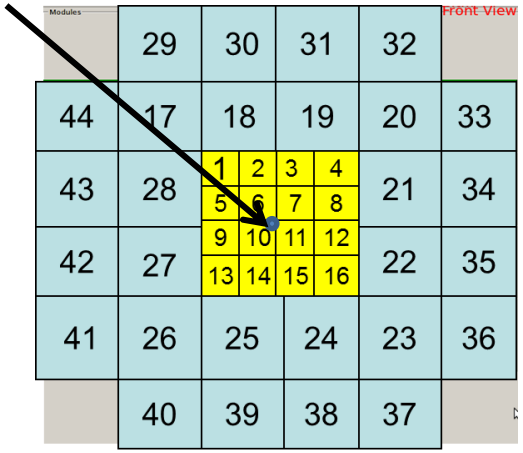
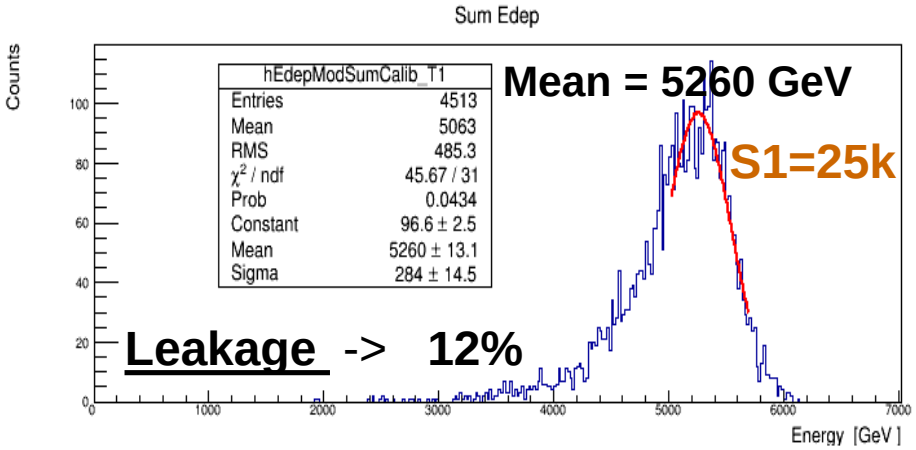
The PSD at Pb-Pb run

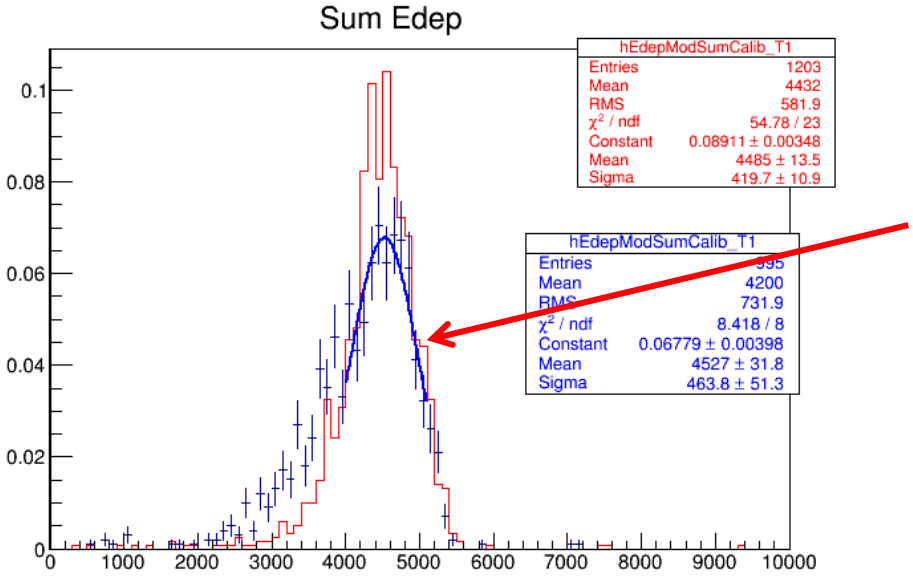
- PSD drawbacks at Ar beam
- Proposal for improvement of the PSD response at PbPb run
- Some details of the PSD upgrade

First problem in Ar-run: shower leakage for Ar-ions.

Beam 150 AGeV







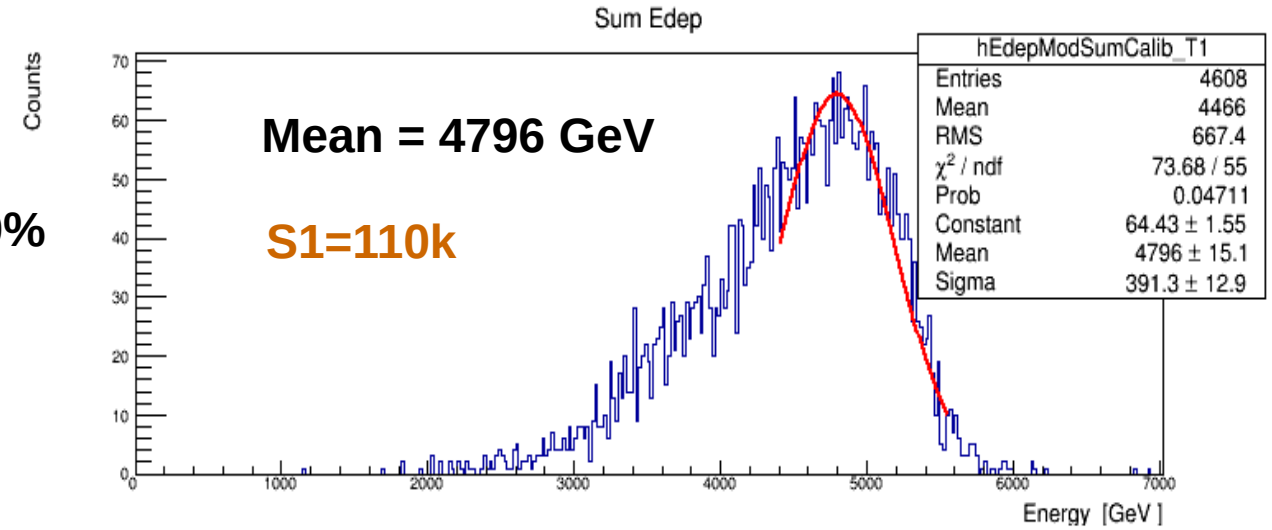
Brass degrader in front of PSD ϕ50x100 mm^2 ($0.6\Lambda_i$) reduces the left tail without the loss of total energy deposition.

