



# Beam diagnostics for **HIE-ISOLDE**

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# Acknowledgement

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Special collaboration with the HIE-ISOLDE linac and HEBT working groups, and the beam instrumentation group at TRIUMF is acknowledged.

why do we need  
beam diagnostics?

to determine  
beam quality

stable beam (mostly Ne,  $A/q = 4$ )

intensity

$I \sim 100 \text{ pA}$

Faraday cup

size & position

$\text{FWHM} \sim 5 \text{ mm}$

FC + scanning slit

energy, time of flight

$E/A \sim 5 \text{ MeV/u}$ ,  $v \sim 30 \text{ m}/\mu\text{s}$

Si detector

transverse emittance

FC + 2 ss

# DIAGNOSTIC BOXES

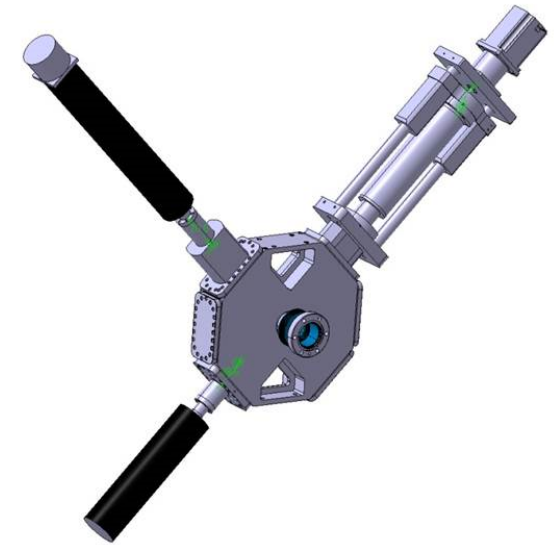
Faraday cup

scanning slit

circular & linear collimators

Si detector (x 2)

carbon stripping foils (x 6)



Mechanical design by W. Andreazza,  
in collaboration with AVS (Spain).

# DIAGNOSTIC BOXES

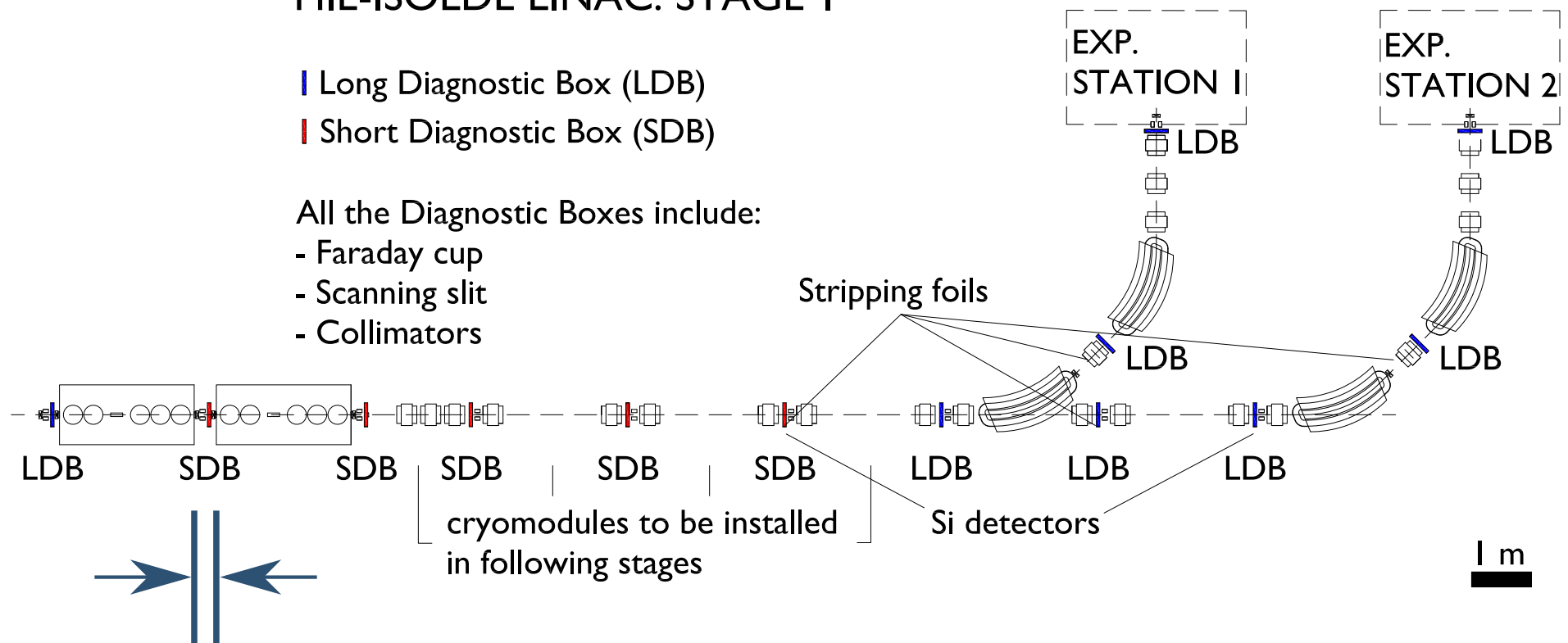
8 long (HEBT)  
5 short (linac)

## HIE-ISOLDE LINAC: STAGE I

- | Long Diagnostic Box (LDB)
- | Short Diagnostic Box (SDB)

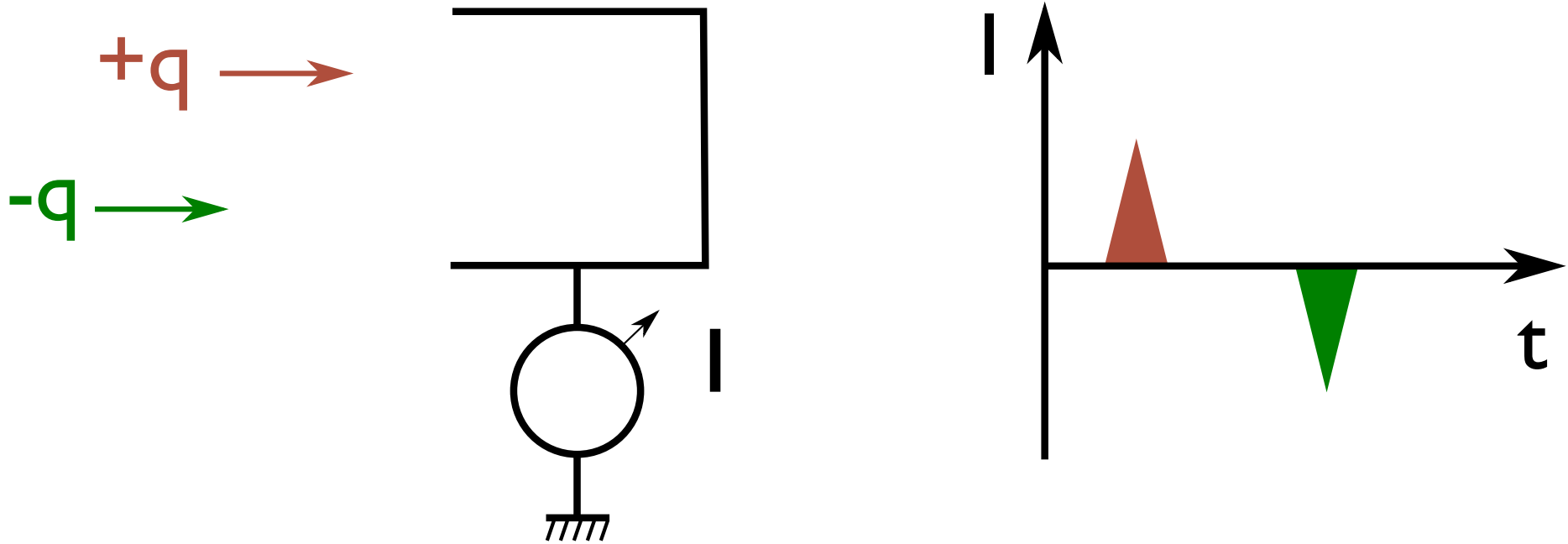
All the Diagnostic Boxes include:

