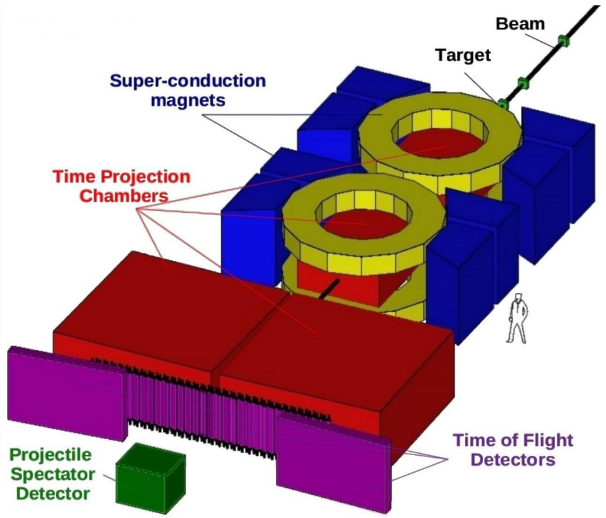
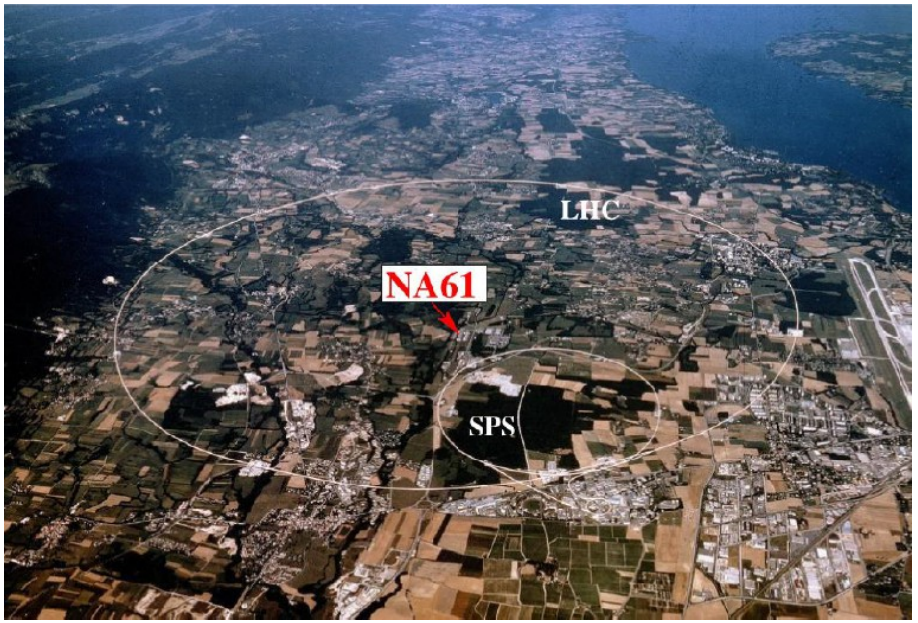
Performance of hadron calorimeter (Projectile Spectator Detector – PSD) at NA61/SHINE experiment

Sergey Morozov, Fedor Guber, Alexander Ivashkin, Marina Golubeva
on behalf of INR RAS, Moscow

