



Machine Status and Top Up Operation

Francis Perez



Outline

- Operation
 - 2013
 - 2014 (so far)
- Top Up
- Accelerator Developments
 - Injection bump closure
 - FOFB
 - Beam lifetime
 - Energy measurement
 - Interferometry beam size
 - “67 MeV” injector

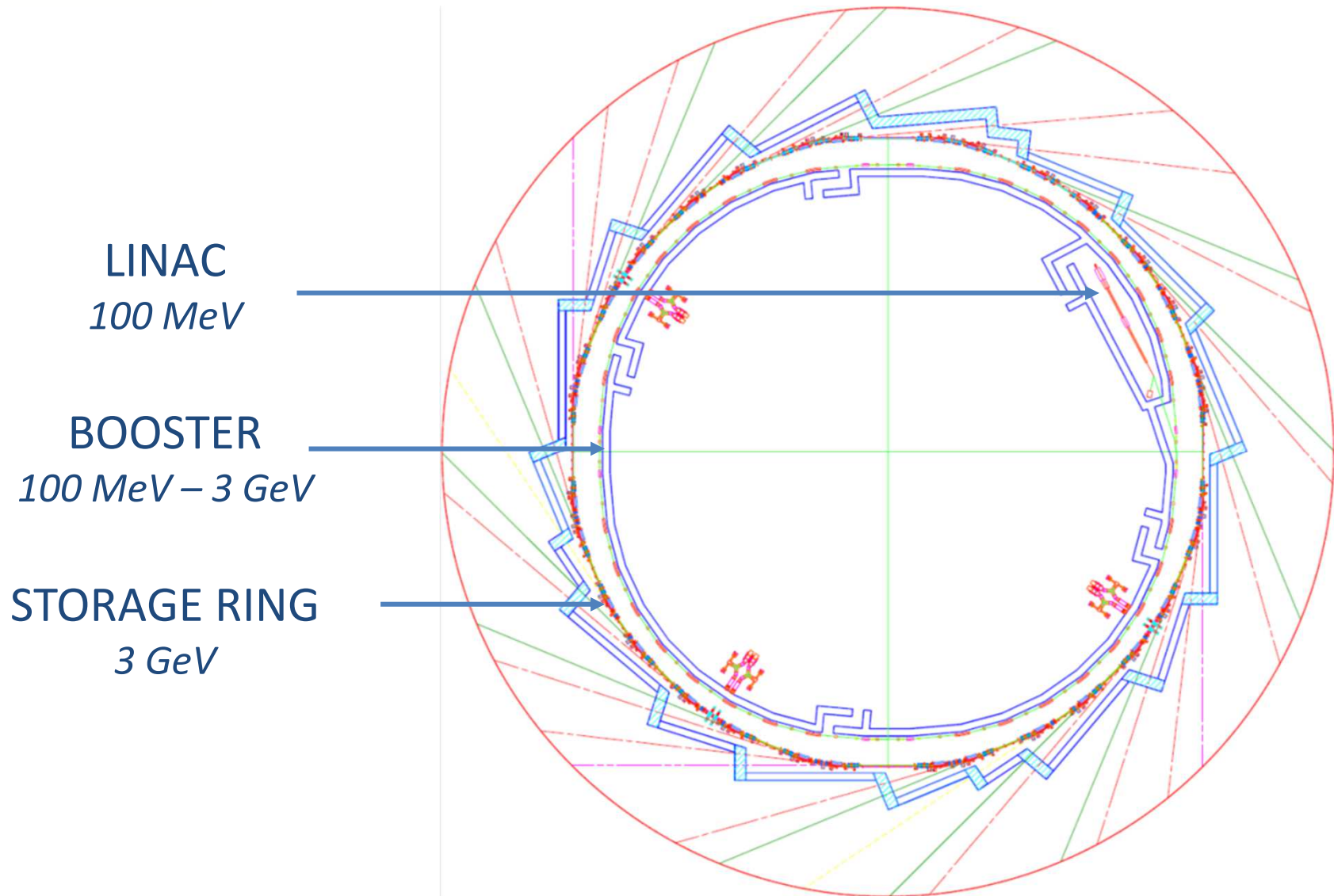


Operation

- ALBA Accelerators
- Operation 2013
- Operation 2014 (so far)



ALBA Accelerators





ALBA Accelerators

Bending

RF cavities

In vacuum undulator



SR

Booster



ALBA Storage Ring

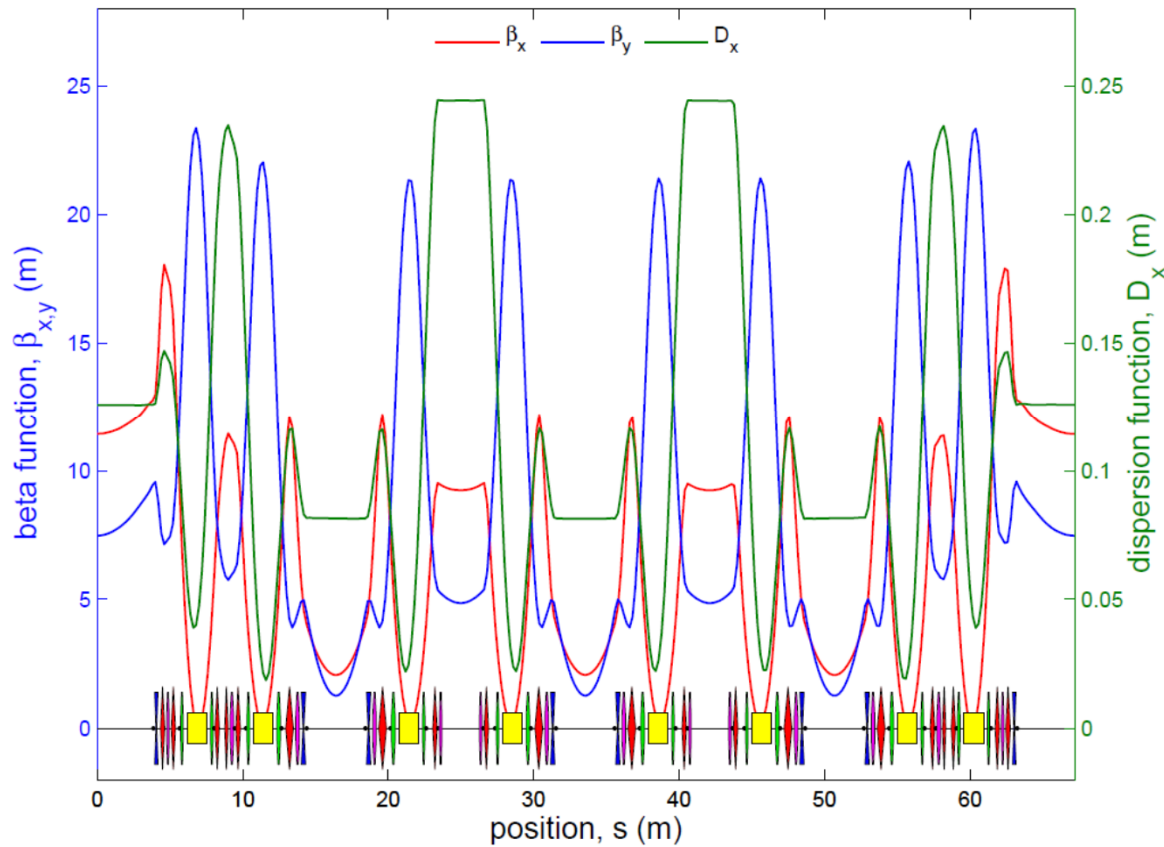
Electron beam energy	3.0 GeV
Storage Ring Circumference	268.8 m
Number of cells	16
Symmetry	4

Straight sections:	4 Long	8.0 m	for 3 ID & Injection
	12 Medium	4.4 m	for 12 ID
	8 Short	2.6 m	for 2 ID & RF & Diagnostics

Beam current	250 mA
Emittance	4.3 nm.rad
Lifetime	> 10 h



ALBA Storage Ring

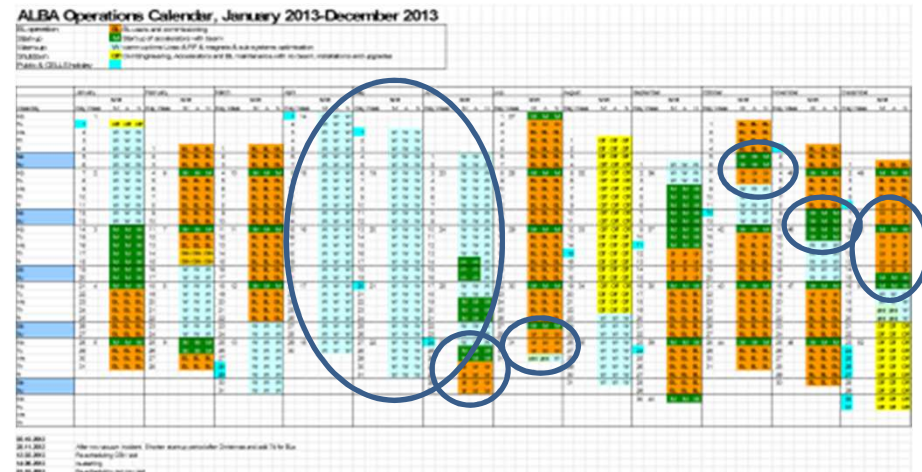
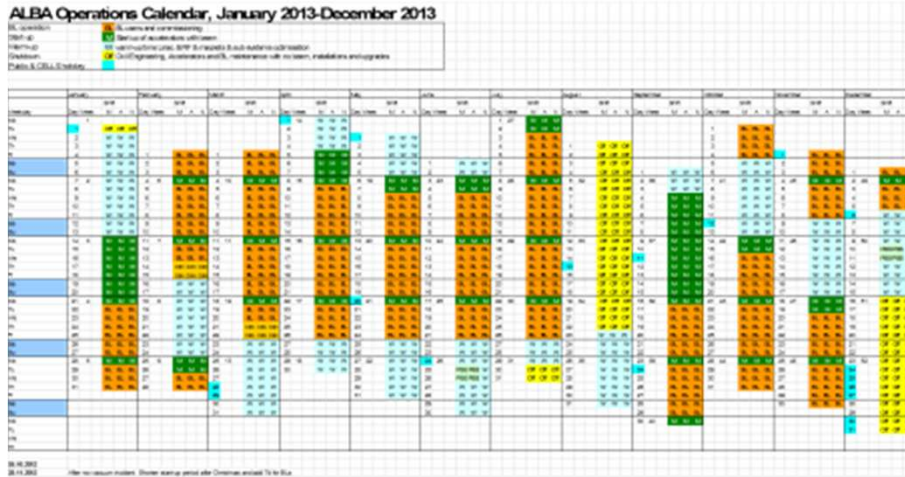


E [GeV]	3
C [m]	268.8
Q_x	18.19
Q_y	8.24
ϵ_x [nm rad]	4.3
ξ_x	-34
ξ_y	-24.5
α_p	8.4×10^{-4}
a_2	2.5×10^{-3}
$\delta E/E$	1.05×10^{-3}
$J_x/J_y/J_E$	1.3/1/1.7
$t_x/t_y/t_E$ [ms]	4.0/5.3/3.1



Operation 2013

The cooling incident force a major modification of the operations calendar in July 2013



Total hours lost (runs 03 to 05): **1416 h**

Total hours added (runs 06 to 09): **824 h**



Operation 2013

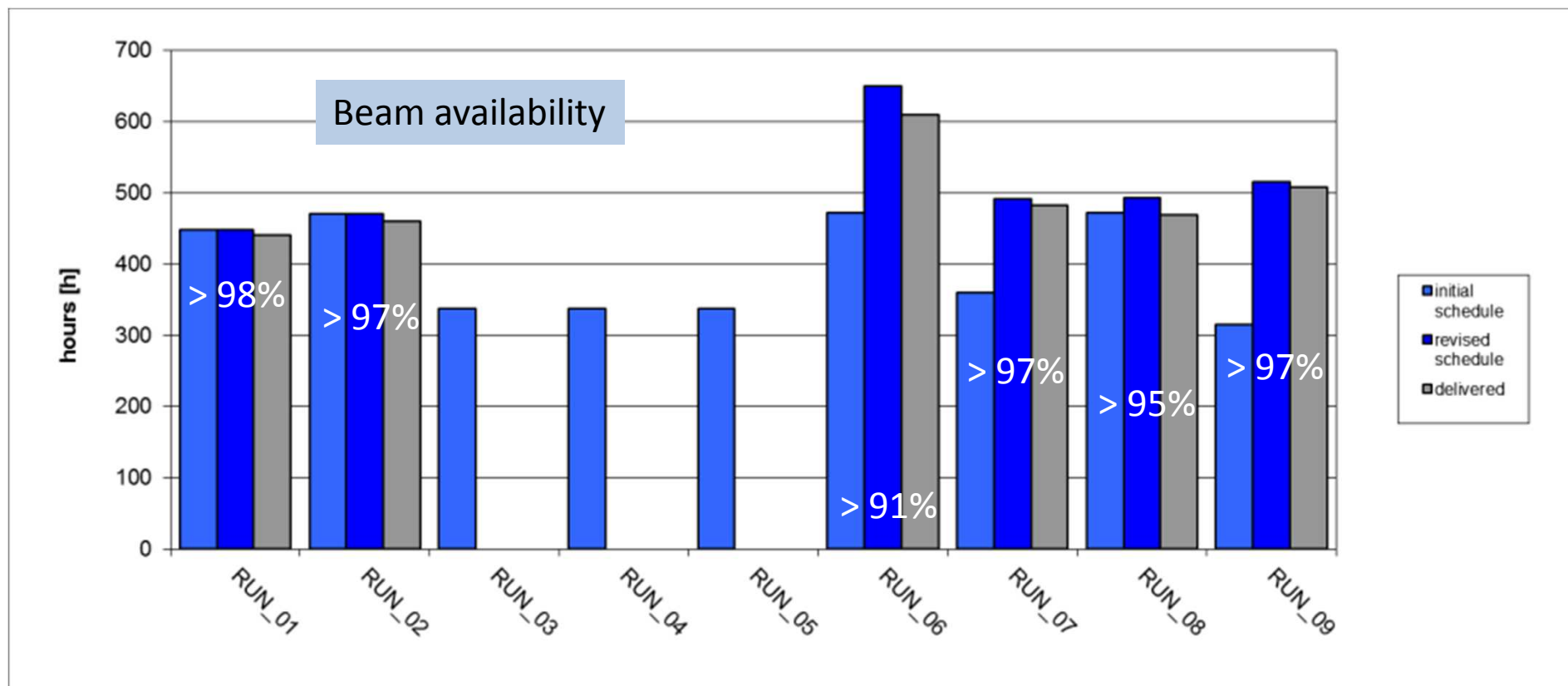
The cooling incident force a major modification of the operations calendar in July 2013