- Faraday cup
- Scanning slit
- Collimators

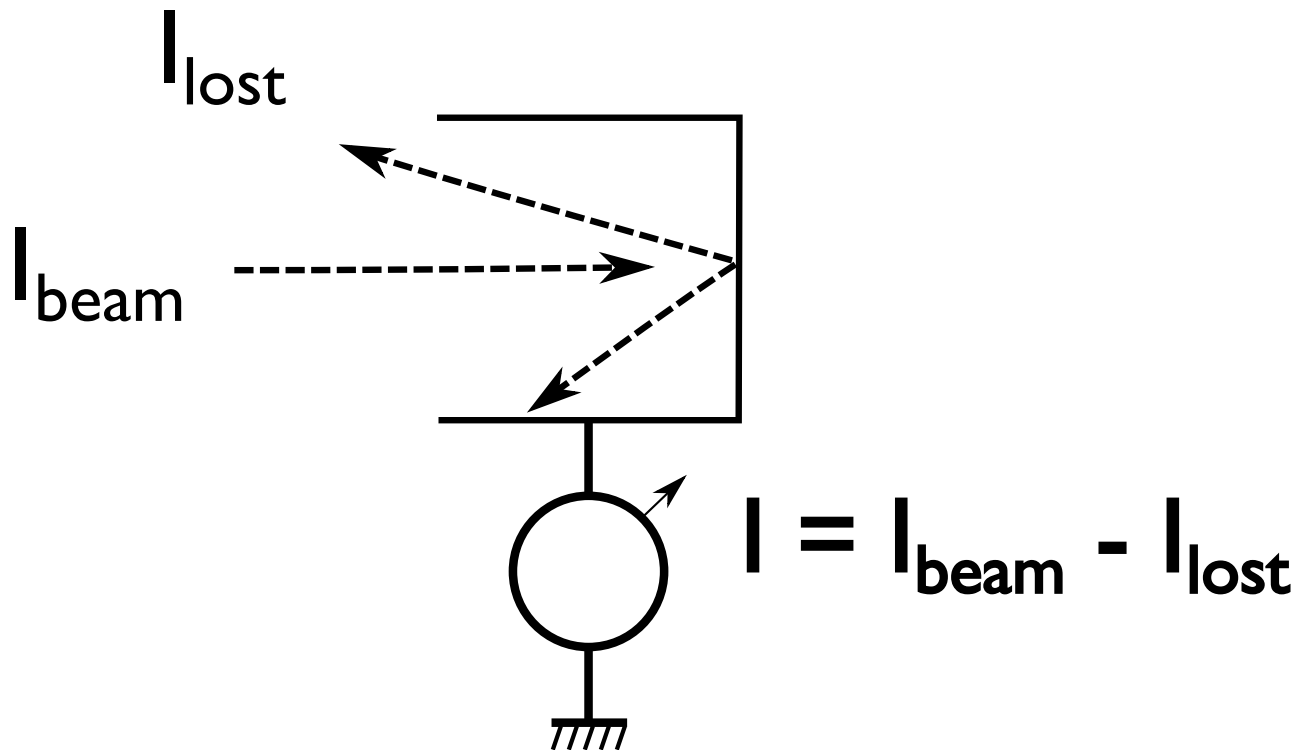


tight longitudinal space  
compact design of instruments

# beam current measurement



# beam current measurement



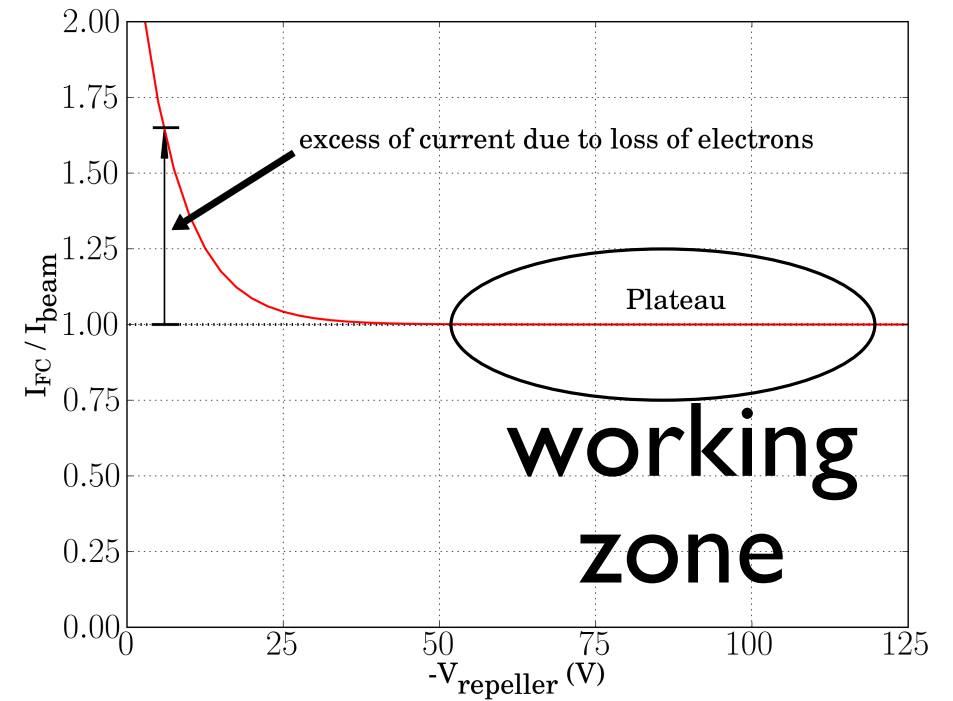
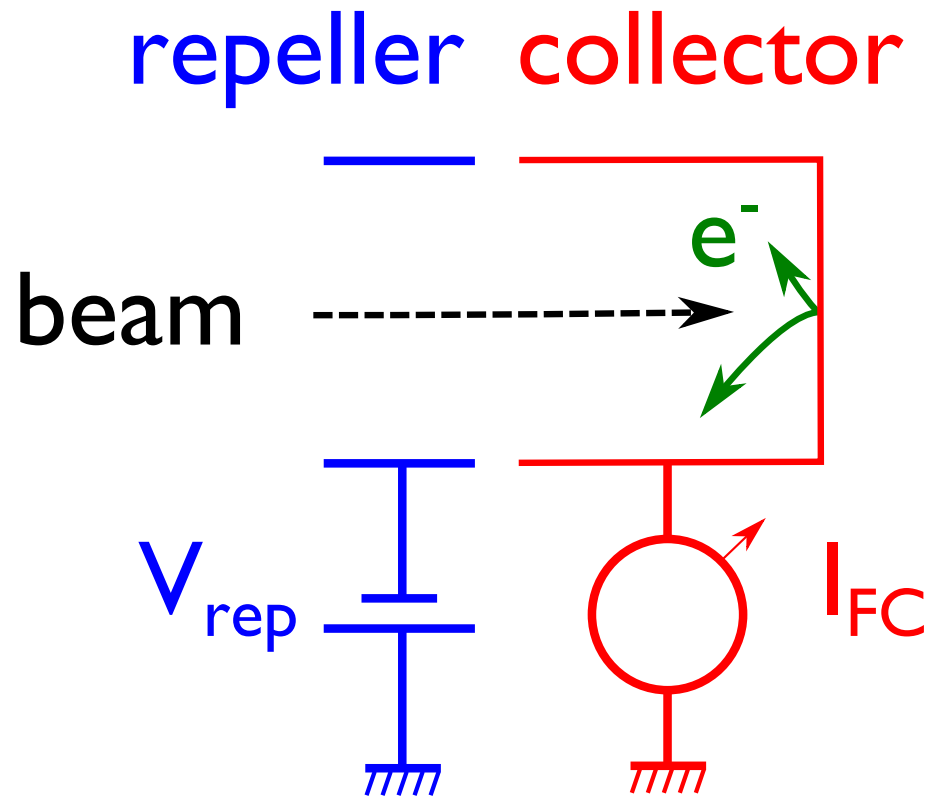
if lost charges are  $e^-$ :

$$I_{\text{lost}} < 0$$

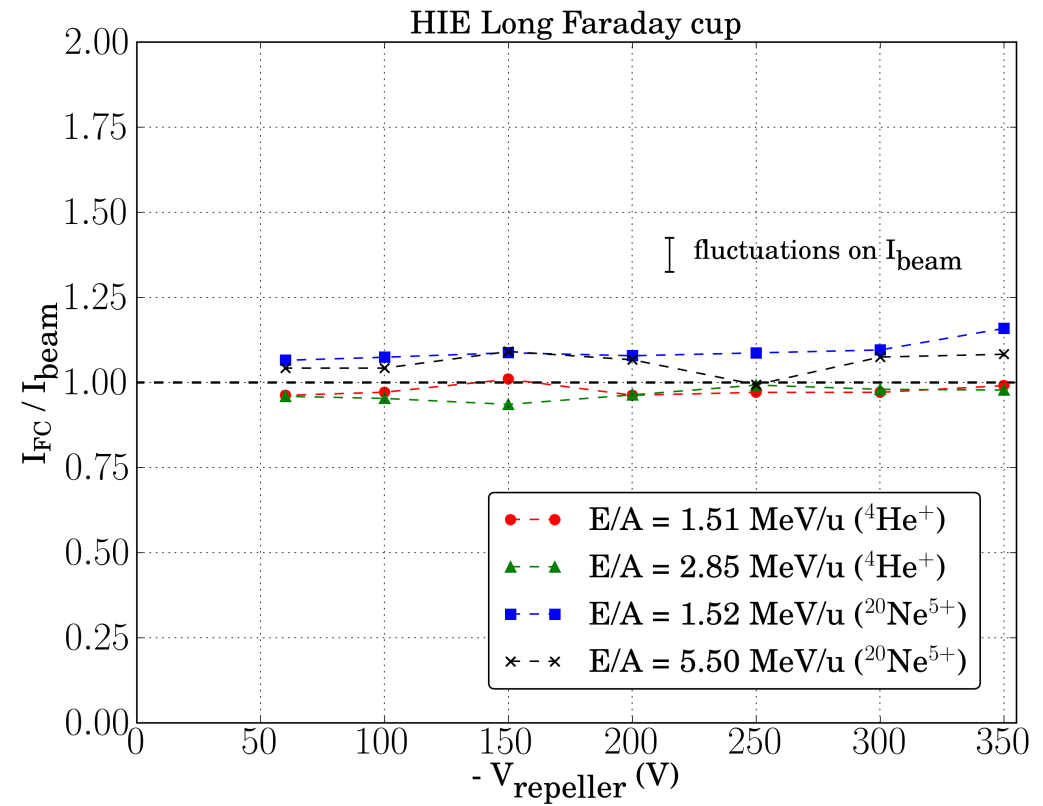
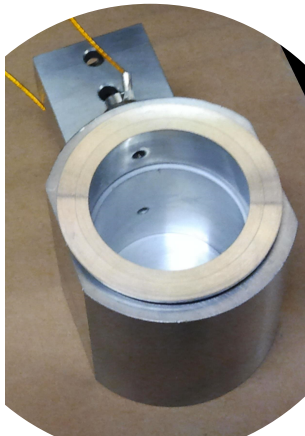
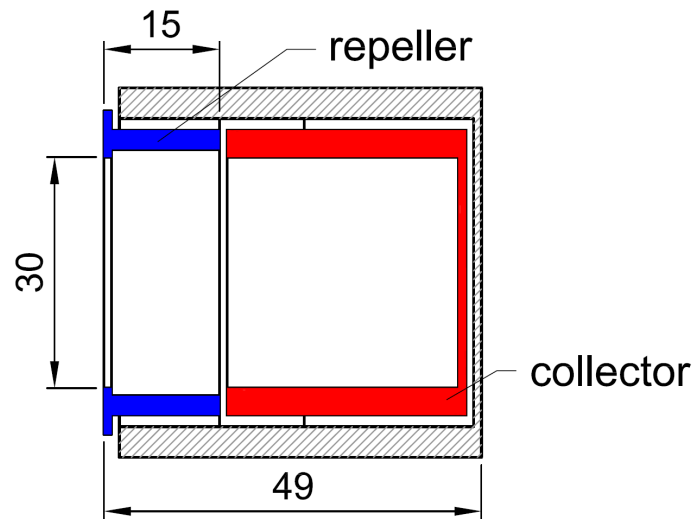
$$I > I_{\text{beam}}$$



