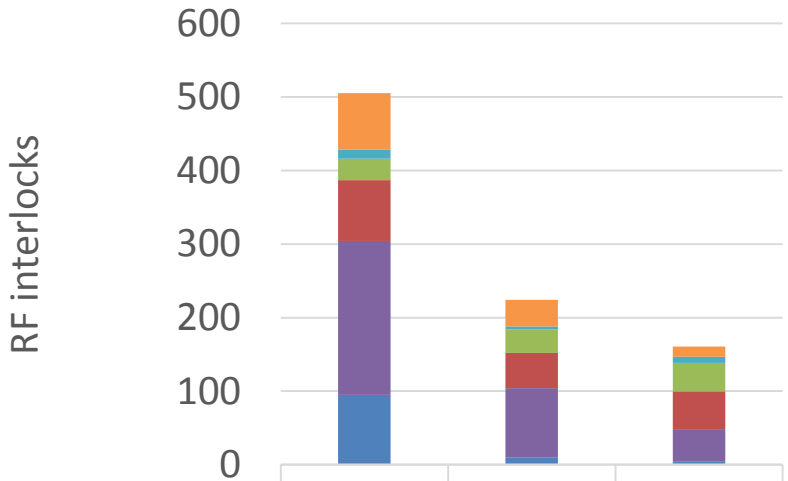
2015 interlocks (so far)



	2015
Water	3
IOT arc	32
Cavity arc	37
Other arc	28
Damaged components	6
Other	10

- 3120 hours completed
- 1200 more to go
- Total of 116 interlocks
- Only 9 beam losses
- IOT arcs include both RF and DC arching
- ~2/3 of the cavity arcs happen in 06B

Evolution since 2013

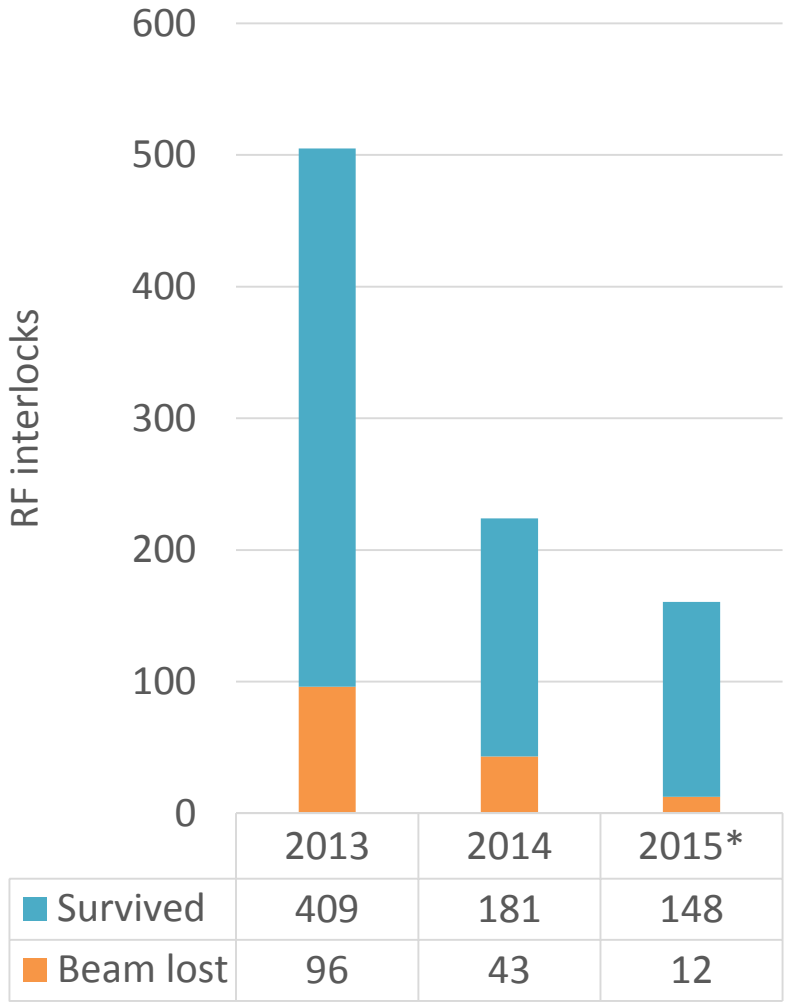


	2013	2014	2015 *
Other	77	36	14
Damaged components	12	4	8
Other arc	29	32	39
Cavity arc	83	48	51
IOT arc	209	94	44
Water	95	10	4

- 79% reduction in 2 years
- Water interlocks almost eliminated
- IOT arching reduced ~50%/year
- Cavity arching reduced from 2013 to 2014. This year is similar.

