LAL, CERN, IRFU, Kiev U

First trial with PHIL beam

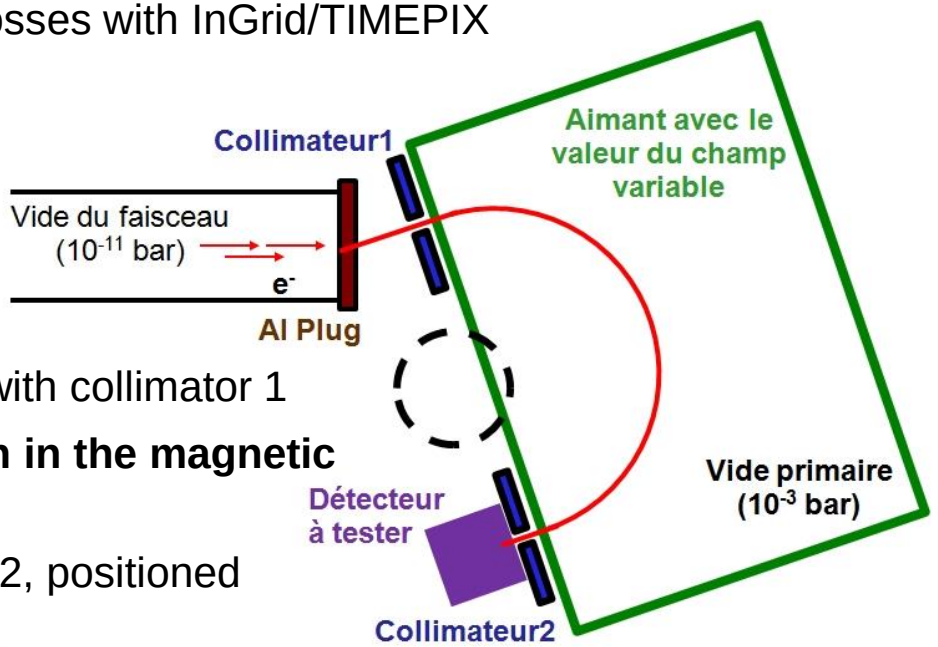
DEPACC meeting, 17.12.2014

Goal: deliver samples of electrons with adjustable energy (< 5 MeV) and intensity

- **Test Bench**
  - Gaseous detector tests, e.g. **Micromegas InGrid** performance tests, optimization of the protection layer (Generic R&D, Applications: ILC TPC with Micromegas/InGrid R/O option, CLIC TPC, CAST, … integrated (competence & facilities) in the RD51 program)
  - Studies of **crystal properties for UA9**
  - **FTOF**: particle ID and monitors using time-of-flight in DIRC
  - Measurements of scintillators (e.g. **SuperNEMO**)
  - Tests of **diamond sensors** (profile monitor, tracking, …)
  - Si tests for the ILC calorimeter
- **Physics:** e.g. non-relativistic electron energy losses with InGrid/TIMEPIX
- **Students' hands-on**

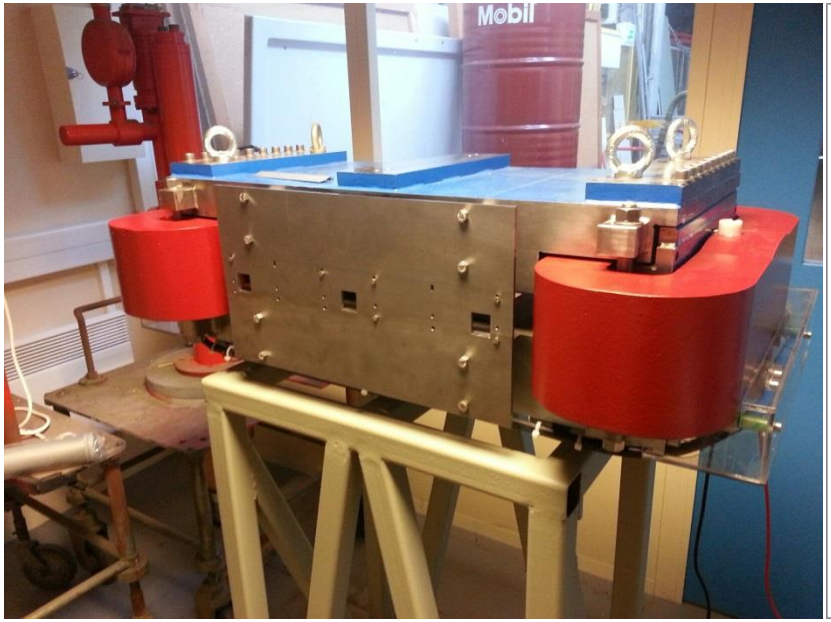
Setup principle

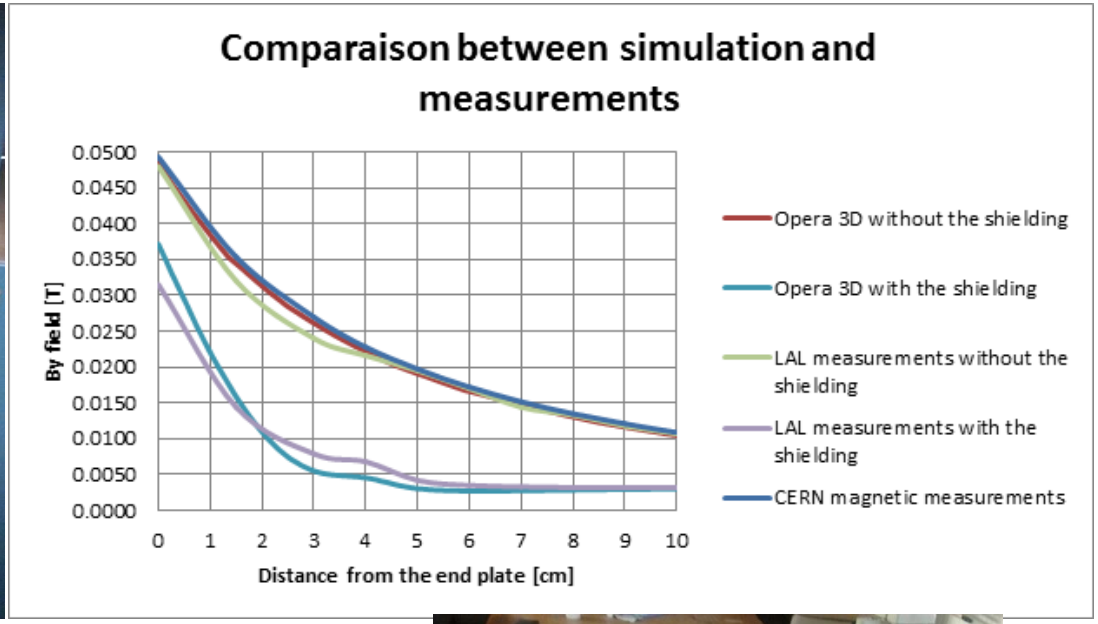
- Use electrons from PHIL, reduce energy/intensity using Al plug
- Select direction for electrons passing the plug with collimator 1
- Select required energy by **half-turn of electron in the magnetic field** (field value)
- Adjust intensity/energy spread using collimator 2, positioned in front of tested detector