	Initial schedule	Revised schedule	Delivered
BL(2012)			2387.3
BL(2013)	3539.5	3069.0	2971.5
Injections	252.5	219.0	
M+csn	1488.0	1368.0	
W	2432.0	3240.0	
Off	1048.0	864.0	

Total hours lost (runs 03 to 05): **1416 h**

Total hours added (runs 06 to 09): **824 h**

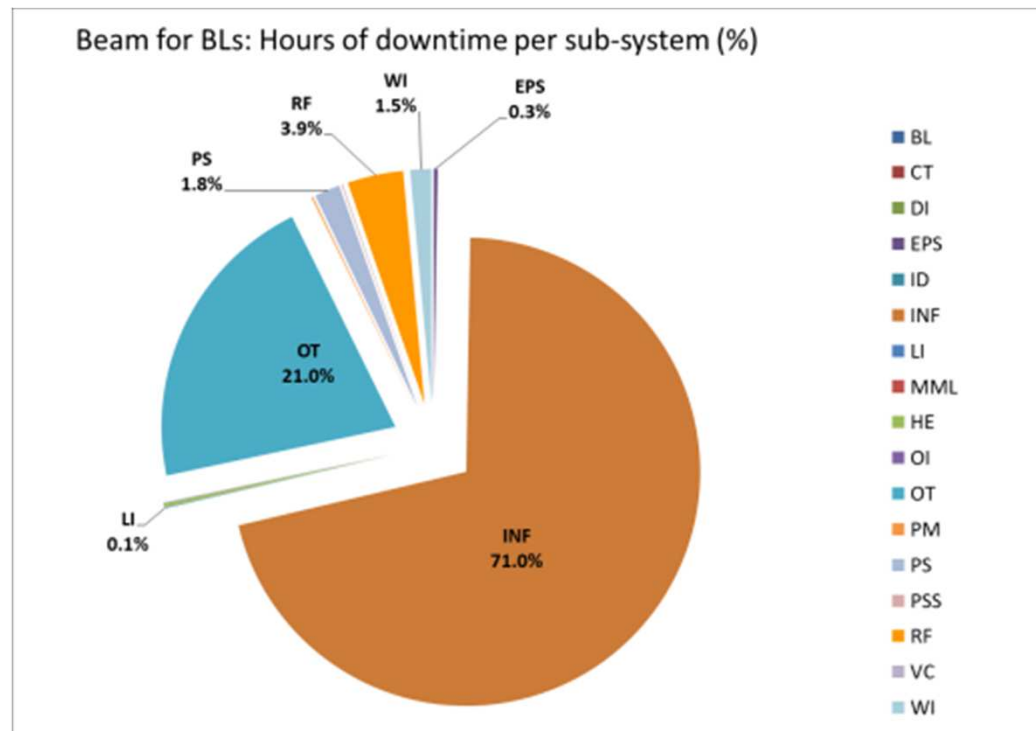
Operation 2013



83.8 % average over initial schedule
 96.8 % average over revised schedule

Operation 2013

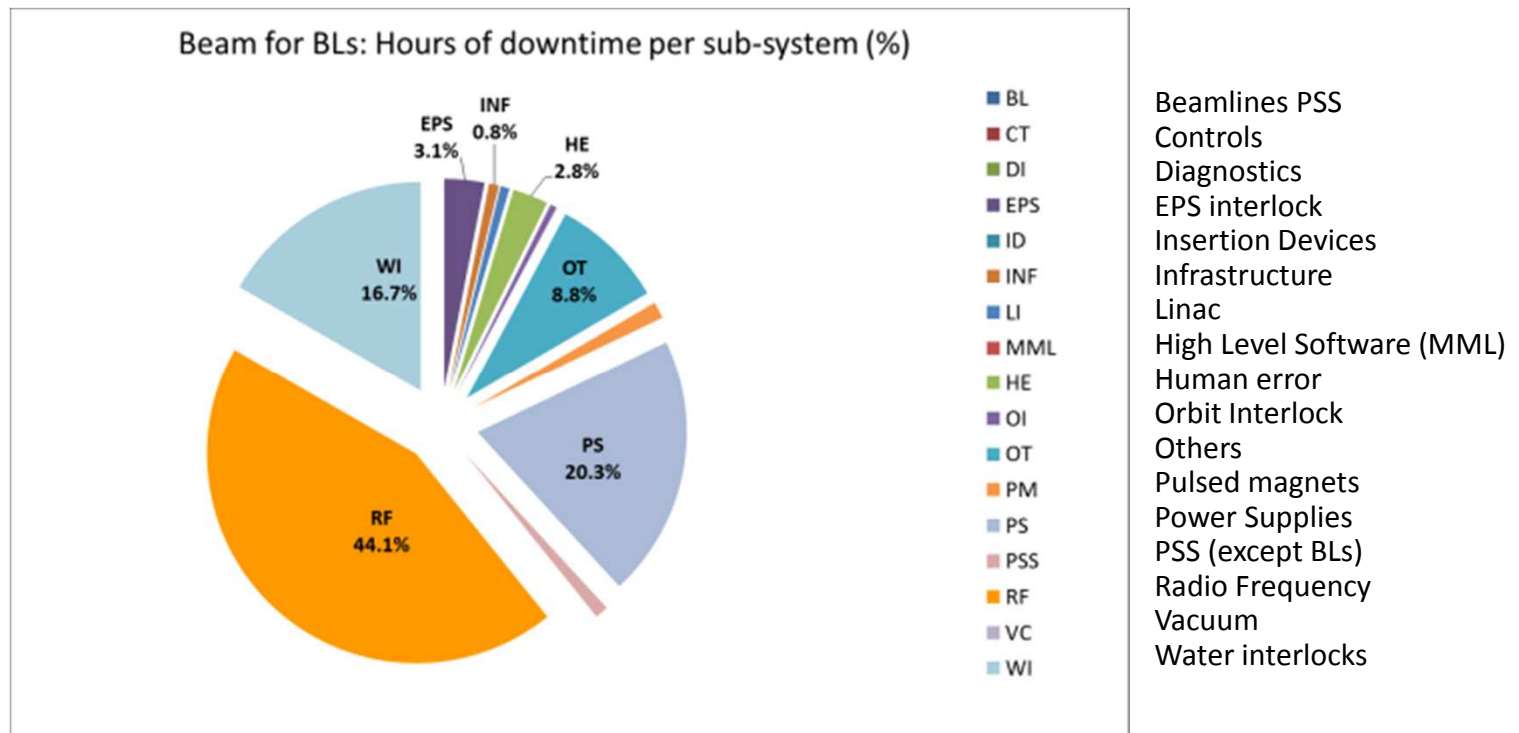
Analysis of failures per sub-system
Total of 1109.5 h of beam downtime



- Beamlines PSS
- Controls
- Diagnostics
- EPS interlock
- Insertion Devices
- Infrastructure
- Linac
- High Level Software (MML)
- Human error
- Orbit Interlock
- Others
- Pulsed magnets
- Power Supplies
- PSS (except BLs)
- Radio Frequency
- Vacuum
- Water interlocks

Operation 2013

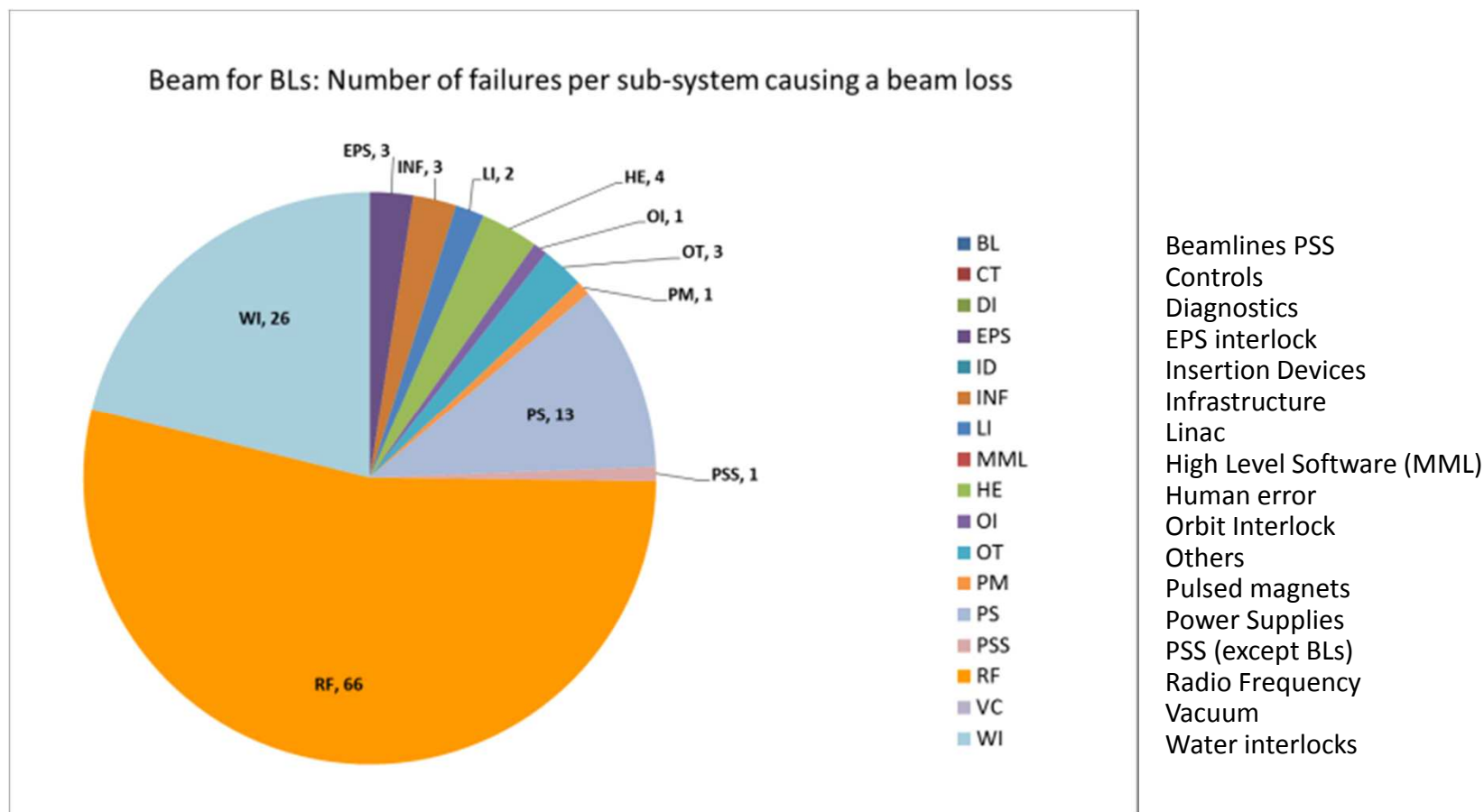
Analysis of failures per sub-system w/o cooling & MPW chamber replacement
Total of 97 h of beam downtime ≈ 0.7 h/BL day



Operation 2013

Analysis of failures per sub-system w/o cooling & MPW chamber replacement

Total of **123 failures** causing a beam dump ≈ 0.9 failure/BL day $\rightarrow$ **25 h MTBF**





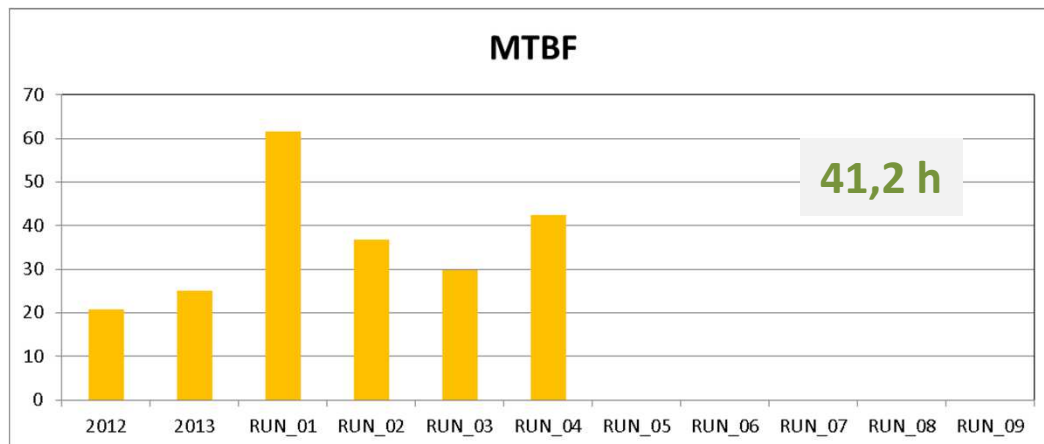
Operation 2013

Summary

	2012	2013
Beam for BLs	2387.3	2971.5
Availability	85 %	96 % *
MTBF	21.0	25.0 *
MTTB(back)	1.0	0.8 *

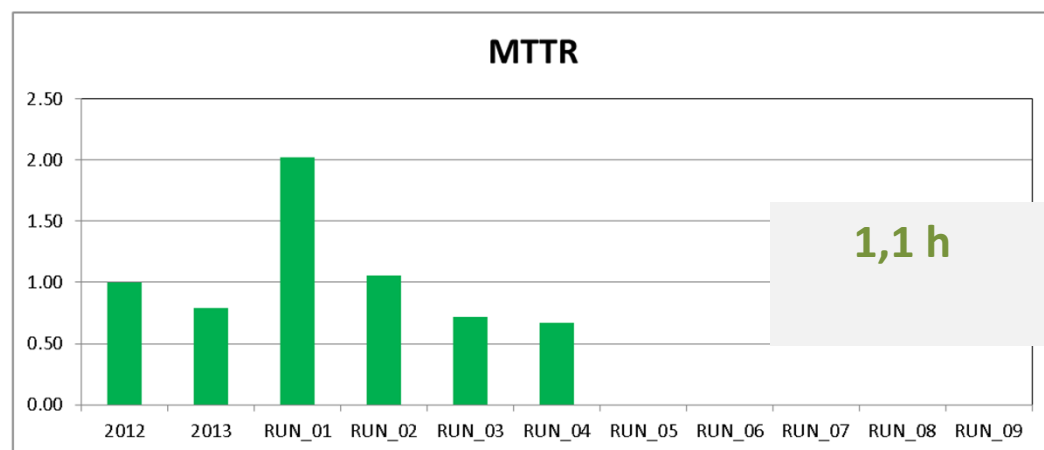
*** Excluding water
cooling problem**

Operation 2014 (so far)