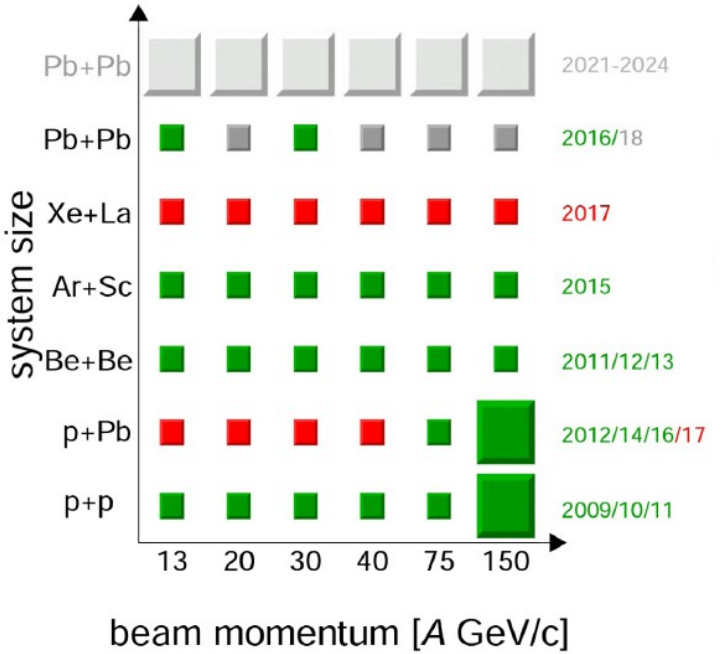


Hadron calorimeter (PSD) at NA61/SHINE

NA61/SHINE experiment at CERN SPS



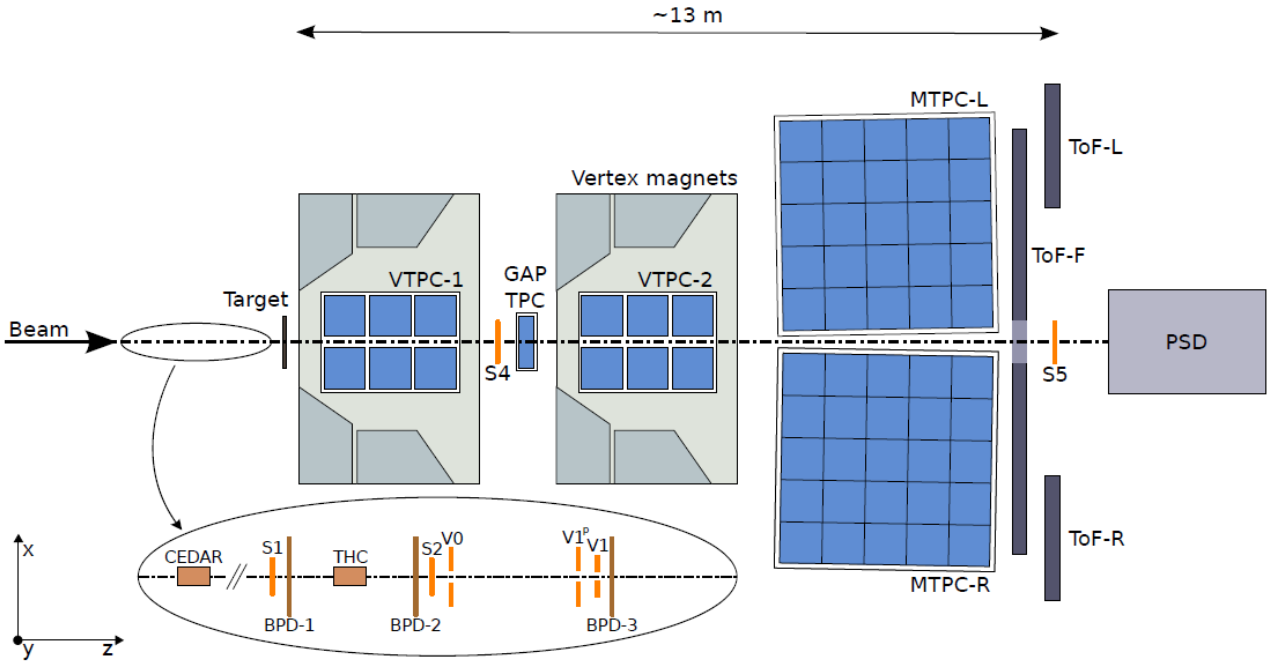
Physics program at NA61



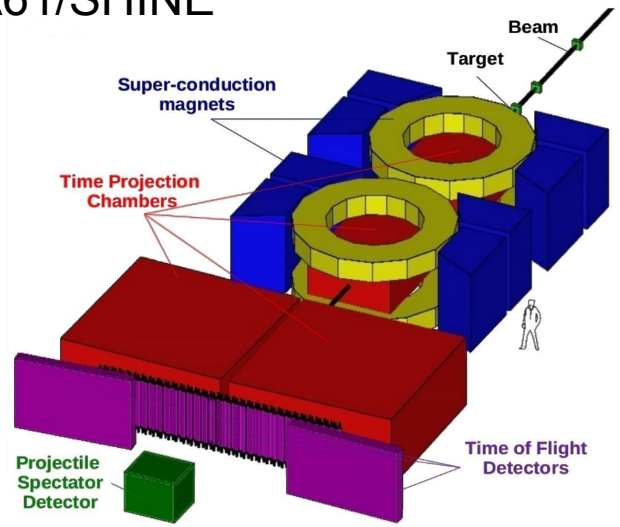
NA61/SHINE facility:

- accelerator chain, beam line and detectors
- hadron production spectrometer for h+p, h+A, A+A
- energies: 13 – 150 AGeV/c (400)
- precise measurements of produced particles (charge, mass, momentum)