- **Multiplicity** at high electron flux (~10^4 electrons ~1 fC): simulation; electron counting at low fluxes: InGrid to calibrate detector settings or count electrons on individual bunch basis

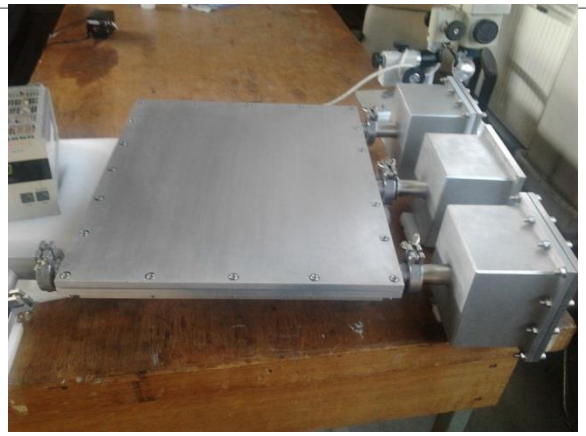
Dipole magnet produced at CERN (Roberto and Davide),
and delivered to LAL in April 2014





Supports for dipole and for collimator boxes/detector
(Marc et Co)

Vacuum chamber and collimation system produced in Kiev
(Oleg, Larisa, Vlad, Daniil, …)
and delivered to LAL



Shielding to reduce stray field

Filip adjusted the shielding in front of the dipole – merci !

Still remaining residual field …

→ Trajectories of the electrons in PHIL beam pipe modified (was clearly seen with YAG3 monitor). Additional beam steering was needed.

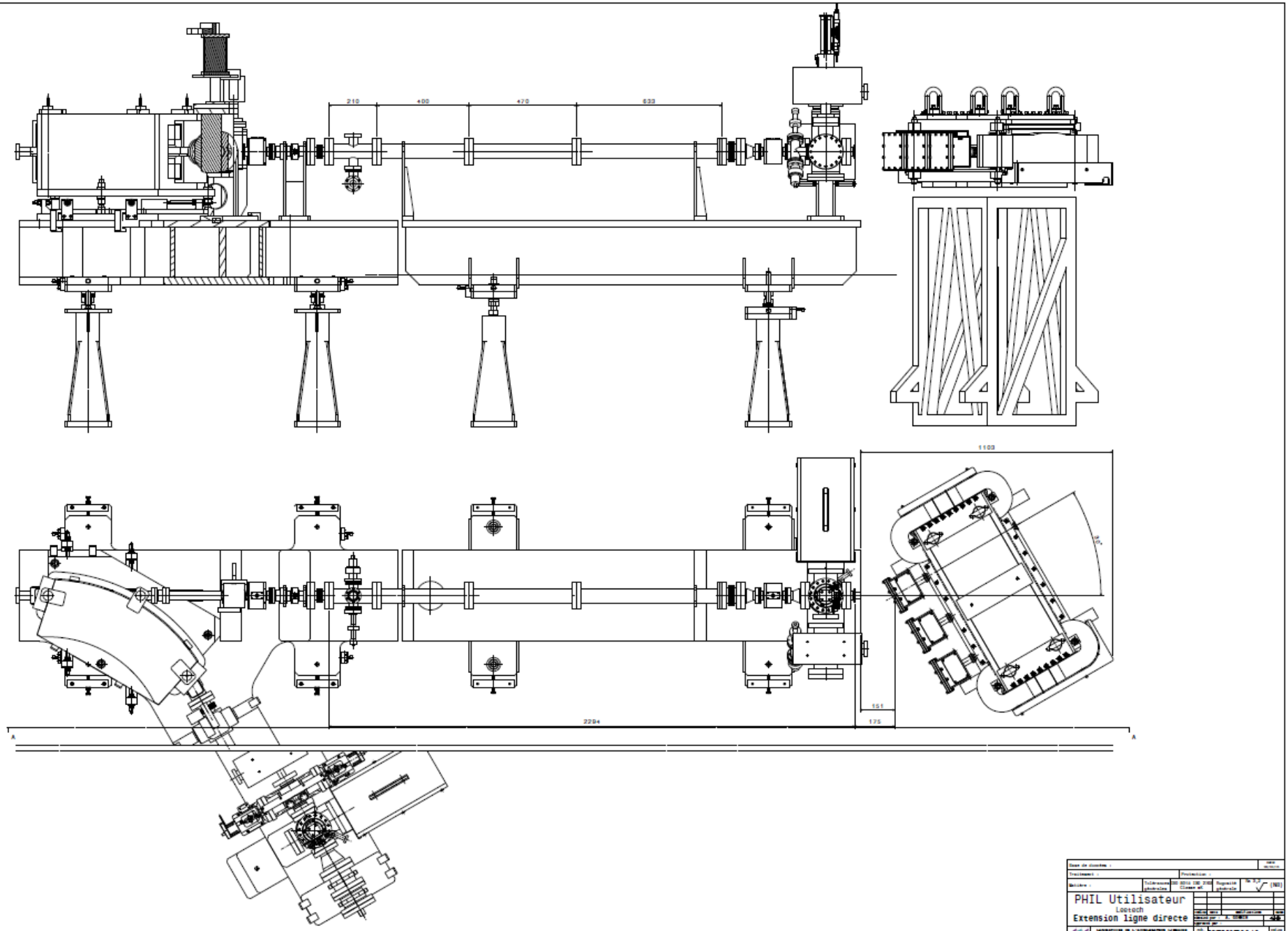
→ Scintillator coupled to large size PMT did not work as a detector.