Beam availability:

RUN_01	96.7 %
RUN_02	97.1 %
RUN_03	97.6 %
RUN_04	97,7 %



1,1 h

11.0 h

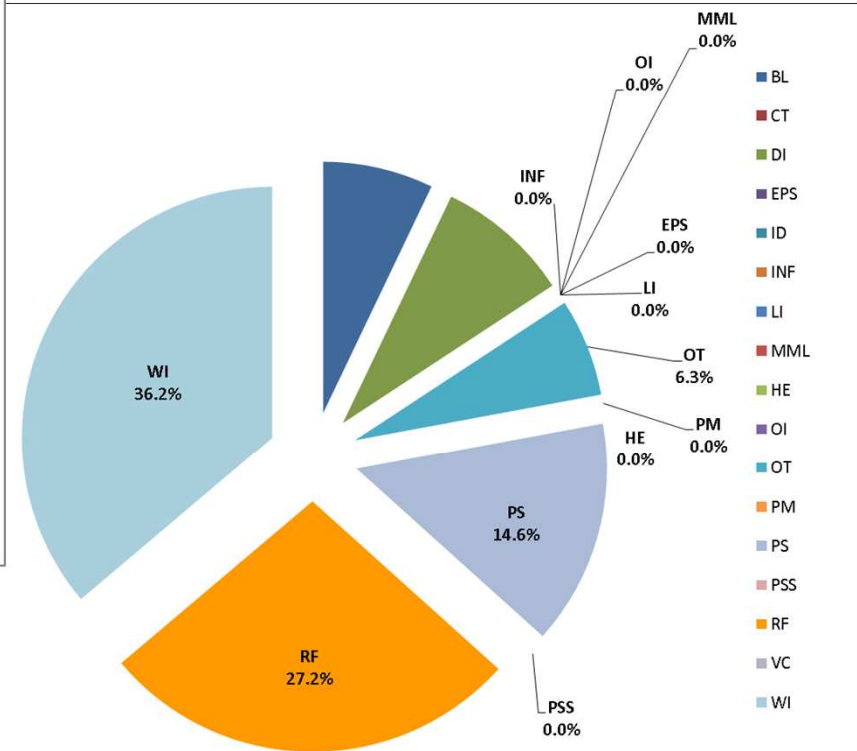
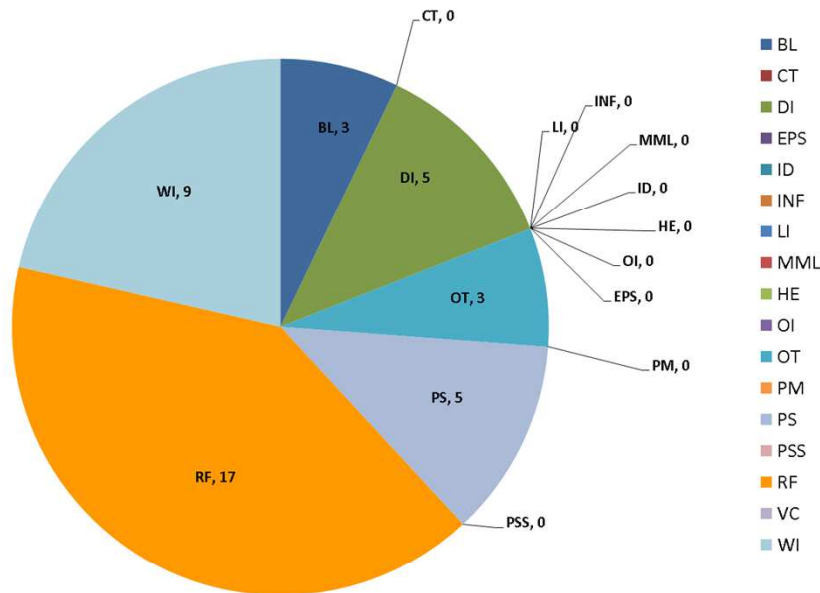
2.3 h

Water leak at FE34

PSS intlk at BL09

Operation 2014 (so far)

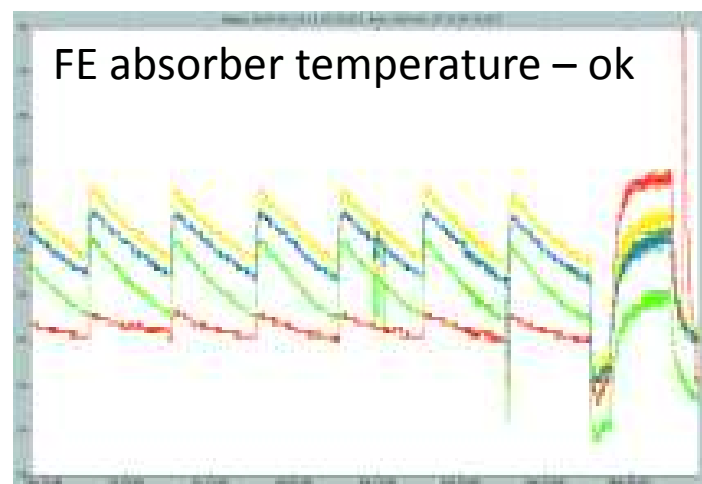
BEAM FOR BEAMLINES:
NUMBER OF FAILURES w BEAM LOSS



Pinhole aluminium window water leak

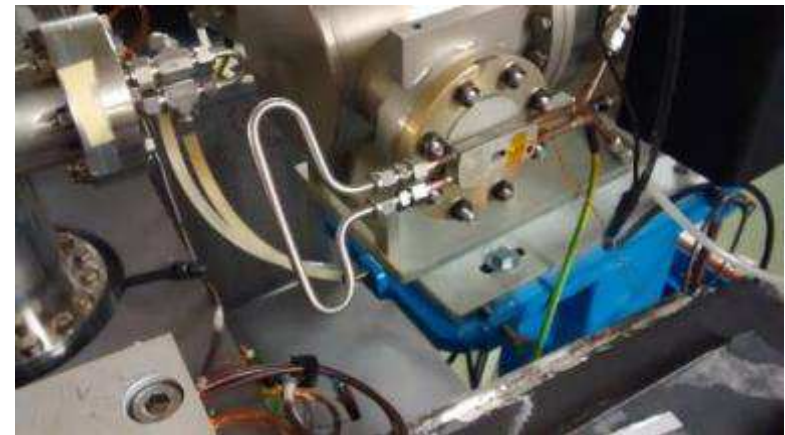
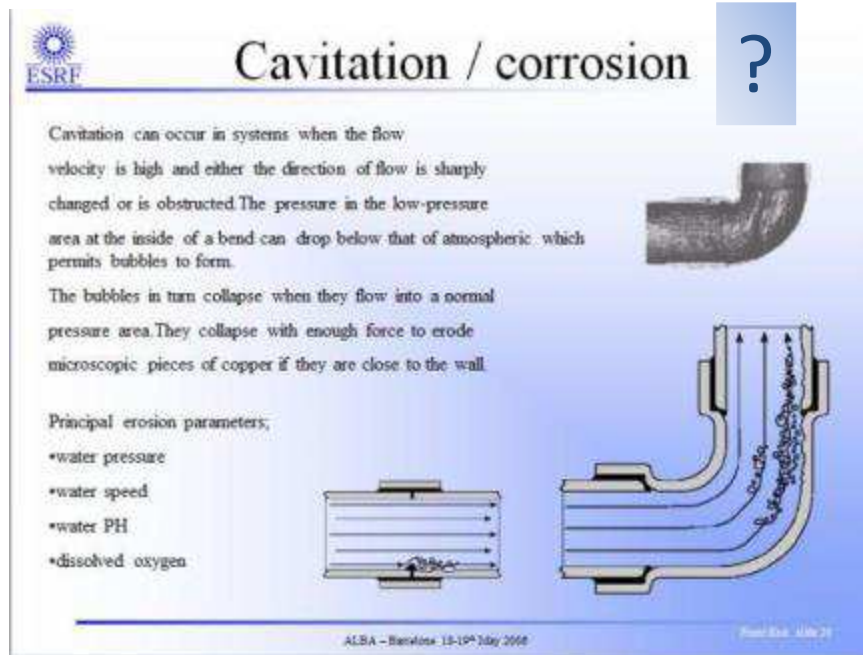


Damaged
Kicker
Electronics



Pinhole aluminium window water leak

Small (350um) hole in the Cu cooling pipe



Repaired the following day



LINAC Gun High Voltage PS

Before starting run #3, during the subsystem tests, the LINAC Gun High Voltage PS (-90 kV) did broke.

We did not have available spare:



Exchanged by -50 kV PS (*from RF group*) and commissioned the Linac with reduced e-gun beam energy.

BESSY lend us a -90 kV as back-up

(many thanks to Andreas that pick up the phone on May 1st and SOLEIL that offered also their spare)

Reparation already done and new spare purchased

Back to normal along this week



IOTs – RF transmitter upgrade

IOTs Upgrade: 1 prototype
4 series units

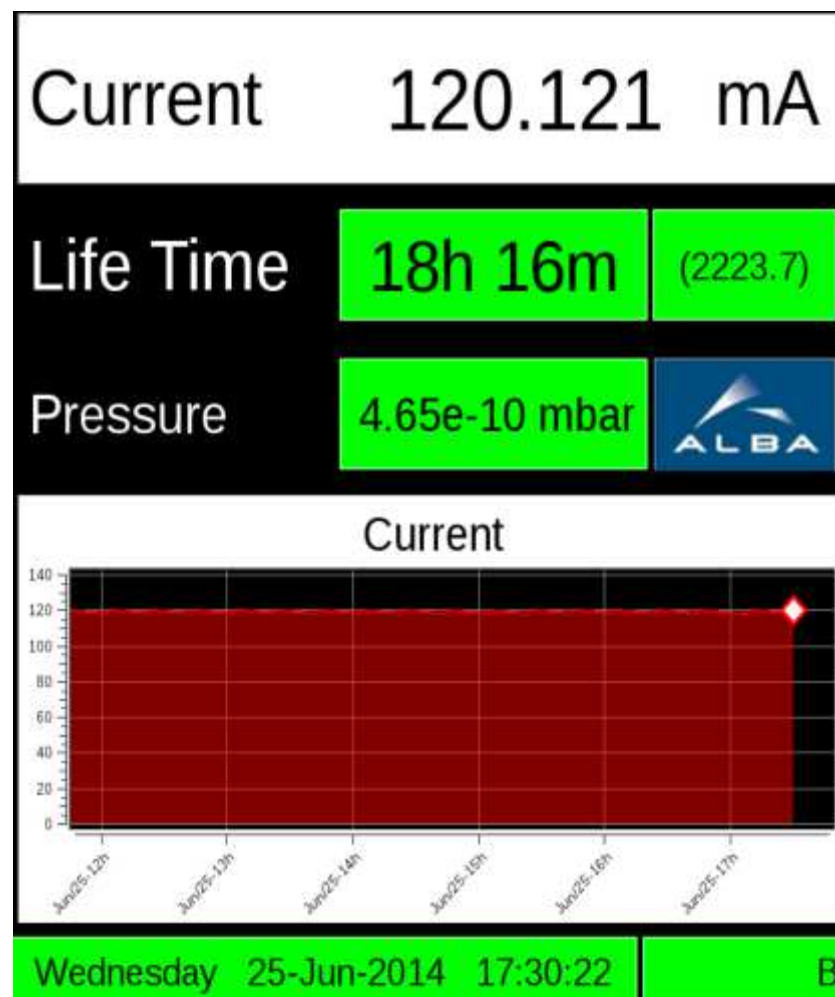
end of 2014
summer 2015



In addition, more Thales IOTs spares purchased.



