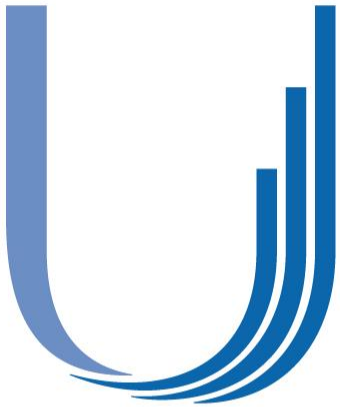
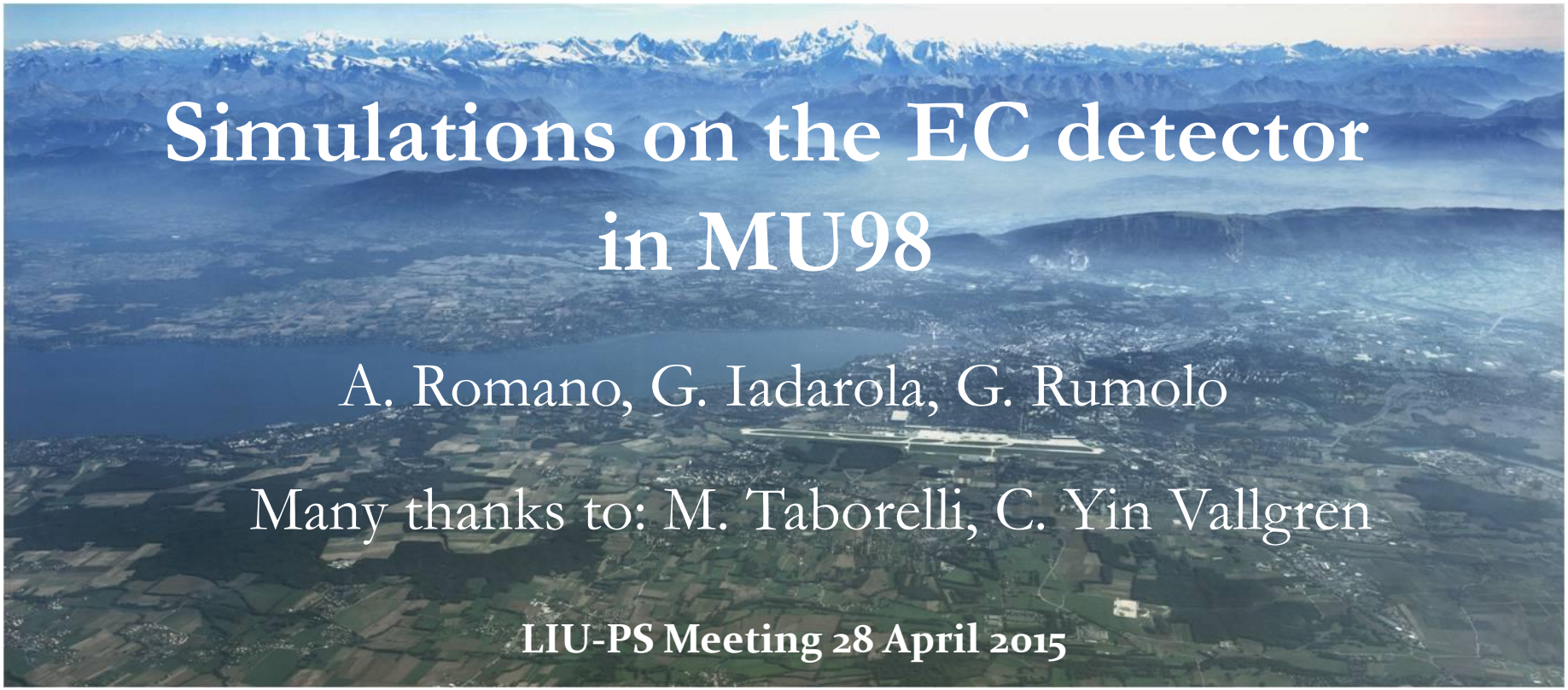


LHC Injectors Upgrade



LHC Injectors Upgrade

Simulations on the EC detector in MU98

A. Romano, G. Iadarola, G. Rumolo

Many thanks to: M. Taborelli, C. Yin Vallgren

LIU-PS Meeting 28 April 2015

CERN

Outline

Introduction

Simulation of the PS Electron Cloud detector

- Implementation of the PS Electron Cloud detector in PyECLOUD
- Simulations scans for different operating conditions(radial position, bunch intensity, bunch length)

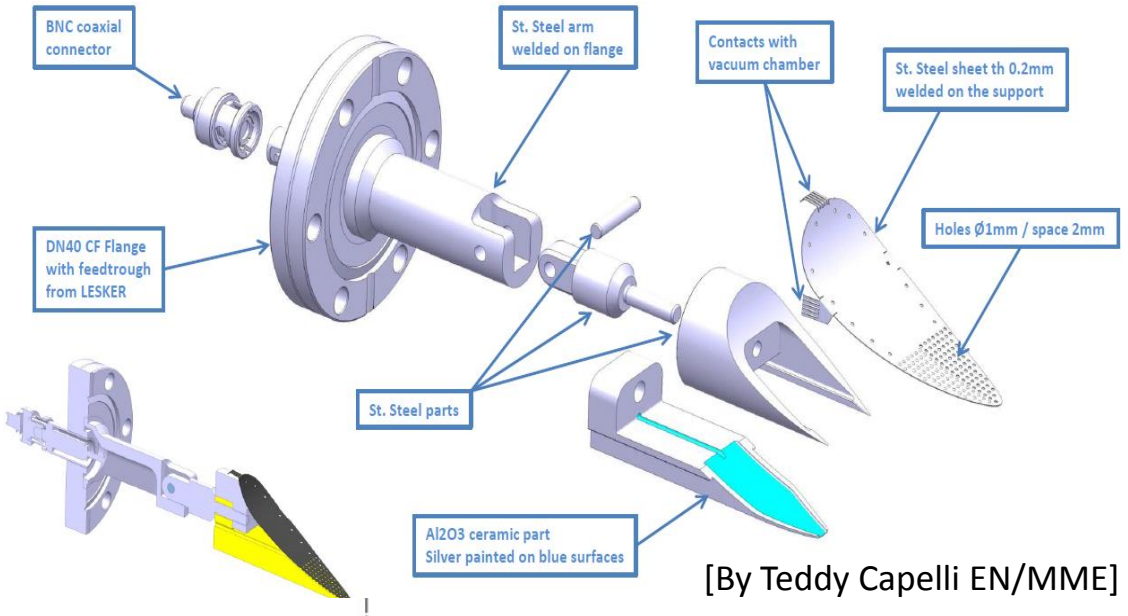
Summary

PS detector in MU98

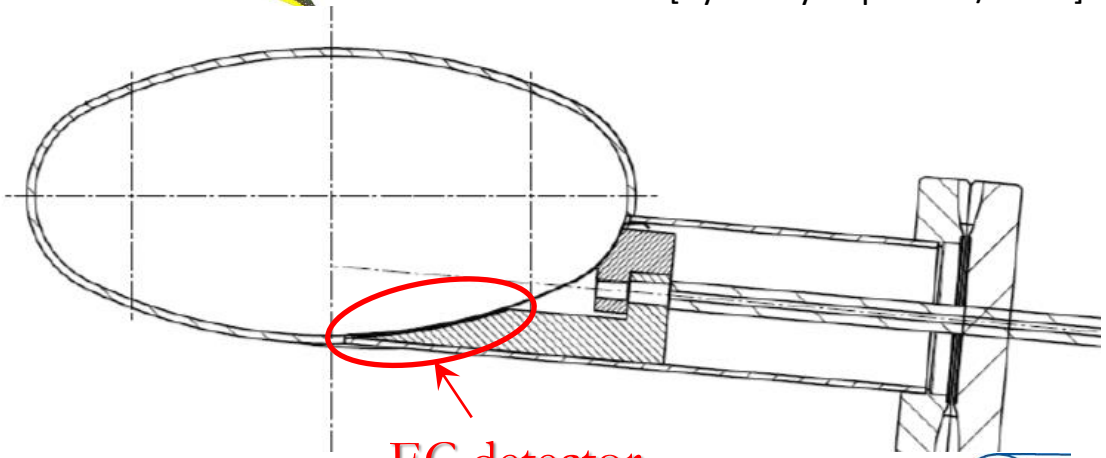
PS MU98 detector

- The pick-up is made by a ceramic block shielded from the main chamber with a 0.2 mm thick stainless steel sheet consisting of a series of holes (1 mm diameter and 2 mm pitch).

- The detector is mounted in the right part of the beam pipe (on the bottom); the distance between the end of the pick-up and the y-axis of vacuum chamber is 1.2 cm



[By Teddy Capelli EN/MME]



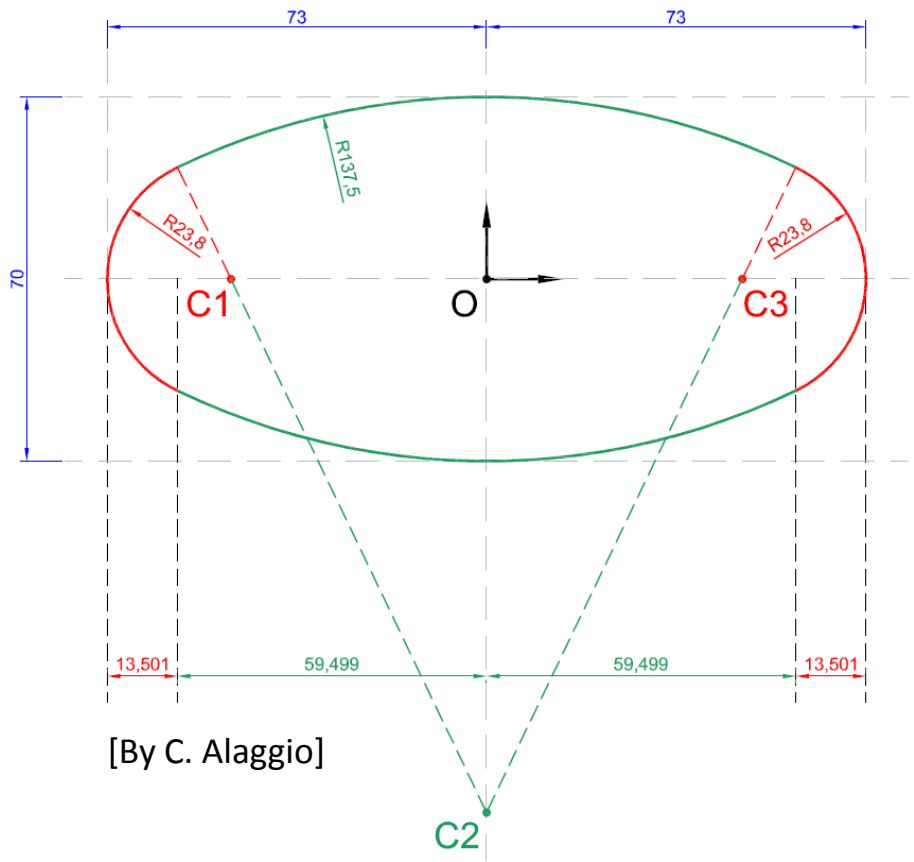
Simulation Strategy

Simulation strategy:

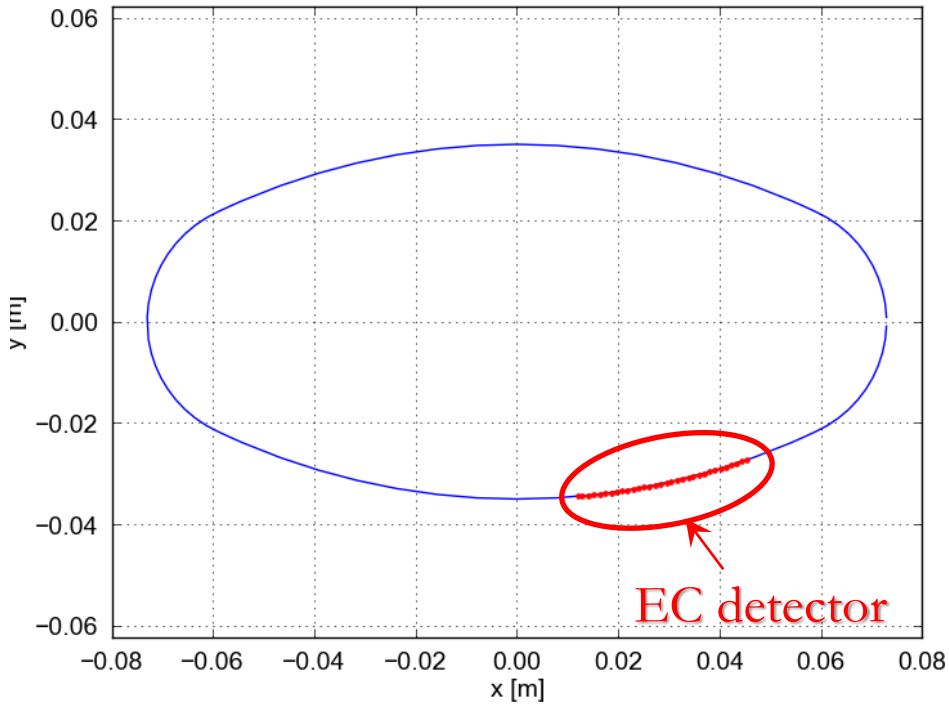
- Development of a reliable model both of the PS vacuum chamber and of the EC detector
- Implementation of these models in PyECLOUD
- Numerical simulations were carried out to quantify the expected signal at the detector under different beam conditions:
  - Beam radial position [-3,3] cm
  - Bunch length [4,16] ns
  - Bunch population [1.0,2.5]x 10^{11} ppb

