ALBA Status

Ferran Fernandez

On behalf of the Accelerator Division

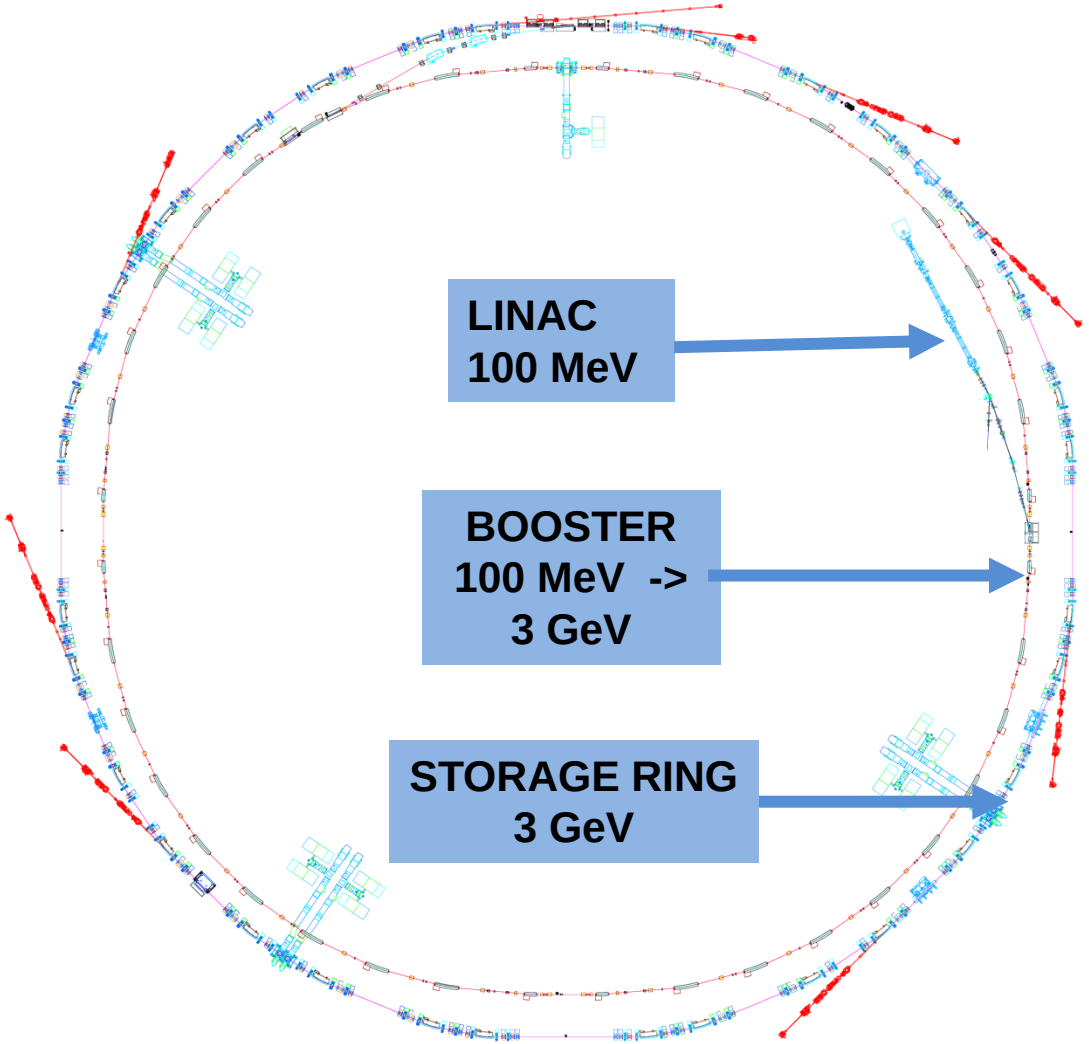
Outline

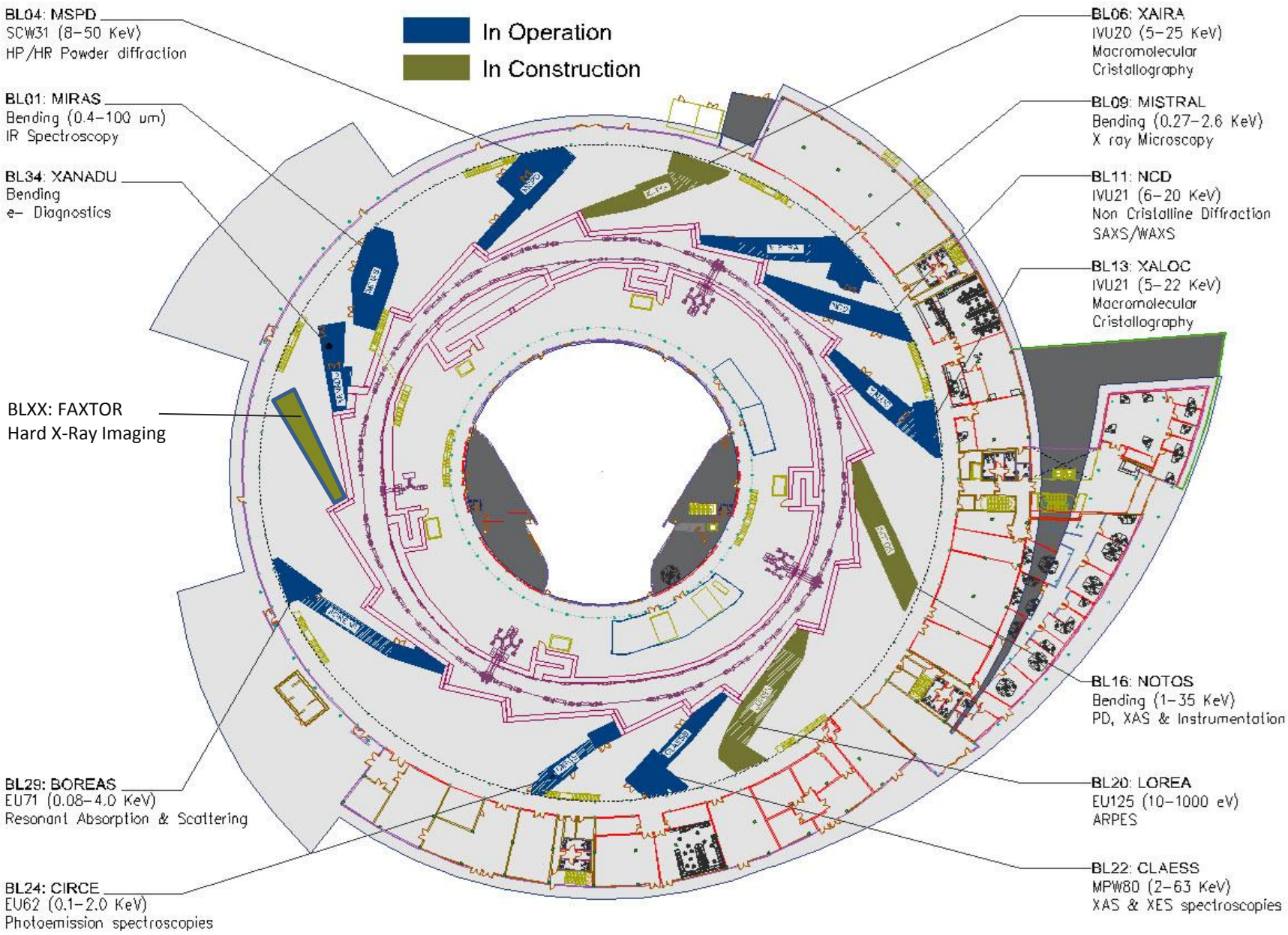
- Introduction
- Operation
  - Statistics
  - SCW reparation
  - RF operation improvements
- Accelerator Developments
  - Linac
  - Beam Dynamics
  - Radiofrequency
  - Beam instrumentation
  - Magnetic measurement lab.

Introduction

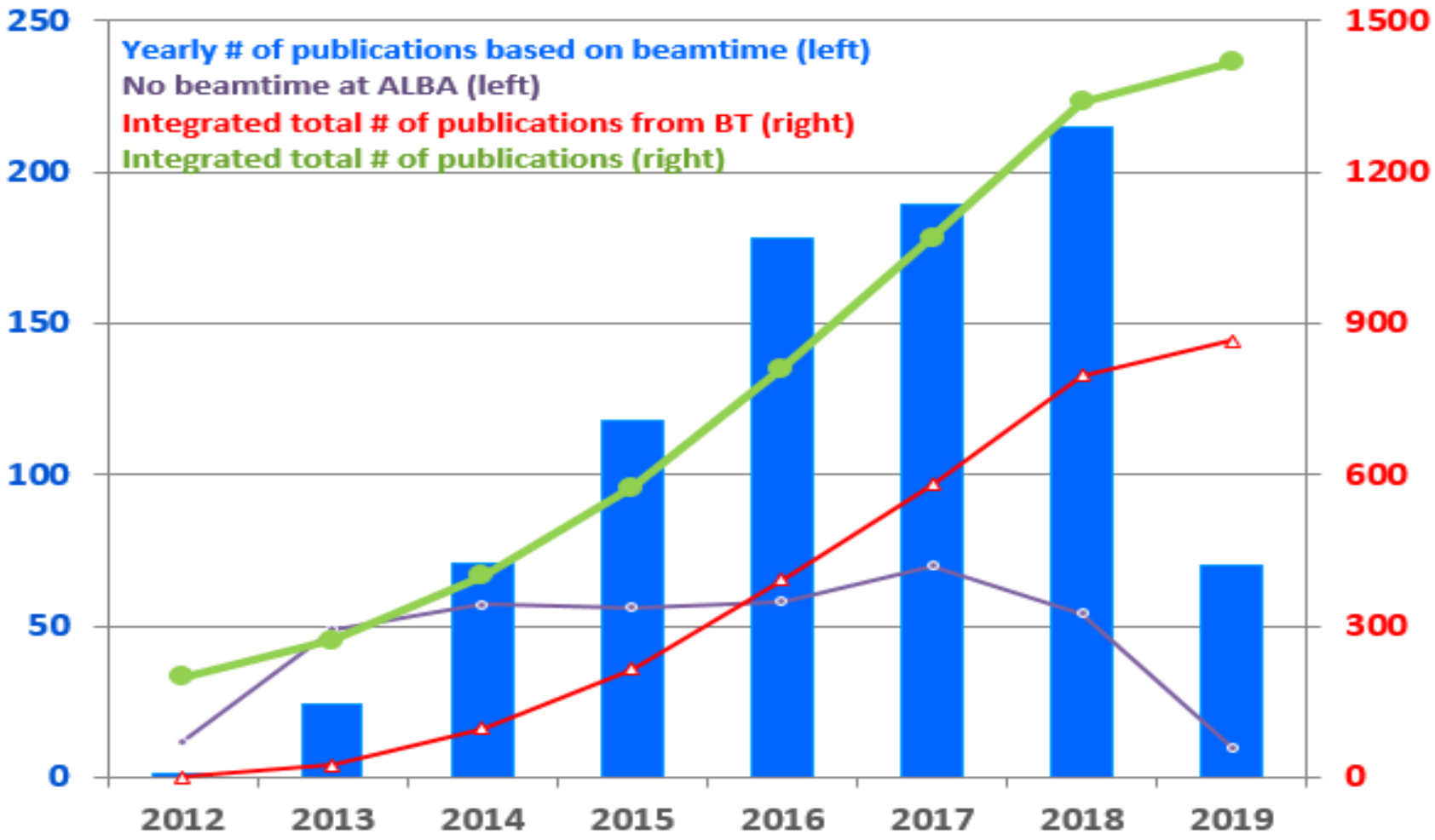
Layout

Parameter	Value
Energy	3 GeV
Circumference	268.8 m
Emittance	4.5 nm·rad
Current	250 mA
Rf frequency	500 MHz
# cavities	6
Long straights	4 (8 m)
Medium straights	12 (4 m)