Important for the selection of central collisions!

Second problem :
dependence of reconstructed beam energy on beam rate.

The problem is that MAPD pixel's recovery time ~ some 10 μs.

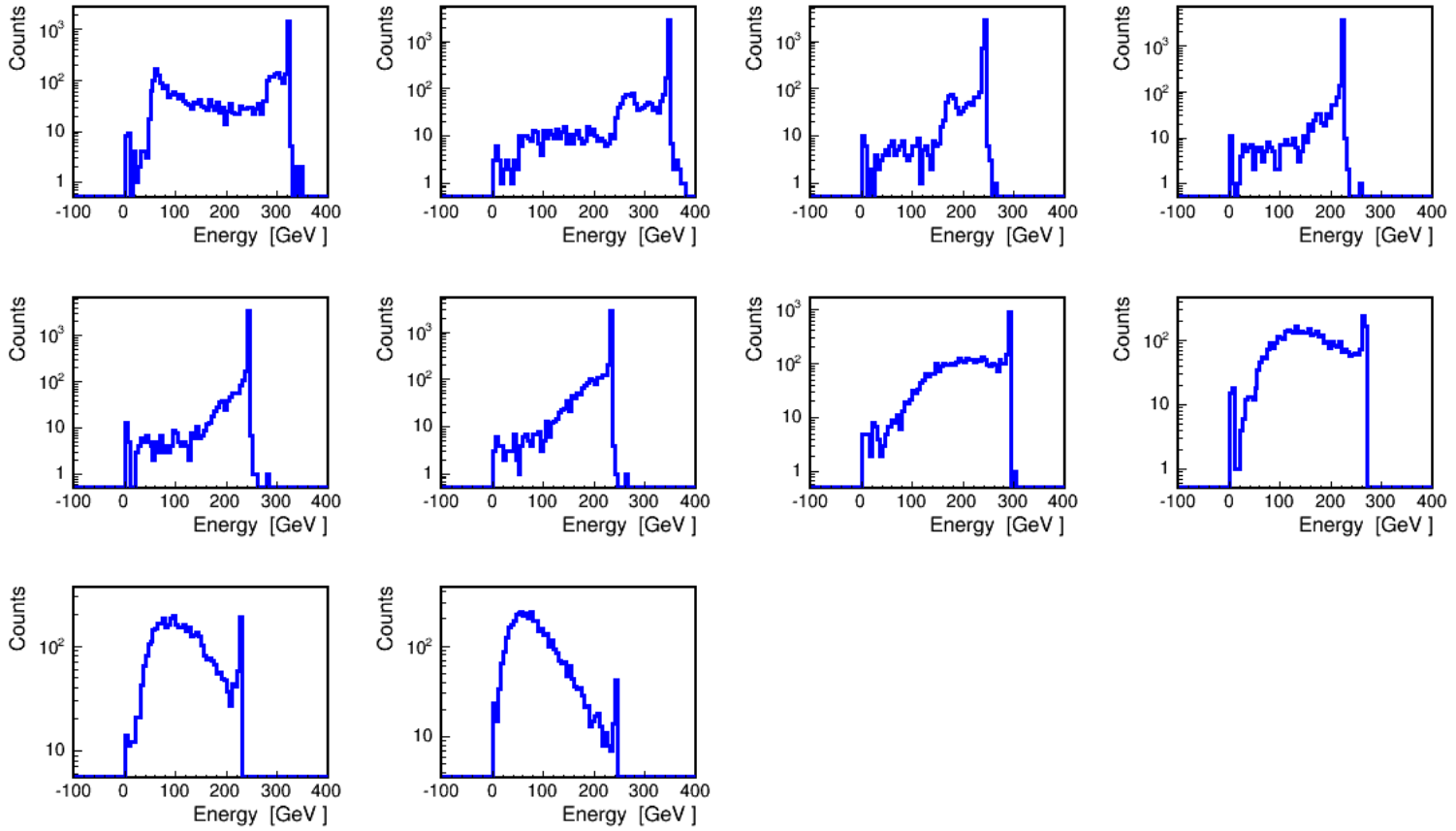
MAPD saturation - > 9%



Total loss of Ar-energy is (12+9+..)~22%.

Third problem:
ADC saturation for energy more than10 nucl./module

Energy spectra in 10 sections, where Ar hits the center of module.