* Data from 2015 is extrapolated to the total expected operating hours

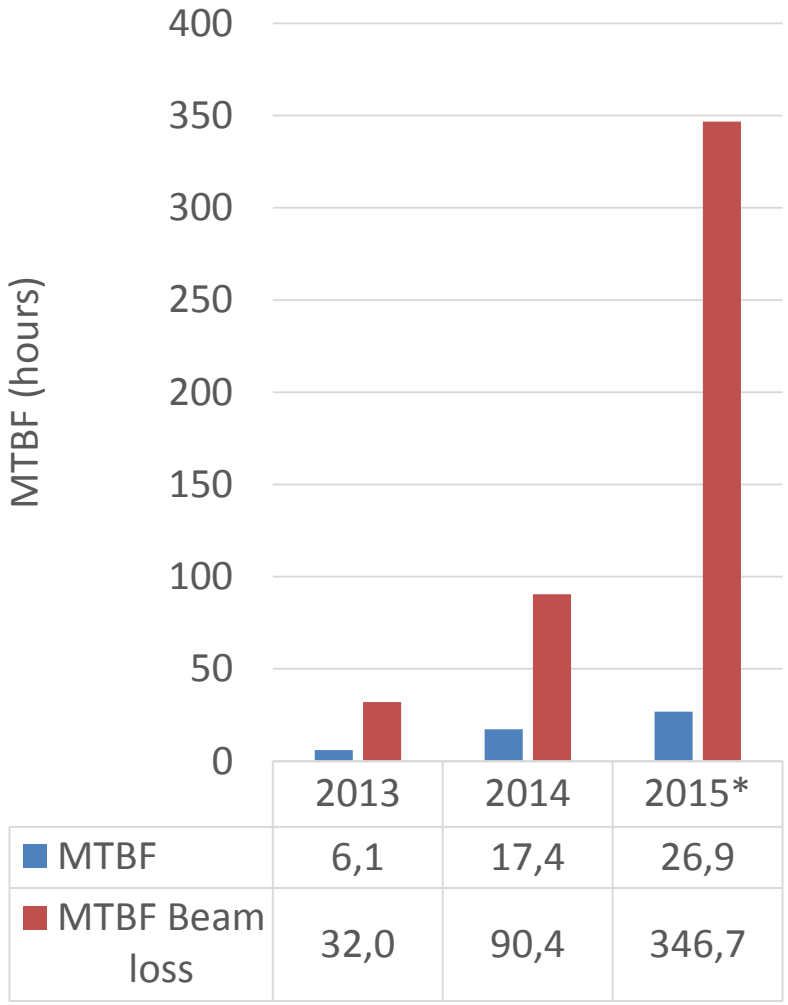
Beam losses since 2013



Year	Total interlocks
2013	505
2014	224
2015	161

* Data from 2015 is extrapolated to the total expected operating hours

MTBF evolution since 2013



Year	Operation hours
2013	3069
2014	3888
2015	4320

Year	Days without a beam loss
2013	1,3
2014	3,8
2015	14,4

* Data from 2015 is extrapolated to the total expected operating hours

Available IOT's

TX	Type	SN	HV hrs	FIL hrs
Booster	L3	100005	3741	3927
06A1	L3	100009	794	929
06A2	L3	100007	716	844
06B1	THALES	747211	13522	15297
06B2	THALES	731330	15305	17933
10A1	THALES	766836	7344	8312
10A2	THALES	771181	6198	6255
10B1	THALES	762037	8003	8994
10B2	THALES	1634010	4232	4553
14A1	THALES	617549	20622	26506
14A2	THALES	759044	8063	8886
14B1	L3	100006	869	924
14B2	L3	100008	140	291
	THALES	720105	13412	16071
	THALES	623099	13053	18956
	THALES	499443	19028	25877

- THALES average
  - 12092 FIL hours
  - 10411 HV hours
- 4 new L3 tubes from this summer
- 3 old tubes stored in queue for cleaning