(primary) Vacuum

Bruno et Christophe – merci !

With permanently operating pump, 2×10^{-4} vacuum
Remains below 10^{-3} for extra ~hour(s)

LEETECH integration (Alexandre)

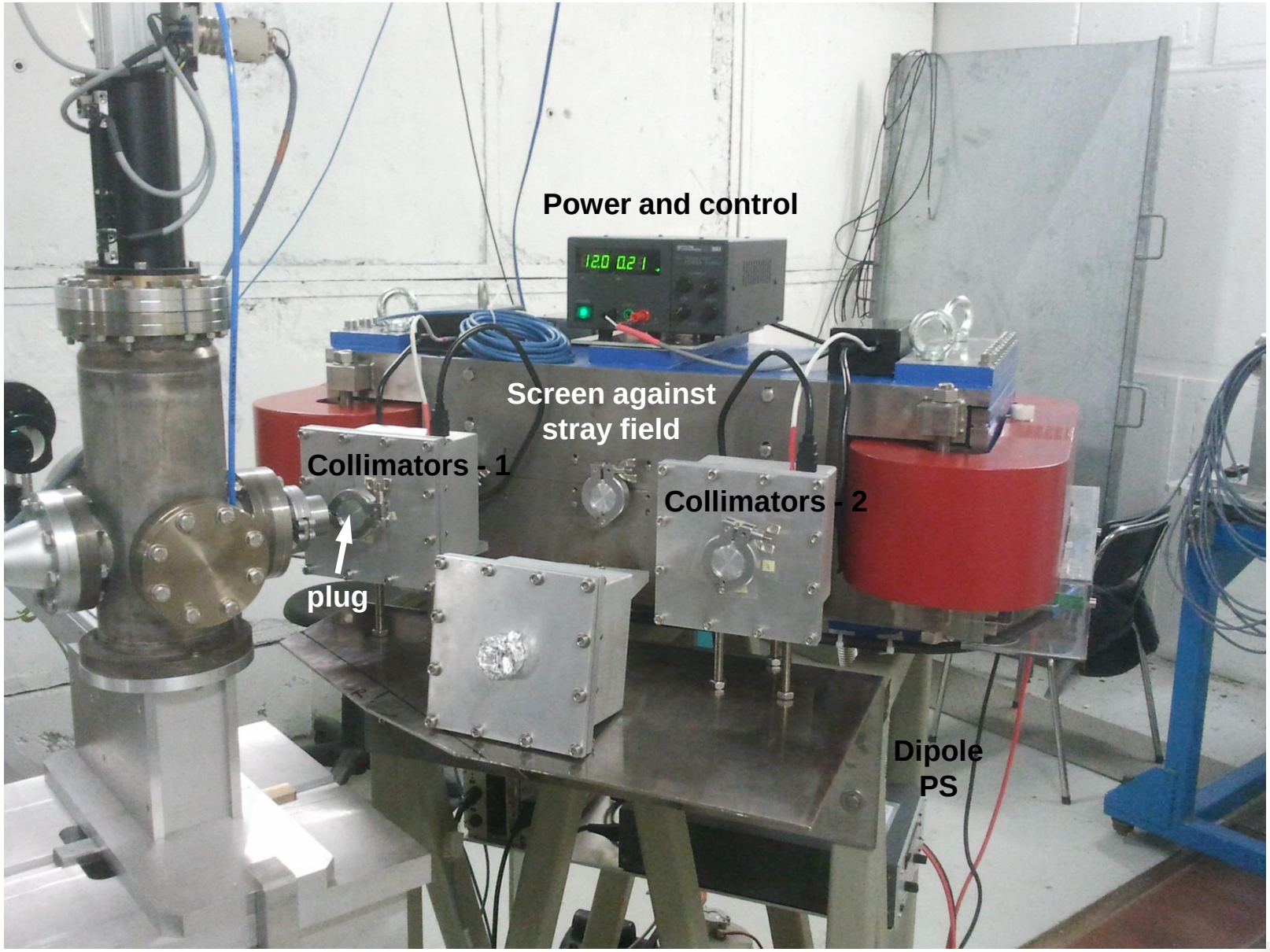


PHIL extention (Alexandre et Co)

- Installed by October 22
- No additional focusing !

LEETECH assembly

Remote control of collimators and magnetic field from the PHIL control room



Four days at PHIL, three days running

First electrons at the exit from LEETECH seen on November 5

Beam conditions optimized by PHIL experts
maximum charge or maximum energy (better solution)