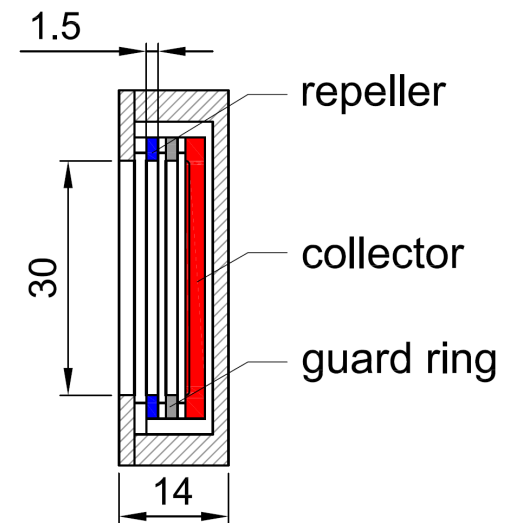
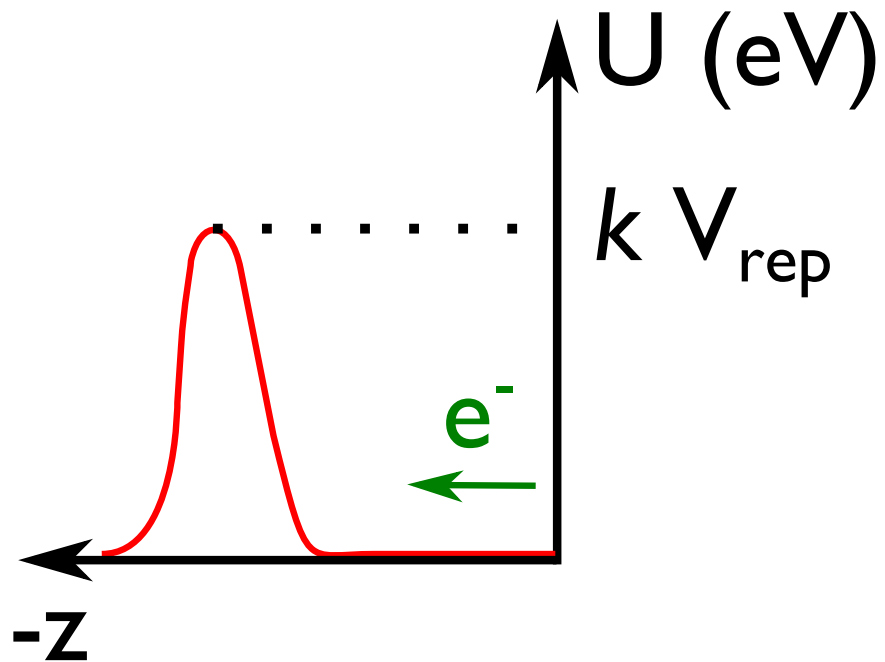
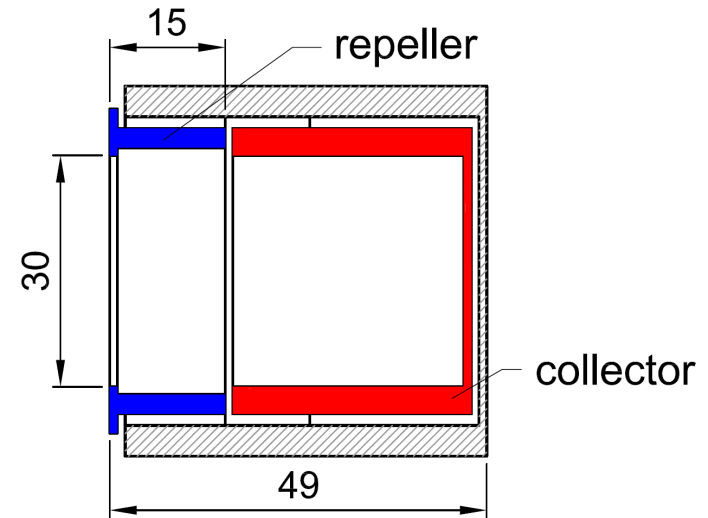
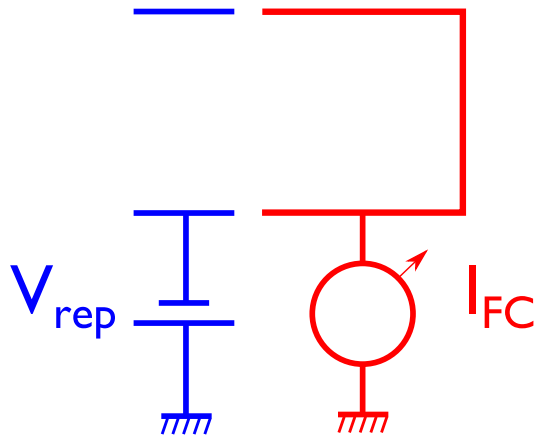
# beam current measurement FARADAY CUP



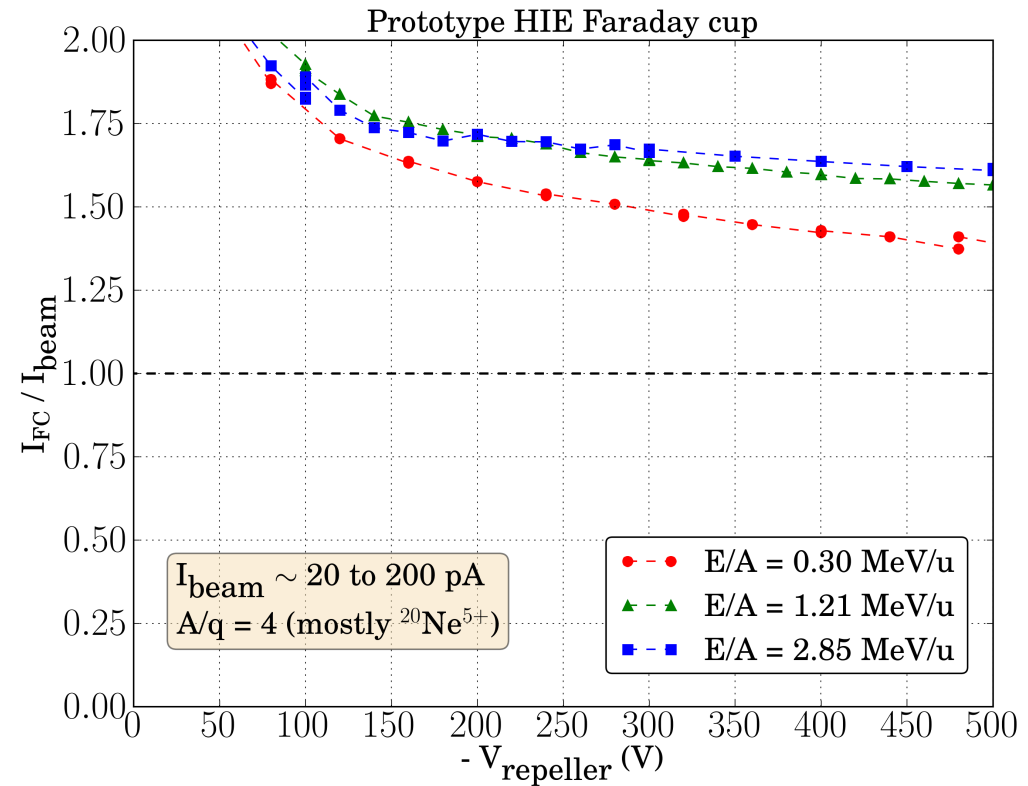
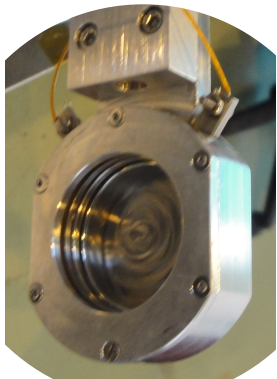
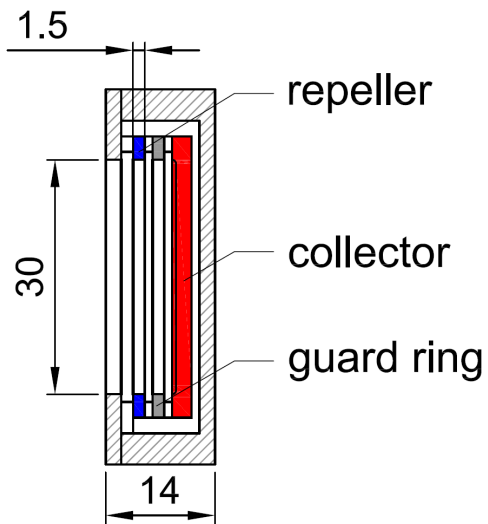
# HIE-ISOLDE LONG FARADAY CUP



# towards a compact FARADAY CUP...

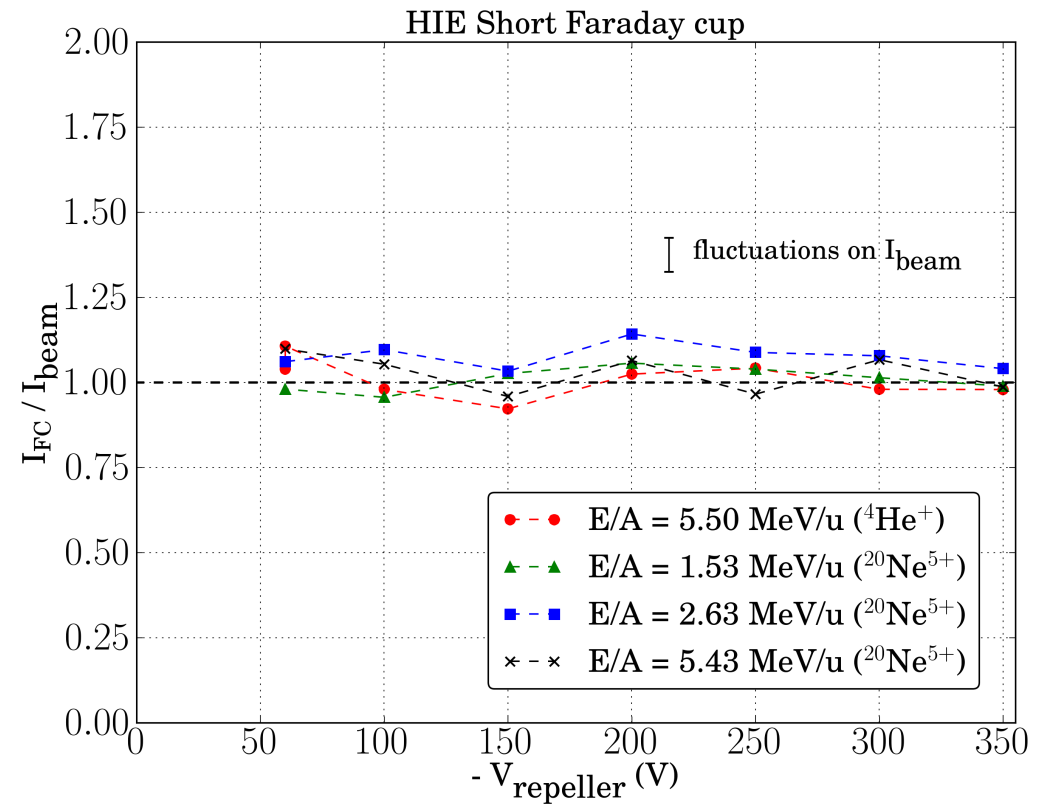
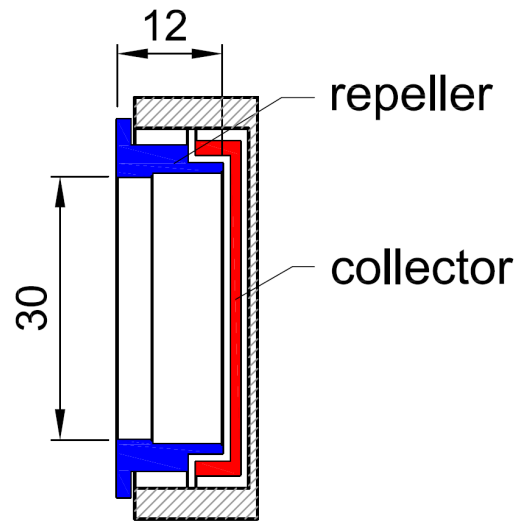