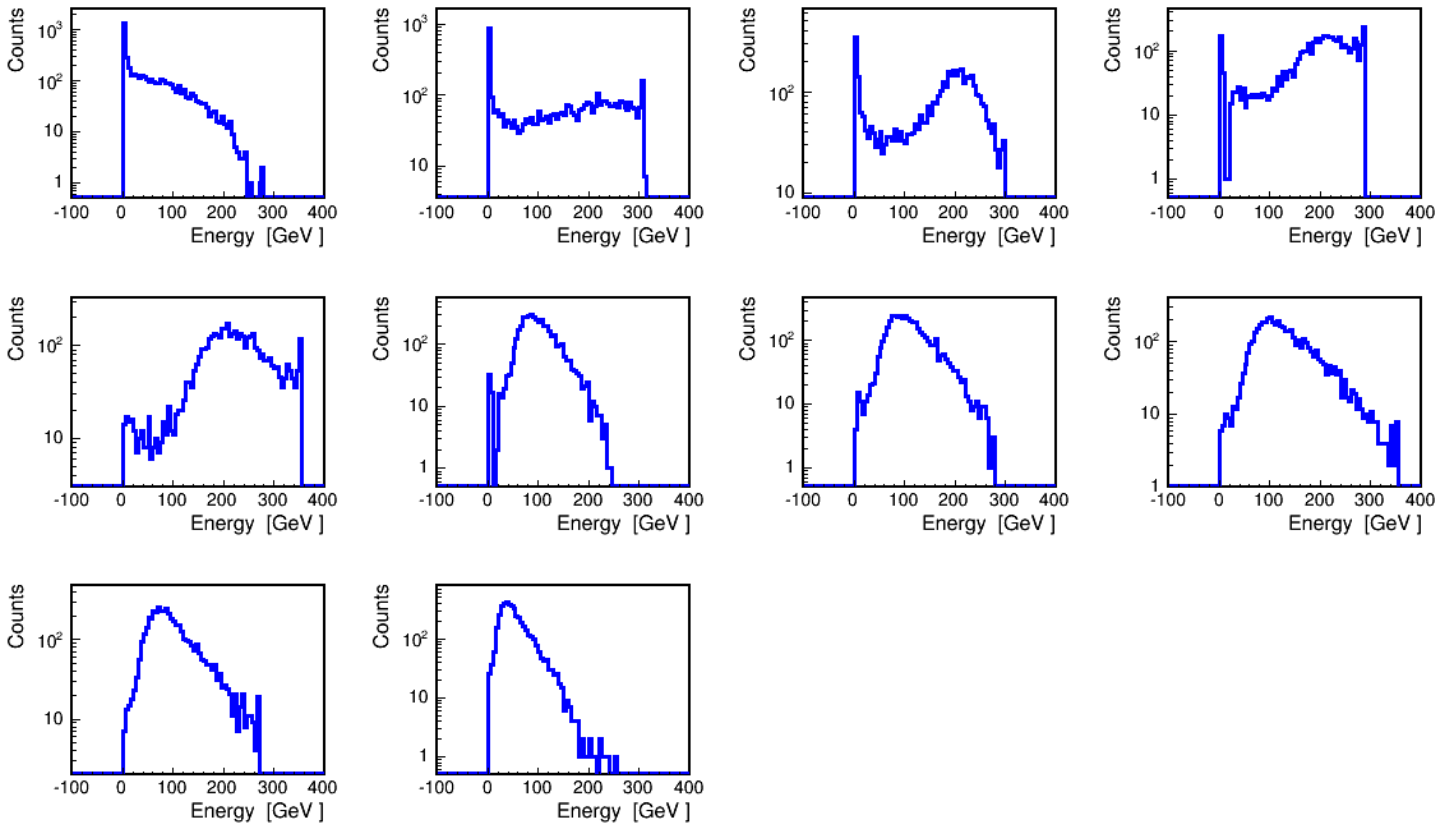
One needs to detect nucleons in range 13 GeV-150 GeV – factor 10 x 10 nucleons
=> We have dynamic range =100. Difficult to get more!

For Pb beam the dynamic range must be *2000* (!) in central module!

Forth problem:
trigger saturation for energy more 25-30 nucl./module (saturation of amplifiers) for Ar-beam at 150 GeV

Last two problems are solved if beam hits the PSD center. The shower is distributed between 4 central modules.

Energy spectra in 10 sections of module #6, if Ar-beam hits the center of PSD.



How to solve above problems for Lead run?

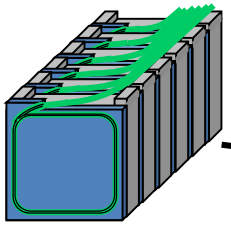
The shower leakage in rear side of calorimeter for heavy fragments can not be avoided. But one can put active degrader (small module) in front of central PSD module (#6) to enlarge the total absorption length for beam ions.

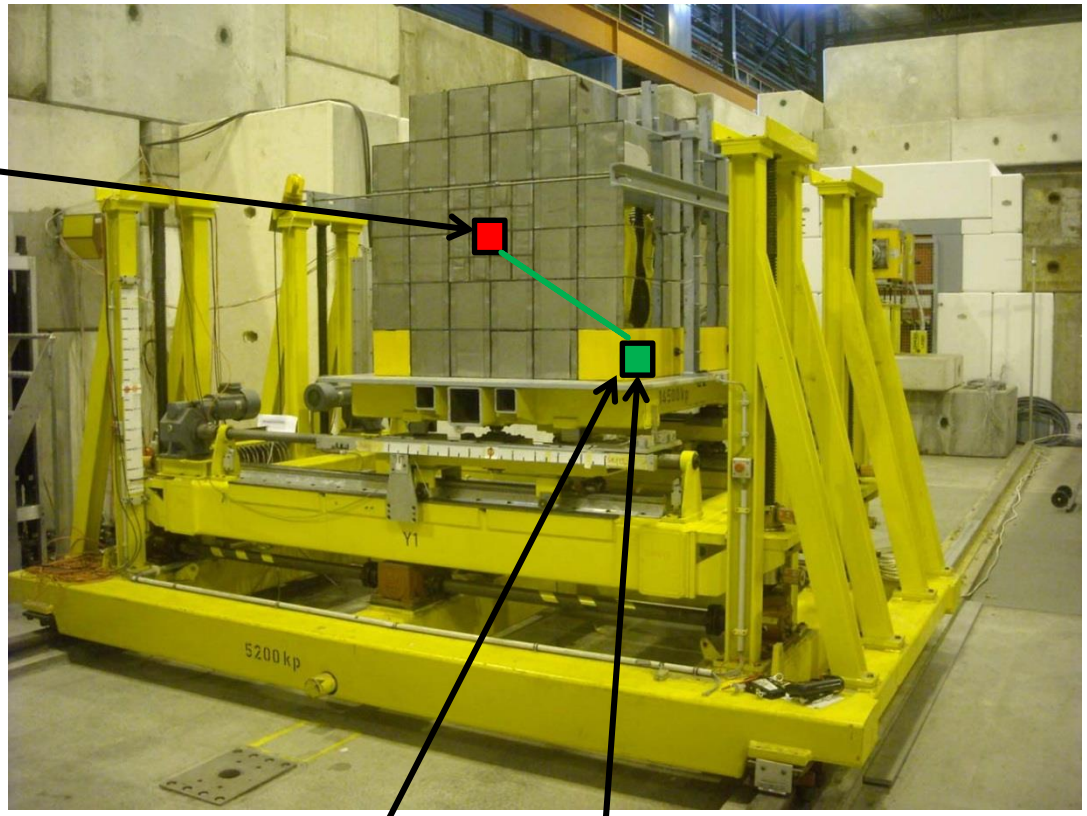
Present MAPDs were developed in 2008. Saturation of pixels (recovery time) of MAPDs is know problem. To solve the problem a new SiPMs with fast recovery time must be used.