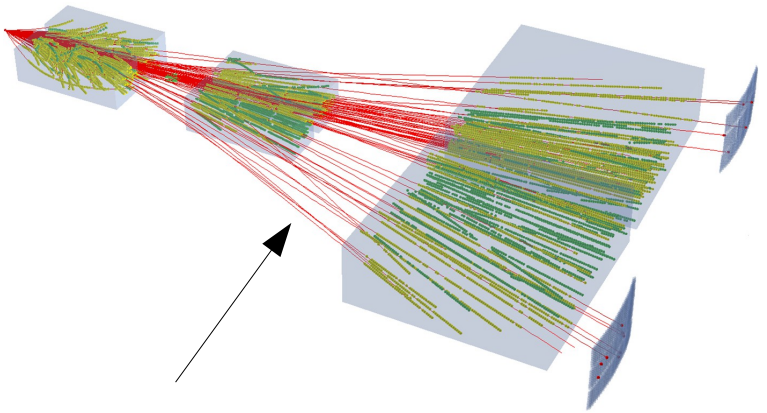
Hadron calorimeter (PSD) at NA61/SHINE



NA61/SHINE

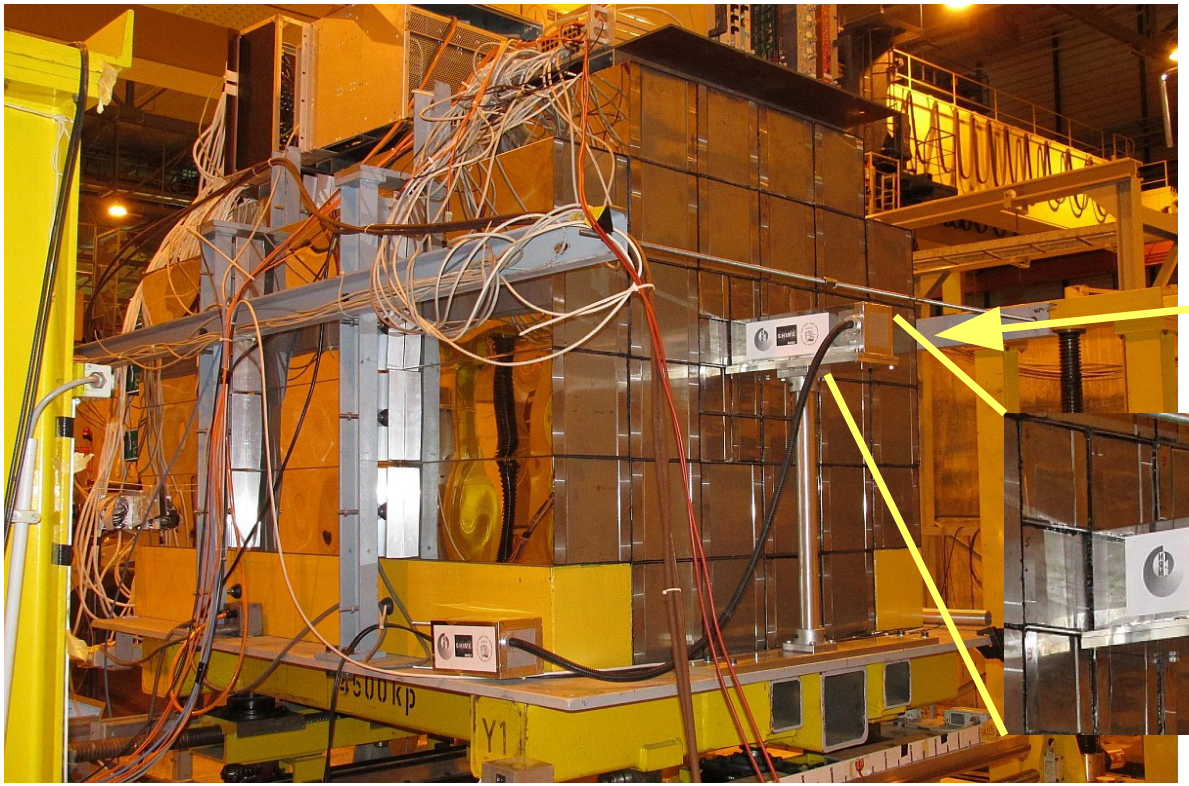


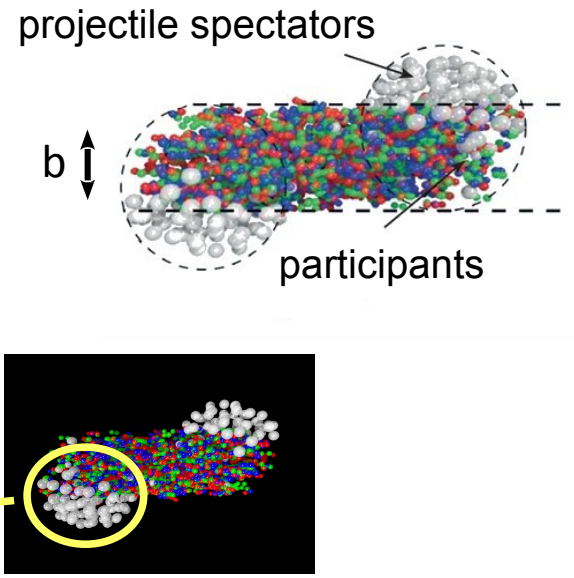
Ar + Sc @ 150 AGeV/c



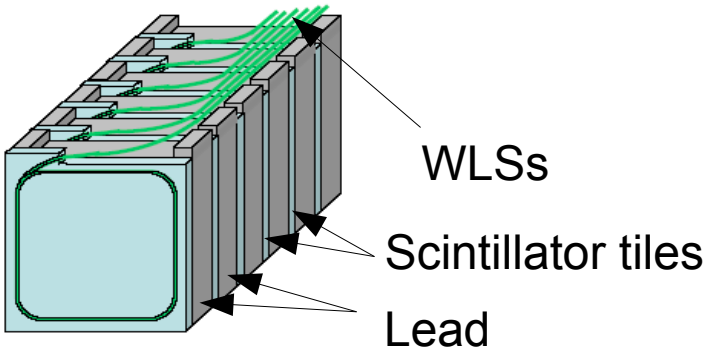
tracks reconstructed

Hadron calorimeter PSD at NA61/SHINE

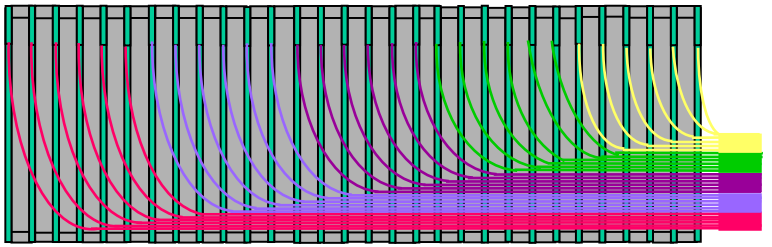


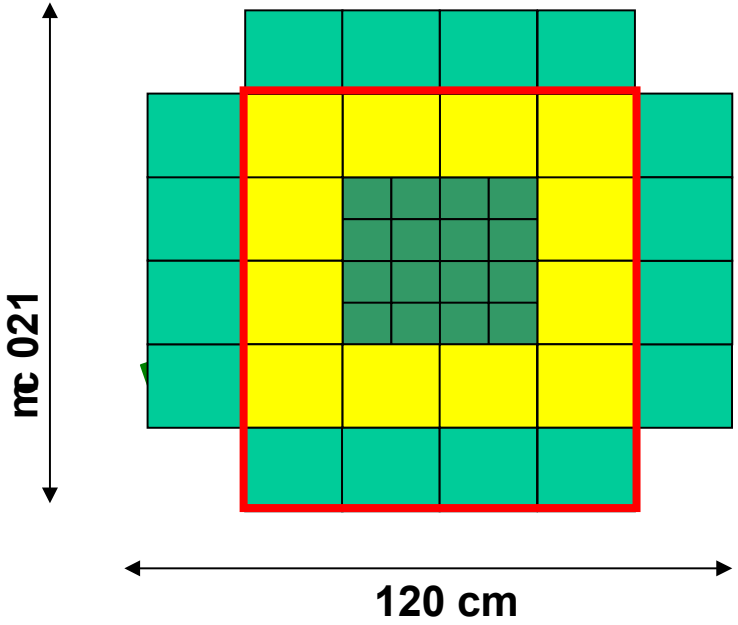


Hadron calorimeter (PSD) at NA61/SHINE



PSD section schematic


Module schematic



44 modules + 1:

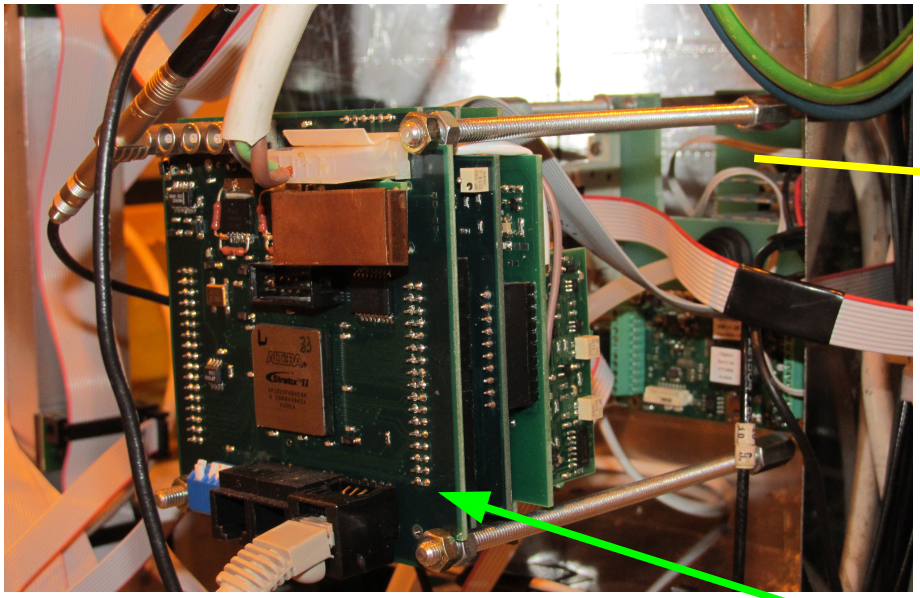
16 small: 10cm x 10cm size
28 large: 20cm x 20 cm size

(10 sections in 1 module) => ~5.6 int. length

1 short module of 2 sections

450 channels to read-out

Hadron calorimeter (PSD) at NA61/SHINE



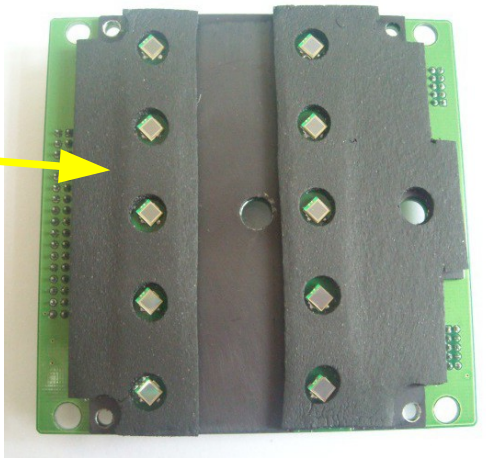
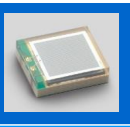