Broken IOT's

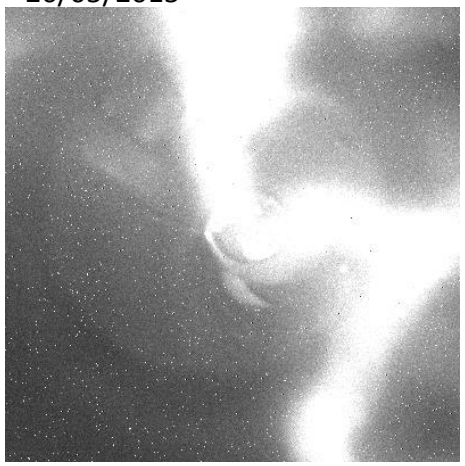
Manufacturer	SN	HV hrs	FIL hrs
THALES	747014	0	0
THALES	611024	34	58
THALES	726543	50	74
THALES	724075	39	97
THALES	591095	106	150
THALES	610736	25	200
THALES	499413	840	1280
THALES	761523	1482	1694
THALES	720785	1088	1714
THALES	623097	515	2316
THALES	610737	3324	4221
THALES	610735	4851	7468
THALES	629734	5080	7828
THALES	723734	6501	8203
THALES	**758883**	**7977**	**8977**
THALES	**760354**	**8273**	**9496**
THALES	617550	6970	10296
THALES	608802	7585	10627
THALES	623098	12004	15456
THALES	620408	13250	18257
THALES	617551	13637	18621
THALES	634238	15713	18979
THALES	**617302**	**17377**	**22507**
THALES	**623096**	**19648**	**25290**

- 24 broken IOT's since May 2010
- 10735 FIL hours average
- 8118 HV hours average
- RED: tubes broken in 2015

Arcs in 06B

- Real arcs, but not in the body
  - Only with beam
  - Light detected close to the end of HOM damper
  - Voltage does not drop until RF is removed
- Damper inspected, but looks OK
- Fake arcs are almost discarded
  - Redundant arc detector added

26/05/2015



Damaged parts

- 4x SSA drivers
- 1x circulator PLC
- 4x IOT’s broken
  - 1 in the Booster. Arc in the gun
  - 2 in the SR. Arc breaks output window.
  - 1 while handling

L3 L4444-C installation

Installation of 5 L3 IOT's for the ALBA RF system.

Overview

- Public tender awarded to BTESA (Spain)
- Colaboration with Comark TV (USA)
- IOT's fgrom L3 comunications (USA)

- 1 prototype tested in 02/2015
- 4 units installed in 08/2015

L3 L-4444C IOT's

- Single output cavity.
- Input cavity.
- Operation power: 60kW or 2x30kW.
- 12 hours SAT at 80kW

	Conf. 80 kW
Cathode voltage	-37 kV
Idle beam current	0.2 A
Gain	22 dB
Efficiency	69 % 80 kW

THALES TH-794

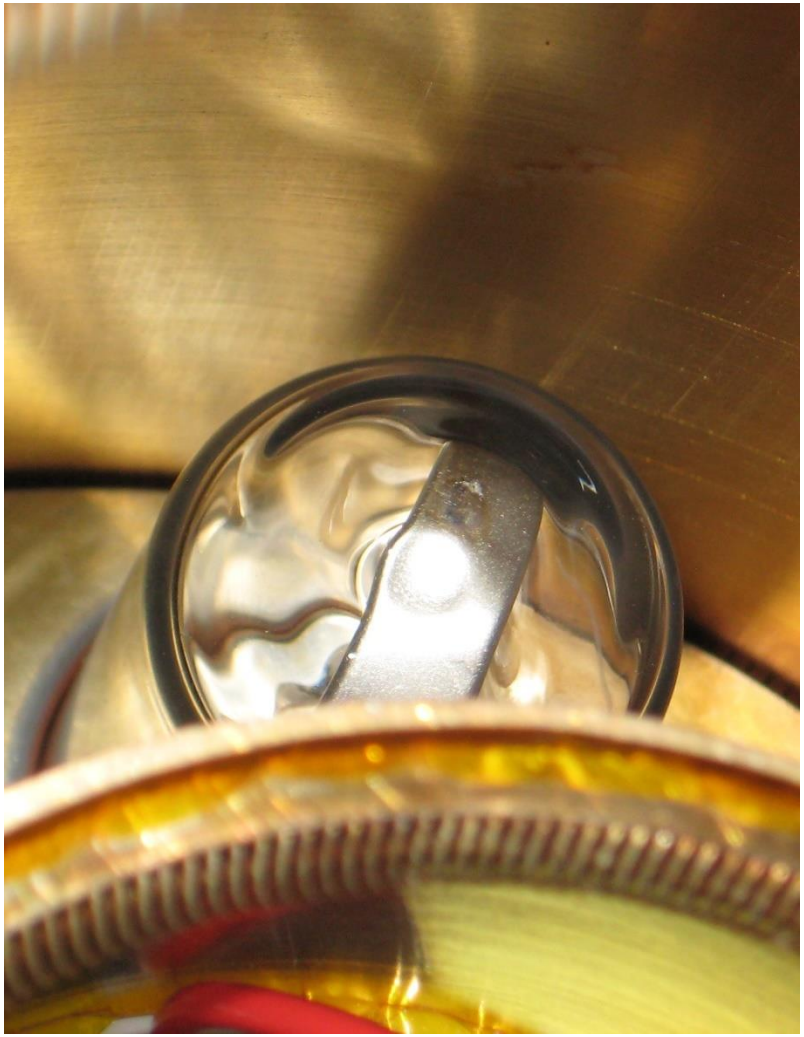
- Dual output cavities
- No input cavity.
- Operation power: 2x30kW. Up to 45kW in some cases.

