Low Momentum Particle Detector at NA61/SHINE Experiment

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Outline

- **LMPD**
  - Physics objectives
  - Operation principle
- **Detector**
  - Prototype (2010)
  - “Jura” and “Saleve”
- **Measurements in downstream position**
  - 13 GeV
  - 158 GeV
- **Measurements in target position**

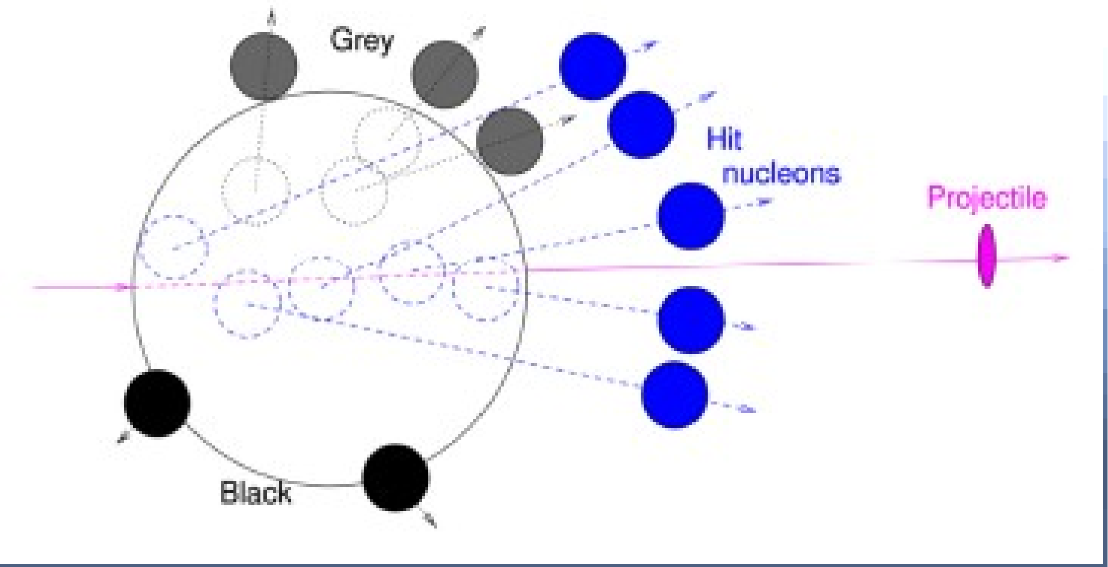
LMPD - *Physics objectives*

- ***h+A interactions:*** low momentum (“grey” region) particle measurement: energy and identification

  Number of these slow particles is sensitive to the centrality of the collision → *Centrality Detector*

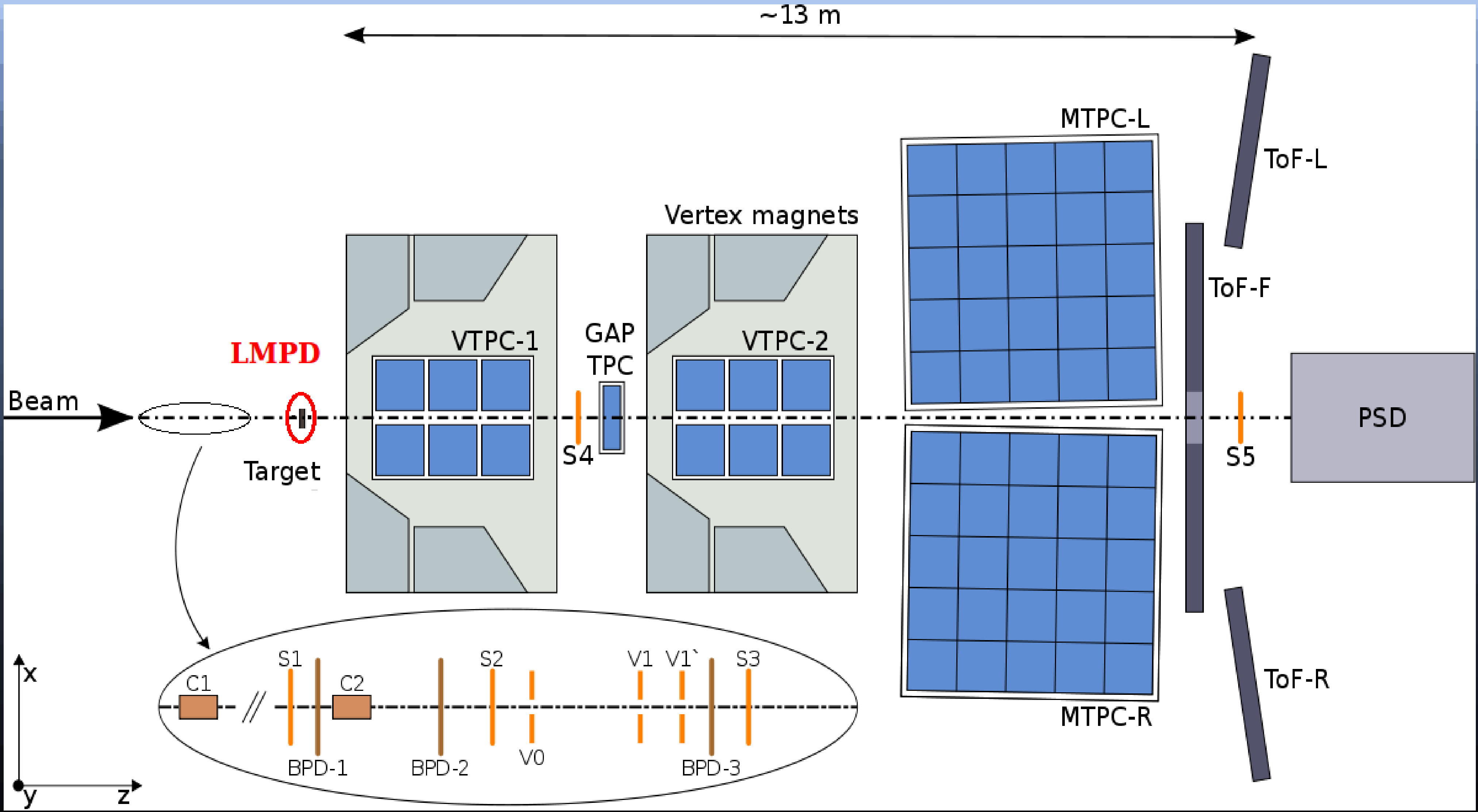
- ***A+A interactions:*** backward multiplicity (if it can work in high multiplicity environment)

Centrality of p+A collisions

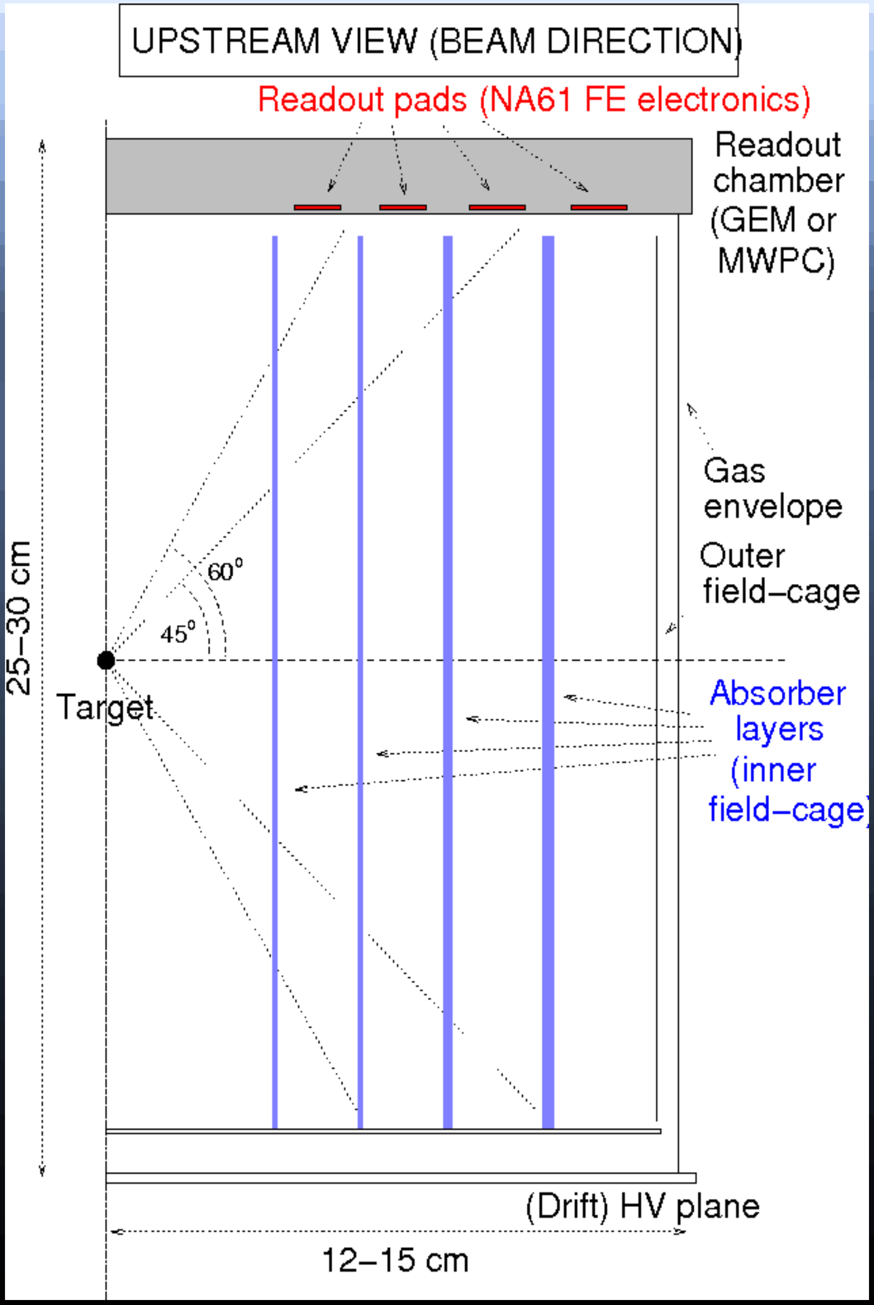


- Projectile (p, h) hits nucleons when passing through a nucleus (A)
- Some of hit nucleons can knock out other nucleons (“grey” protons)
- Centrality of collision is correlated to the number of slow nucleons (produced by the break-up of the nucleus)

