Overview of the available detectors for beam loss measurements and monitoring

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Acknowledgements: D. J .Allen, B. Mikulec and R. Scrivens

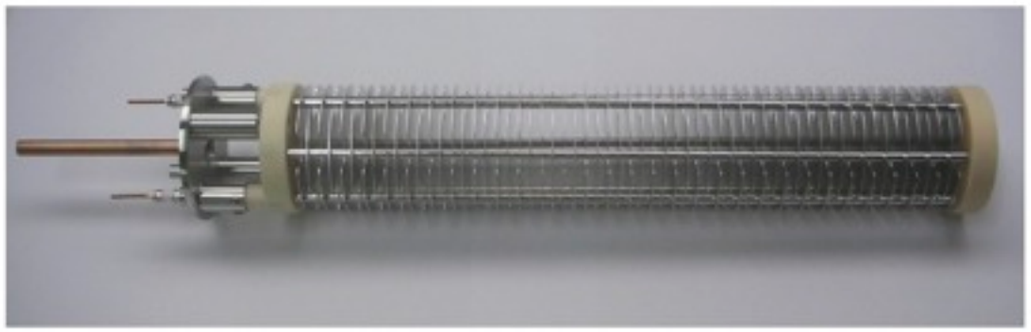
Outlook

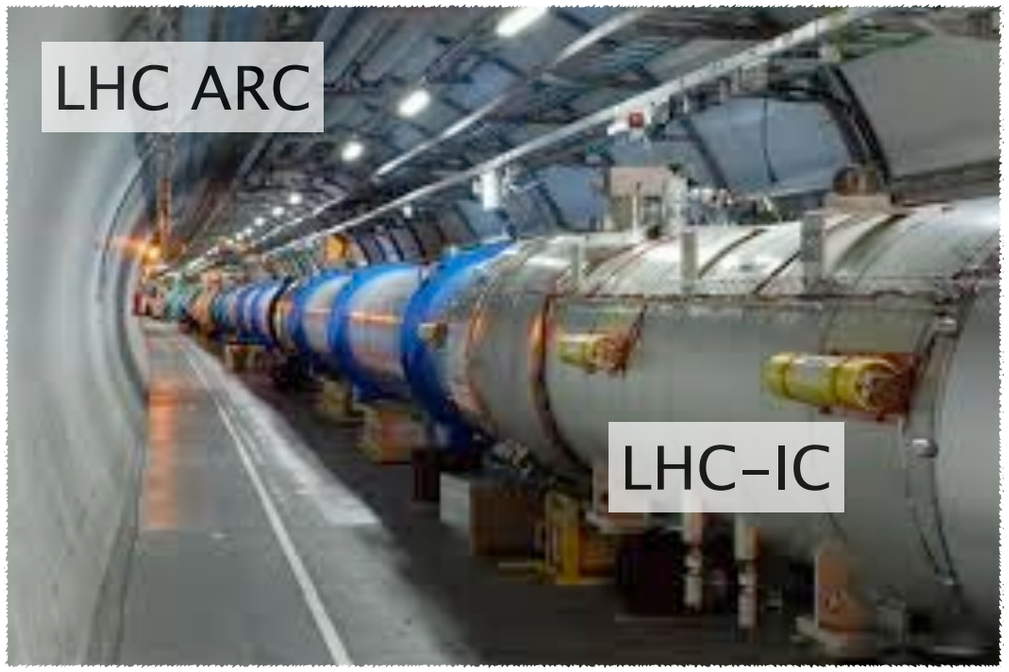
- Monitor description
- Overview of measurements
  - LINAC2
  - GIF
  - PSB
- Summary and conclusions

Detector description

Detector description I

LHC-type BLMs



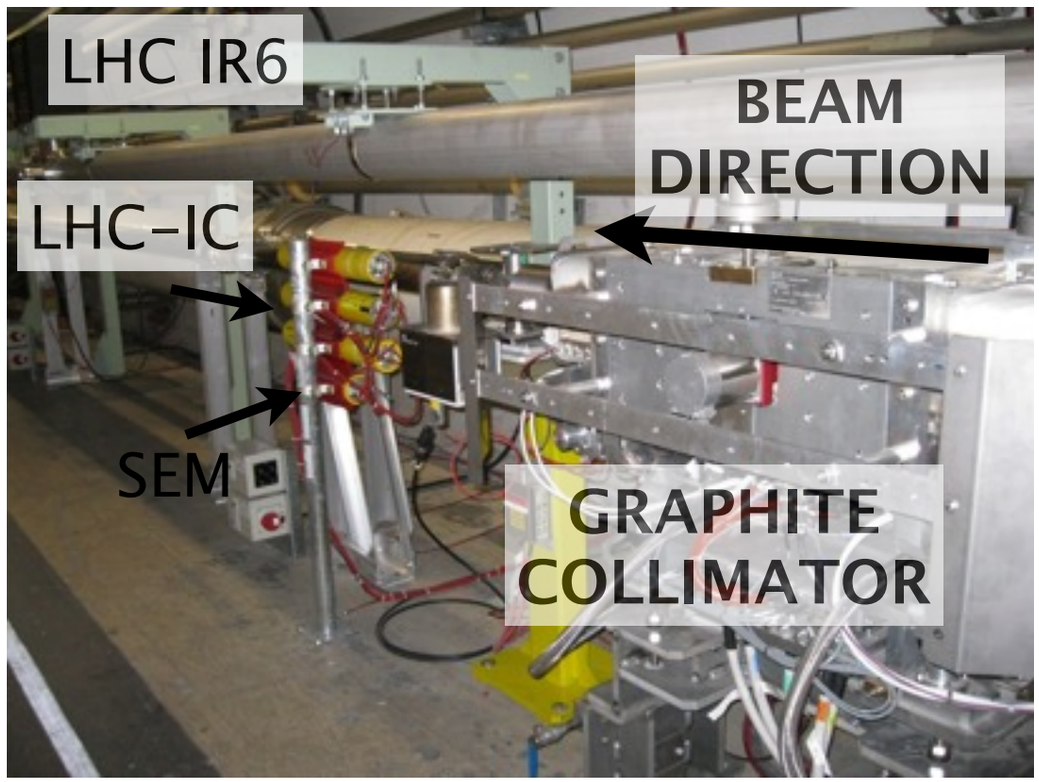


- parallel plate Ionization chambers
- 61 Al electrodes (60 active volumes)
- Diameter 8.9 cm
- Length ~ 60 cm
- Total active Volume ~ 1.5 l
- Ionization medium N_2 at 1.1 bar
- HV = 1500 V

http://ab-div-bdi-bl-blm.web.cern.ch/ab-div-bdi-bl-blm/Talks_and_papers/IEEE_NSSMIC_2006/IEEE_paper_final_2006.pdf

Detector description II

SEM (Secondary Emission Monitors)

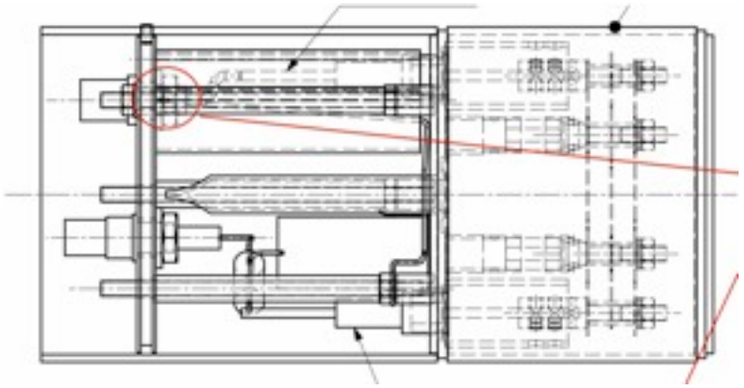


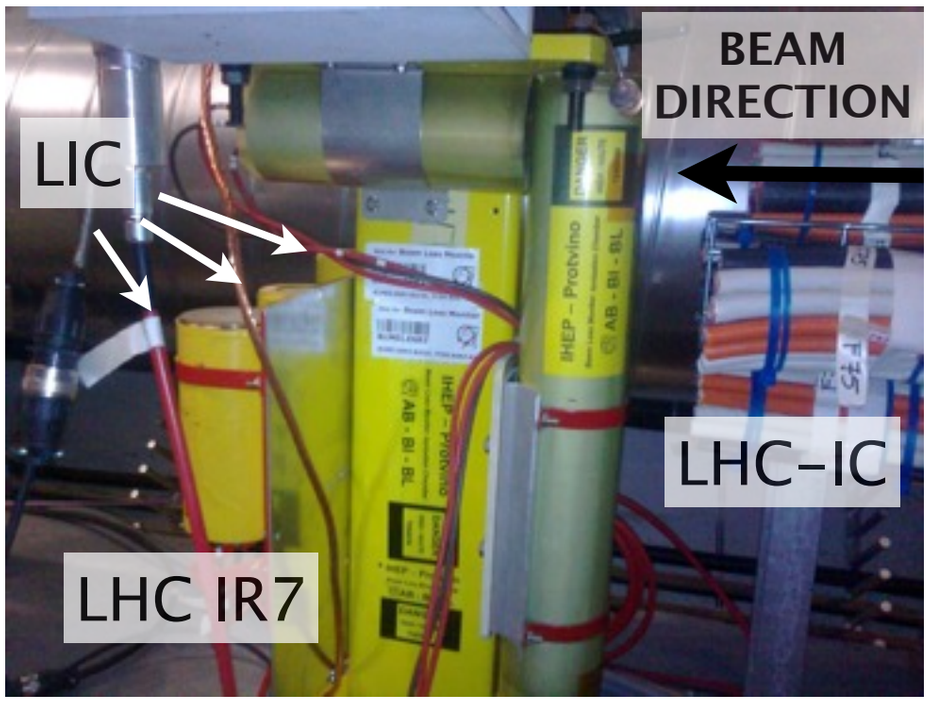
- parallel plate electrode
- Central electrode of Ti to profit from its secondary emission properties
- Diameter 8.9 cm
- Length ~ 15 cm
- Total active Volume ~ 0.05 l
- Vacuum (1. E-7 mbar)
- HV = 1500 V
- Developed for high radiation areas in the LHC

http://ab-div-bdi-bl-blm.web.cern.ch/ab-div-bdi-bl-blm/Talks_and_papers/Siena06/DKramerIPRD06v2.pdf

Detector description III

LIC (Little Ionization Chambers)