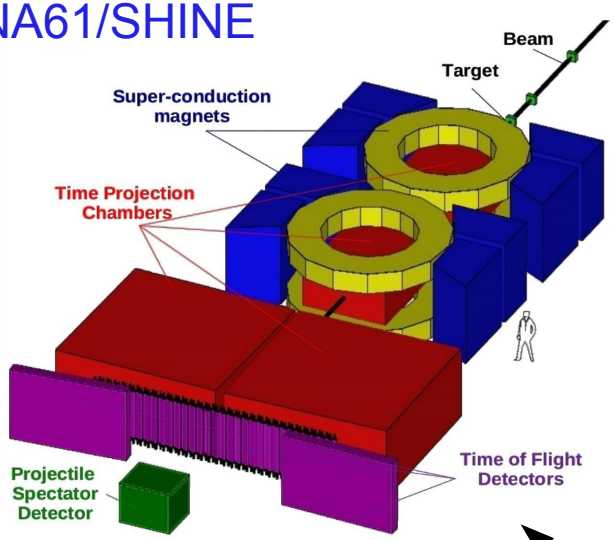
Photo-diodes on FEE board

FPGA based read-out electronics

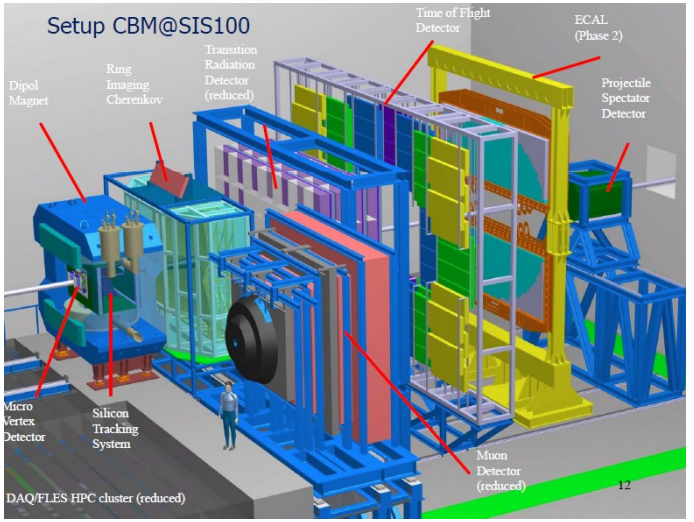
		
Name	Zecotek MAPD-3A	Hamamatsu S12572-010P
Number of pixels	135 000	90 000
Nominal gain	6 x 104	1 x 105
Pixel recovery time	1 – 10 μs	10 ns