The problem of the saturation of ADCs and trigger signal could be solved by decreasing the gain of amplifiers in central module (#6).

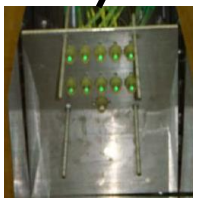
The following PSD upgrade can be suggested:

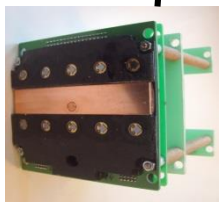
Improvement of beam energy collection.

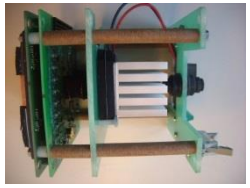




- Installation of additional ~1Λ_0 active degrader (2 sections) in front of central module).
- It includes 12 Lead/Scintillator sandwiches with WLS-fiber light readout.
- 12 WSL-fiber pass to PSD horizontal support platform and collected into 2 optical connectors.
- 2 optical connectors are viewed by 2 fast SiPMs with the corresponding FEE.

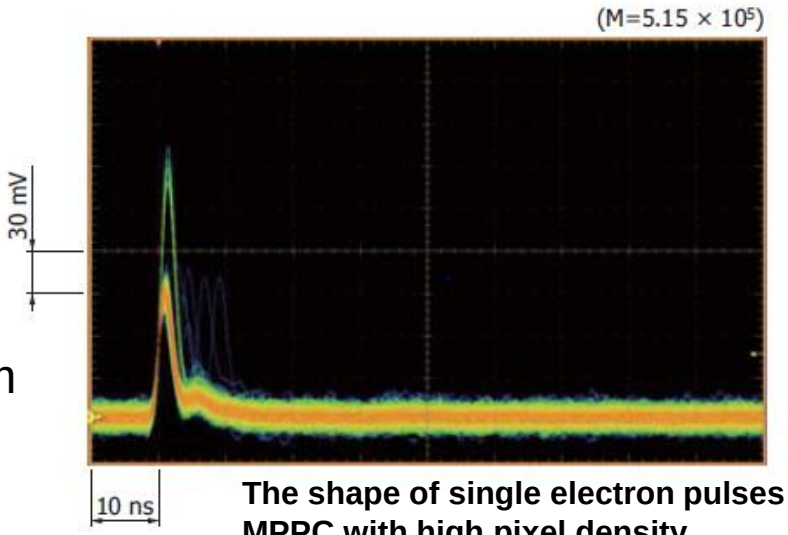






Proposed new photodetectors.

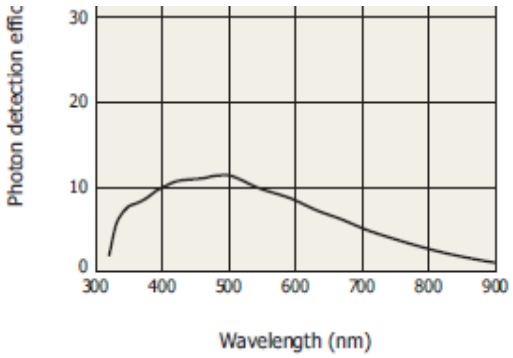
- Recently Hamamatsu Co. announced MPPC S12572-010C/P with pixel density 10000/mm^2.
- The pixel sizes are 10x10 μm^2 .
- The recovery time of the pixels as well as the length of the single electron pulses is about 7 ns.
- It means, that during the light pulse from WLS-fiber (60 ns) each pixel can be recharged up to 6 times, and the equivalent pixel density could achieve up to 60000/mm^2.

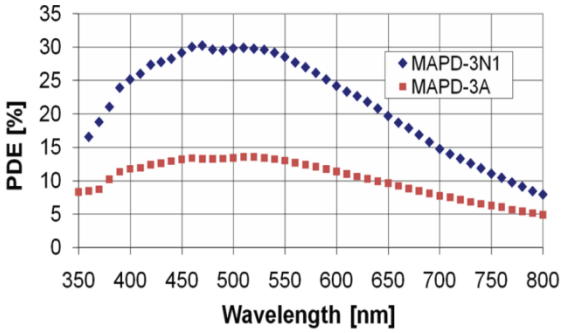


The shape of single electron pulses of MPPC with high pixel density.