	Conf. 50 kW	Conf. 80 kW
Cathode voltage	-32 kV	-36kV
Idle beam current	0.15 A	0.2 A
Gain	22.9 dB	23.4 dB
Efficiency	59 % 50 kW	70 % 80 kW

Measurements by P. Sánchez

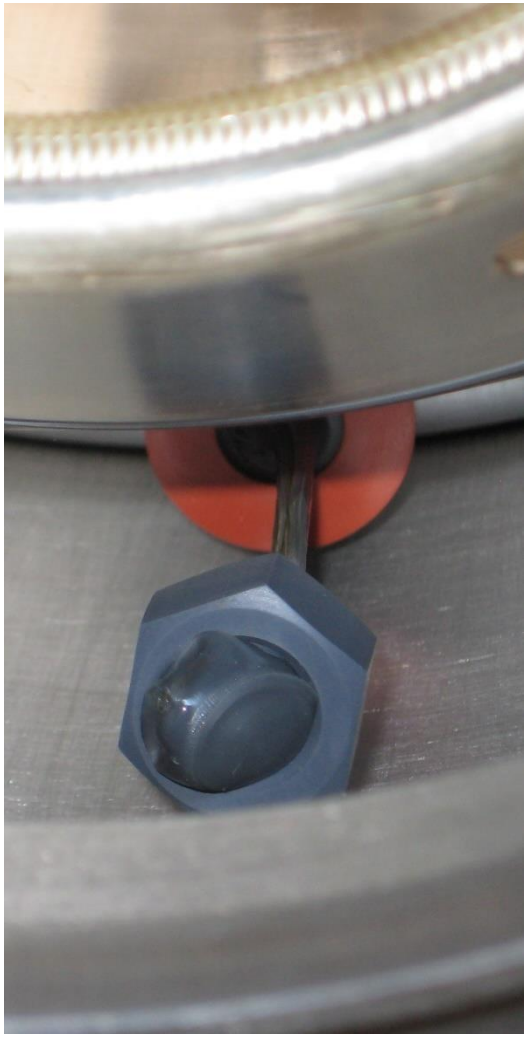
Incidents with L3 IOT's

- Input cavity damaged twice
  - Arc in RF loop.
    - Quartz glass damaged



Incidents with L3 IOT's

- Input cavity damaged twice
  - Arc in RF loop
    - Quartz glass damaged
  - Neutralization problems
    - Noise in ion current
    - Screws melt
    - Possible bad finger contact



Incidents with L3 IOT's

- Arc detector photocell in prototype output cavity damaged.

- Repetitive arching 06A2.
  - Under investigation
    - Possible damage in output cavity
    - Bad tuning may cause the gain to be too high and cause cavity arching
    - Suspicious spot in output window (residues of a temperature test in factory)

Reliability of L3 IOT's in operation

- A couple of arcs during the first month are normal according to L3
- They have disappeared in 4 tubes after 1 month of operation
- 1 tube is not improving

