New Intermediate BCTs for PSB Injection Watchdog

BI Day 2017

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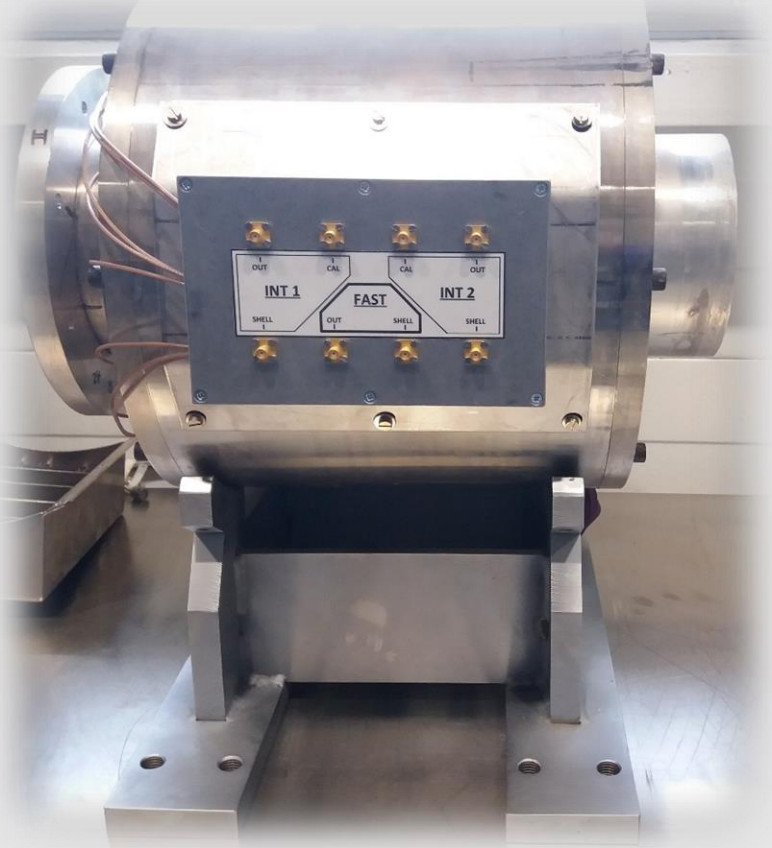

OUTLINE

- *INTRODUCTION*
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- *SOLUTIONS USED*
- *DISMANTLING OF OLD MONITORS*
- *LABORATORY MEASUREMENTS OF TOROIDS*
- *INSTALLATION OF MONITORS IN PSB*
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- *FIRST TESTS ON PSB RING 3*
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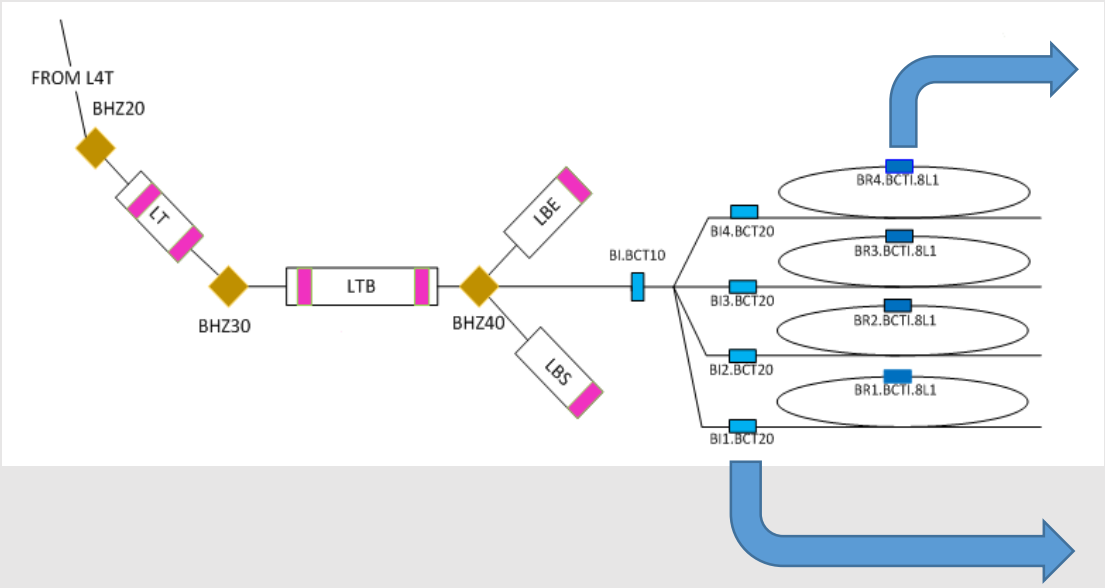
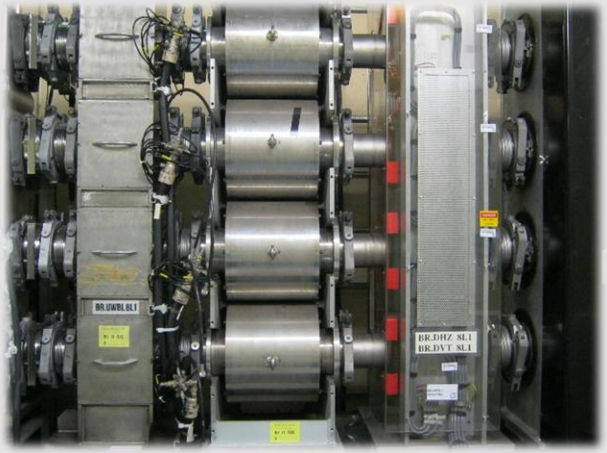
Measurement of injection efficiency after Linac 4 connection in LS2 :

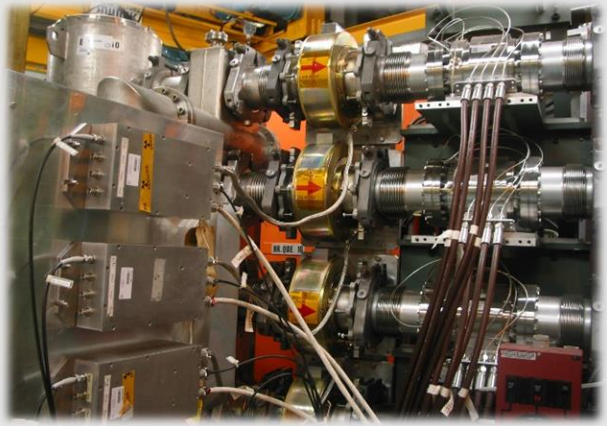
- Intensity comparison between 4 ring BCTs (BRi.BCTI*) in sector 8L1 and 4 BCTs (BIi.BCT20) in the injection lines.