Simulation Strategy: PS chamber

Realistic PS chamber



[By C. Alaggio]



PS chamber implemented in PyECLOUD

- The surface of beam pipe is made of adjacent segments of different size and SEY

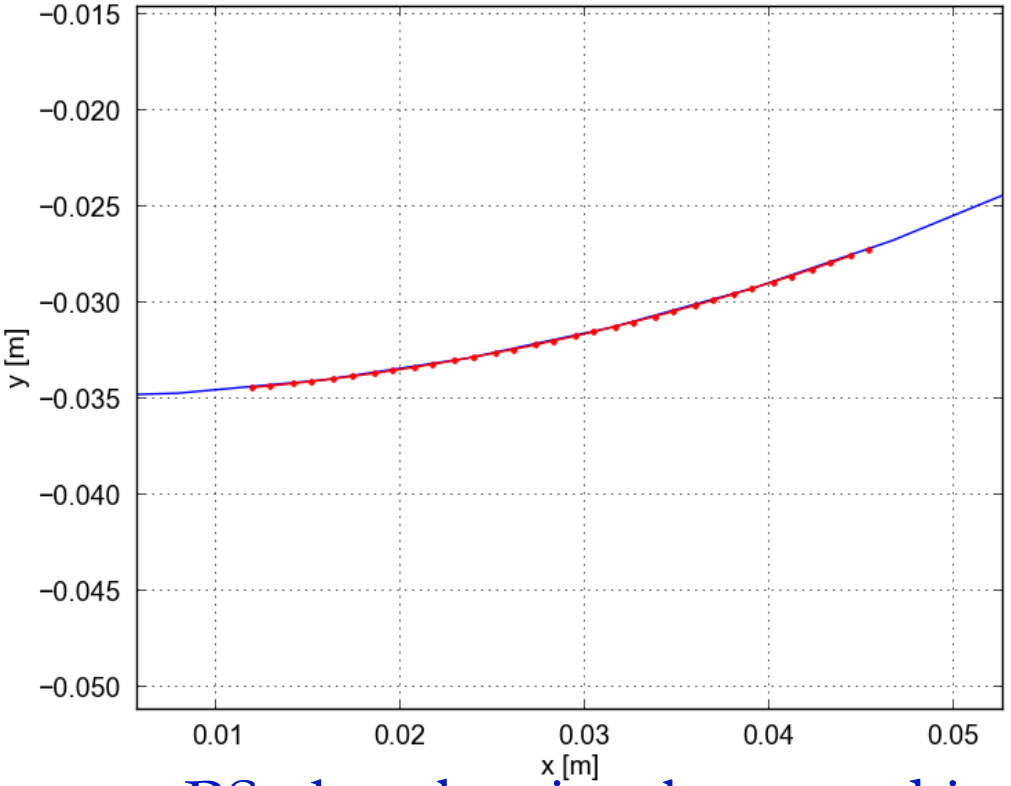
Simulation Strategy: PS chamber

hole

- **SEY = 0 (absorbing surface)**

chamber

- **SEY=[1.0-2.2]**

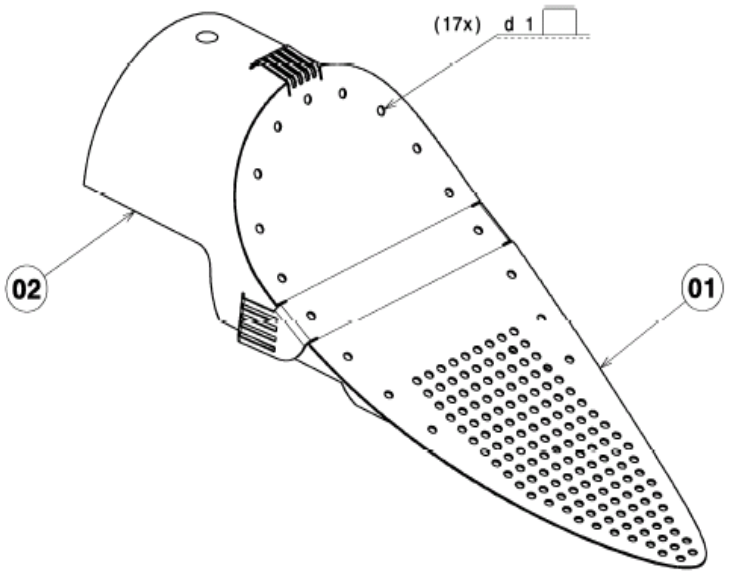


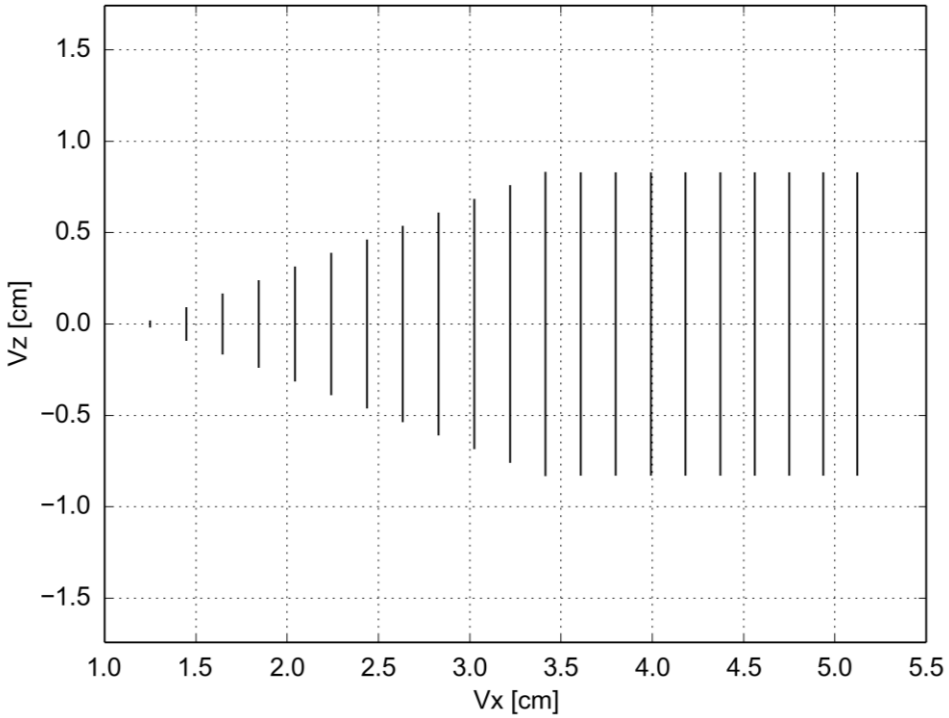
PS chamber implemented in PyECLOUD

- The surface of beam pipe is made of adjacent segments of different size and SEY

Simulation Strategy: EC detector

Realistic EC detector





EC detector implemented in PyECLOUD

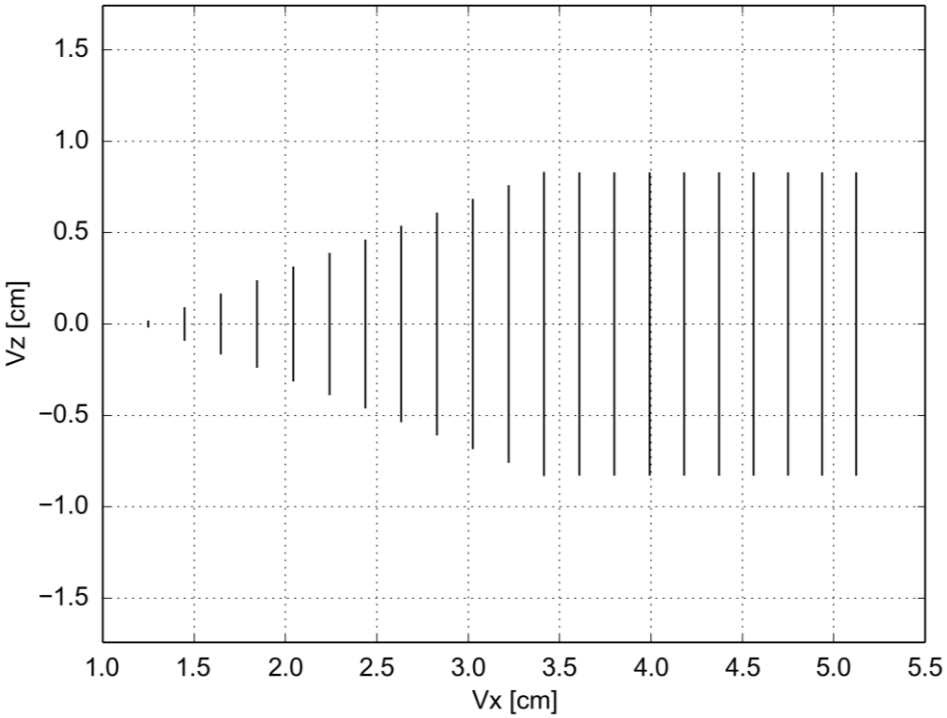
EC is measured as a current signal by the detector

Simulation Strategy: EC detector

$$I = F*L_z*q/T$$

where:

- F is the total number of e- per unit length throught each hole over the simulation time



EC detector implemented in PyECLOUD

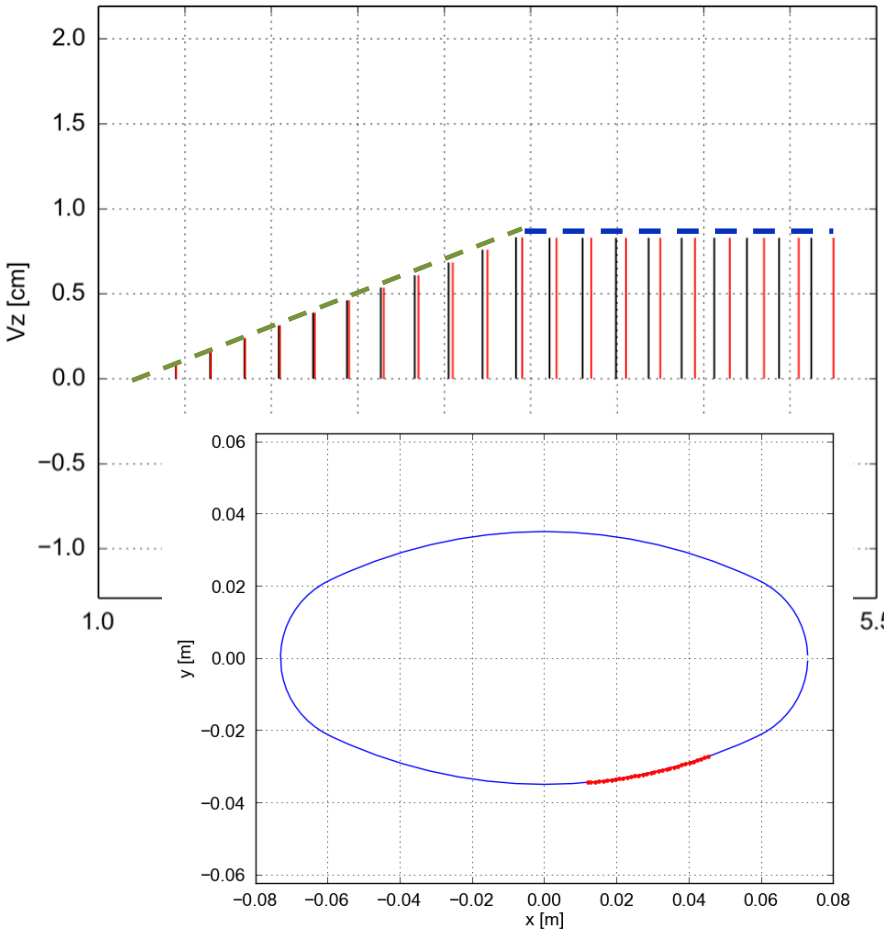
EC is measured as a current signal by the detector

Simulation Strategy: EC detector

$$I = F * L_z * q / T$$

where:

- F is the total number of e- per unit length throught each hole over the simulation time
- **L_z** is the length of the detector with respect to each hole position (s_{hole}).