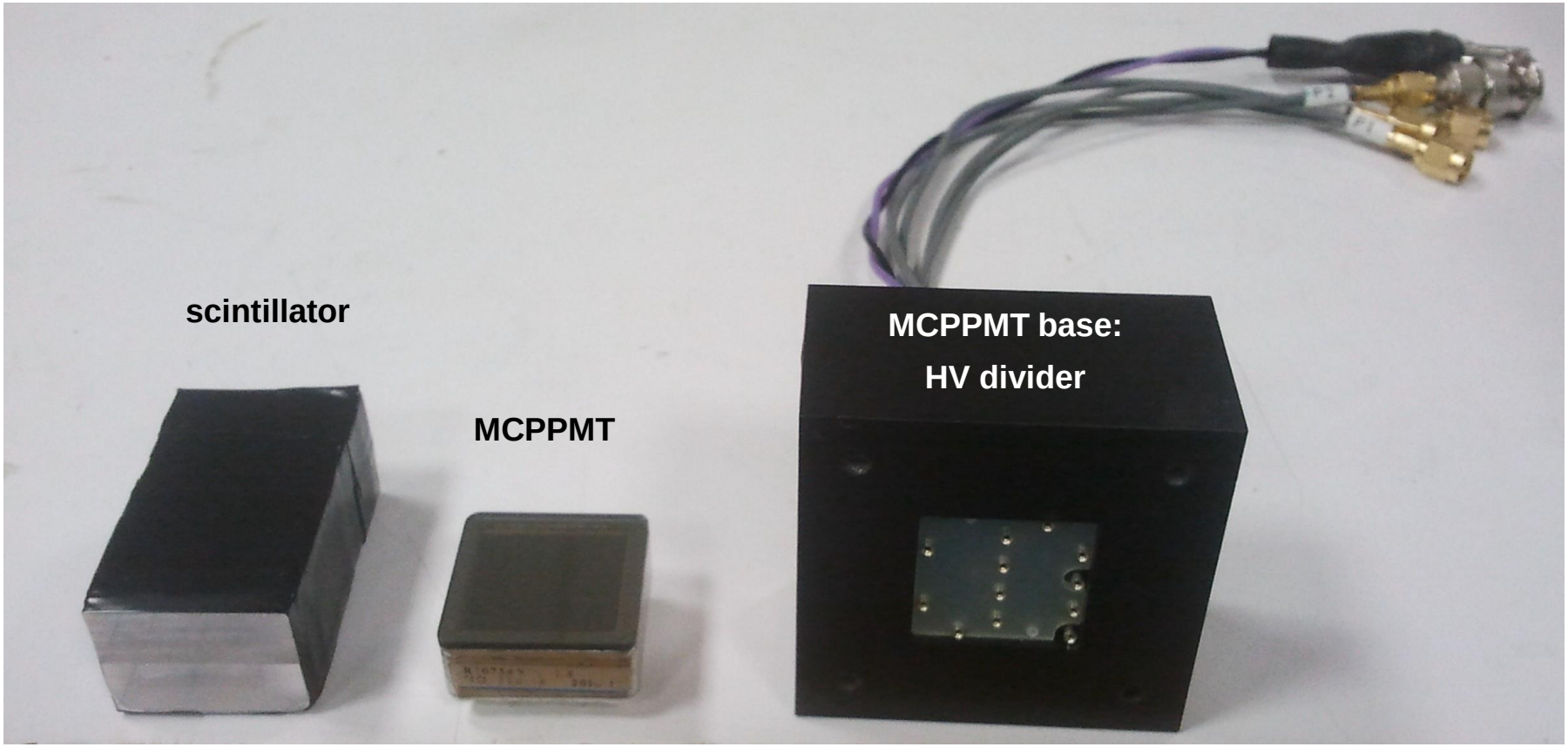
Energy 3.3 – 3.5 MeV

Charge 90 – 105 pC, variations with time by up to ~10% per hour

Many thanks to all staying with us to provide the beam !!!

Hugues, Jean-Noël, Noureddine, Pierre, Sophie, Viktor, Vincent, …

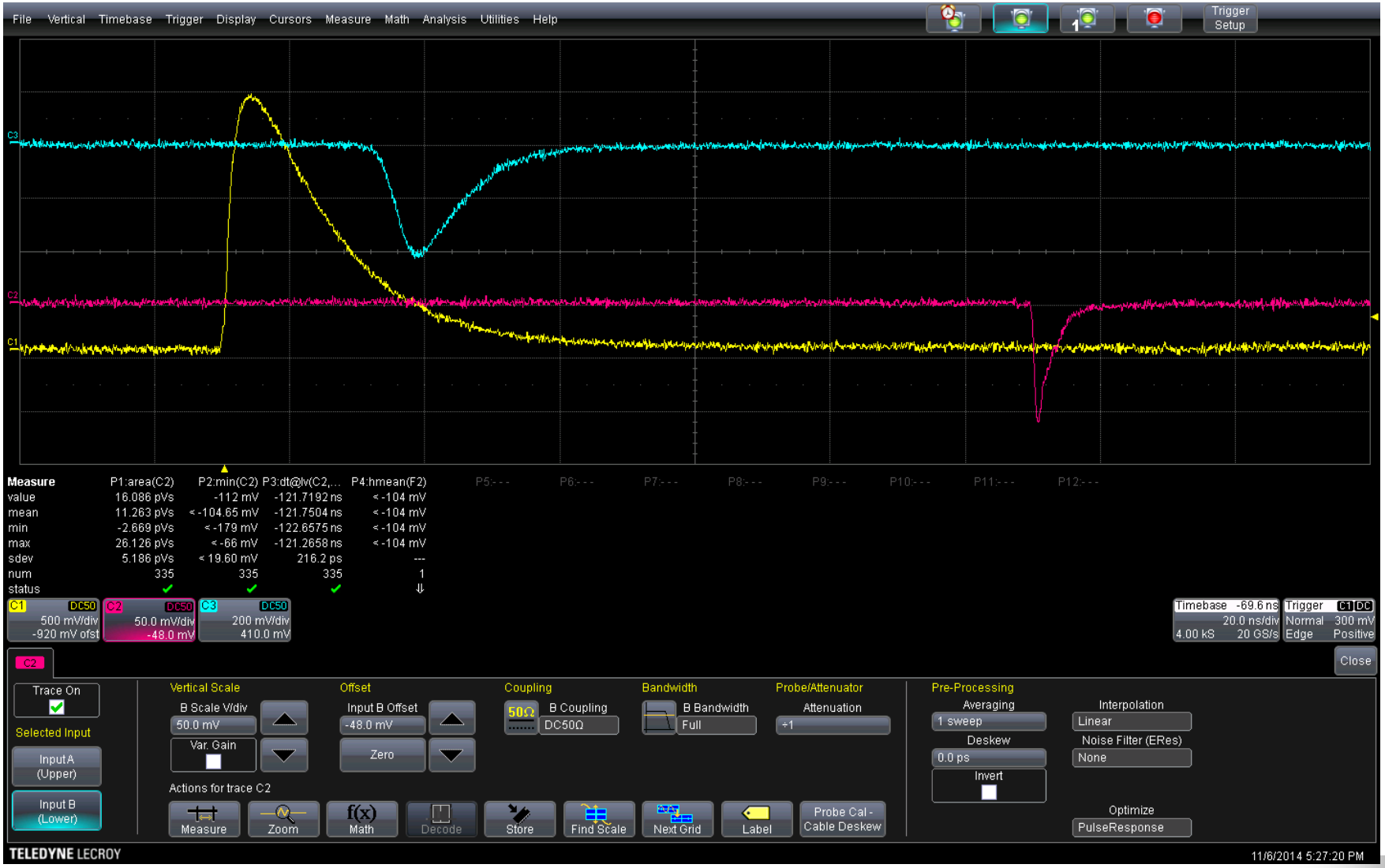
Detector: MCPPMT coupled to scintillator (Leonid)