Hadron calorimeter (PSD) at NA61/SHINE

NA61/SHINE

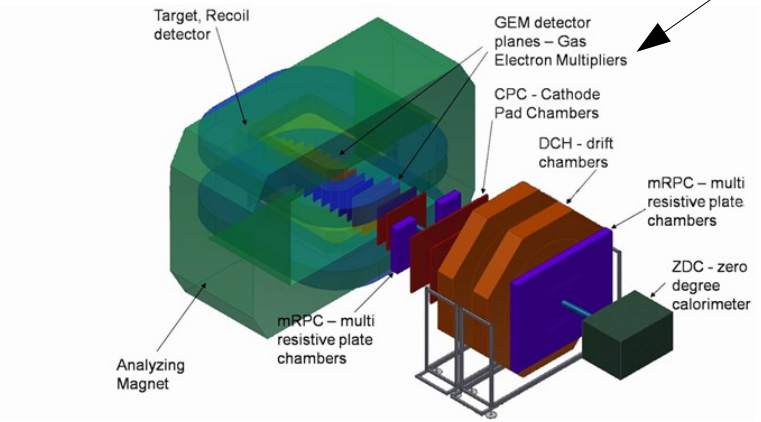


CBM @ FAIR

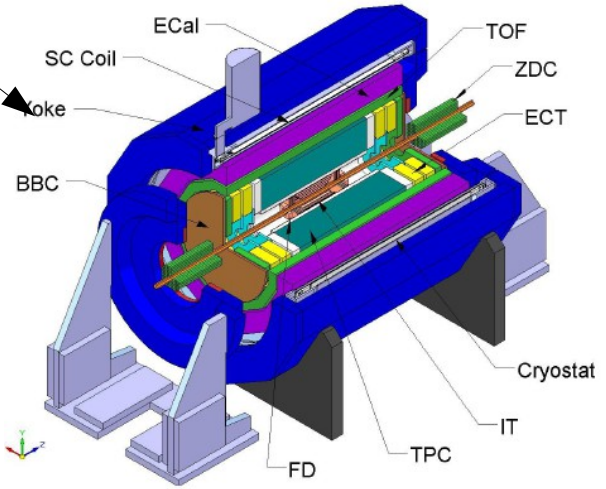


PSD

BM @ Nuclotron



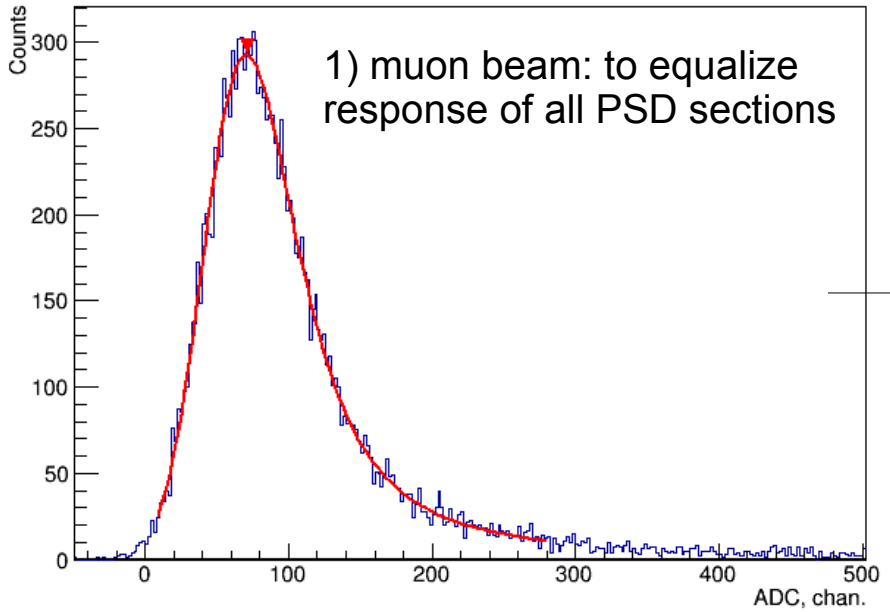
MPD @ NICA



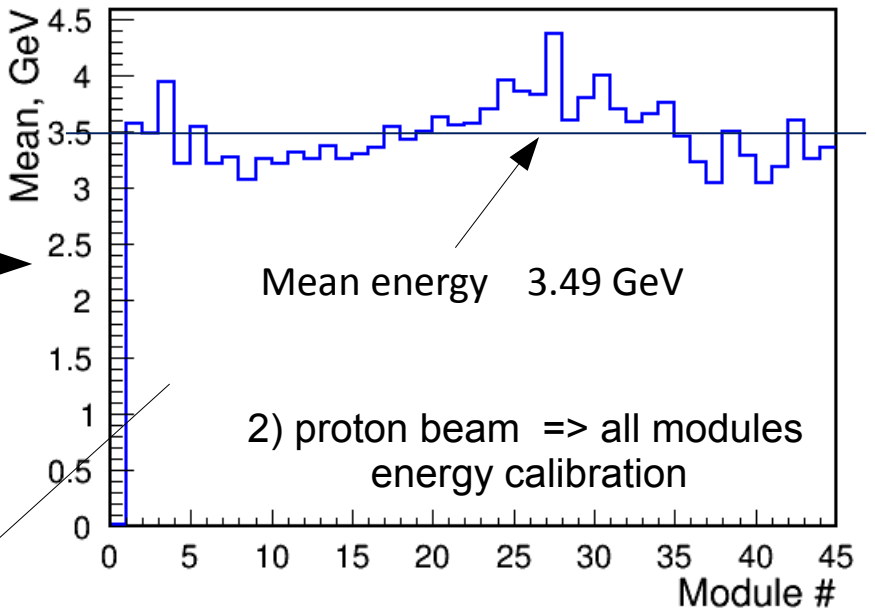