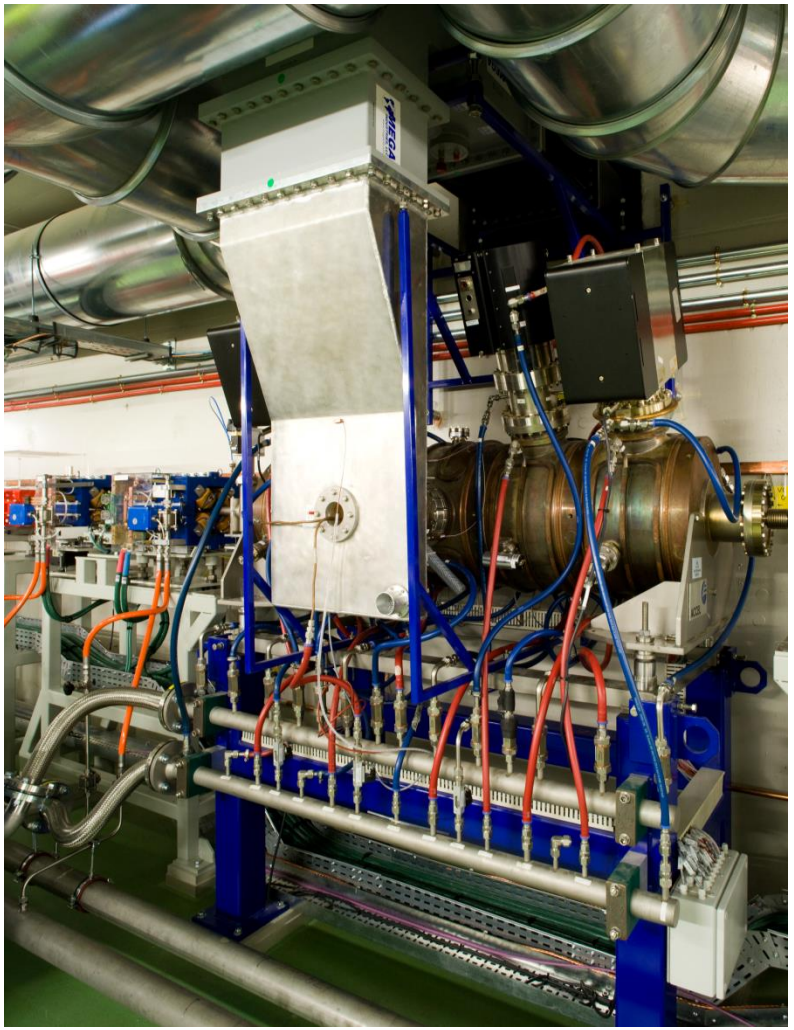

In Operation
In Construction
BL04: MSPD
SCW31 (8–50 KeV)
HP/HR Powder diffraction
BL01: MIRAS
Bending (0.4–100 um)
IR Spectroscopy
BL34: XANADU
Bending
e– Diagnostics
BLXX: FAXTOR
Hard X-Ray Imaging
BL29: BOREAS
EU71 (0.08–4.0 KeV)
Resonant Absorption & Scattering
BL24: CIRCE
EU62 (0.1–2.0 KeV)
Photoemission spectroscopies
BL06: XAIRA
IVU20 (5–25 KeV)
Macromolecular
Cristallography
BL09: MISTRAL
Bending (0.27–2.6 KeV)
X ray Microscopy
BL11: NCD
IVU21 (6–20 KeV)
Non Cristalline Diffraction
SAXS/WAXS
BL13: XALOC
IVU21 (5–22 KeV)
Macromolecular
Cristallography
BL16: NOTOS
Bending (1–35 KeV)
PD, XAS & Instrumentation
BL20: LOREA
EU125 (10–1000 eV)
ARPES
BL22: CLAESS
MPW80 (2–63 KeV)
XAS & XES spectroscopies