LMPD at NA61

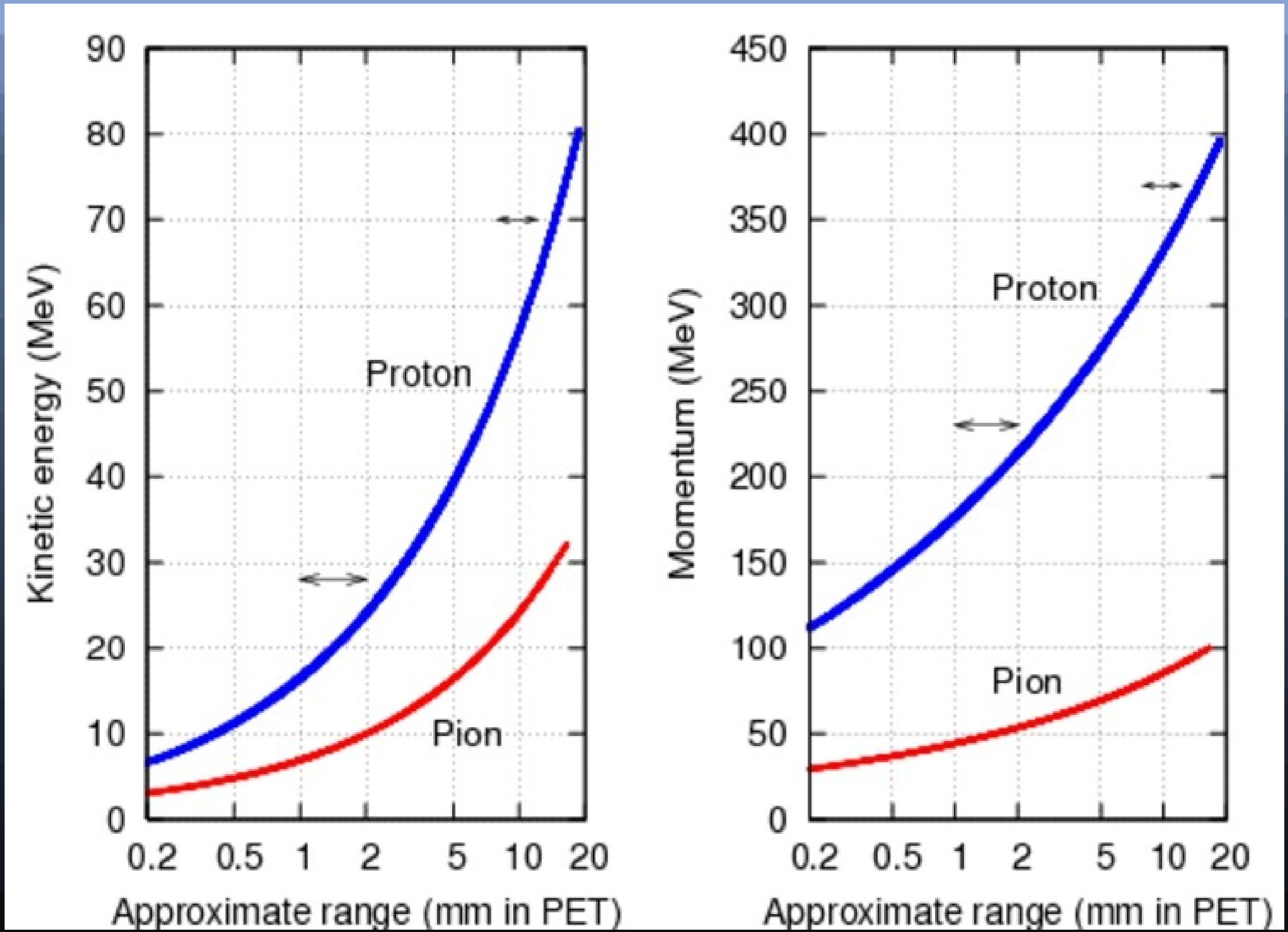

~13 m
MTPC-L
ToF-L
Vertex magnets
ToF-F
LMPD
VTPC-1
GAP
TPC
VTPC-2
Beam
S4
S5
PSD
Target
MTPC-R
ToF-R
x
C1
S1
C2
S2
V1
V1`
S3
BPD-1
BPD-2
V0
BPD-3
y
z

Construction outline: operation principle



- Time Projection Chamber
- Simultaneous measurement of dE/dx and range: energy and identification
- Intervals in particle range defined by absorber layers
- dE/dx measured over 1.2 cm in a small TPC (field cage printed on absorber)
- Electronics: same as NA61

Momentum (energy) – range relation

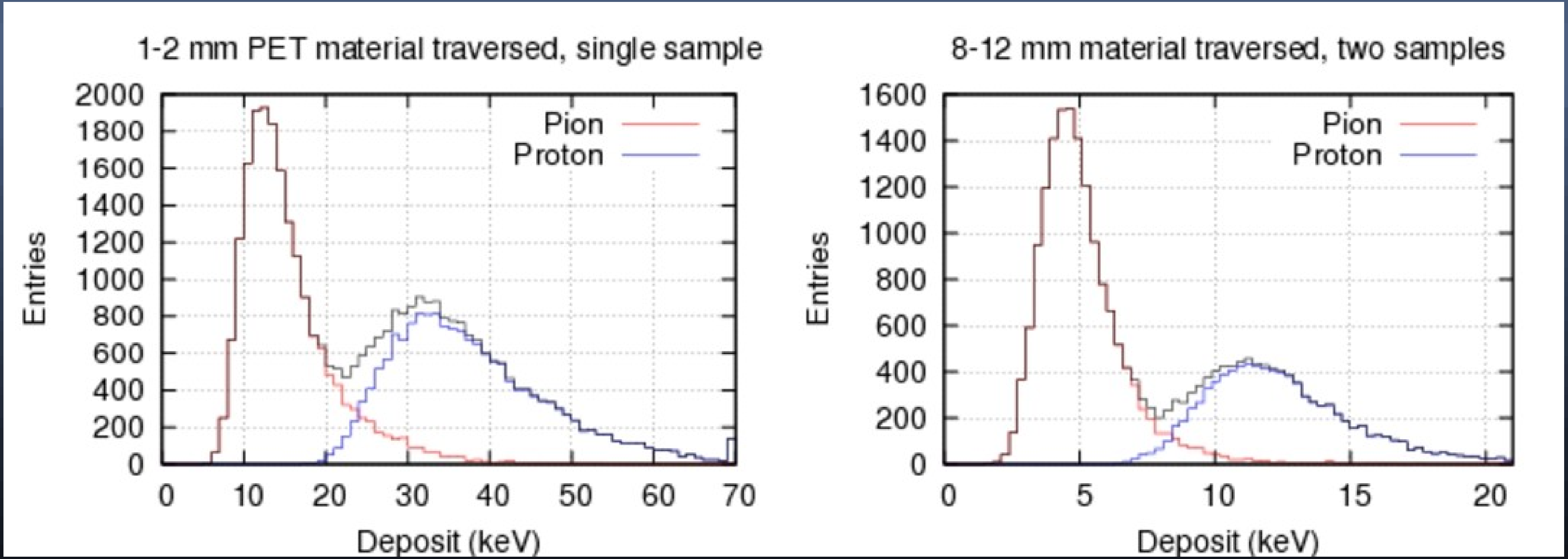


- Useful range: 0.2 – 6 mm in glass epoxi
- Minimal target thickness needed (0.5 mm Pb and 2 mm C was used)

Arrows indicate the ranges on figures on the next side

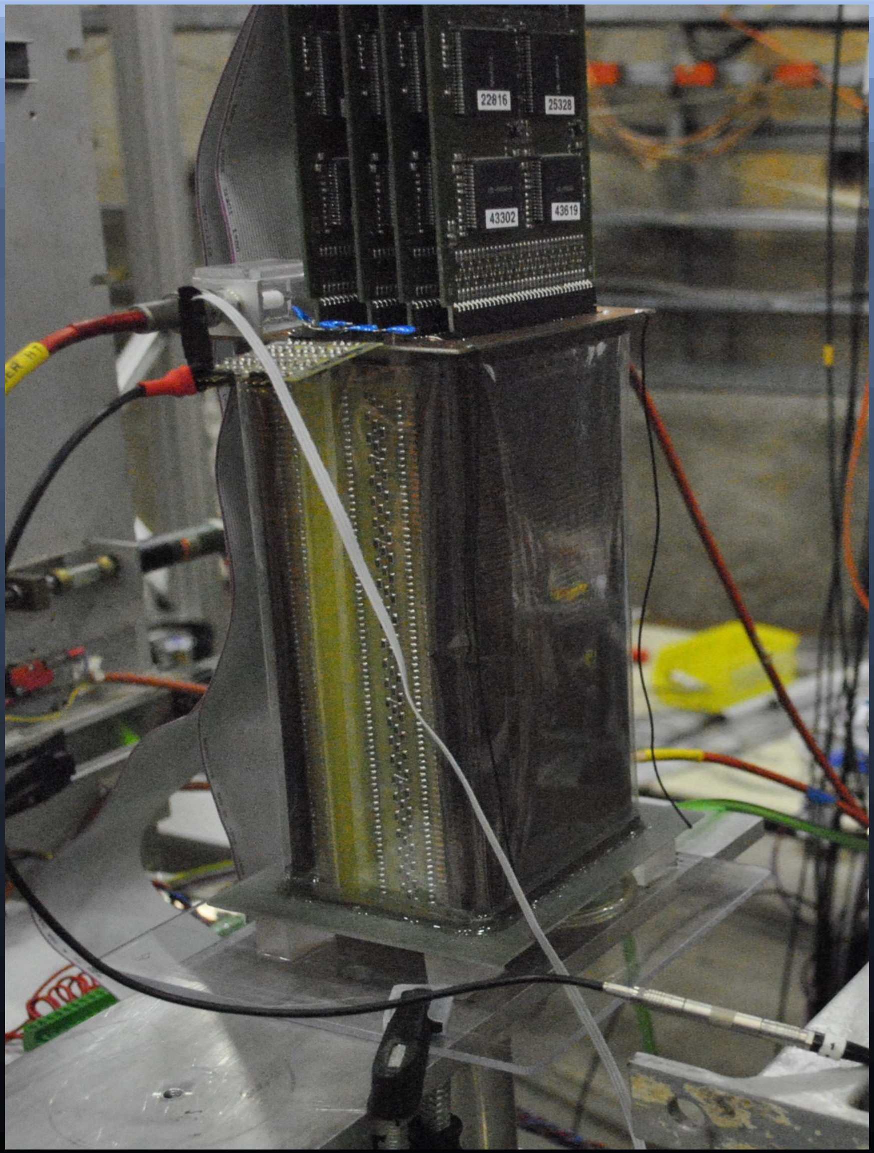
Operation principle: Simulation

- Fermi-model of ionization
- Deposit distribution in range intervals:



Expectation: clearly identified proton (and pion) peak

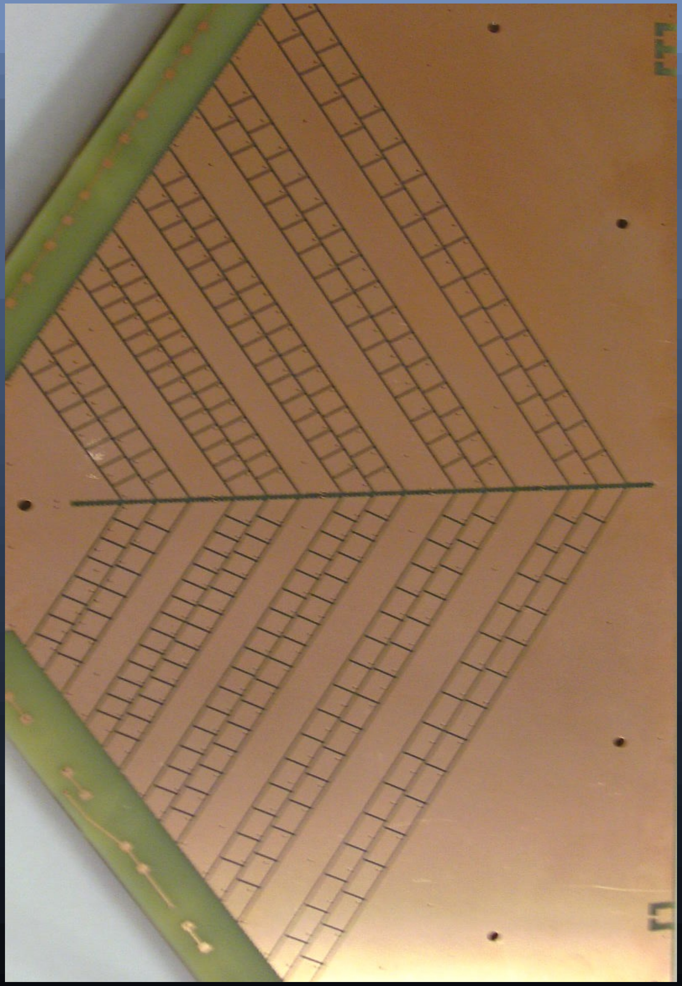
LMPD Prototype (2010)