Detector: MCPPMT coupled to scintillator (Leonid)

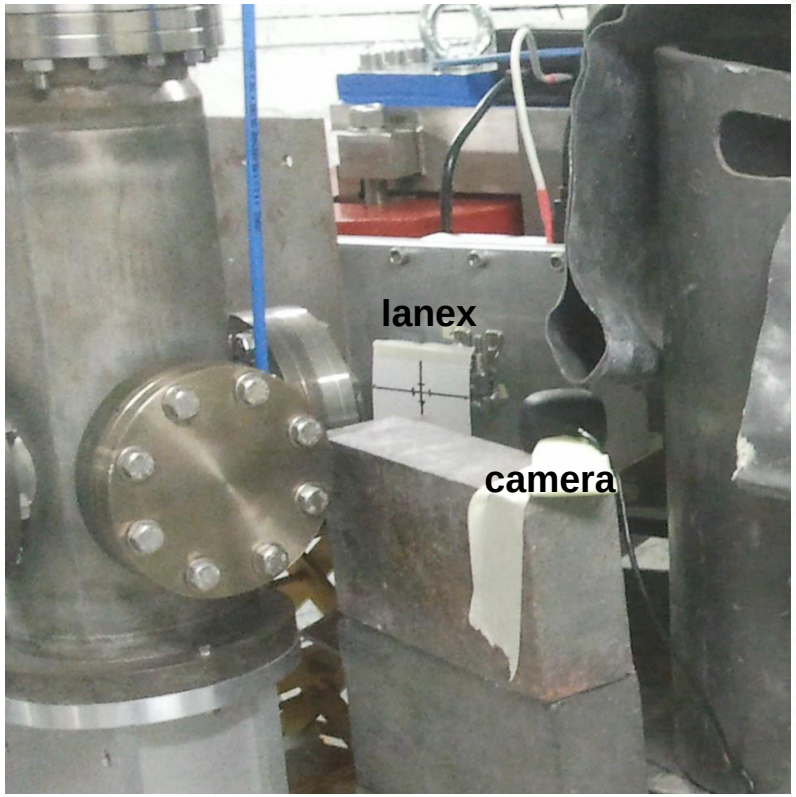
Last ~2 hours operated with the additional delay line at the R/O