Scientific productivity



Operation

- Statistics
- SCW reparation
- RF operation improvements



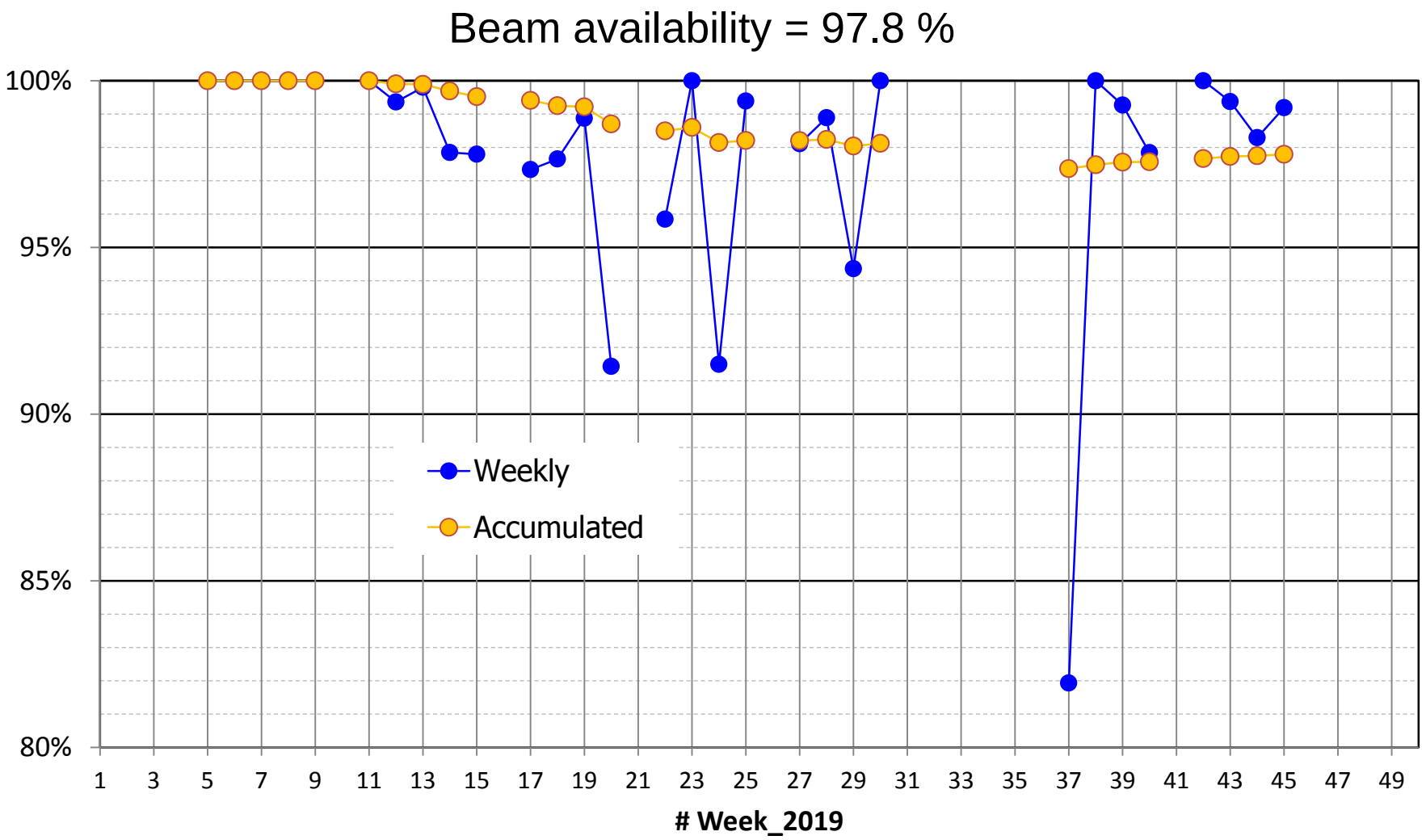
2019 Operation

Weekday	JANUARY Week Day	Shift M	A	N	FEBRUARY Week Day	Shift M	A	N	MARCH Week	Shift M	A	N	APRIL Week Day	Shift M	A	N	MAY Week	Shift M	A	N	JUNE Week Day	Shift M	A	N	JULY Week Day	Shift M	A	N	AUGUST Week Day	Shift M	A	N	SETEMBER Week Day	Shift M	A	N	OCTOBER Week Day	Shift M	A	N	NOVEMBER Week Day	Shift M	A	N	DECEMBER Week Day	Shift M	A	N
Mo	1												1	M	M	M									1	M	M	M																				
Tu	1	W	W	W									2	BL	BL	BL									2	BL	BL	BL									1	BL	BL	BL								
We	2	W	W	W									3	BL	BL	BL	1	BL	BL	BL					3	BL	BL	BL									2	BL	BL	BL								
Th	3	W	W	W									4	BL	BL	BL	2	BL	BL	BL					4	BL	BL	BL	1	Off	Off	Off					3	BL	BL	BL								
Fr	4	W	W	W	1	BL	BL	BL	1	BL	BL	BL	5	BL	BL	BL	3	BL	BL	BL					5	BL	BL	BL	2	Off	Off	Off					4	BL	BL	BL	1	BL	BL	BL				
Sa	5	W	W	W	2	BL	BL	BL	2	BL	BL	BL	6	BL	BL	BL	4	BL	BL	BL	1	BL	BL	BL	6	BL	BL	BL	3	Off	Off	Off					5	BL	BL	BL	2	BL	BL	BL				
Su	6	W	W	W	3	BL	BL	BL	3	M	M	M	7	M	M	M	5	BL	BL	BL	2	BL	BL	BL	7	BL	BL	BL	4	Off	Off	Off	1	W	W	W	6	M	M	M	3	BL	BL	BL	1	BL	BL	BL
Mo	2 7	W	W	W	4	M	M	M	4	SPR	W	W	8	BL	BL	BL	6	M	M	M	3	M	M	M	8	M	M	M	5	Off	Off	Off	2	SPR	SPR	W	7	PSS	W	W	4	M	M	M	2	M	M	M
Tu	8	W	W	W	5	BL	BL	BL	5	W	W	W	9	BL	BL	BL	7	BL	BL	BL	4	BL	BL	BL	9	BL	BL	BL	6	Off	Off	Off	3	SPR	SPR	W	8	PSS	W	W	5	BL	BL	BL	3	BL	BL	BL
We	9	W	W	W	6	BL	BL	BL	6	W	W	W	10	BL	BL	BL	8	BL	BL	BL	5	BL	BL	BL	10	BL	BL	BL	7	Off	Off	Off	4	W	W	W	9	W	W	W	6	BL	BL	BL	4	BL	BL	BL
Th	10	W	W	W	7	BL	BL	BL	7	W	W	W	11	BL	BL	BL	9	BL	BL	BL	6	BL	BL	BL	11	BL	BL	BL	8	Off	Off	Off	5	M	M	W	10	W	W	W	7	BL	BL	BL	5	BL	BL	BL
Fr	11	W	W	W	8	BL	BL	BL	8	W	W	W	12	BL	BL	BL	10	BL	BL	BL	7	BL	BL	BL	12	BL	BL	BL	9	Off	Off	Off	6	M	M	W	11	W	W	W	8	BL	BL	BL	6	BL	BL	BL
Sa	12	W	W	W	9	BL	BL	BL	9	W	W	W	13	W	W	W	11	BL	BL	BL	8	BL	BL	BL	13	BL	BL	BL	10	Off	Off	Off	7	M	M	M	12	W	W	W	9	BL	BL	BL	7	BL	BL	BL
Su	13	W	W	W	10	BL	BL	BL	10	W	W	W	14	W	W	W	12	BL	BL	BL	9	BL	BL	BL	14	BL	BL	BL	11	Off	Off	Off	8	M	M	M	13	W	W	W	10	M	M	M	8	BL	BL	BL
Mo	3 14	W	W	W	11	M	M	M	11	M	M	M	15	W	W	W	13	M	M	M	10	M	M	M	15	M	M	M	12	Off	Off	Off	9	M	M	M	14	M	M	M	11	PSS	W	W	9	M	M	M
Tu	15	W	W	W	12	BL	BL	BL	12	BL	BL	BL	16	W	W	W	14	BL	BL	BL	11	BL	BL	BL	16	BL	BL	BL	13	Off	Off	Off	10	BL	BL	BL	15	BL	BL	BL	12	PSS	W	W	10	BL	BL	BL
We	16	W	W	W	13	BL	BL	BL	13	BL	BL	BL	17	W	W	W	15	BL	BL	BL	12	BL	BL	BL	17	BL	BL	BL	14	Off	Off	Off	11	BL	BL	BL	16	BL	BL	BL	13	W	W	W	11	BL	BL	BL
Th	17	W	W	W	14	BL	BL	BL	14	BL	BL	BL	18	W	W	W	16	BL	BL	BL	13	BL	BL	BL	18	BL	BL	BL	15	Off	Off	Off	12	BL	BL	BL	17	BL	BL	BL	14	W	W	W	12	BL	BL	BL
Fr	18	W	W	W	15	BL	BL	BL	15	BL	BL	BL	19	W	W	W	17	BL	BL	BL	14	BL	BL	BL	19	BL	BL	BL	16	Off	Off	Off	13	BL	BL	BL	18	BL	BL	BL	15	W	W	W	13	BL	BL	BL
Sa	19	W	W	W	16	BL	BL	BL	16	BL	BL	BL	20	W	W	W	18	BL	BL	BL	15	BL	BL	BL	20	BL	BL	BL	17	Off	Off	Off	14	BL	BL	BL	19	BL	BL	BL	16	W	W	W	14	BL	BL	BL
Su	20	W	W	W	17	M	M	M	17	BL	BL	BL	21	W	W	W	19	M	M	M	16	BL	BL	BL	21	BL	BL	BL	18	Off	Off	Off	15	BL	BL	BL	20	BL	BL	BL	17	W	W	W	15	M	M	M
Mo	4 21	W	W	W	18	M	M	M	18	M	M	M	22	W	W	W	20	W	W	W	17	M	M	M	22	M	M	M	19	Off	Off	Off	16	M	M	M	21	M	M	M	18	M	M	M	16	BL	BL	BL
Tu	22	W	W	W	19	BL	BL	BL	19	BL	BL	BL	23	W	W	W	21	W	W	W	18	BL	BL	BL	23	BL	BL	BL	20	Off	Off	Off	17	BL	BL	BL	22	BL	BL	BL	19	BL	BL	BL	17	BL	BL	BL
We	23	M	M	W	20	BL	BL	BL	20	BL	BL	BL	24	M	M	M	22	W	W	W	19	BL	BL	BL	24	BL	BL	BL	21	Off	Off	Off	18	BL	BL	BL	23	BL	BL	BL	20	BL	BL	BL	18	BL	BL	BL
Th	24	M	M	W	21	BL	BL	BL	21	BL	BL	BL	25	M	M	M	23	W	W	W	20	BL	BL	BL	25	BL	BL	BL	22	PSS	W	W	19	BL	BL	BL	24	BL	BL	BL	21	BL	BL	BL	19	BL	BL	BL
Fr	25	M	M	M	22	BL	BL	BL	22	BL	BL	BL	26	BL	BL	BL	24	W	W	W	21	BL	BL	BL	26	BL	BL	BL	23	PSS	W	W	20	BL	BL	BL	25	BL	BL	BL	22	BL	BL	BL	20	W	W	W
Sa	26	M	M	M	23	BL	BL	BL	23	BL	BL	BL	27	BL	BL	BL	25	W	W	W	22	BL	BL	BL	27	BL	BL	BL	24	PSS	W	W	21	BL	BL	BL	26	BL	BL	BL	23	BL	BL	BL	21	W	W	W
Su	27	M	M	M	24	BL	BL	BL	24	BL	BL	BL	28	BL	BL	BL	26	W	W	W	23	W	W	W	28	M	M	M	25	PSS	W	W	22	BL	BL	BL	27	BL	BL	BL	24	BL	BL	BL	22	W	W	W
Mo	5 28	M	M	M	25	M	M	M	25	M	M	M	29	M	M	M	27	M	M	M	24	W	W	W	29	Off	Off	Off	26	PSS	W	W	23	M	M	M	28	M	M	M	25	M	M	M	23	W	W	W
Tu	29	BL	BL	BL	26	BL	BL	BL	26	BL	BL	BL	30	BL	BL	BL	28	BL	BL	BL	25	W	W	W	30	Off	Off	Off	27	PSS	W	W	24	BL	BL	BL	29	BL	BL	BL	26	BL	BL	BL	24	W	W	W
We	30	BL	BL	BL	27	BL	BL	BL	27	BL	BL	BL					29	BL	BL	BL	26	W	W	W	31	Off	Off	Off	28	PSS	W	W	25	BL	BL	BL	30	BL	BL	BL	27	BL	BL	BL	25	W	W	W
Th	31	BL	BL	BL	28	BL	BL	BL	28	BL	BL	BL					30	BL	BL	BL	27	W	W	W					29	SPR	W	W	26	BL	BL	BL	31	BL	BL	BL	28	BL	BL	BL	26	W	W	W
Fr					29	BL	BL	BL	29	BL	BL	BL					31	BL	BL	BL	28	W	W	W					30	SPR	W	W	27	BL	BL	BL					29	BL	BL	BL	27	W	W	W
Sa					30	BL	BL	BL	30	BL	BL	BL									29	W	W	W					31	W	W	W	28	BL	BL	BL					30	BL	BL	BL	28	W	W	W
Su					31	BL	BL	BL	31	BL	BL	BL									30	W	W	W									29	BL	BL	BL									29	W	W	W
Mo																																	30	M	M	M									30	W	W	W
Tu																																													31	W	W	W

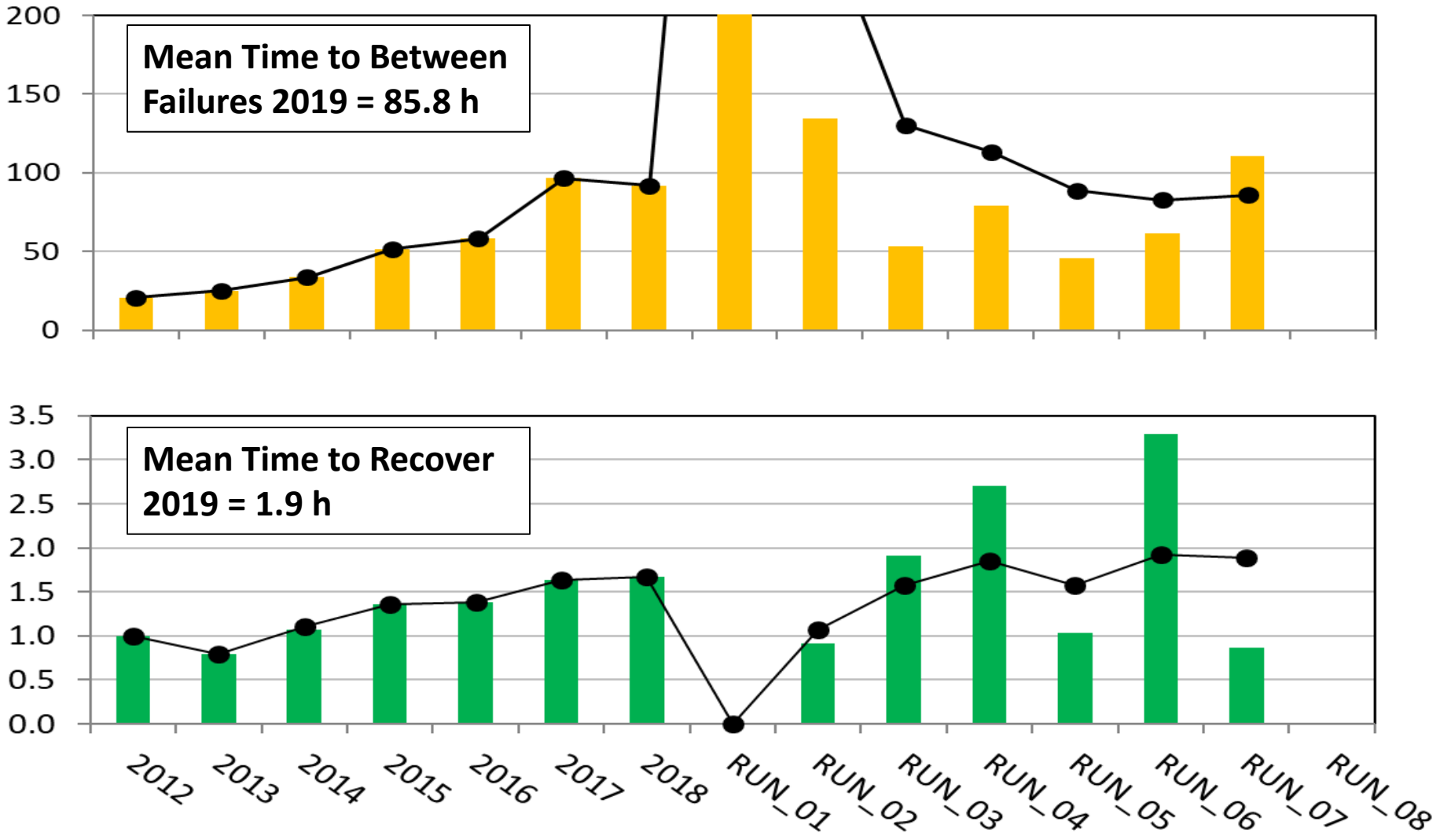
BL [h]	4680
M [h]	1192
SPR [h]	16
CSN [h]	0
TOTAL [h]	**5888 h**

Same numbers for 2020

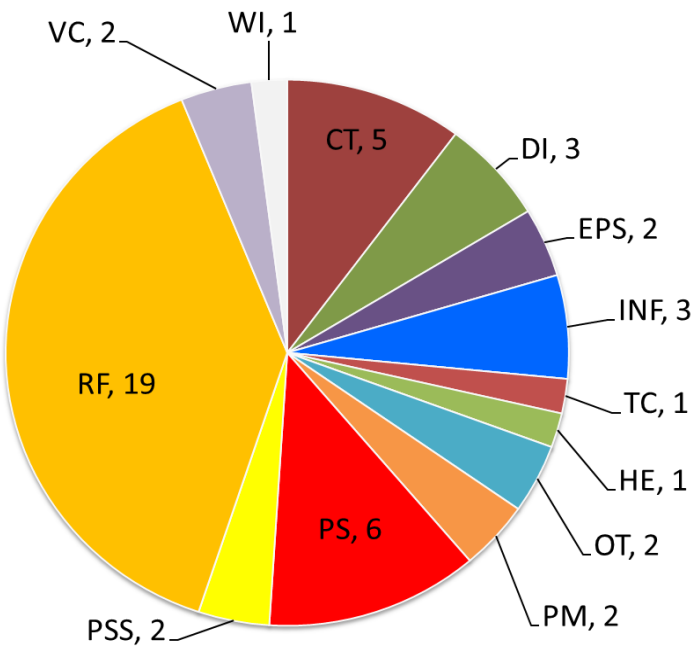
Beam Availability (until 18/11/2019)