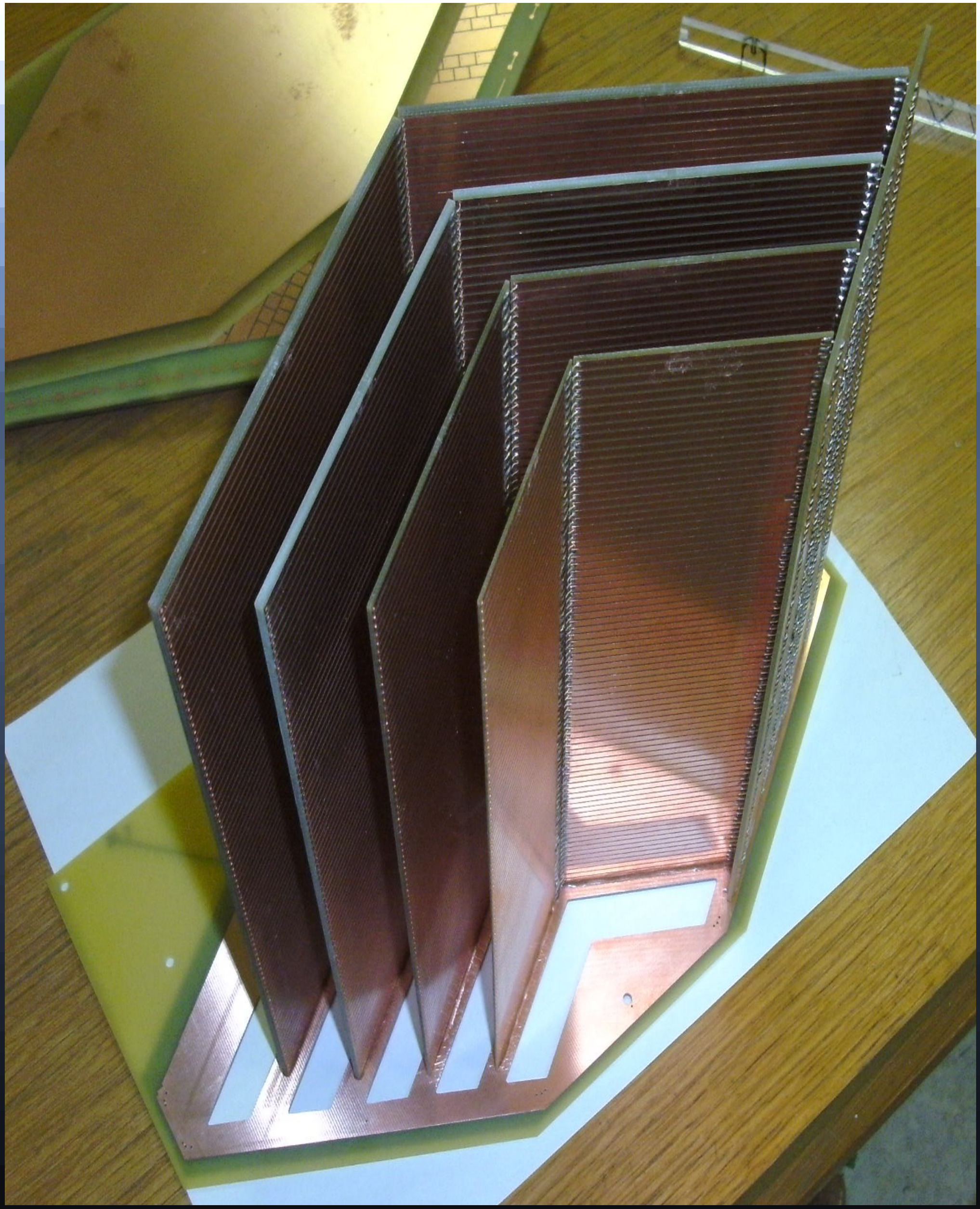


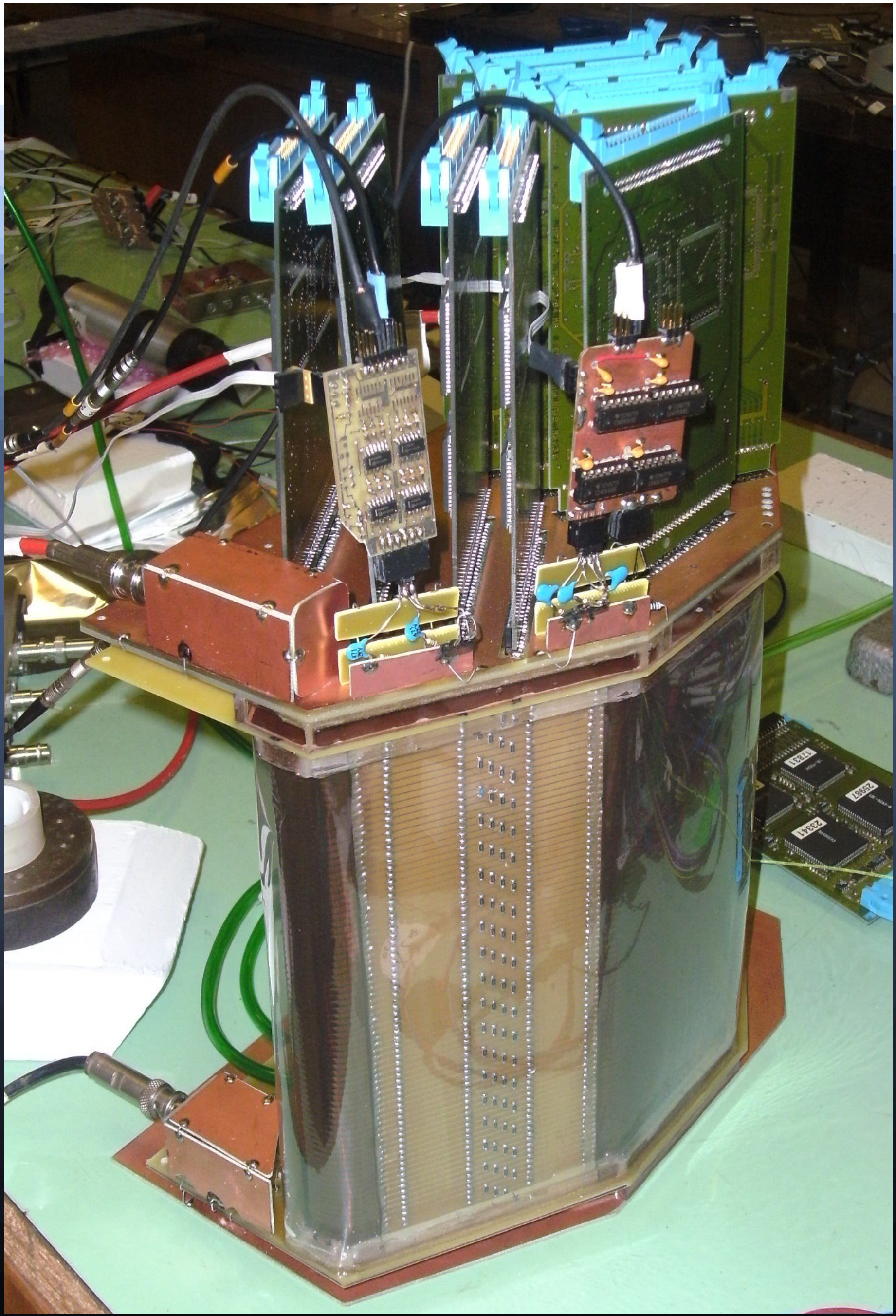
- Readout technology: MWPC
- 8 detection layers, 16 pads in each row
- 3 absorber layers (0.5, 1 and 2 mm thick)
- Outer field-cage: 60 micron Kapton, printed with 5 micron Cu strips
- Inner field-cage: printed on absorbers
- Conclusion: prototype construction fully satisfactory

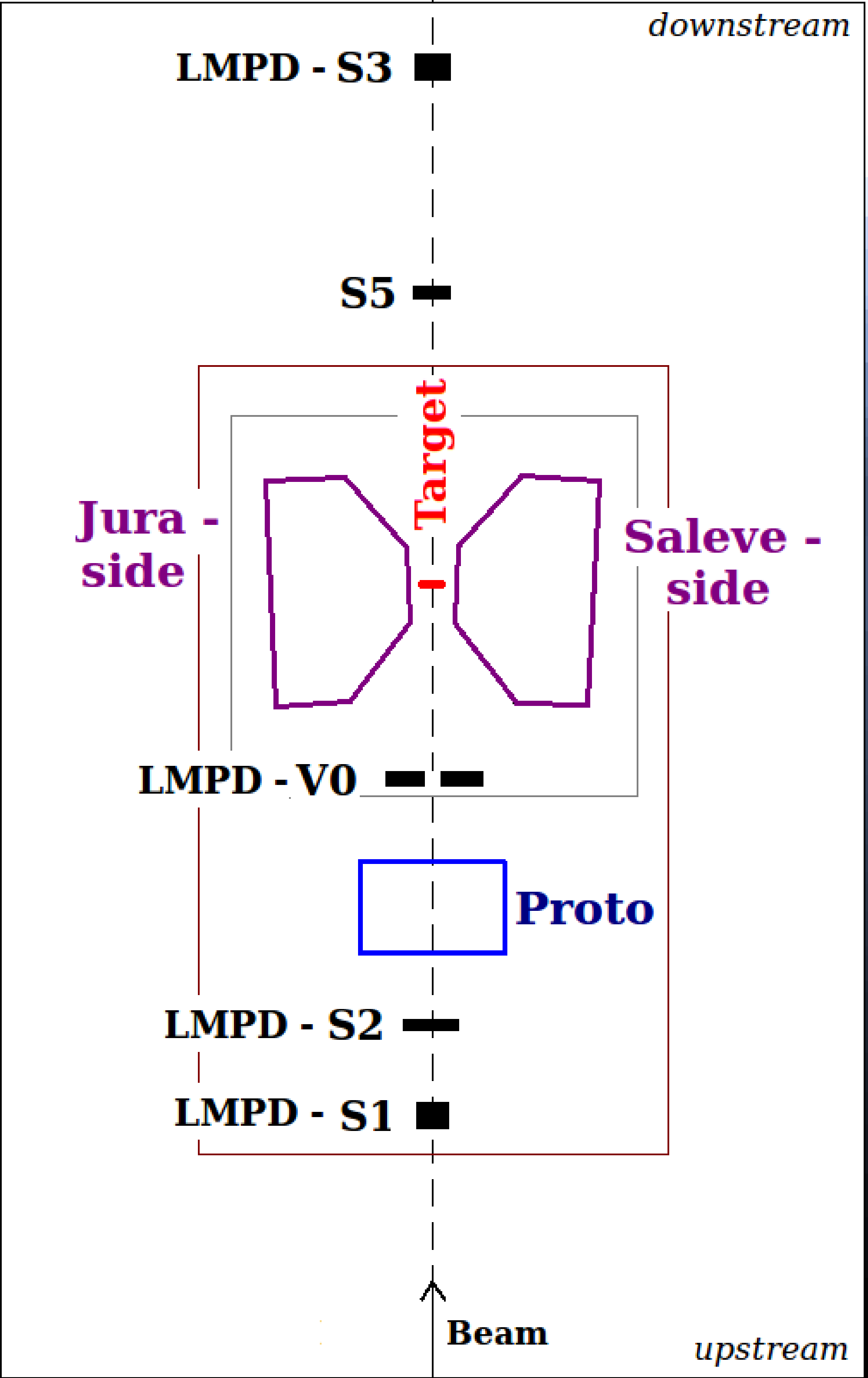
LMPD - “Jura” and “Saleve”