- PSB Injection Watchdog stops beam if losses are too high.



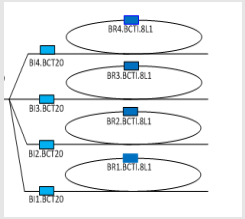


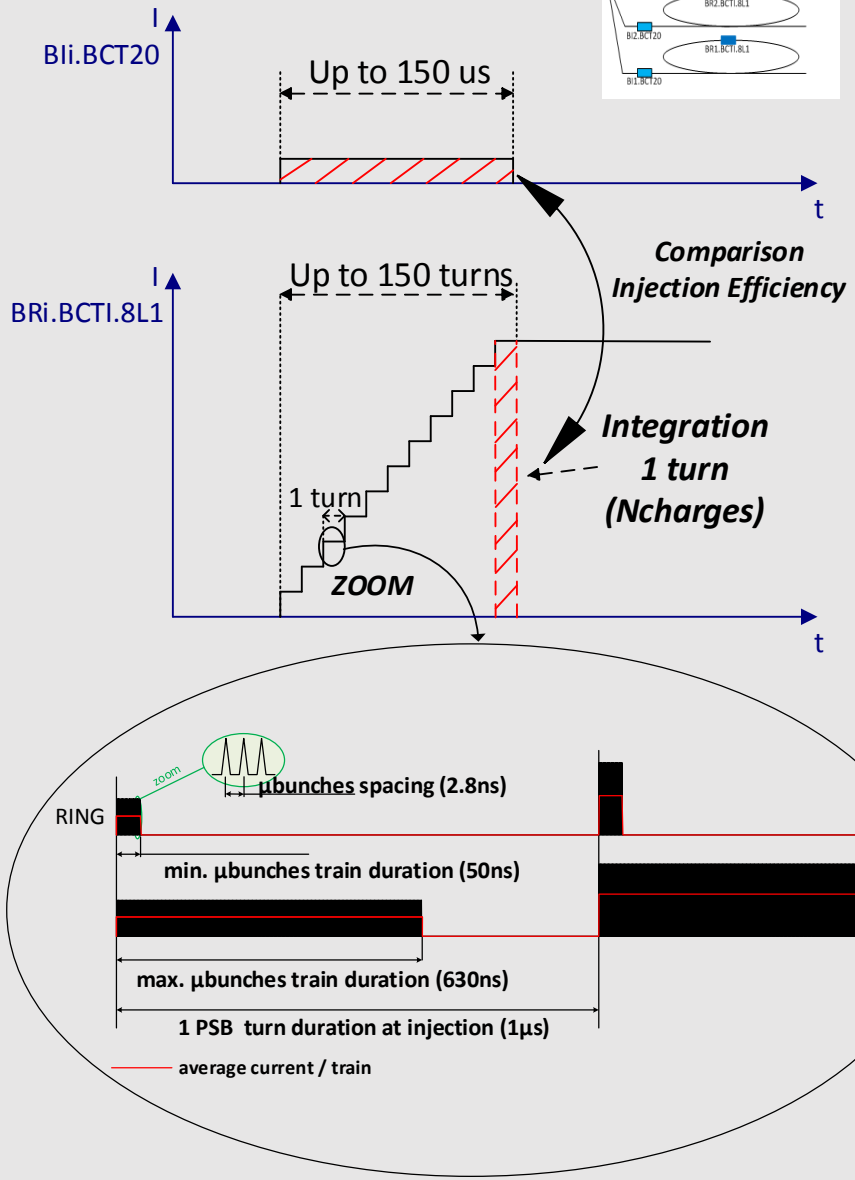
Losses → Inj.Watchdog



* Intermediate BCT : Frequency Bandwidth between 18 Hz to 38 MHz .