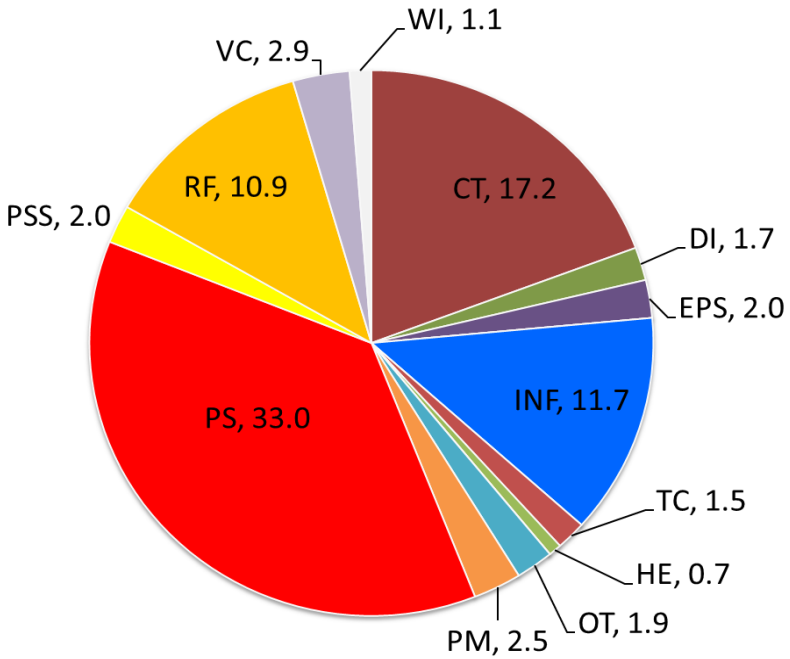


MTBF & MTTR


Mean Time to Between Failures 2019 = 85.8 h
200
150
100
50
0
Mean Time to Recover 2019 = 1.9 h
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
2012
2013
2014
2015
2016
2017
2018
RUN_01
RUN_02
RUN_03
RUN_04
RUN_05
RUN_06
RUN_07
RUN_08

No beam events





Beam for BLs: No beam events

Beam for BLs: Down time

49(-2) no beam events

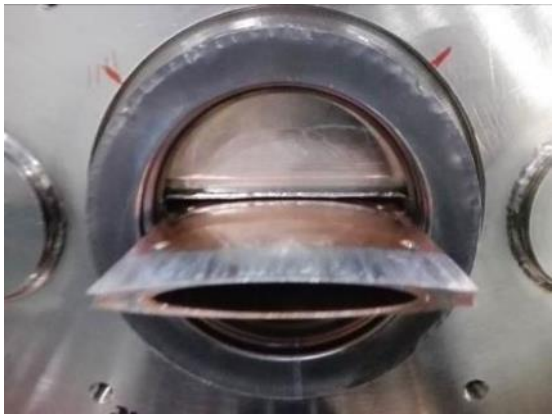
+131.2 h in decay mode

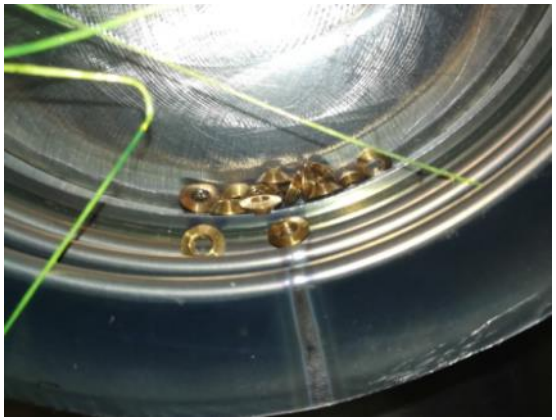
89.0 h of no beam

5 FAILURES ACCOUNT FOR MORE THAN 40% OF THE DOWNTIME

SCW repair

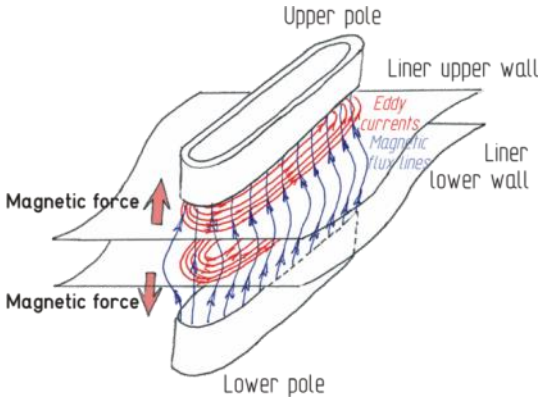
- On September 2018 current increased from 150mA to 200mA
- Start having quenches at SCW (*reported on ESLSW-2018*)
- Winter shutdown SCW repair
- Bronze screws were broken.
- Two halves of liner were separated, touching the cryostat vacuum chamber.






SCW repair

REASON (?): Stress on liner by eddy currents when quenching *(?)*

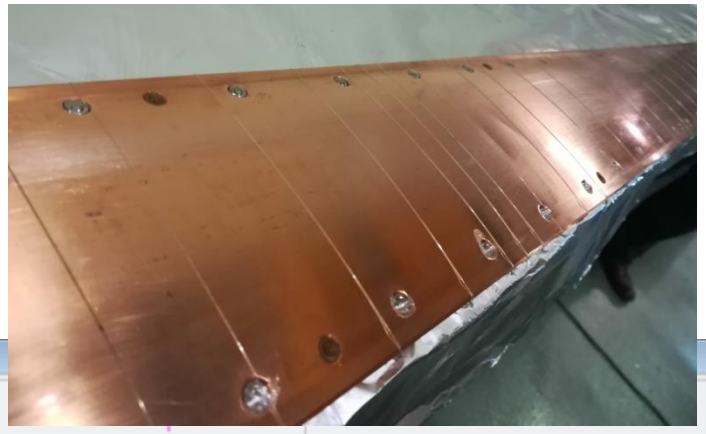


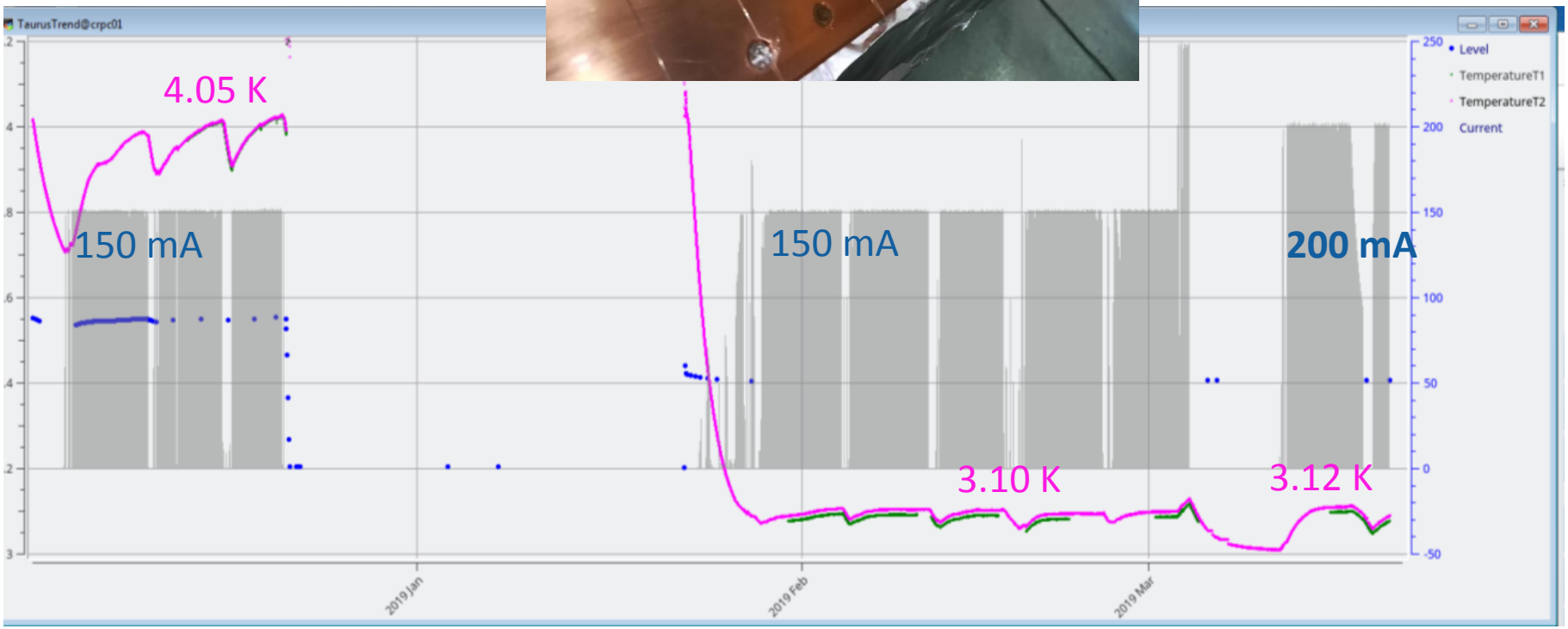
1. When a **quench** in one of the SC coils is detected, the power supply is **disconnected** and the system of coils is **discharged** through a **dump resistor**.
2. The **decreasing magnetic field** induces **eddy currents** on the **copper liner** trying to compensate the change of magnetic flux.
3. Those **induced current loops** have an associated **magnetic moment** and are **attracted** towards regions of higher magnetic flux density, i.e. **towards the magnetic poles**.

Force estimations (at $t = 0$)	
Induced current per pole [Amp]	400
Force on each liner wall per pole [N]	140
Total force on each liner wall [Tons]	1.67
Force per screw [kg]	17

SCW repair

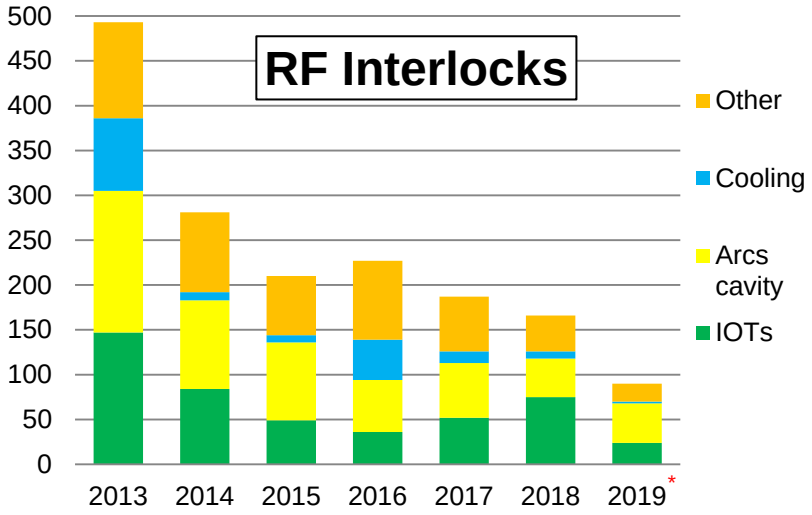
Replace all bronze screws by stainless steel ones





RF operation improvements

- RF team is continuously working on reducing the beam dumps
  - September 2019: 250 mA top-up
  - Cavities voltage increased (3 MV total RF voltage)
  - More conditioning is needed
  - SR fully filled with L3 IOT since May 2019.

