
CERN

The Linac4 H0/H- monitor

Jean Tassan-Viol - BI Day 2017

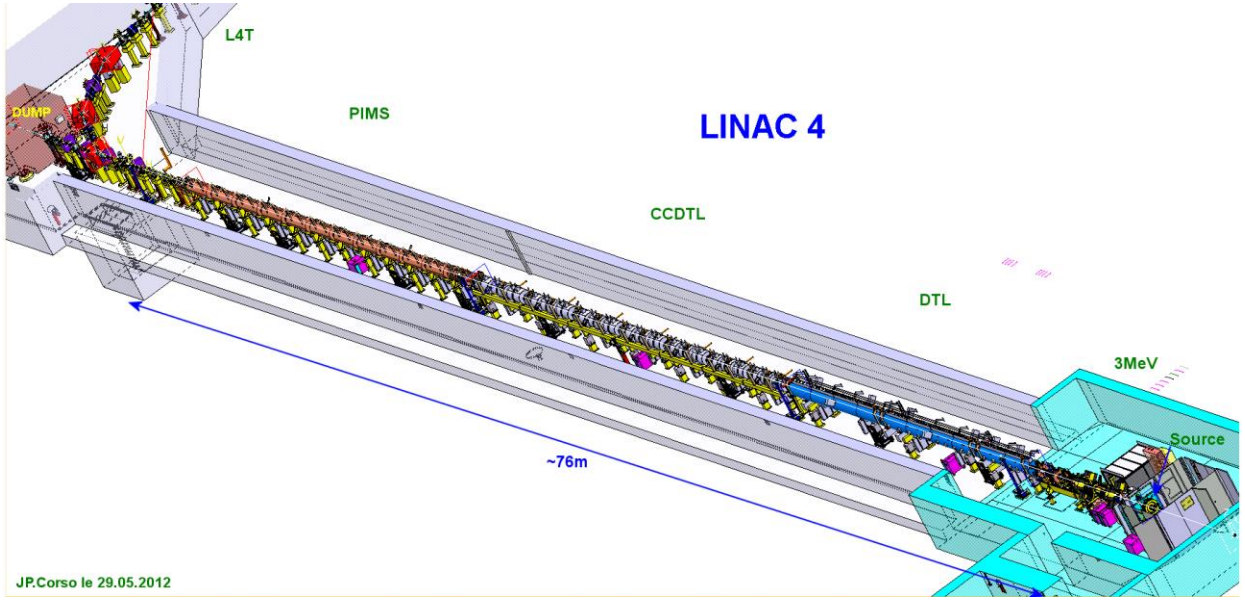
Thanks to :

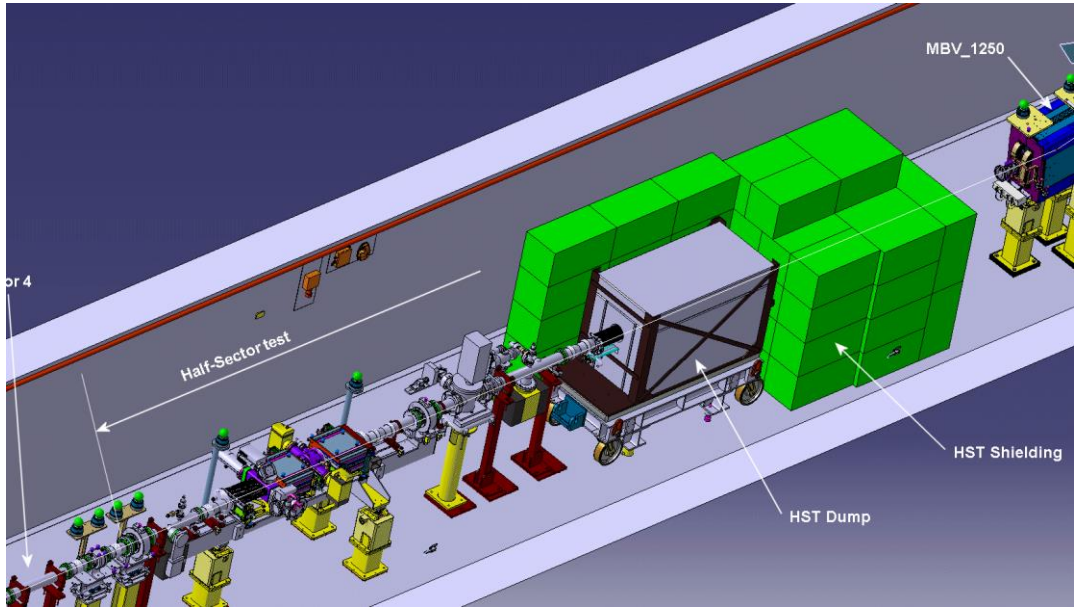
Federico Roncarolo (BE-BI), Gerrit Jan Focker (BE-BI), Araceli Navarro Fernandez (BE-BI), J.B. Ruiz (BE-BI), Morad Hamani (BE-BI), Sylvain Leblanc (BE-BI), Claude Rinaldi (BE-BI), Wim Weterings (TE-ABT) , Louise Jorat (TE-ABT), Bettina Mikulec (BE-OP), Marco Garlasche (EN-MME), Jean-Pierre Corso (EN-ACE), Damien Grenier(EN-STI), Nicolas Thaus (TE-VSC)

Outline

- Introduction to new PSB injection region
- H0/H- beam current monitors
- Assembly challenges
- Electronics
- Measurements examples at HST
- Conclusions