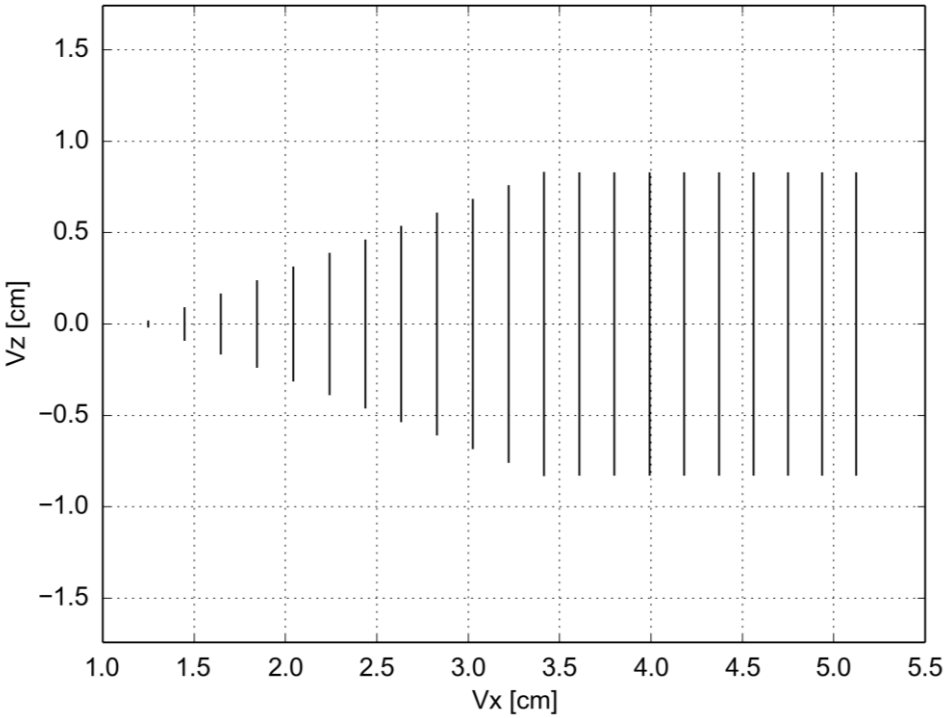
EC is measured as a current signal by the detector

Simulation Strategy: EC detector

$$I = F * L_z * q / T$$

where:

- F is the total number of e- per unit length throught each hole over the simulation time
- **Lz** is the length of the detector with respect to each hole position(s_hole).
- **q** is the charge of e-



EC detector implemented in PyECLOUD

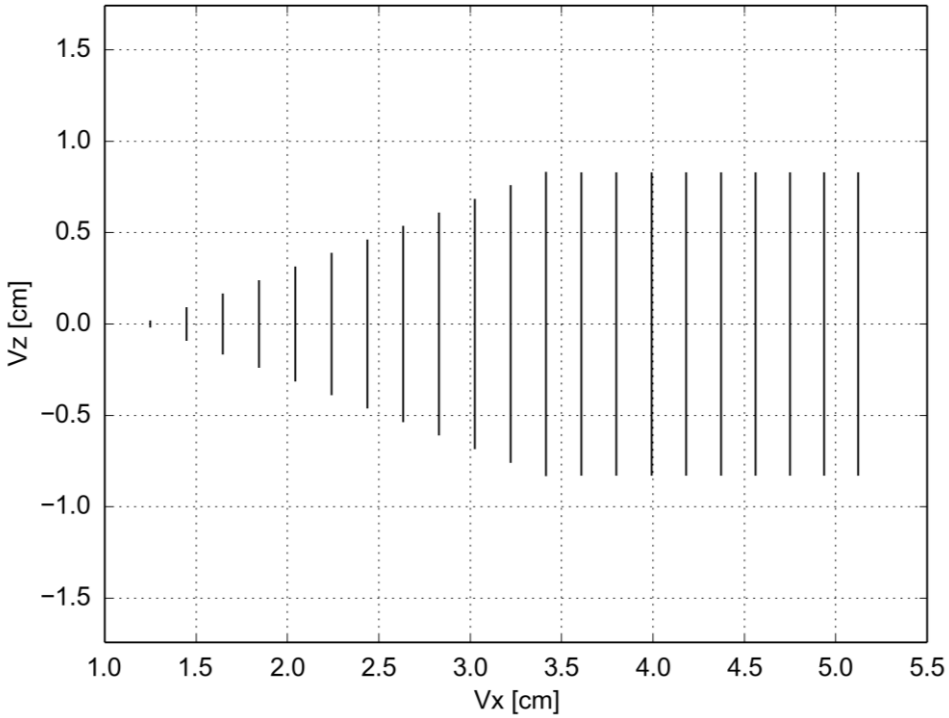
EC is measured as a current signal by the detector

Simulation Strategy: EC detector

$$I = F * L_z * q / T$$

where:

- F is the total number of e- per unit length throught each hole over the simulation time
- L_z is the length of the detector with respect to each hole position(s_{hole}).
- **q** is the charge of e-
- **T** is a simulated time interval



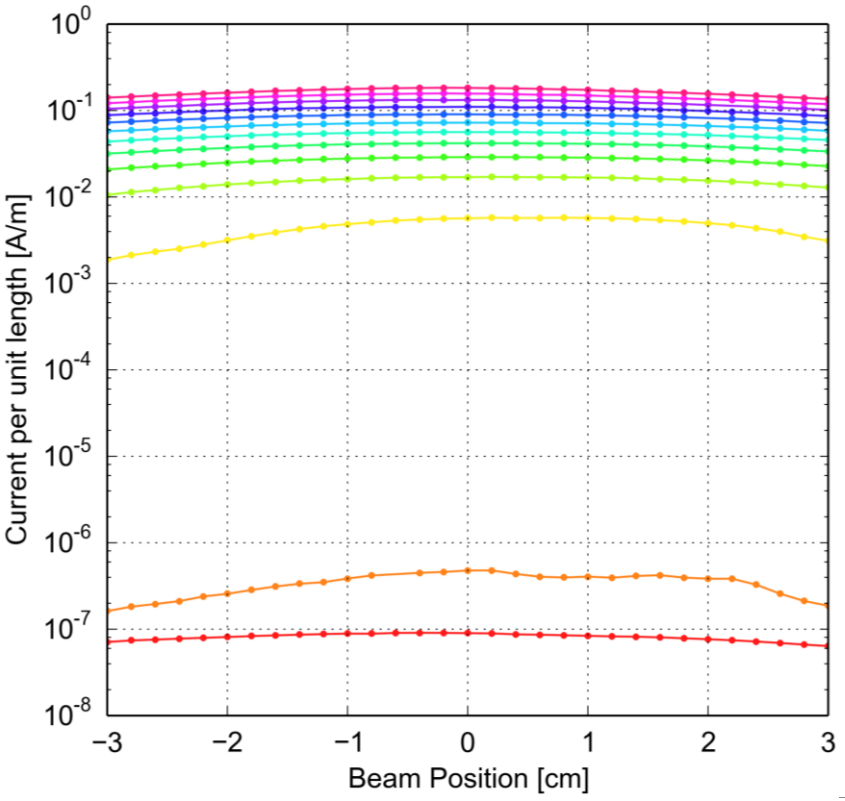
EC detector implemented in PyECLOUD

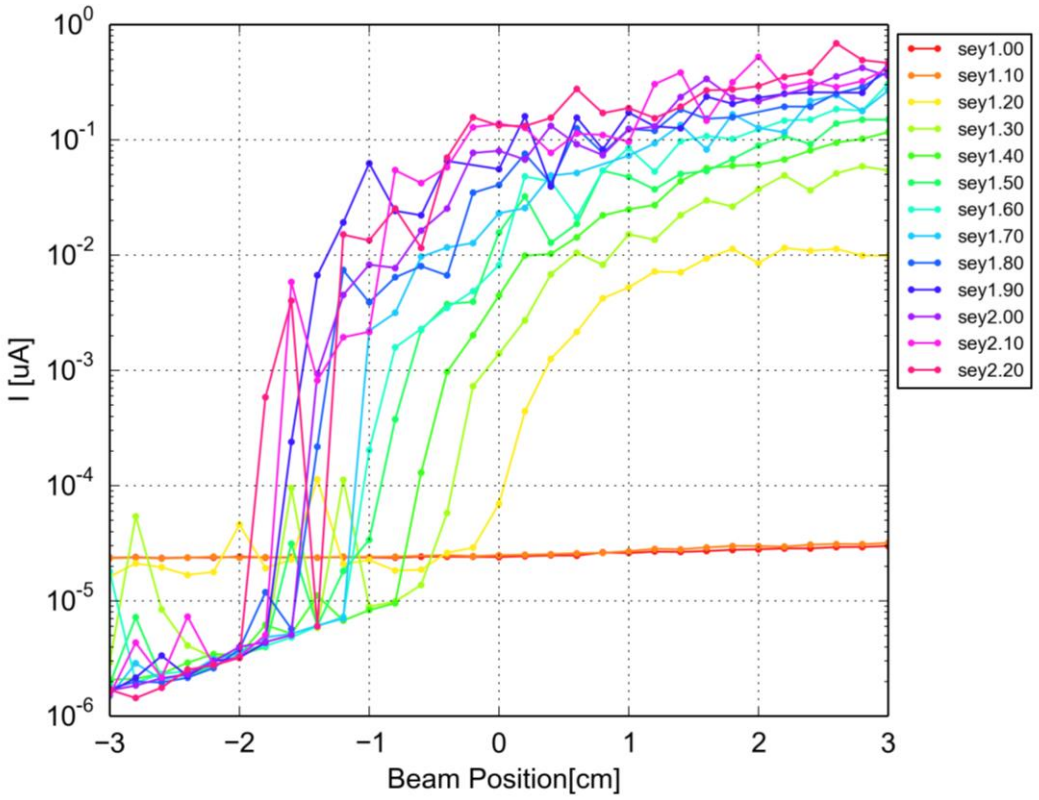
EC is measured as a current signal by the detector

Case Study

- Simulations scans for different beam radial position

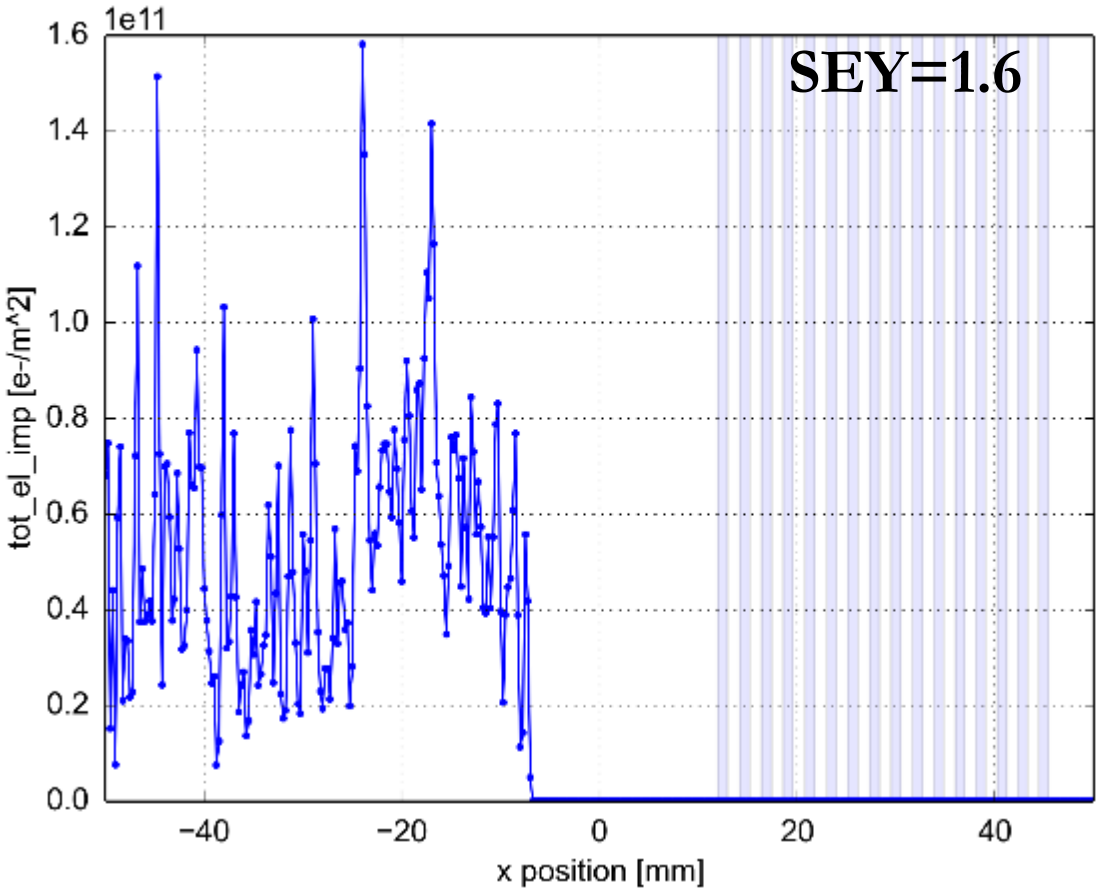
The detector is slightly displaced with respect to vertical axis of the chamber, for this reason the dependence of the signal on the radial beam positions was investigated