SPECIFICATIONS





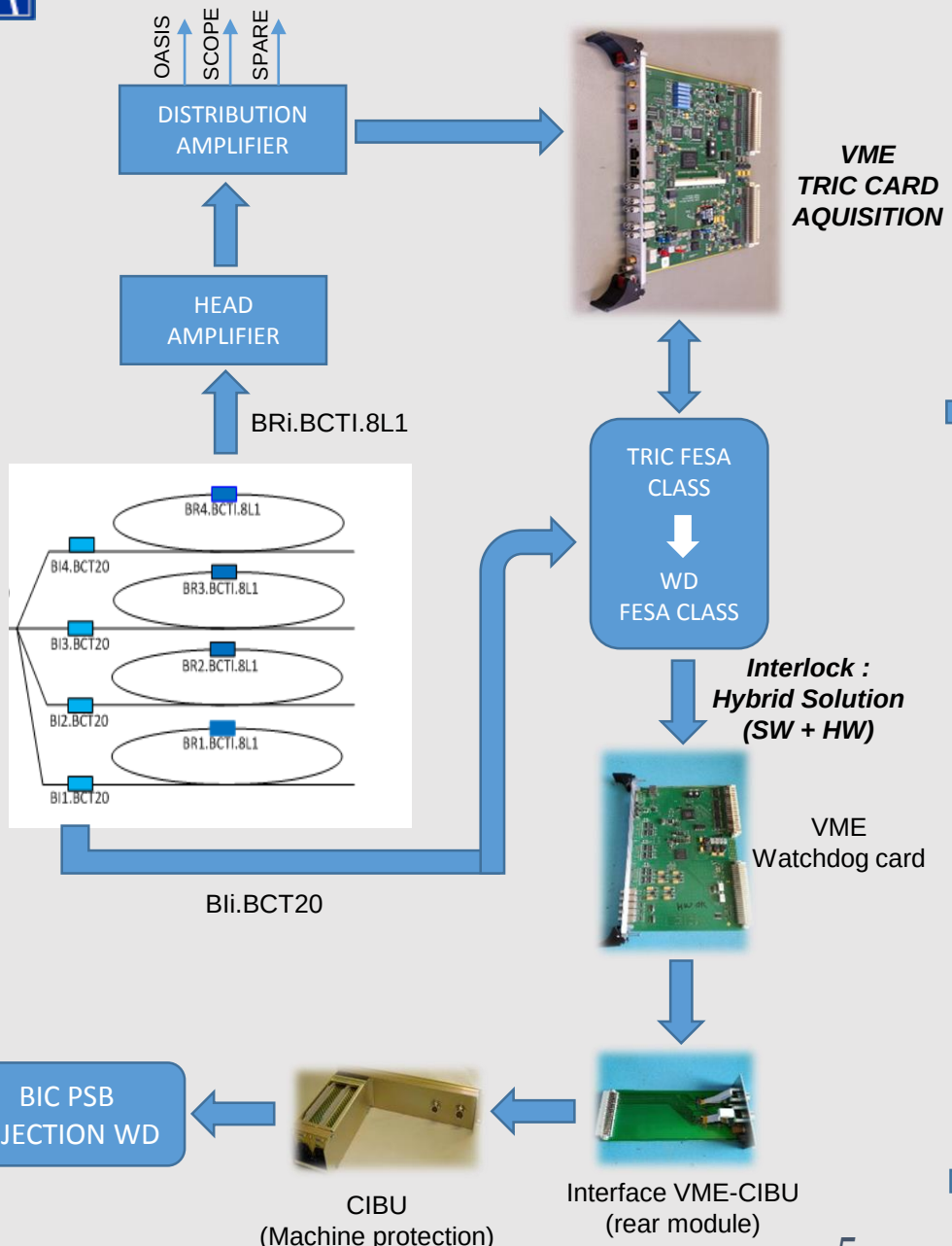
Indicative value. Depends of Linac 4 current source.

Beam	average current / train	# charges / µbunch	# µbunches / turn	train duration / turn	# charges / turn	# turns injected	# charges / ring	average current / train (at the end of the injection) (BCTI)
	[A]	[-]	[-]	[s]	[-]	[-]	[-]	[A]
LHC pilot	3.00E-02	5.32E+08	18	5.11E-08	9.57E+09	1	9.57E+09	3.00E-02
Linac 4 commisionning (1/10 optimum)	3.00E-03	5.32E+07	18	5.11E-08	9.57E+08	1	9.57E+08	**3.00E-03**
Linac 4 commisionning (optimum)	3.00E-02	5.32E+08	176	5.00E-07	9.36E+10	1	9.36E+10	3.00E-02
Nominal	3.00E-02	5.32E+08	222	6.30E-07	1.18E+11	64	7.55E+12	1.92E+00
Ultimate	3.00E-02	5.32E+08	222	6.30E-07	1.18E+11	150	1.77E+13	**4.50E+00**
	Linac 4 & injection line					**PSB ring**		

➢ ***Many parameters to take into account :***

- Large Intensity range in PSB (***64 db***) :
  - Min : 3 mA
  - Max : 4.5 A
- Number of Charges / µbunch.
- Variable number of µbunches (train duration 50 ns to 630 ns).
- Variable Turns number (up to 150 turns).
- ***PSB Injection Watchdog*** :
  - Comparison ***per ring*** between 4 BIi.BCT20 and 4 BRi.BCTI after 150 turns (max).
  - Detect losses with an accuracy of 2 % rms at the end of the last injection.

SOLUTIONS USED



- Used four existing monitors BRi.BCTI (old BRi.TMD with 1 per Ring) after some modifications :

  → Change the number of turns on the toroids.

- BCTs signal delivery on 4 ranges.

- TRIC card for Acquisition.

- FESA classes :

  - TRIC FESA for intensity measurements.
    - ***Correct range must be selected before injection.***

  - WD FESA to measure losses and to trigger the CIBU :

    BIi.BCT20 – BRi.BCTI > Threshold

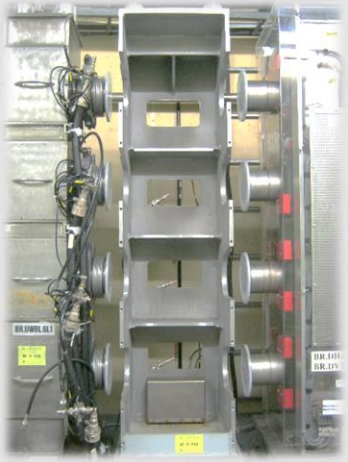
- Watchdog card with CIBU interface :

  → Interlock to stop the Beam.

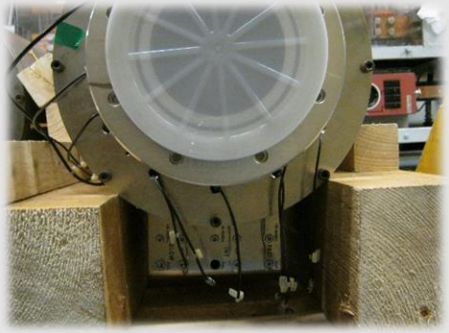
DISMANTLING OF OLD MONITORS

- Removing 4 old monitors (110 Kg/pcs) in the PSB 16 December 2016 with the help of BI-ML section, vacuum group and transport service.

