LEIR injection PU commissioning

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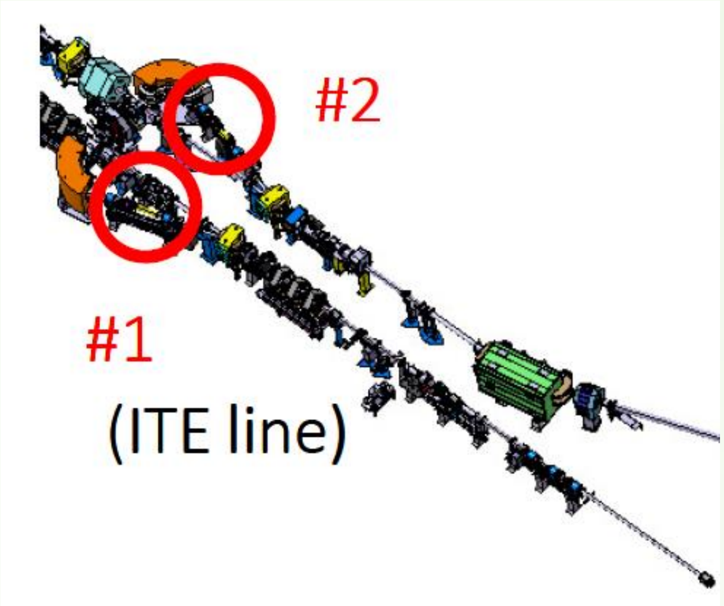
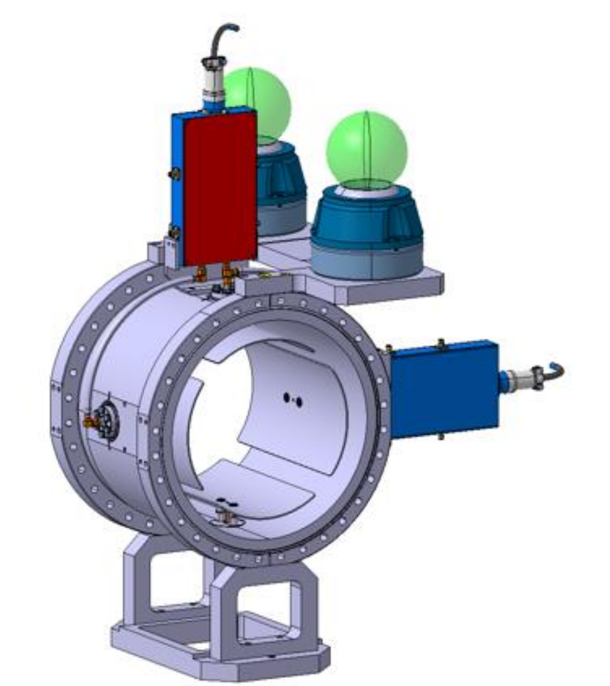
on behalf of the BPM commissioning team