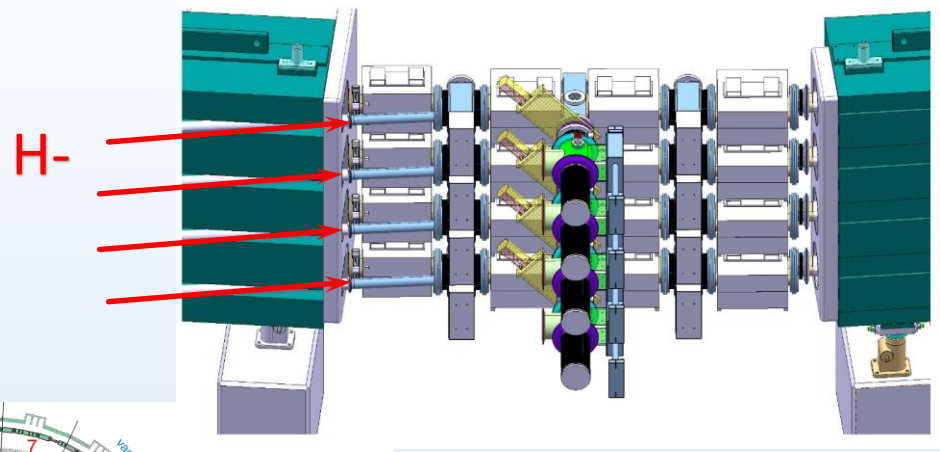
Linac4

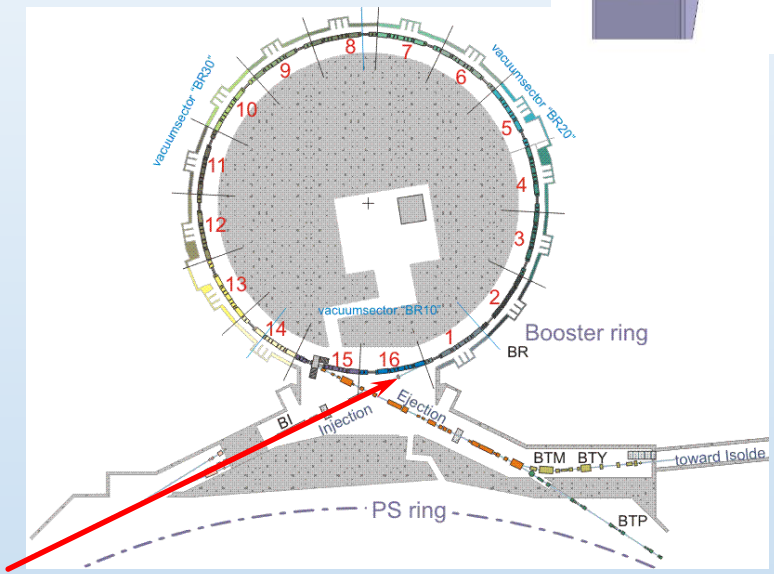




Half sector test

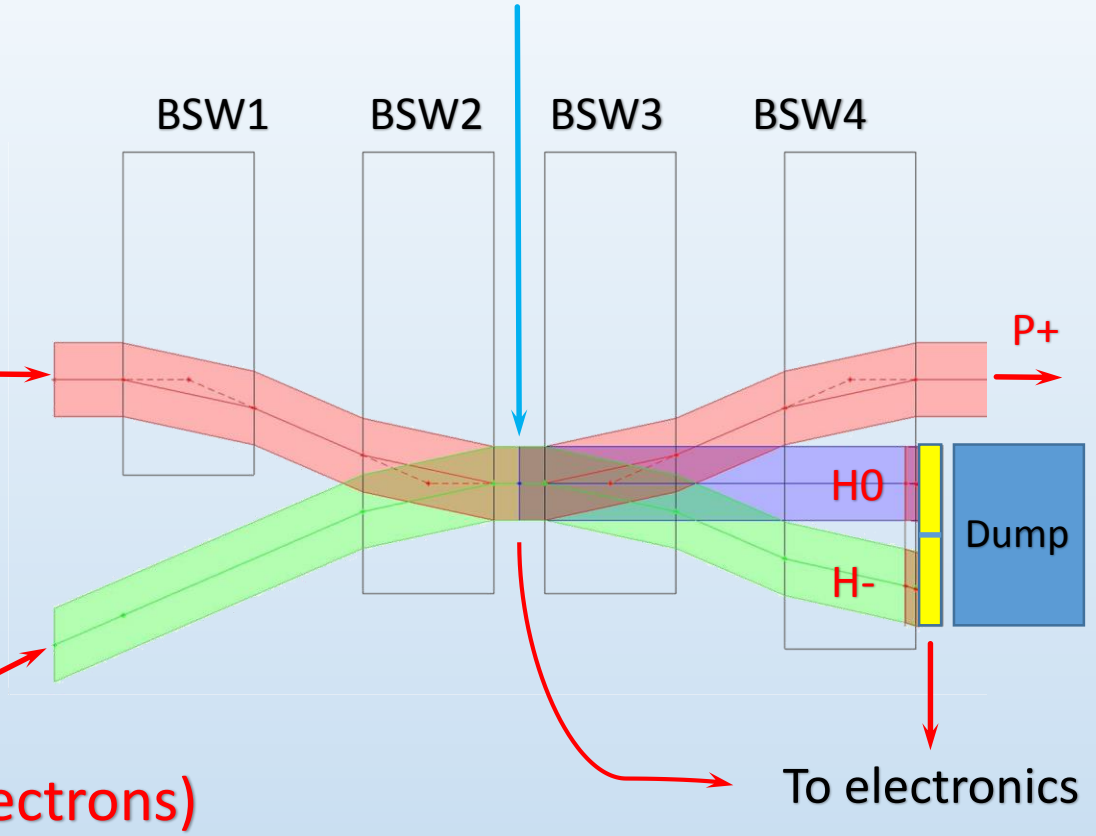
Introduction to new PSB injection region





160 MeV H- beam
from LINAC4

Stripping foil
(x% efficiency)



P+ Circulating beam

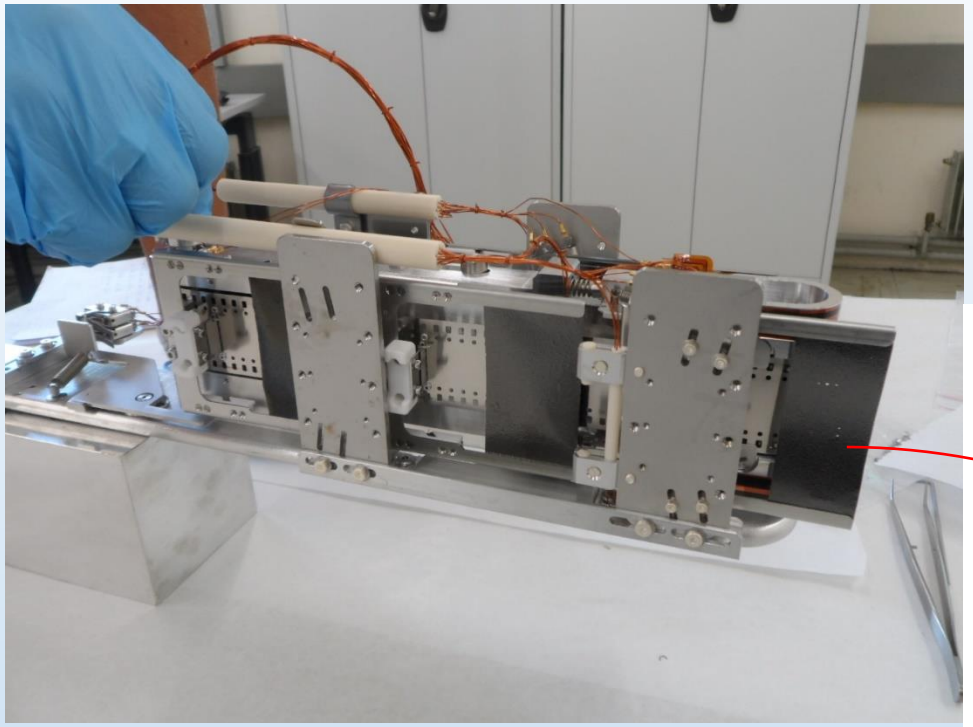
H-
(=1 proton+2electrons)