- parallel plate Ionization chambers
- 3 Al electrodes (2 active volumes)
- Diameter 8.9 cm
- Length ~ 15 cm
- Total active Volume ~ 0.05 l
- Ionization medium N_2 at 0.4 bar
- HV = 1500 V
- Developed for high radiation areas in the LHC

https://espace.cern.ch/be-dep/IPAC2012/Forms/Document%20Set/docsethomepage.aspx?ID=392&FolderCTID=0x0120D52000BE80241DDD6FBB4DB24DDE65DBF7BEC4&List=eef982d7-4746-4108-abee-ee0c415ff55b&RootFolder=%2Fbe-dep%2FIPAC2012%2FBI%2FEduardo%20Nebot%20Del%20Busto

Overview of measurements

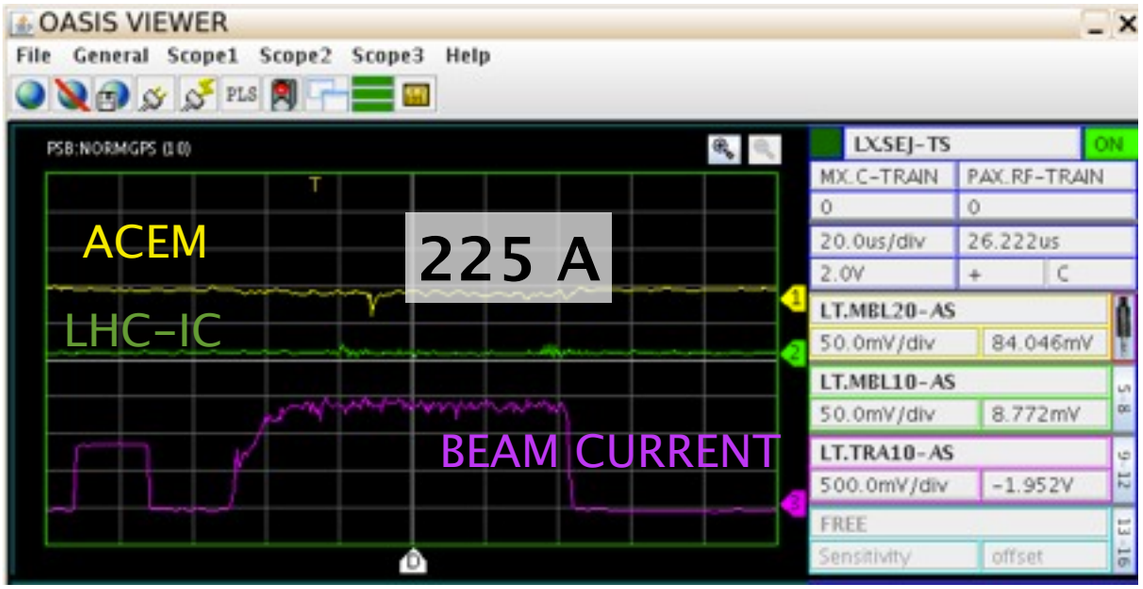
LINAC2 measurements

- Extensive experience with LHC-type BLMs from 2010-2012 operation (detection of secondary particles produced by interactions of 450 GeV - 4 TeV protons)
- Main goal. Verification of suitability of LHC-type BLMs for LINAC (detection of secondary particles produced by 50 MeV protons)
- Comparison of signals observed in ACEM and Ionization Chamber. Detectors installed downstream of LT.QFN40

- I ~ 3.5 E+13 p injected into PSB
- Losses produced by detuning quad LT.QDN12 (increase CCV from 220 A to 240 A)

LINAC2 measurements

- Signals observed in neither ACEM nor BLM-type for nominal quad settings.



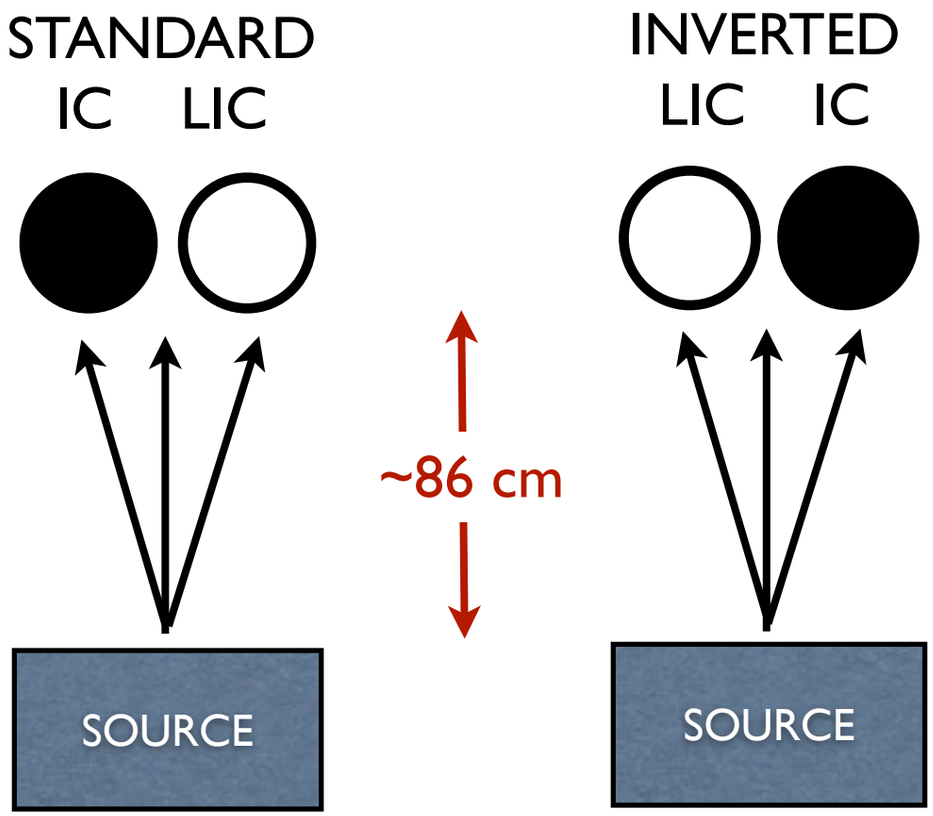
- BLM-type detector shows enough sensitivity when integrating signals (320 us).

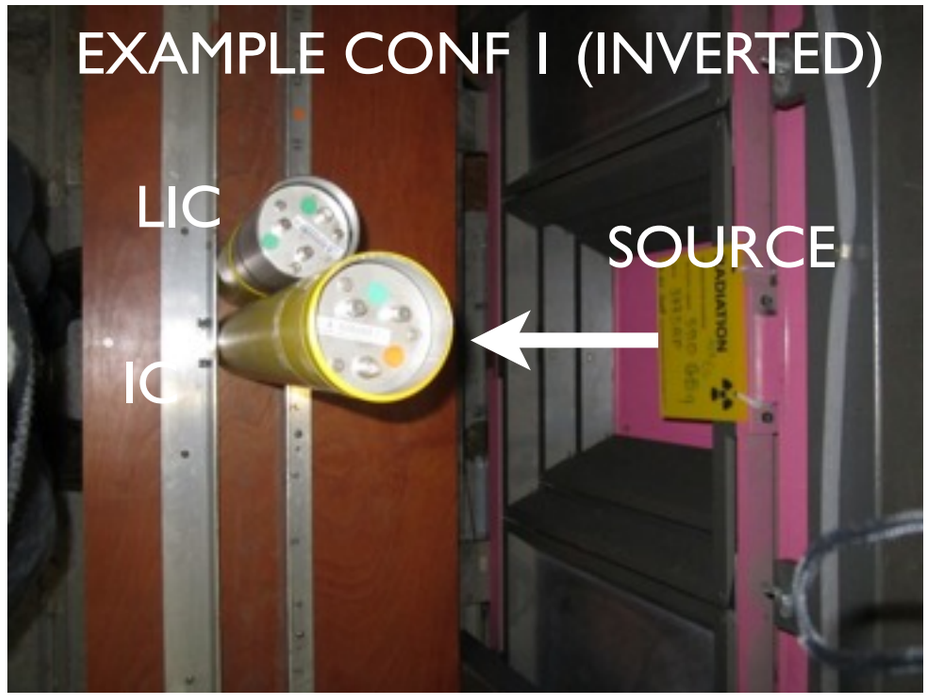
LT.QDN12 CCV	LHC-type (mA)	ACEM (mA)
225	0.06	0.1
230	0.21	0.2
235	1.0	1.2
240	3.4	4.0