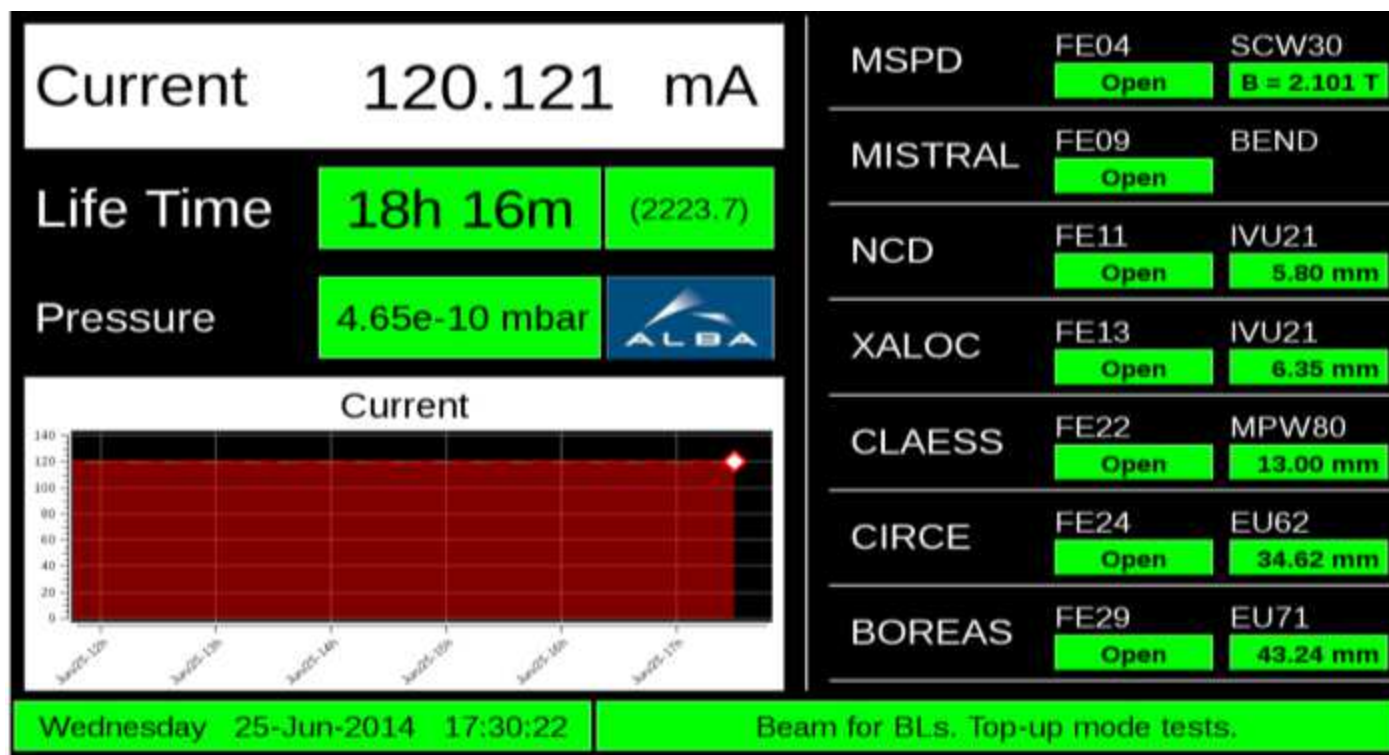
Top Up





Top Up

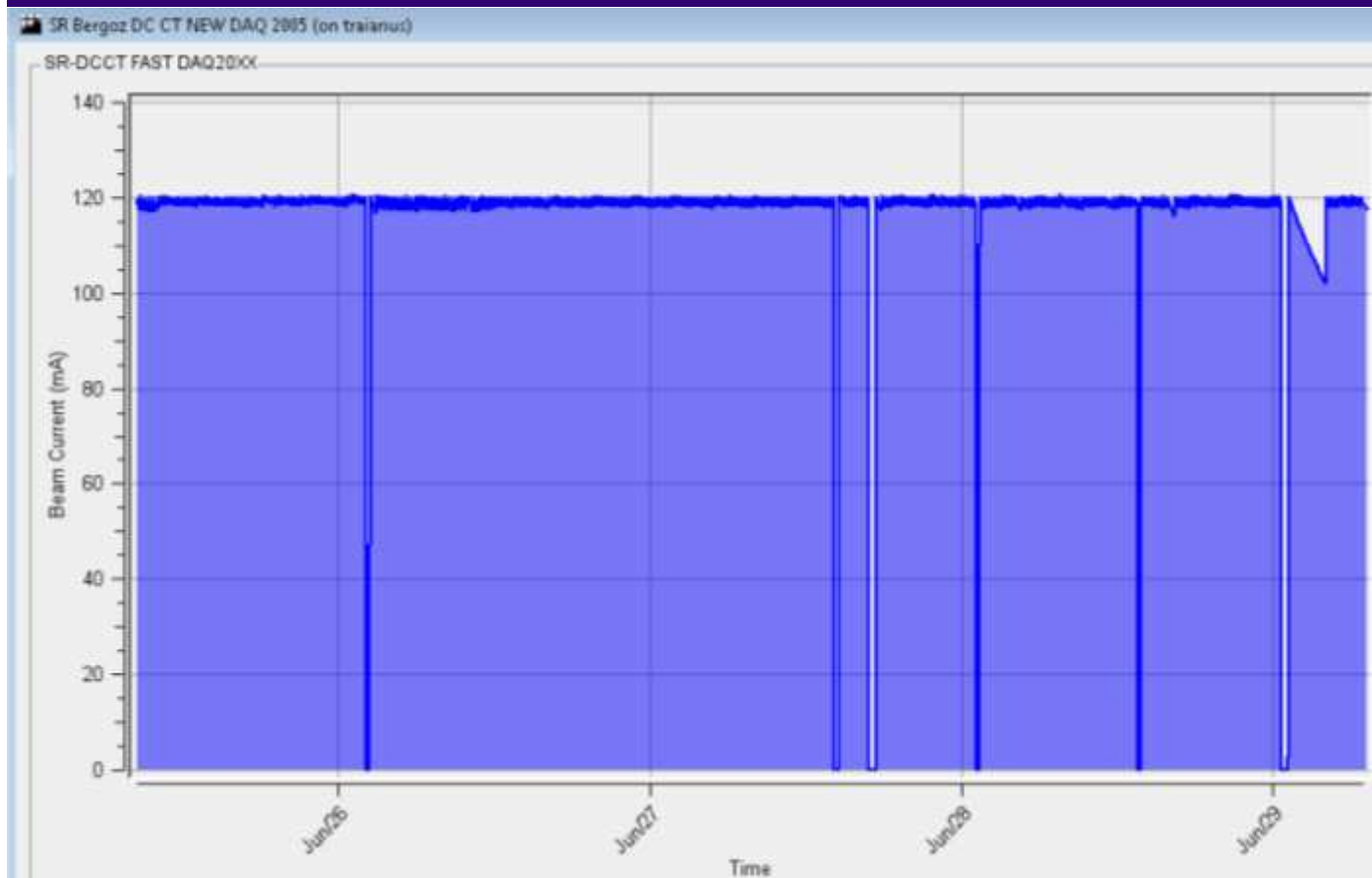
Top-up operation test with users: *last week*
June 25th – 28th, 2014





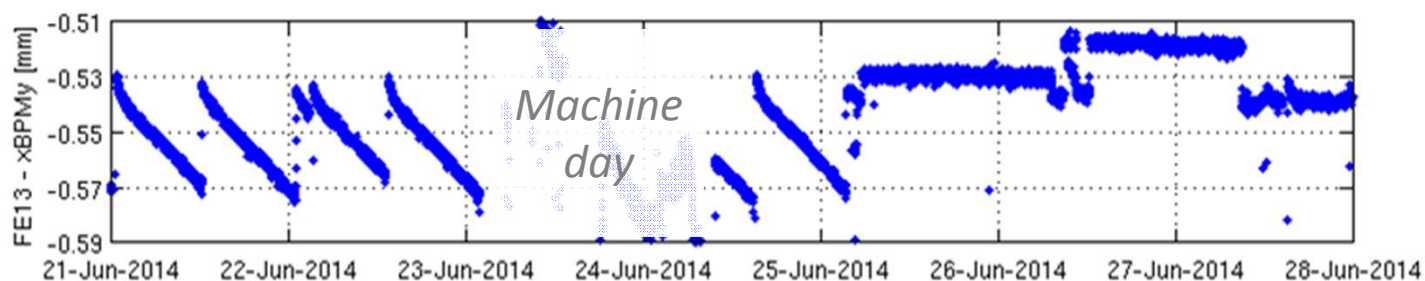
Top Up

Top-up operation test with users: *last week*
June 25th – 28th, 2014



Top-up operation test with users: *last week*
June 25th – 28th, 2014

XALOC: $x\text{BPM}_{(y)}$



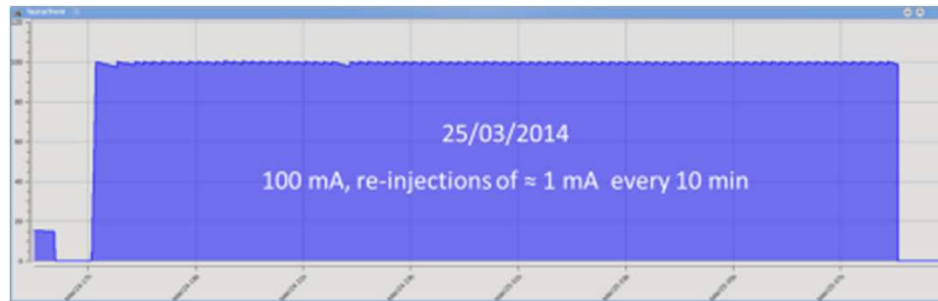
←
→

Decay mode

Top-up
(jumps are due to changes in the ID gap)

Top Up

Influence of injection on BLs,
after several test together with the BL scientists.



	sensitive to BO	sensitive to KI
BL04	No	
BL09	No	
BL11	No	
BL13	No	
BL22	No	
BL24	Slight increase of noise, but the effect is marginal	Yes, gating is needed
BL29	No	Slight increase of noise but the effect is marginal. No gating is needed



*Soft
gating
provided
to BLs*

Acoustic noise -due to the Booster PS ramping at 3 Hz- at Experimental Hall

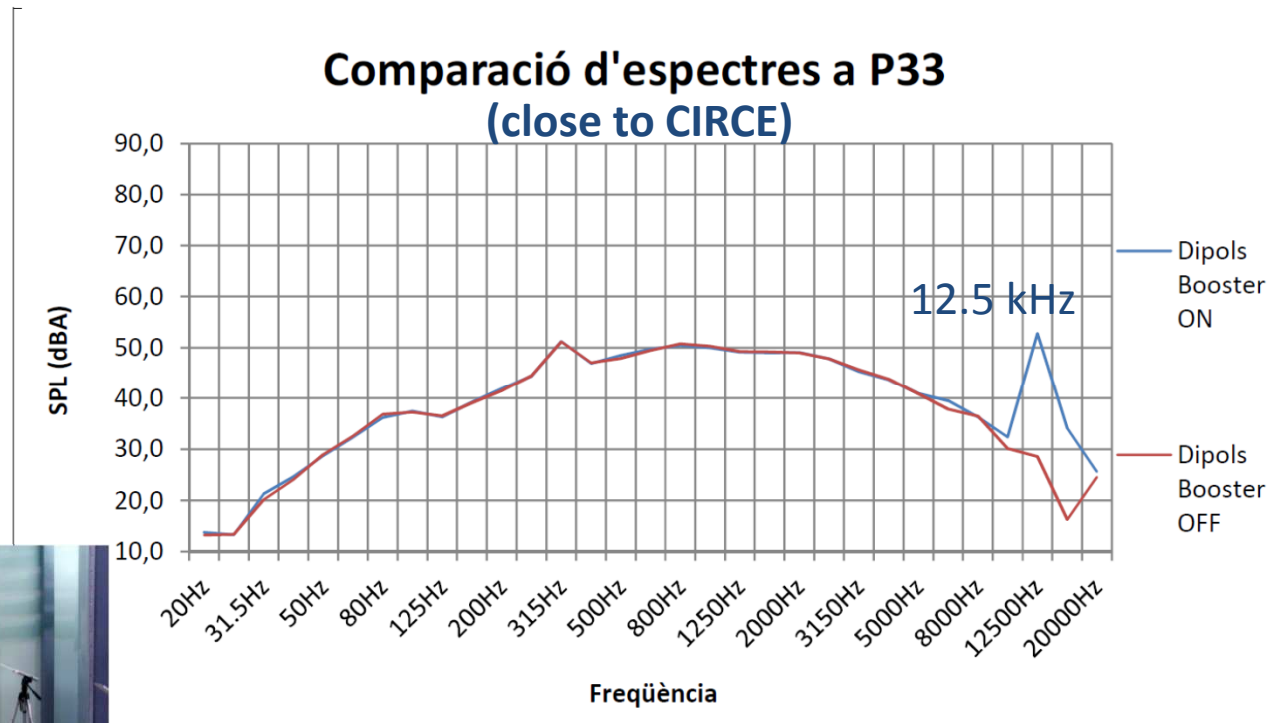


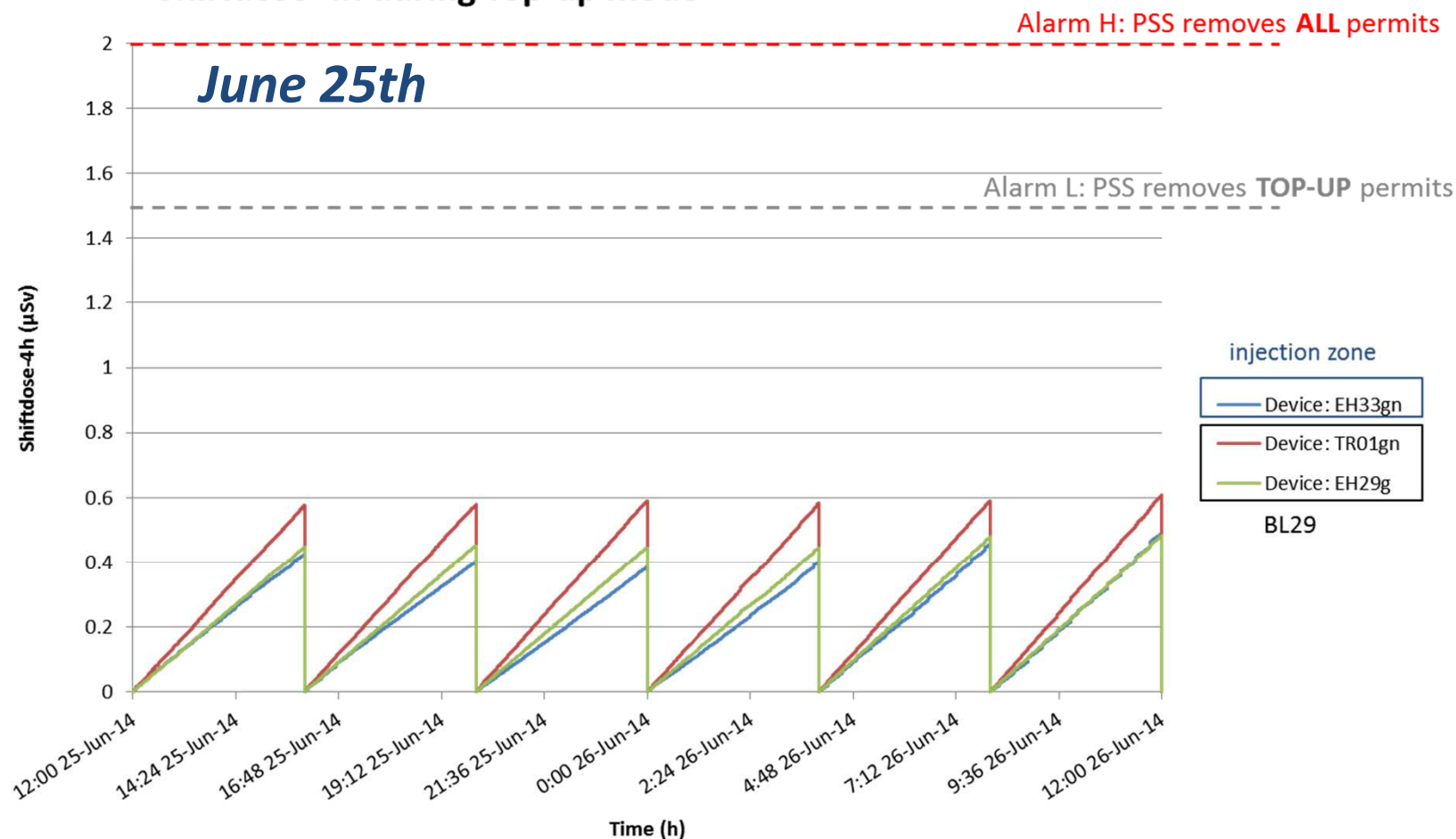
Figura 3.3: Comparació entre els terços d'octava a P33.