⟹ Dismantle BCTs in tunnel.



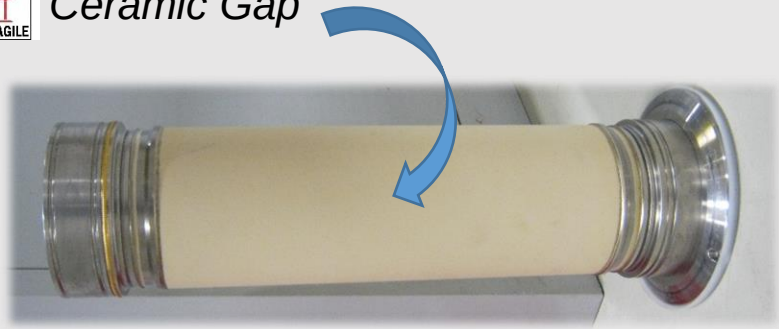
- Transport to radioactive Lab. in B.867 to order to change the number of turns on the toroids.



DISMANTLING OF OLD MONITORS

- Removed carefully the vacuum chambers inside the monitors :

Ceramic Gap



Vacuum Chamber

- Removed sensors from the magnetic shielding :

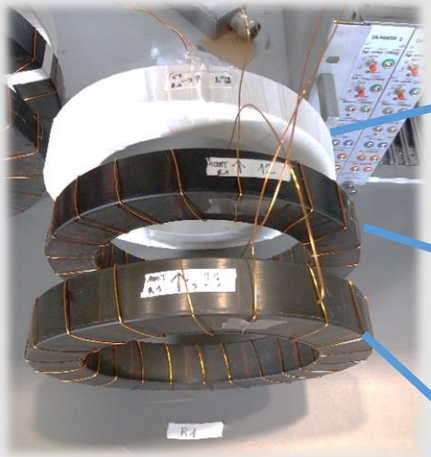
BRi.TFA.8L1 (Fast BCT)

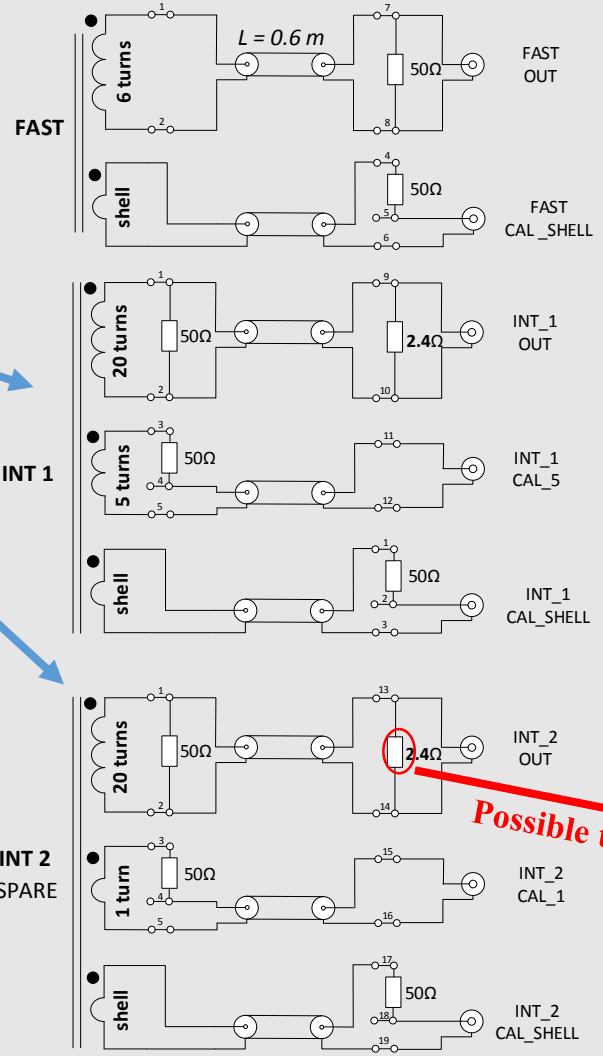
BRi.TSW.8L1 (Slow BCT)

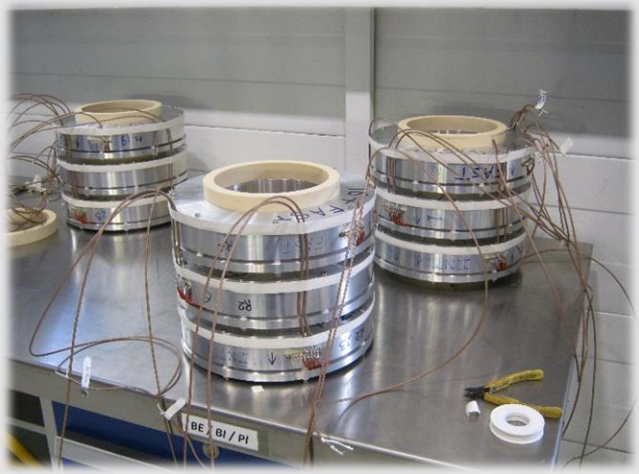
BRi.TMD.8L1 (Intermediate BCT)

LABORATORY MEASUREMENTS OF TOROIDS

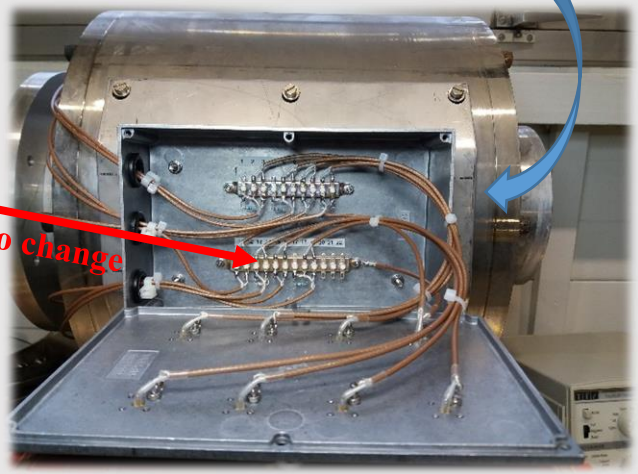
- Old toroids were kept but we have changed the windings to comply with new specifications.
- Replaced old coaxial cables.