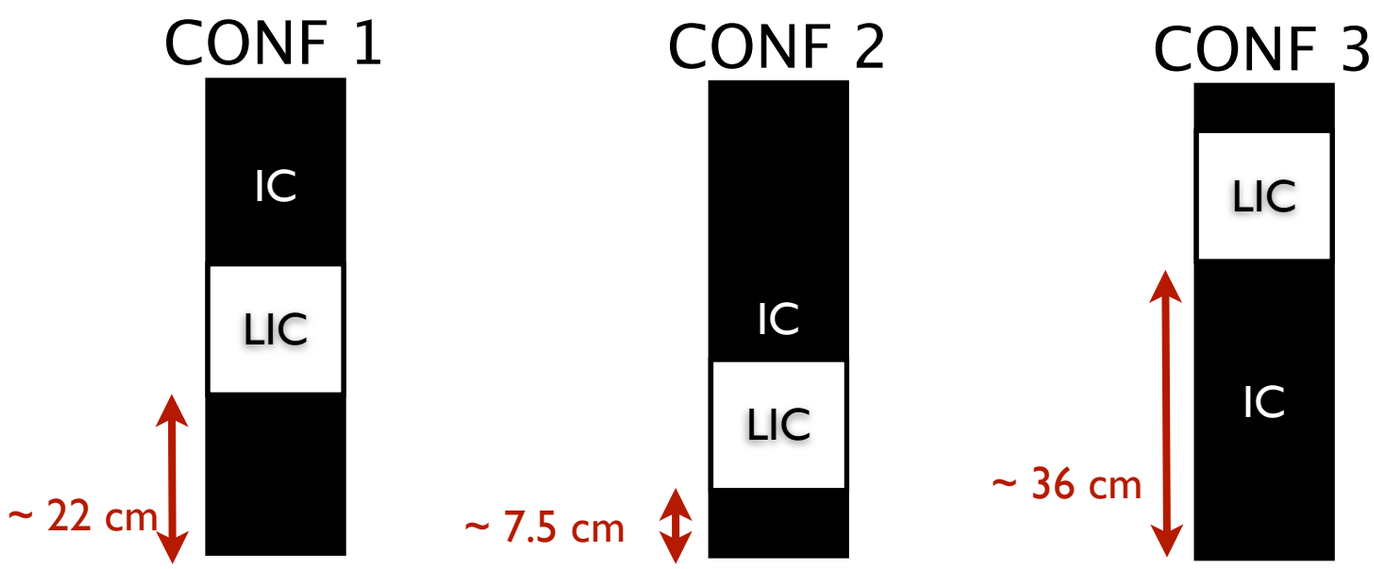
GIF measurements

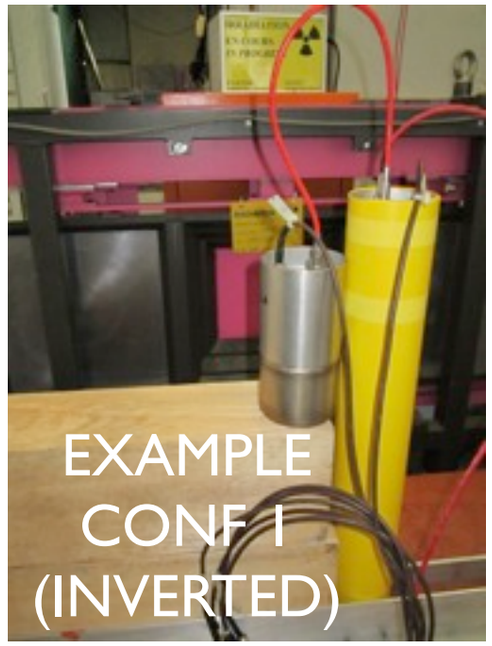
- Comparison of the response of LHC-type BLMs and LIC detectors against low energy photons (Cs137 662 keV).
- One LHC-type and one LIC detector irradiated.
- Detectors located in 6 different positions
- Two independent measurements per configuration.
- Signals integrated in 1s.
- Same set of measurements were performed with inverted polarity.

GIF. Detector configuration

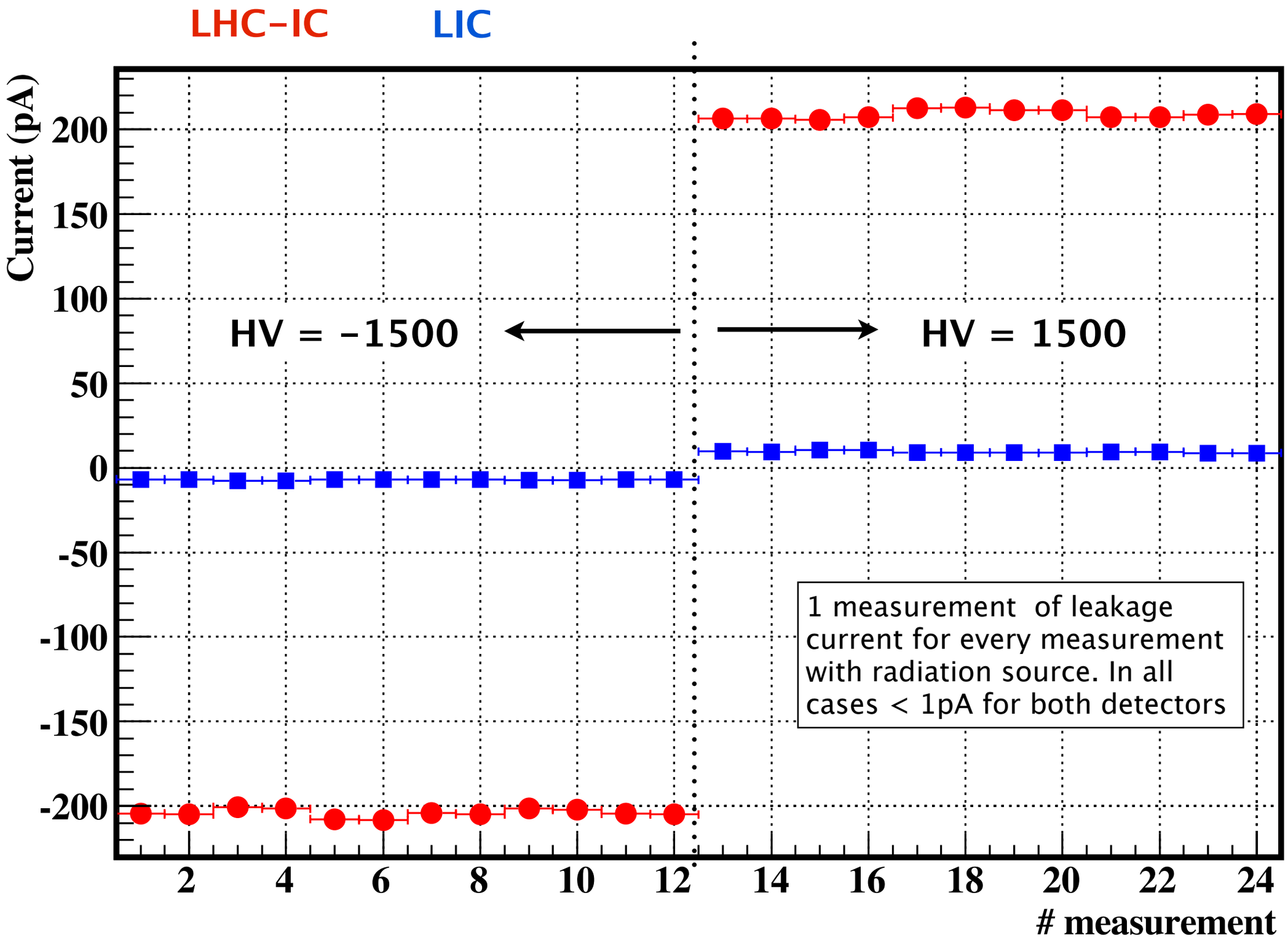






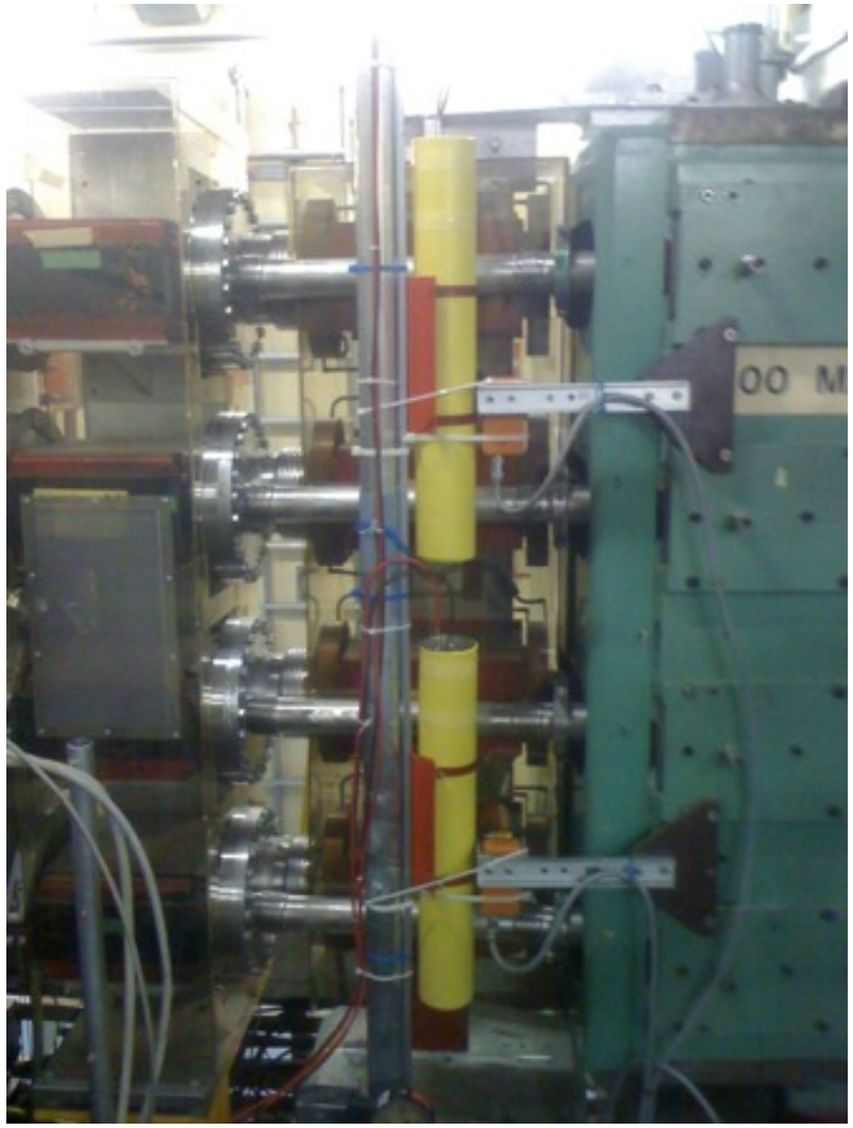


GIF measurements



PSB measurements

LHC-type BLM installed in section 15 beside extraction septum. Two independent test with main goal observing the X-talk between the two BLMs:



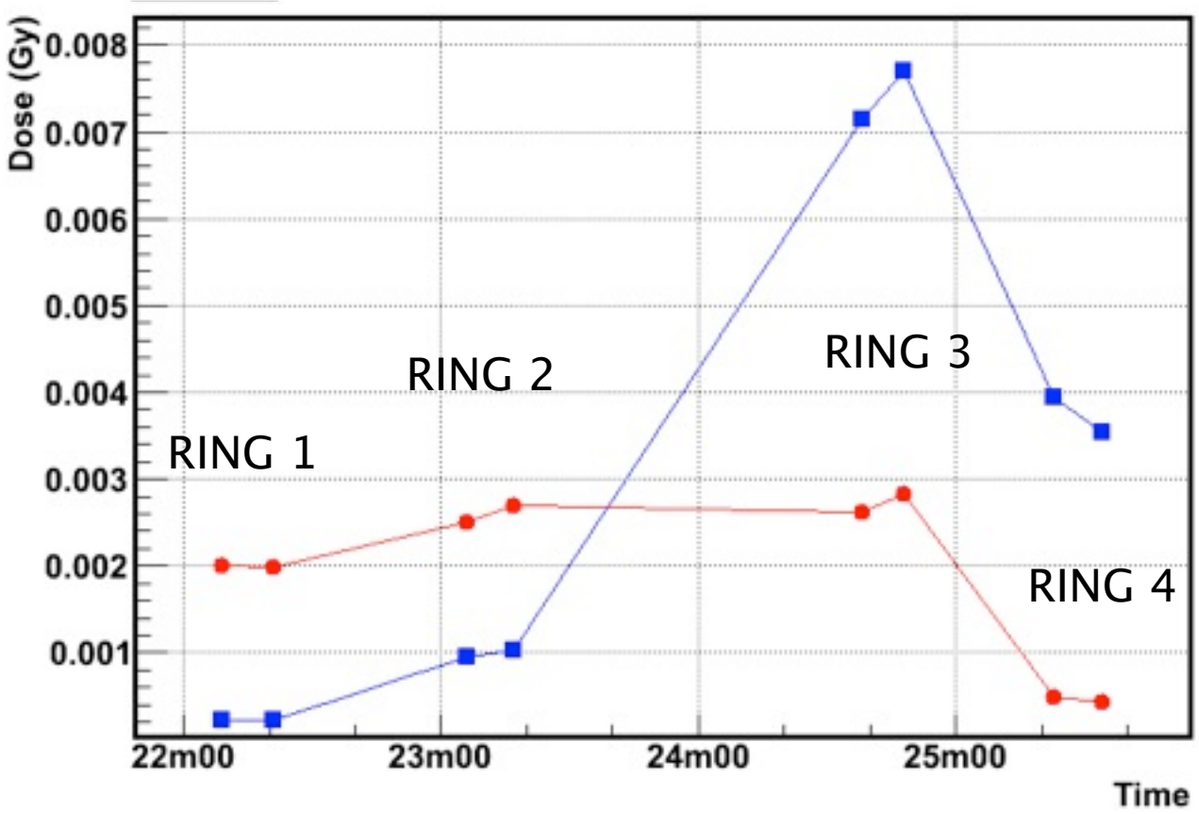
I. Create losses (in each ring) with a NORMHRS beam by switching off kick of extraction kicker. Signals integrated with LHC-like readout.

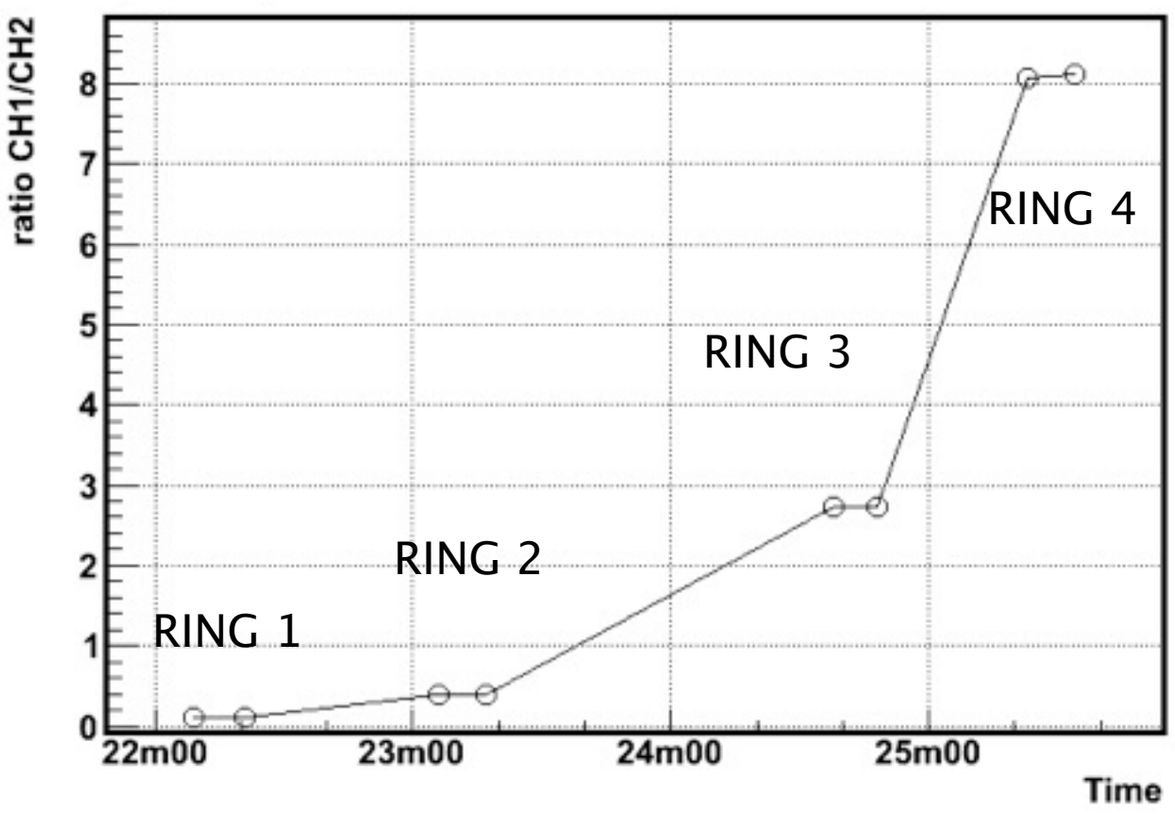
II. Create losses by decreasing extraction bump by 140 A

PSB measurements I

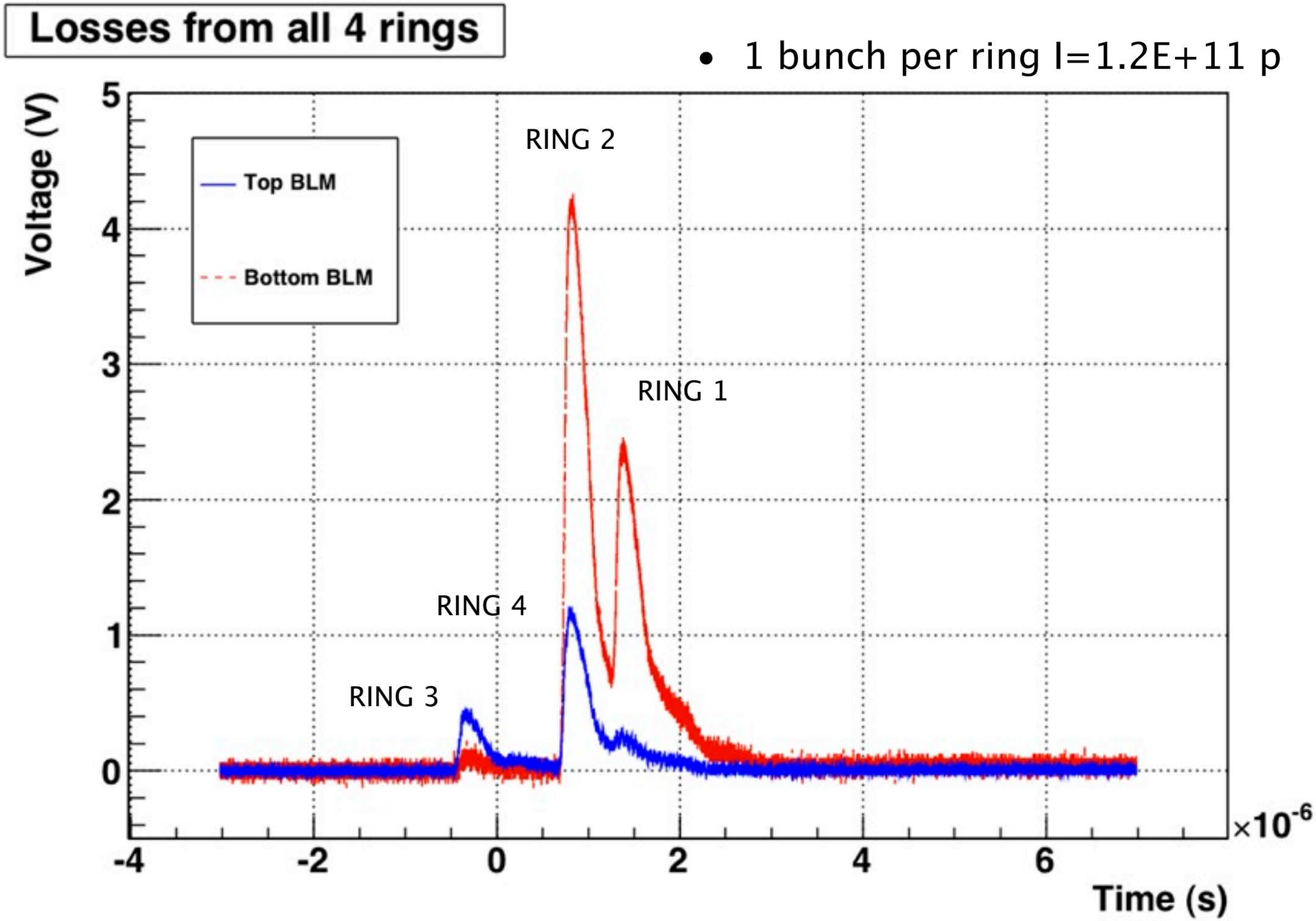
- Losses produced with I=0.8E+13 p/4
- Signals integrated over 40 us