To electronics

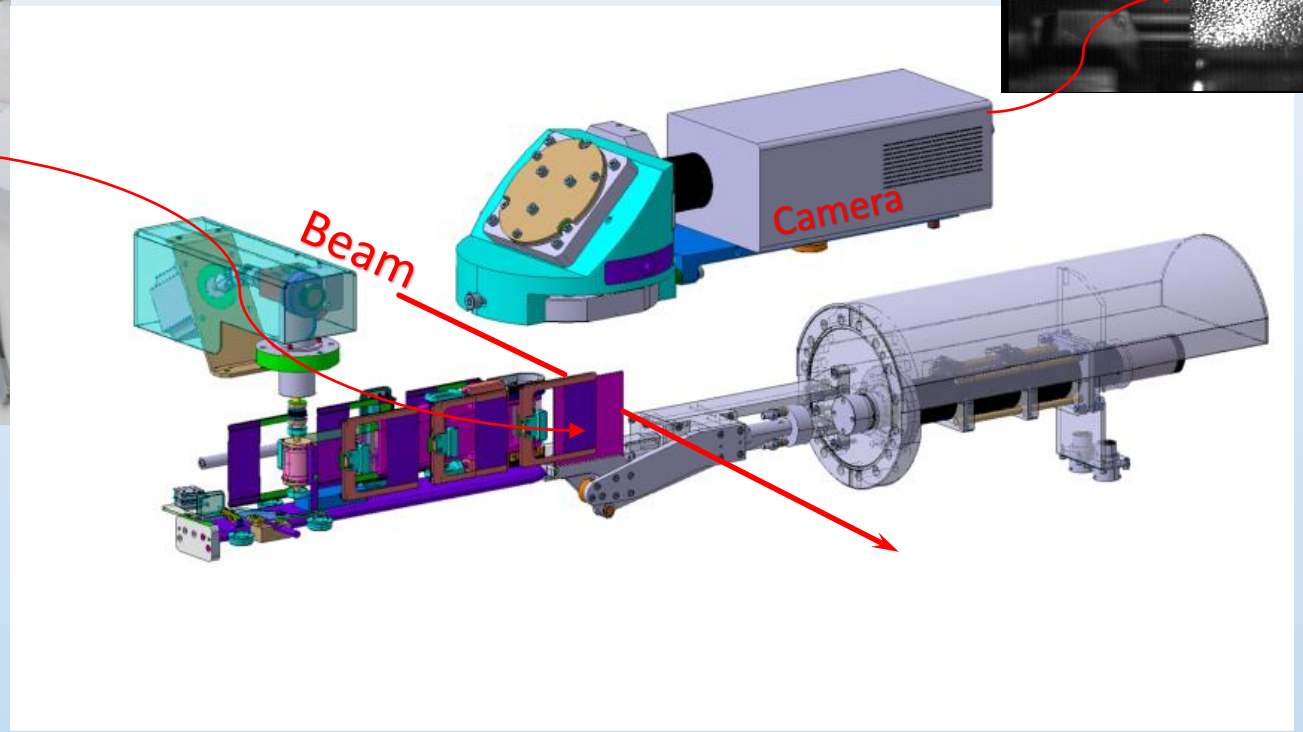
Need to measure H0 and H- charges !
- **On line monitoring of SF degradation**
- **Protect dump in case of foil breakage**

Stripping foil loader and BTV

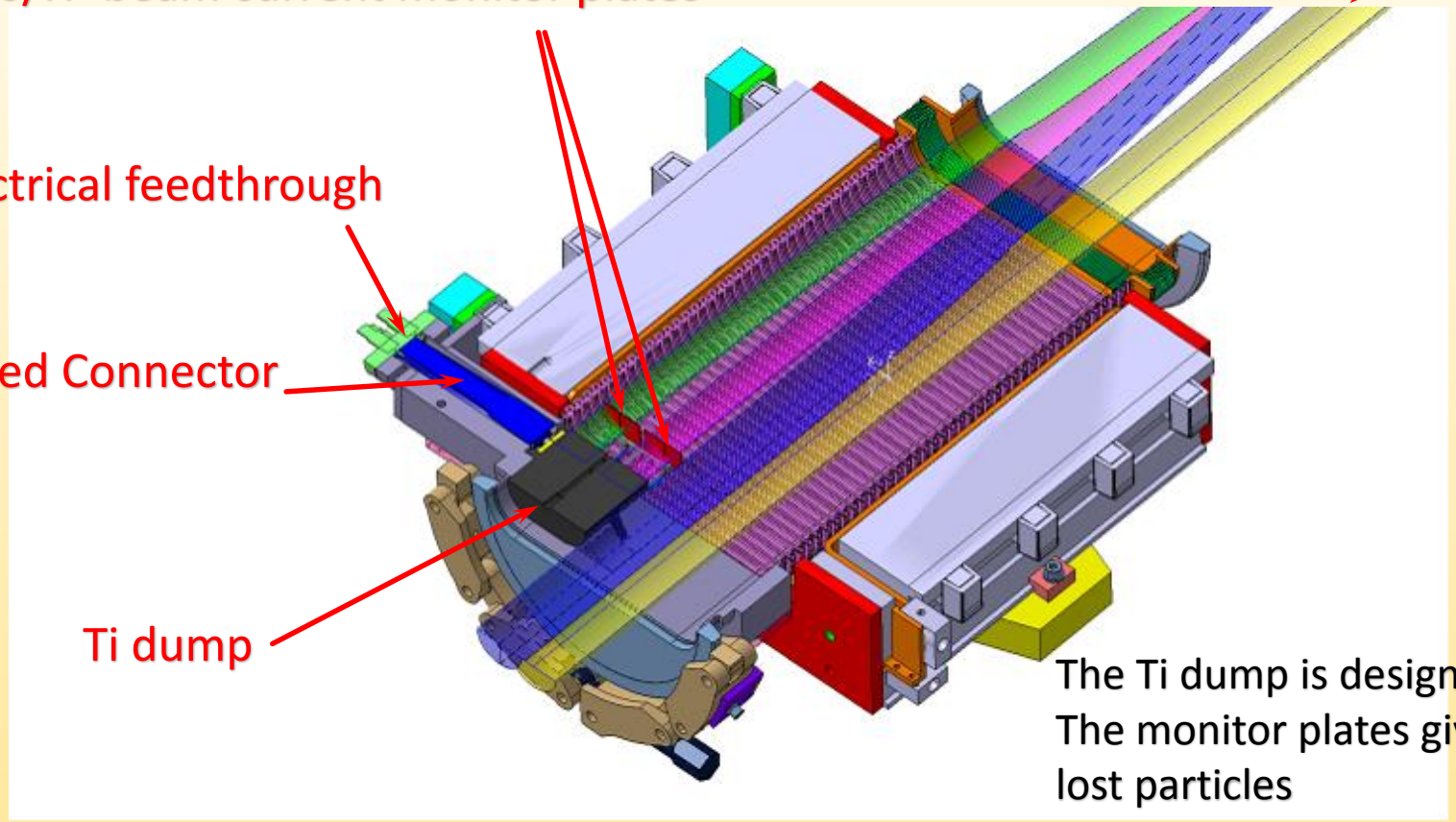
The BTV with its rad hard camera allows operator to check visually the beam and the stripping foil