ITE line installation

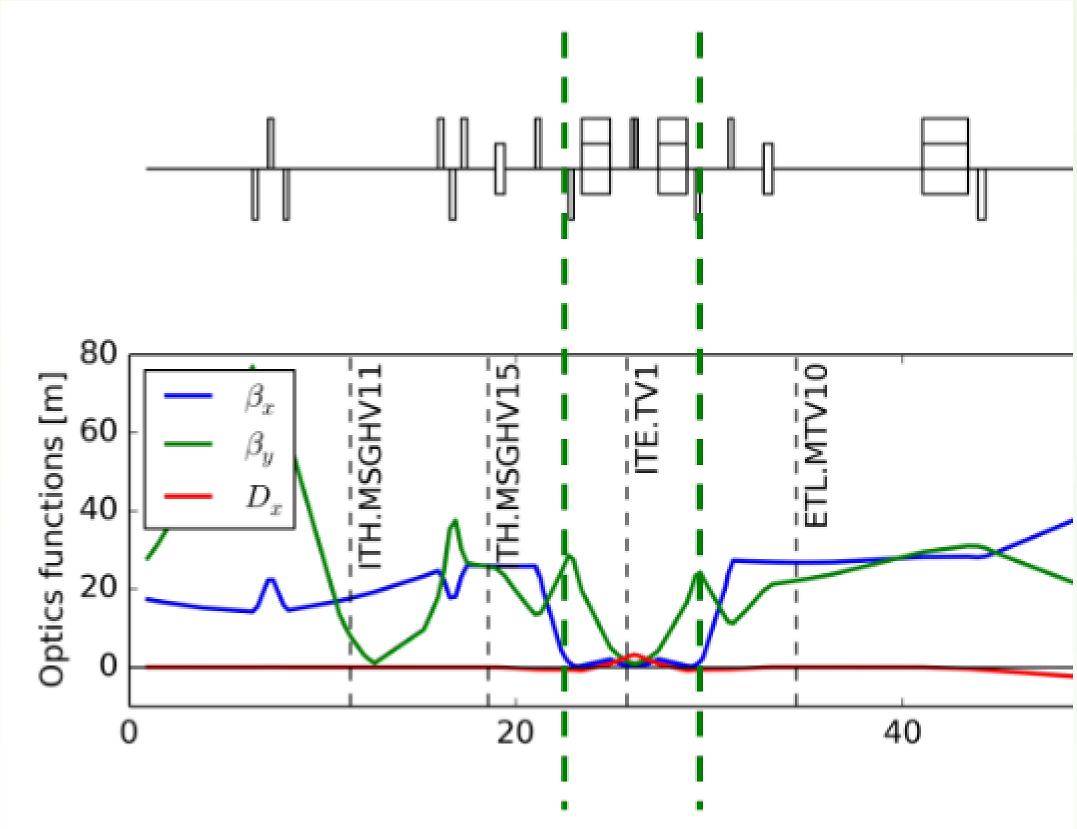


- 2 installed BPMs in the ITE line
- PU#1 after ITE.QDN02
- PU#2 before ITE.QDN04
- 7 more during YETS



- Electrostatic dual plane PUs
  (**sensitive to the charges in the PU volume**)
- Charge head amplifiers with Σ & Δ output
  current integrator 60Hz ... 1MHz
  Δ gain = 2 * Σ gain
- Electrode diameter ~190mm
- Pipe diameter ~ 145mm