# PROTOTYPE SHORT FARADAY CUP

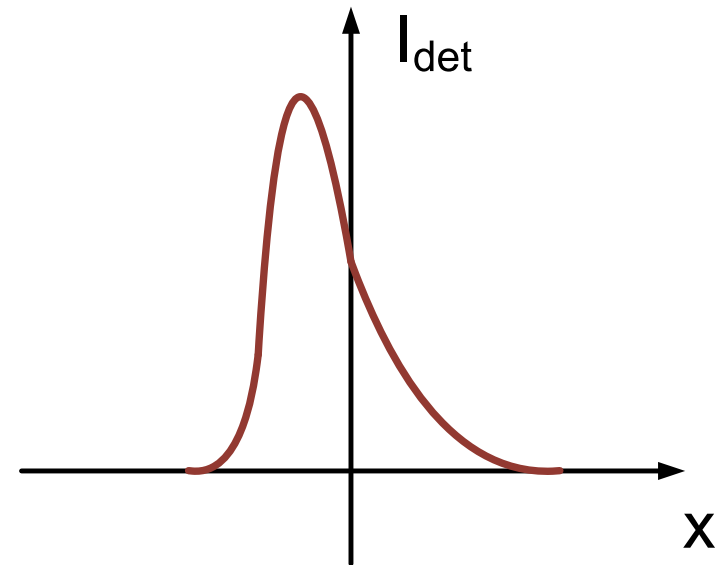
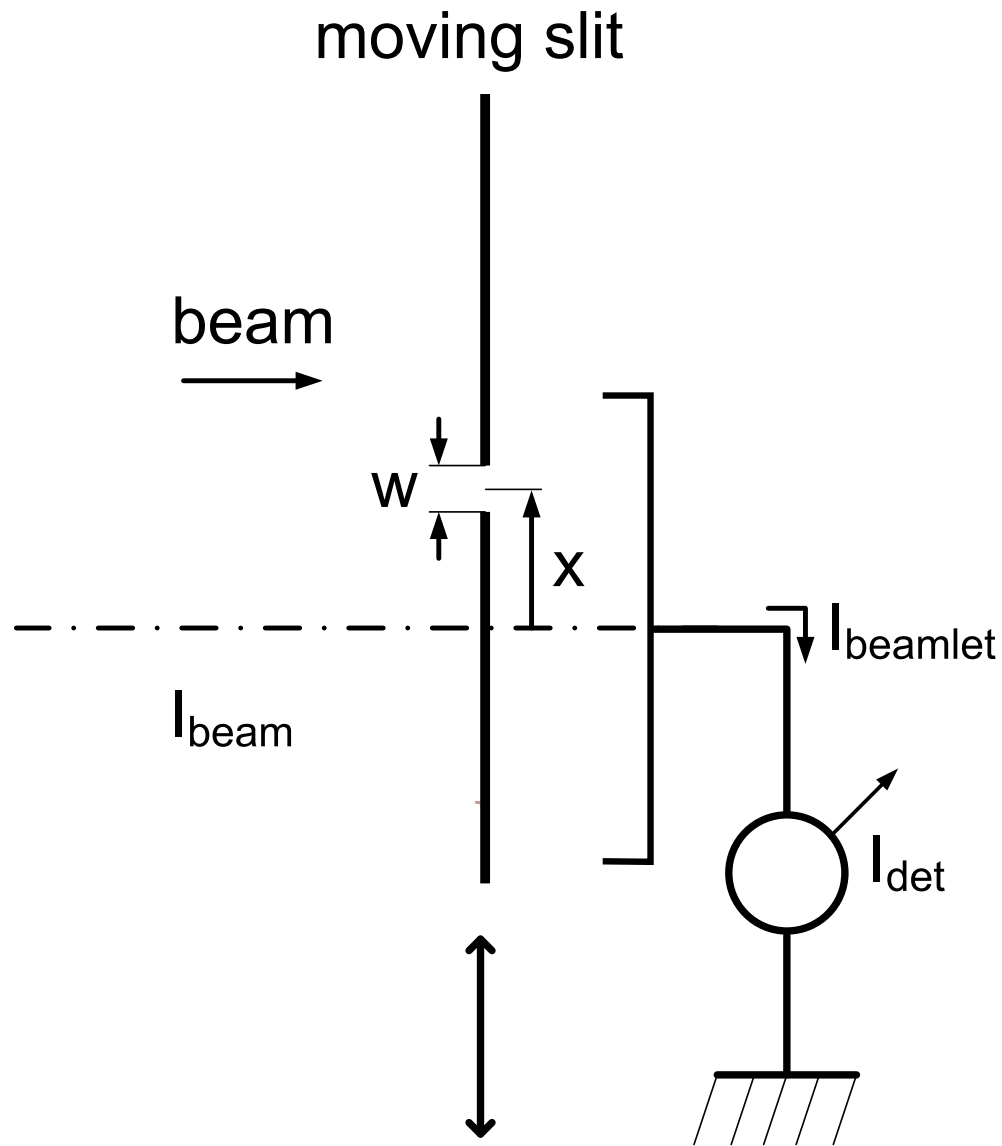
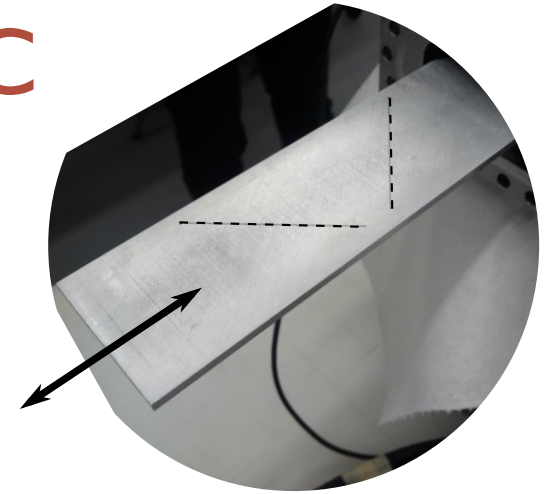


+ MC simulation of electrons loss

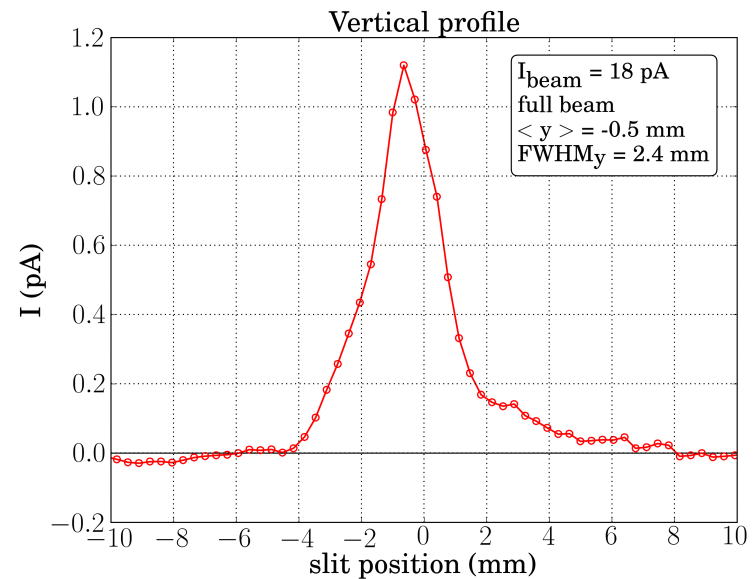
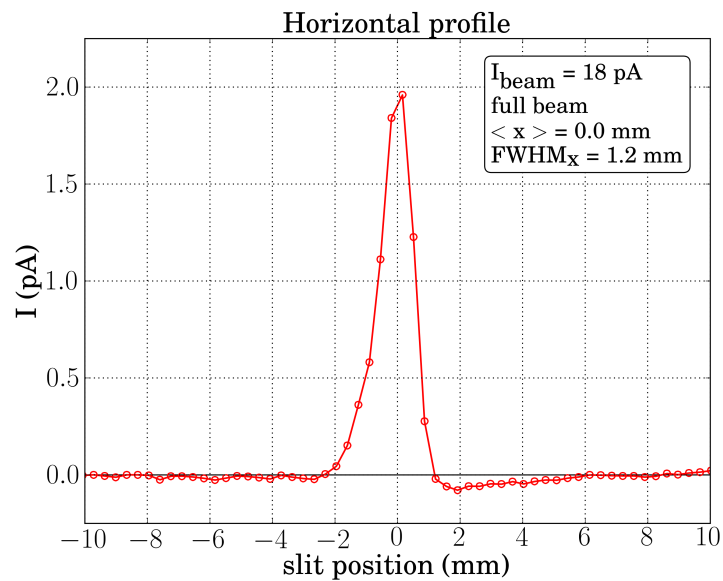
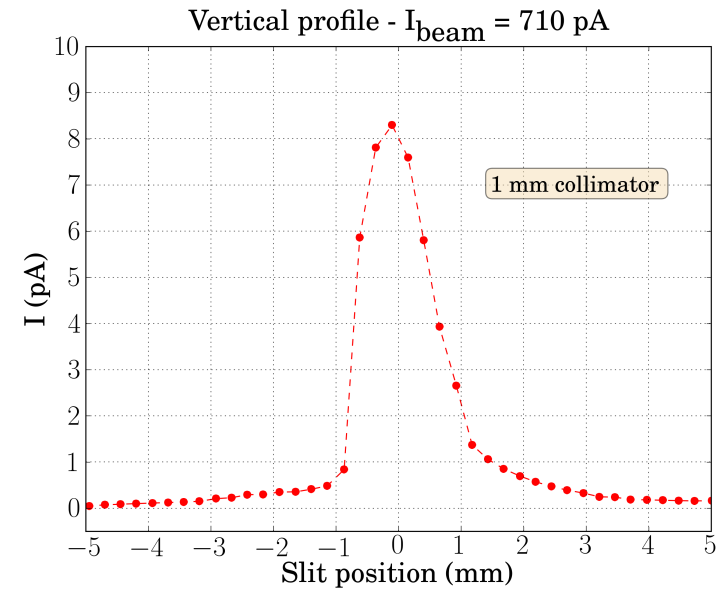
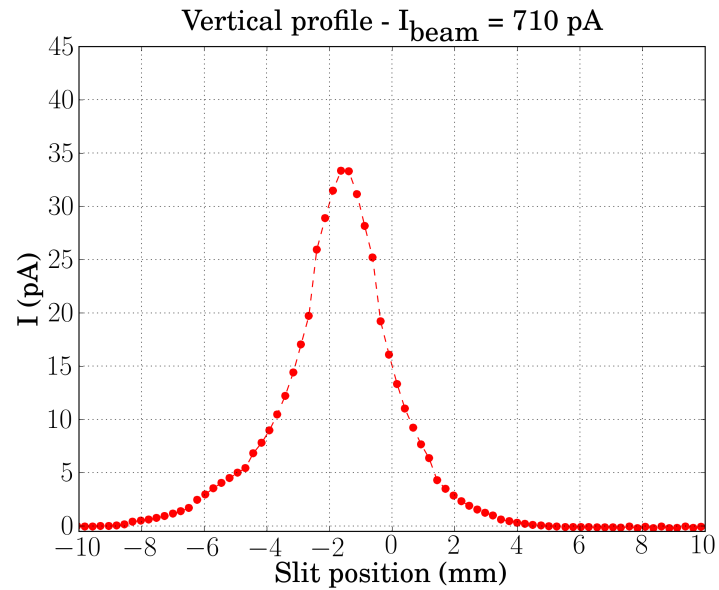
# HIE-ISOLDE SHORT FARADAY CUP