New Interconnexion Box with cabling accessible

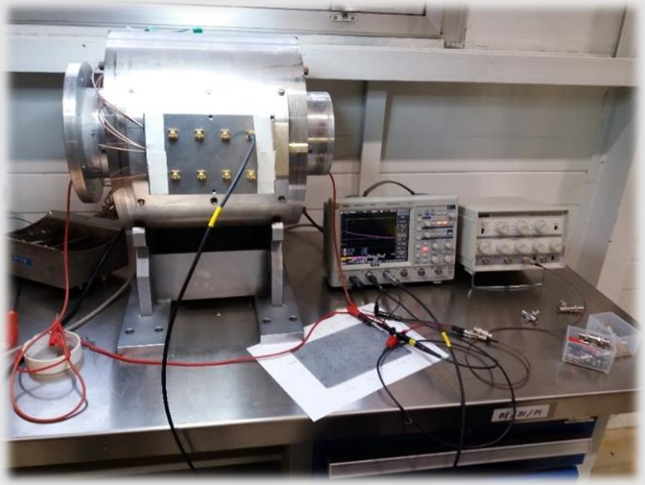


Old BCT	New BCT
BRi.TFA.8L1 (FAST) ***6 turns***	BRi.BCTF.8L1 (FAST operational) ***6 turns***
BRi.TSW.8L1 (SLOW not used) ***1000 turns***	BRi.BCTI.8L1 (Intermediate 1 operational) ***20 turns***
BRi.TMD.8L1 (Intermediate) ***100 turns***	BRi.BCTI.8L1 (Intermediate 2 spare) ***20 turns***

Last check before replacing monitors :

- Signal polarity (correct winding direction).
- Signal amplitude (correct numbers of turns and load resistor).
- Time constant.

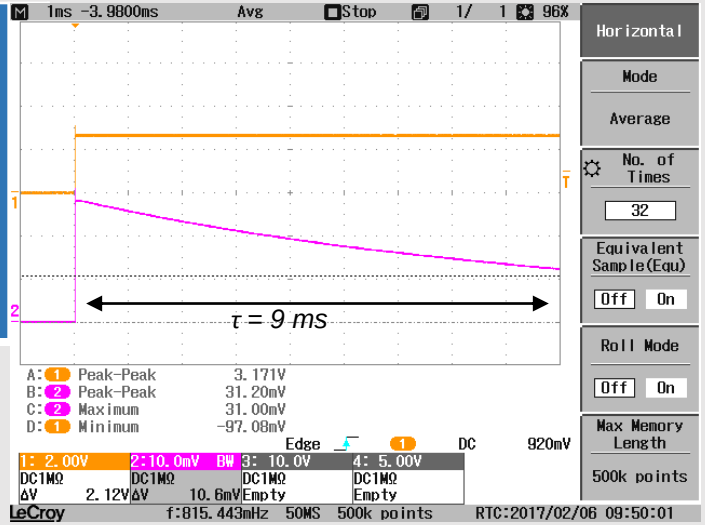
All Test are OK ⟹ Replace monitors in PSB.



BRi.BCTI.8L1
Injection to calibration windings .

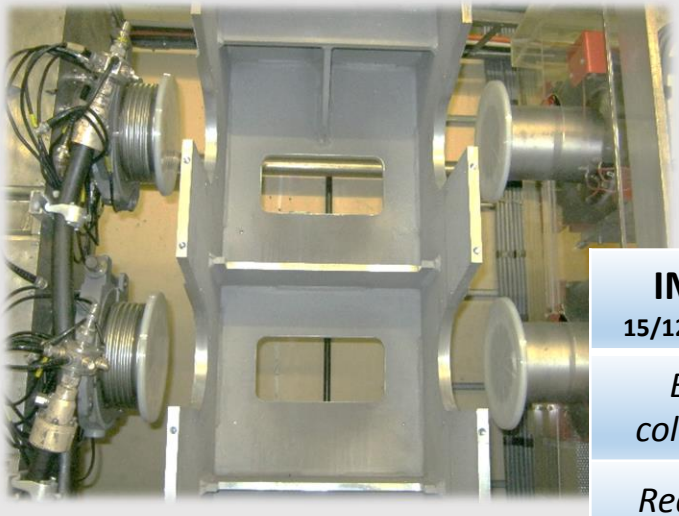
CH.1 : CAL IN

CH.2 : OUT 50Ω



INSTALLATION OF MONITORS IN PSB

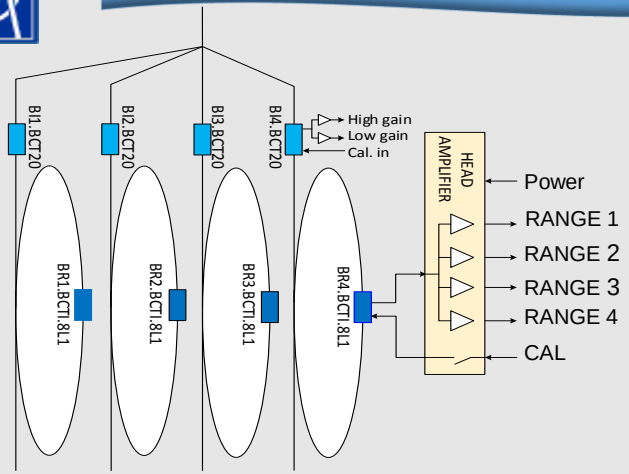
- Monitors replaced in PSB 10 March 2017.