Optic of the line



PU#1 PU#2

Matched optics in the line with initial conditions measured in November 2015

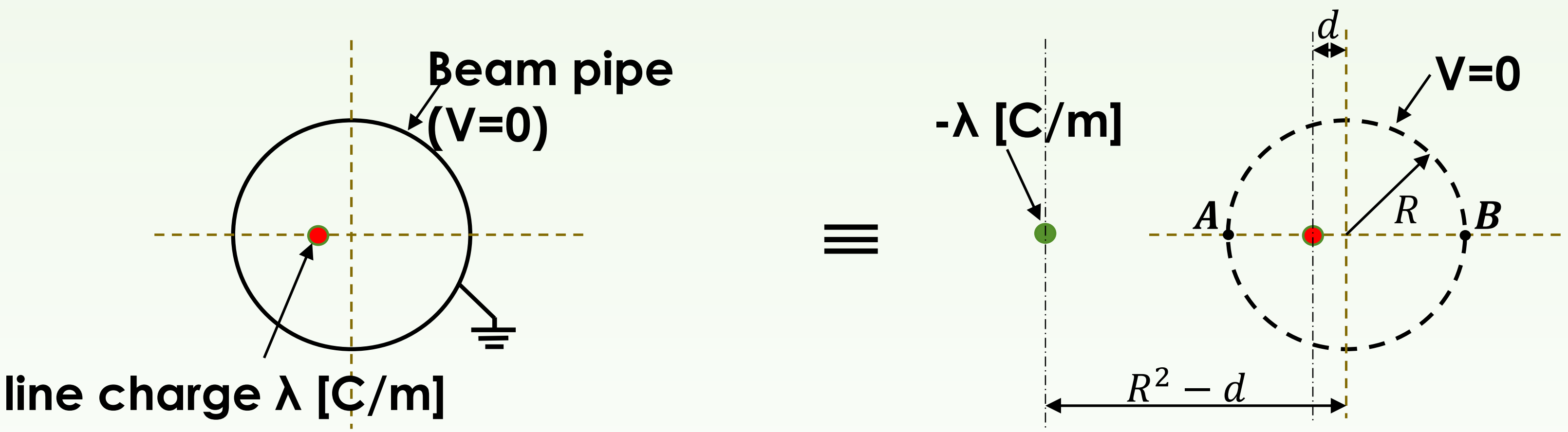
[EDMS: **LEI-BP-ES-0001]**

Position sensitivity

$d = S \cdot \frac{\Delta}{\Sigma}$ S (sensitivity)=51mm

Value obtained by bench measurement and EM simulation

Exercise: Verification of the BPM sensitivity (simplified model)



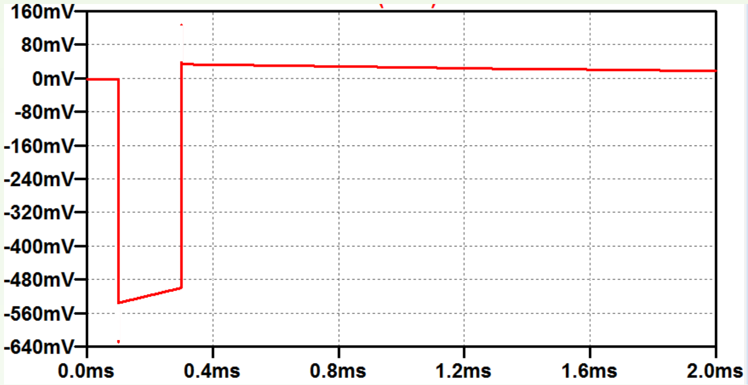
$$\begin{cases} \boldsymbol{E}(A) = \dfrac{\lambda}{2\pi\varepsilon_0}\left(\dfrac{1}{R-d} + \dfrac{1}{\frac{R^2}{d} - R}\right) \\ \boldsymbol{E}(B) = \dfrac{\lambda}{2\pi\varepsilon_0}\left(\dfrac{1}{R+d} - \dfrac{1}{\frac{R^2}{d} + R}\right) \end{cases}$$

with R=100mm & d=1mm

$$S = \frac{\Sigma}{\Delta} = \frac{E(A)+E(B)}{E(A)-E(B)} \cdot 1mm = 50mm$$

BPM signals

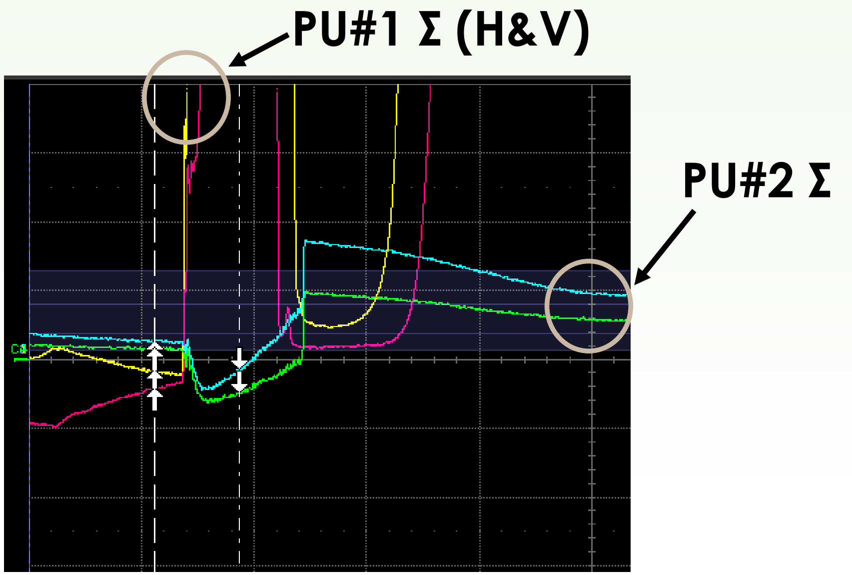
Ideal simulated response



Sum signal with a square 30uA current pulse. Slope due the low pass cutoff frequency of the amplifier.