- Radial pad-structure
- 10 detection layers, 4 absorber layers, 2x2 wedges
- The gain is far below the “normal” TPC gain due to high ionization: gating grid is not necessary
- Gradually increasing gain towards outer pad-rows: following decreasing ionization due to increasing range







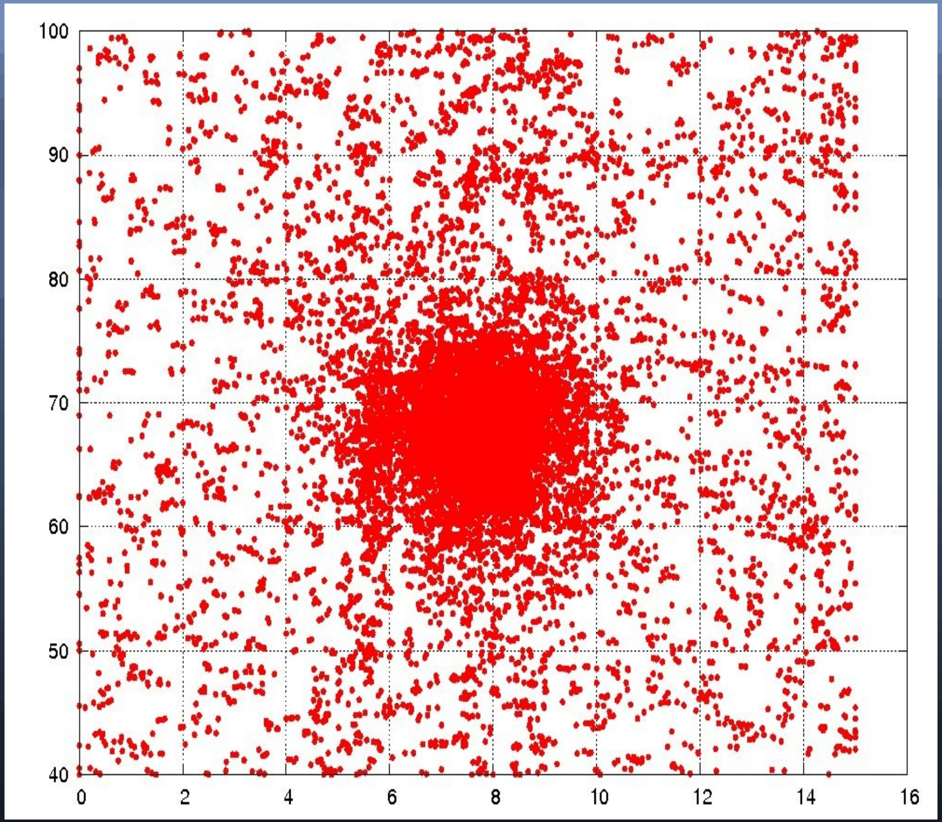


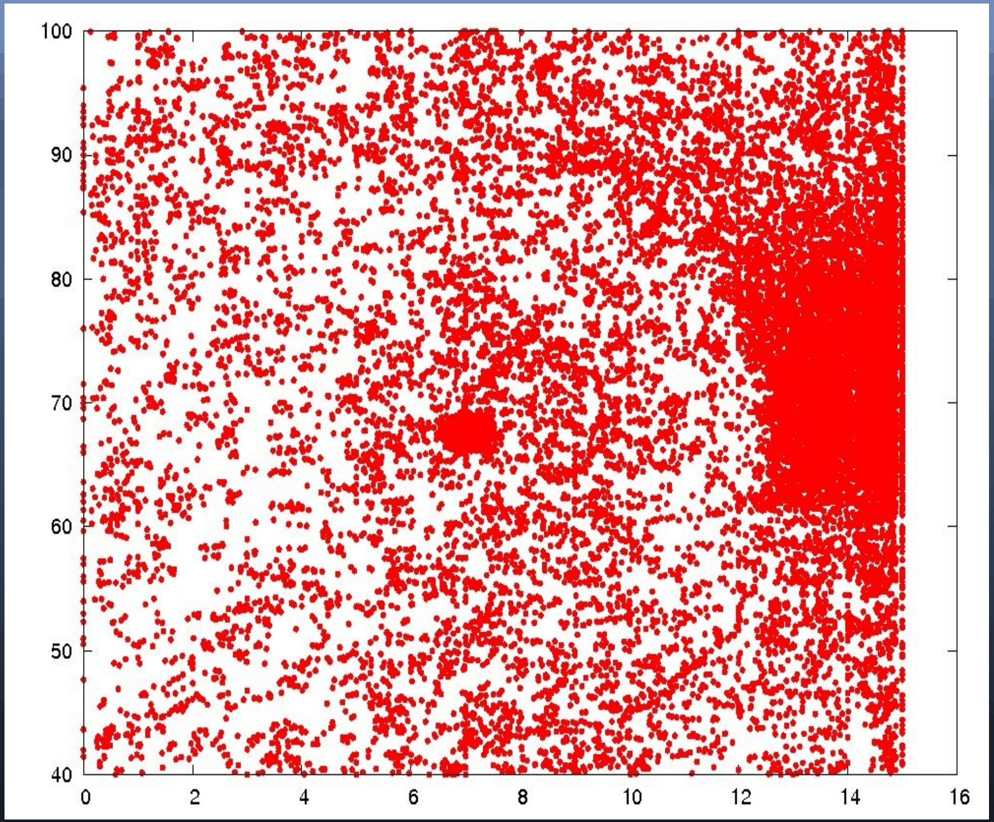
Measurements at 13 GeV/c

- Different setups, different triggers
- Target: “alignment target”, 1mm Pb
- Prototype ~ Beam Position Detector
- Alignment measurements
- Due to very broad beam spot, physics quality data was not taken