# beam size and position SLIT + FC



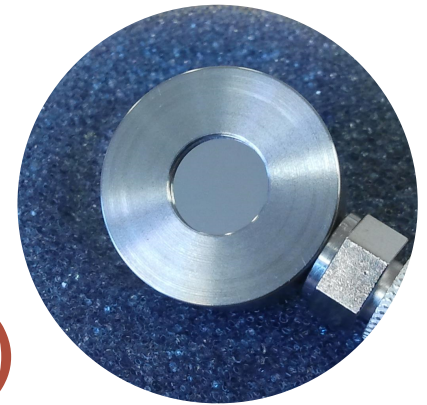
# beam size and position SLIT + FC



longitudinal beam profiles **Si detector**

energy spectrum

**mass composition (impurities)**  
**calibration of accelerator energy**

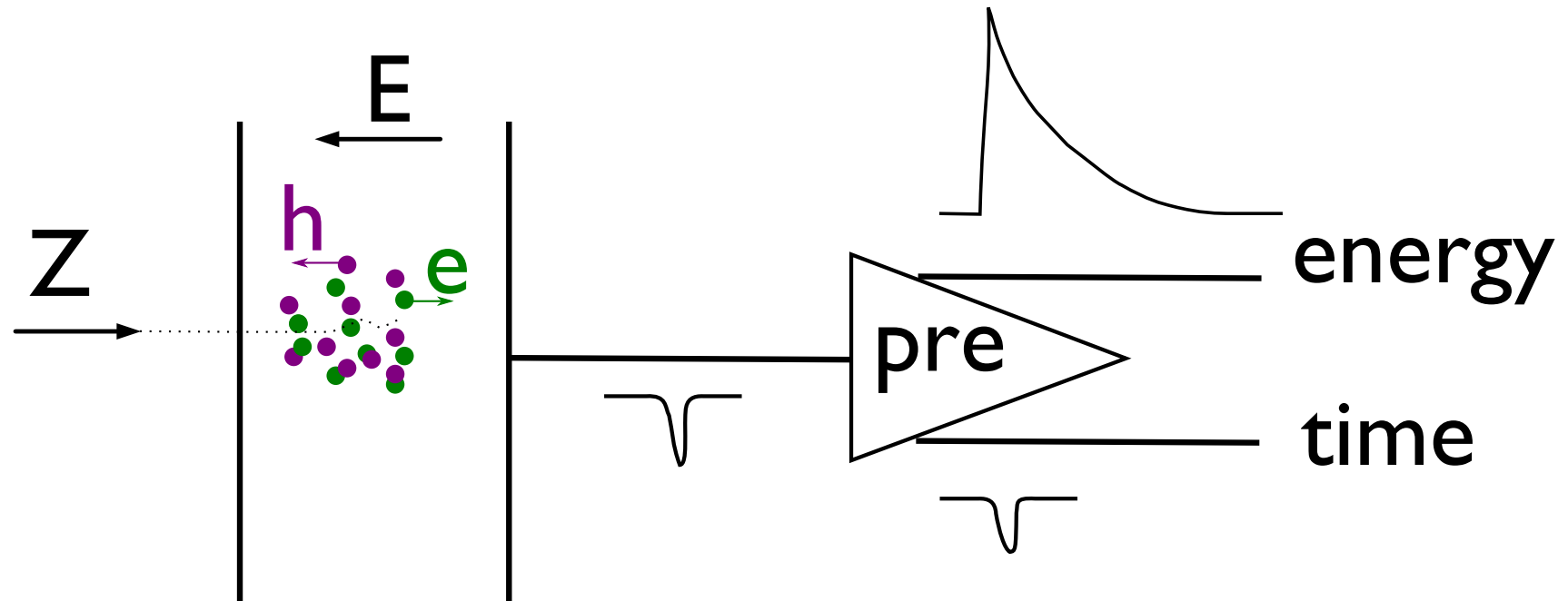


time spectrum

**synchronization (phase)**

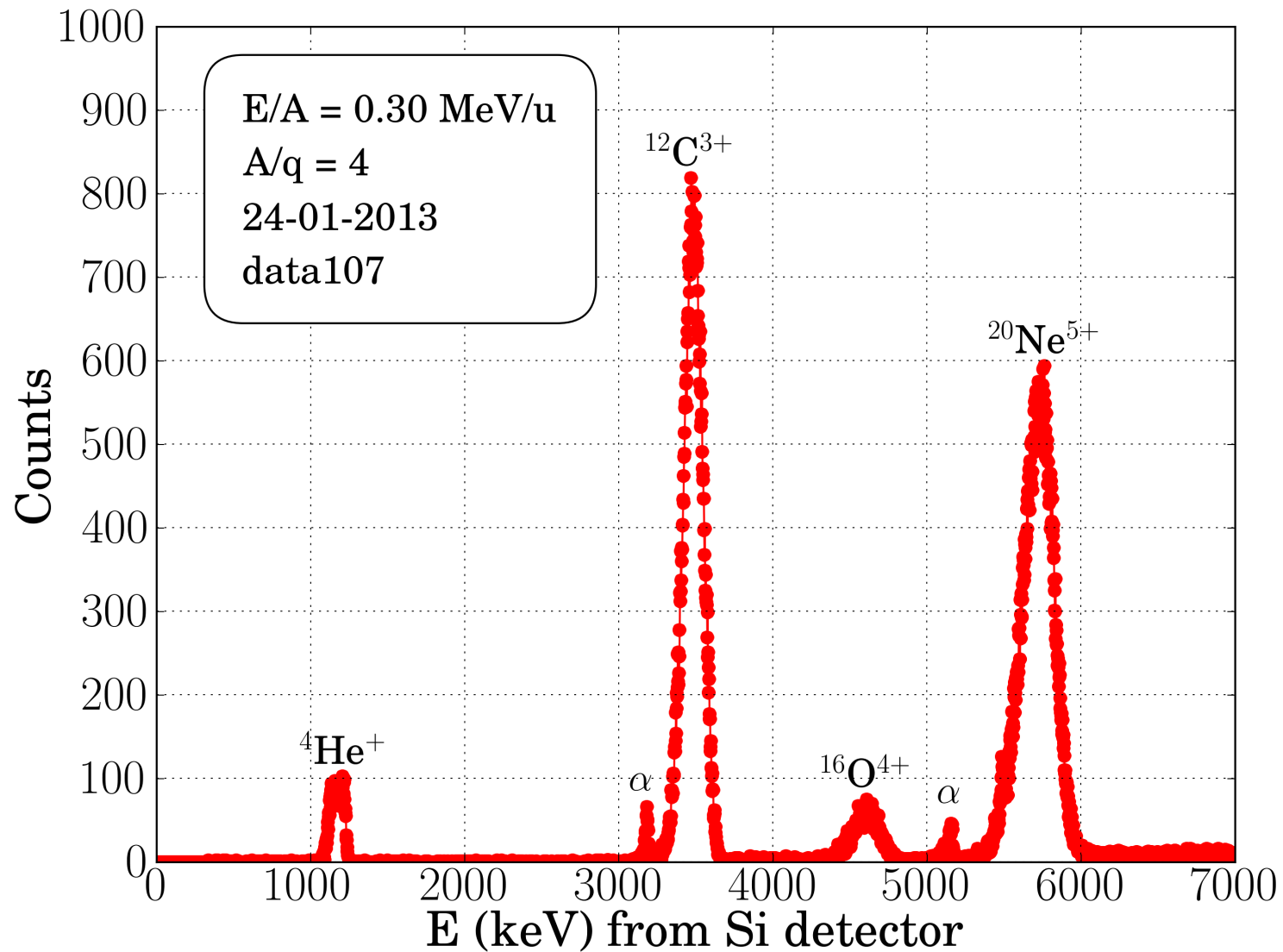


# longitudinal beam profiles Si detector

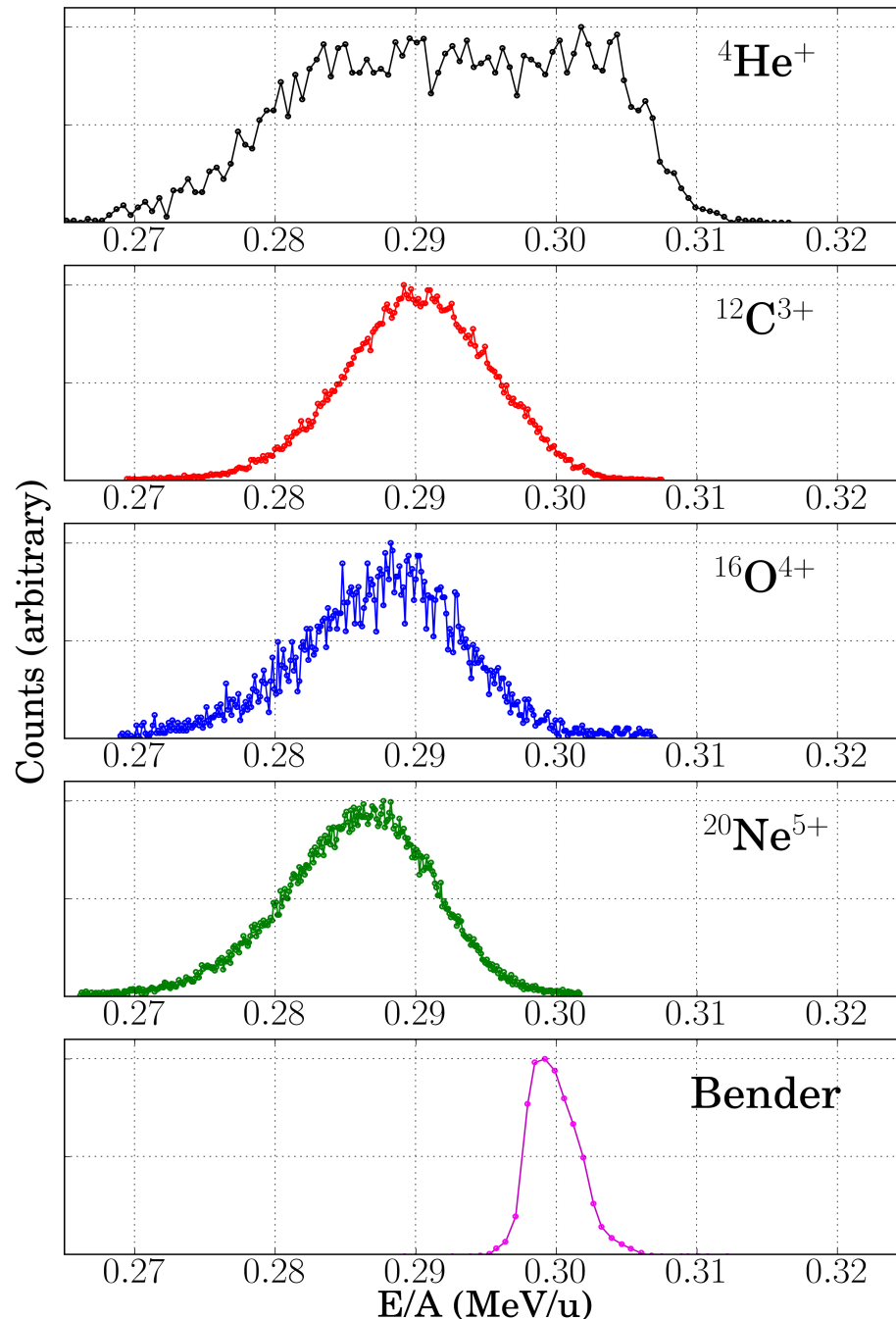