- Electrodes get charged negative
- Slit aperture reduction and steering reduce the effect
- PU#1 more affected than PU#2

Real beam response

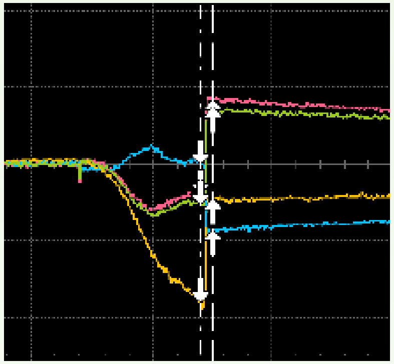


POSSIBLE REASONS

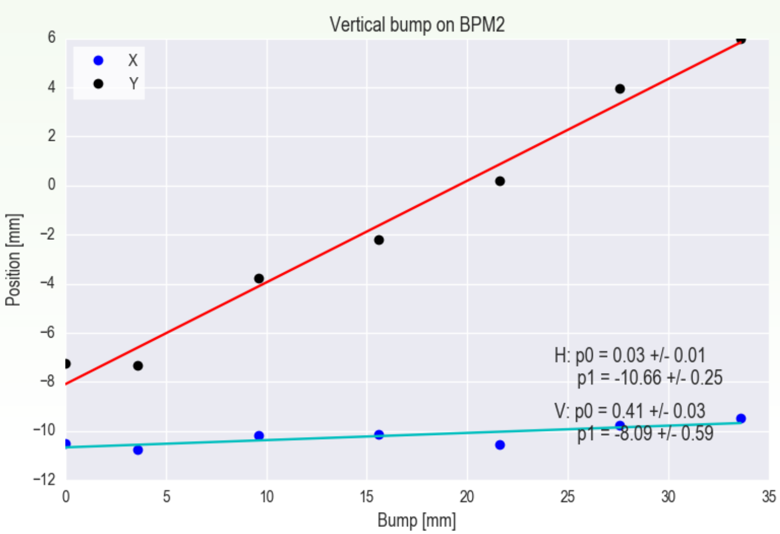
1. Vacuum pipe scraping
2. Residual gas ionization
3. Different charge states (beam measurement suggest < 0.1%)

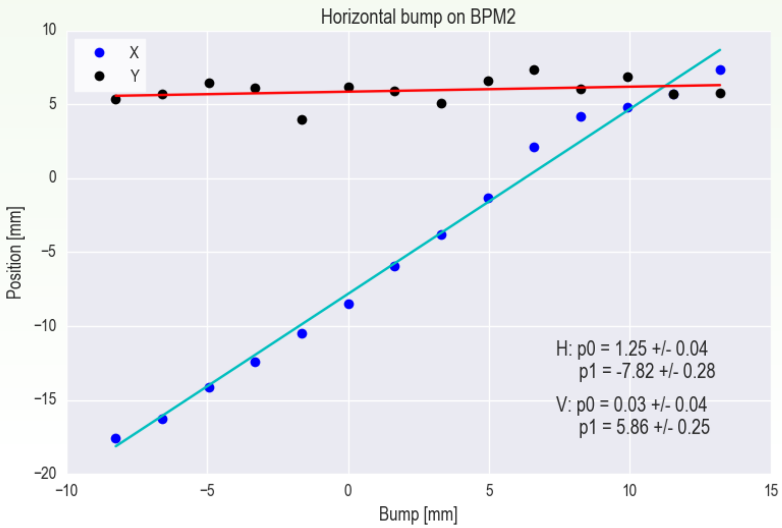
Position measurements before upgrade

(by BE/OP on 27/06)