Beam profile with LMPD Proto → 2 cm beam spot

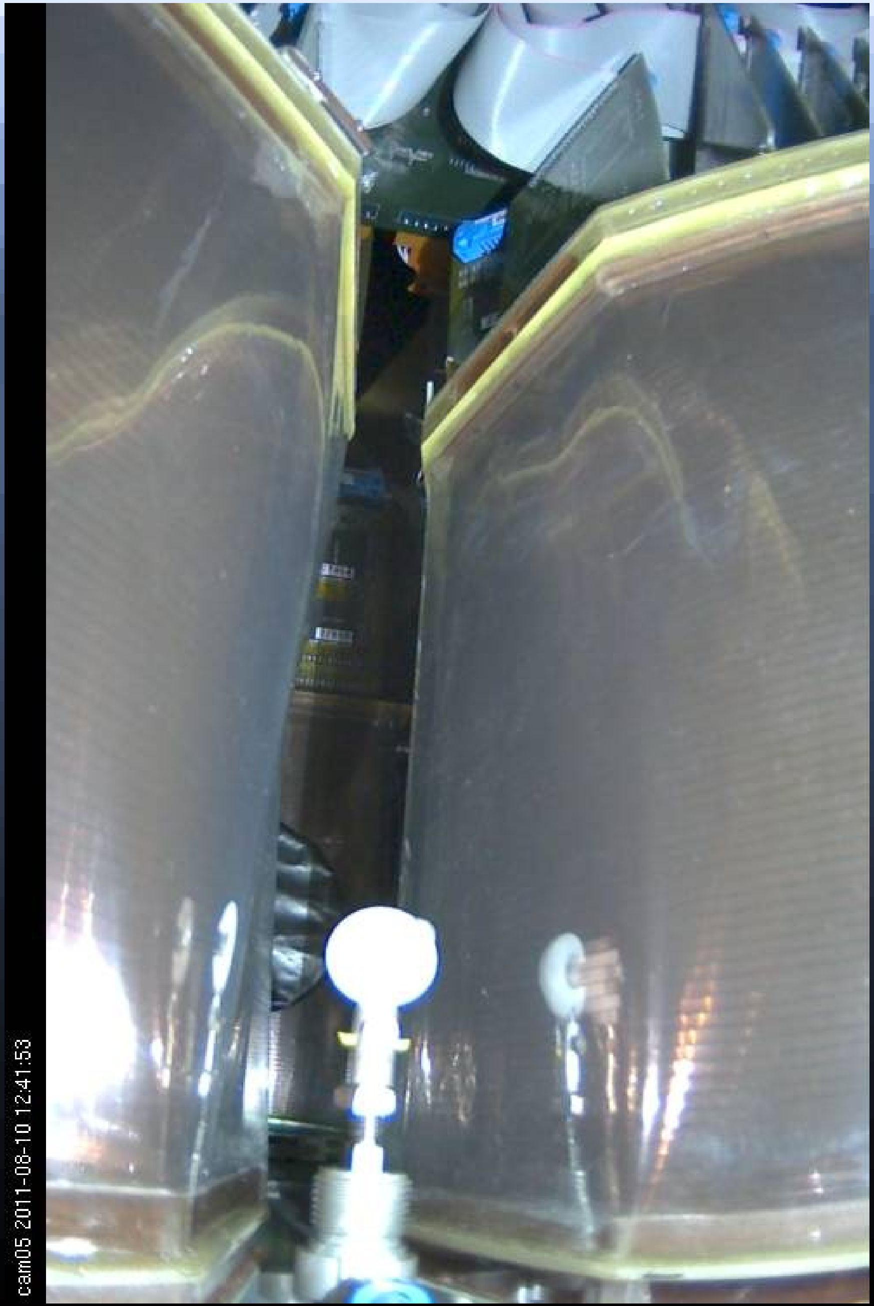
S2 x S4 x V0bar x S3bar



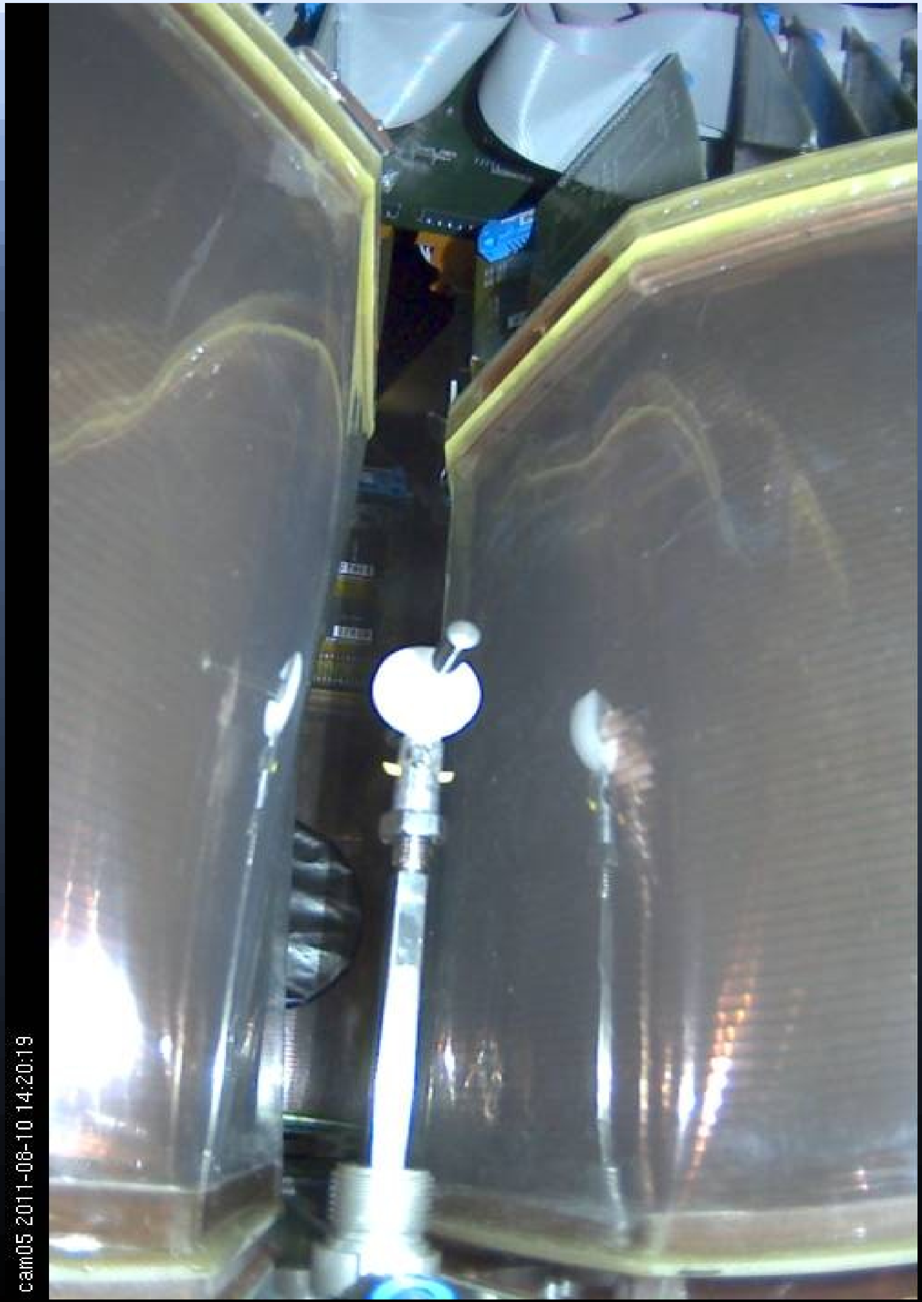


Special “V0” unit with 5 mm diameter hole: very small effective beam spot size at LMPD

Target out

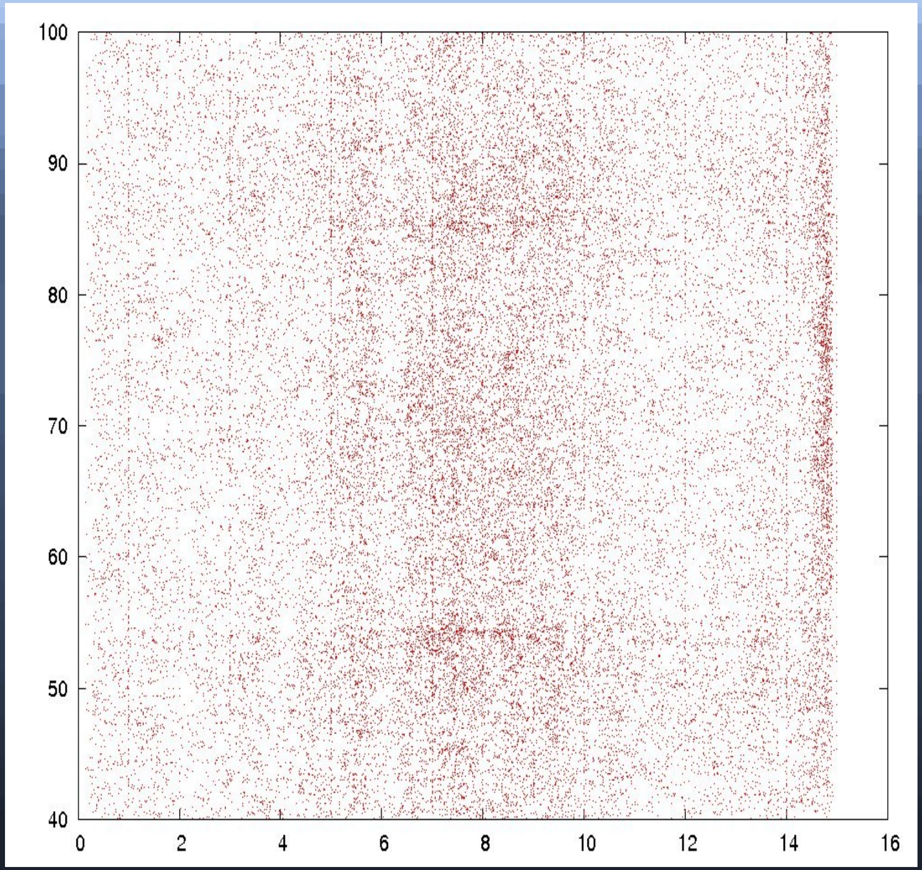


Target in



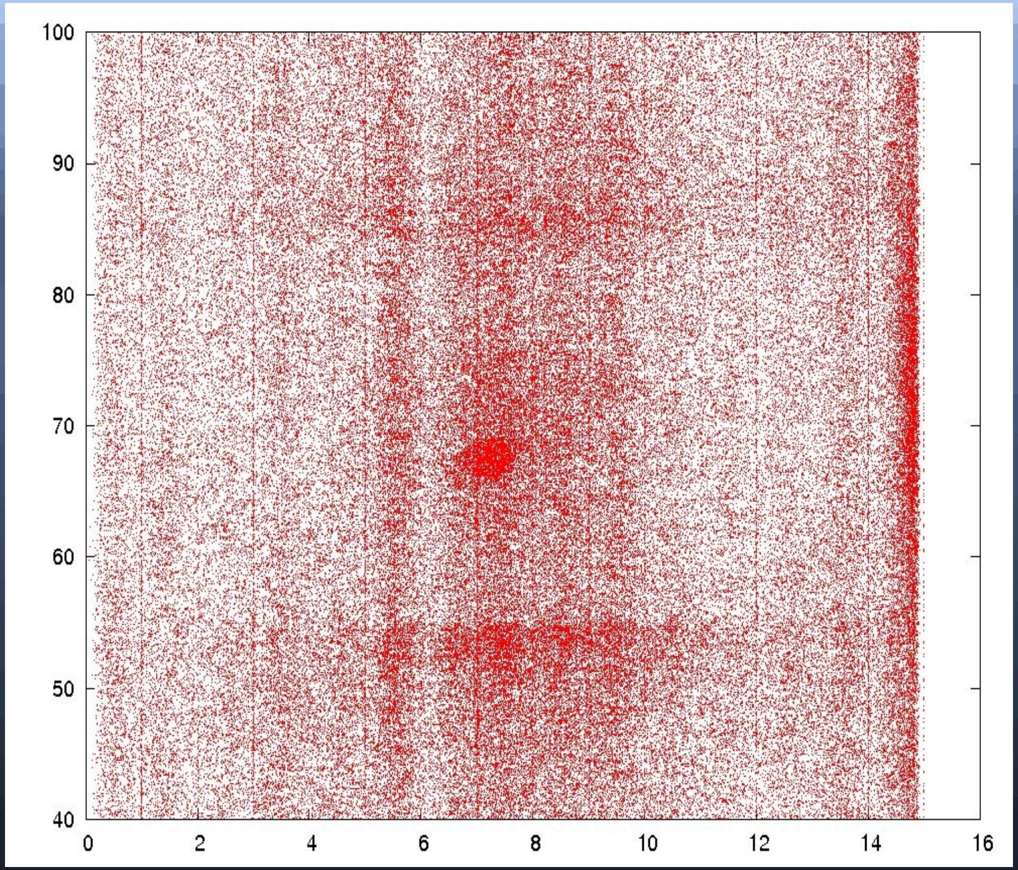
Target out

(interaction trigger)



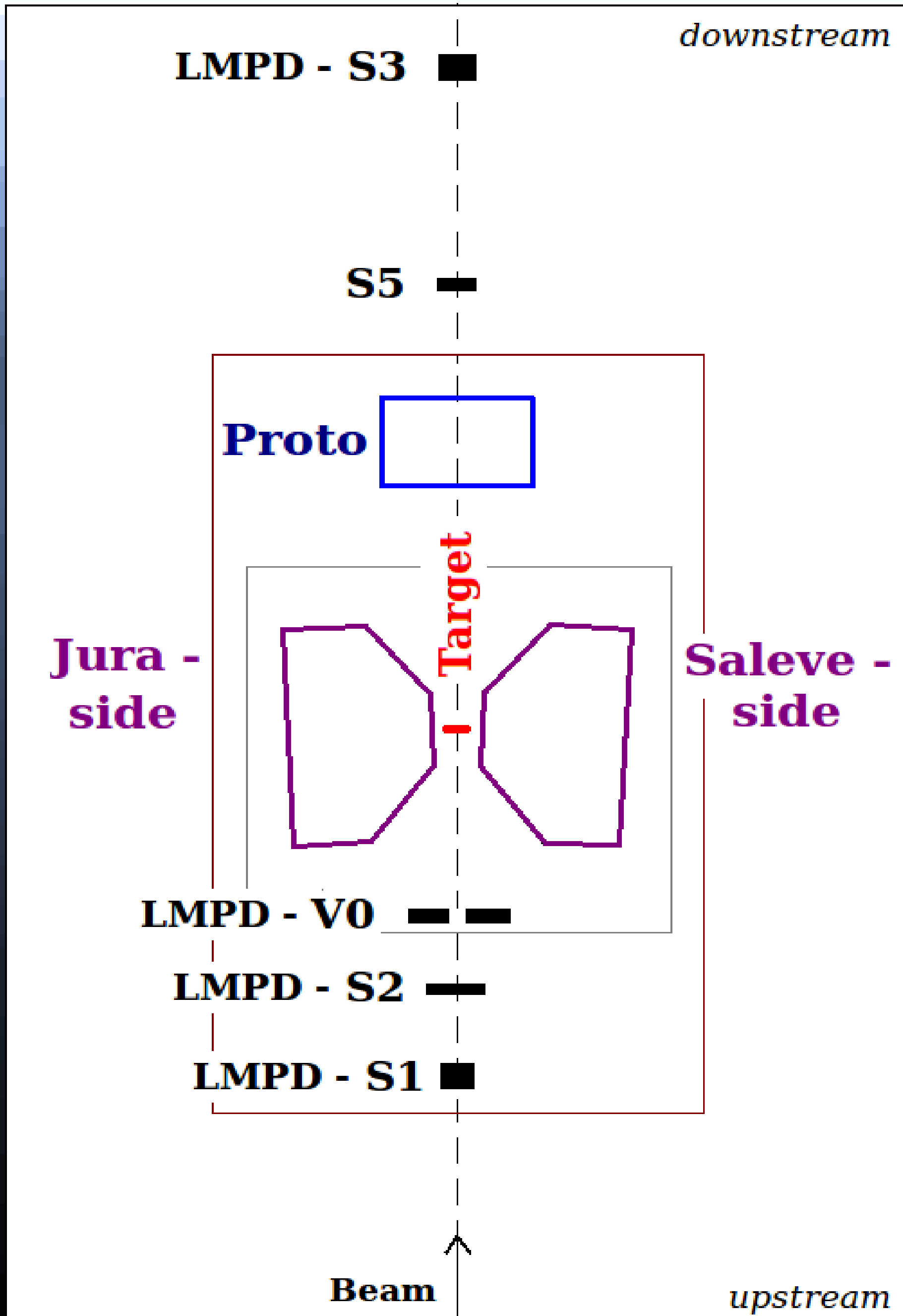
Target in

(interaction trigger, V0 out of beam definition)