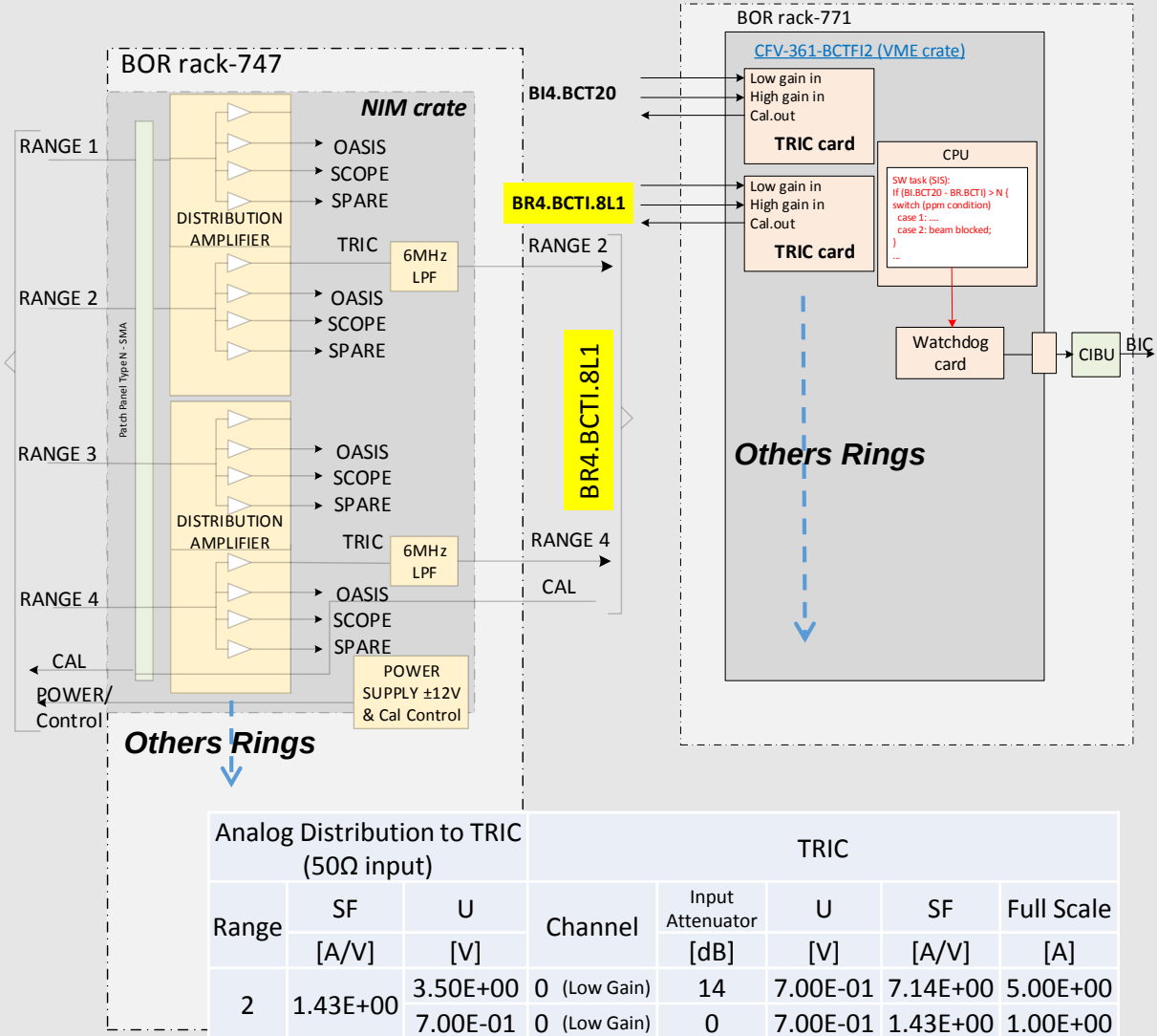


IMPACT n° 15/12/16 to 17/03/17	85382
Estimated collective dose	360 µSv
Real collective dose received	**48 µSv**

NEW ELECTRONICS DESIGN

General Layout :





Analog Distribution to TRIC (50Ω input)			TRIC				
Range	SF [A/V]	U [V]	Channel	Input Attenuator [dB]	U [V]	SF [A/V]	Full Scale [A]
2	1.43E+00	3.50E+00	0 (Low Gain)	14	7.00E-01	7.14E+00	5.00E+00
		7.00E-01	0 (Low Gain)	0	7.00E-01	1.43E+00	1.00E+00
4	5.71E-02	3.50E+00	1 (High Gain)	14	7.00E-01	2.86E-01	2.00E-01
		7.00E-01	1 (High Gain)	0	7.00E-01	5.71E-02	4.00E-02

➢ Tunnel :

- Head Amplifier with calibration control.

➢ Surface :

- *BOR 747* : Distribution Amplifier in NIM Crate (x2 / BCT).
- *BOR 771 :*

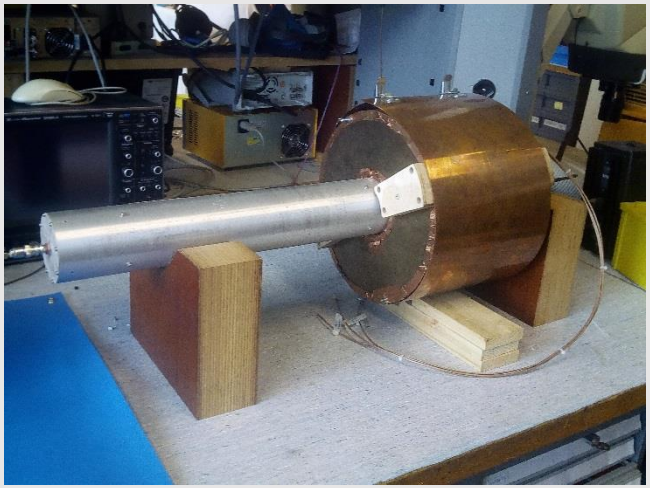
- TRICs Card Acquisition (200 MHz) in same VME Crate BIi.BCT20 (x1 / BCT for 2 Ranges).