Stripping foil loader



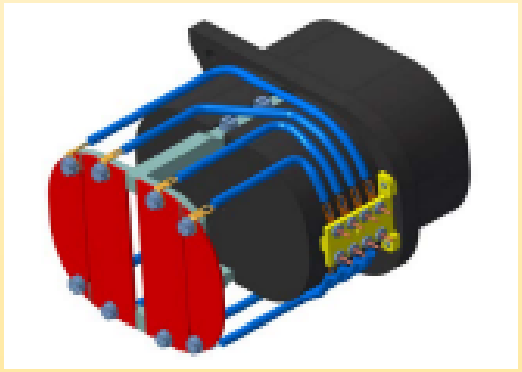
Internal view of the BSW4 tank

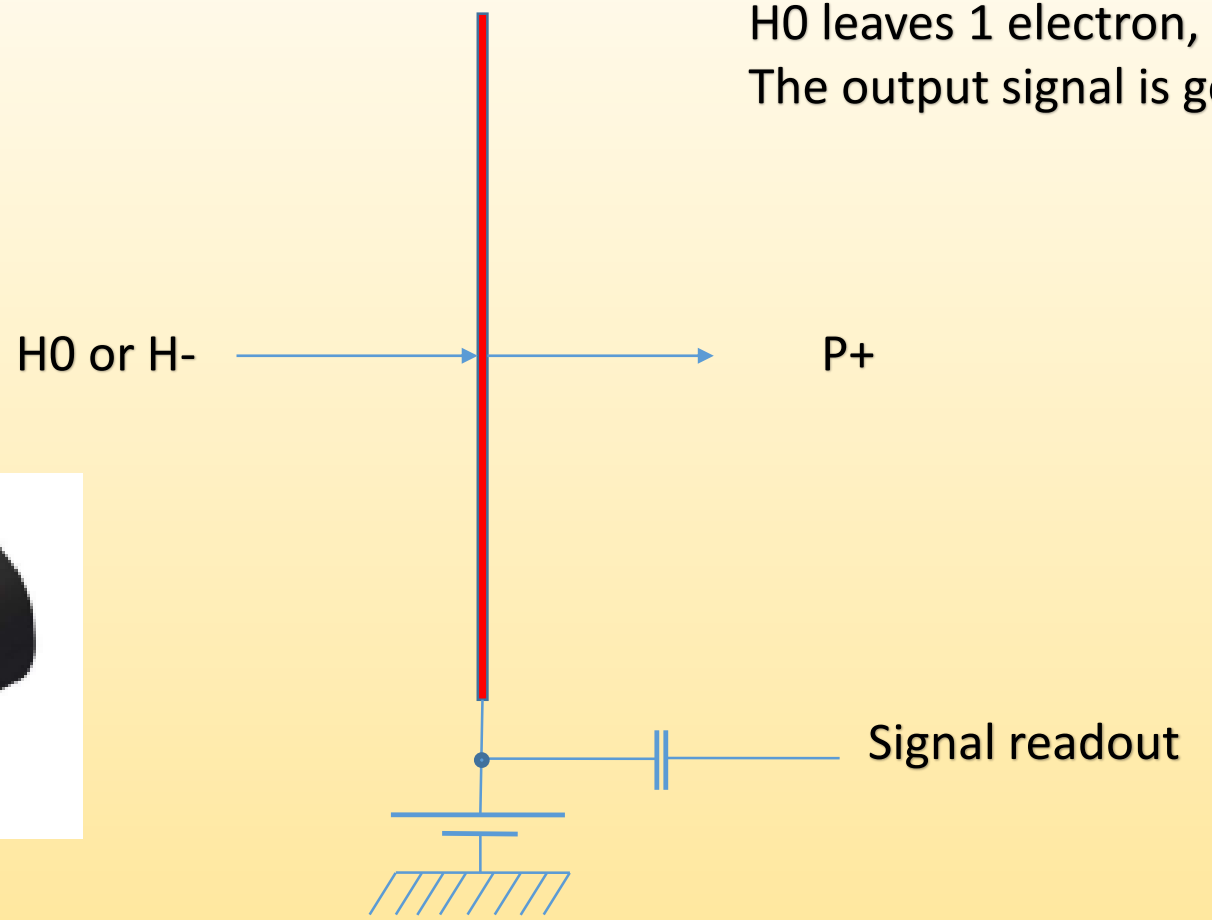


The Ti dump is designed to withstand 5 LINAC4 pulses
The monitor plates give a signal proportional to the amount of lost particles
An interlock is generated when too many particles are lost

Monitor principle

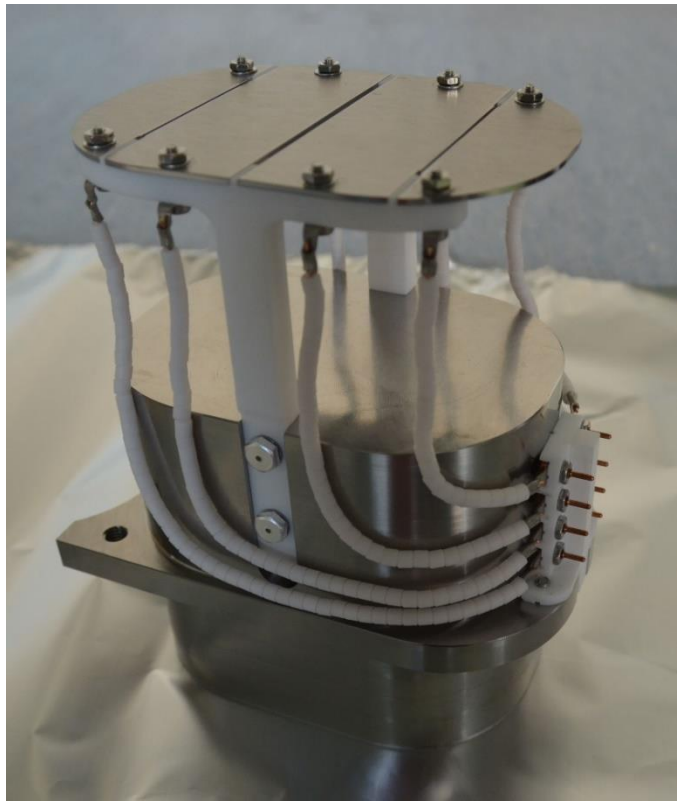
The ions are stripped when crossing the Ti plates,
H0 leaves 1 electron, H- leaves 2 electrons
The output signal is generated by these electrons



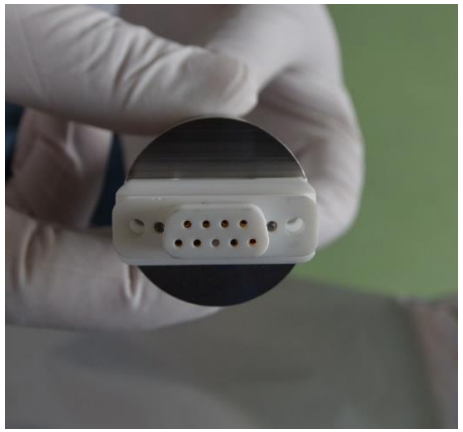


Assembly challenges

TE-VSC request : no kapton → single core copper wire in ceramic beads… Wiring time multiplied by 20
Several issues with too tight clearance gaps of delicate Macor parts
Some parts needed to be adjusted in bldg 865 workshop … (thanks to Sylvain)