Странно показаны 10 нсек и 30мв!!
Смещены?

- **Nice dynamical range**
- **Fast recovery time**
- **PDE and gain are similar to MAPDs**





Our proposal for PSD upgrade before PbPb run at the end of 2015.

- Installation of short (2 sections) module (active degrader) with 12 Pb/Scint sandwiches and WLS-fiberreadout in front of the PSD.

- It might be installed

a) in front of module #6 or
b) in front of PSD center (cross of four central modules).

- To avoid the MAPD saturation one needs to install new MPPCs :

a) only in module #6 or
b) in 4 central modules.

- To avoid the ADC and trigger signal saturation one needs to reduce the amplifier gain for a factor of 10:

a) only in module #6 or
b) in 4 central modules.

- New calibration of central module(s) is to be done at proton beam at different MPPC voltages. To get an appropriate dynamic range the gain of MPPC must be adjusted for each beam energy.

- The FEE and readout electronics would be the same.

Schedule of the PSD upgrade.

We consider here the case a) – modification of module #6 only.

Work at INR (June – September 2015):

- Construction of components for short (2 sections) module (active degrader) with 12 Pb/Scint sandwiches with WLS-readout.

- Construction of 2 electronic readout modules with MPPCs and corresponding electronics for short module and module #6.

Work at CERN (October 2015, see next slide) :

- Assembling of 2 sections at CERN by INR technician and installation it at the PSD platform.

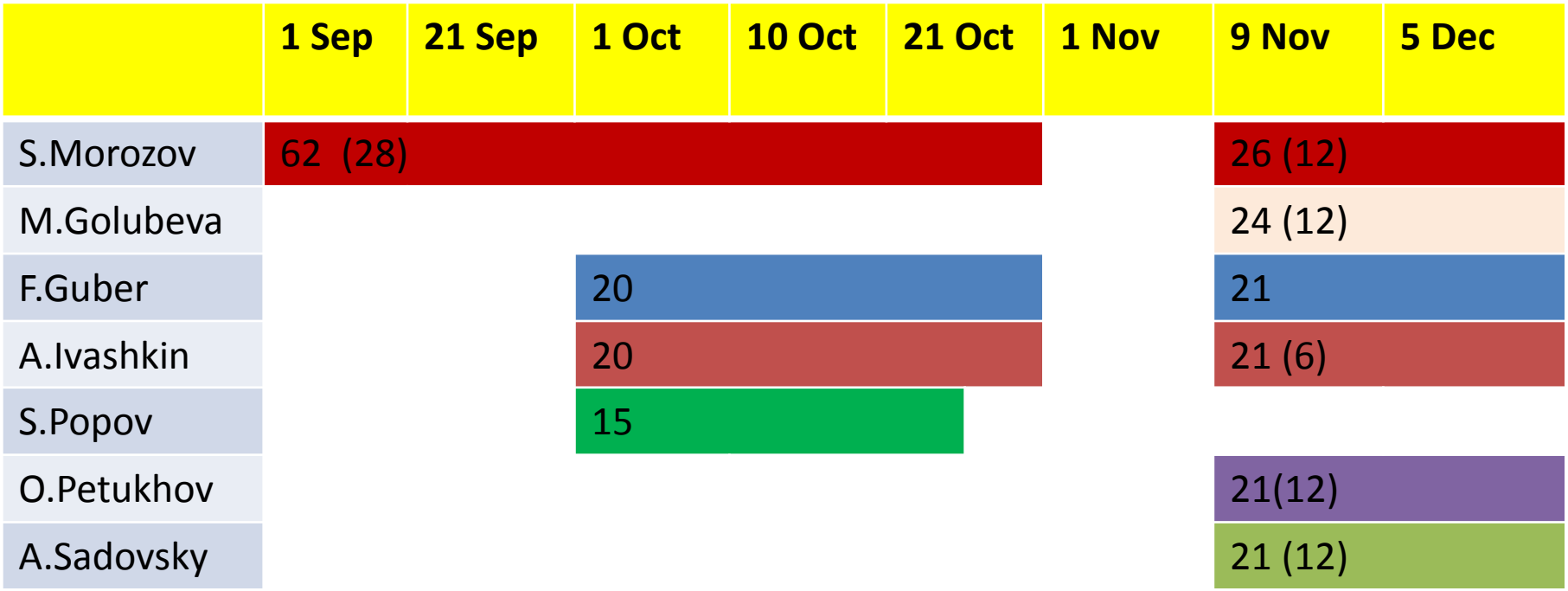
- Installation of electronics for two sections on the PSD platform and its integration in the slow control and DAQ readout as a separate 45^{th} module.

- Replacement of slow MAPD photodetectors in the central PSD module by a new fast MPPCs.

- Replacement of analog electronics (with reduced amplifier gains) in central module.

- Calibration of short and central #6 modules at the proton beam.

INR visits and activity during proton and Pb Pb runs in Sep –Dec 2015



- 2 PSD sections assembly
- Tests of electronics
- Calibrations at the beam

Requested visit days =(117 + 132) = 260 days

Thank you

BACK UP SLIDES

Simulation of PSD response to heavy ions revealed some problem with GEANT.

The obtained spectra are strange.