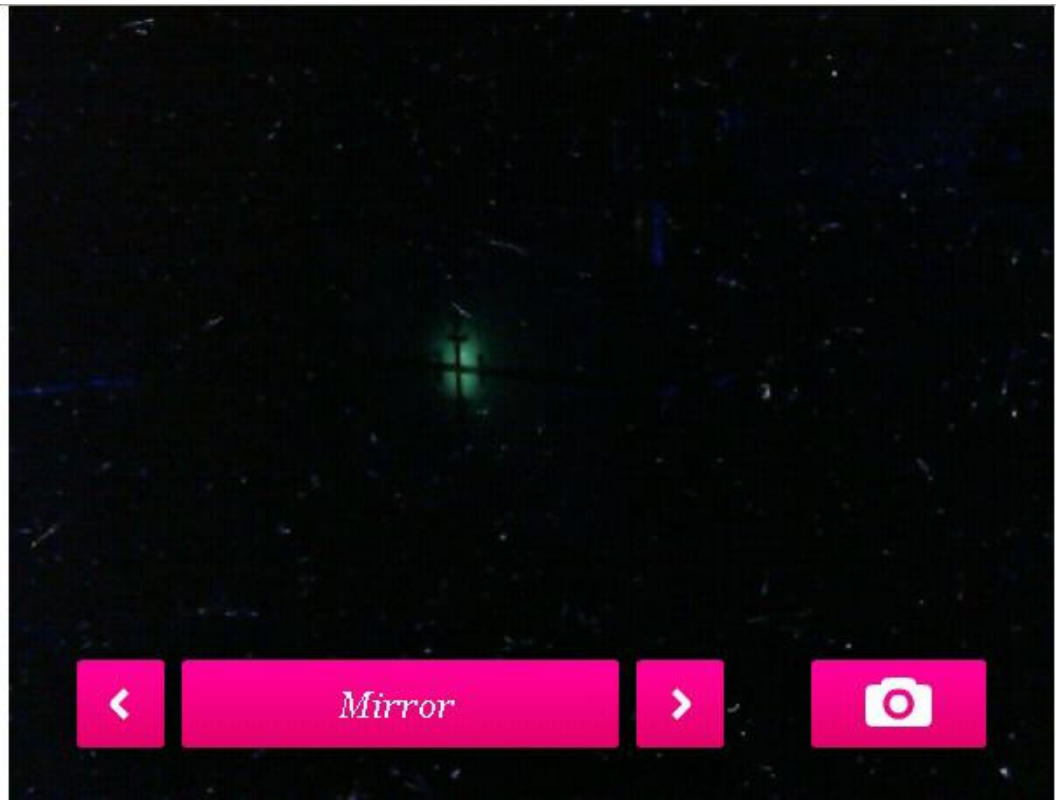
→ no oscillations, very clean signal



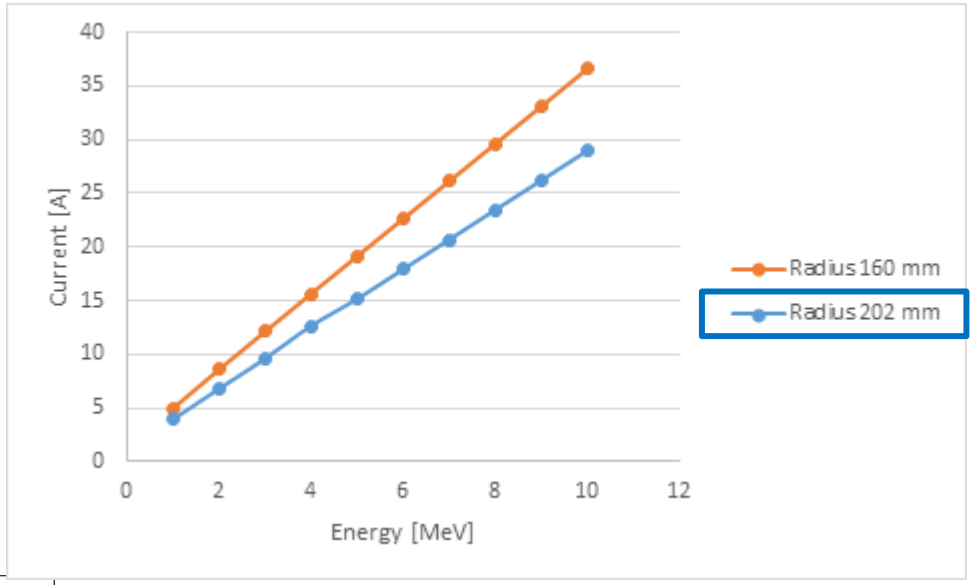
Visualization of the beam profile at the entrance of LEETECH:
Lanex fine luminescent film for beam spot monitoring

Merci, Hugues !