Technical solutions to damp the noise are under investigation

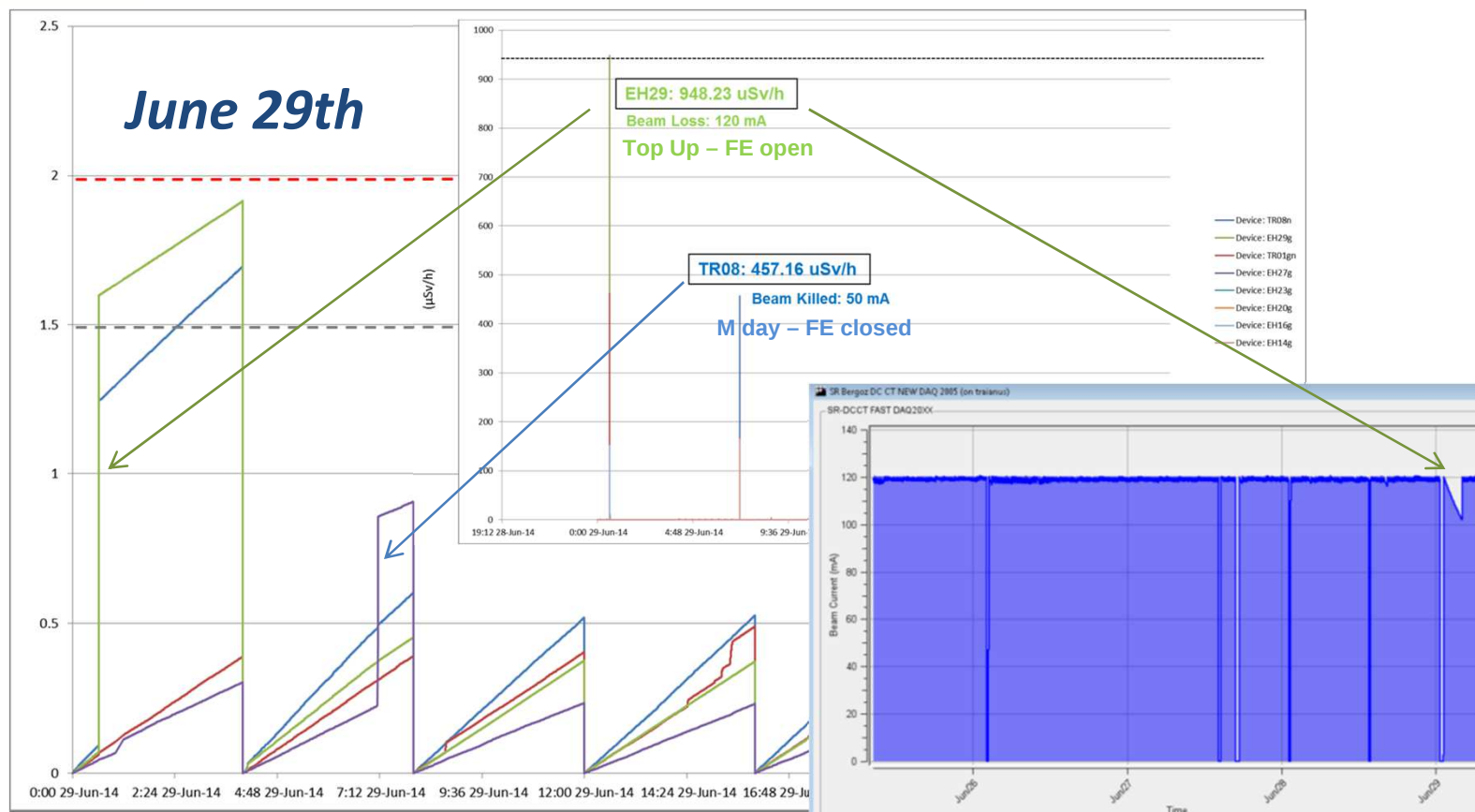
Radiation measured during Top-Up

Shiftdose-4h during Top-up mode



Well below Public Zone & Similar to decay mode

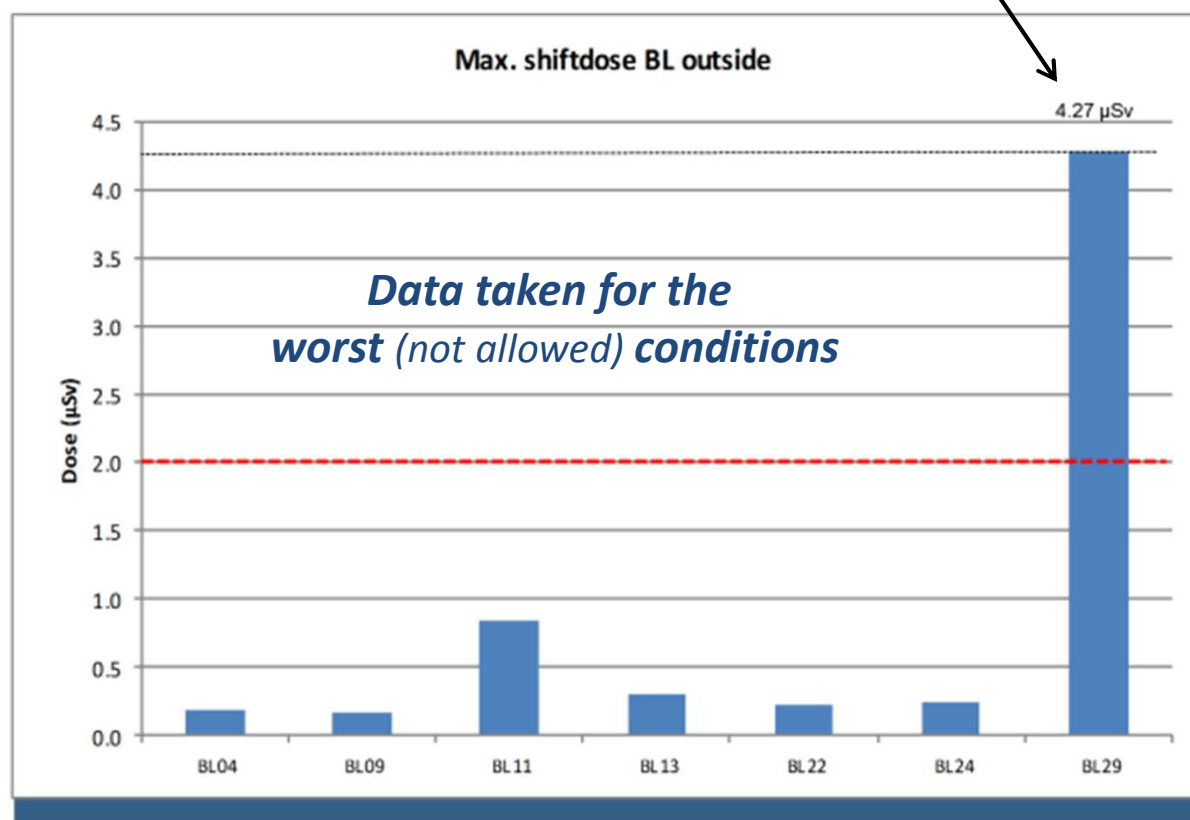
Radiation measured during Top-Up



These are beam loses, not Top Up related radiation, but triggered the Top Up PSS logic to act in order to maintain the dose below 2 μSv / 4h – Public Zone.

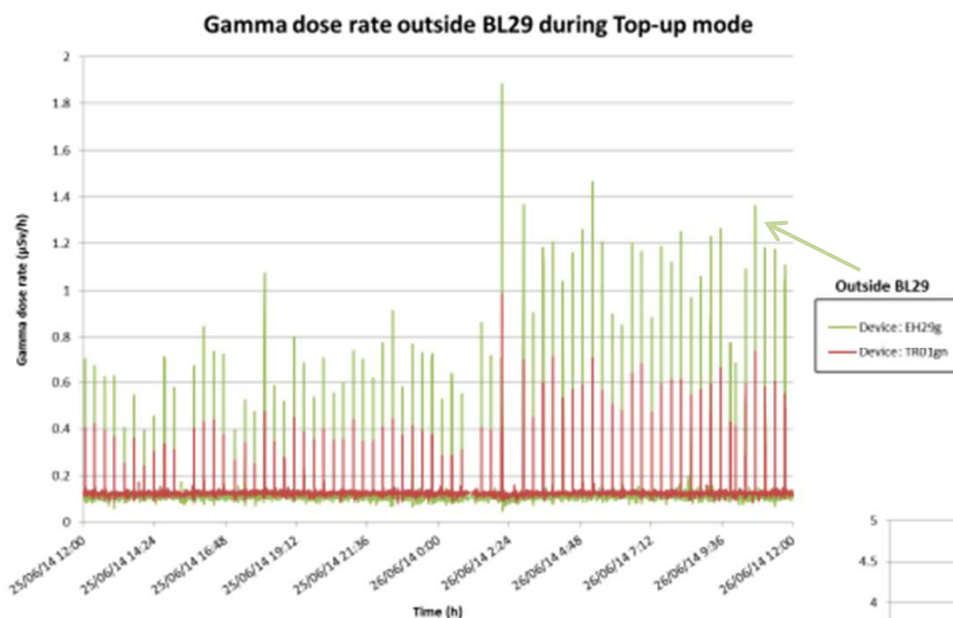
Radiation measured during Top-Up

Specific measurements at BOREAS Optical Hutch, only BL where higher doses were detected



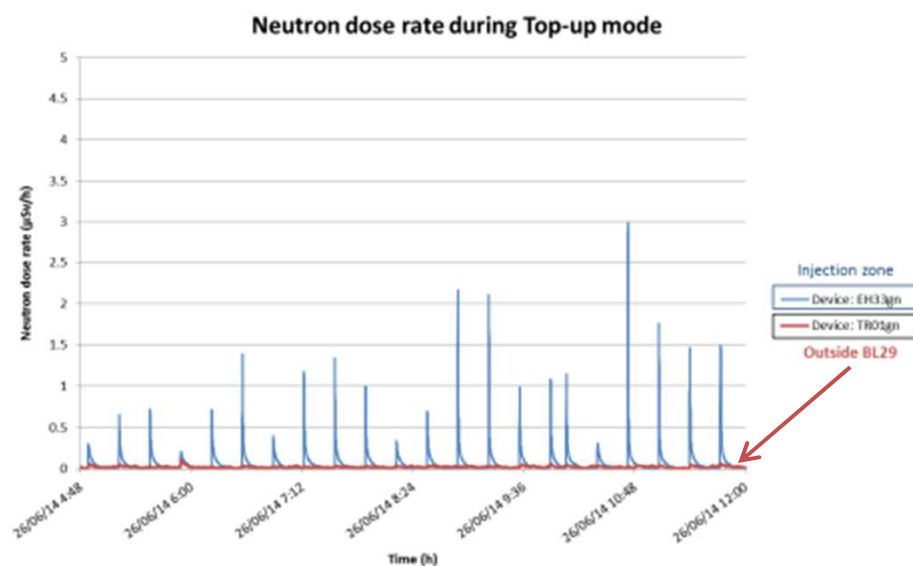
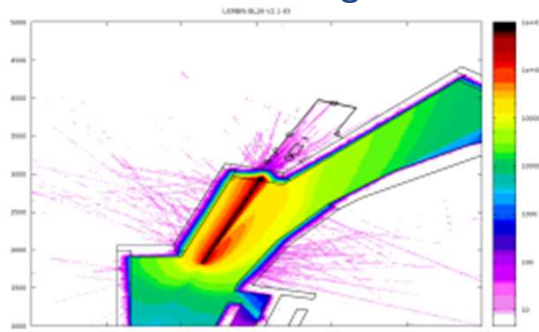
From last SAC