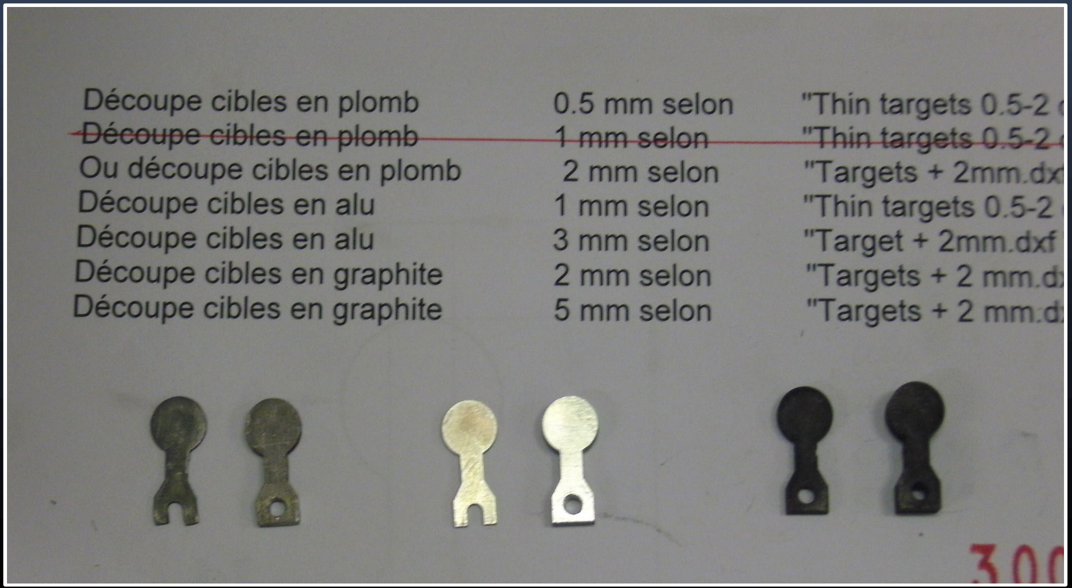


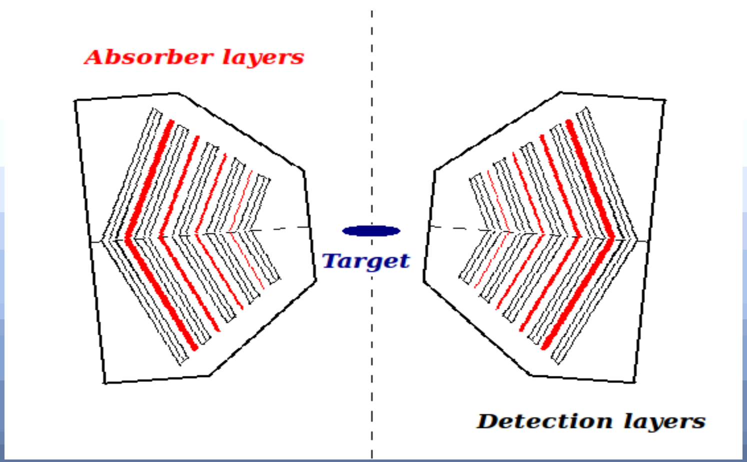
Thick target directly visible as incoming but no outgoing beam → V0 geometry versus target position can be precisely cross-checked

Measurements at 158 GeV/c

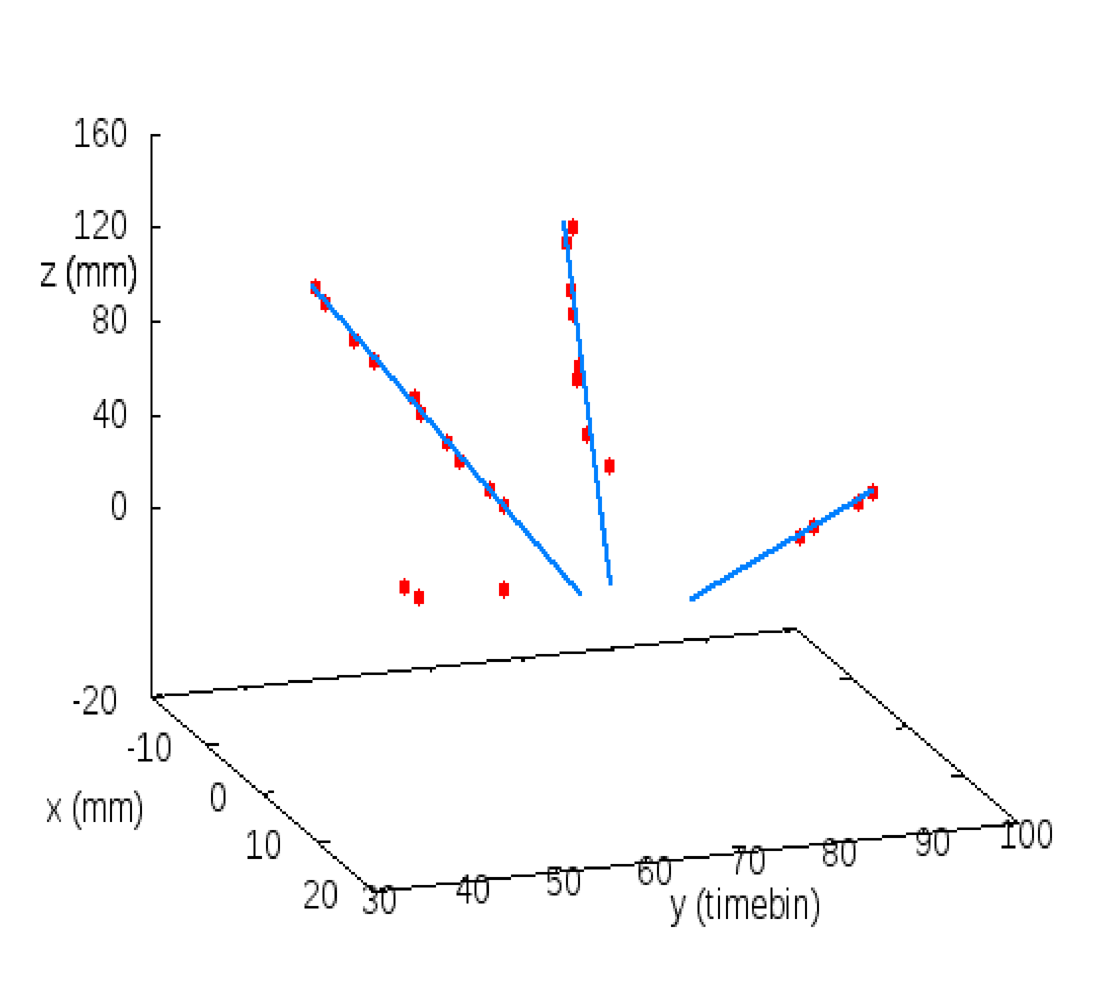


- Different triggers (beam, interaction)
- Different targets (Pb, C, Al)