TOP = CH1 **BOTTOM = CH2**





PSB measurements II



- 1 bunch per ring I=1.2E+11 p

Summary and conclusions

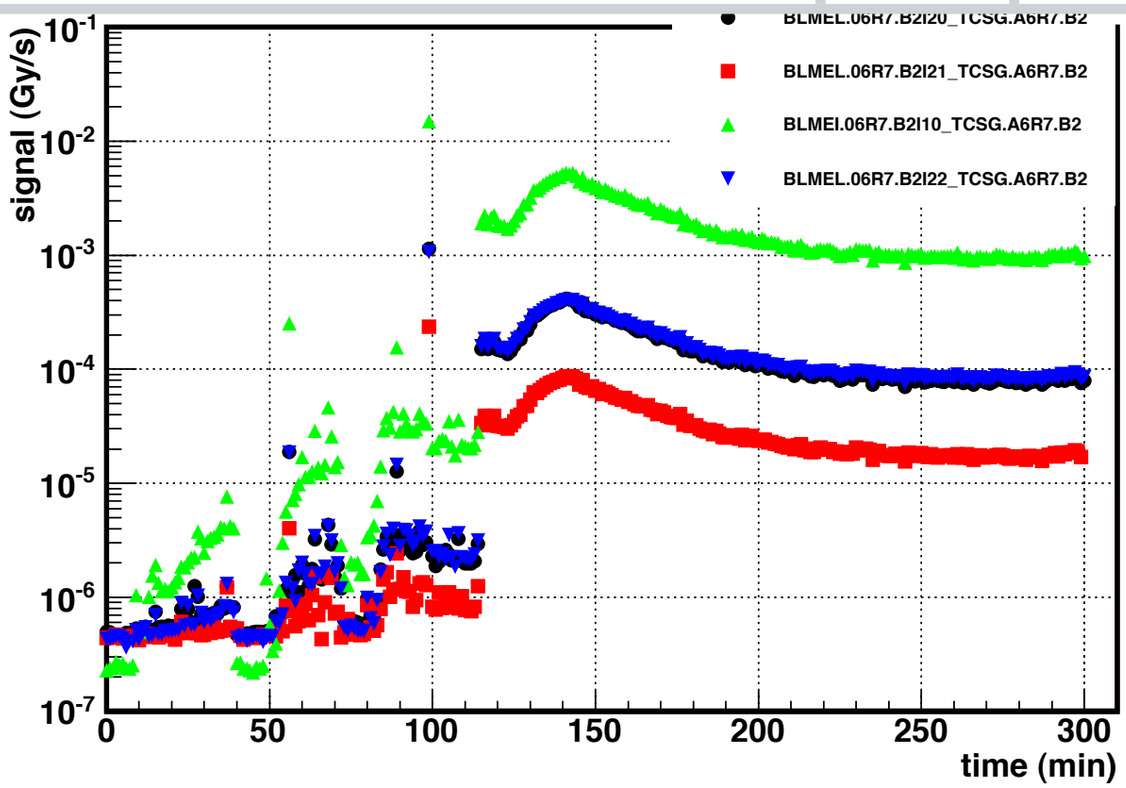
- Three type of available Beam Loss monitors: LHC-IC, LIC and SEM
- LHC-IC is the most suitable detector due to its higher sensitivity
- Some experience gained on (non LHC) beam loss monitoring
- Beam Loss detection at LINAC2 with LHC-IC is achievable via signal integration
- Both LHC-IC and LIC have proved to be sensitive to low energy photons (GIF) via signal integration

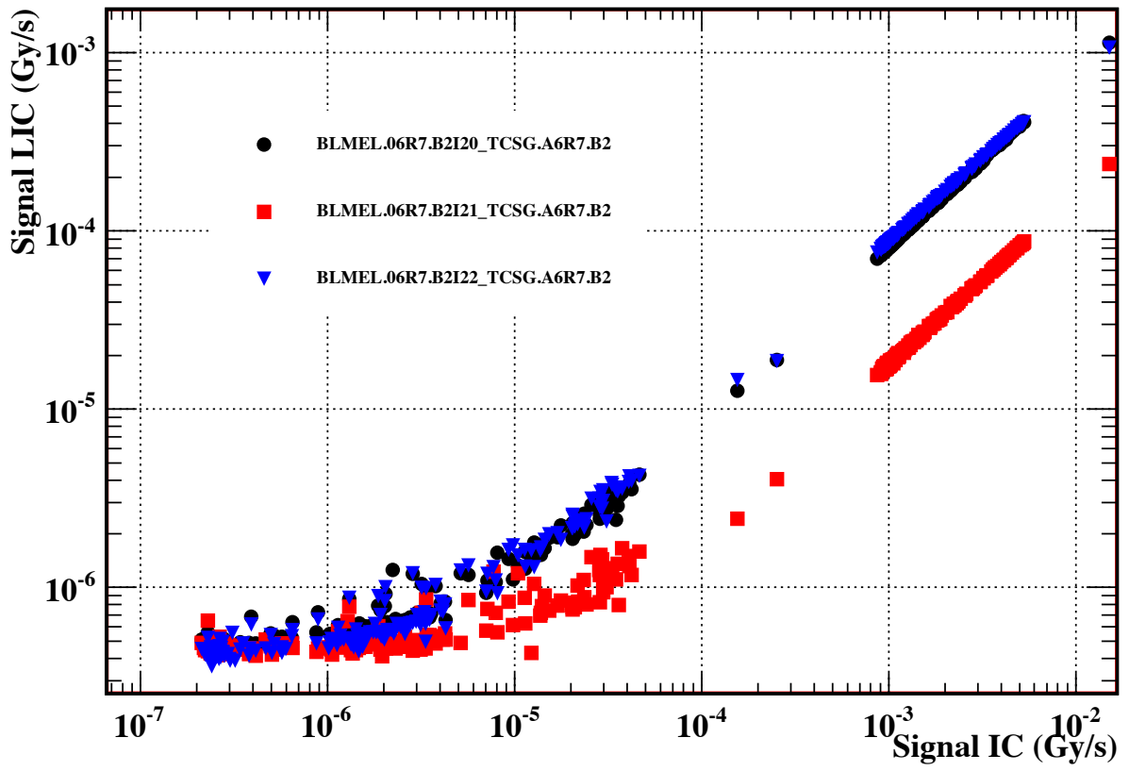
Extra slides

Slow losses. LHC Betatron cleaning.

- Three LIC detectors located in IR7 downstream a secondary collimator.
- 5h in Fill 2208 (2011-10-13 00:54:00)

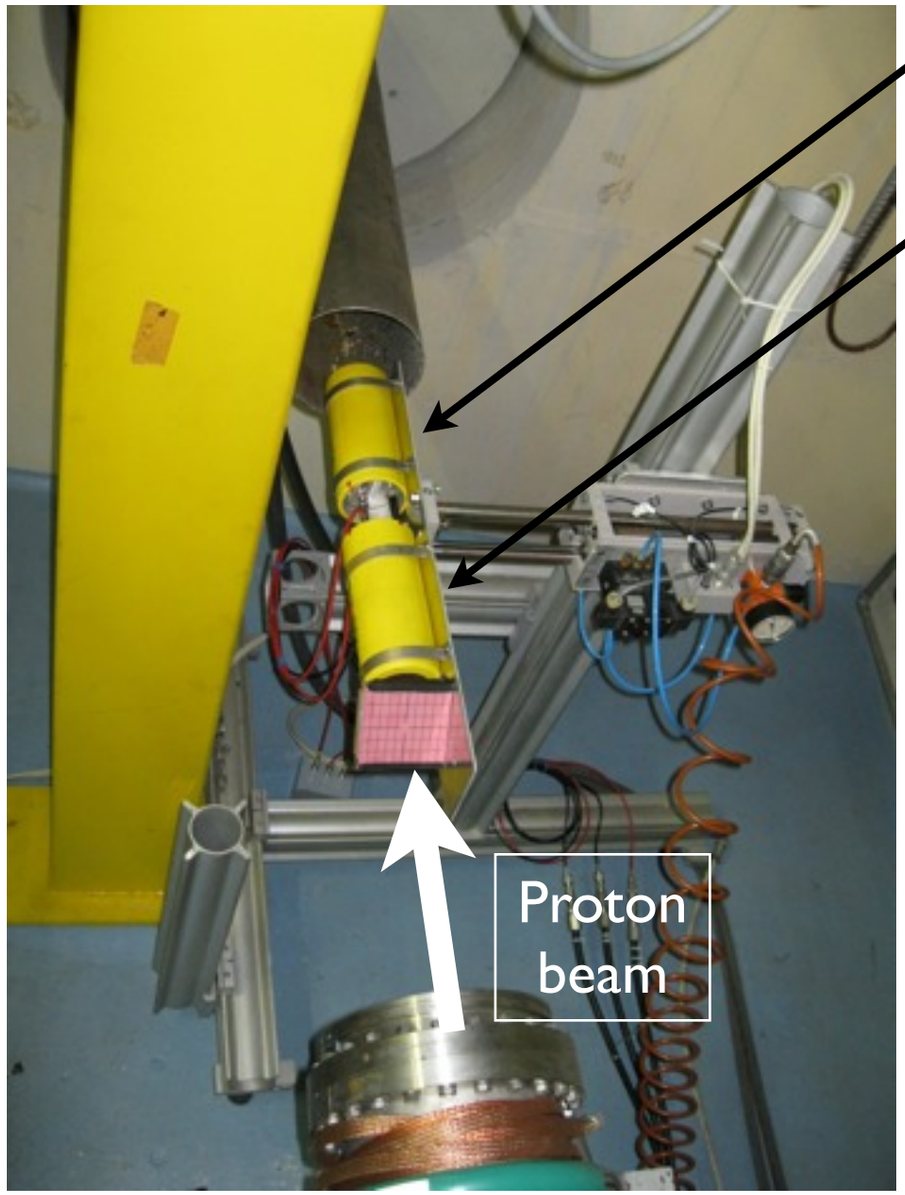
Monitor Name	Type	P (bar)	ratio
BLMEI.06R7.B2I10_TCSG.A6R7.B2	IC	1.1	---
BLMEL.06R7.B2I20_TCSG.A6R7.B2	pLIC	1.1	12.5
BLMEL.06R7.B2I21_TCSG.A6R7.B2	LIC	0.4	58.8
BLMEL.06R7.B2I22_TCSG.A6R7.B2	pLIC	0.1	12.0