# beam energy spectra Si detector

## mass composition



# beam energy spectra Si detector



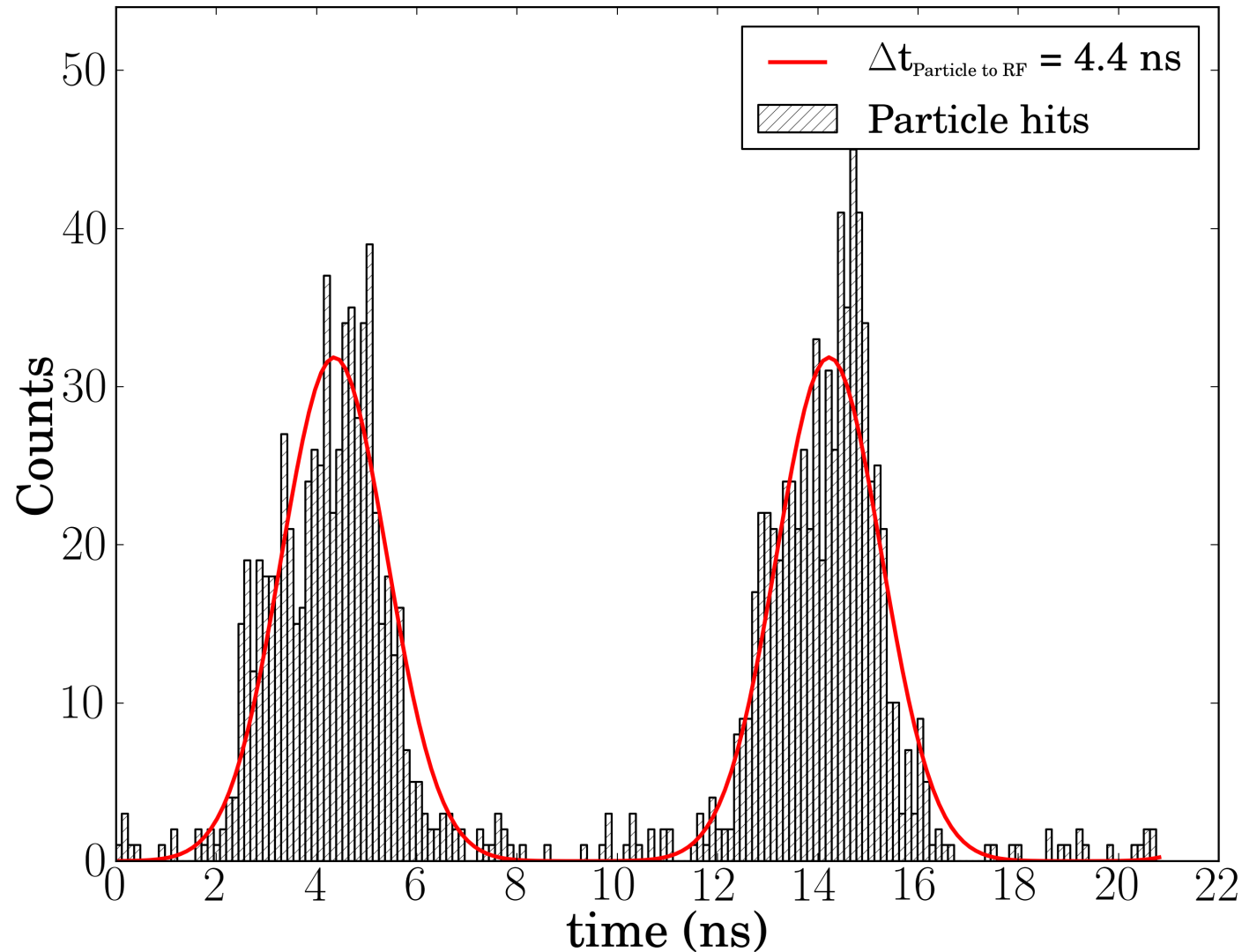
energy calibration

Si det. resolution

**improves**  
for higher energies

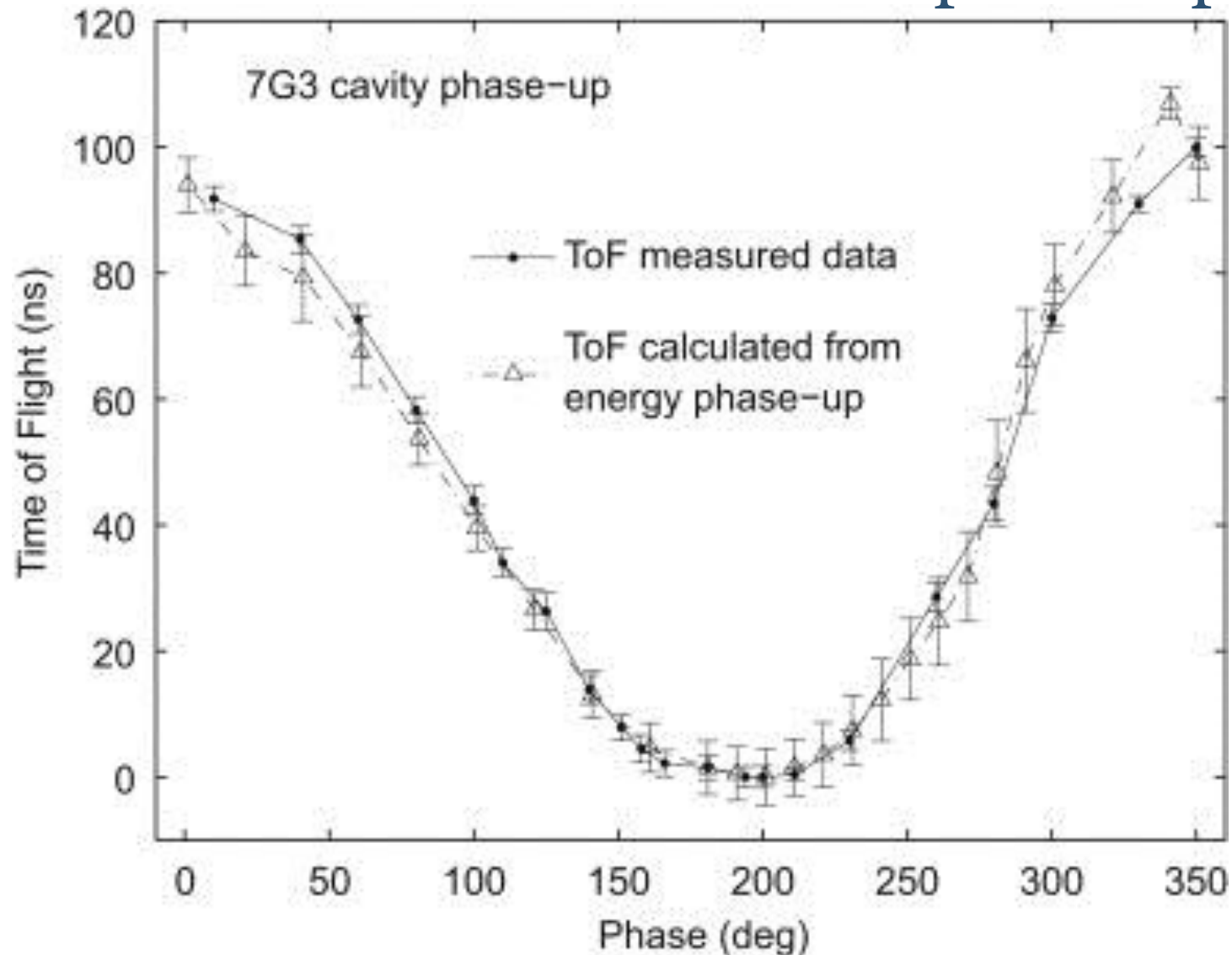
# time of flight spectra Si detector

## longitudinal phase space



# time of flight spectra Si detector

cavities phase-up



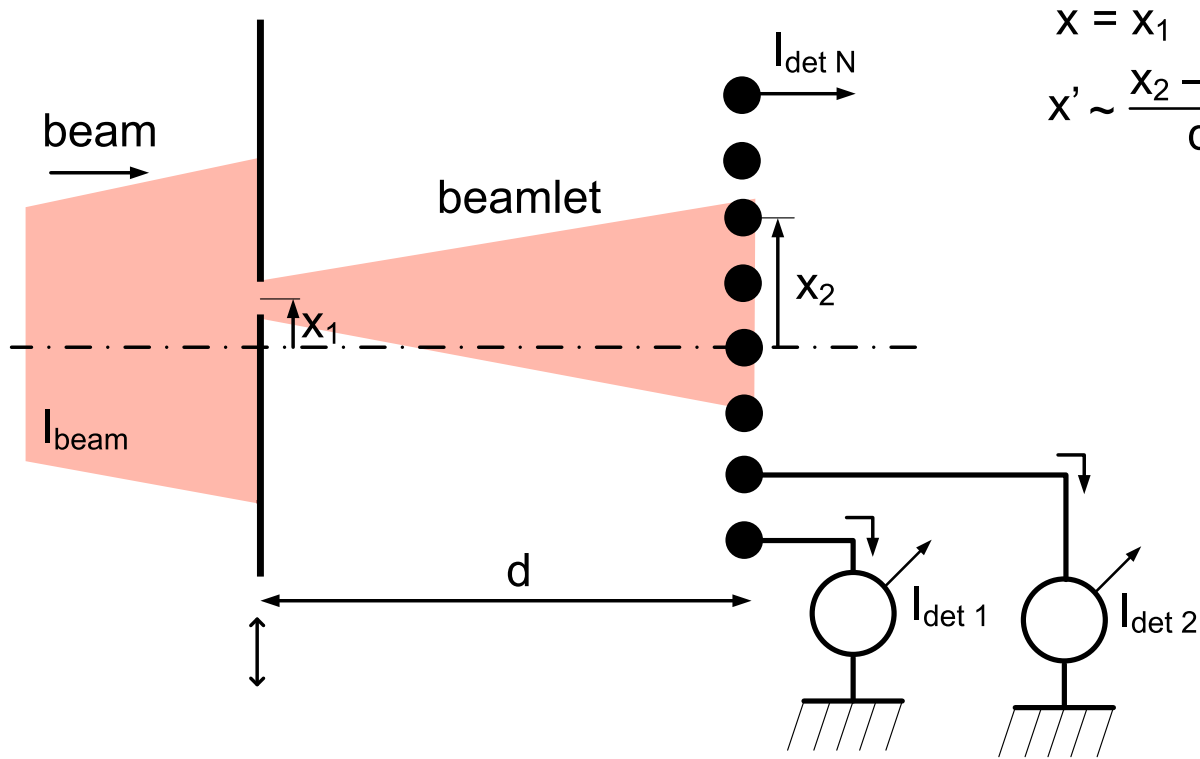
transverse emittance:

Parameter of quality of beam transverse shape; the lower the better.