Simulations were done for Ar ions at 39 AGeV and Pb ions at 29 AGeV for different geome setups , with corresponding magnetic field

Standalone framework: VMC, Geant4, FTFP_BERT 2.0 physical list (allows to simulate interactions of ions with matter)

Simulated geometry setups (not to scale):

① "1 SECT"
② "2 SECT"
"VACUUM"

1 section or 2 sections before PSD:
6 (12) slices of (Pb+Sc)
10x10 cm, 12.24 (24.48) cm

PSD: 120x120 cm, 140 cm

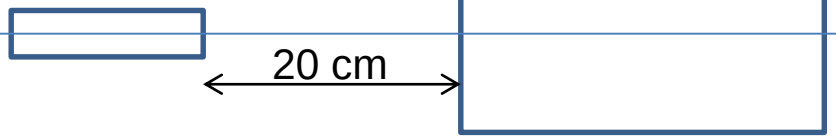
Ar@39 AGeV
Pb@29 AGeV

③ "DEGRADER"

DEGRADER:
Copper, 10 cm length,
diameter 5 cm

PSD

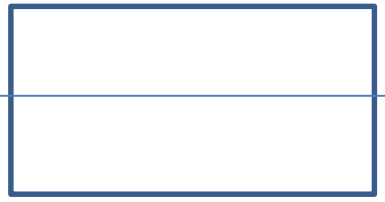
Ar@39 AGeV
Pb@29 AGeV

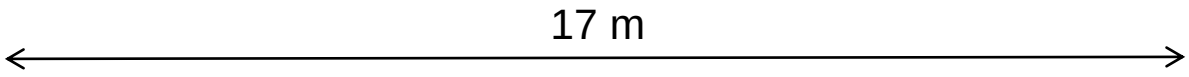


④ "onlyPSD"

PSD

Ar@39 AGeV
Pb@29 AGeV

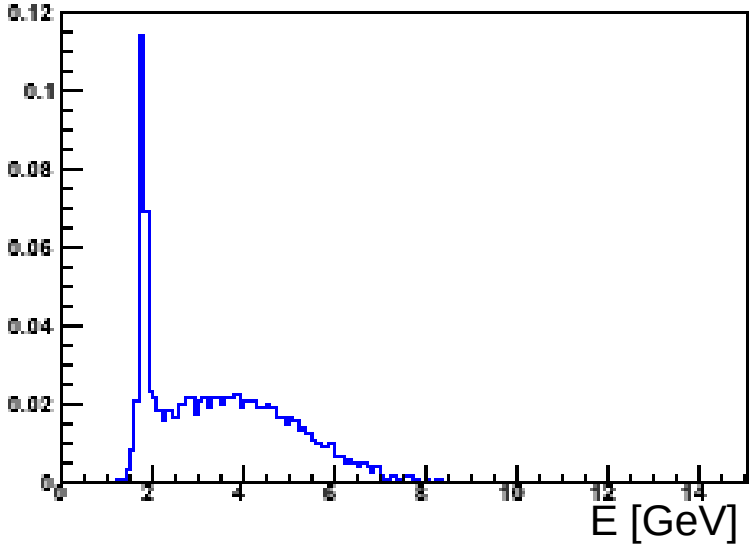


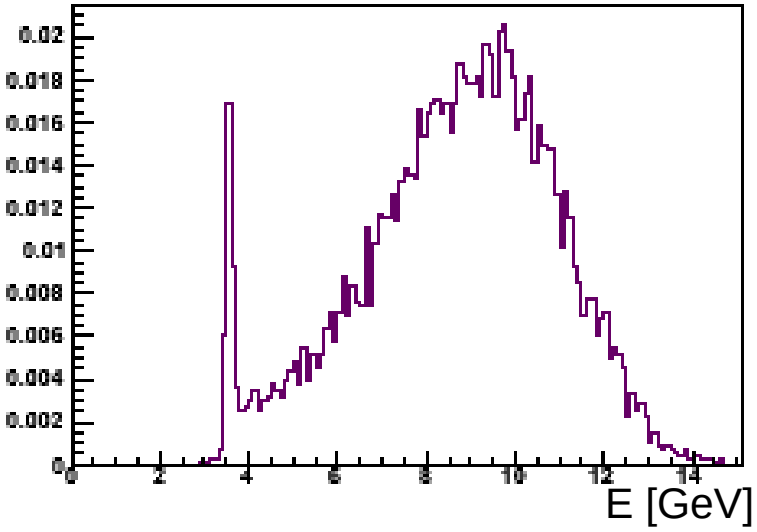


Deposited energy in sections before PSD

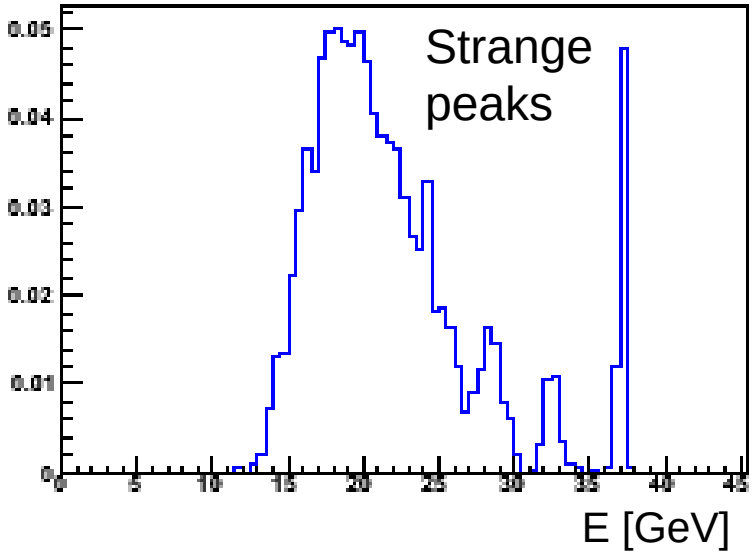
Setup: 1 section before PSD 2 sections before PSD