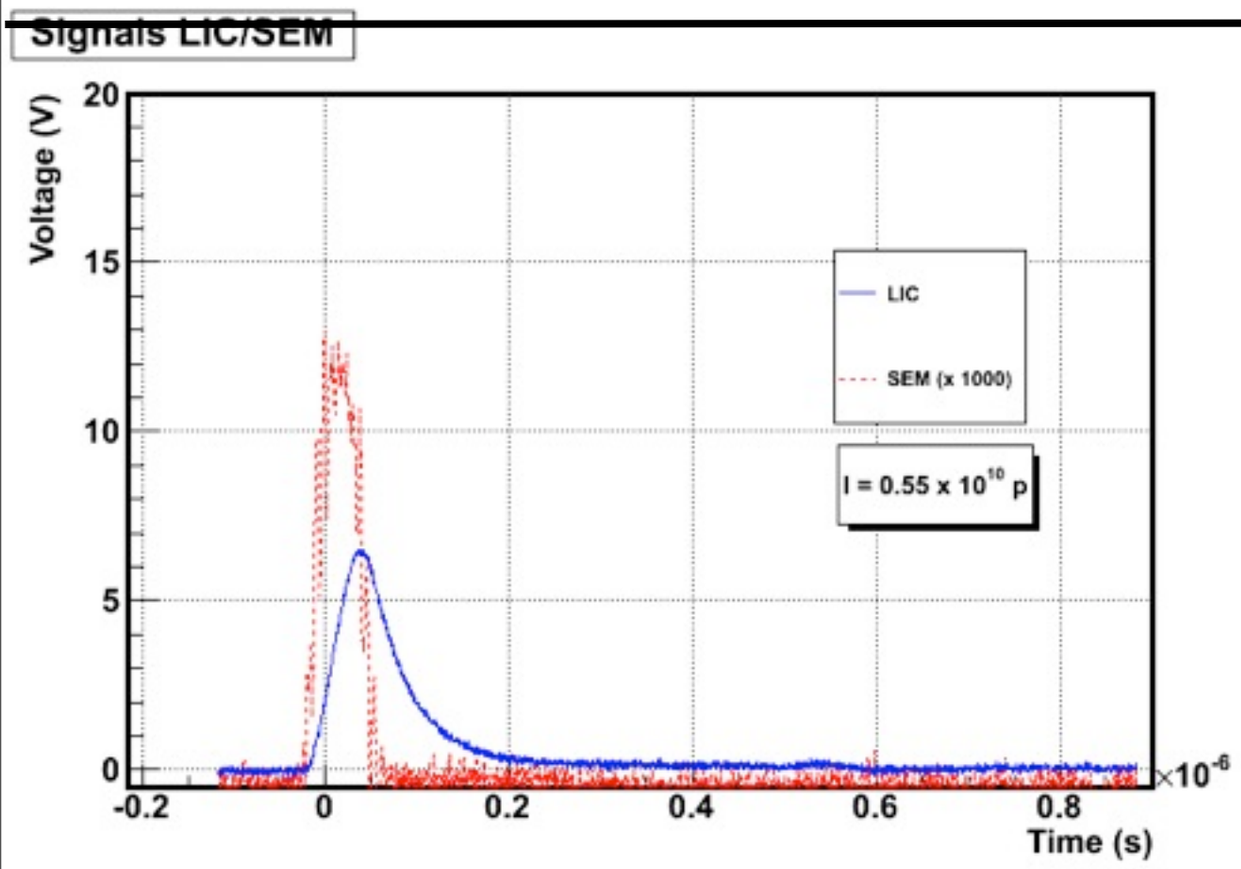


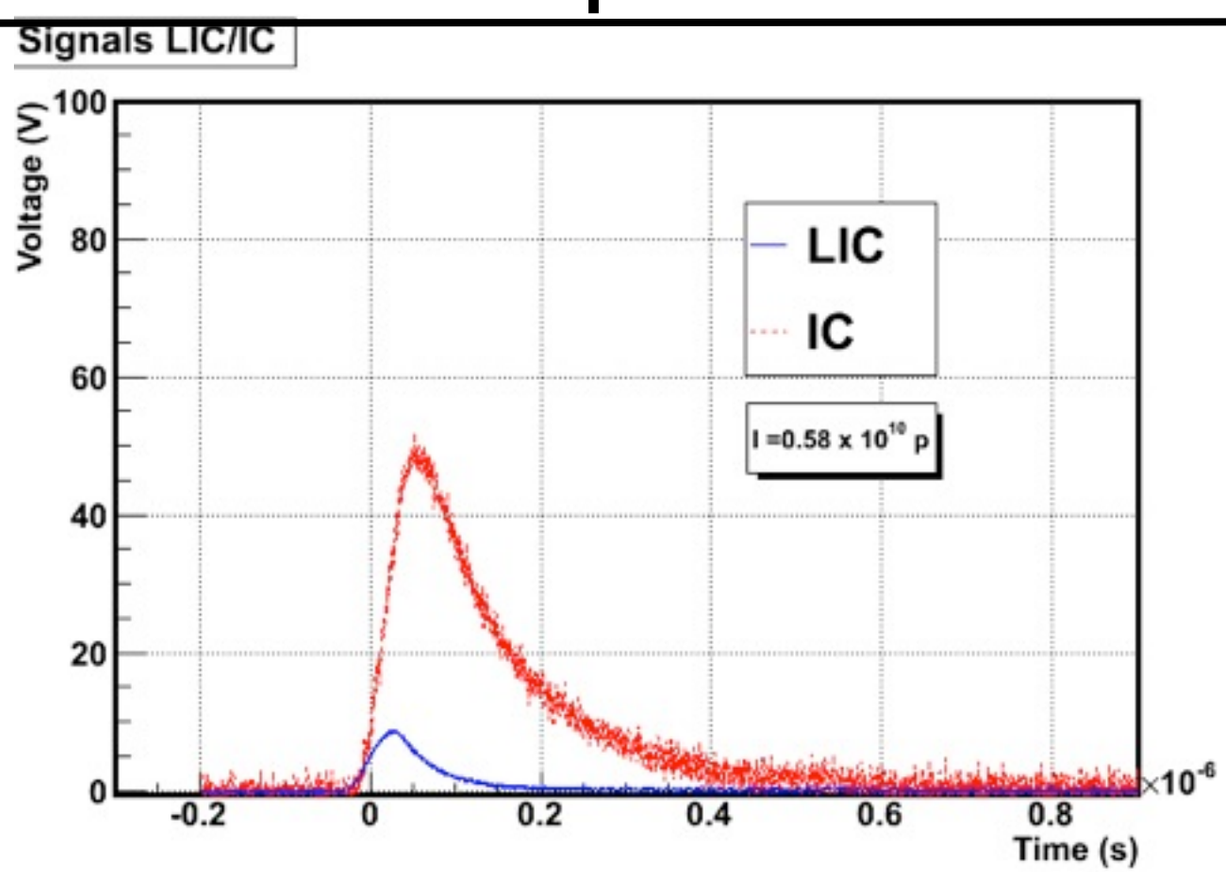
PSB Dump Line measurements

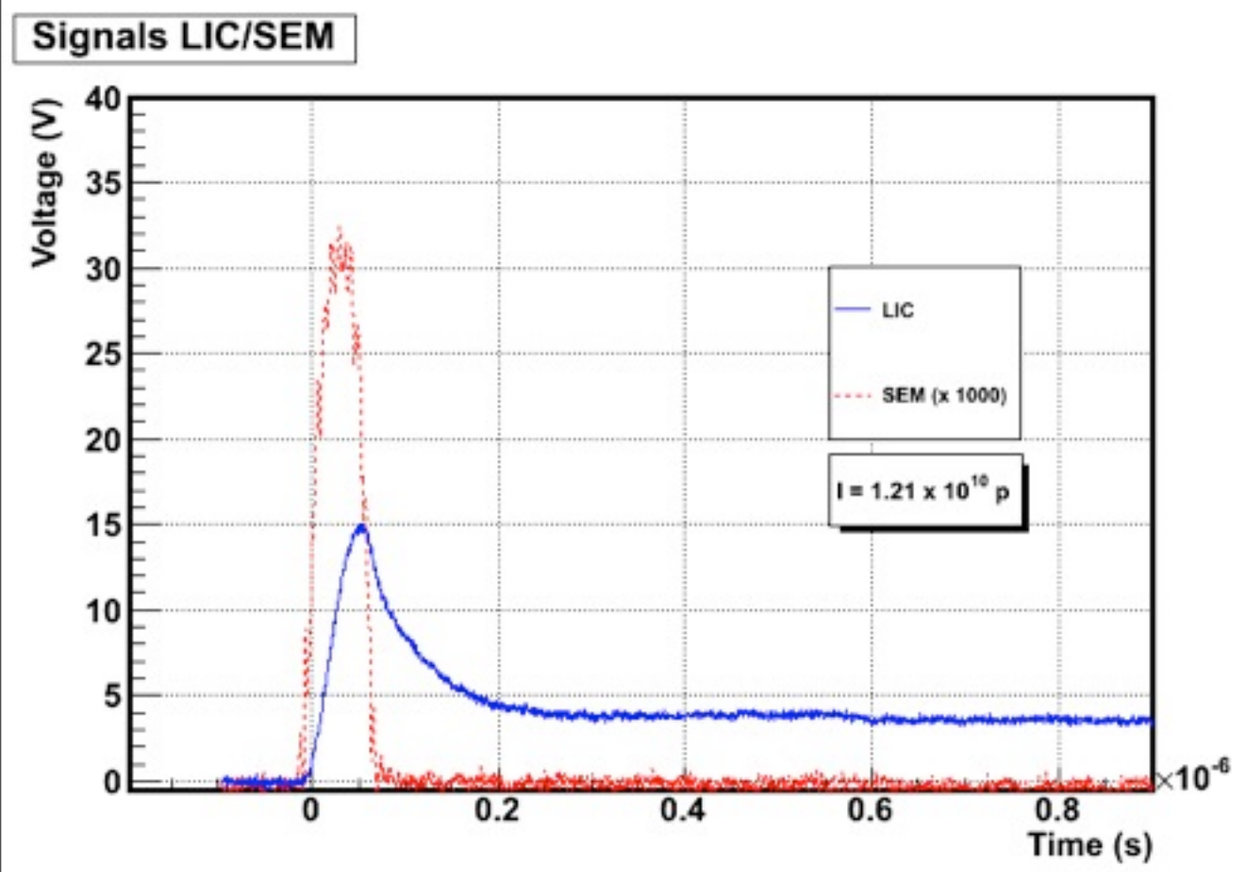
- Response to short pulses:
  - One bunch ~50ns long
  - Intensities 0.5-2.0 E+10