Radiation measured during Top-Up

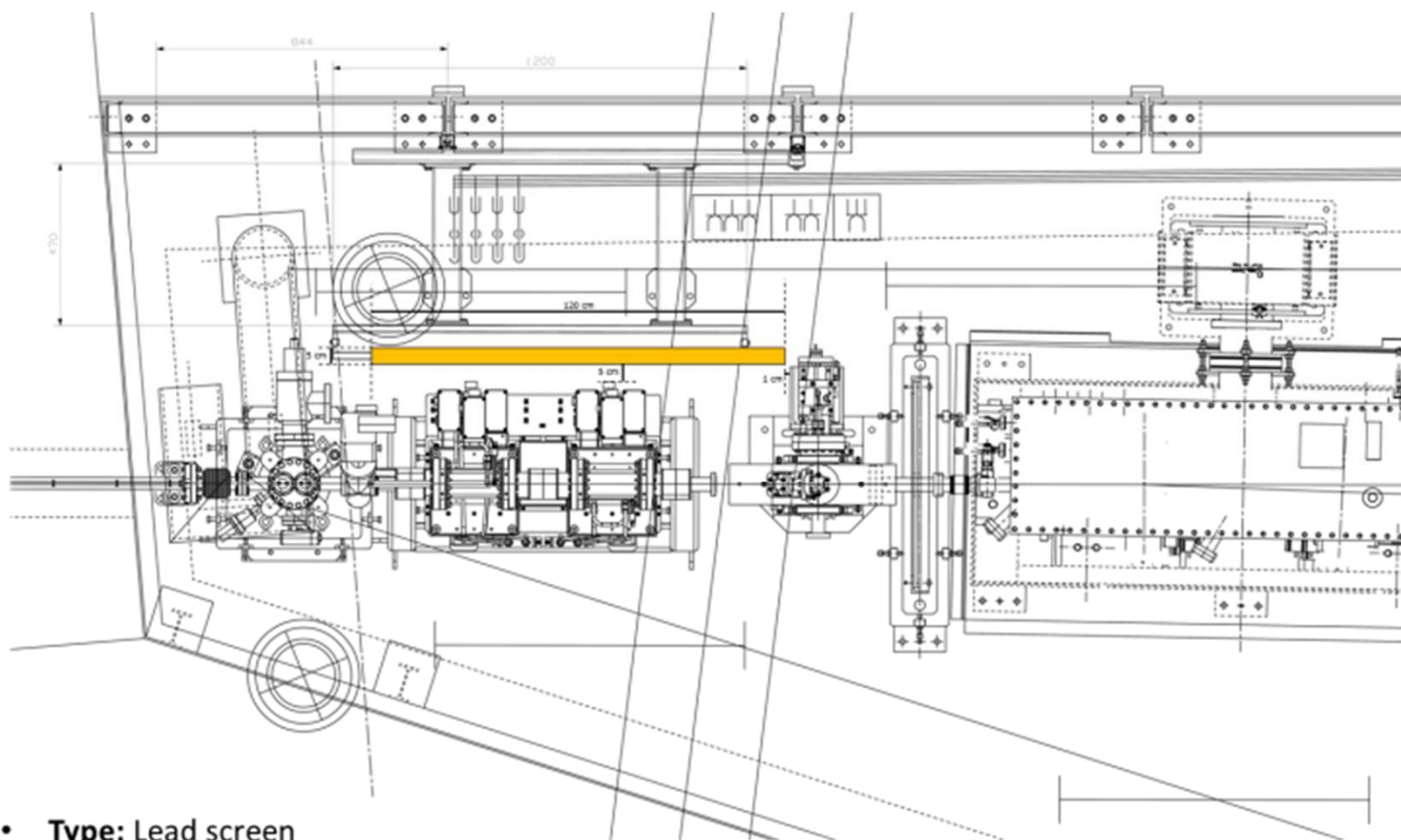


Only gammas detected
at BOREAS

Under investigation



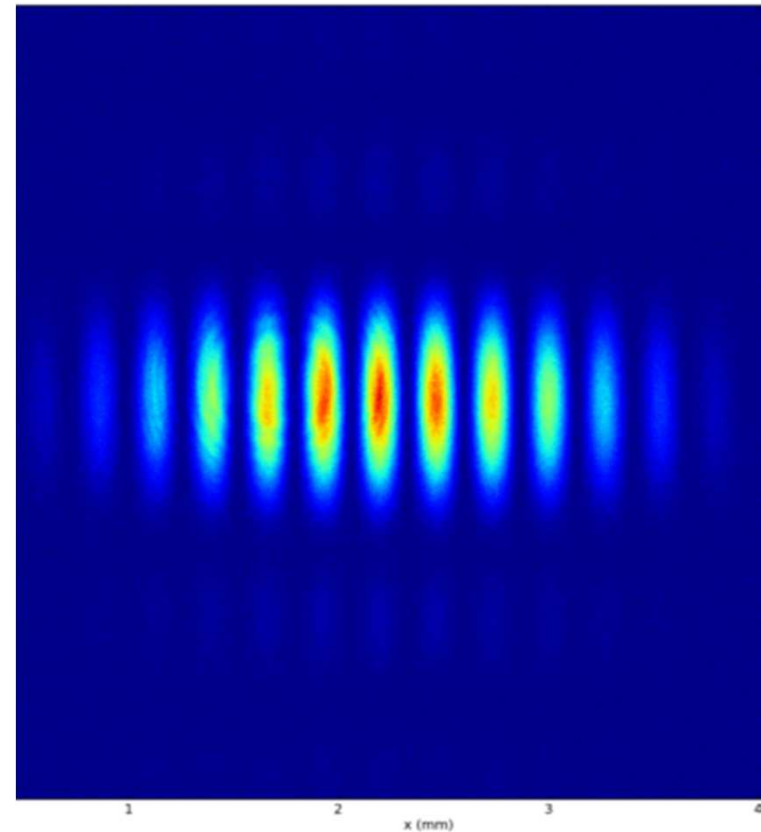
Additional Shielding BOREAS - BL29



- **Type:** Lead screen
- **Dimensions:** 120 cm x 5 cm x 80 cm
- **Vertical position:** centered at 140 cm from ground level

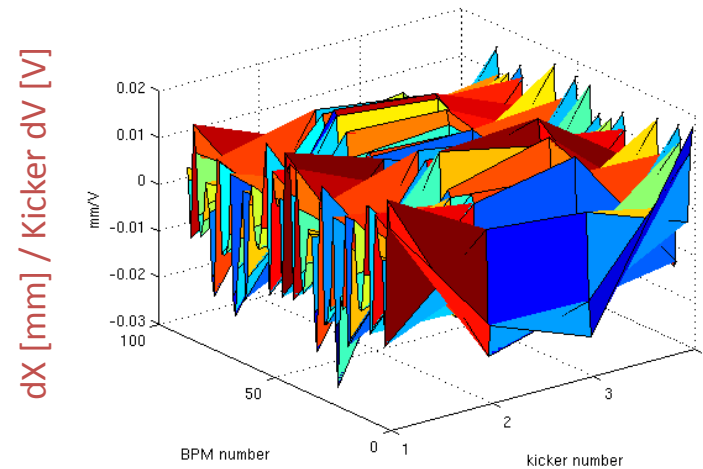
Accelerator Developments

- Injection bump closure
- FOFB
- Beam lifetime
- Energy measurement
- Interferometry beam size
- “67 MeV” injector



Injection Bump Closure

The BPM turn by turn data response matrix to the kicker voltage is measured at turn #9 (*end of kicker pulse*)

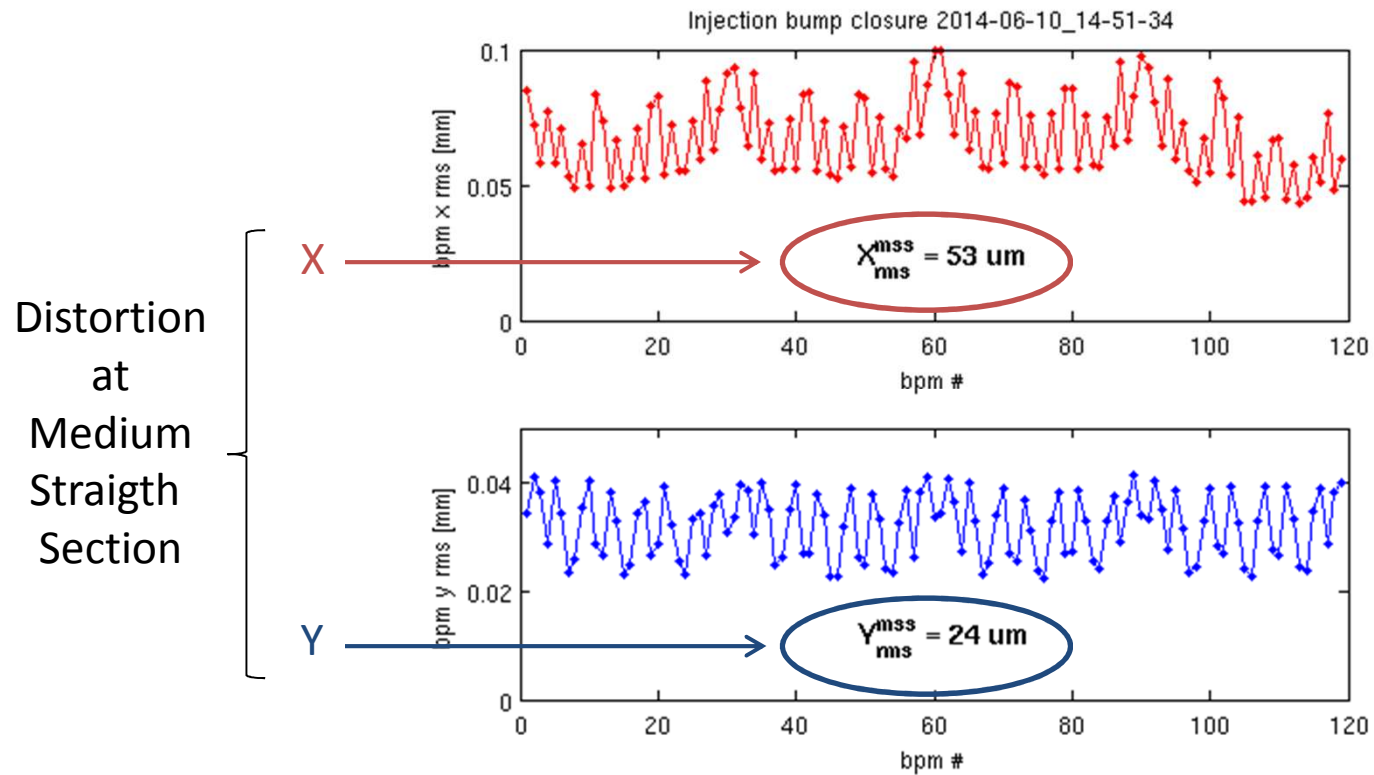


TbT orbit oscillations are corrected applying an SVD

Nowadays, manual readjustment are done

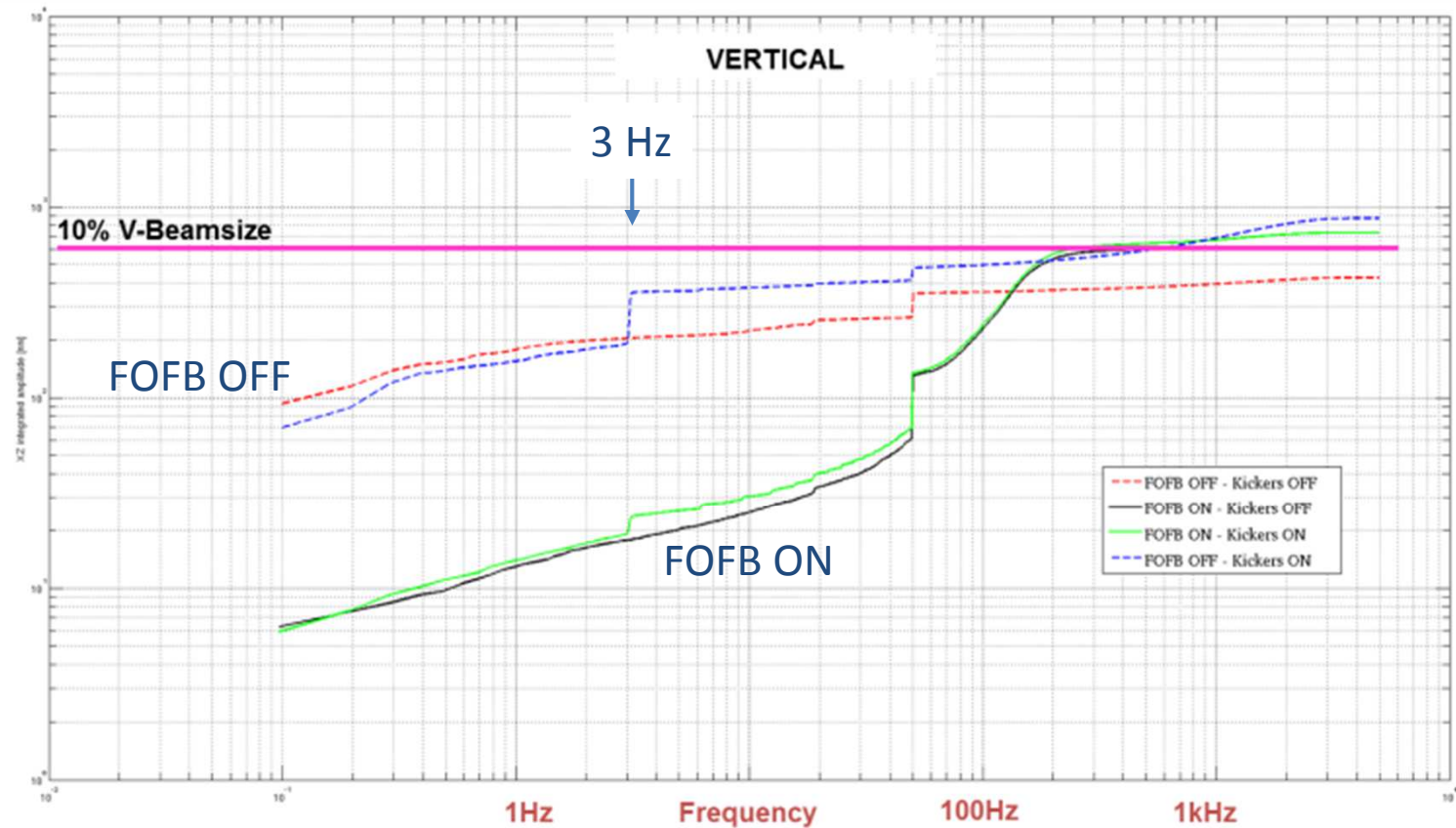
Injection Bump Closure

Best achieved



Fast Orbit FeedBack (Vertical)

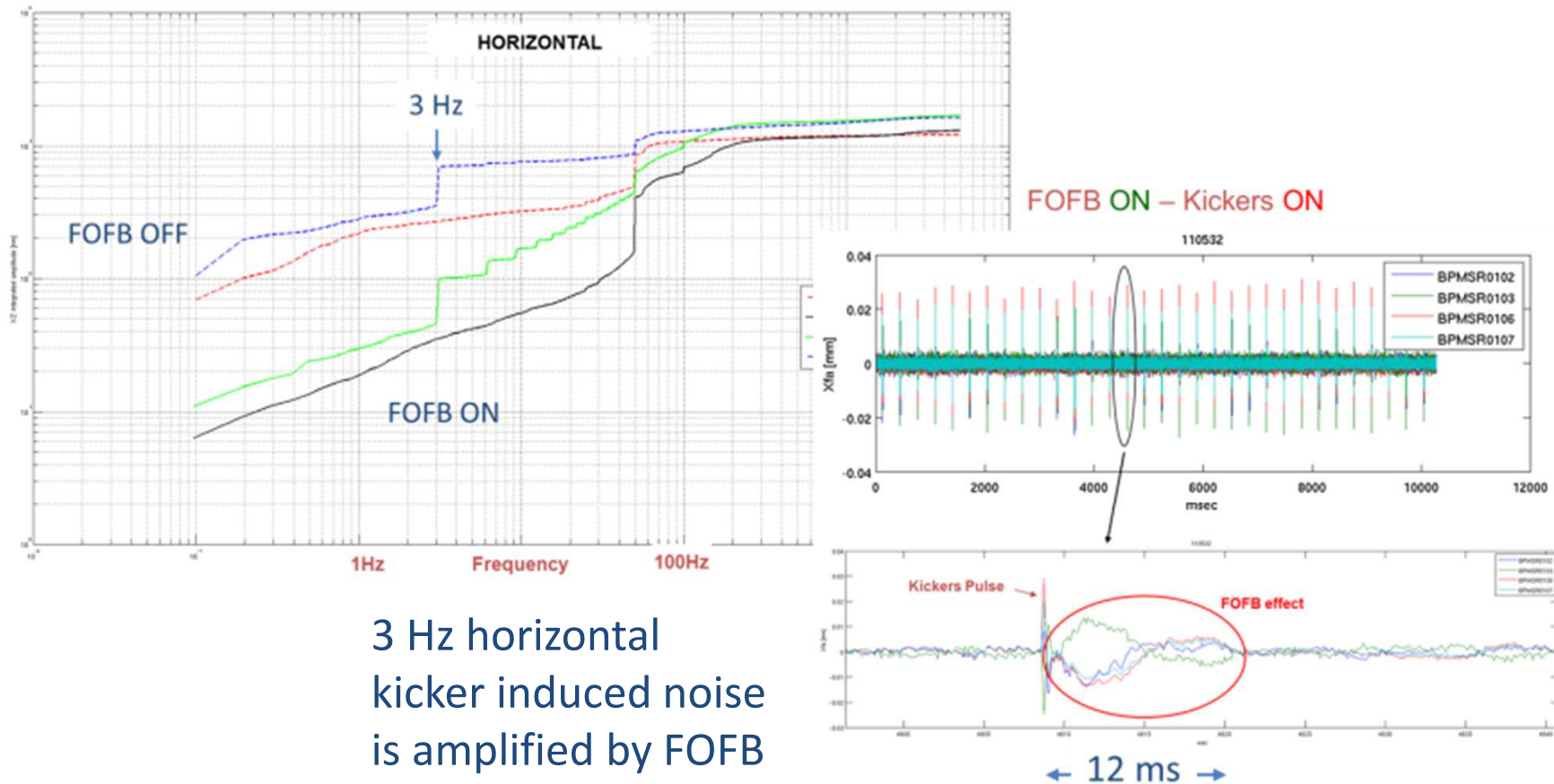
FOFB OFF/ON – Kickers OFF/ON



Fast Orbit FeedBack (Horizontal)