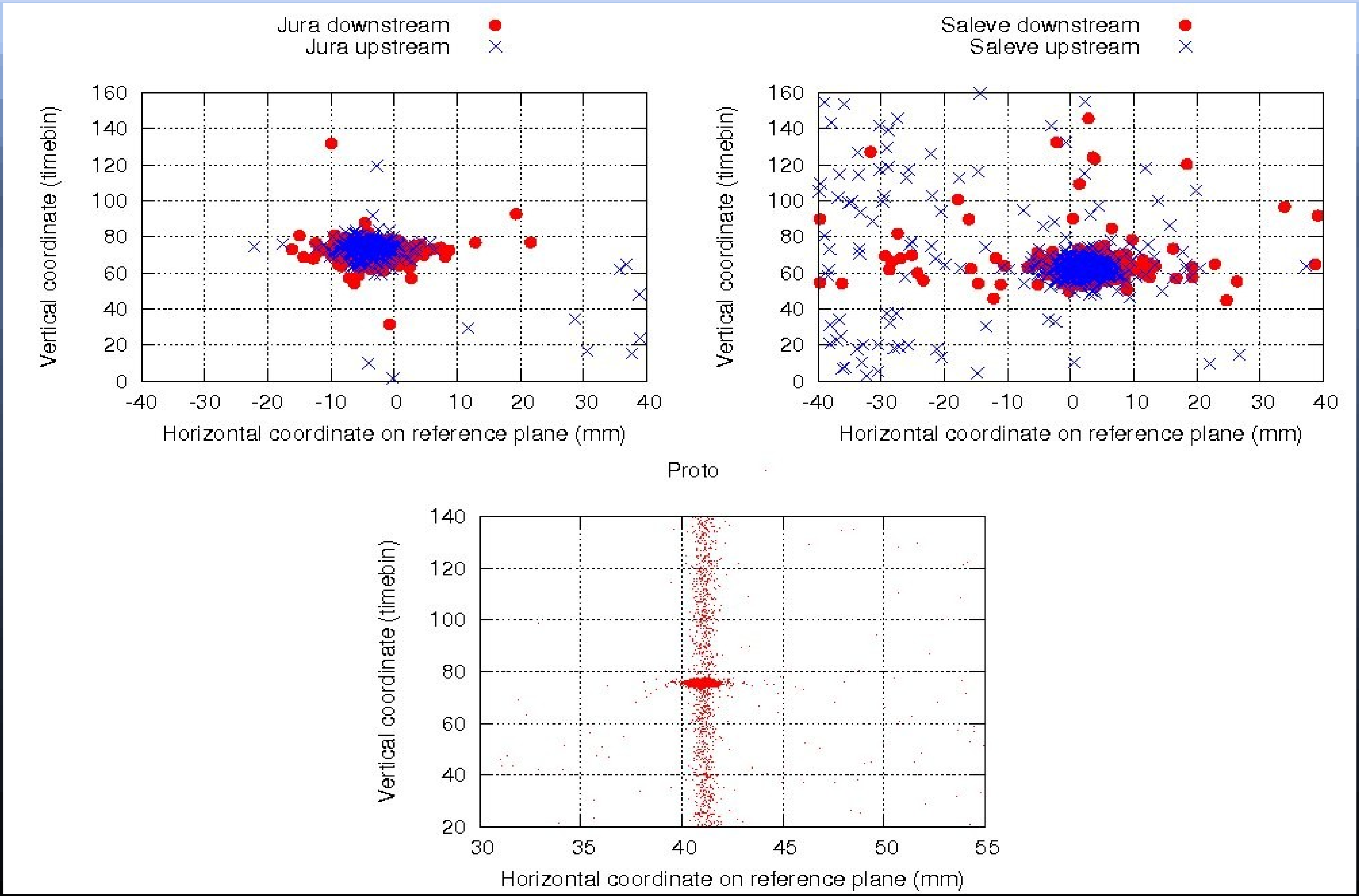


Reconstruction

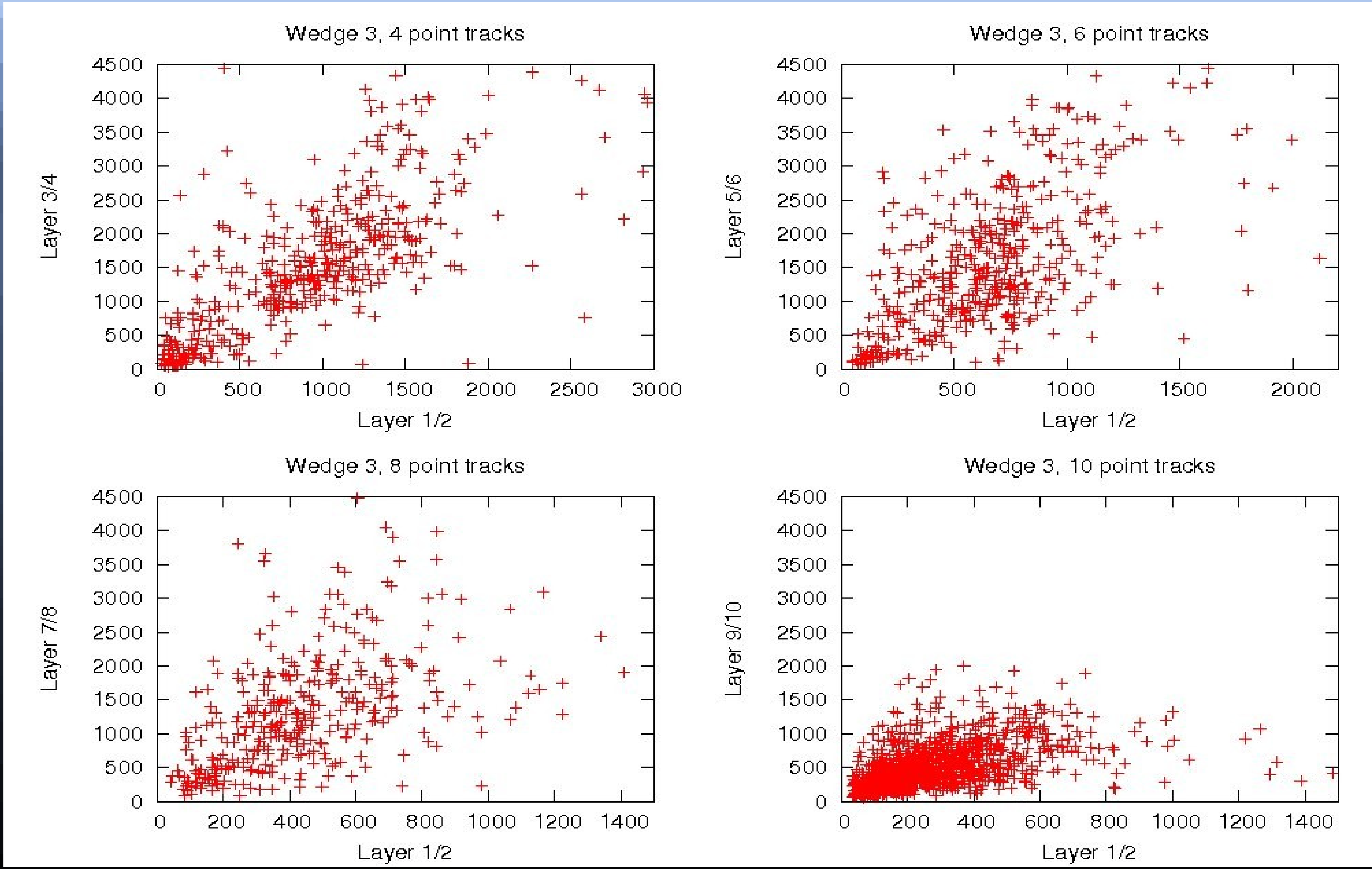


- Cluster level reconstruction works
- Track level reconstruction works
- Independent reconstruction inside wedges
- Main vertex visible after tracking