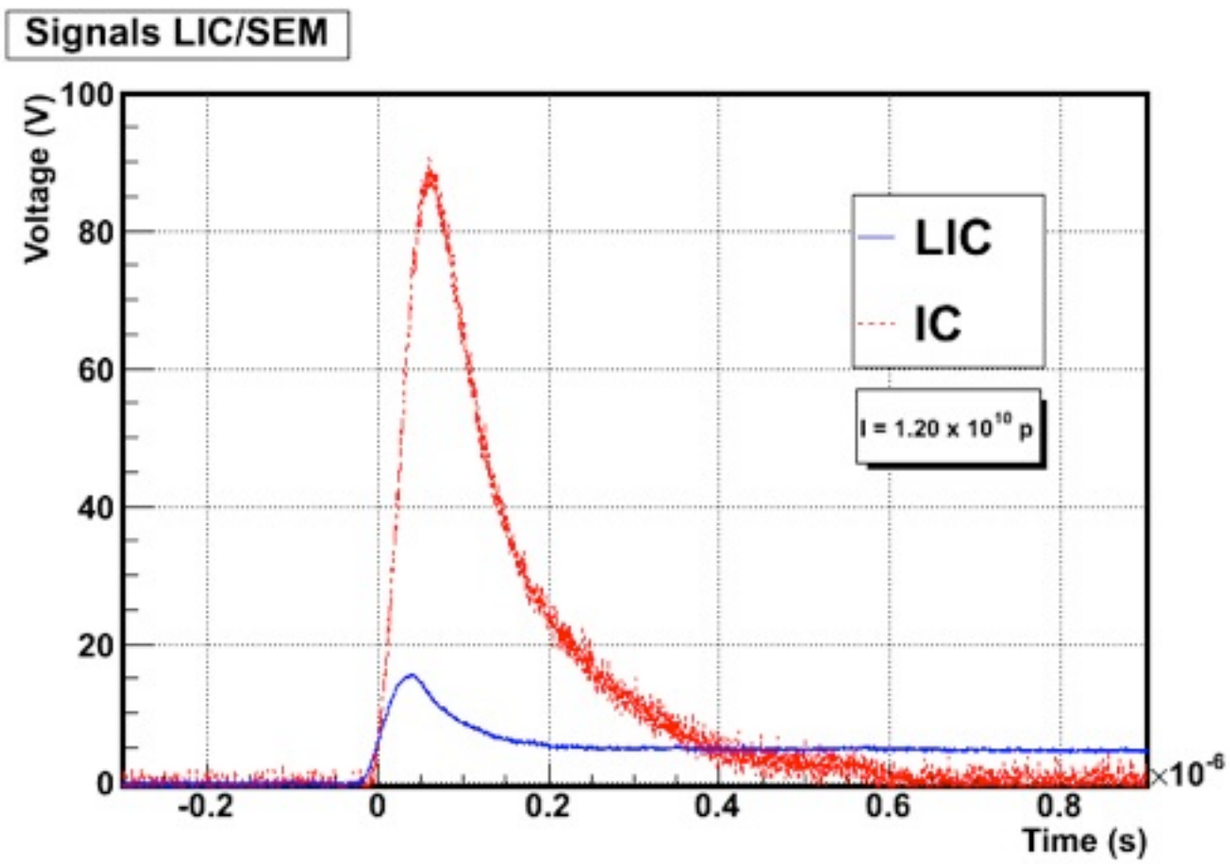


PSB Measurements. Pulse shapes

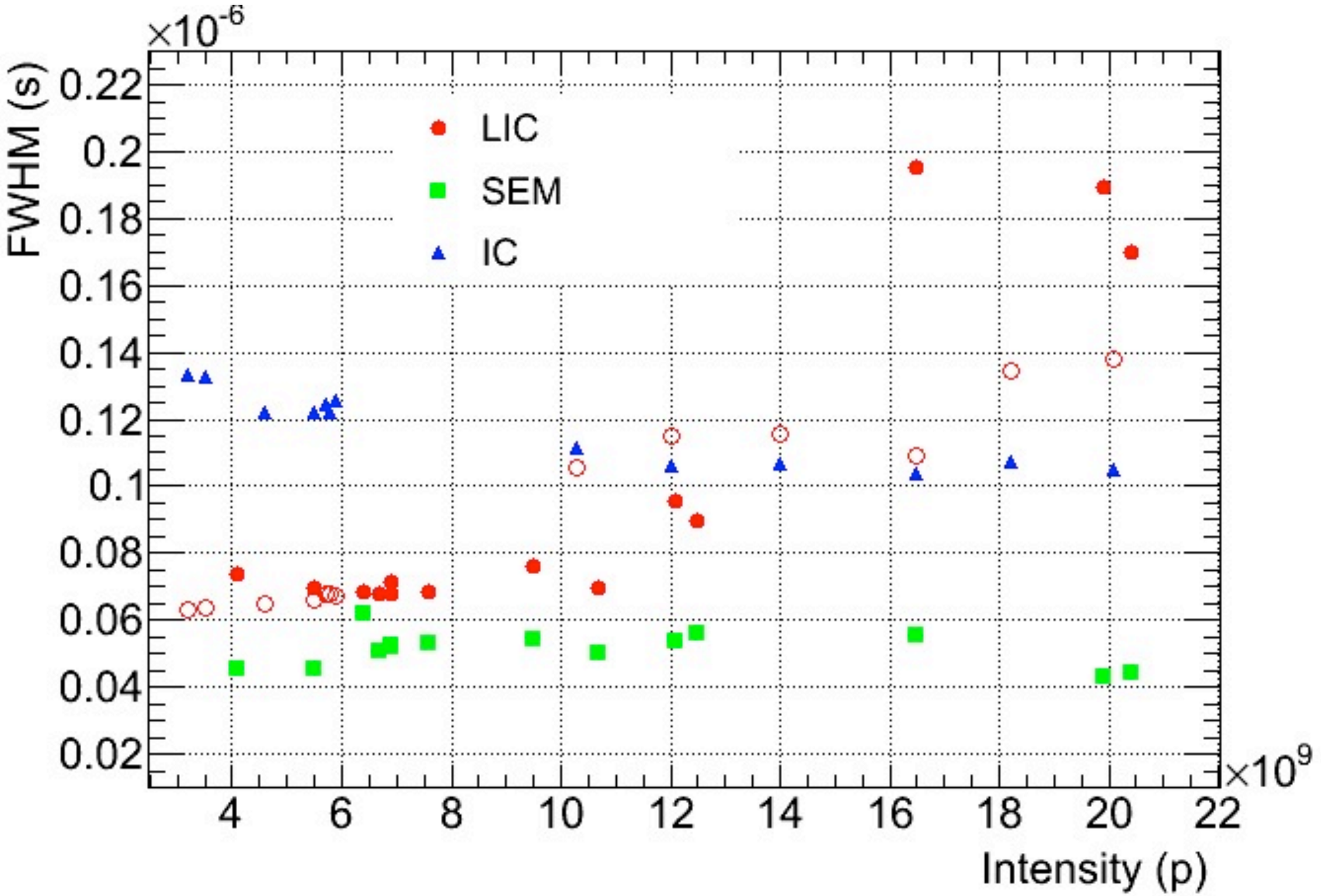




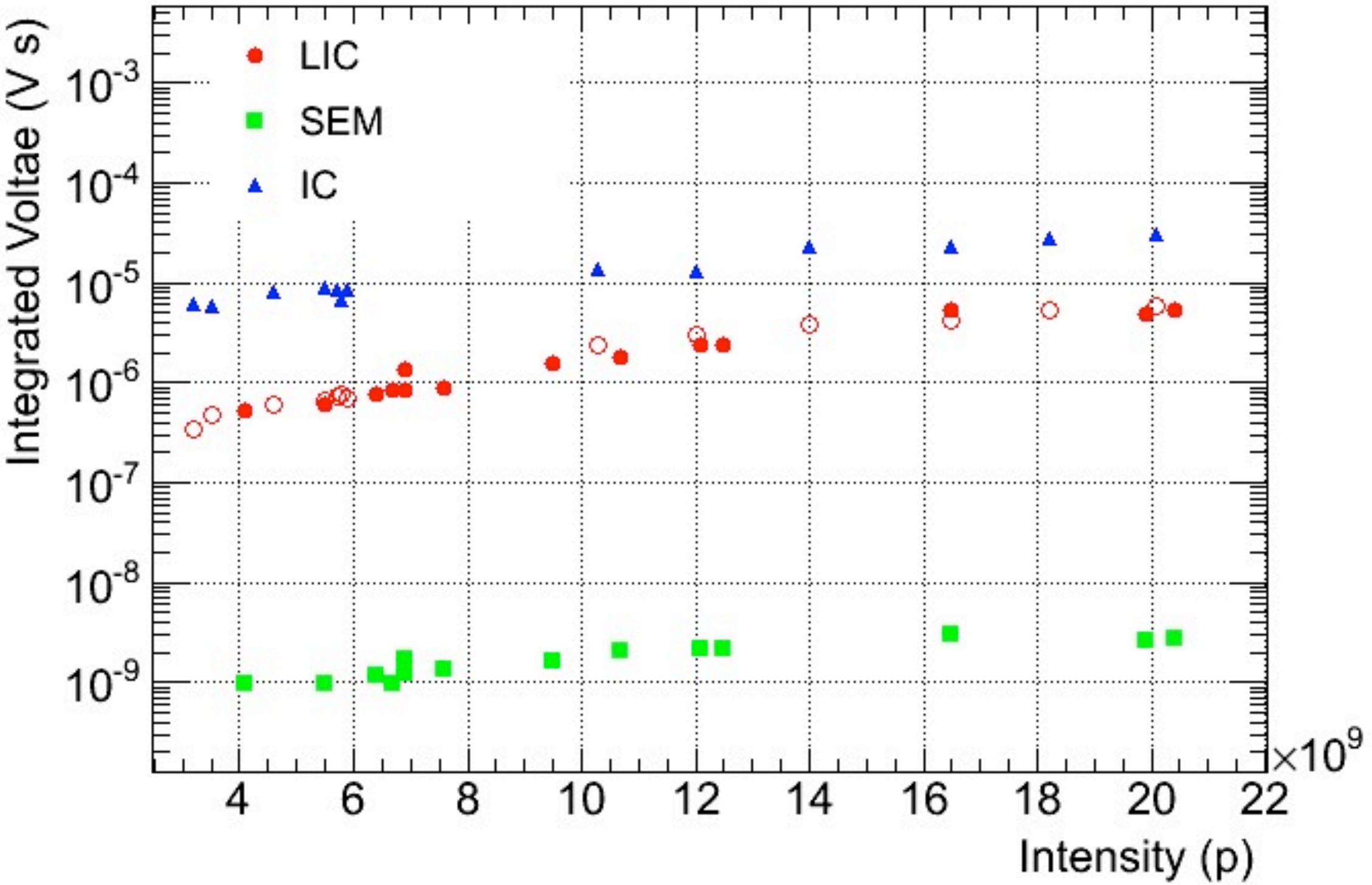




Time response

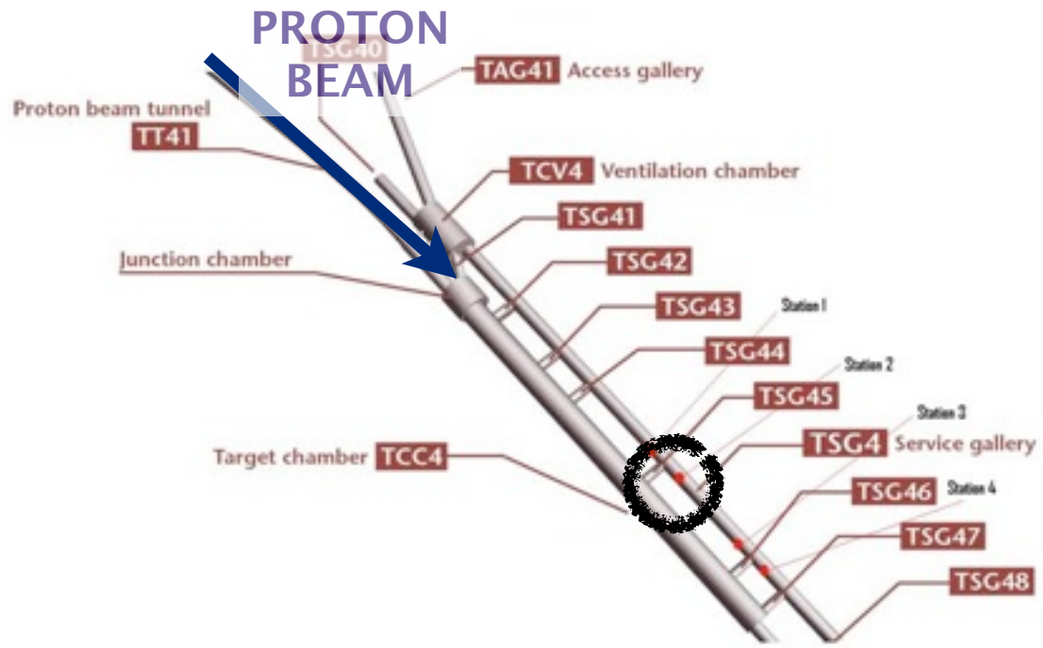


Signal response



CNRAD measurements (behind CNGS target)

- Uniform mixed radiation field:
  - 2 pulses of 10us separated by 50 ms
  - Intensities of ~ 2.0E+13 pot produces a recorded signal of ~14Gy/s in 40us



Experiment setup

TUNNEL INSTALLATION

SURFACE INSTALLATION

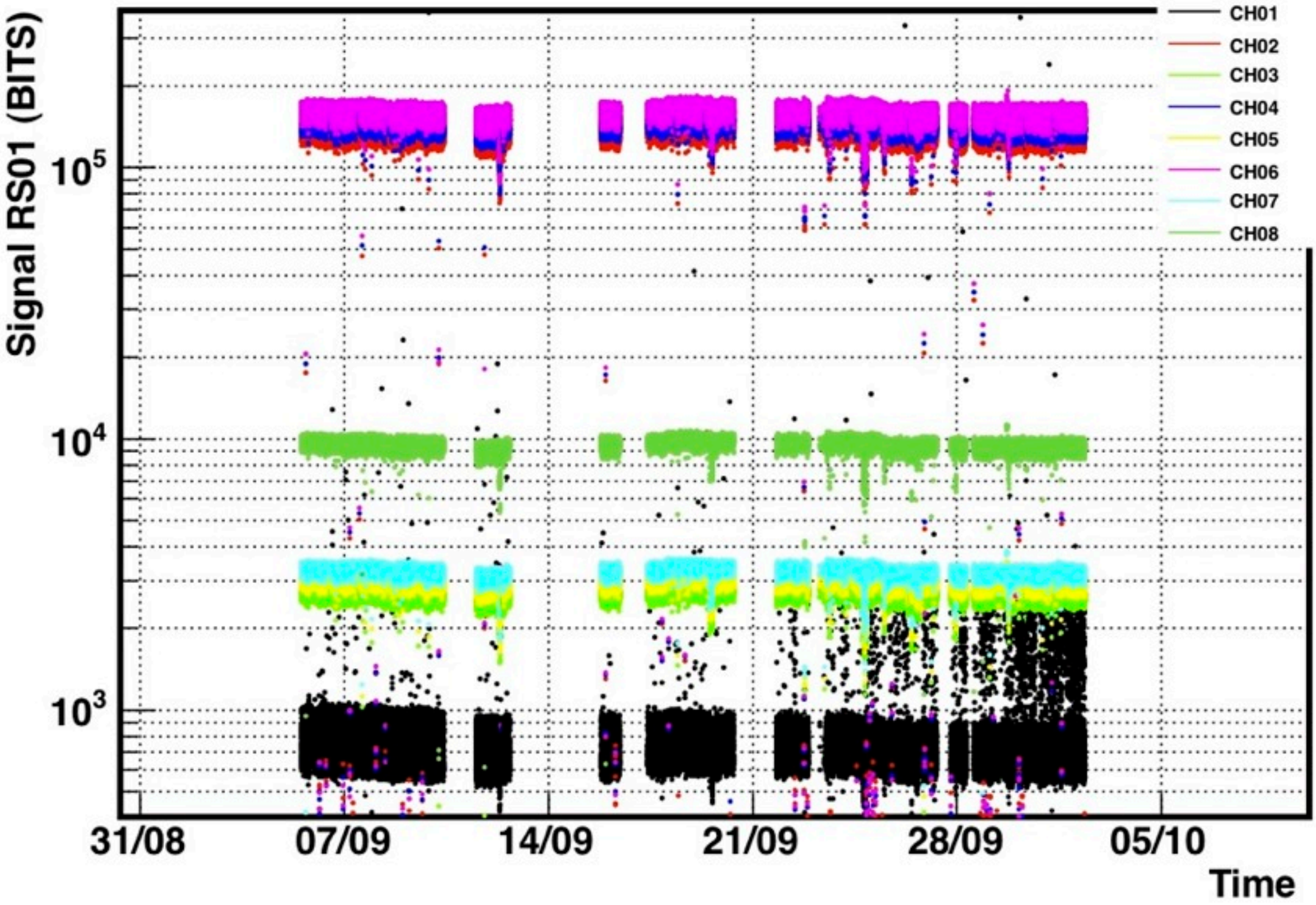
- Detectors : Eight ICs assembled in a metallic cross at TSG45. 3 LHC-ICs for calibration purposes.