Monitor and dump

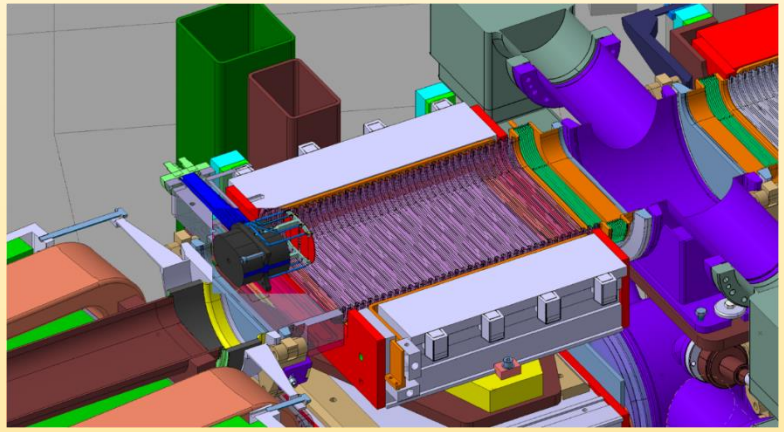


Shielded connector

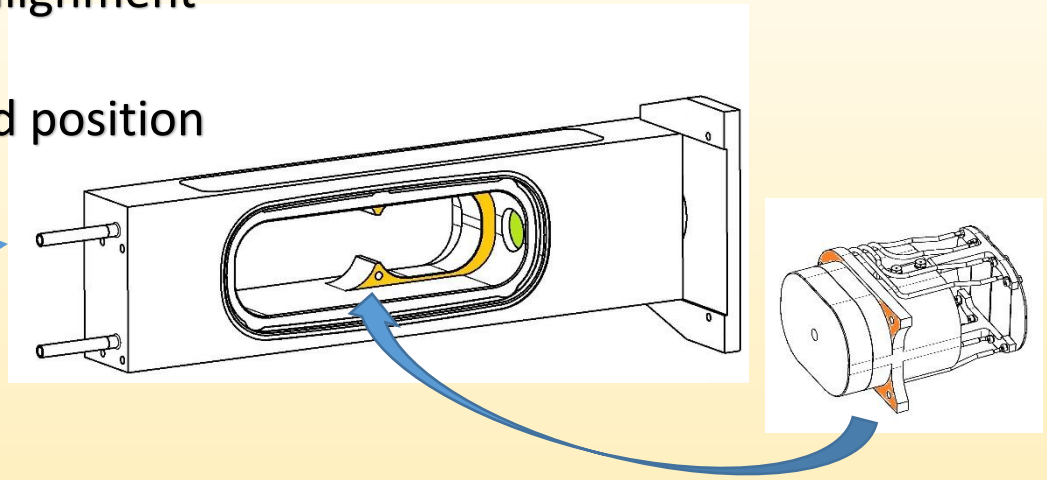
Mounting in the vacuum chamber

Assembly challenges

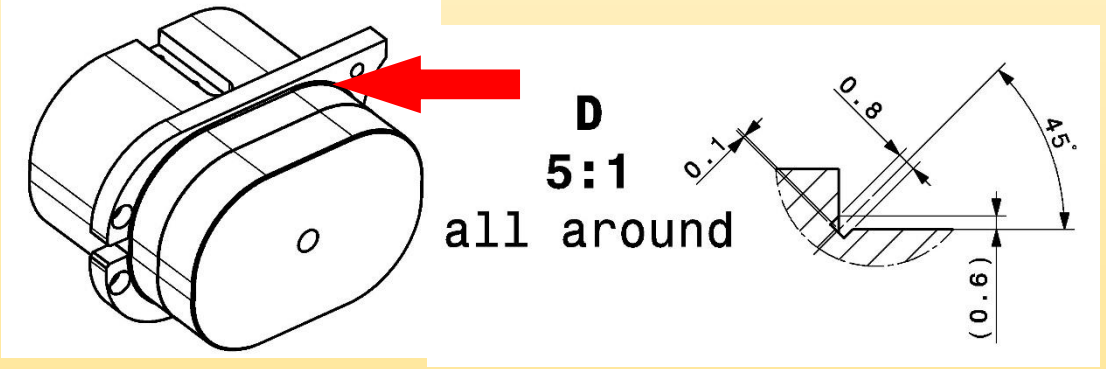
Dump mounting issue :
Shielded connector unconnectable due to dump misalignment
Bad thermal contact dump/cooling support
Dumps modified to inprove the thermal exchange and position



Water cooling



Modification made by EN-STI



Electronics

1 EDA-03210 VME board for each ring . Two main functions

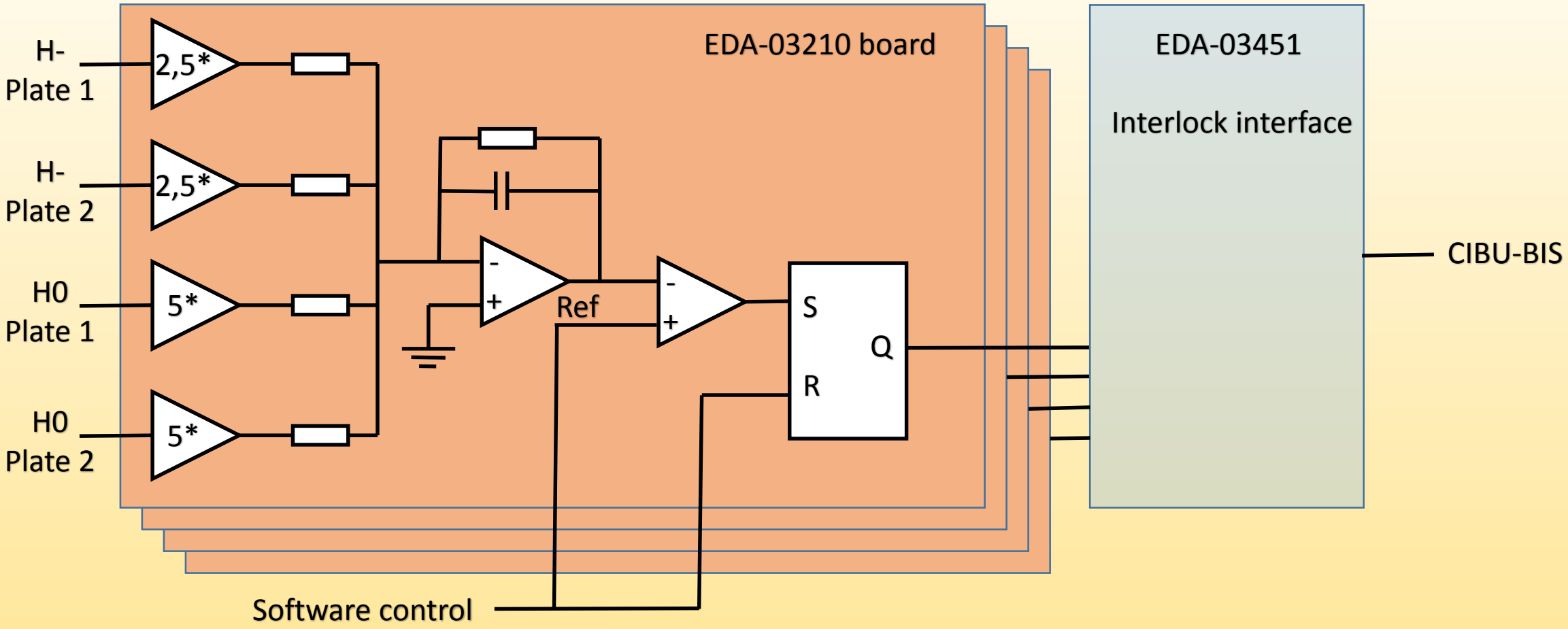
→ Gives an interlock signal if the foil is perforated or broken : Relatively high current, slow integration.