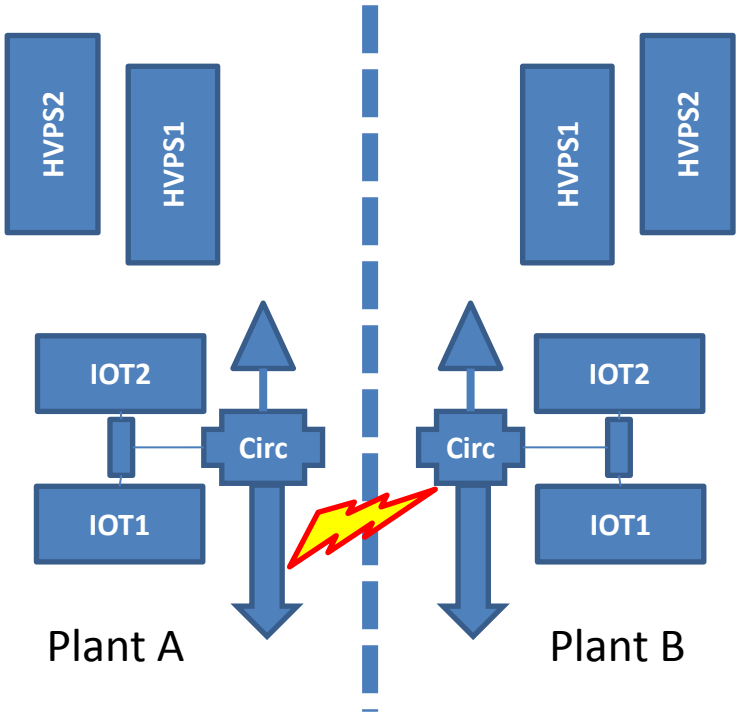


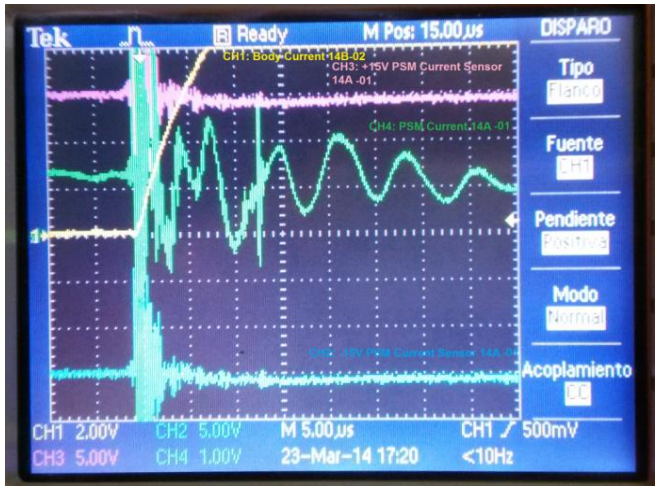
* Until September 2019

	2017	2018	2019
RF ITCK with beam dump	18	28	17
Beam Downtime due to RF [hours]	12.3	18.1	10.9

RF operation improvements

- After Body Current interlock, noise is induced in electronics of neighbour plant
  - PSM current filtered with ferrites
  - PSM voltage filtered with RF low pass filters
  - HV enable signal filtered with optical link

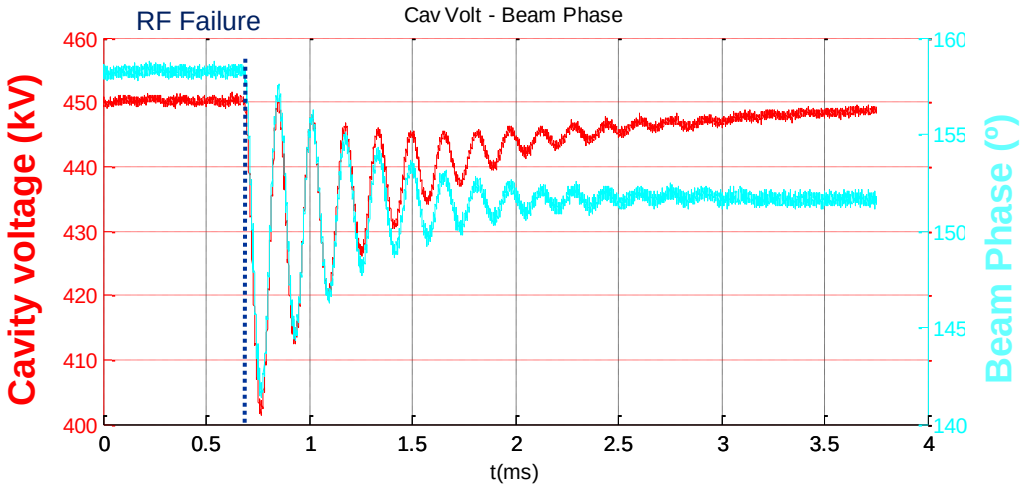


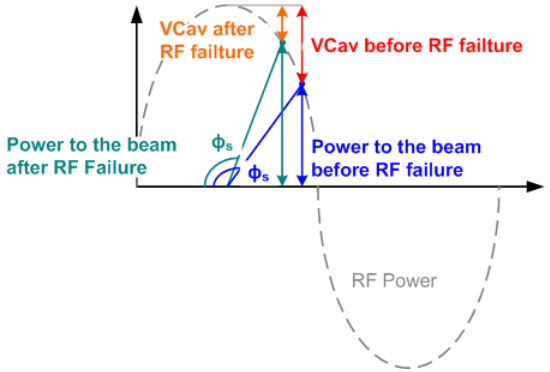


Body currents that tripped the beam
Jan 2018 - Aug 2019: **31%**
From Sept 2019: **0%**

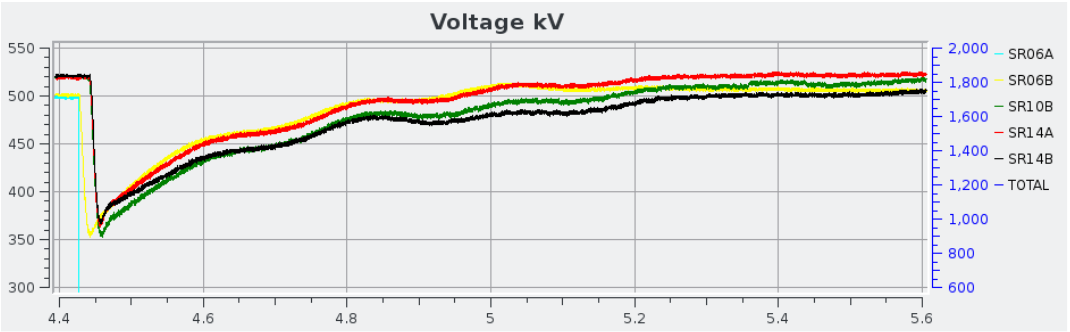
RF operation improvements

- **Trip compensation**: Oscillations after a trip cause voltage drop in the cavity and therefore to lose the beam



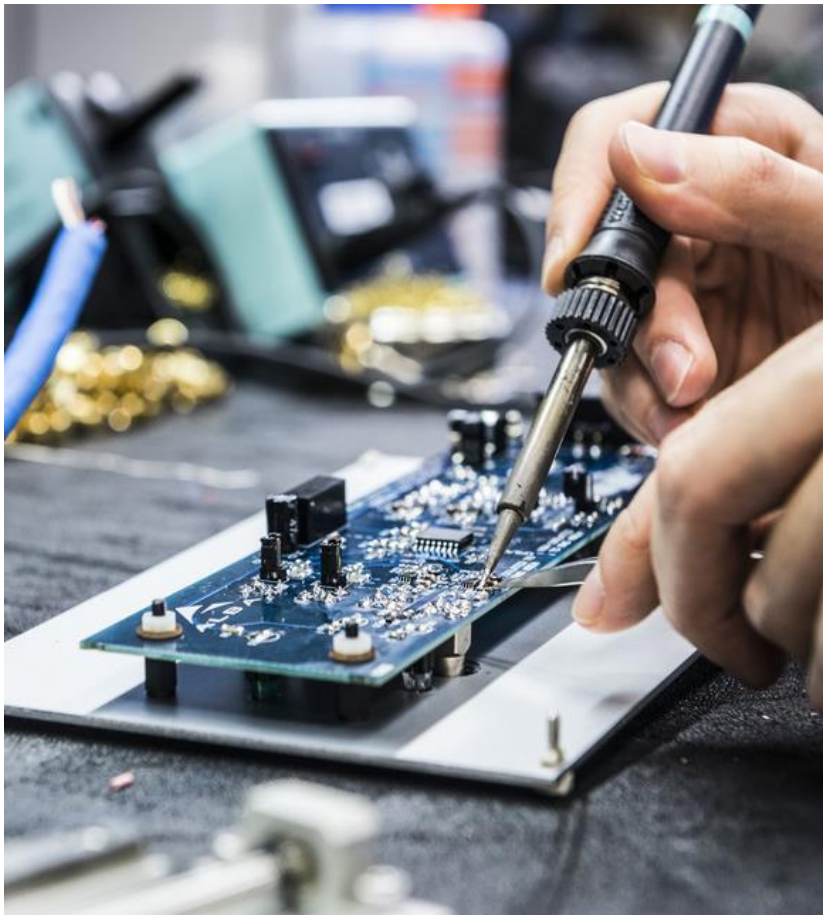


- Trigger is sent to the DLLRF for feedforward compensation



Accelerator Developments

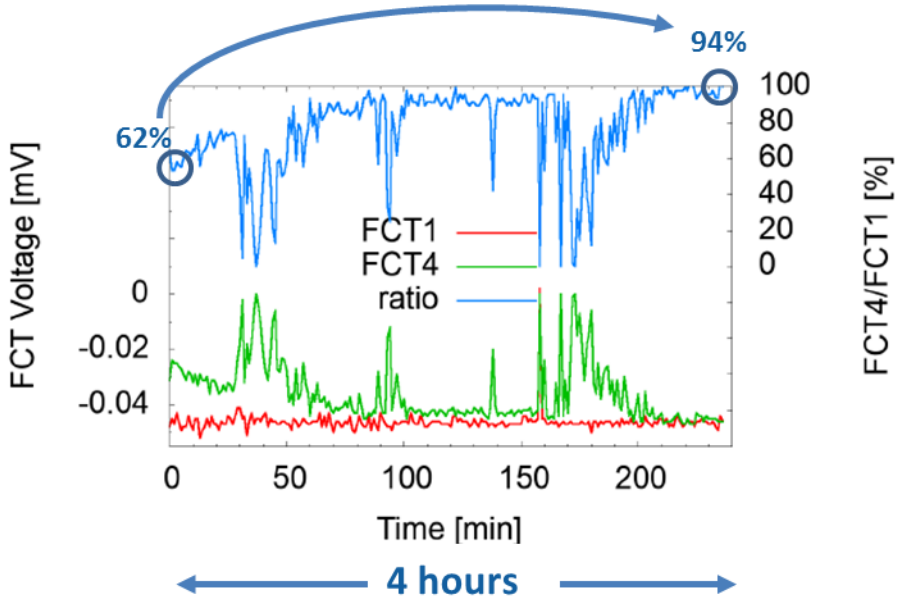
- Linac
- Beam Dynamics
- Radiofrequency
- Beam instrumentation
- Magnetic meas. lab.