FOFB OFF/ON – Kickers OFF/ON

10% H-Beamsize



3 Hz horizontal
kicker induced noise
is amplified by FOFB



Fast Orbit FeedBack

FOFB is working *but still*:

- Fine tune required
- Robustness (long runs) to be tested
- Error handing
- Friendly user interface

Theoretical Lifetime Calculation

$$\frac{1}{\tau_{total}} \approx \frac{1}{\tau_{gas}} + \frac{1}{\tau_{touschek}}$$

Project [under development](#),
but we already take into account:

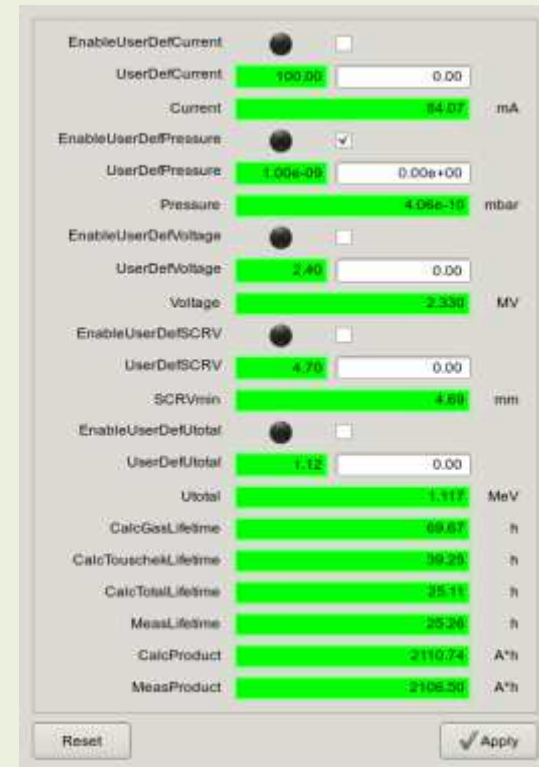
- Current
- Pressure
- SCRV
- RF Voltage
- Energy Loss per Turn

Next step:

Improve Touschek Lifetime Calculation using
Piwinski Model (Coupling, RF Voltage)

Lifetime calculator

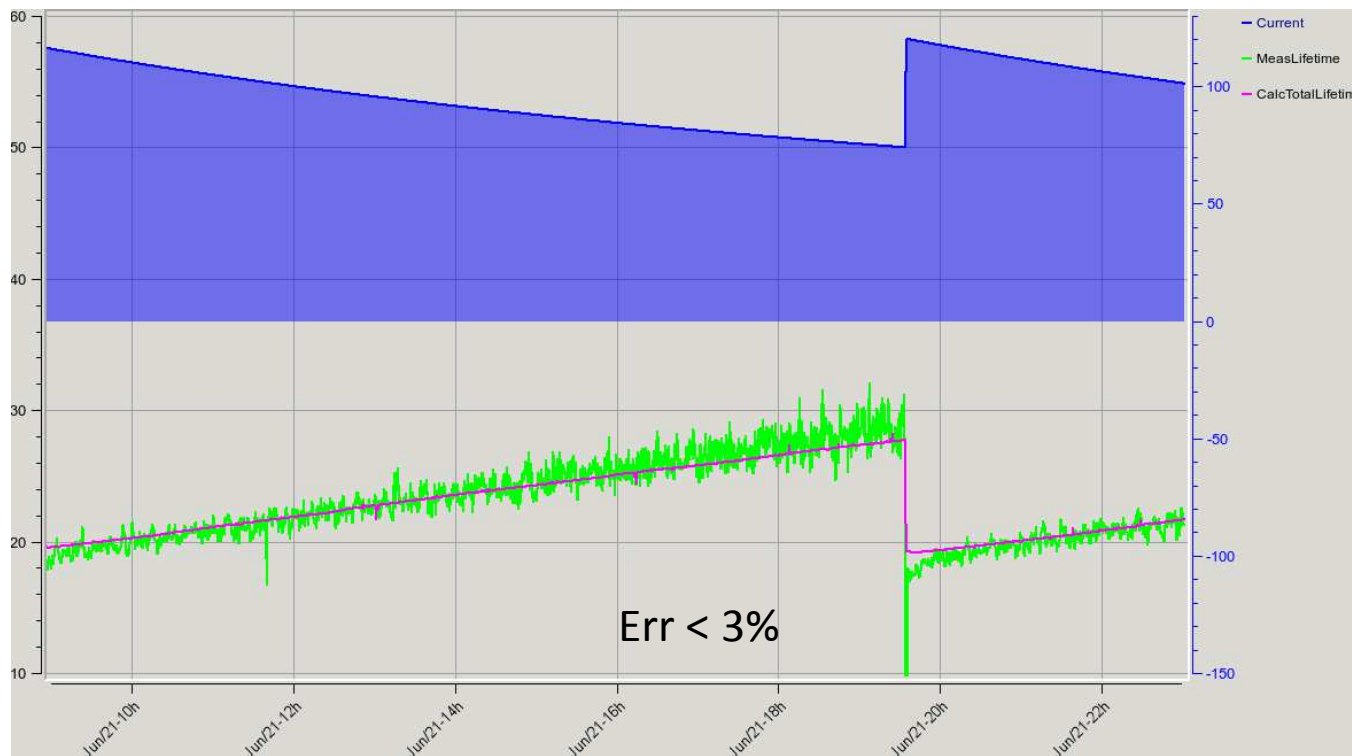
- Measured data
- or
- User defined values



Parameter	User Defined Value	Calculated Value	Unit
EnableUserDefCurrent	☐		
UserDefCurrent	100.00	0.00	
Current		84.07	mA
EnableUserDefPressure	☒		
UserDefPressure	1.00e-08	0.00e+00	
Pressure		4.08e-10	mbar
EnableUserDefVoltage	☐		
UserDefVoltage	2.40	0.00	
Voltage		2.330	MeV
EnableUserDefSCRV	☐		
UserDefSCRV	4.70	0.00	
SCRVmin		4.68	mm
EnableUserDefUtotal	☐		
UserDefUtotal	1.12	0.00	
Utotal		1.317	MeV
CalcGasLifetime		69.67	h
CalcTouschekLifetime		39.28	h
CalcTotalLifetime		25.11	h
MeasLifetime		25.26	h
CalcProduct		2110.74	A*h
MeasProduct		2108.50	A*h

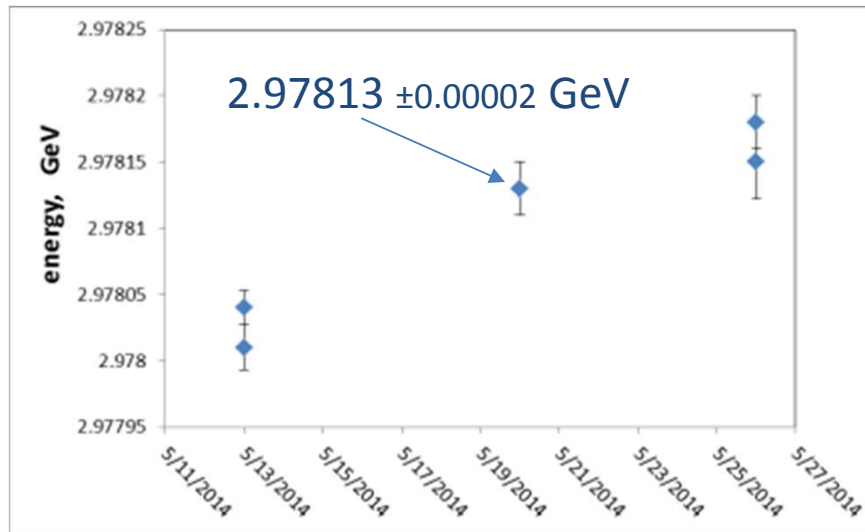
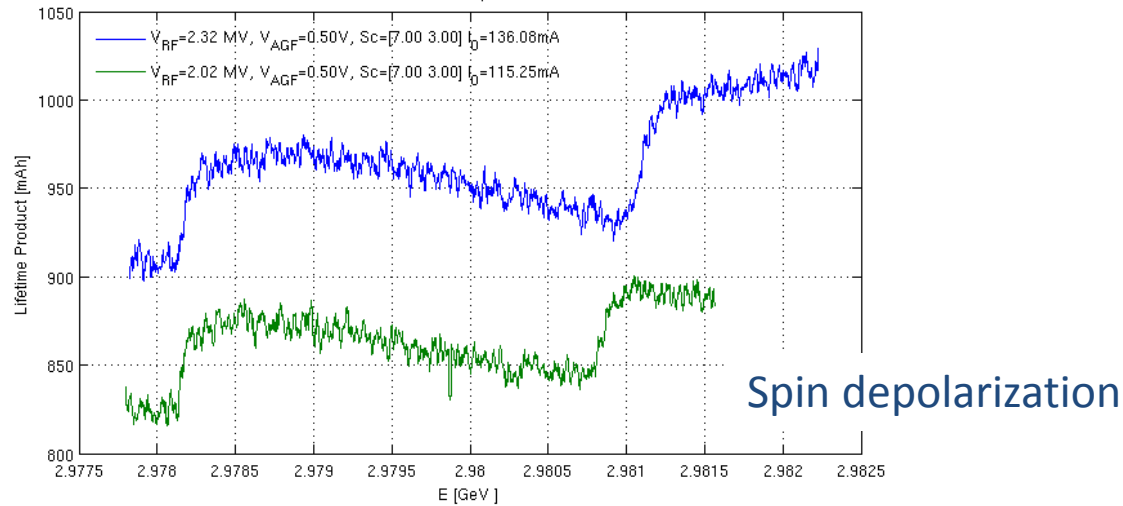
Buttons: Reset, Apply

Good agreement with the measured Lifetime



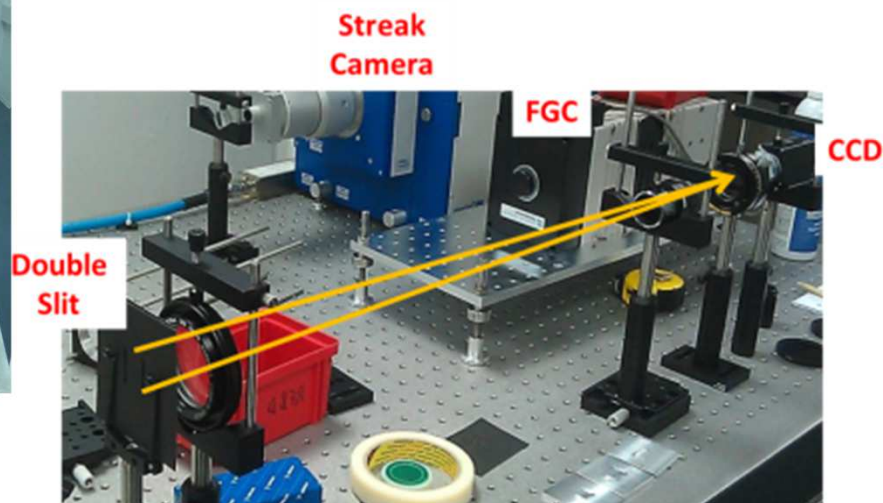
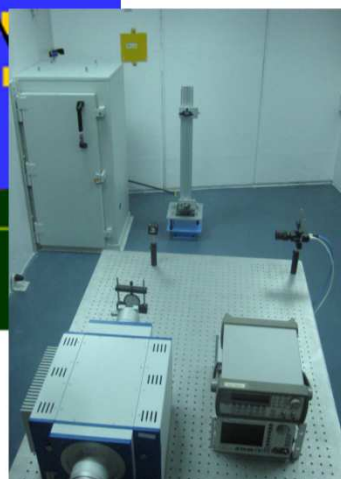
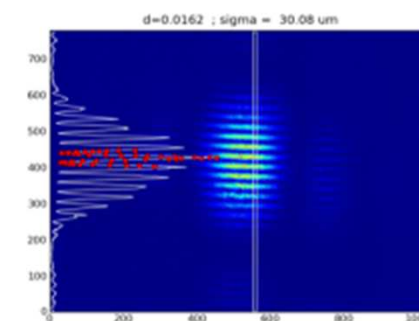
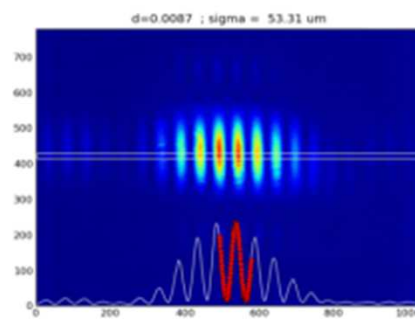
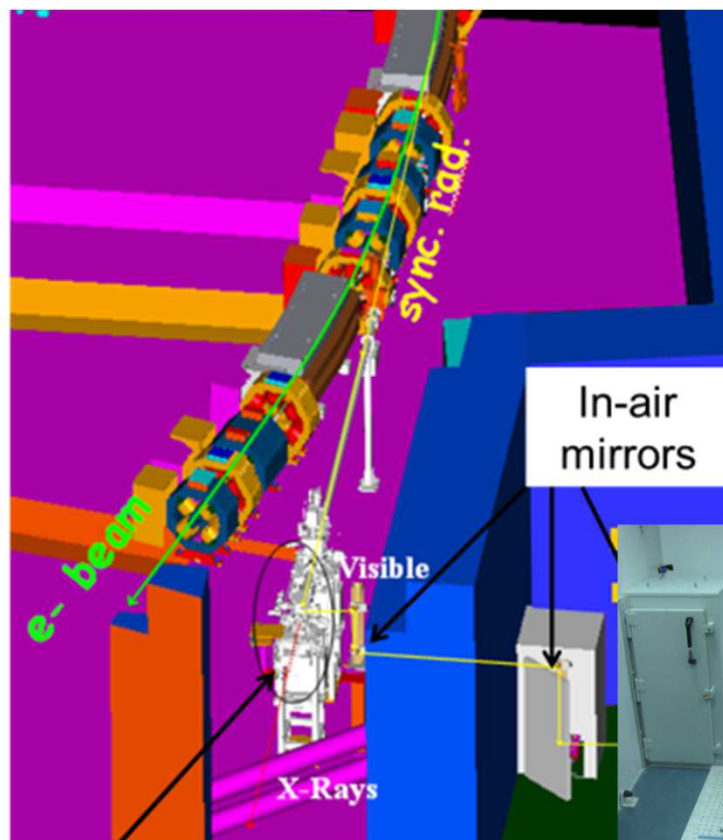
It is still a work in progress, some constants are manually adjusted