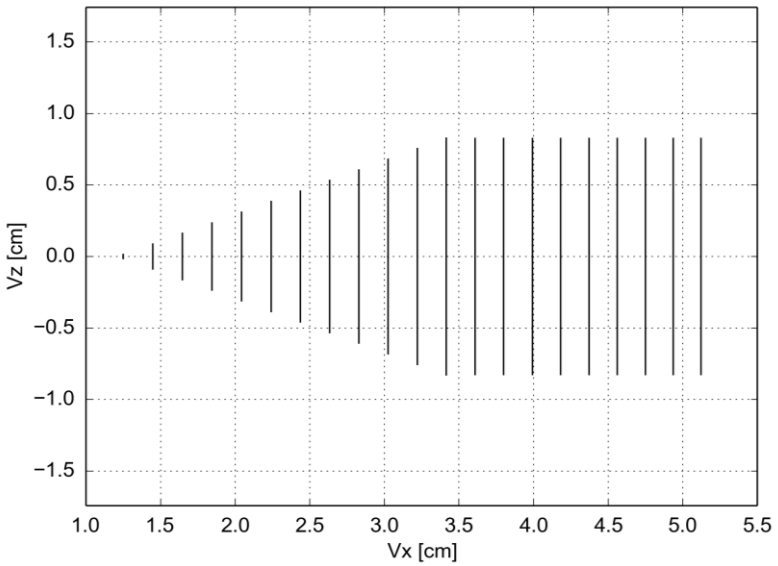


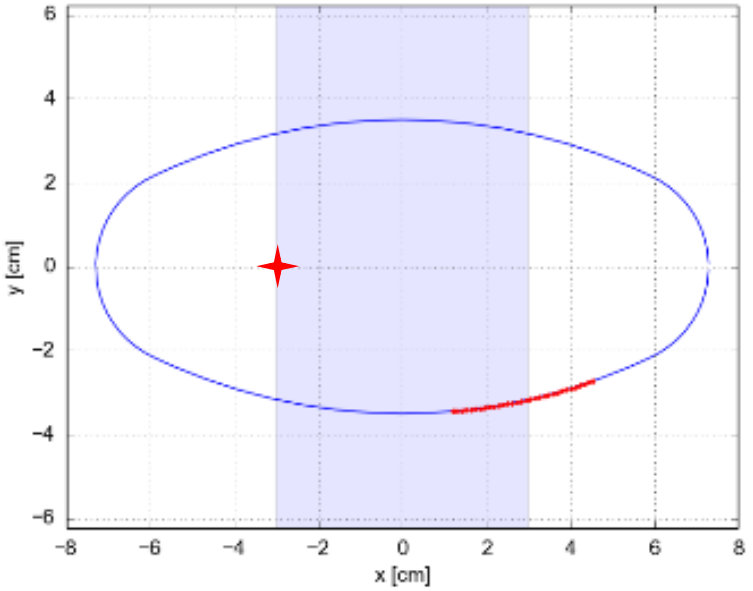


Case Study

Beam position = -30 mm

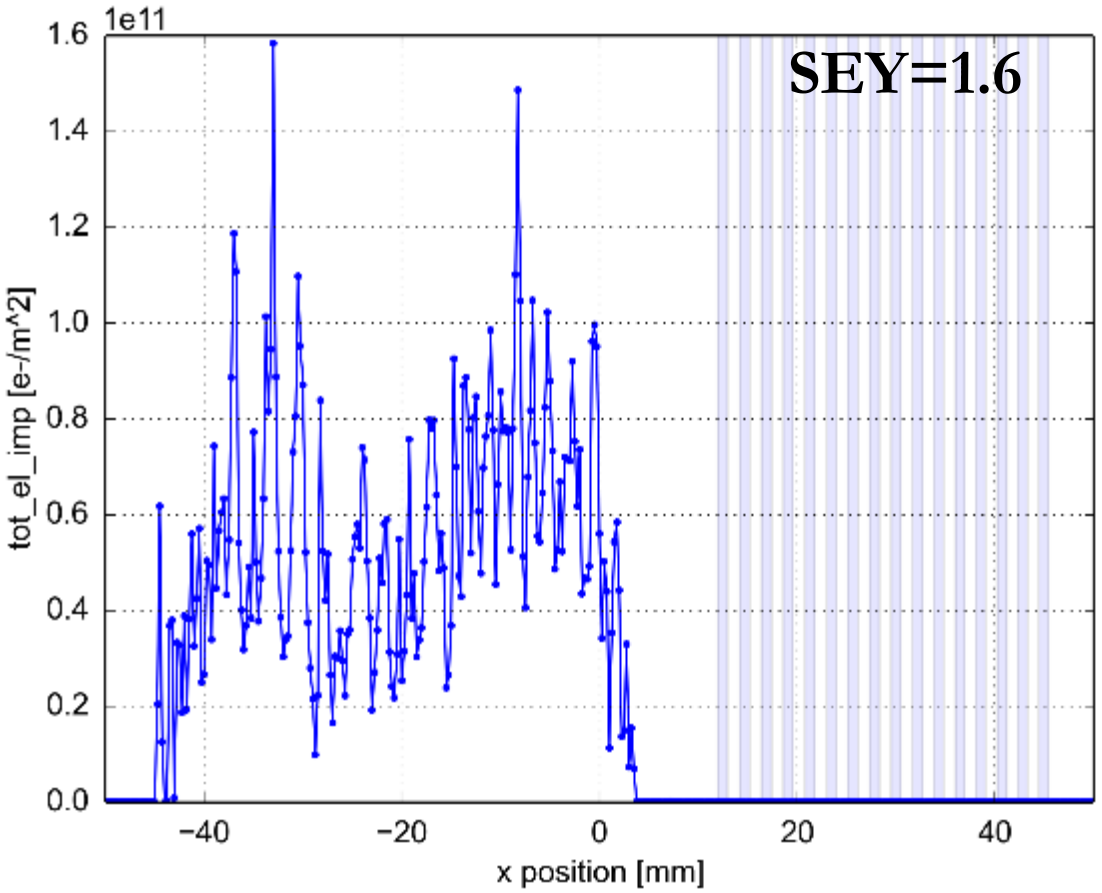


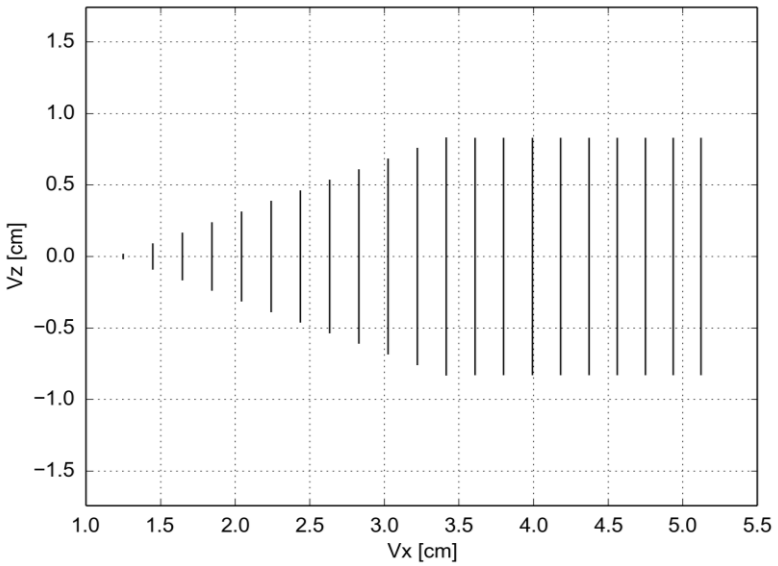


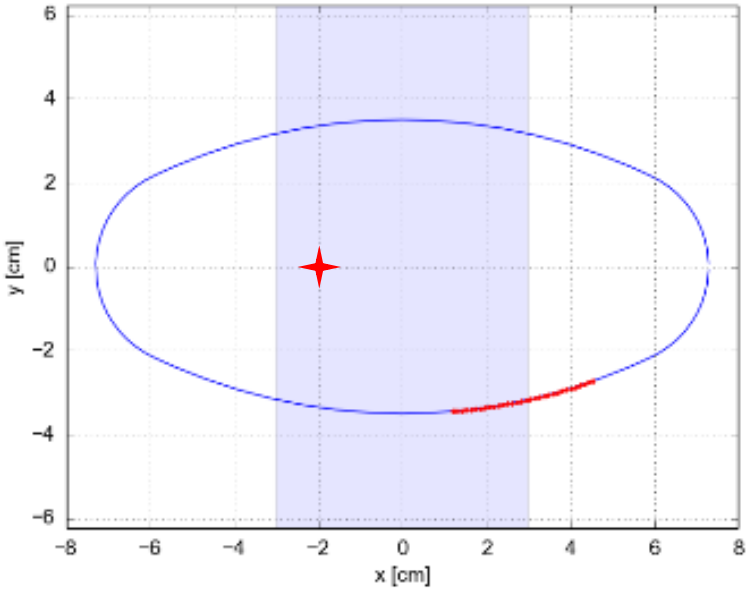


Case Study

Beam position = -20 mm

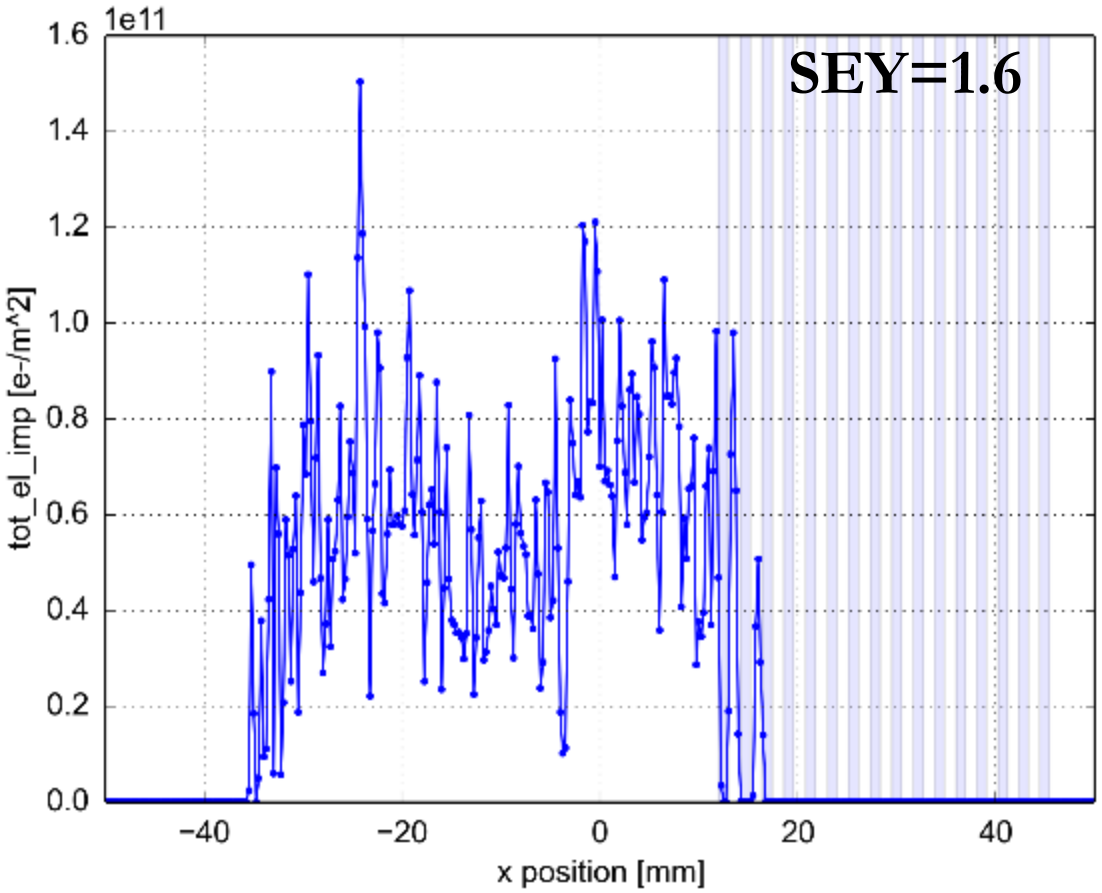


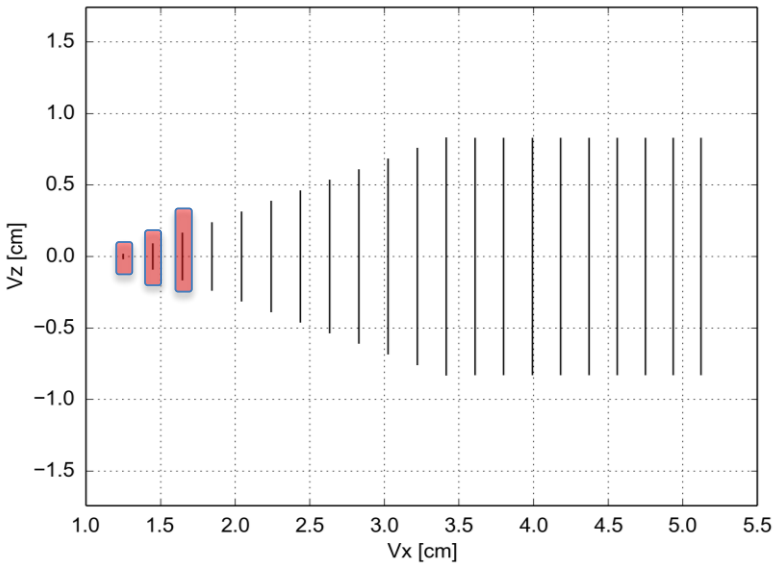


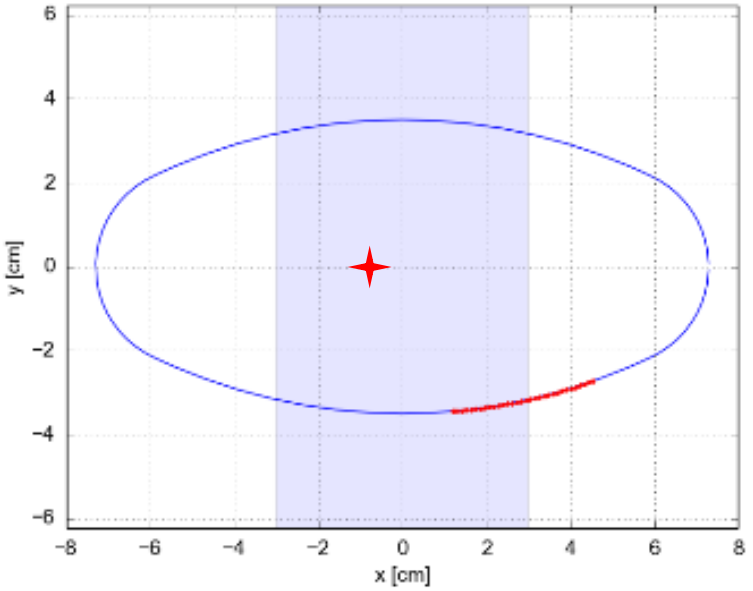