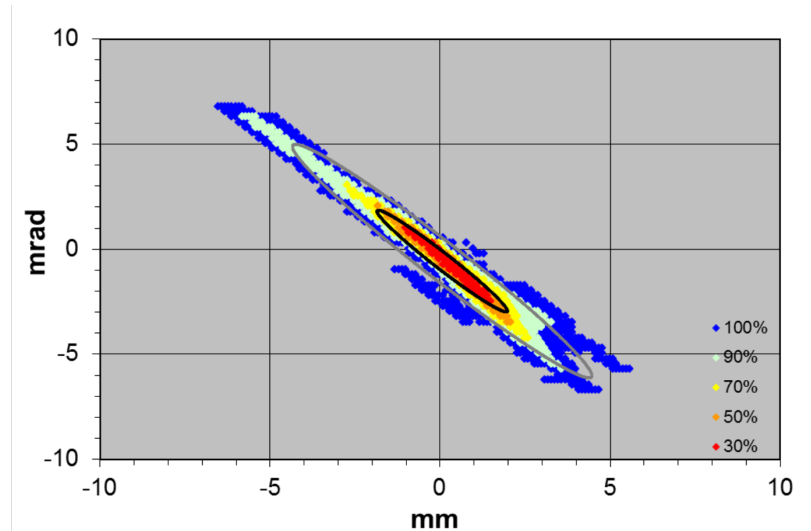
Useful to understand beam transport stages.

Projections in phase space  $(x, x') - (y, y')$ .

# transverse emittance **SLIT + grid**

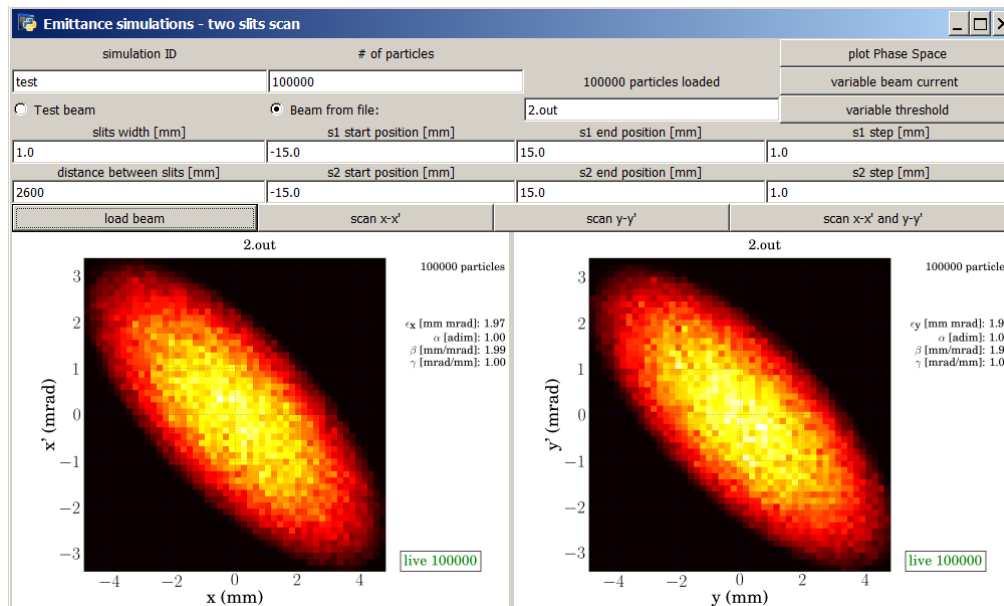
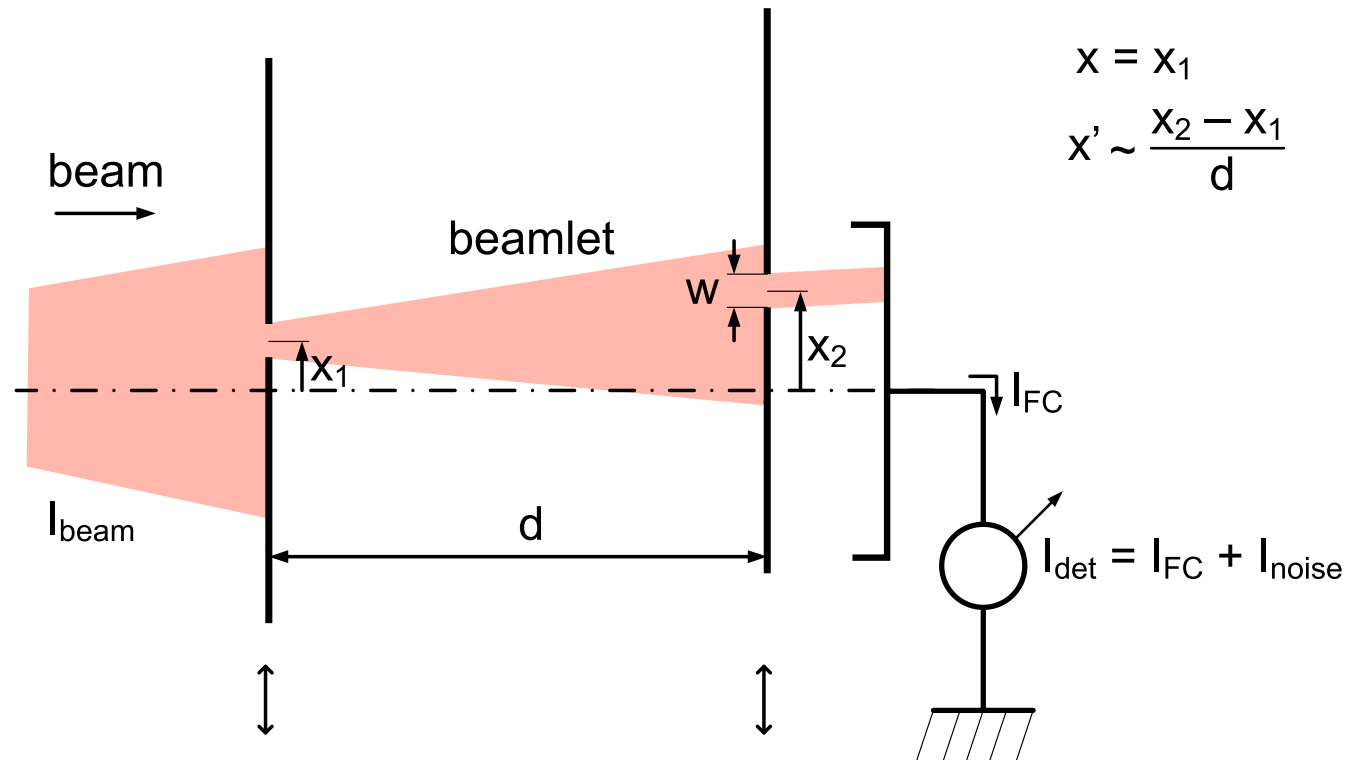


$$x = x_1$$
$$x' \sim \frac{x_2 - x_1}{d}$$



Already implemented and working in REX-ISOLDE  
D. Lanaia et al, CERN-ACC-NOTE-2014-0013

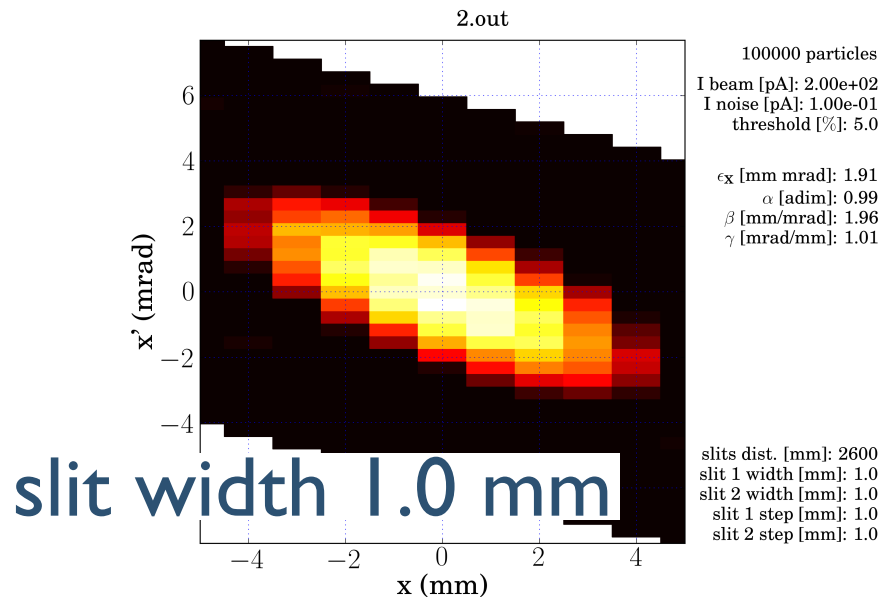
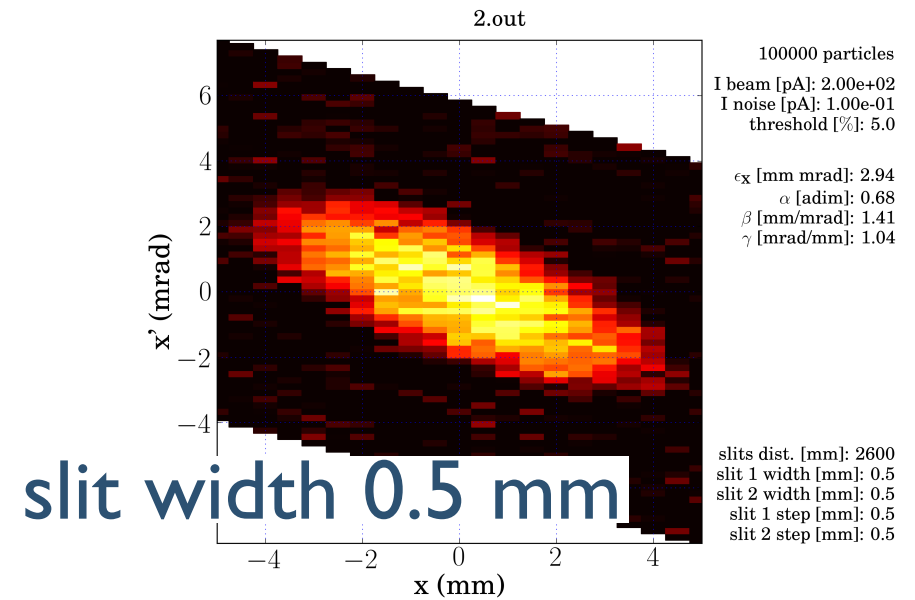
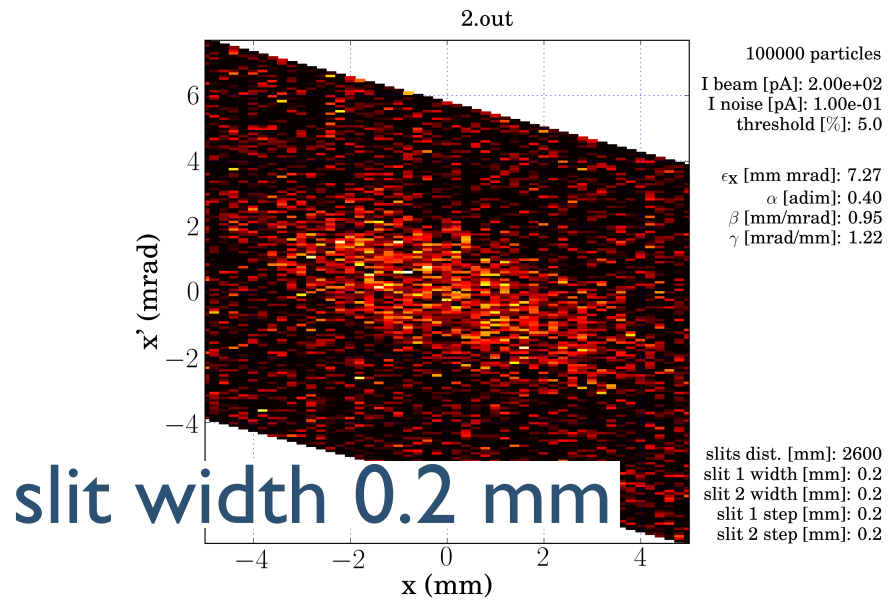
# transverse emittance SLIT + SLIT + FC