- Watchdog Card to trigger the CIBU.

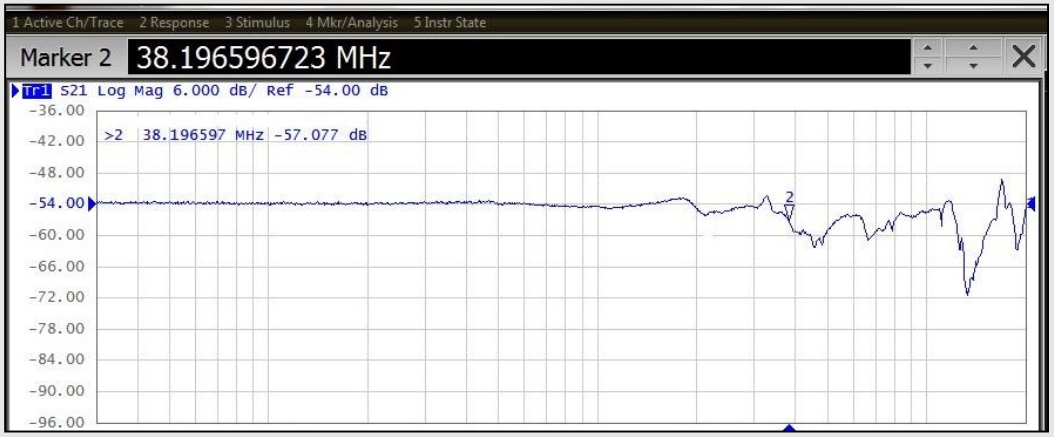
➢ Software Interface:

- FESA Class to be defined.

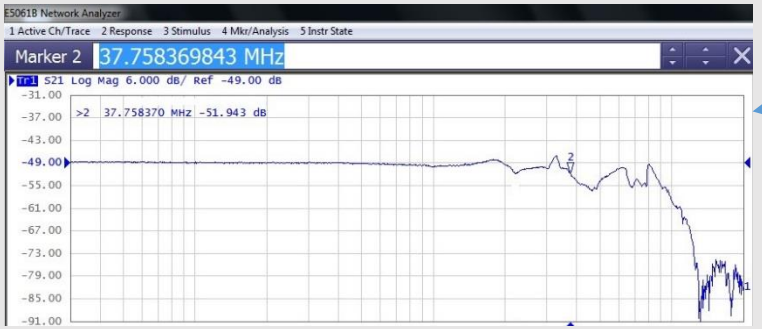
Test bench in the Lab



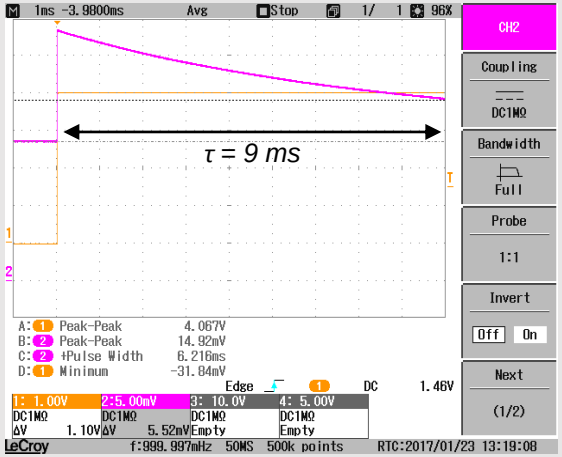
Frequency Response Test bench + BCTI.8L1



+



Head Amplifier output signal for Range 1



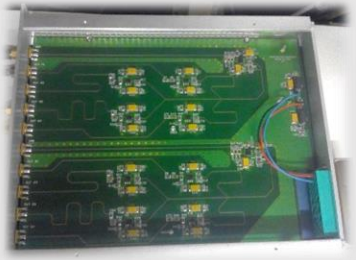
	Analog Distribution to OASIS, local scope, … (50Ω input)				
Range	SF [A/V]	FS [A]	FS [V]	LF Cut off [Hz]	HF Cut off [MHz]
Range 1	5.00E+00	2.50E+01	5	18	38
Range 2	1.00E+00	5.00E+00	5	18	38
Range 3	2.00E-01	1.00E+00	5	18	38
Range 4	4.00E-02	2.00E-01	5	18	38

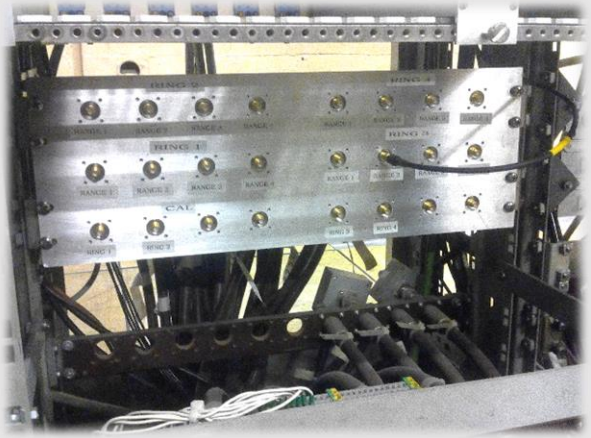
Electronics Installations and Cabling on Ring 3 :