Case Study

Beam position = -10 mm

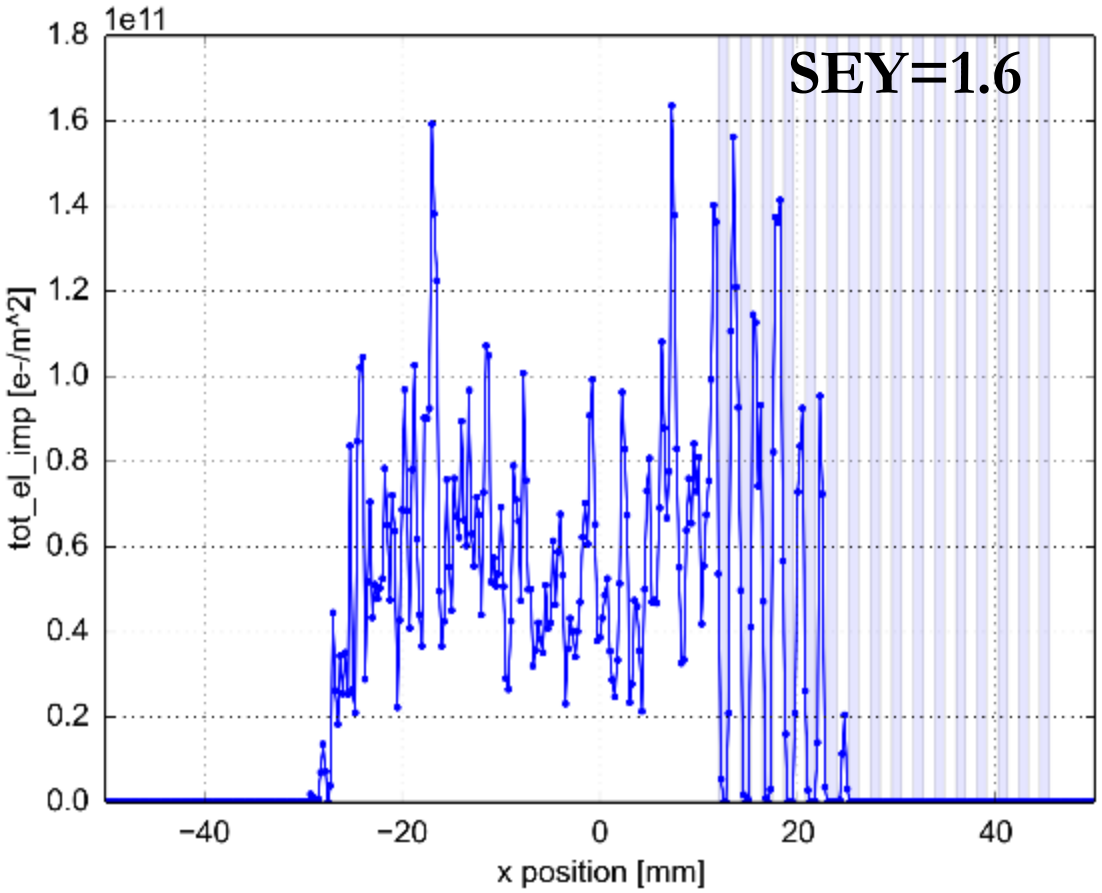


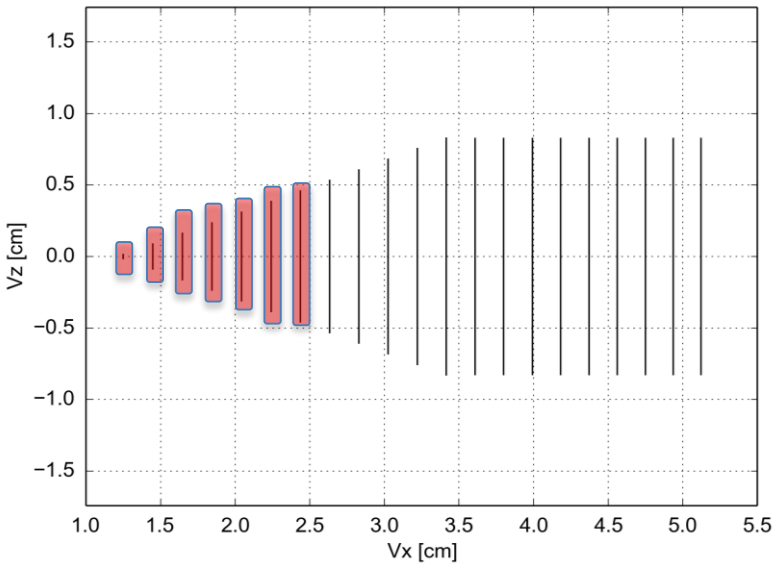


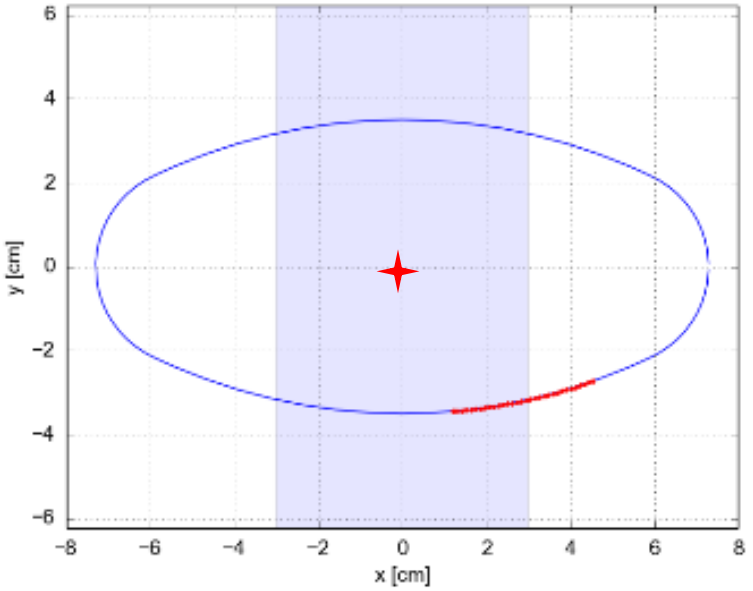


Case Study

Beam position = center

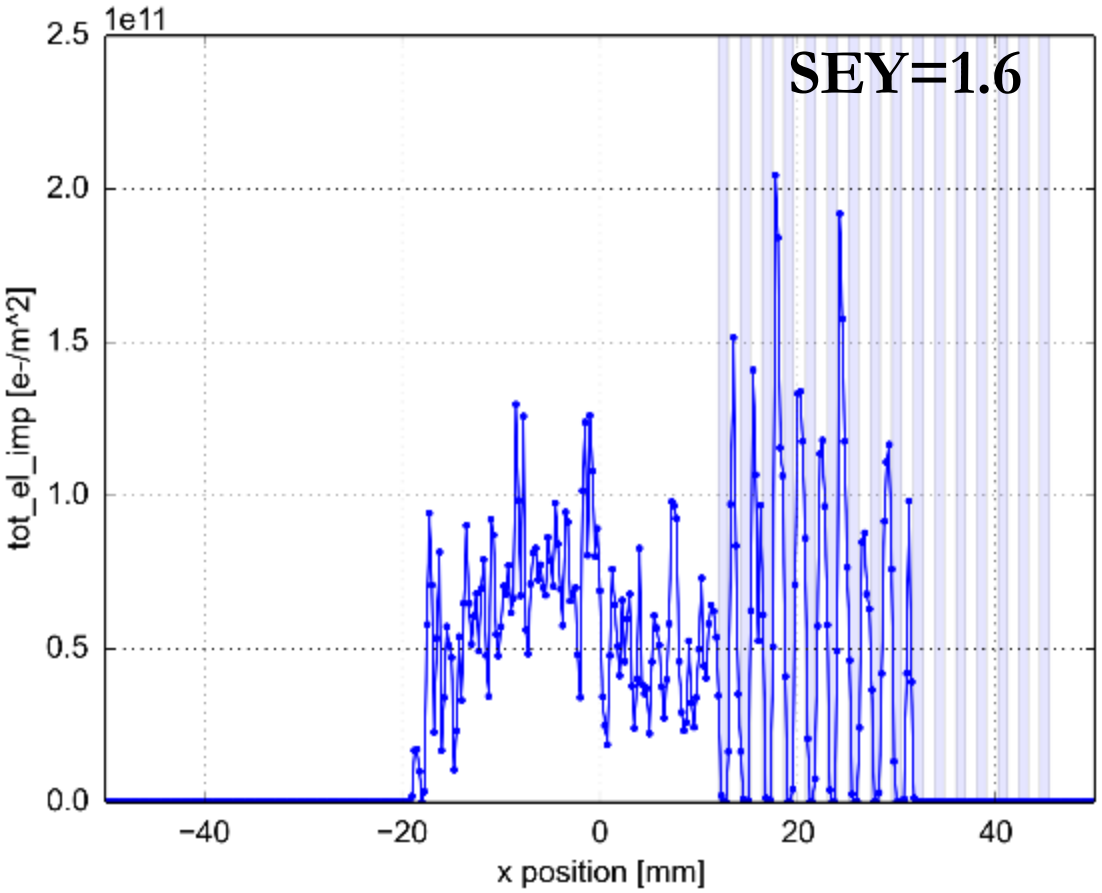


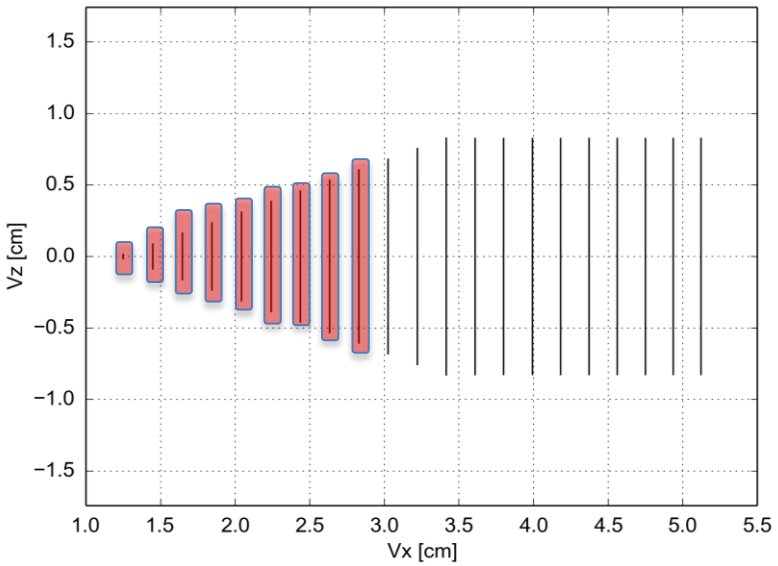


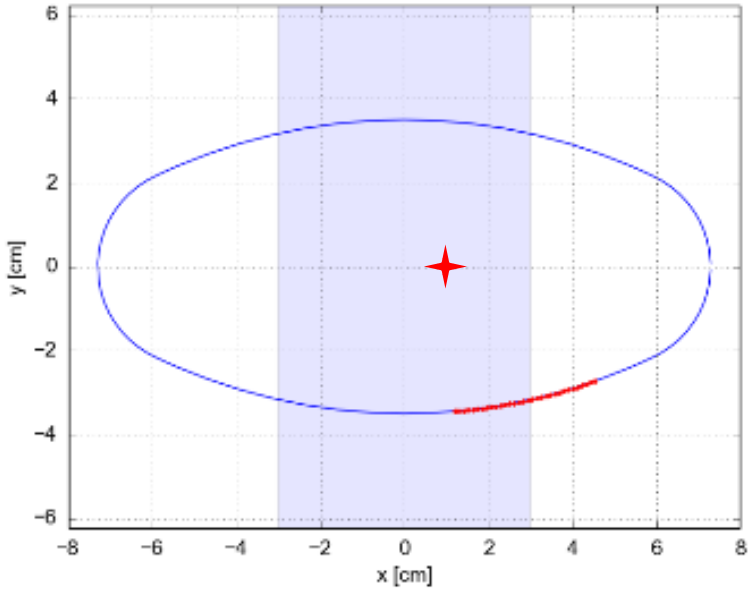


Case Study

Beam position = 10 mm

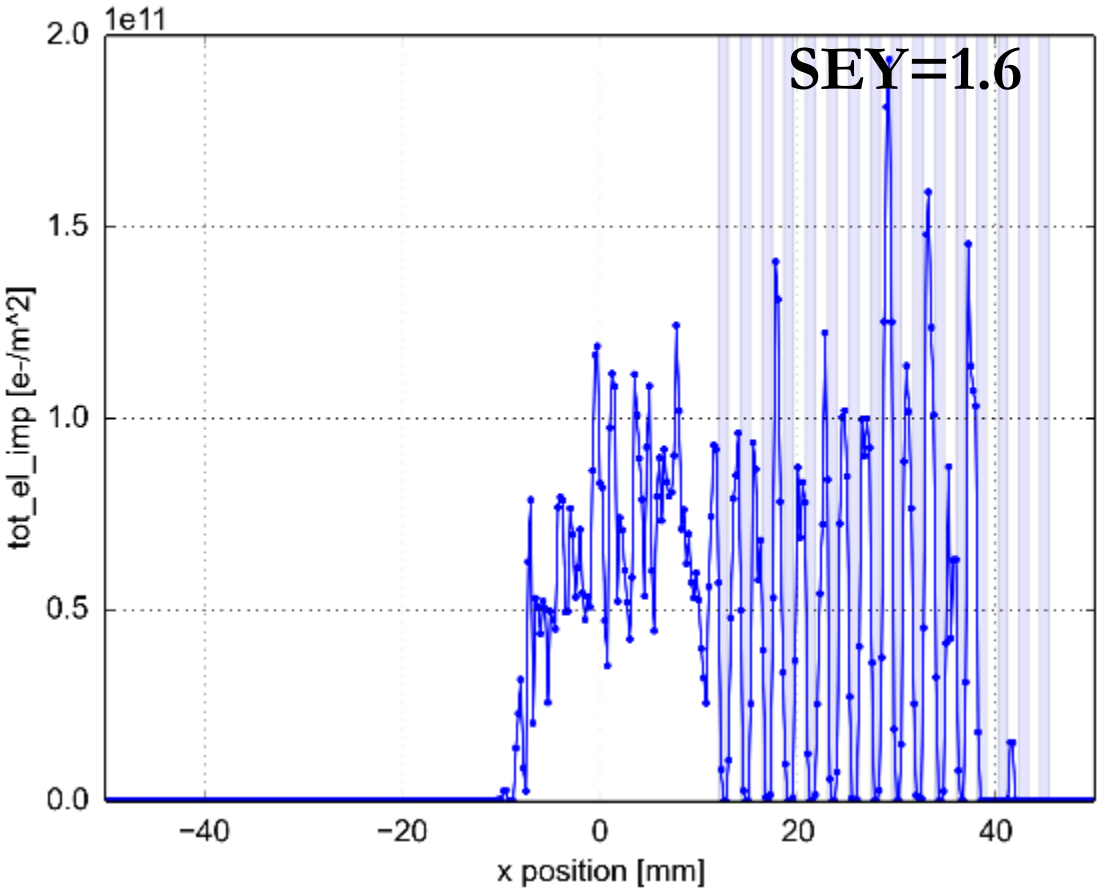