→ Measures the amount of unstripped Ions (stripping foil efficiency) : Low currents, high speed integration. This information helps deciding whether or not the stripping foil needs to be changed. Expected: 2% of LINAC4 beam current, change foil at 10%

Electronics : interlock function

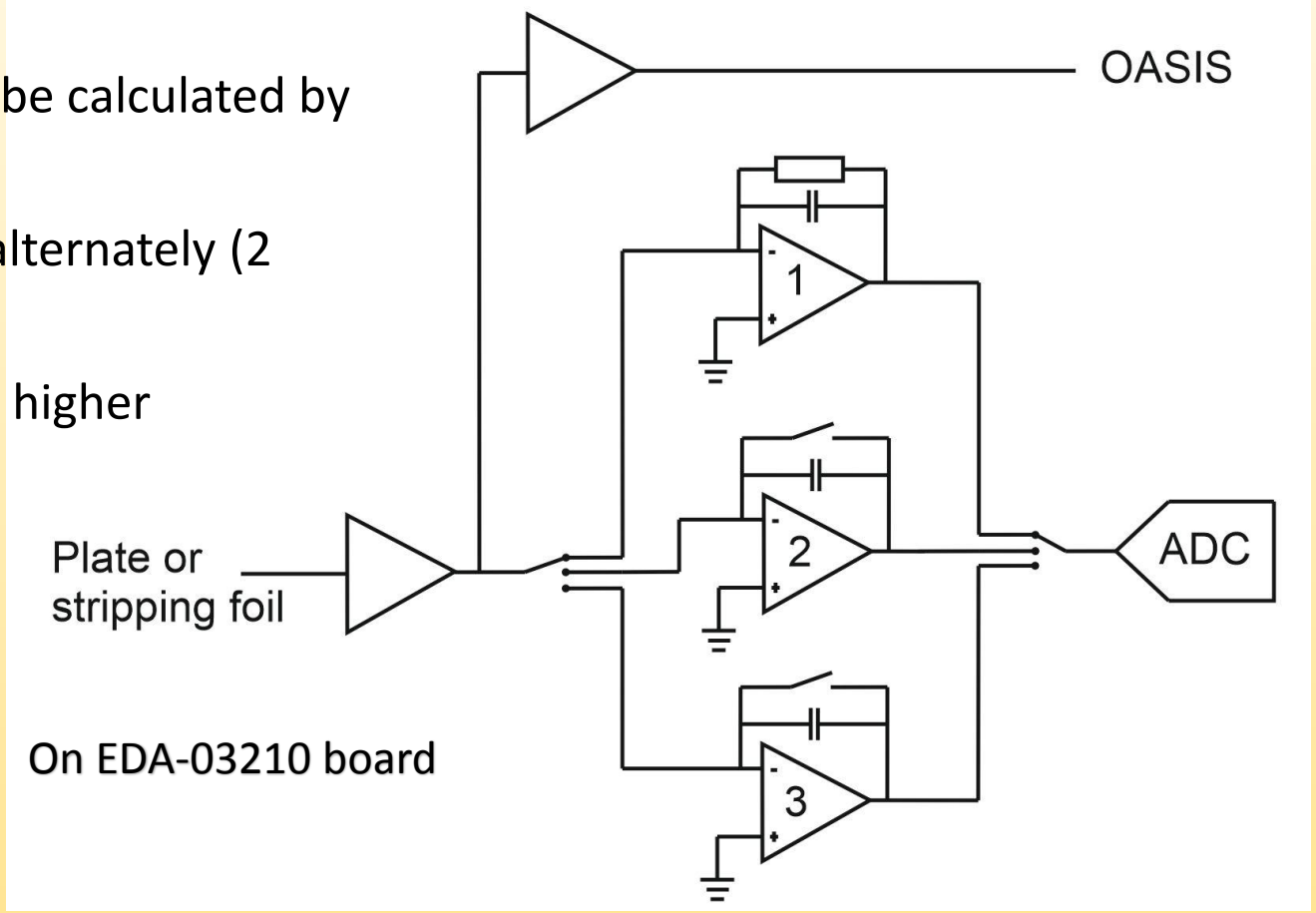
1 ring interlock amplifier

Low gain. Made to detect big holes in the stripping foil

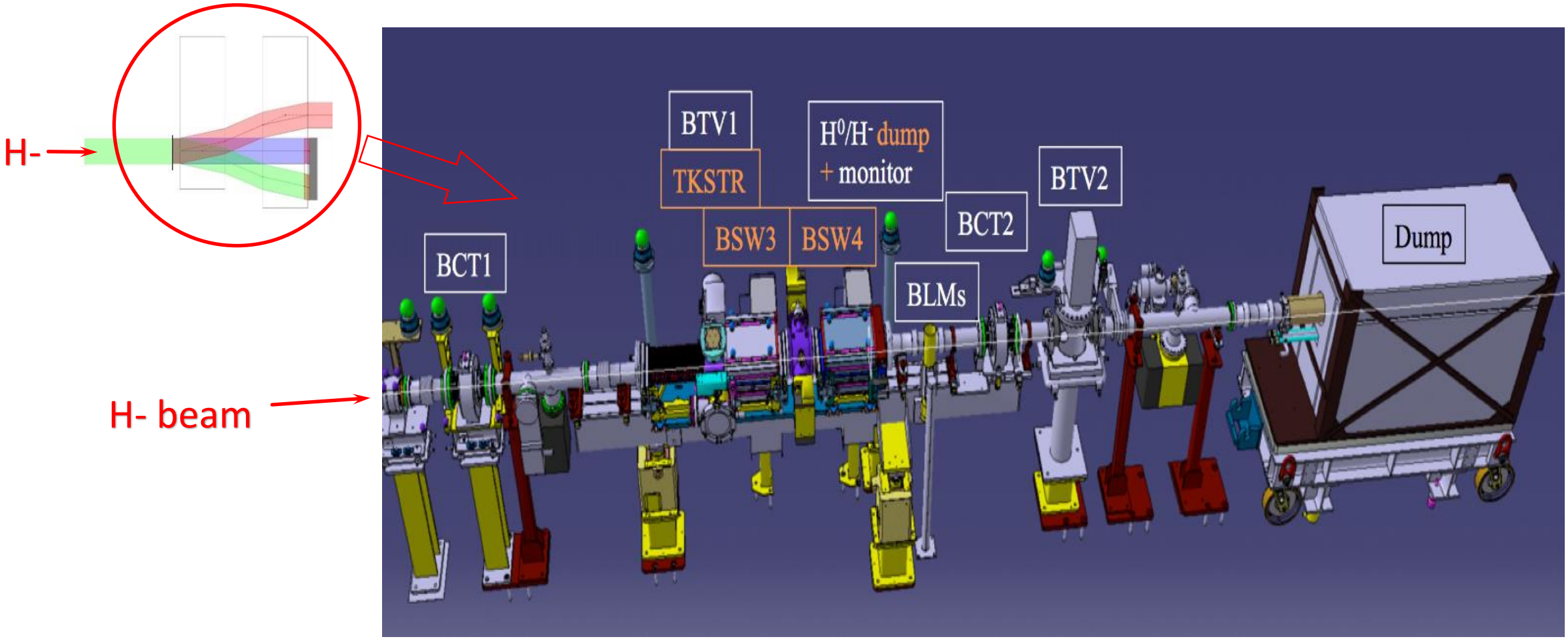


Electronics : Single turn amplifier function

- Injection time can vary from 50ns up to 150µs
- Current from each plate is integrated at each ~1µs Booster turn , stored in memory, then sent to FESA
- Measurement window from 150 to 950ns
- For longer injection times the average current can be calculated by software
- Each input channel has two integrators that work alternately (2 and 3)
- Dedicated integrator for single short pulse (1) with higher sensitivity