- Even if signals are corrupted by charging effects we tried to measure the position at edge of the beam exploting the step of the trace due to the beam termination
- The relation between the programmed bump is linear but not 1:1



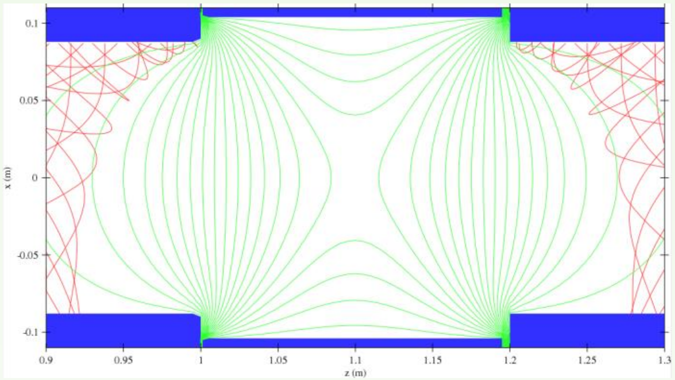


[from LEIR ElogBook]

Mitigating upgrades installed during TS2

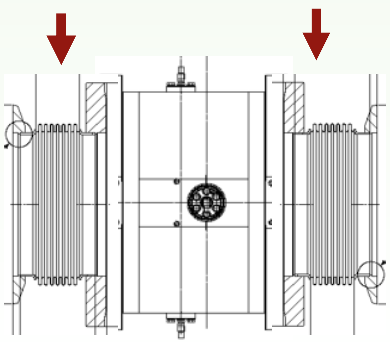
(simulations of R.Scrivens)

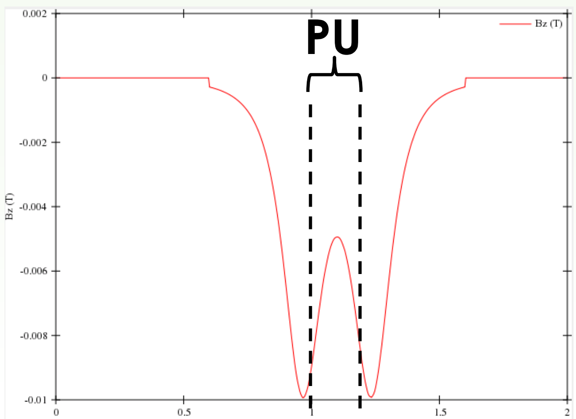
- DC bias voltage to all the electrodes (-50V ... +50V)