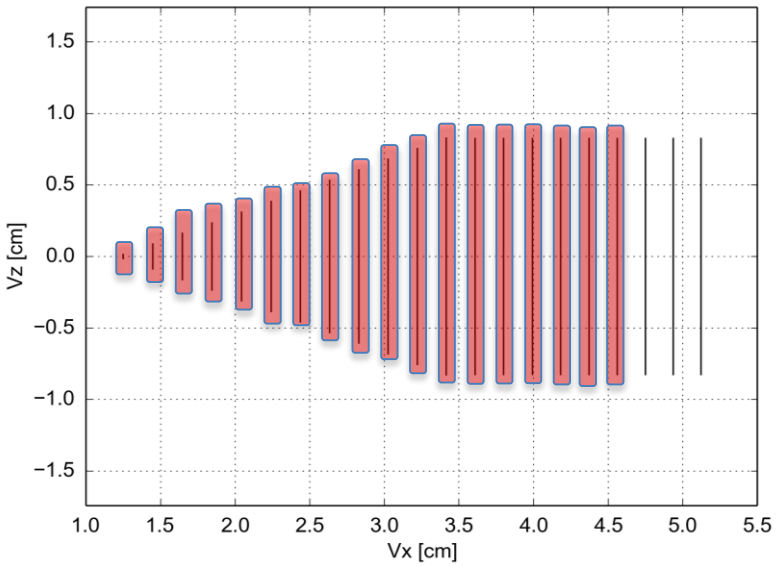


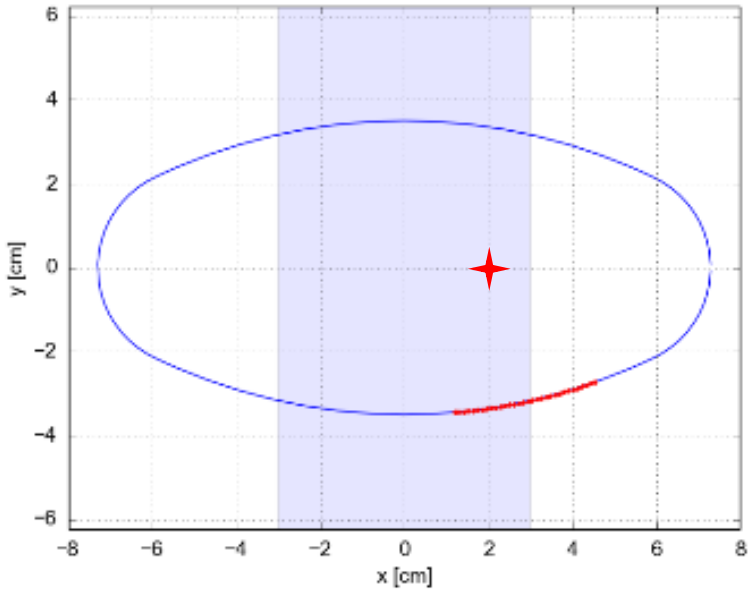


Case Study

Beam position = 20 mm

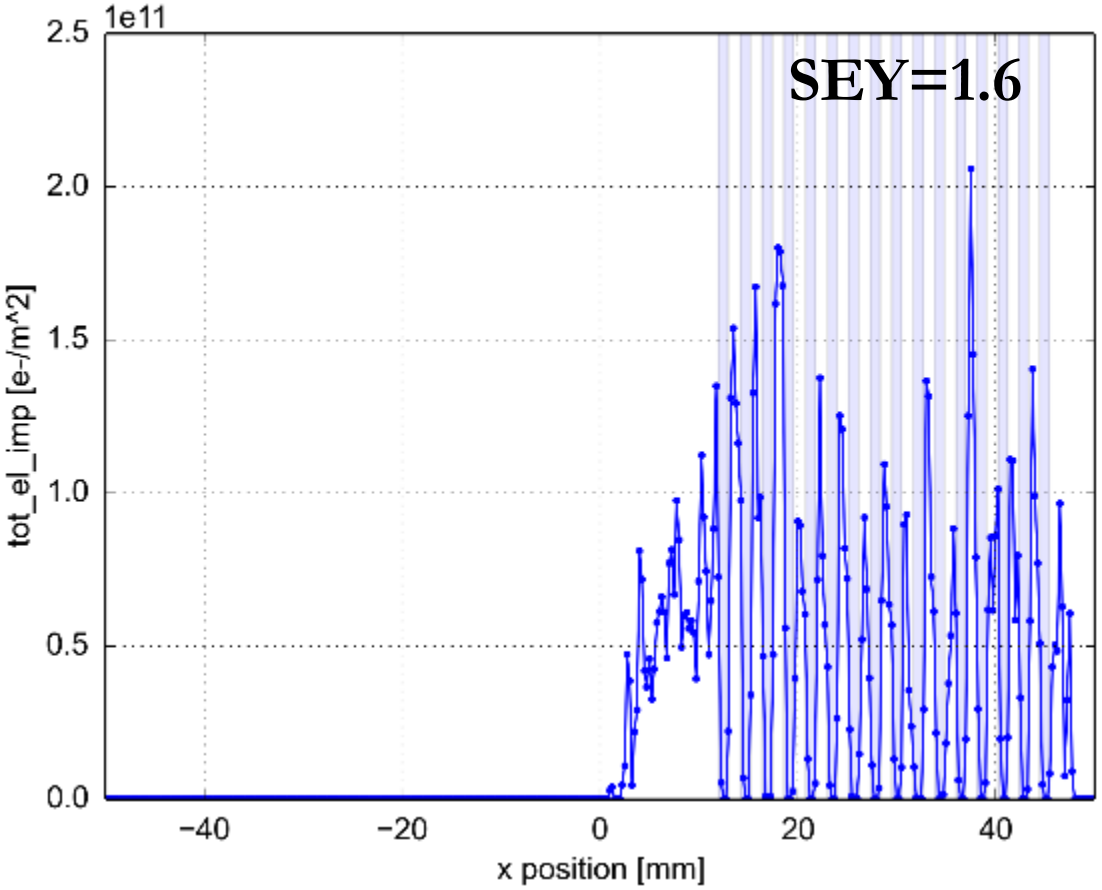


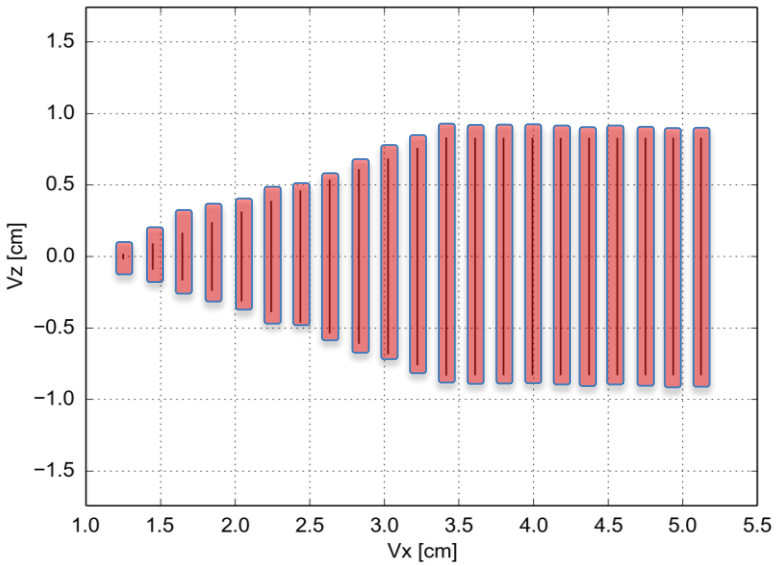


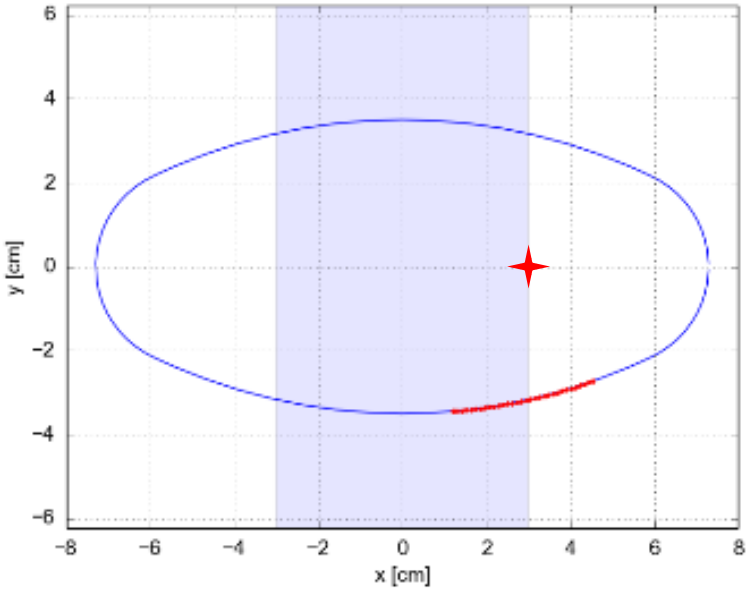


Case Study

Beam position = 30 mm

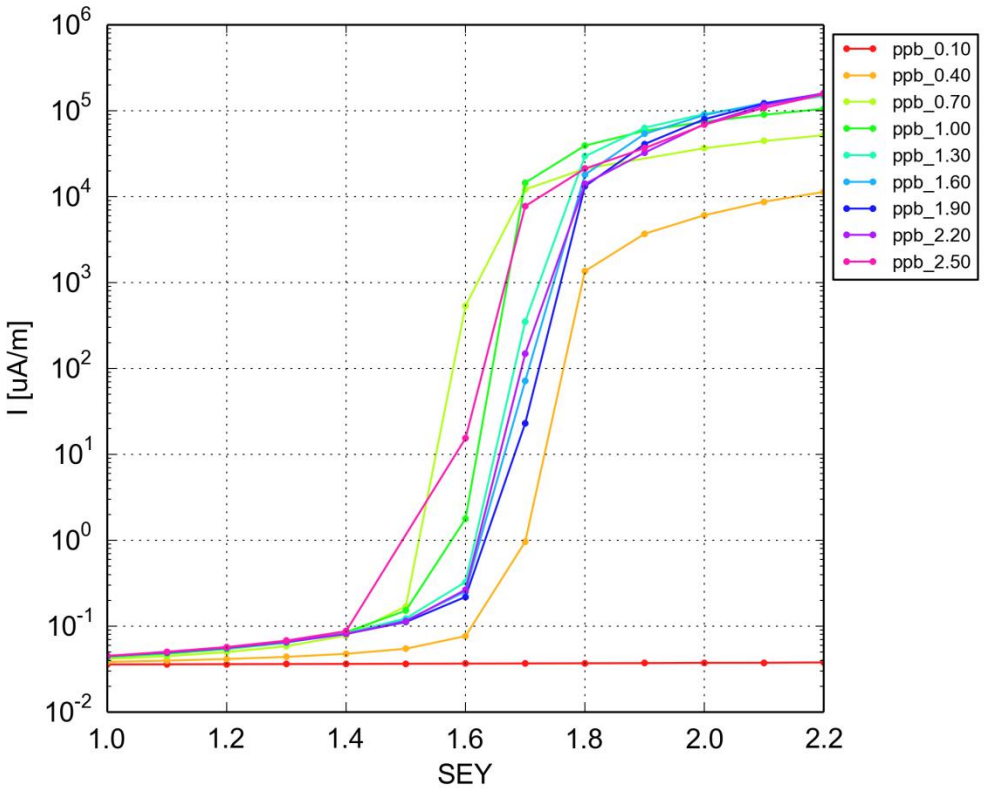




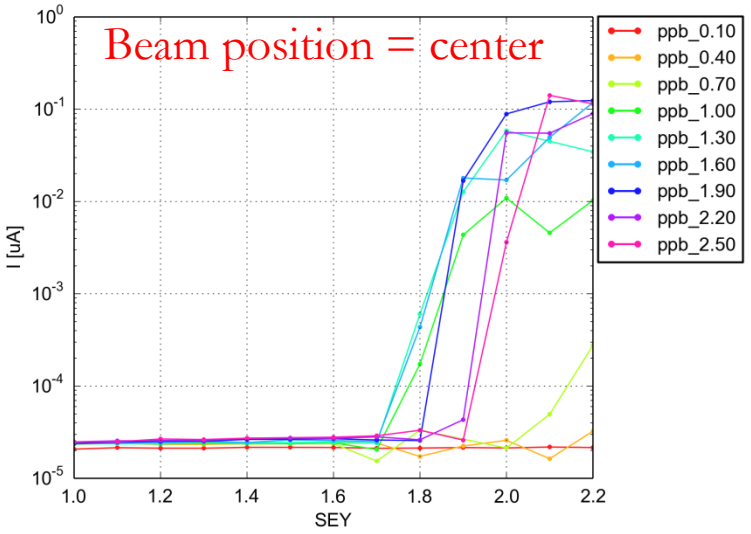


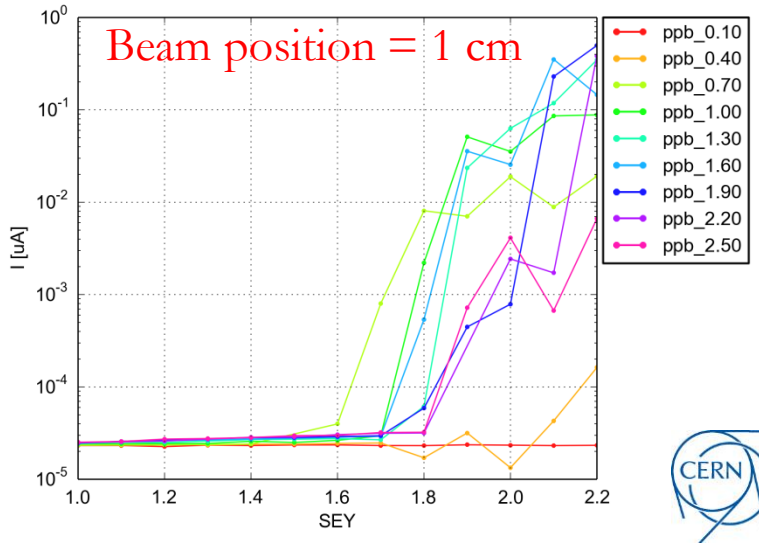
Case Study : bl= 14 ns