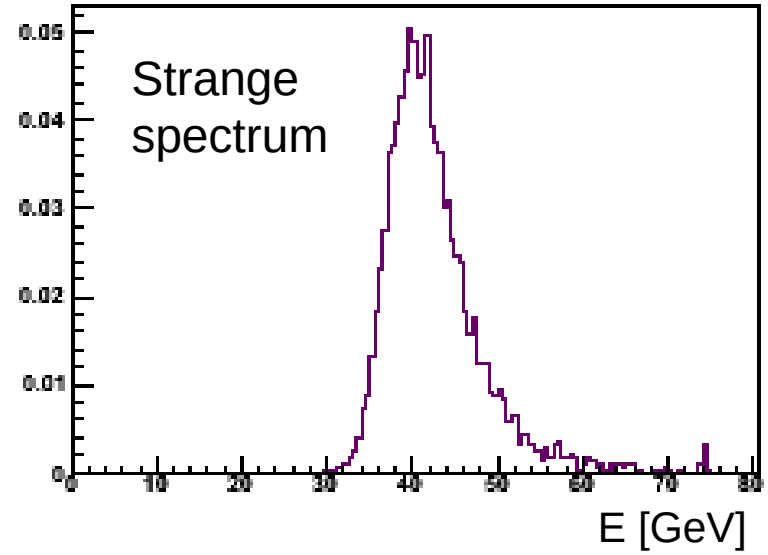
Ar @ 39 AGeV





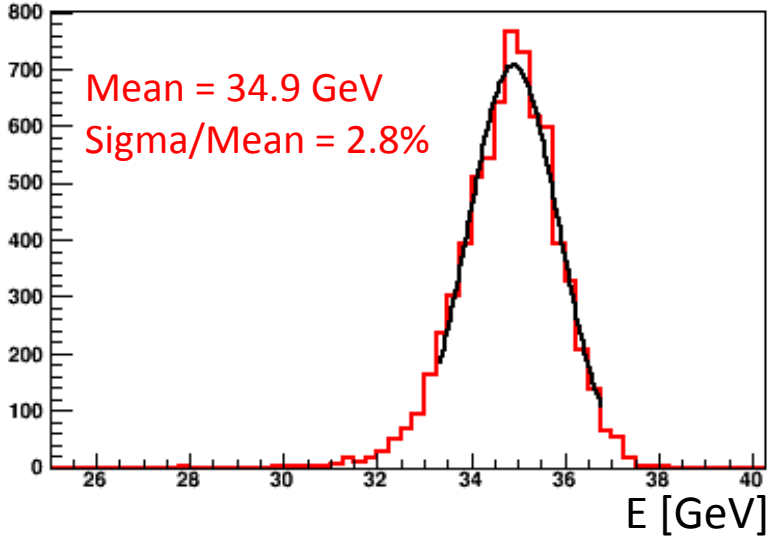
Pb @ 29 AGeV



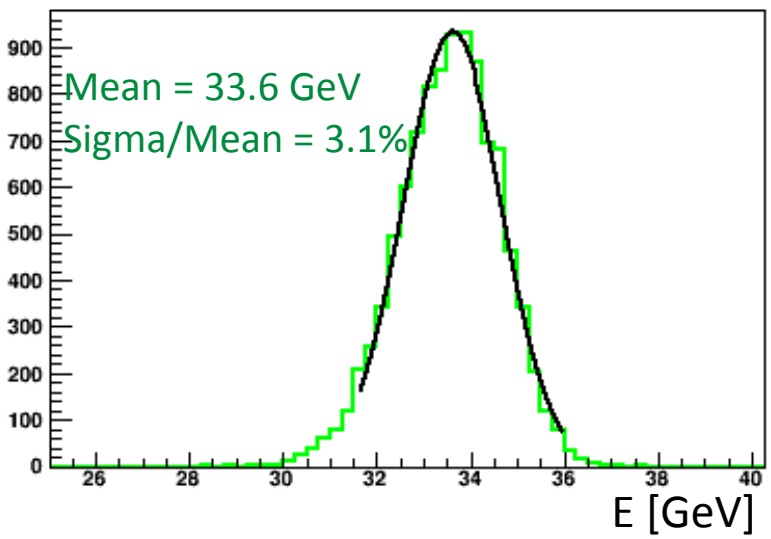


Ar @ 39 AGeV: Deposited energy for different geometry setups

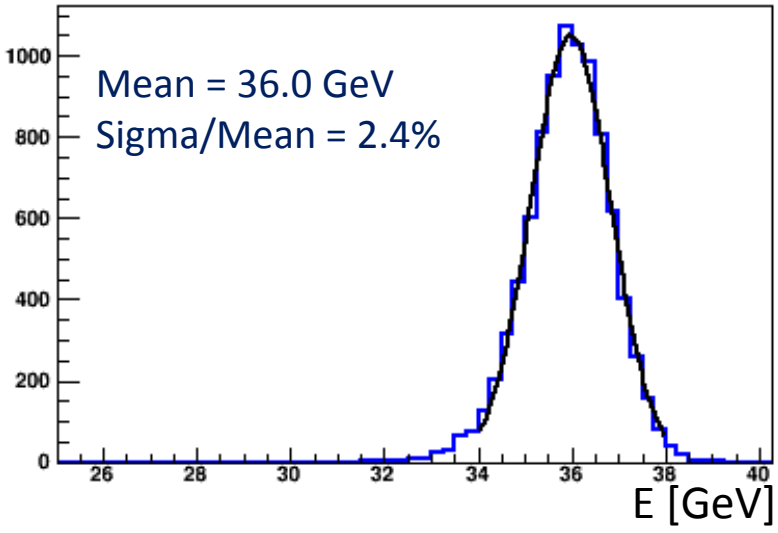
Energy in PSD ("onlyPSD")