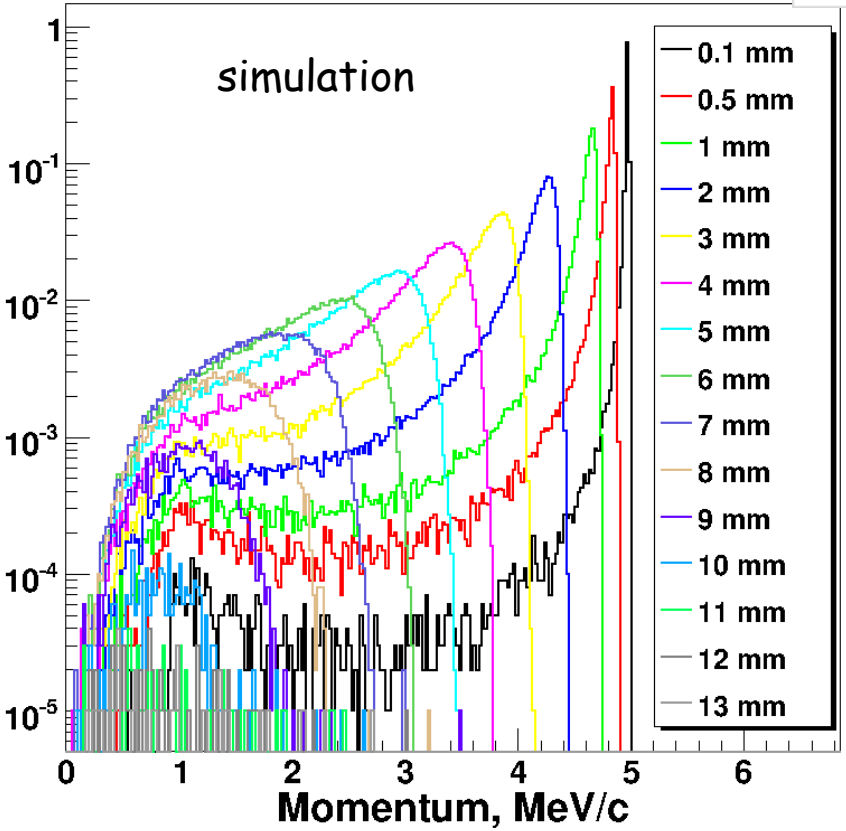




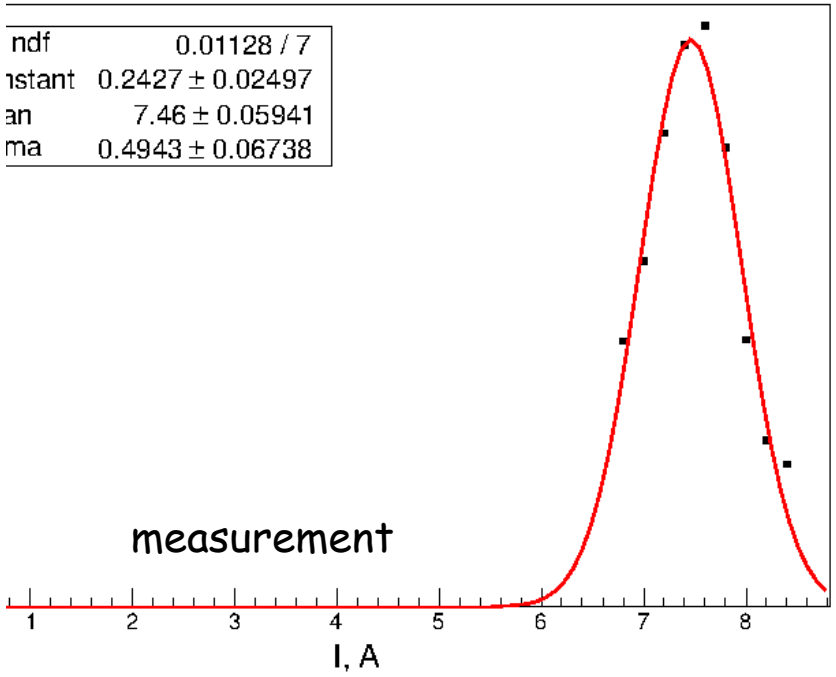
Momentum scan



Beam energy 5 MeV



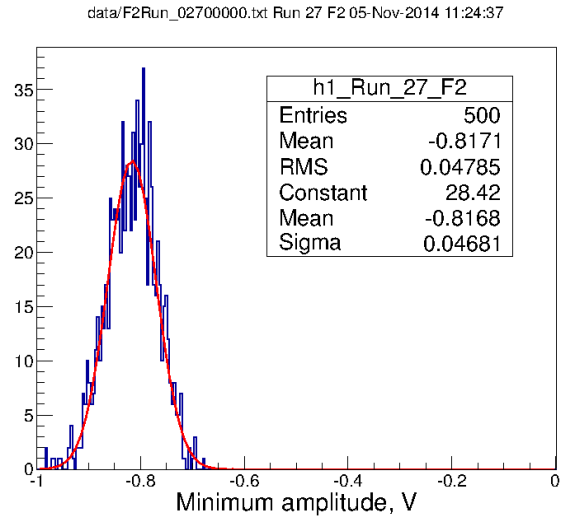
Beam energy ~3.5 MeV,
Al beam plug 1 mm



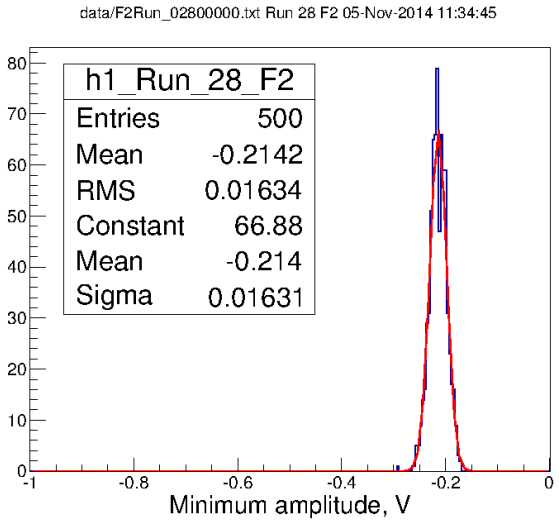
Signal counting: first essay

No shielding around detector yet

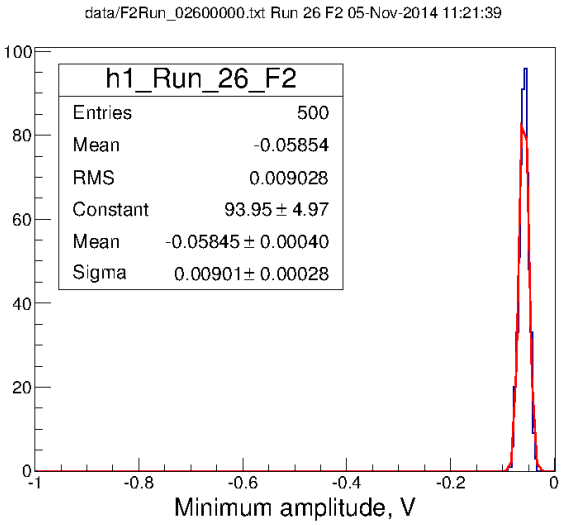
open collimators
at entrance and exit



3-5 mm gaps
at entrance and exit



closed collimators
at entrance and exit



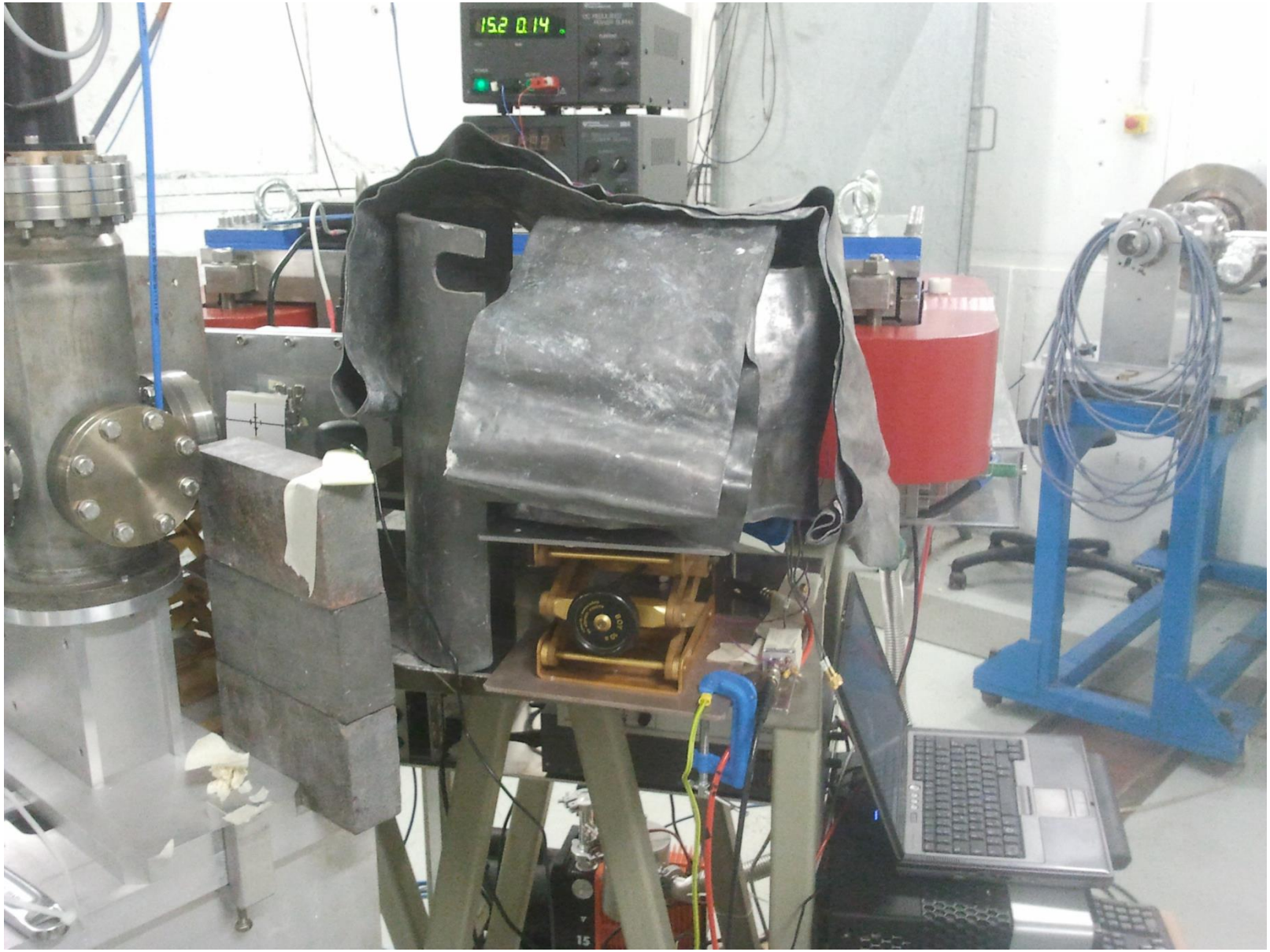
In principle possible to count the number of electrons neglecting beam-associated fluctuations …