Current through the chamber



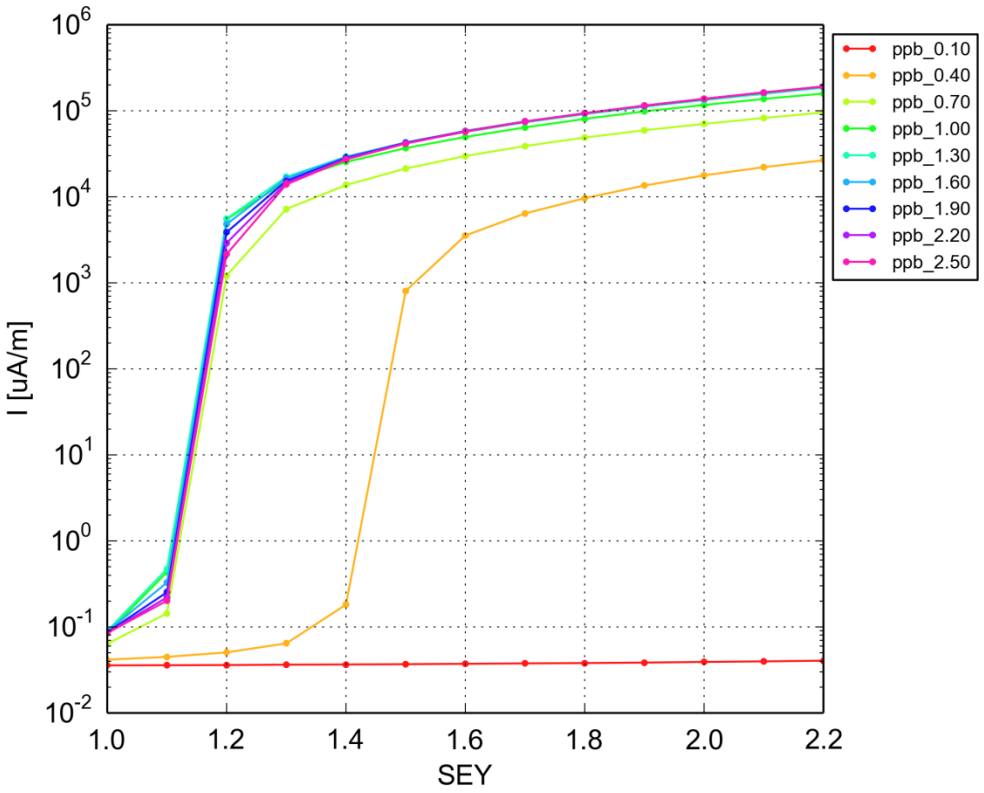
Current through the holes



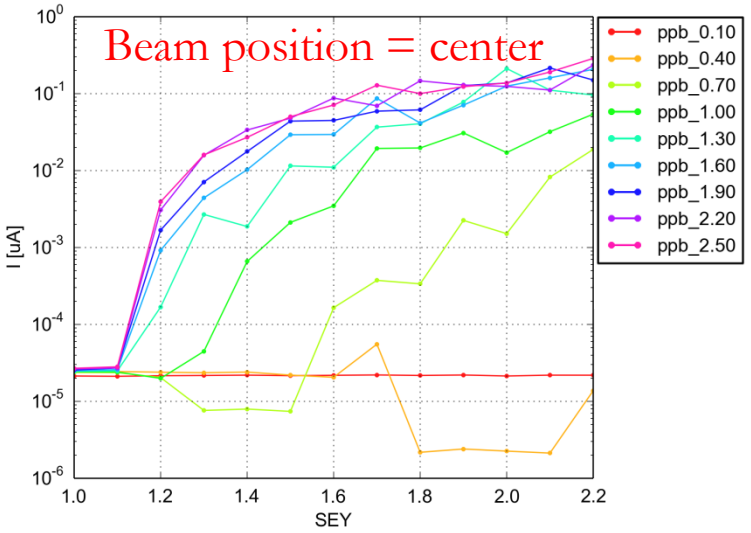


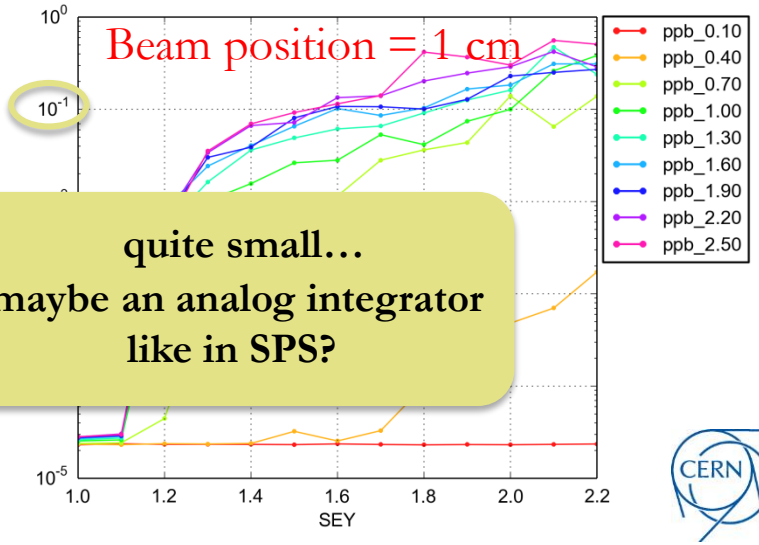
Case Study : bl= 4 ns

Current through the chamber



Current through the holes

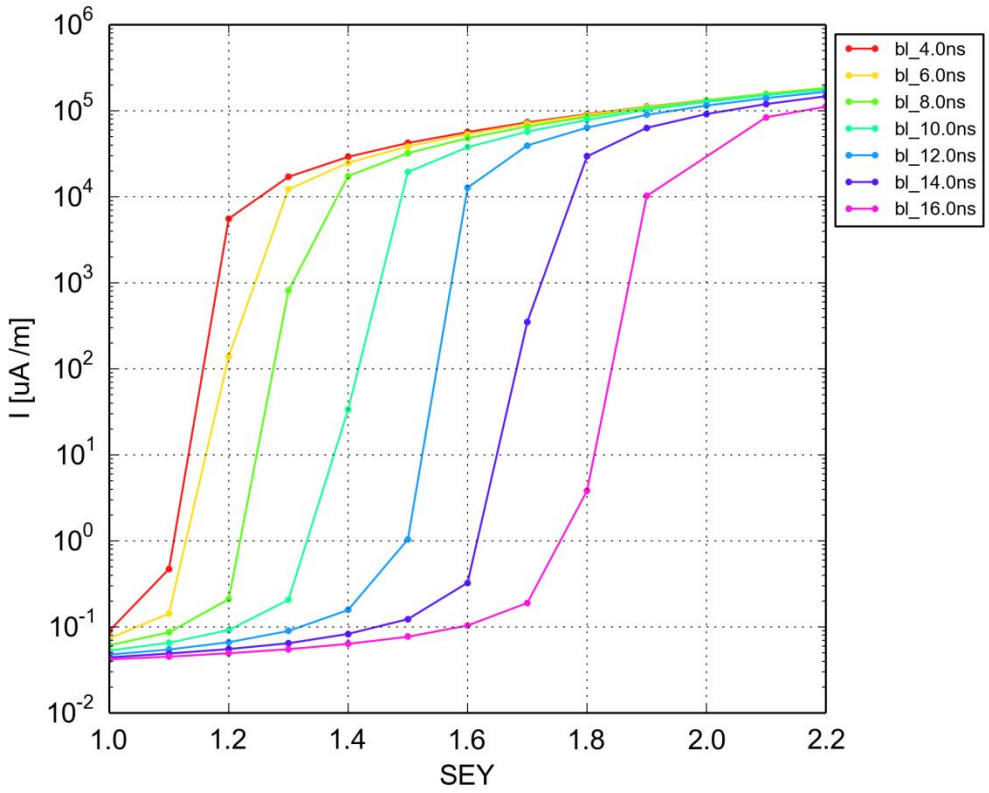




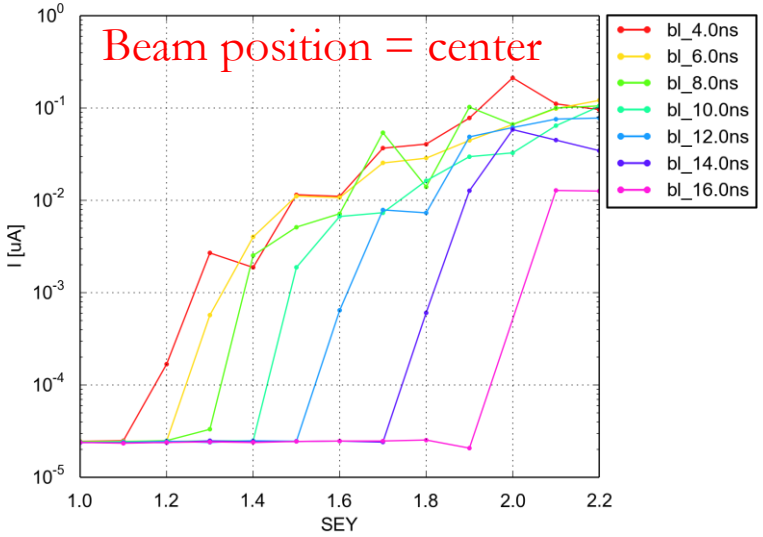
quite small…
maybe an analog integrator like in SPS?