Hadron calorimeter (PSD) at NA61/SHINE

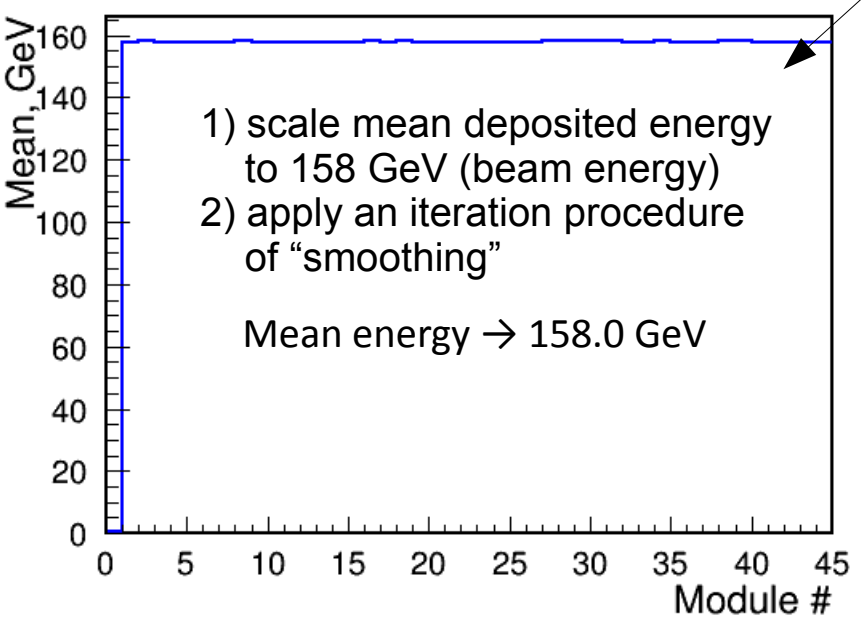
PSD calibrations

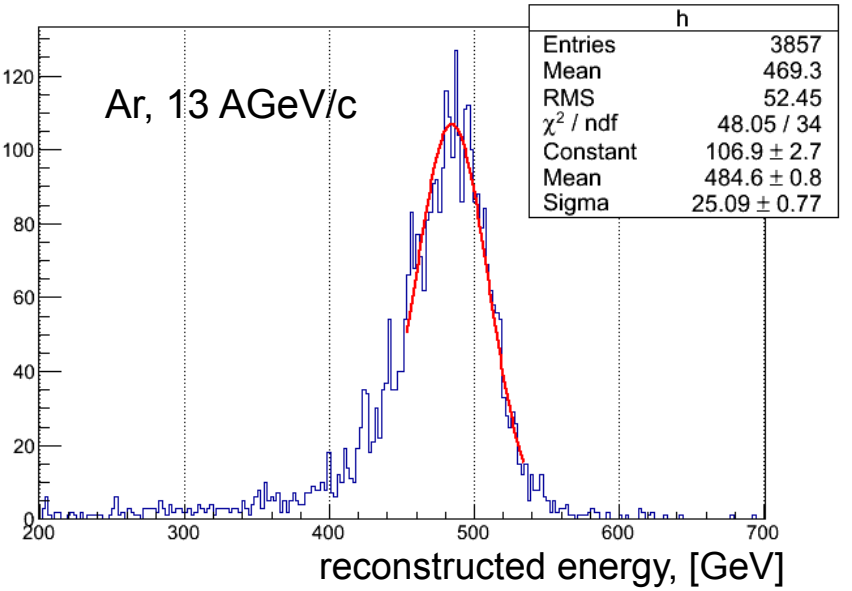
Muon spectrum in PSD section



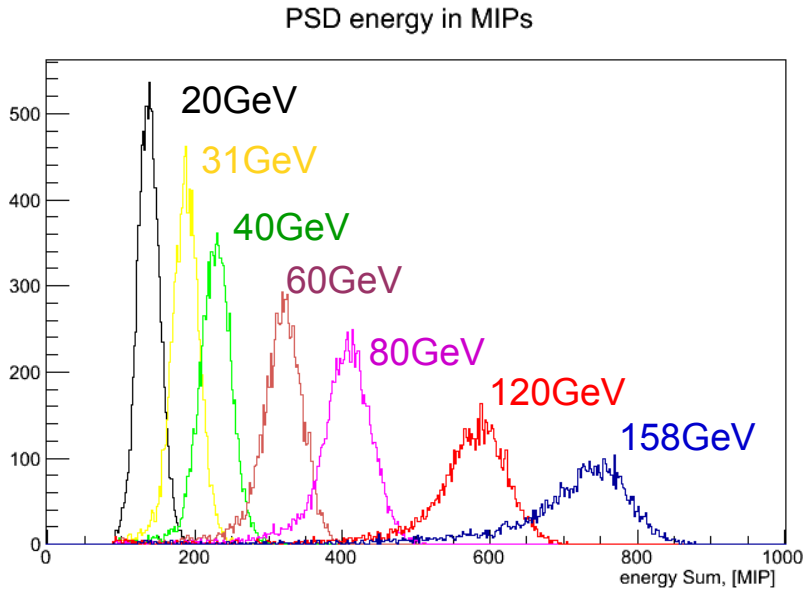
Deposited energy in PSD modules