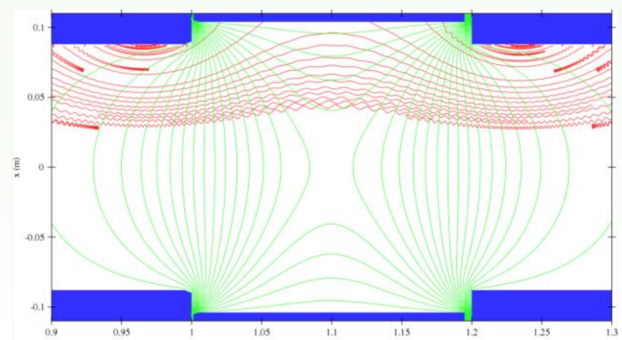


Electrons with energy below the bias voltage are repelled

- Quasi Helmholtz coil (100 turns) on the bellows → few mT @ 10A



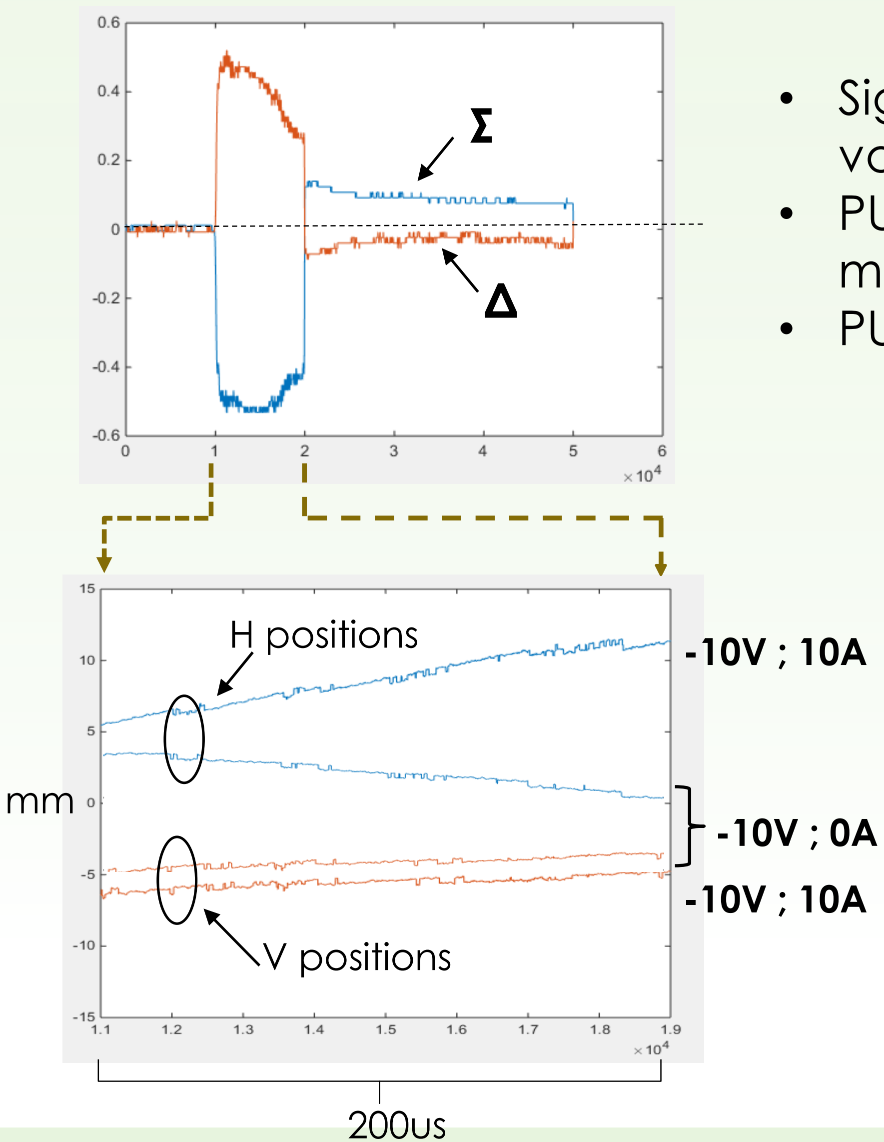




Depending on the energy and emission angle fraction of electrons are either repelled or transported over the PU

Upgrade effects on PU#1 (13/07 15h30)