Montecarlo simulations of particles transport for different  $I_{beam}$ ,  $I_{noise}$  and  $w$ .

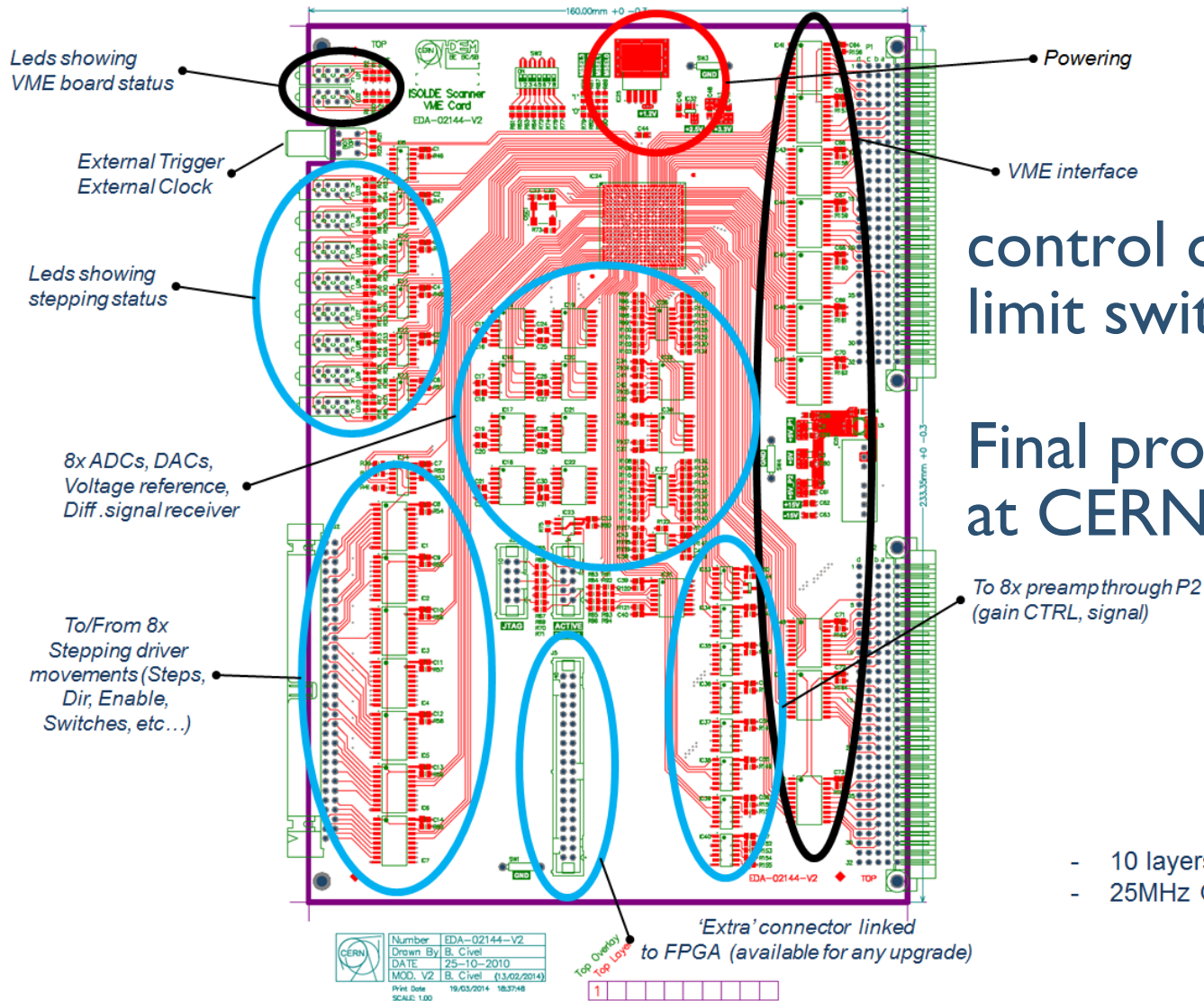


# transverse emittance SLIT + SLIT + FC



optimal slit width  
 $w = 1.0$  mm

# electronics New VME module



control of stepper motors, limit switches and FC acquisition.

Final production will arrive at CERN in **October 2014**.

- 10 layers
- 25MHz Quartz

Electronic design by S. Burger, M. Duraffourg & G. J. Focker.

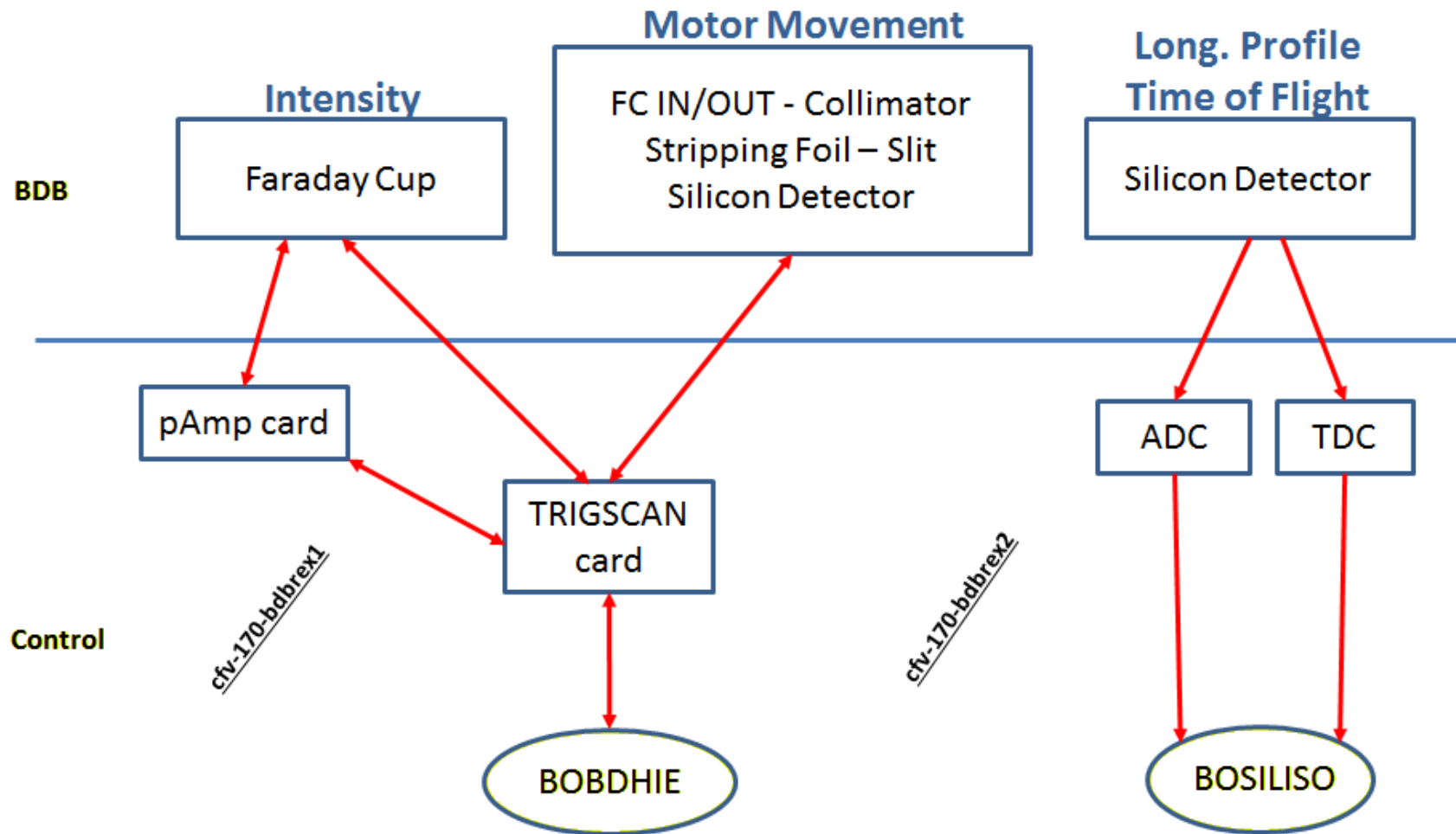
# electronics **New preamplifier for Faraday Cup**

Charge integrating preamplifier, with selectable integration time and acquisition synchronised with EBIS pulse.

Electronic design by M. Duraffourg  
& G. J. Focker.

# software 2 new main FESA servers

Expert GUI tests planned for October 2014.  
Post processing of the energy and TOF histograms to be done at the OP level.



## Status and future work

Hardware design **COMPLETED.**

Instruments tests with beam **COMPLETED.**

Electronics design **COMPLETED.**

Software design **IN PROGRESS (Oct 2014).**

Short diagnostic boxes delivery **Oct 2014.**

Long diagnostic boxes delivery **Nov 2014.**

Electronic modules delivery **Oct 2014.**

Installation starts **Nov 2014.**

Commissioning with beam **July 2015.**



**Thanks!**