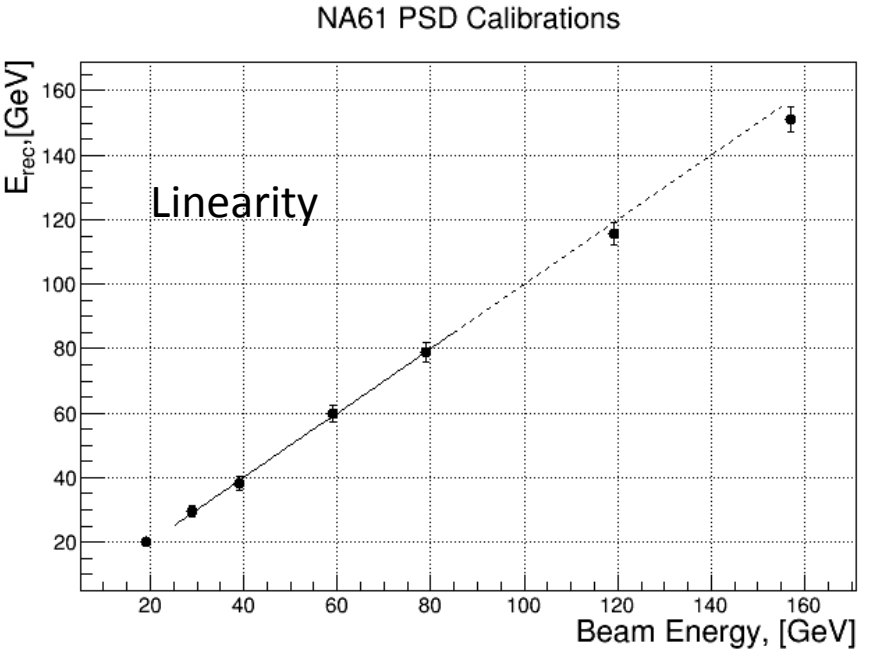


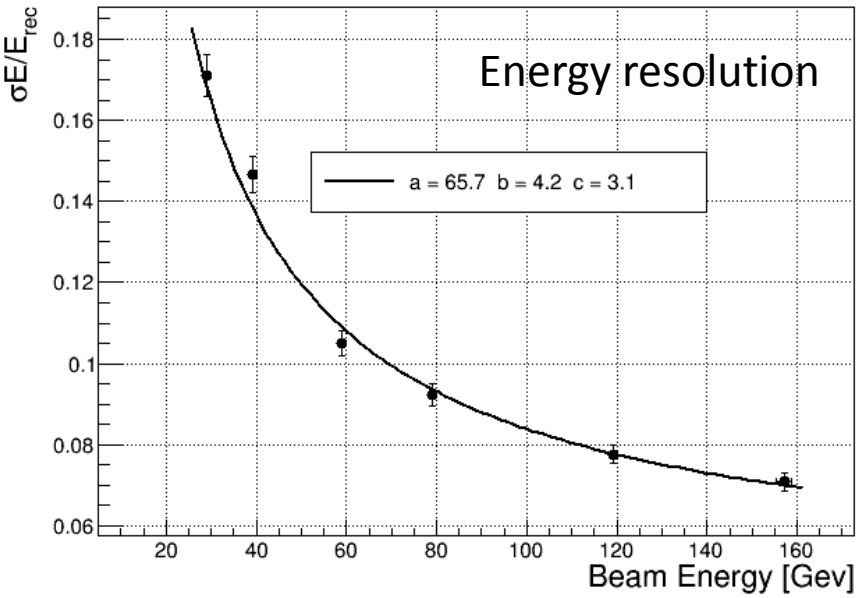


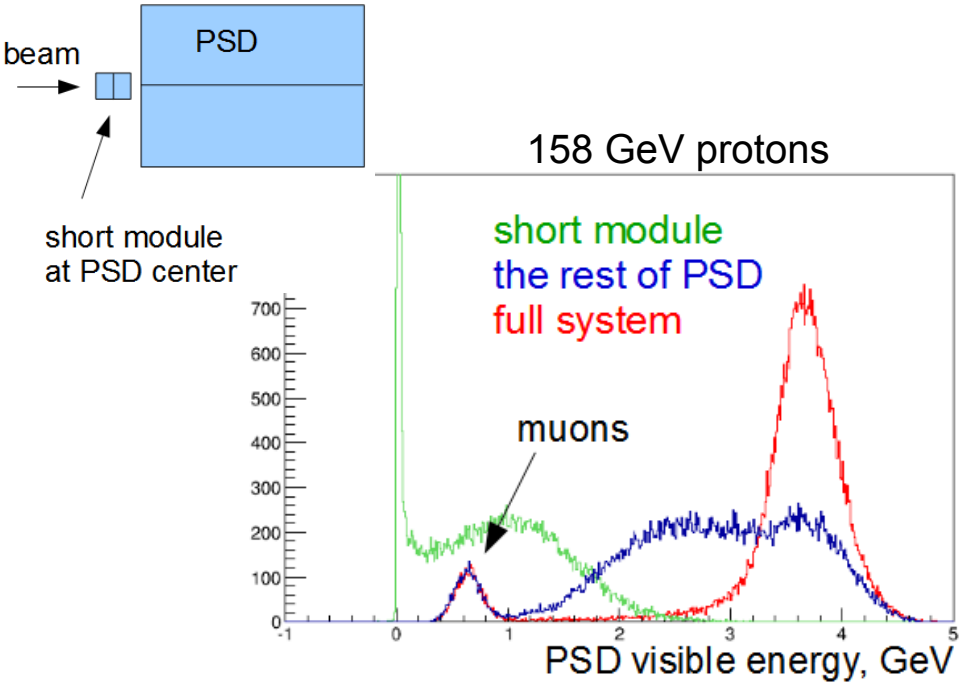


Hadron calorimeter (PSD) at NA61/SHINE

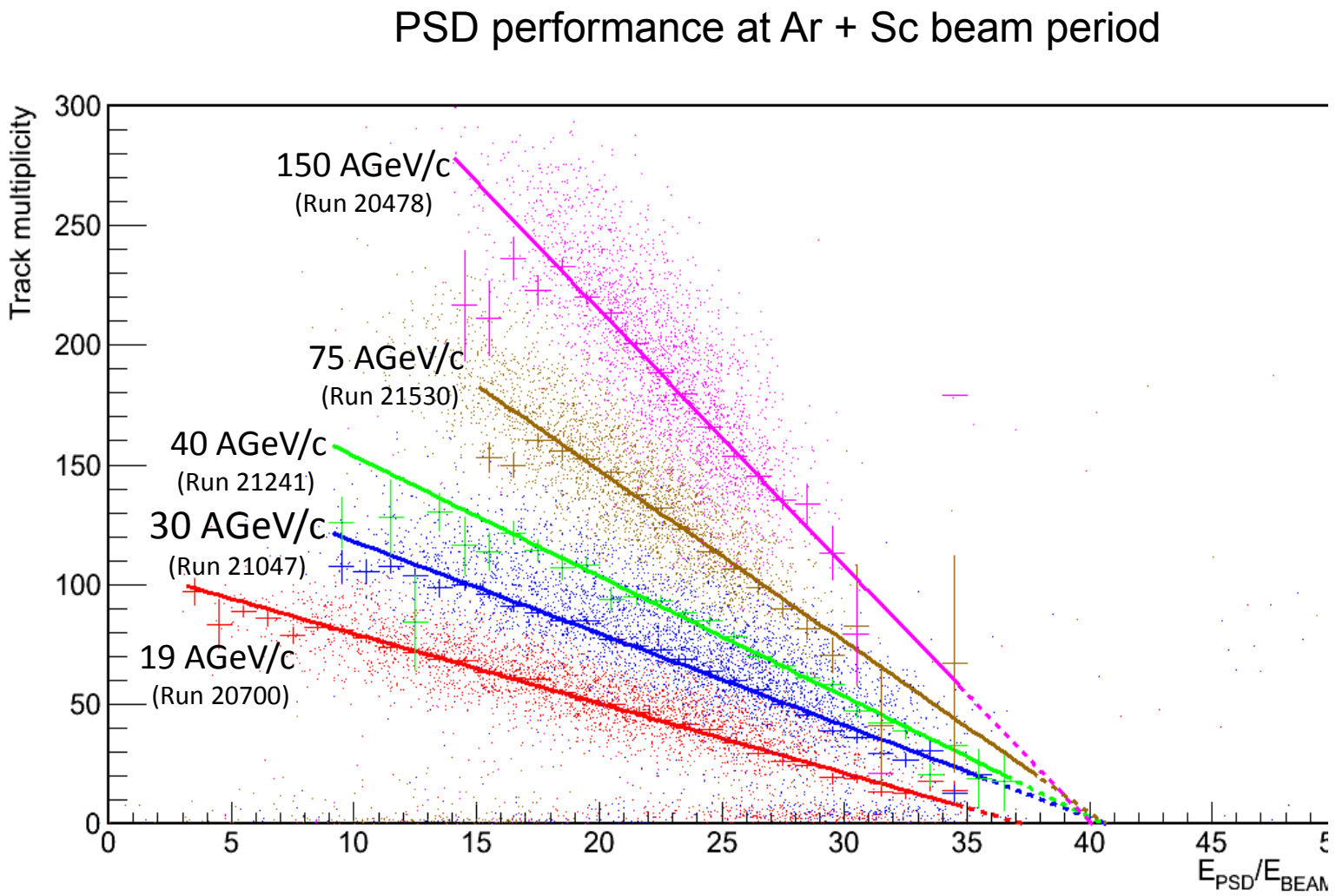




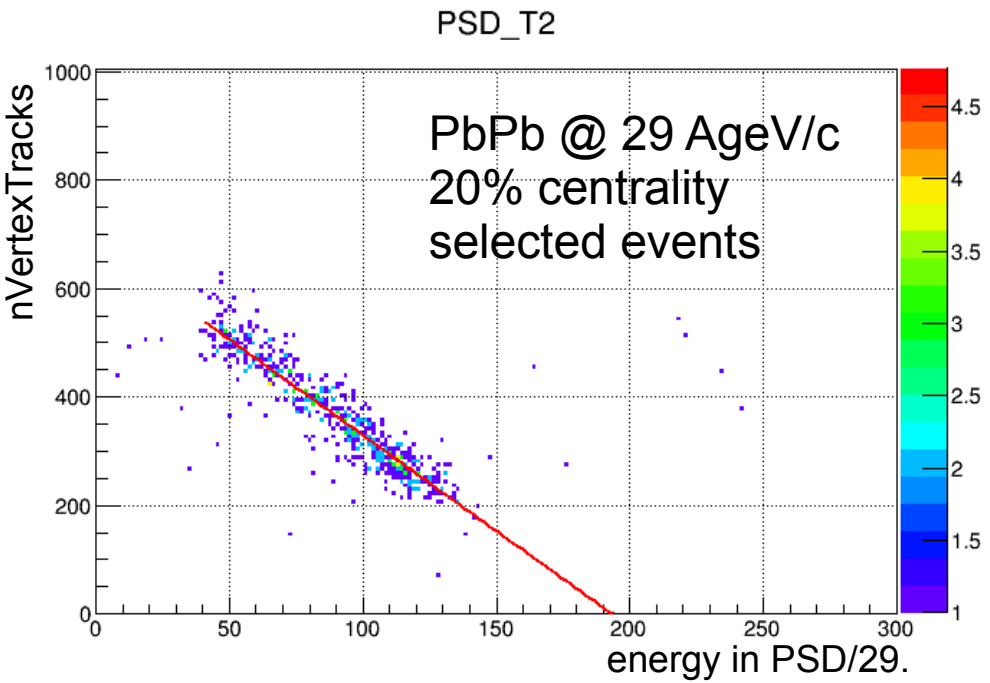