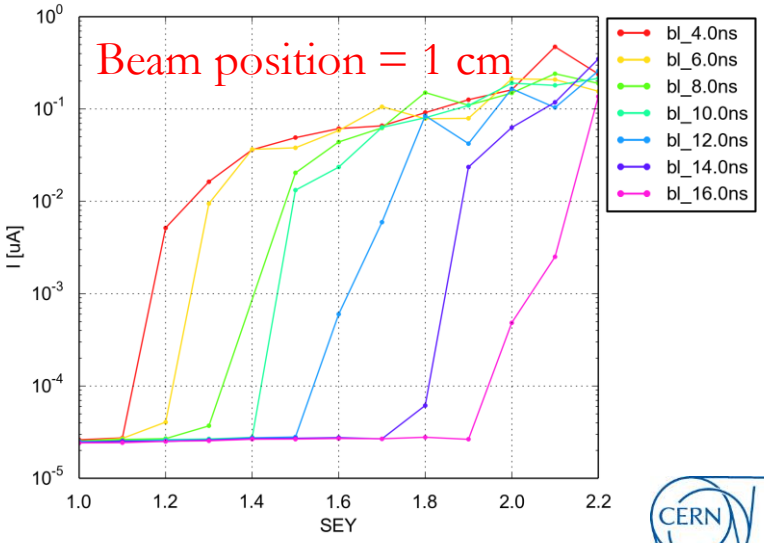
Case Study : ppb= 1.30* 10^{11}

Current through the chamber



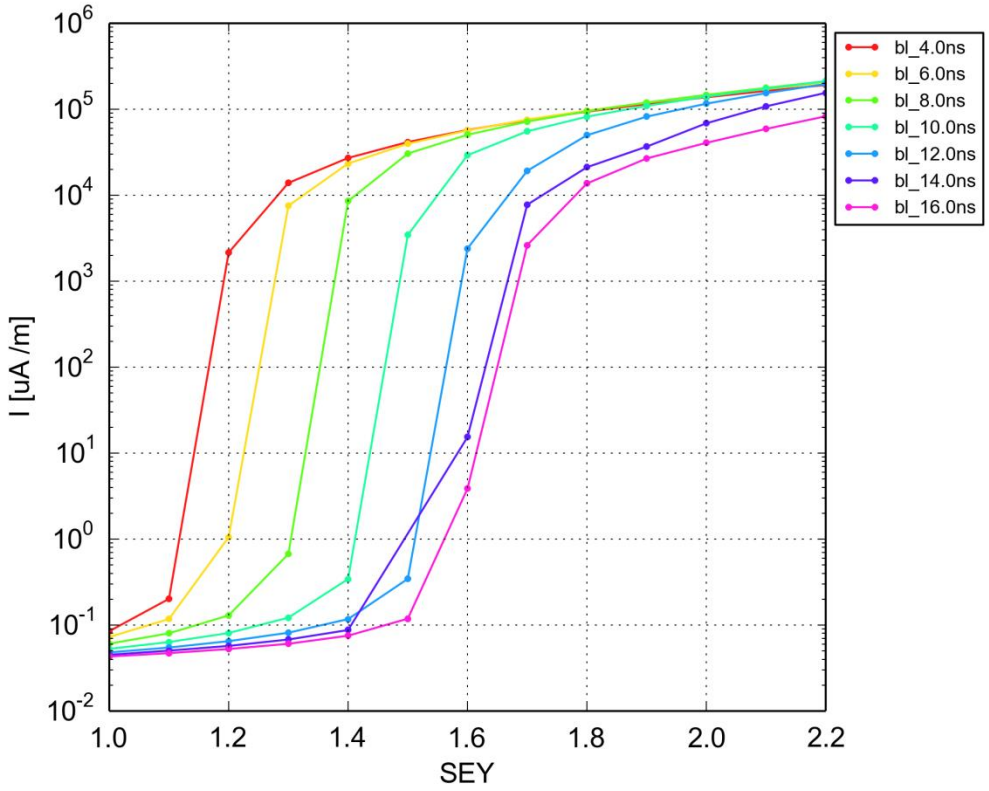
Current through the holes



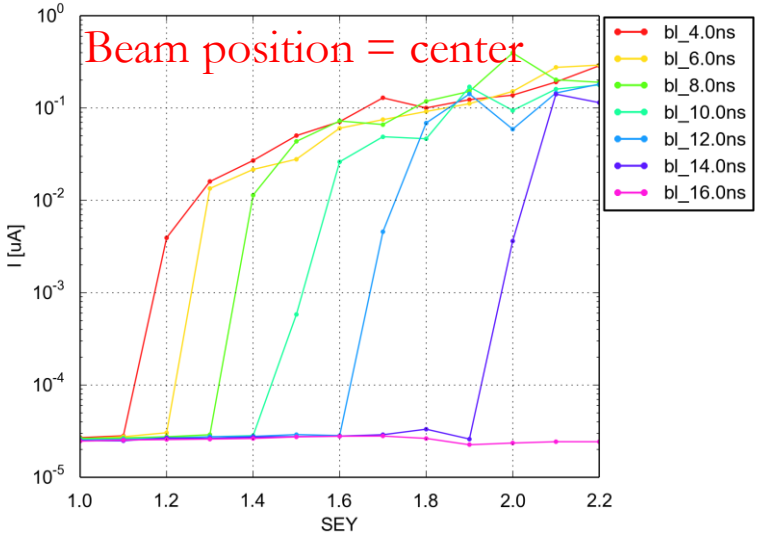


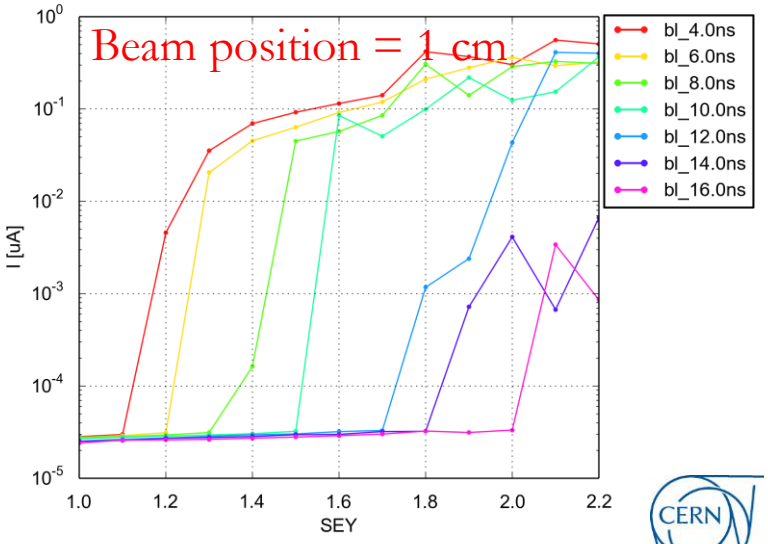
Case Study : ppb= 2.50* 10^{11}

Current through the chamber



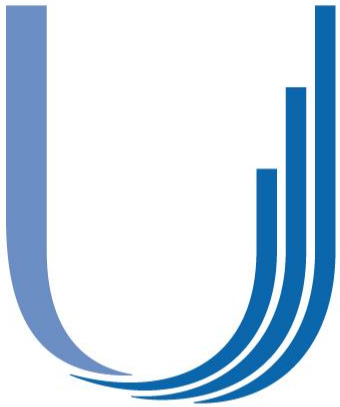
Current through the holes





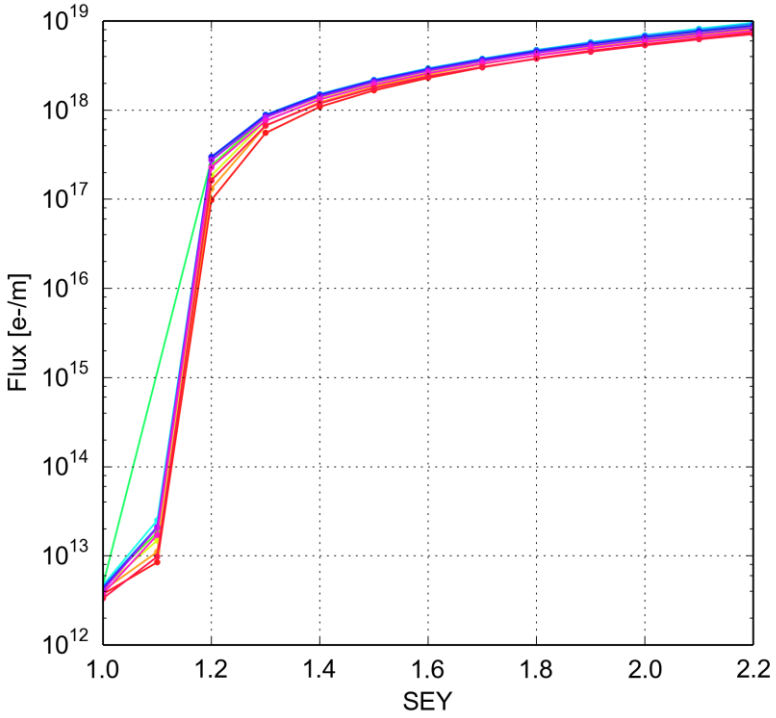
Summary

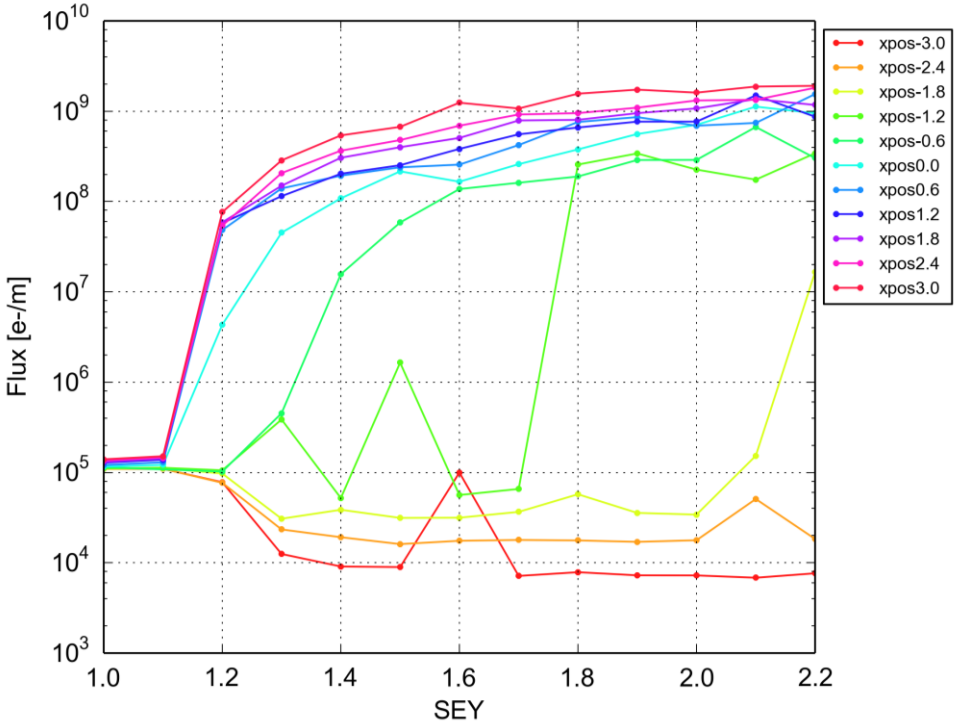
- The results of these studies show that:
  - the electron flux through the holes is strongly affected by the beam displacement; it becomes acceptable only when the beam gets closer to the region of the detector
  - the multipacting threshold decreases when the bunch length decreases and when the bunch intensity increases



LHC Injectors Upgrade

Thanks for your attention !!!!


Flux [e-/m]
SEY
10^{19}
10^{18}
10^{17}
10^{16}
10^{15}
10^{14}
10^{13}
10^{12}
1.0
1.2
1.4
1.6
1.8
2.0
2.2


Flux [e-/m]
SEY
10^{10}
10^{9}
10^{8}
10^{7}
10^{6}
10^{5}
10^{4}
10^{3}
1.0
1.2
1.4
1.6
1.8
2.0
2.2
xpos-3.0
xpos-2.4
xpos-1.8
xpos-1.2
xpos-0.6
xpos0.0
xpos0.6
xpos1.2
xpos1.8
xpos2.4
xpos3.0