- Radiation hard readout card(located in station 1): CFC (integrate the signals in 40 us time windows) and optical link (sends the signals via optical fiber to the surface).

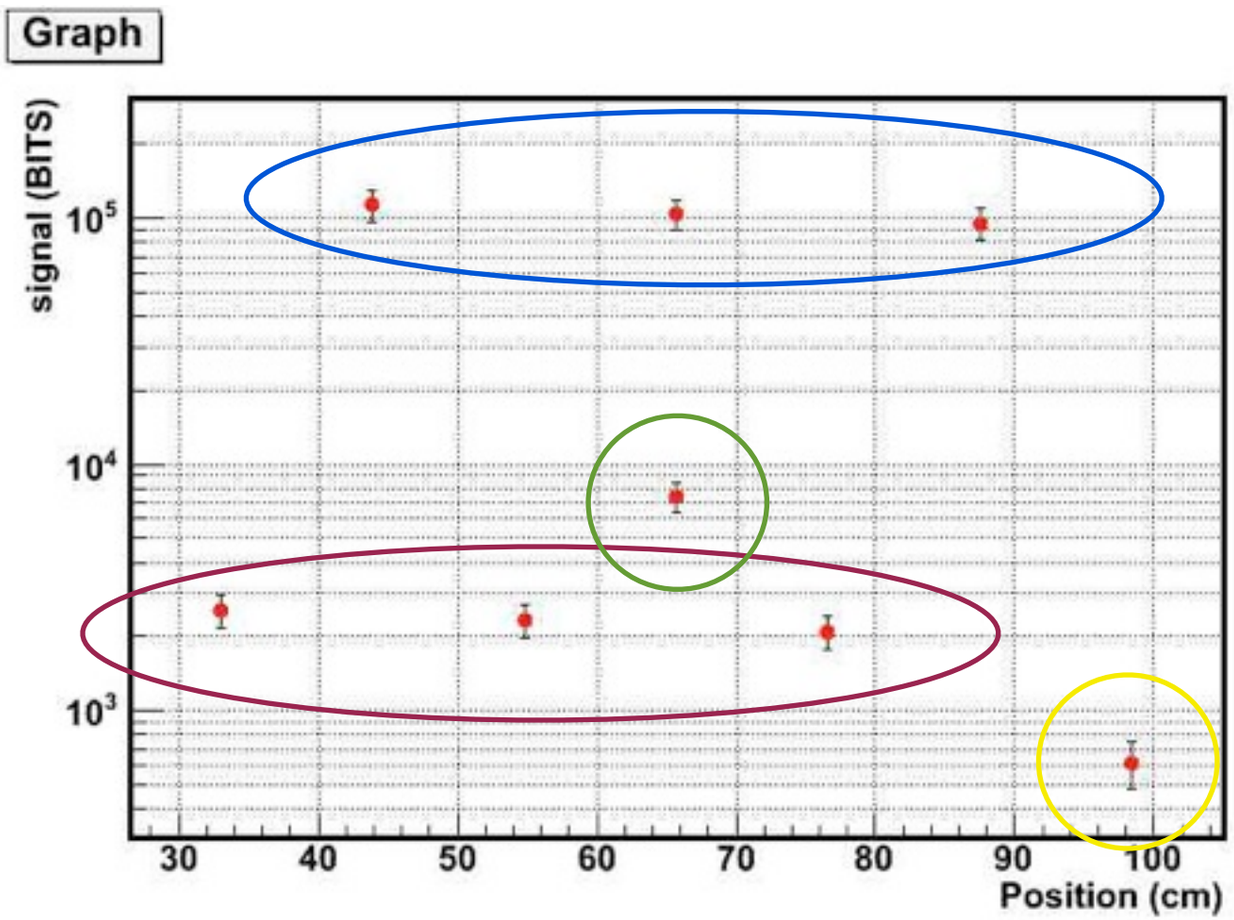
- Data acquisition system (located in the CNRAD counting room): Optical link (decodes the signals coming from the optical fibers), FPGA (computes 12 Running sums, corresponding to signals integrated in 12 different time windows) and Laptop (provides the computing power and stores the data).

Signals vs time

- Uniform Signals integrated in a 40us time window



Position and pressure dependence



IC 1.1 bar

LIC 0.4 bar

LIC 1.1 bar

LIC 0.1 bar

Linear dependence of signals with Pressure