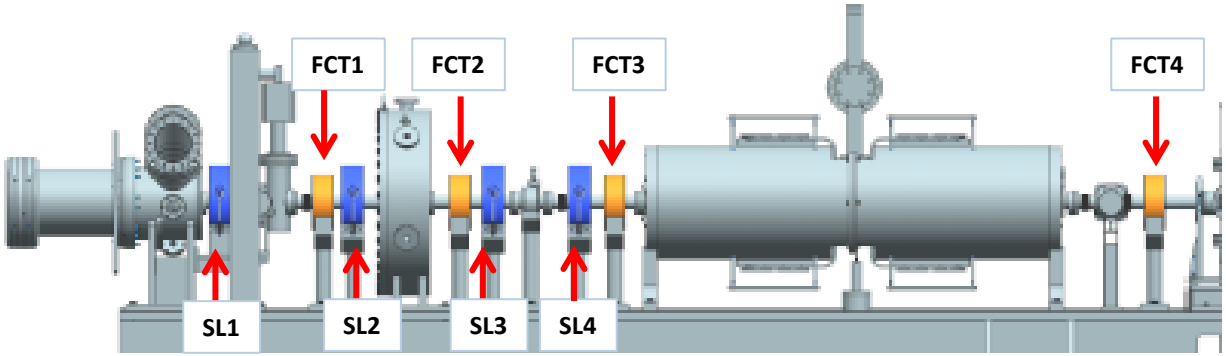


Linac improvements

SBM optimization by "simplex" algorithm

- Goals: improve beam transmission in SBM
- Figure of merit: FCT4/FCT1

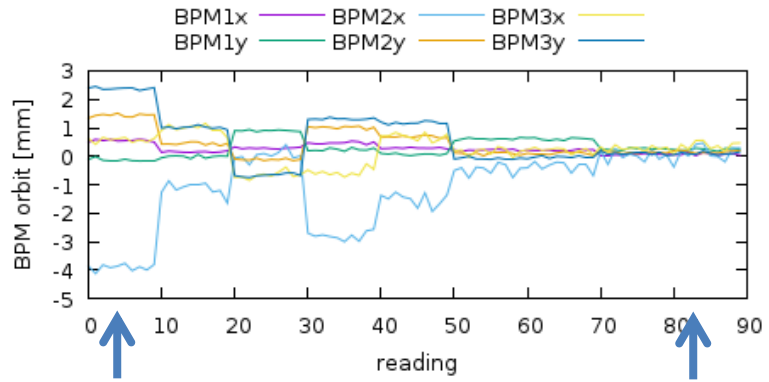




Linac improvements

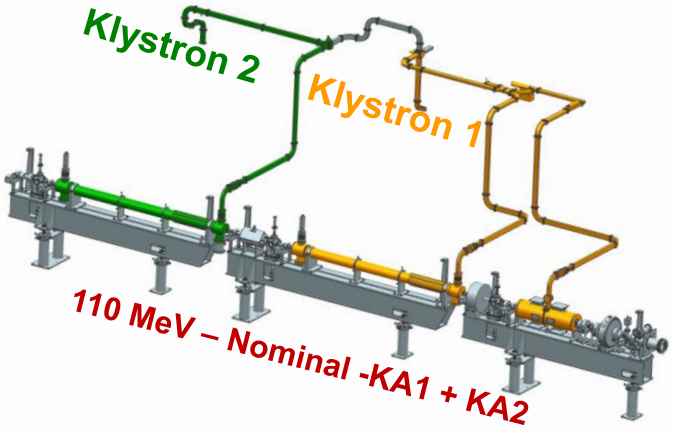
Linac To Booster Optimization Project

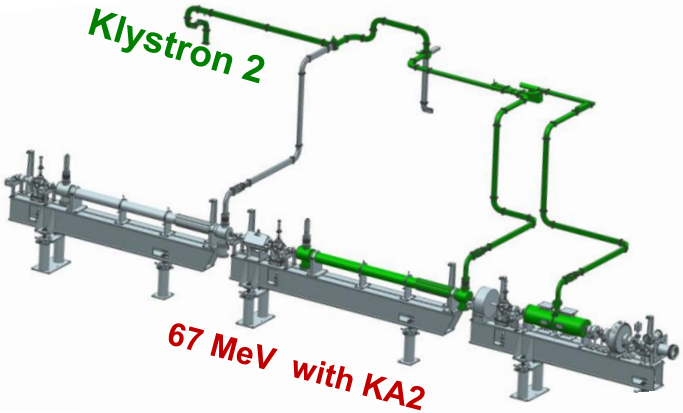
- Ongoing: Li2Bo beam alignment using Beam Base Alignment scripts
- Ongoing: Optimization of LTB_quads settings by Simplex scripts

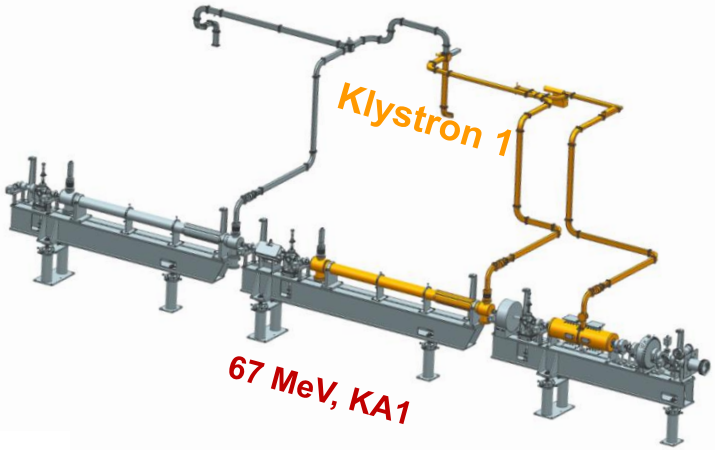


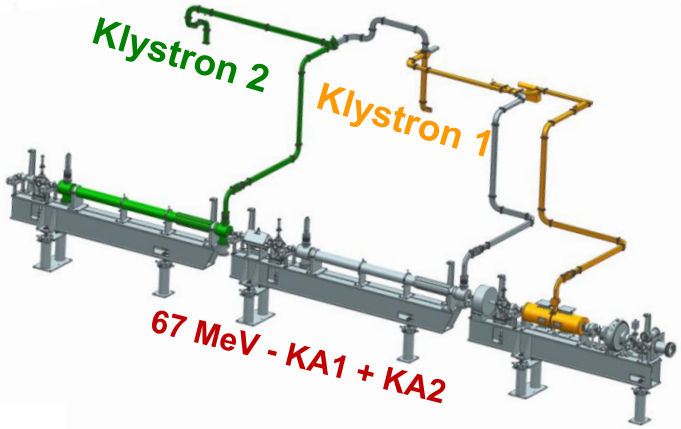
Preliminary results:
Good response to LTB-orbit correction script

Linac improvements









Ongoing: Find a solution in case Buncher-cavity fails

Preparing for LOREA operation

Design Phase:

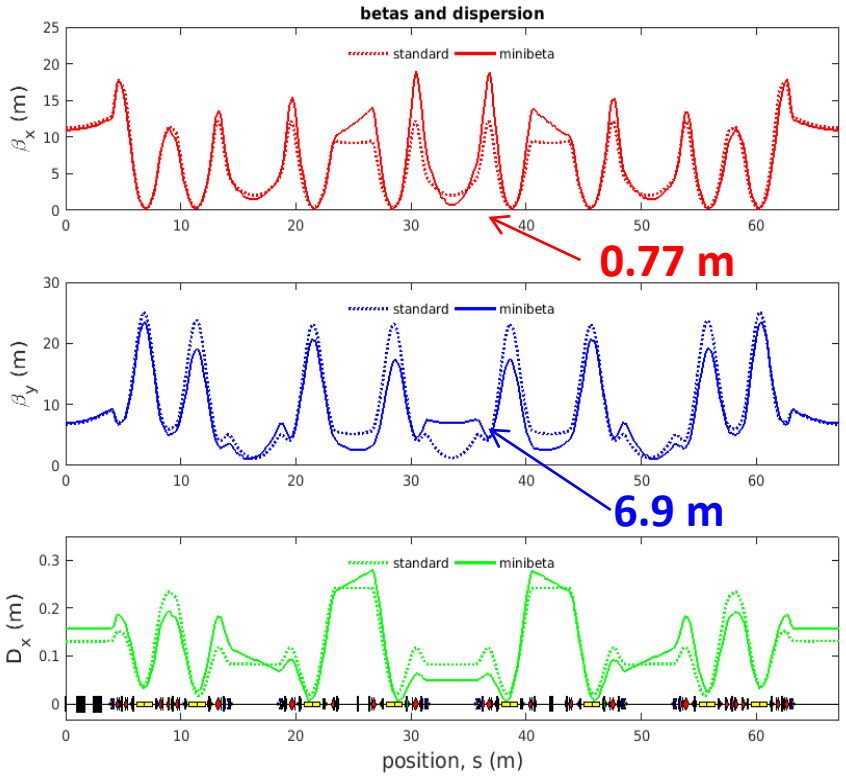
- Check vacuum chamber impedance to ensure beam stability
- Check influence to other beamlines and possible solutions

Presently:

- Correcting coils made of strips glued to vacuum chamber
- Look Up Tables to avoid tune and beta-beating (avoid disturbances to rest of the BLs)

Preparing for FAXTOR operation

- FaXtoR requires a more round beam in its source point
- Several lattices have been studied/tested
- Solution has been found, but lifetime and instabilities have to be improved



Lattice	Lattice	Tunex	Tuney	Emitx (nm rad)	Coupling
standard	a25	18.15	8.36	4.55	0.5%
	minibeta	19.15	8.36	4.02	0.5%

mid MSS

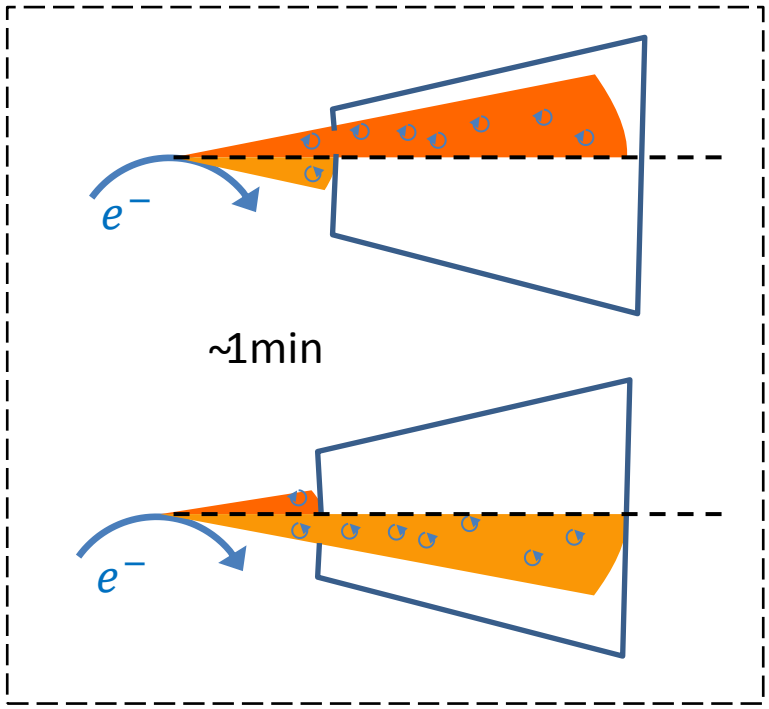
Betx (m)	Bety (m)	Dx (m)	X rms (um)	X' rms (urad)	Y rms (um)	Y' rms (urad)
2.05	1.2	0.083	130	47.1	5.2	4.4
0.77	6.9	0.050	76	72.3	11.8	1.7