… ~170 electrons at the exit for middle histogram

Using calibration of the detector with CORTO muons, collimator openings of ~1mm correspond to ~40 electrons at the exit

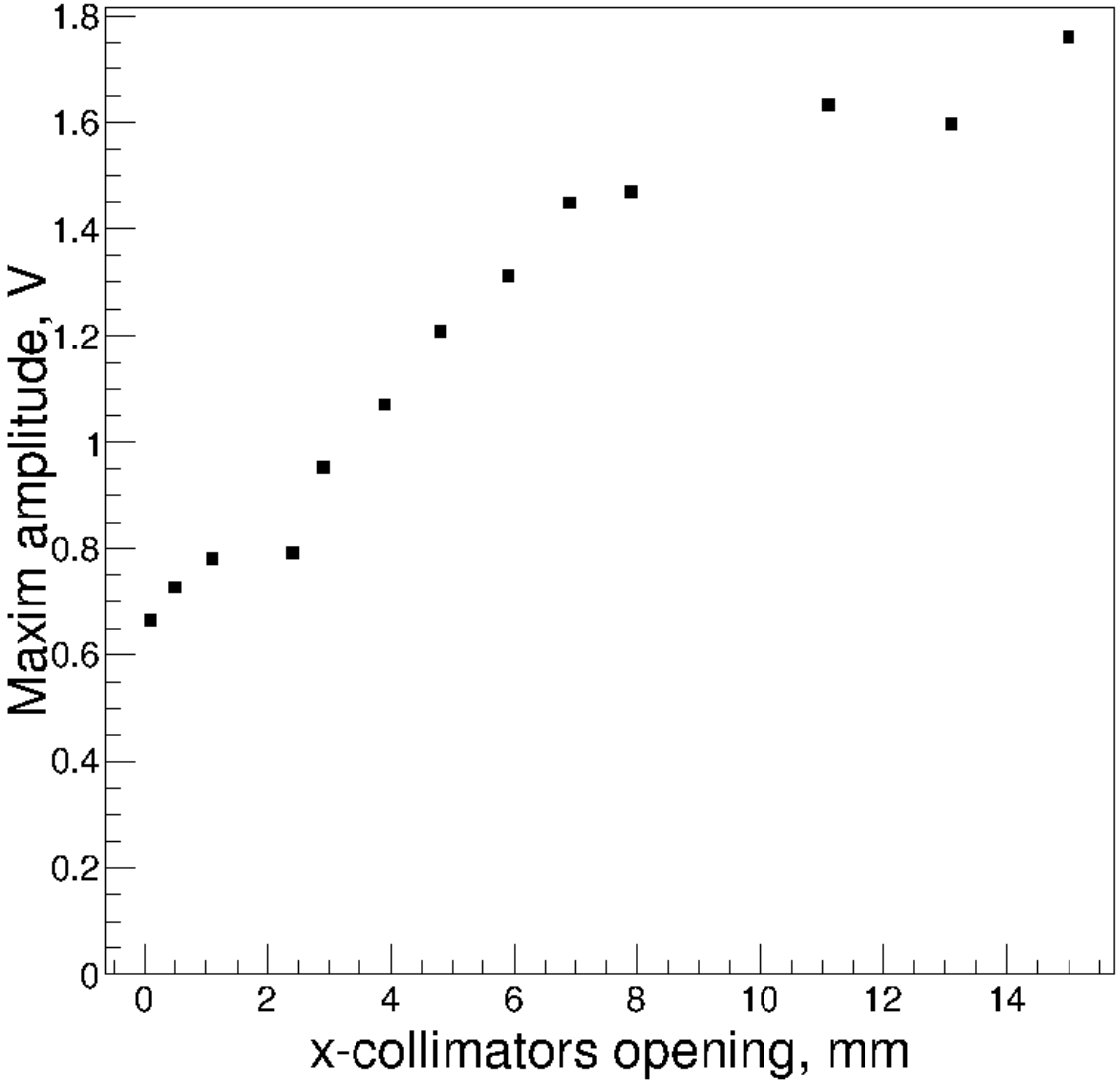
Beam associated background

(temporary version of) Lead shielding to suppress background in the hall



→ No signal in the detector with closed collimators !

Scan against collimator opening (x) at the exit



Summary

- With optimized shielding no background with closed collimators
- Indirect counting of electrons seems reasonable as a first attempt
- Means to reach "single electron" mode:
  - Counting with a dedicated detector, e.g. Ingrid or Sc+MCPPMT or … ;
  - Operation in "low statistics - stable" regime with no-signal in significant percentage of samples
- Future steps:
  - Repeat simulation with 3.5 MeV beam energy;
  - Large clean-up of collimator operation;
  - "Neat" shielding (background) around the detector;
  - Improve shielding (field) around the detector;
  - Production of a set of plugs with different thickness;
  - Installation of gas system
- Co-tutelle thesis (Vlad) at LAL from mid-January
- Hopefully more beam time at PHIL