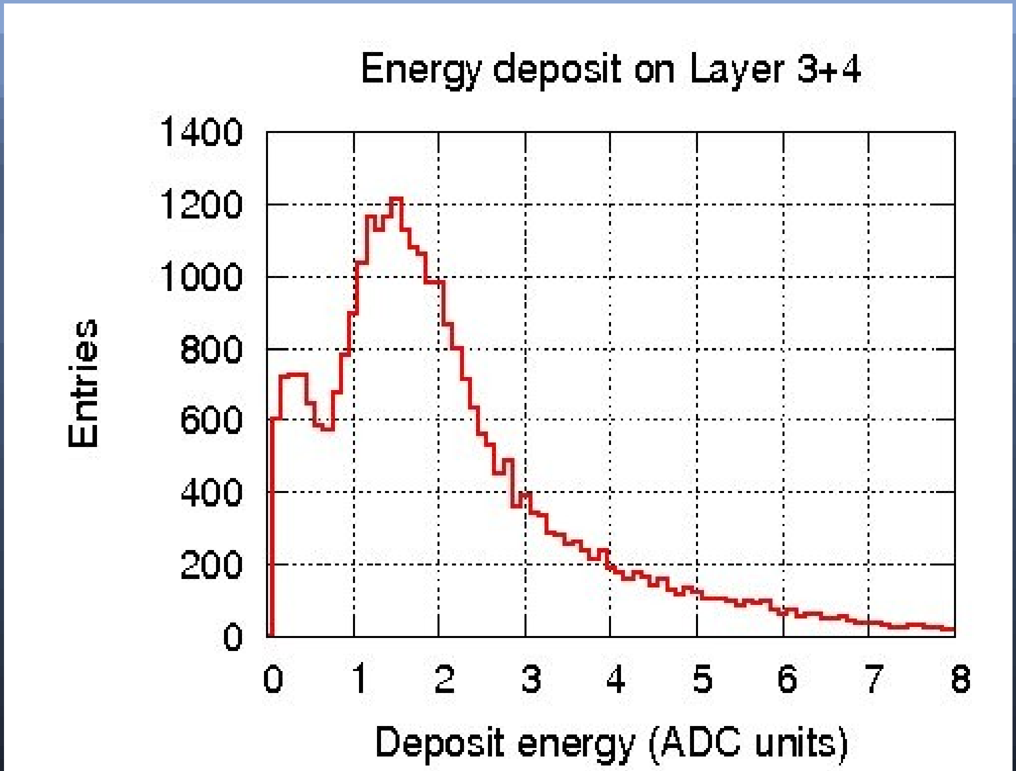
Vertex distributions

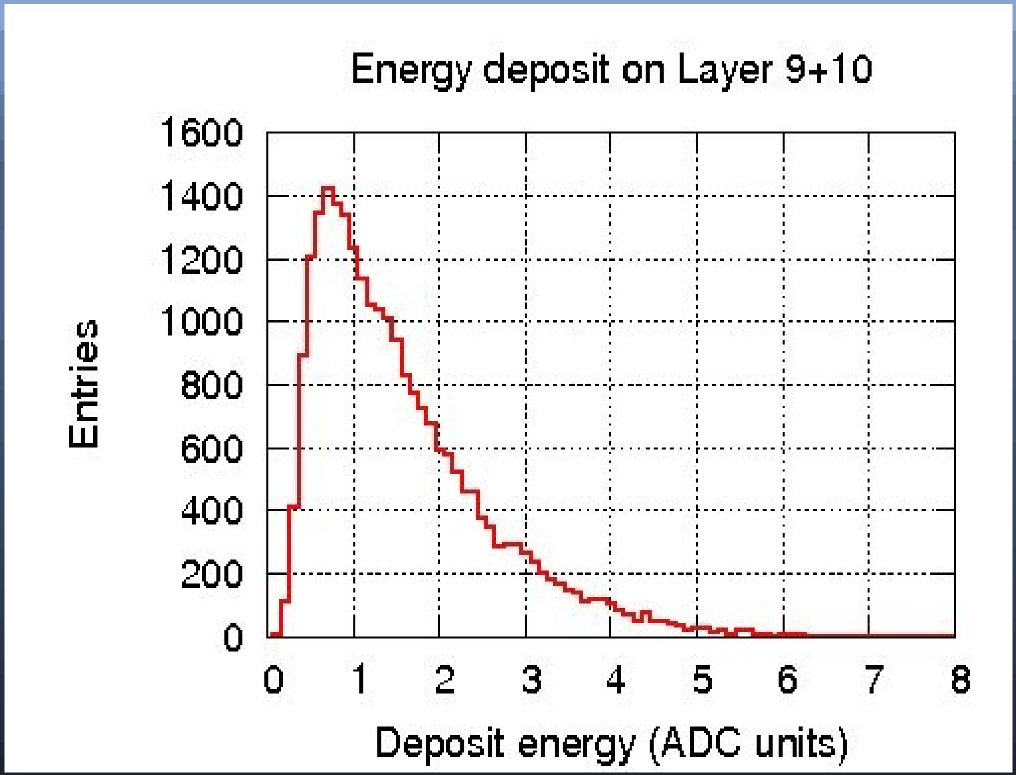


Deposit energy correlations for tracks stopped at specific absorber



Deposit energy distribution:
for stopped tracks proton peak visible

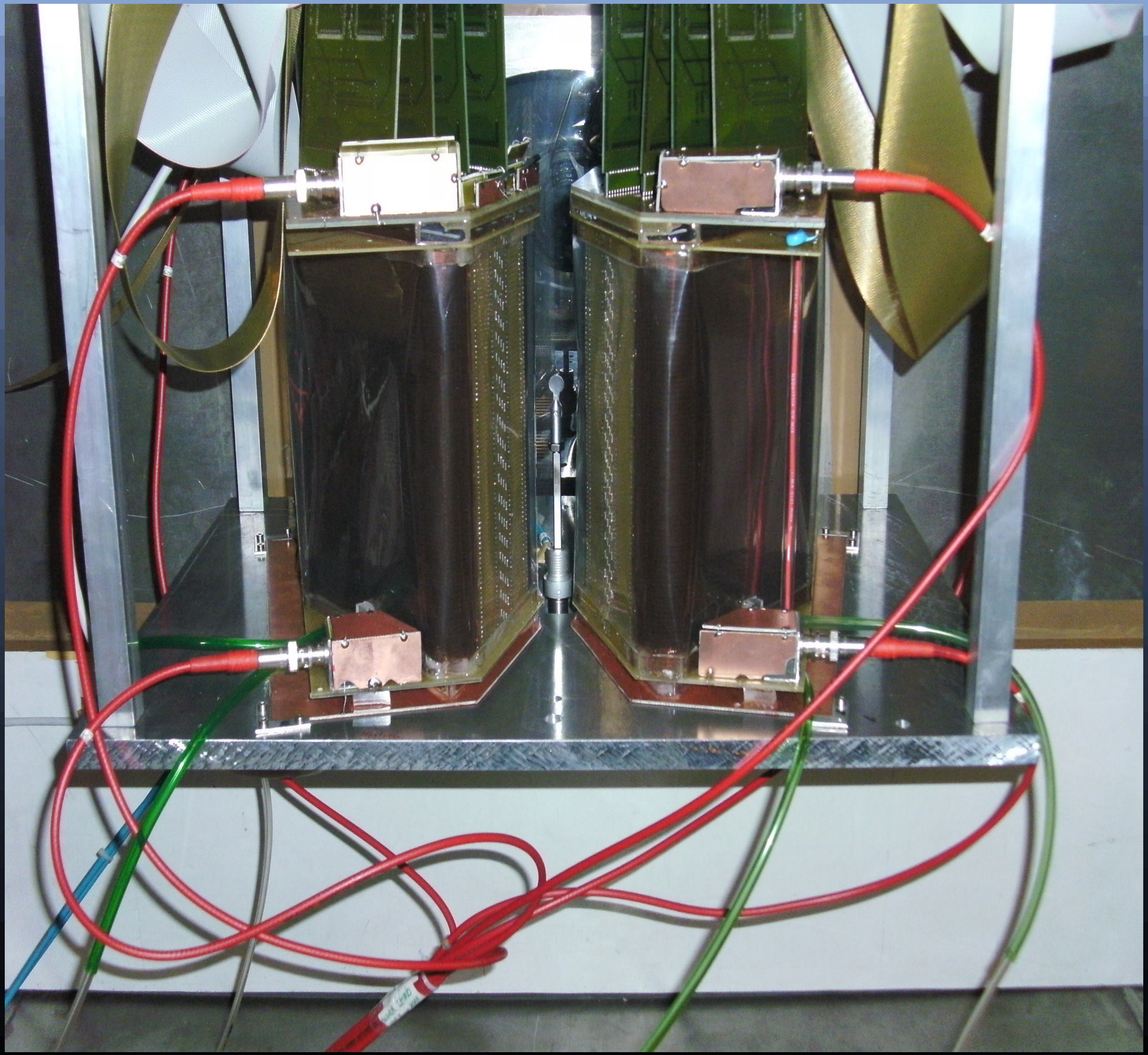




Particles stopped in second absorber
→ proton peak visible

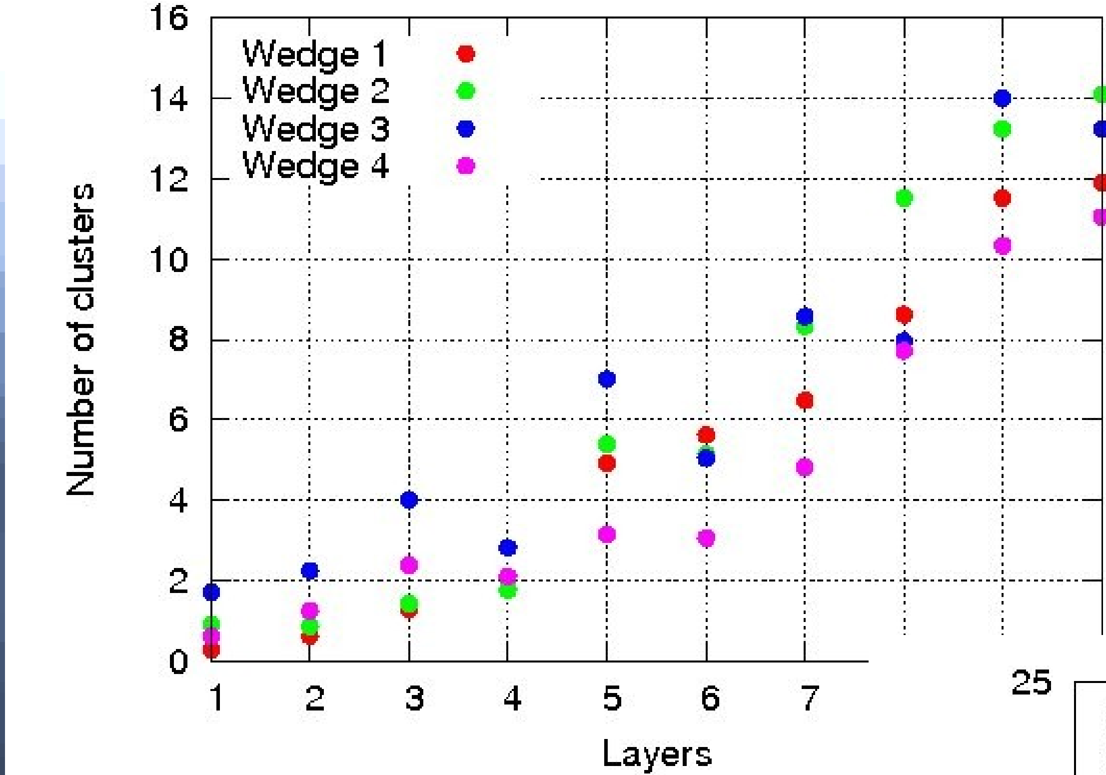
Particles go through the chamber
→ no proton peak

Measurements in target-position



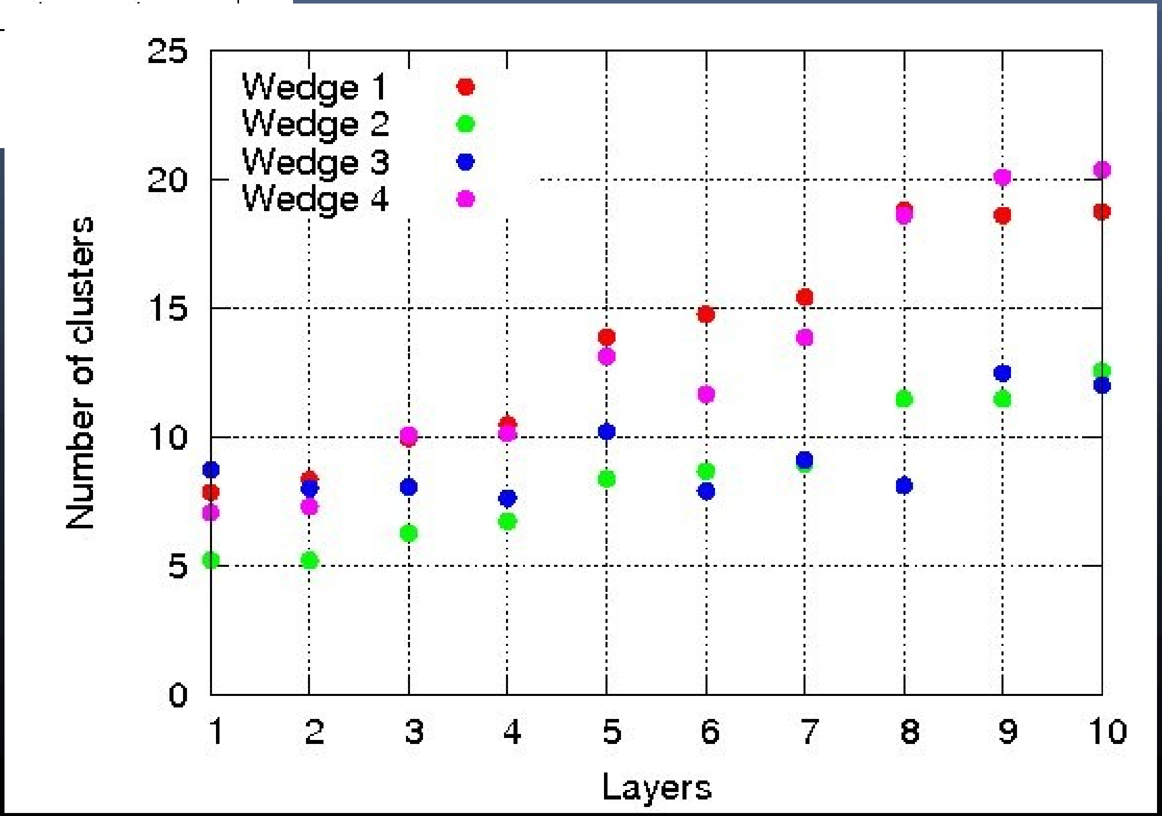
- LMPD integrated with the full NA61 detector
- Hardware issues all tested:
  - Gas: Ar+CO2 at < 20 l/h
  - HV and LV, readout
  - Target system
- Preliminary physics quality p+Pb data

Number of clusters

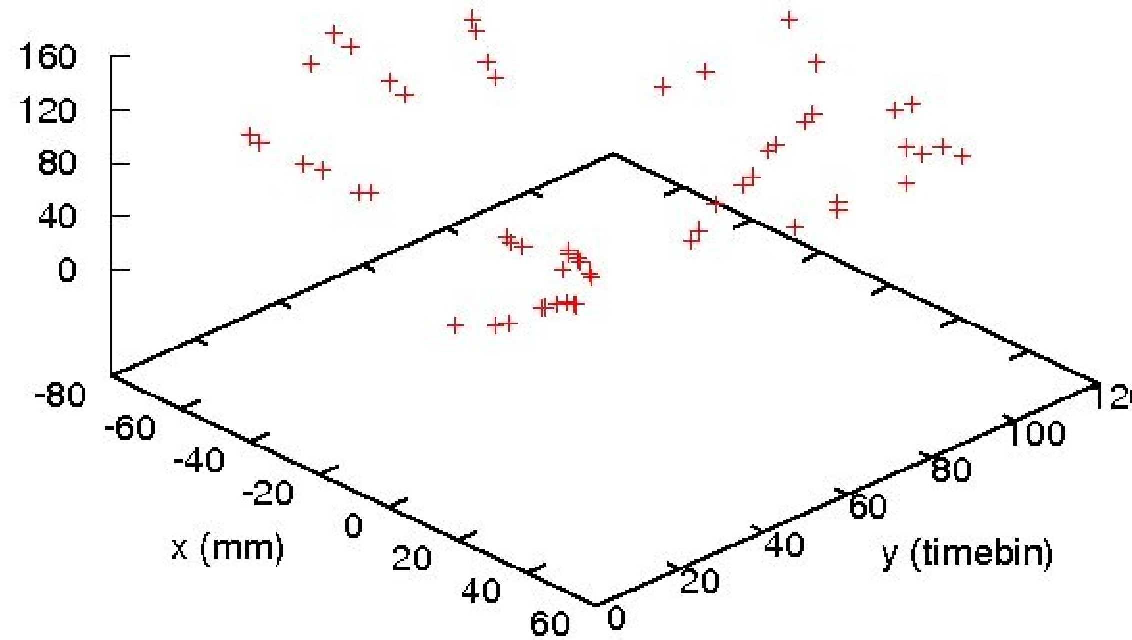


Target out

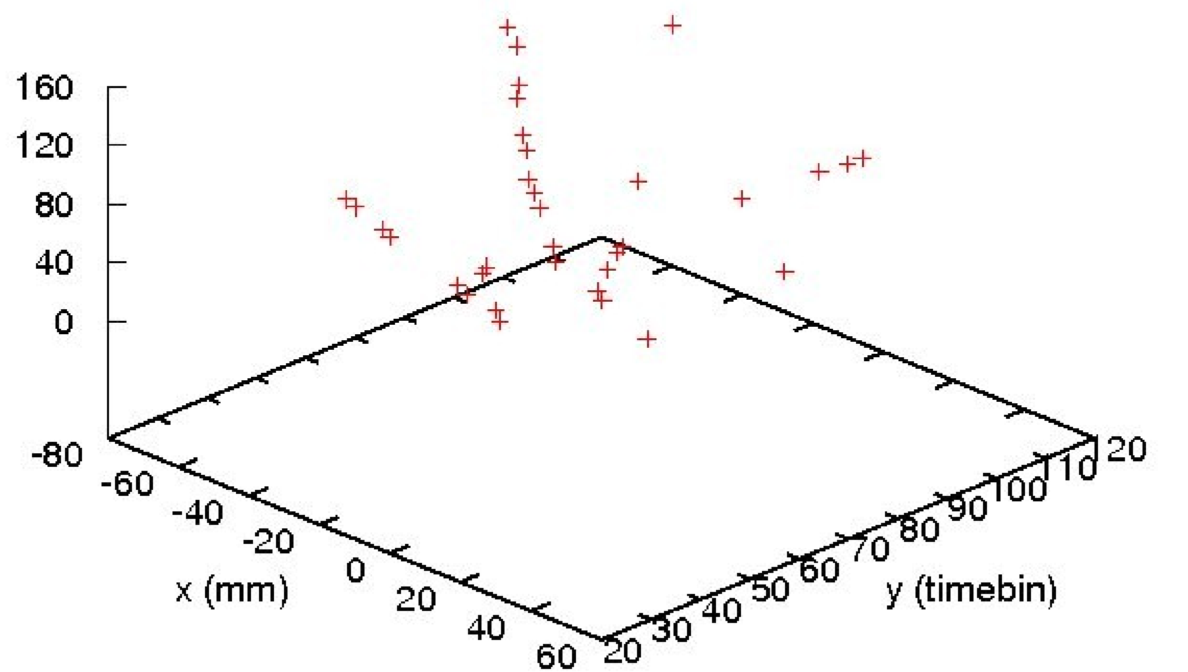
Target in



Events in “Saleve”



Events in “Jura”



Summary

- Low Momentum Particle Detector
    - Centrality Detector in p+A collisions
- LMPD tested downstream of NA61 and in target position
- Hardware issues all tested, basic observables verified (clusters, tracks, vertex)
- Particle identification seems to work as expected
- Physics quality data taken with LMPD (in standalone mode and with NA61)
- LMPD is ready for the p+Pb run in 2012

Thank you for your attention!