side MSS

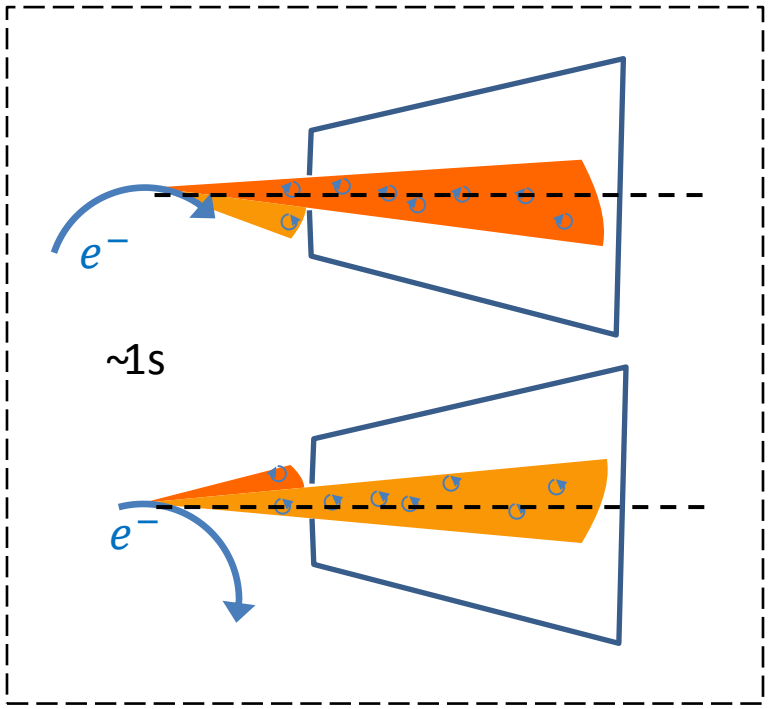
Betx (m)	Bety (m)	Dx (m)	X rms (um)	X' rms (urad)	Y rms (um)	Y' rms (urad)
2.05	1.20	0.083	130	47.1	5.2	4.4
1.59	1.36	0.094	126	50.3	5.2	3.8

Mistral Fast Polarization Switching

Mistral slow (moving the slit) operation during Dichroism measurements



Mistral fast (moving the beam) operation during Dichroism measurements

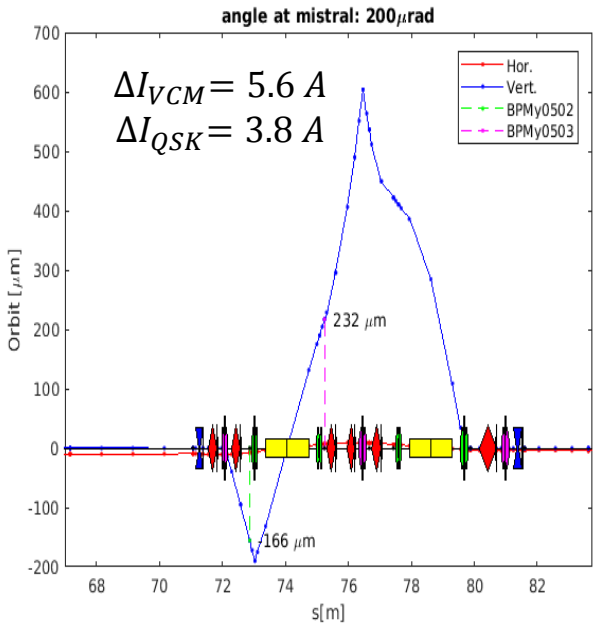


- It allows a faster polarization switch and a more repeatable beamline illumination of the two polarizations

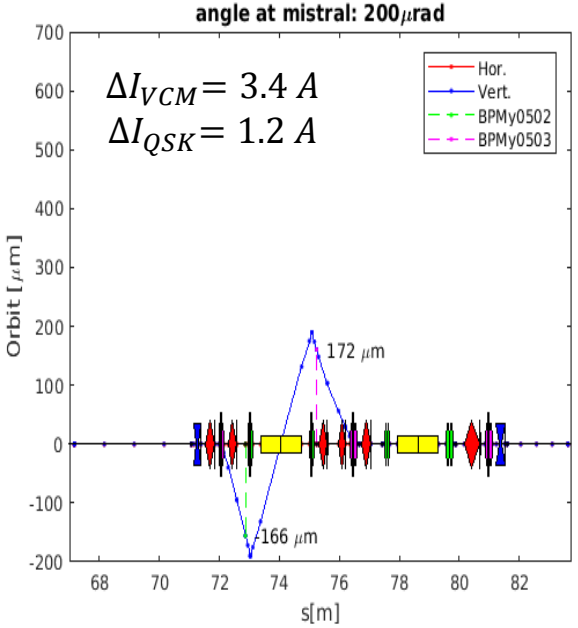
Mistral Fast Polarization Switching

- Angle bump in MISTRAL to switch between two different polarizations
- Change on the FOFB golden orbit; synchronized at 16 sectors
- Simulations, tests with beam, and hardware modifications in power supplies

First tests with existing hardware (July)

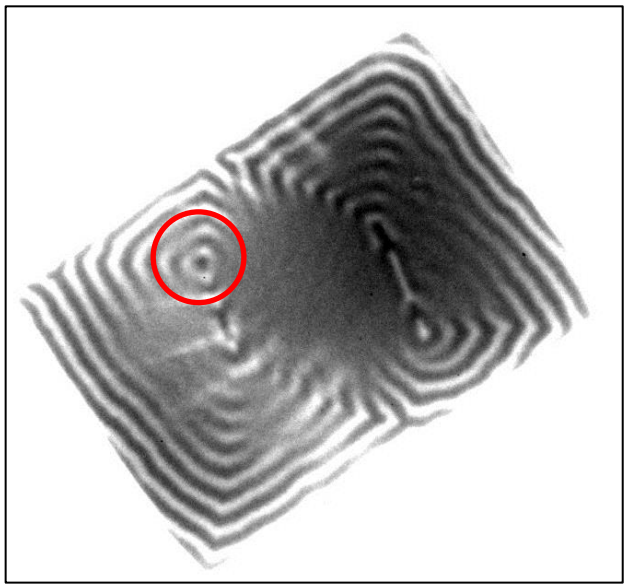


Simulations – HW modifications required

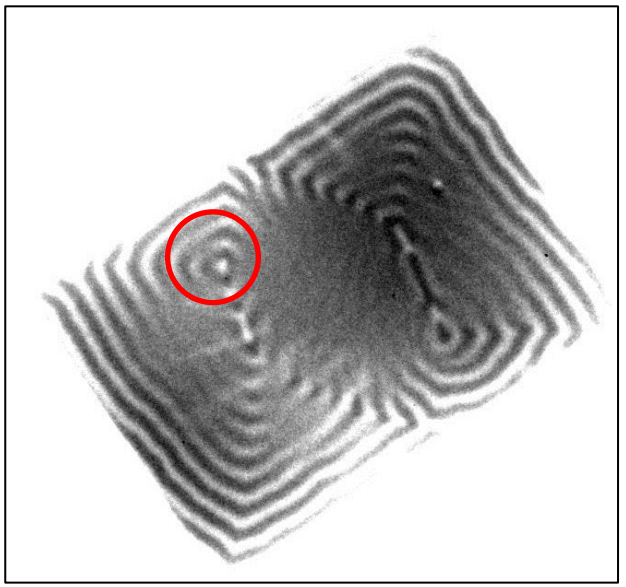


Mistral Fast Polarization Switching

- Tests at the Beamline with a permalloy magnetic particle
- The magnetization polarity of the magnetic domains can be clearly determined



BUMP zero (90 images, 2 sec)
We were almost centered on one polarization



BUMP -280 µrad (60 images, 2 sec)
Reversion around -200 µrad

3rd Harmonic cavity

- 4 cavities at 1,5MHz
- Active (20kW)

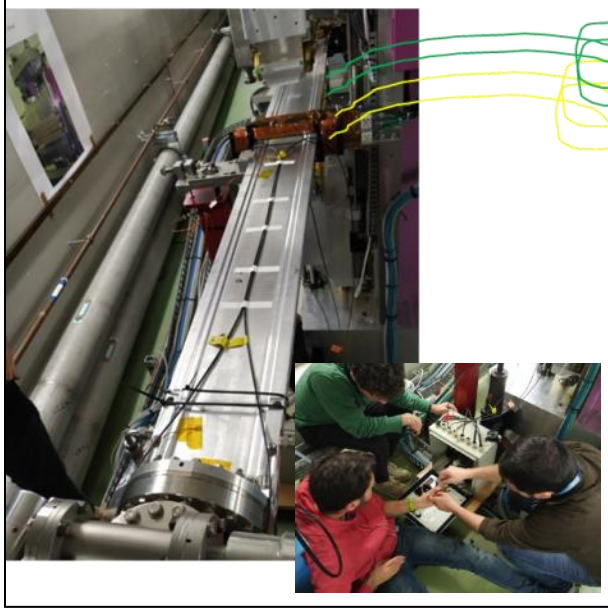
Former CLIC-CERN collaboration

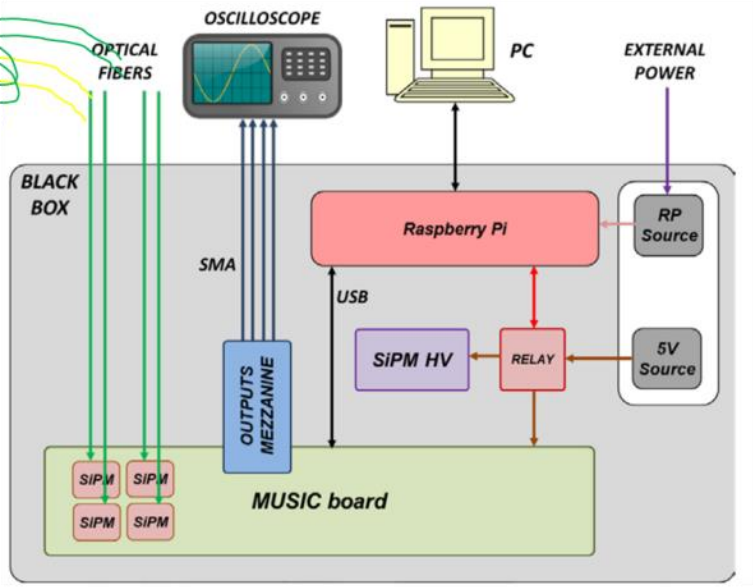
- Same design as SR RF cavities scaled 1/3
- HOM Dampers with N transition to extract power of HOM and to avoid ferrites + brazing
- Cavity Prototype
  - Sept ‘19 signed contract with AVS
  - Delivery expected in spring ‘21
- Transmitter (20kW SSA)
  - Soon…

SiPM Beam Loss Detector

In collaboration with

- Beam lost monitor system based on scintillating optical fibers + SiPM detectors
- Possibility to identify the place of the losses
- Preliminary tests of remote control done using a skippy-TANGO interface