Other projects

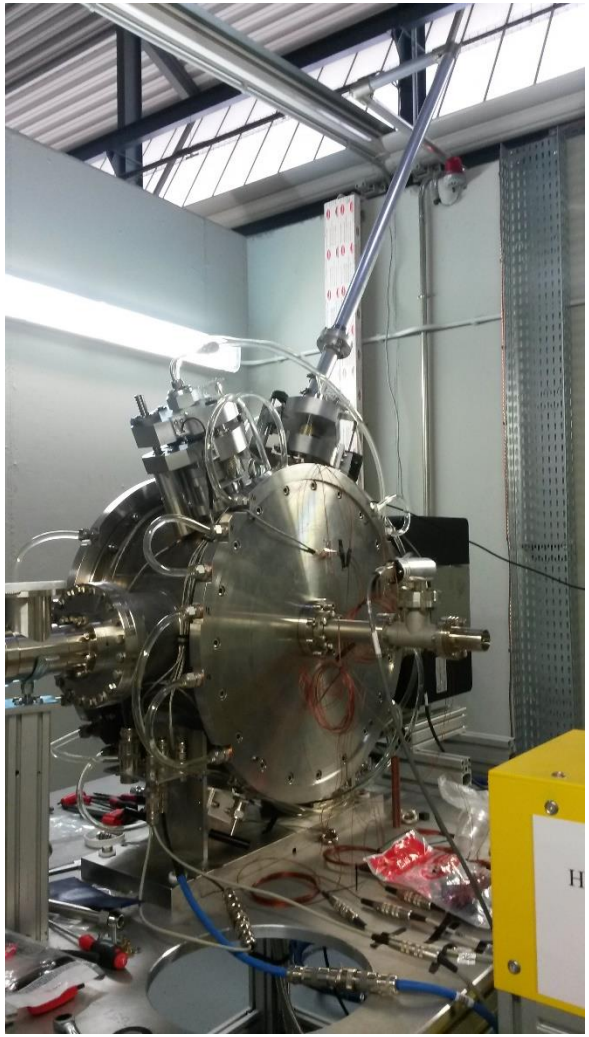
RFLAB

3rd harmonic system

Alternative IOT driver

RFLAB

- IFMIF buncher cavity conditioned successfully for CIEMAT
  - 1 more cavity shortly
  - A cyclotron cavity next year too
- SAT of the prototype L3 IOT
- Recovery of unreliable IOT



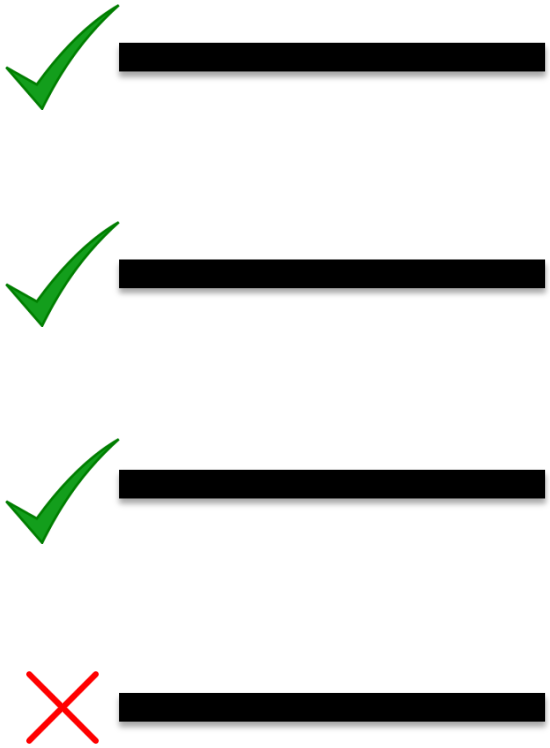
3rd harmonic cavity

- In collaboration with CLIC
  - 1,5 GHz NC active RF system
  - 2 staff in ALBA financed by CERN
    - Mechanical engineer: Cavity design
    - Electronic engineer: LLRF
- ALBA prepares:
  - Cavity simulation and design
  - PhD for 1.5GHz 25kW CW SSA amplifier

Alternative for IOT drivers

- 500W SSA preamplifier
  - Currently: THALES TH 15701-1 AMPSIUM
- Asked for prototype to:
  - TTI (www.ttinorte.es)
  - BTESA (www.btesa.com)

Summary



Overall performance

- Great reduction of interlocks in the overall RF system, while increasing the number of operation hours
  - Particularly those leading to a beam loss

- IOT arc interlocks reduced at expense of power.
  - Prevents us from increasing stored beam current

New L3 IOT's

- Too early to compare both kinds of IOT.

- 3/5 systems have worked flawlessly
  - 1 input cavity damaged
  - 1 output cavity damage (photoresistor)
  - 1 system with arching under investigation.

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Thank you for your attention