Energy Measurement



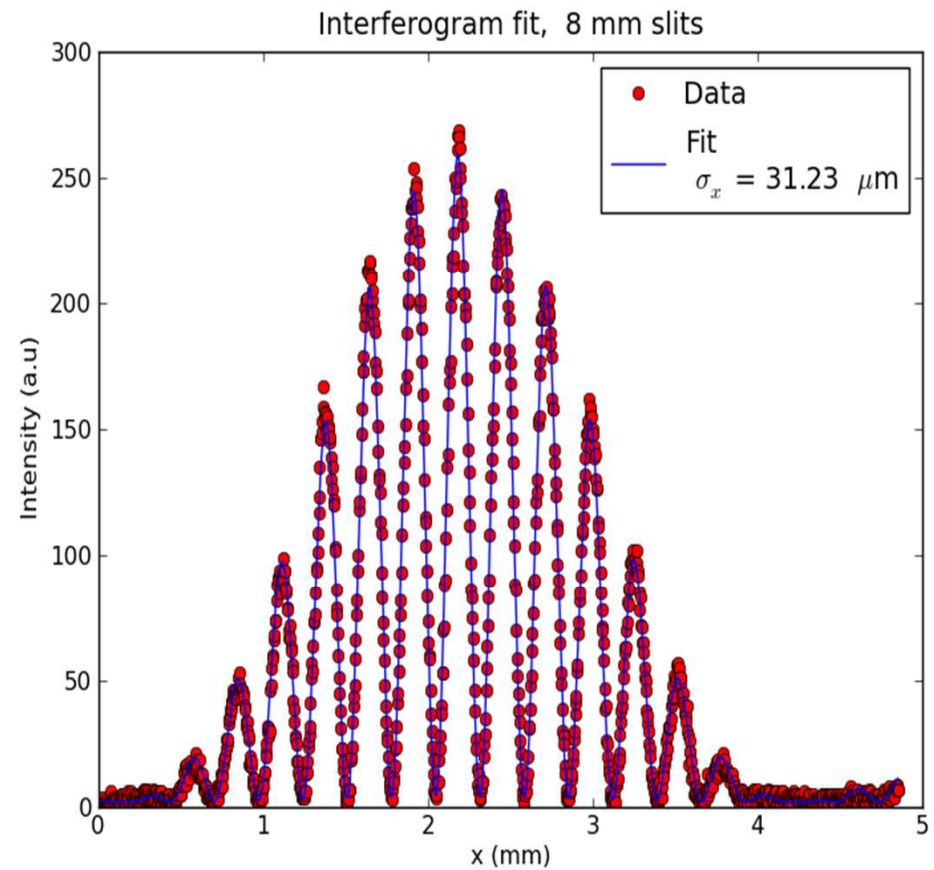
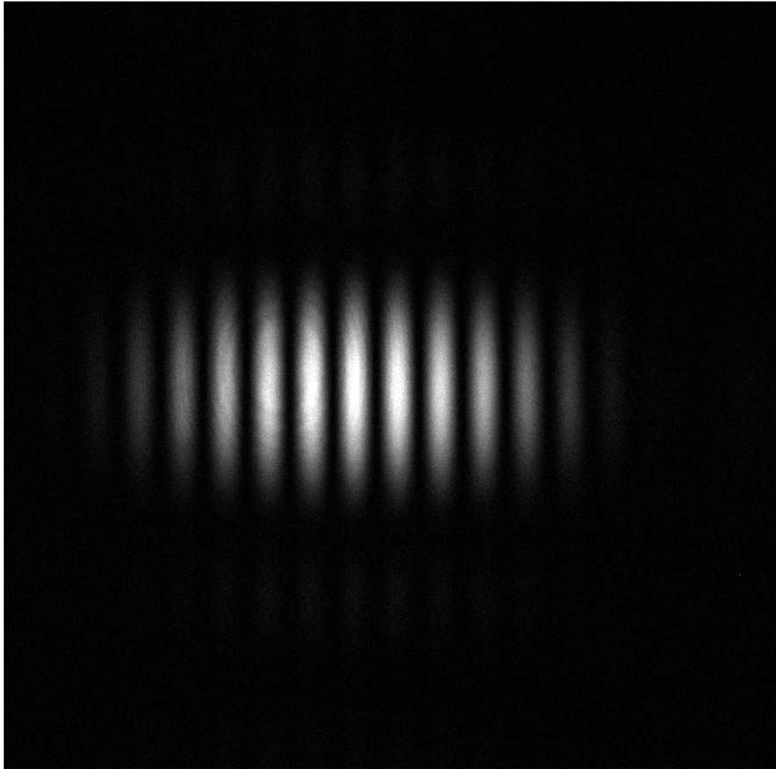
- 3 different days
- 3 different RF frequencies
- 3 different energies: ± 0.0001 GeV

Interferometry beam size



Interferometry beam size

But...



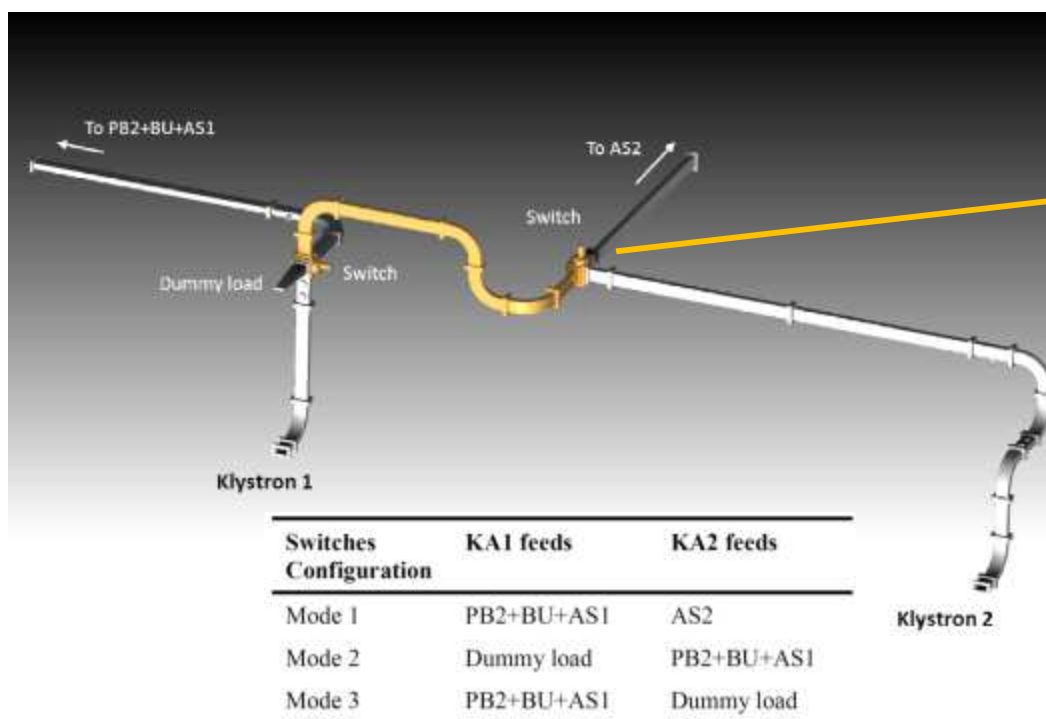
Vibration of the mirrors? Air turbulence?

“67 MeV” injector

Objective:

Operate the LINAC with only one Klystron:

- Either KA1 or KA2, for redundancy
- Compatible with installation and test of the second one

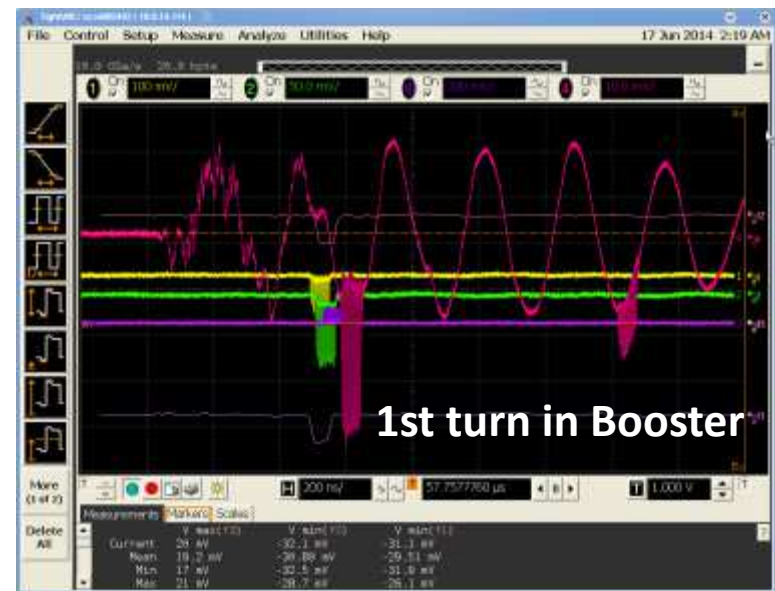
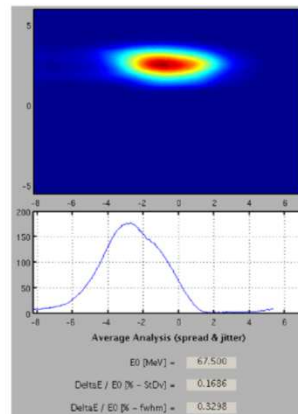
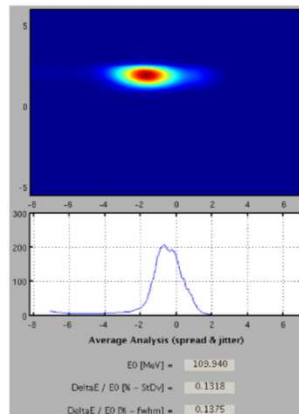




“67 MeV” injector

. Linac

Parameter	Both klystrons	One klystron
Energy	110 MeV	67 MeV
Energy spread	0.30%	0.80%
Norm. Emittance y	8 mm.mrad	16 mm.mrad
Norm. Emittance x	8 mm.mrad	14 mm.mrad



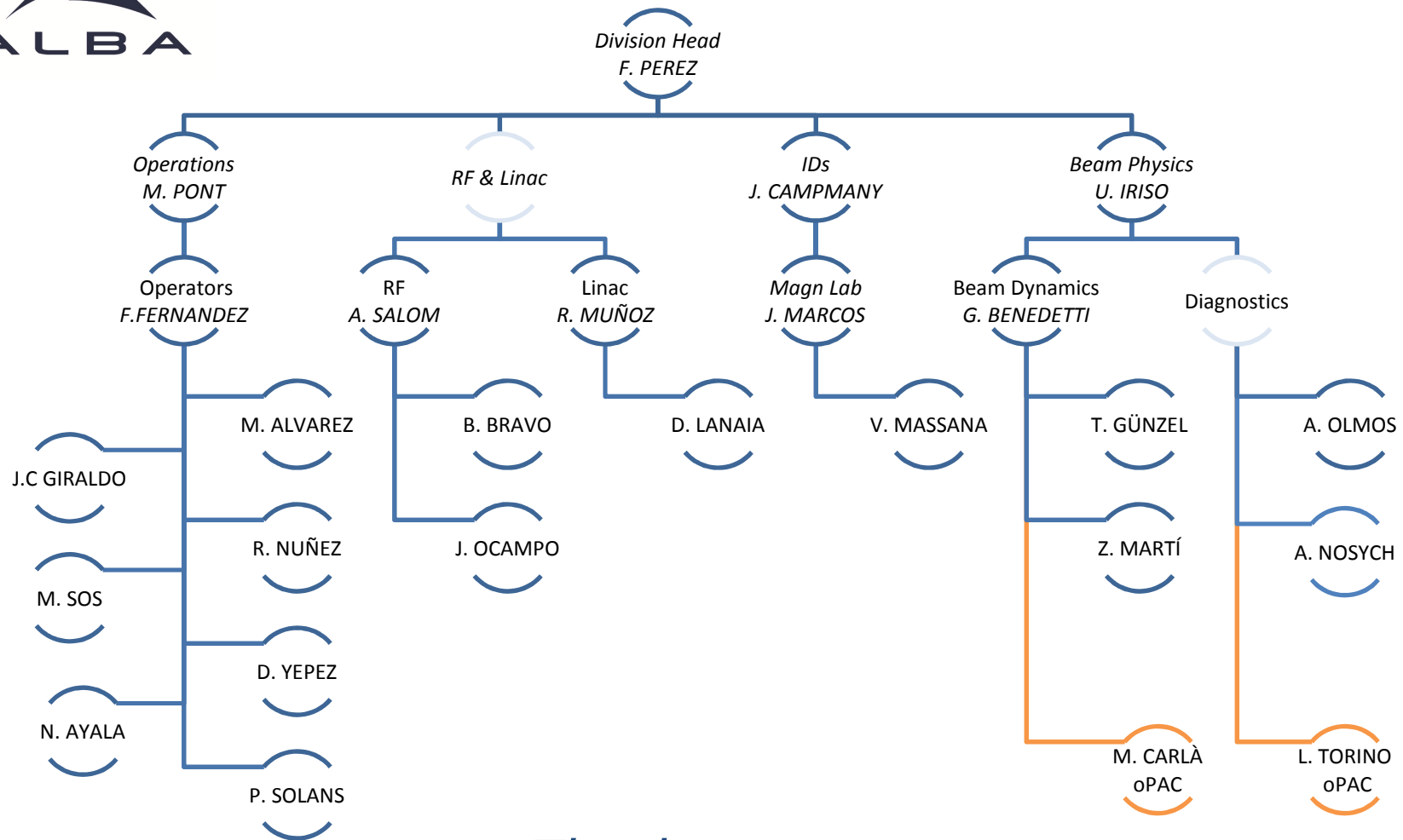


Summary

- ❑ Accelerators operate reliable for users
 - 96% 2013 (excluding cooling problem)
 - 97% 2014 (so far)

- ❑ Top Up operational, but
 - ❑ Acoustic shielding of Booster PS
 - ❑ Radiation local shielding at BL29

- ❑ Objectives until end of 2014
 - ❑ FOFB operational
 - ❑ Injector “67 MeV”
 - ❑ Increase operation current



*Thanks to you,
to the accelerators team
and many others*