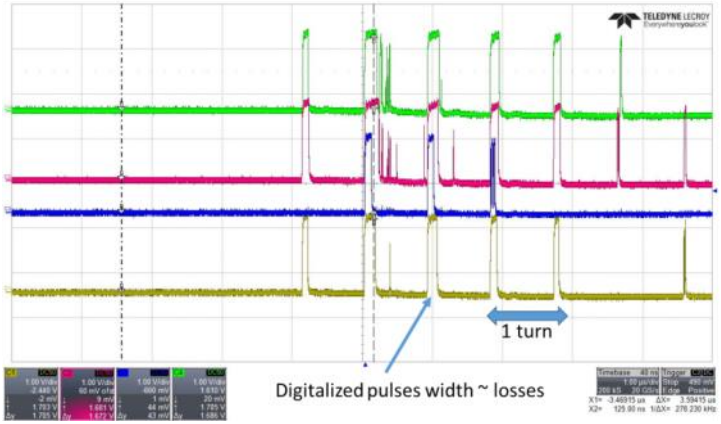




SiPM Beam Loss Detector

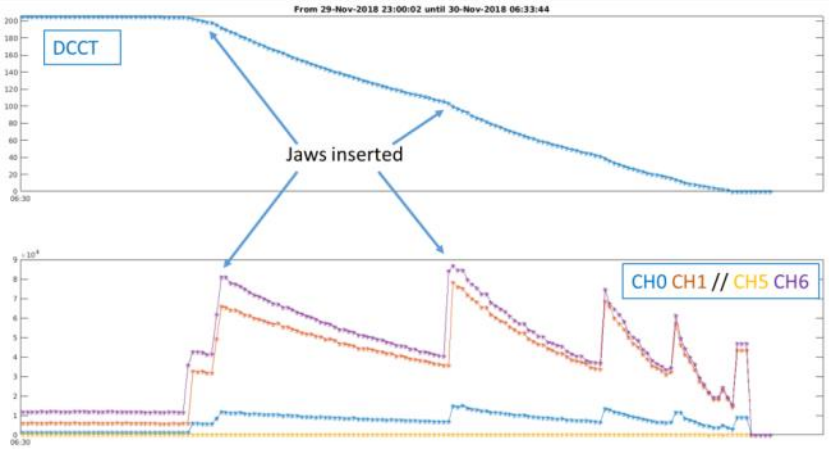
Scope Mode

- Debug mode not intended for normal operation, just for calibration
- Example of turn by turn losses during a TopUp injection cycle



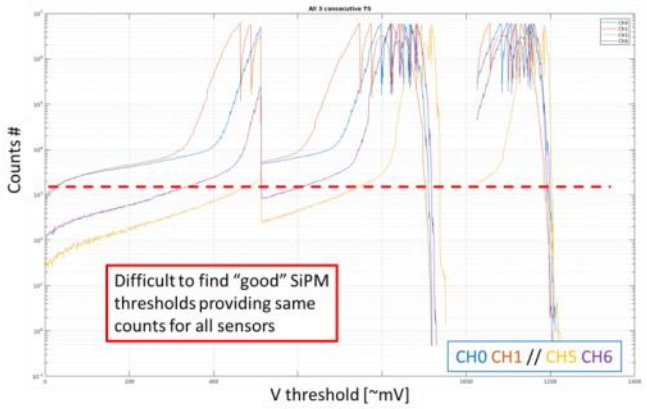
Counting Mode

Example: Acquired losses during a beam scraping

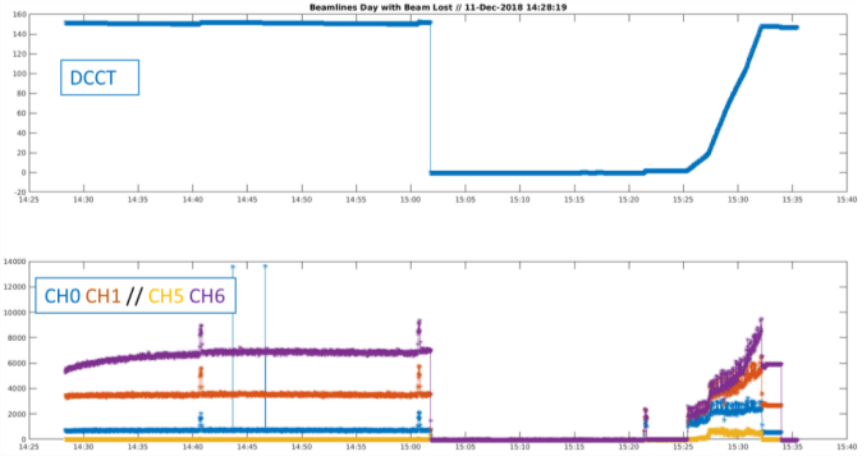


Calibration

SiPM response calibration with beam turned to be too complicated



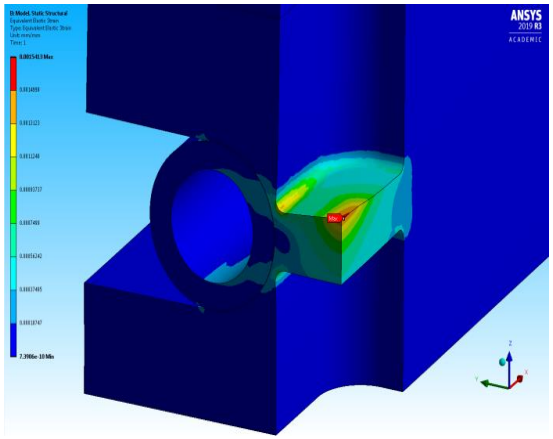
Example: Beam lost and reinjection

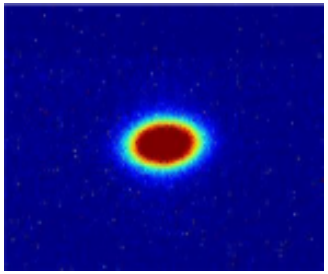


New Pinhole and ICT

New Pinhole

- Complementary beam size measurements for SR
- It will use light from bending magnet at FE21
- Al Window design finished





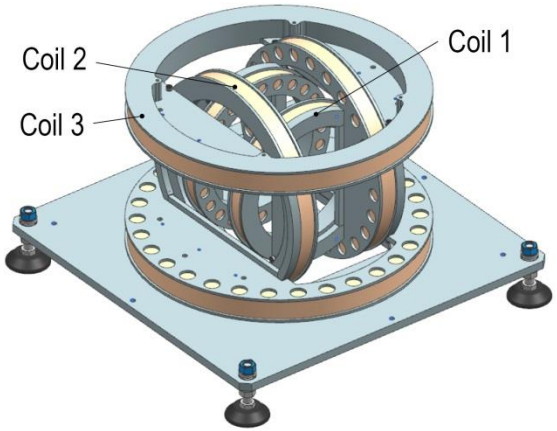
Water cooling design and heat load studies

Integrating Current Transformer

- Alternative beam current measurements at SR (DCCT)
- Pioneer tool for Light Sources (Bergoz)
- Ready for installation during winter shutdown

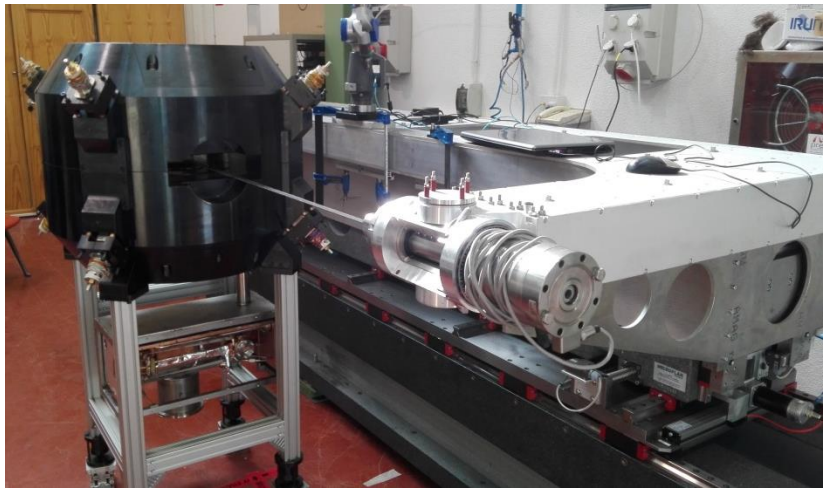
Magnetic measurements lab.

- **3D HELMHOLTZ BENCH**
- Determine 3d hall probe orthogonality
  - Accuracy down to 2mrad

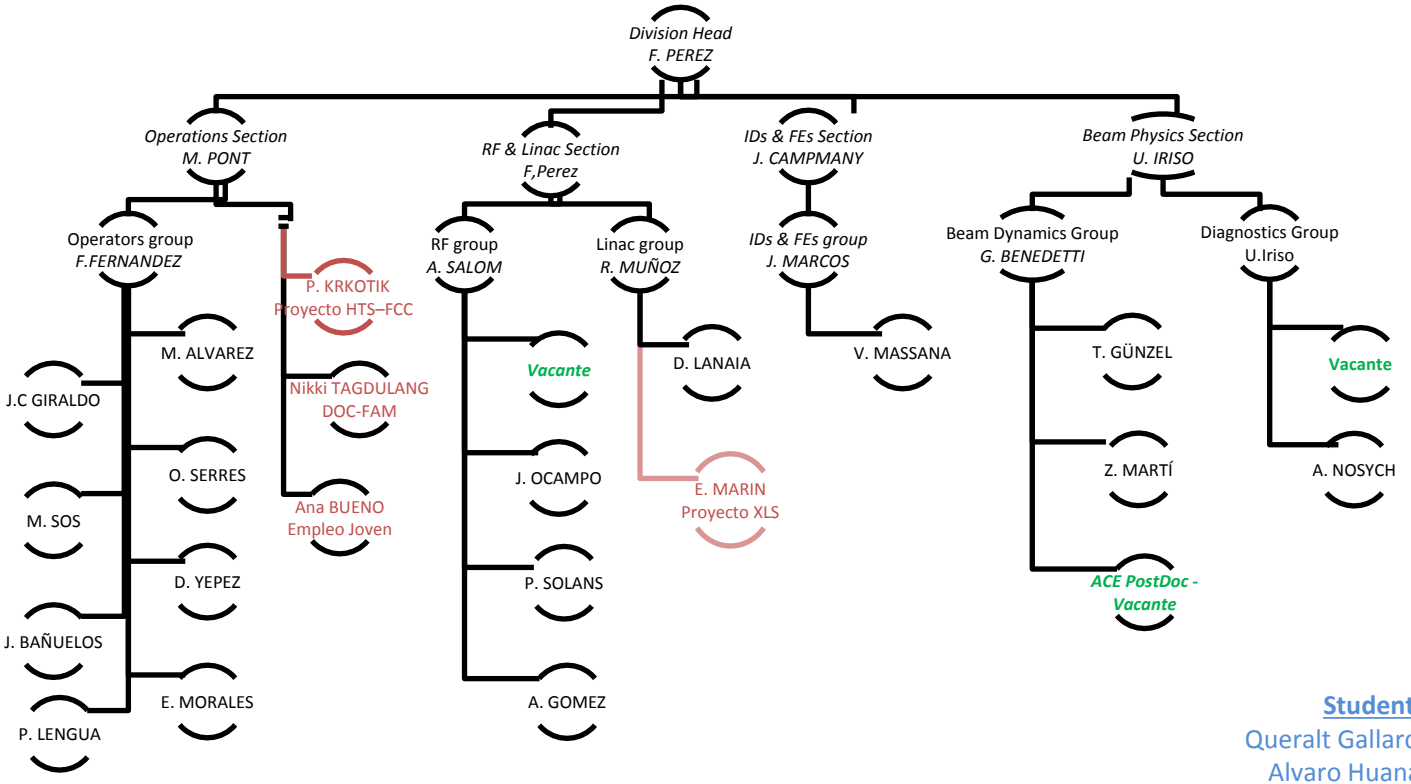


- **FLIPPING and ROTATING COIL**
- Measure small gap multipolar magnets
  - Flipping down to 6mm gaps
  - Rotating down to 11mm gaps

- **NEW HALL PROBE BENCH**
- Measure close structures
  - Now: gaps down to 4.5mm
  - In the future: gaps down to 3mm in vacuum and cryogenics



Thanks to the Accelerator Division…



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… and to ALL other divisions!