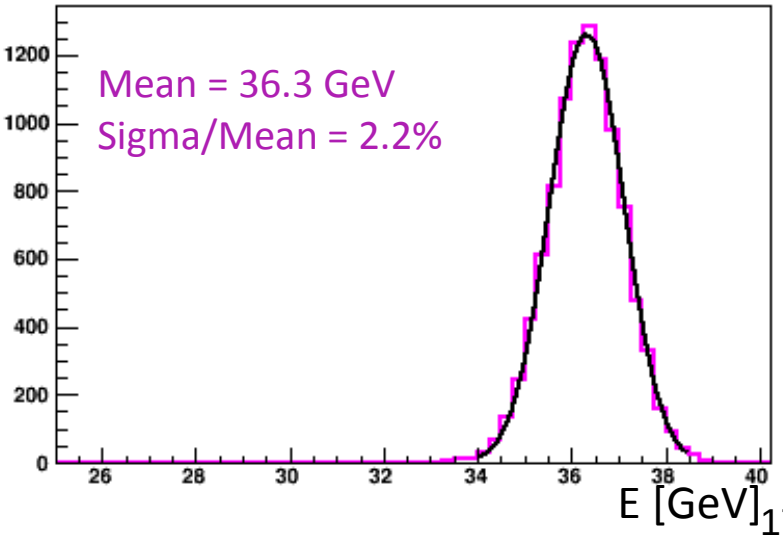
Energy in PSD ("DEGRADER")



Sum of energies in PSD and section ("1SECT")

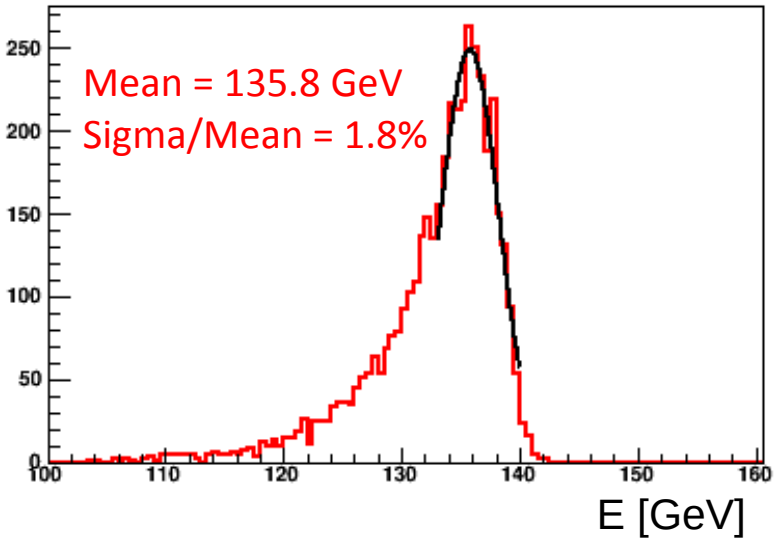


Sum of energies in PSD and 2 sections ("2SECT")

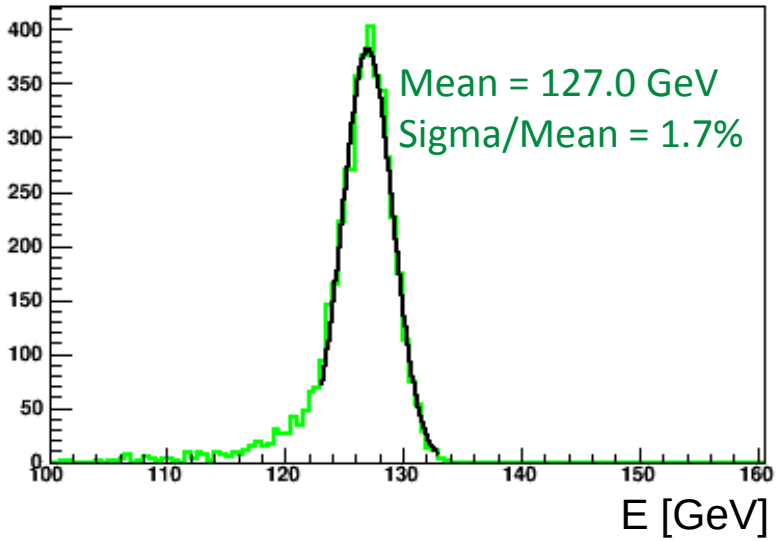


Pb @ 29 AGeV: Deposited energy for different geometry setups

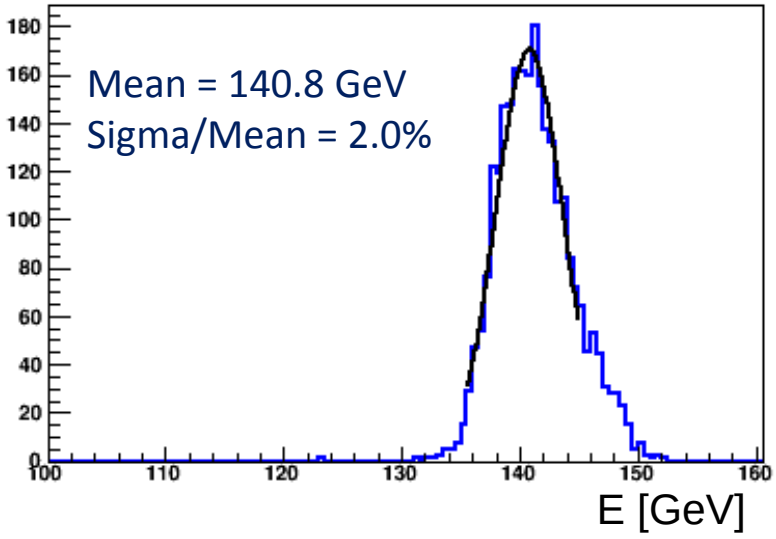
Energy in PSD ("onlyPSD")



Energy in PSD ("DEGRADER")



Sum of energies in PSD and section ("1SECT")



Sum of energies in PSD and 2 sections ("2SECT")