-10V ; 10A

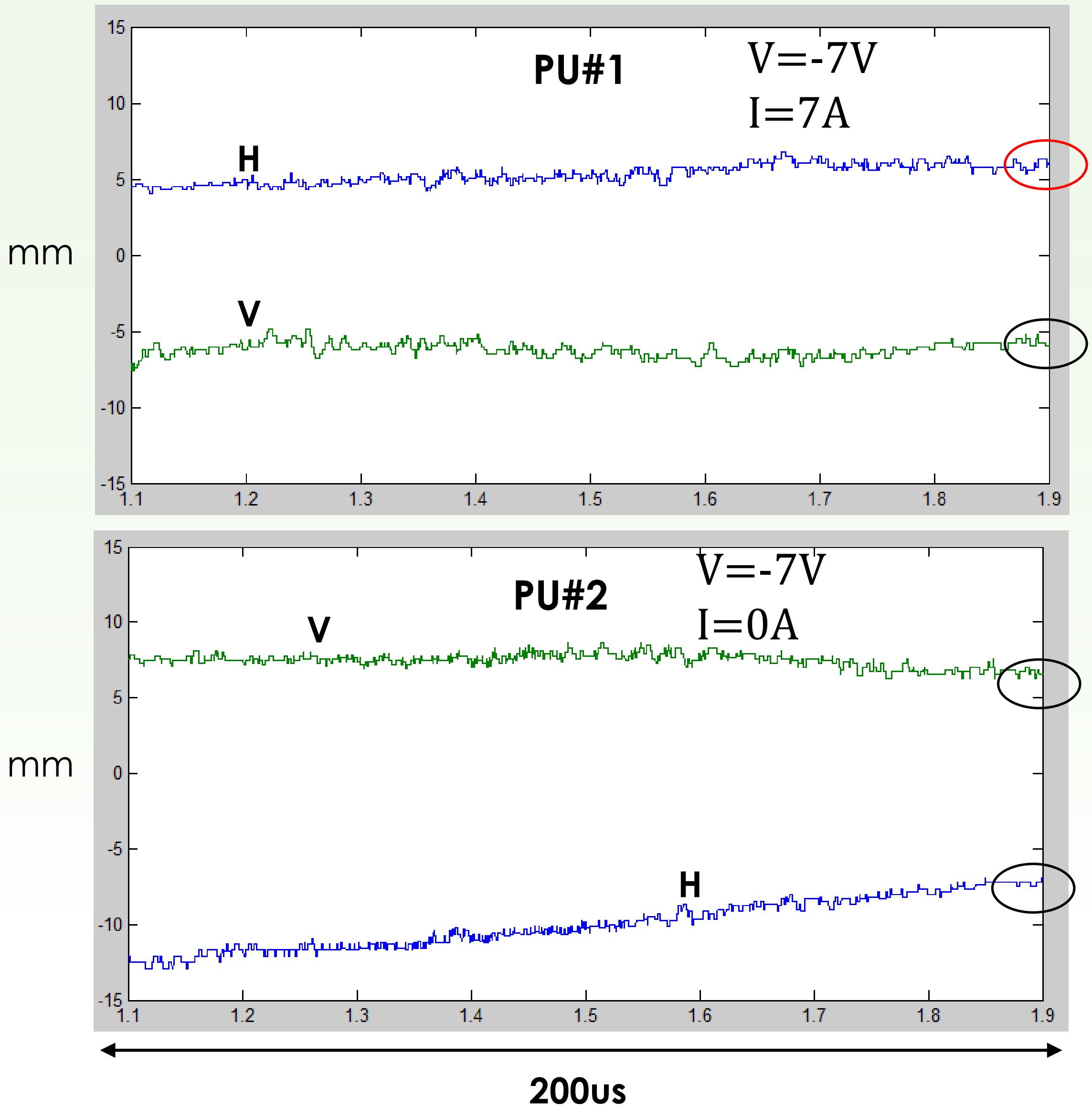


- Signals looks very much better after few volts applied (~3V)
- PU#1 is sensitive to both electric and magnetic fields
- PU#2 good with electric field only

Computed position for PU#1

- Depending on the presence of the magnetic field position H changes drastically

Position measurements (21/07 10h30)



EDGE POSITIONS

PU#1	H:	7.4	V:	-5.1
PU#2	H:	-7.0	V:	6.5

Summary

- PU#1 and PU#2 show different behaviour to the applied fields
- To be decided if we need solenoid for the others PU (challenging integration) and variable voltage (more cabling)
- First measurements showed a different position than the programmed bump (optic to be verified)
- At the moment we have 1 scope connected to each PU
- FESA class still under development (first deployment last week) to be completed and integrated into operation (YASP/application)
- Operational validation (Kick response, etc.)