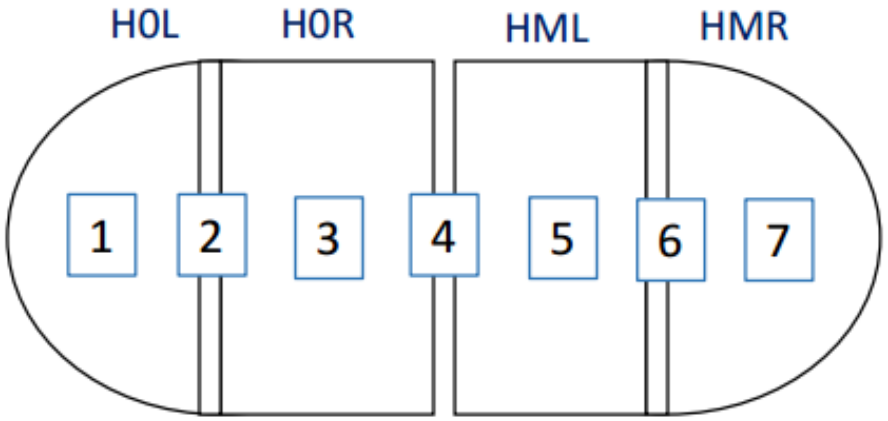


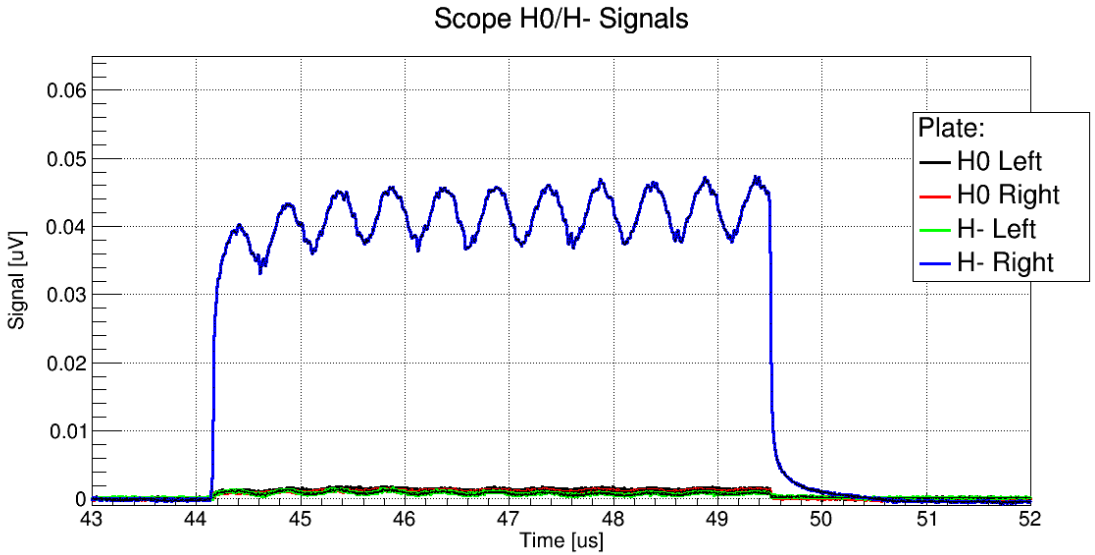
Half Sector Test



The half sector test in the Linac4 transfer line

Measurements at the HST – Calibration Factors



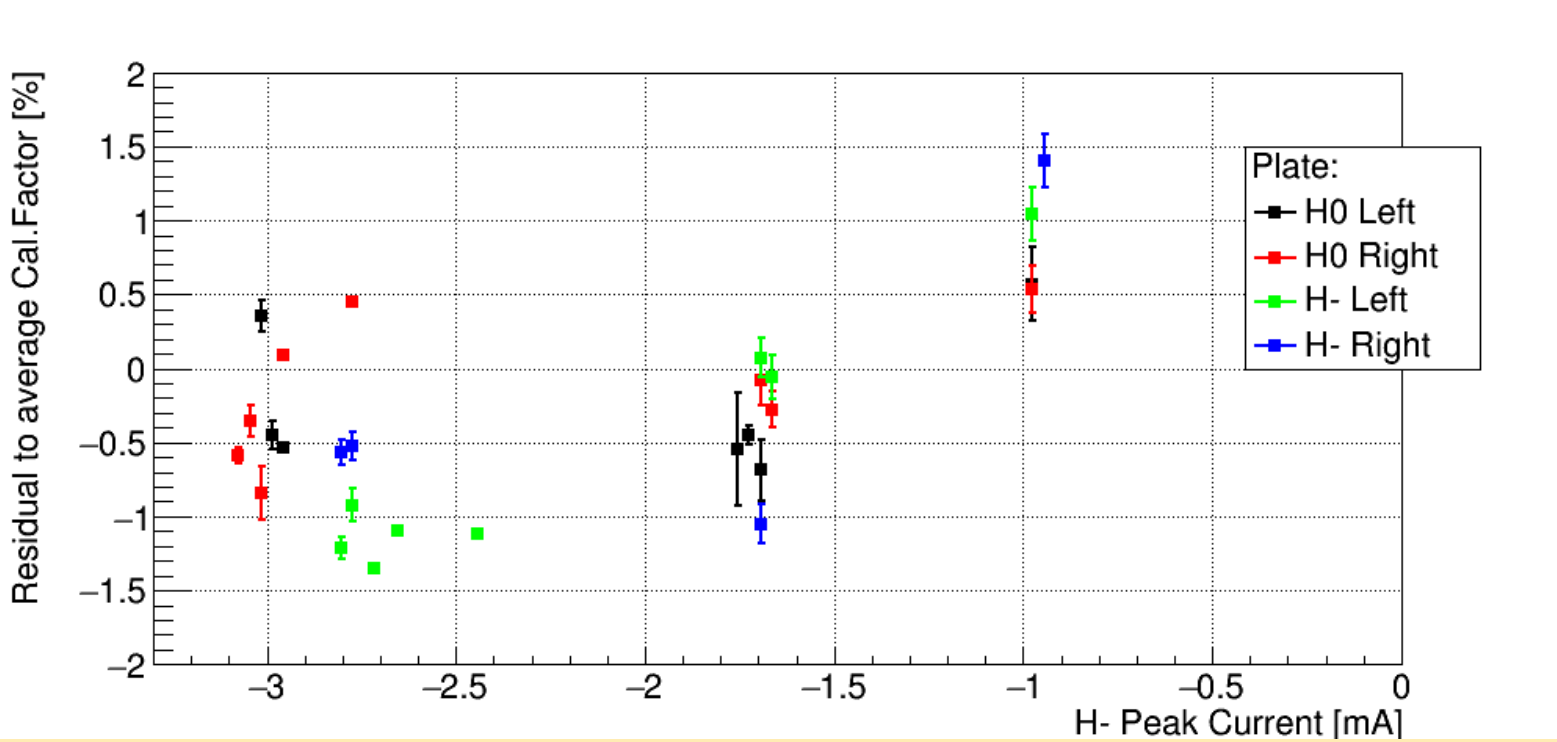


Signal on one plate

Several set of measurements consisting in:

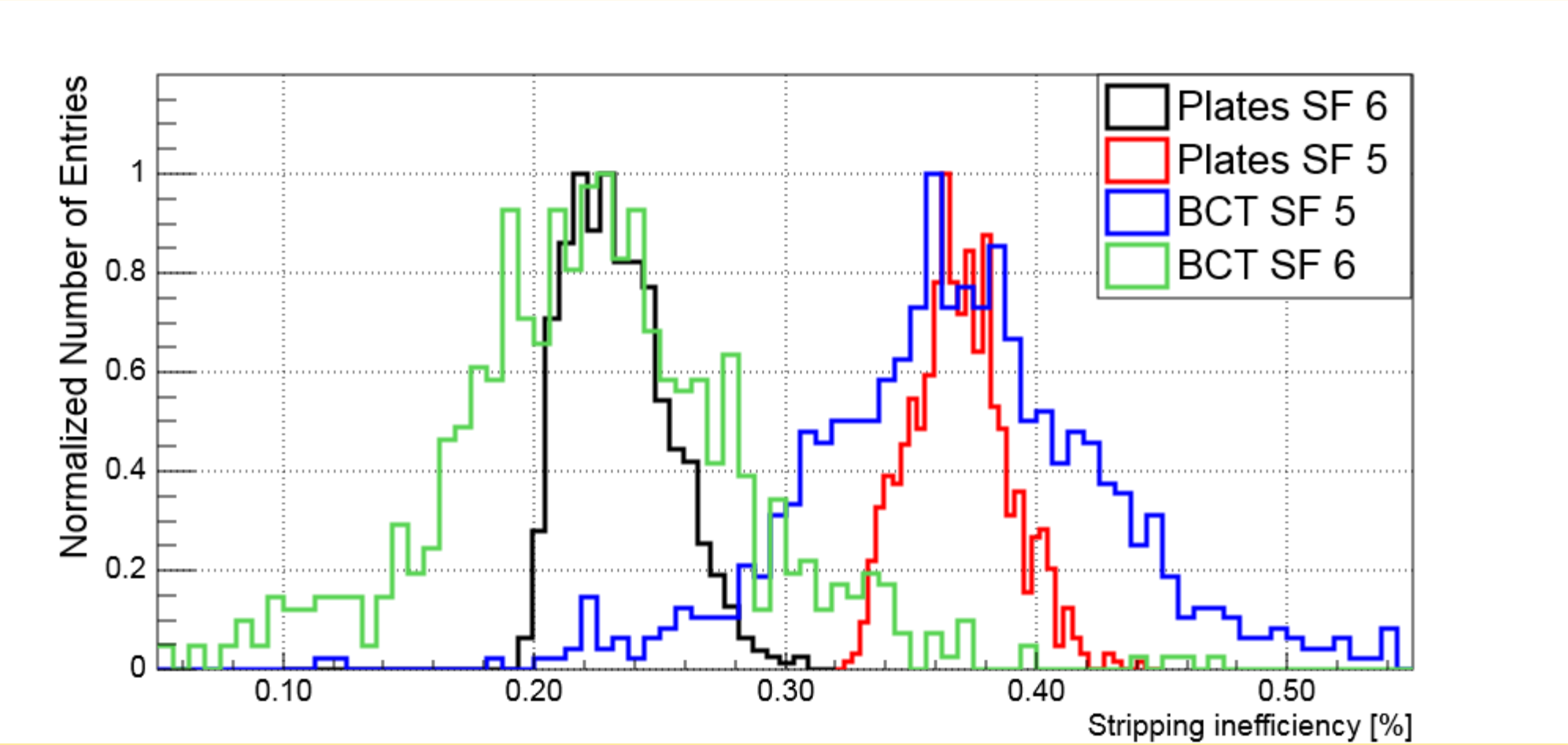
- Reduce H- peak beam intensity and pulse length
- Take OUT stripping foil
- Steer the H- beam on a single plate at a time (pos. 1,3,5,7 on the sketch)
- Each time, normalize the plate signal to the upstream BCT
  → Calibration factor #of charges per ADC unit

Measurement example at HST

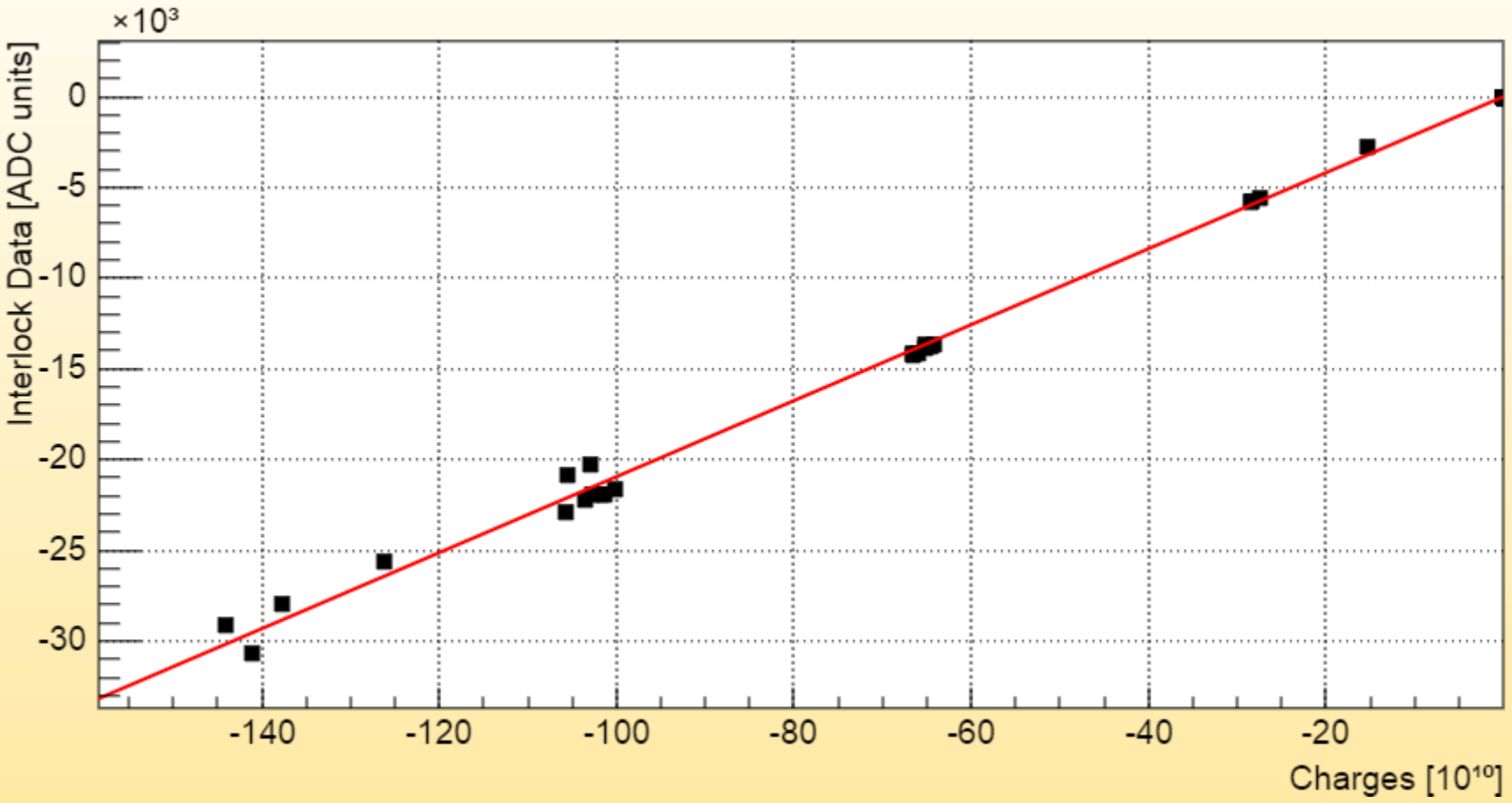


Relative variation of the calibration factors for different plates and intensities

Measurement example at HST



Measurement example at HST



- Qualitative validation of the electronics interlock channel
- Using BI-SW FESA server + DB logging service

Conclusions and outlook

- Successful validation of the first H0-H- monitor prototype (mechanics, electronics + first BI-SW FESA server)
- The prototype of the electronic board is expected for September, and hopefully it’s the final version
- The four H0/H- monitors are assembled , insertion in the vacuum tanks ongoing
- 3 spare monitors are ready, they need special containers for long term storage

Thank you