Tunnel 8L1

BOR 747

Distribution amplifier





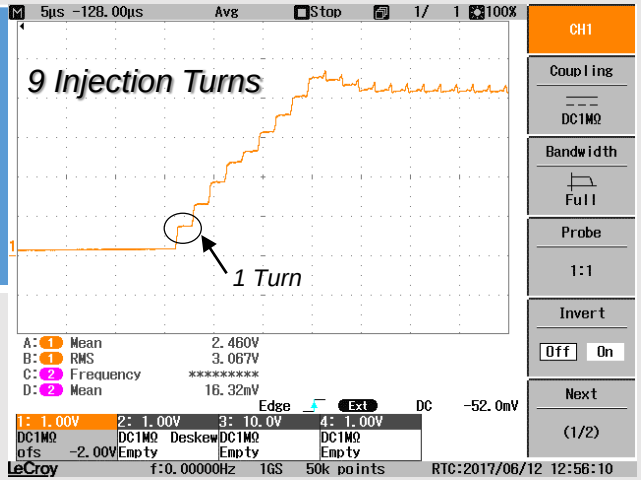
FIRST TEST ON PSB RING 3

➢ First Beam Measurements with LINAC II

User : ISOGPS (PLS 18)

CH.1 : OUT Range 3
Low pass filter 6 MHz

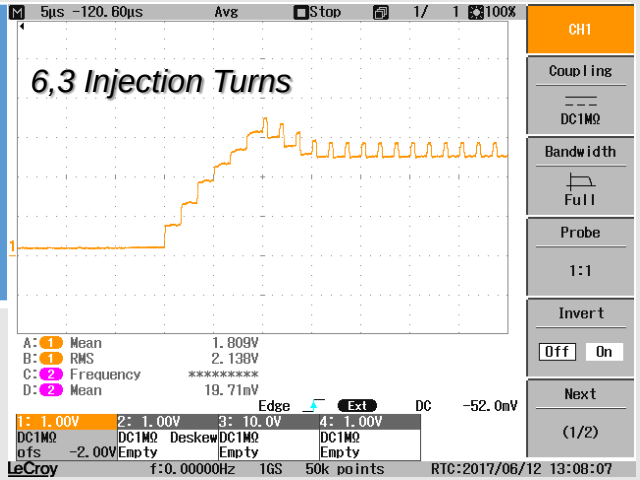
Trigger ext : C275
Injection



User : MTE (PLS 20)

CH.1 : OUT Range 3
Low pass filter 6 MHz

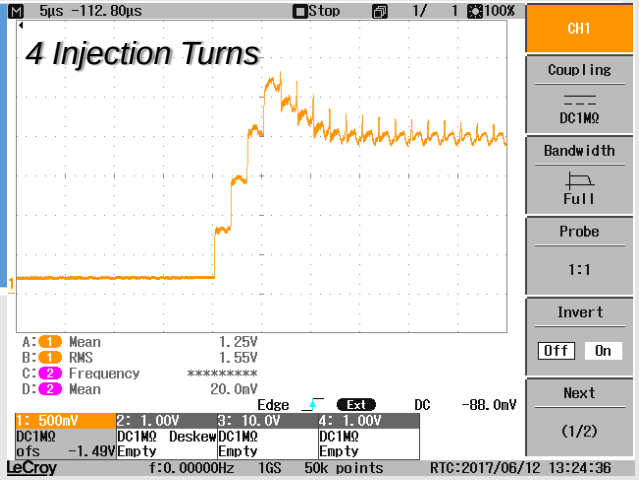
Trigger ext : C275
Injection



User : AD (PLS 1)

CH.1 : OUT Range 3
Low pass filter 6 MHz

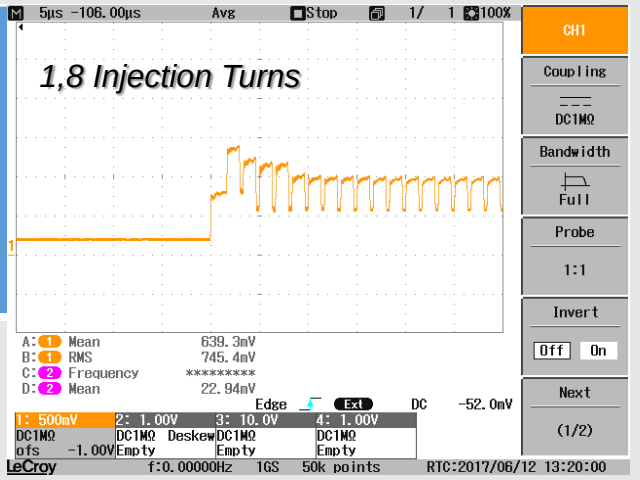
Trigger ext : C275
Injection



User : LHC INDIV
AWAKE (PLS 12)

CH.1 : OUT Range 3
Low pass filter 6 MHz

Trigger ext : C275
Injection



STATUS AND PLAN

STATUS

- First Beam seen on Ring 3.
- NIM Crate is ready to receive Electronics modules.
- All Head Amplifiers are assembled.
  ➡ Test in progress.
- Distribution Amplifier PCBs are being assembled.

PLAN

- Continue the Global test bench on the Lab :
  ➡ BIi.BCT20 and BRi.BCTI.
- Install Head Amplifiers (Ring 1,2,4) (TS in July).
- Install all Distribution Amplifiers.
- Install TRIC cards (x4) and Watchdog card.
- Pull cables for :
  - Distribution Amplifiers (BOR 747) to TRIC cards (BOR 771).
  - OASIS.
- Define WD FESA Class together with OP.
- Calibrate the monitors.
- Test the watchdog if losses are detected.

Thanks to :

- PI Section : Patrick Odier, Romain Ruffieux, Juan Carlos Allica, Lars Soby, Celine Delevaux.
- ML Section : Morad Hamani, Benjamin Moser, William Andreazza.
- SW Section : Lars Jensen, Athanasios Topaloudis.
- OP-PSB : Bettina Mikulec.
- Vacuum Group : Paul Demarest.
- Transport Services.