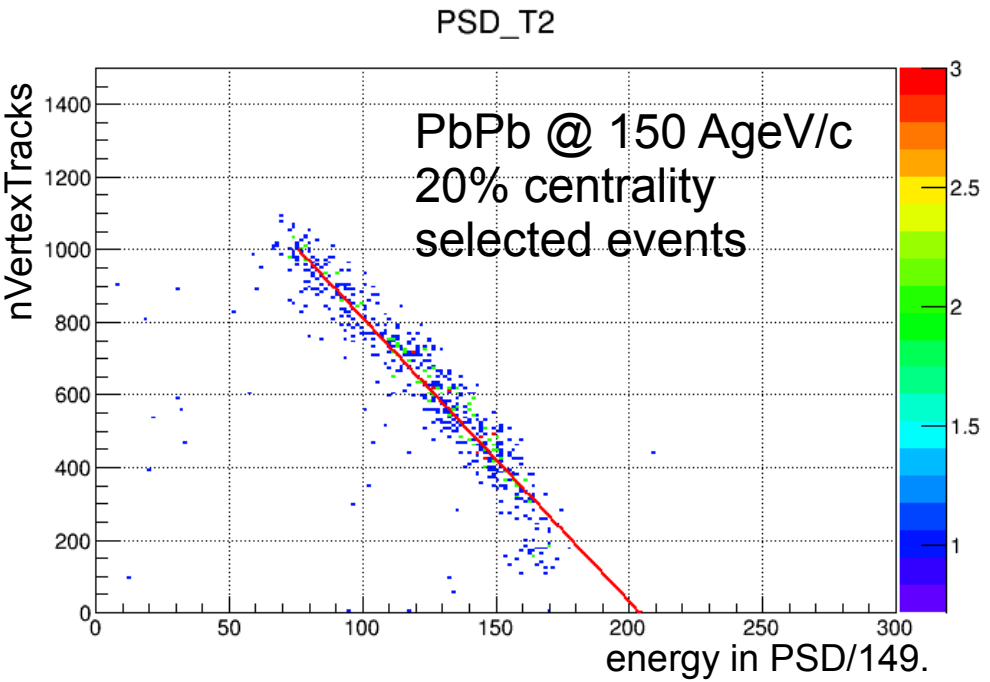


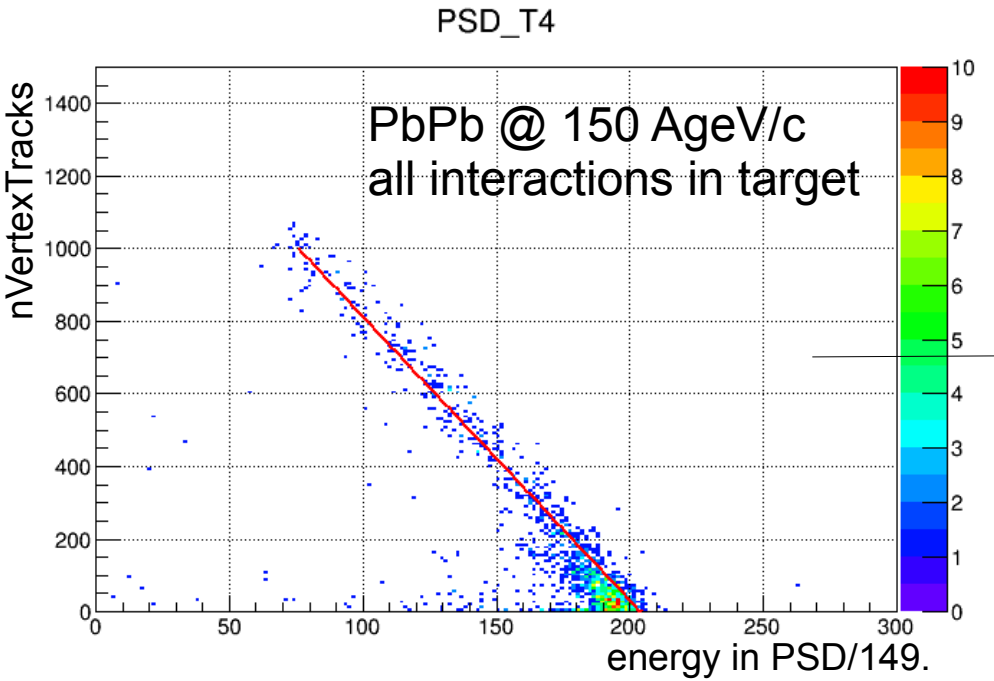
Hadron calorimeter (PSD) at NA61/SHINE

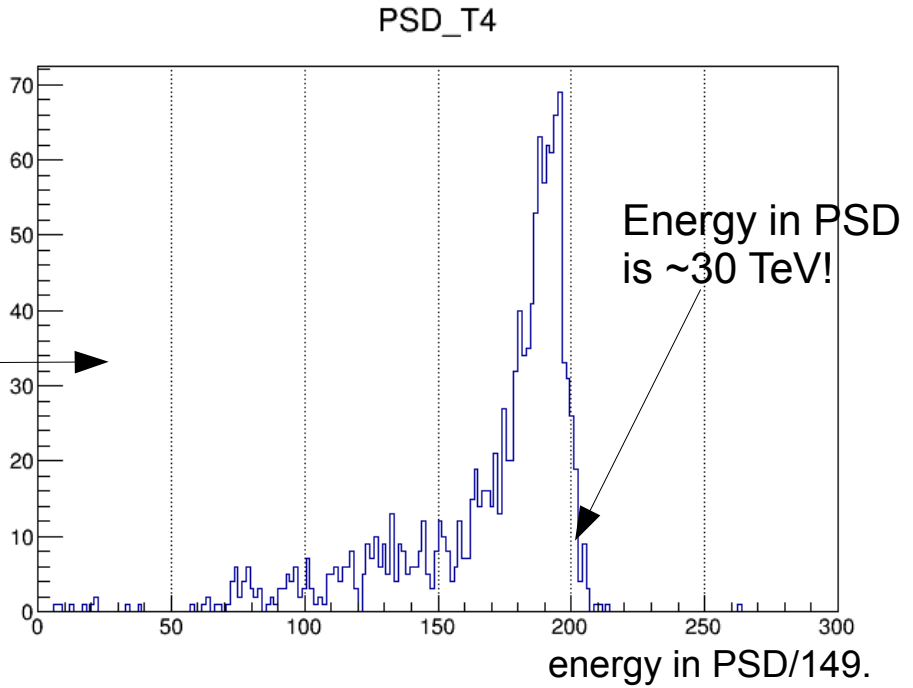


Hadron calorimeter (PSD) at NA61/SHINE



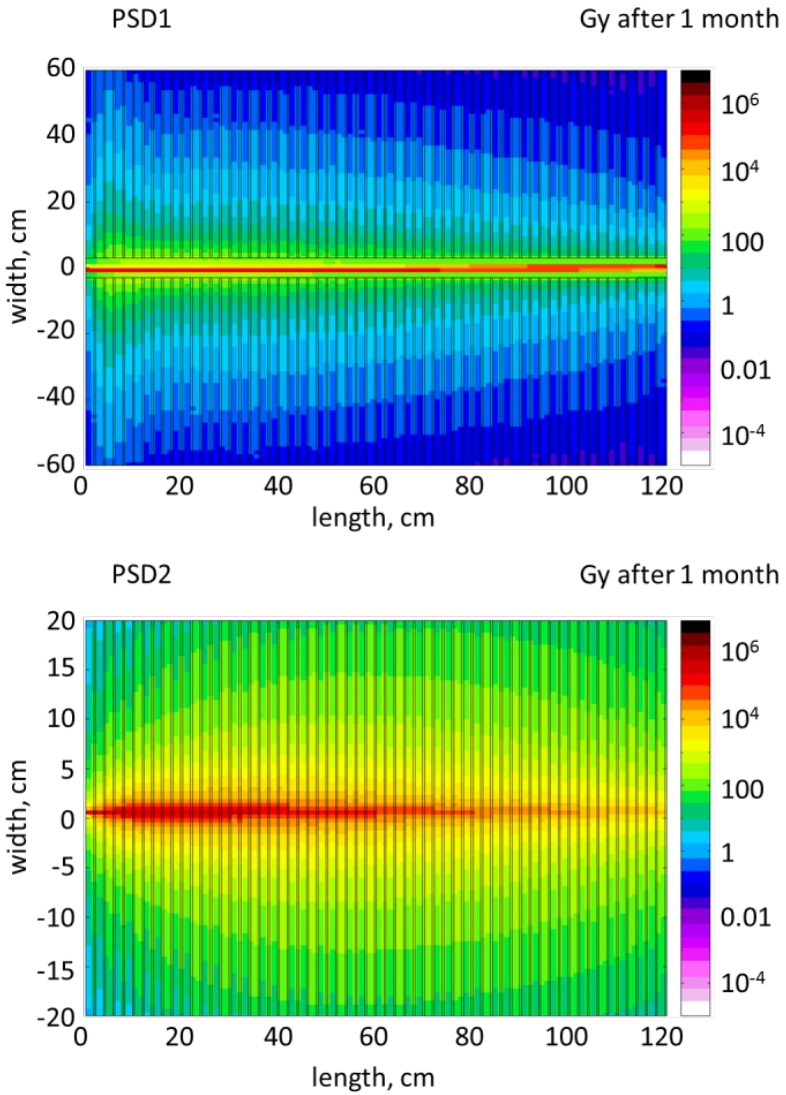






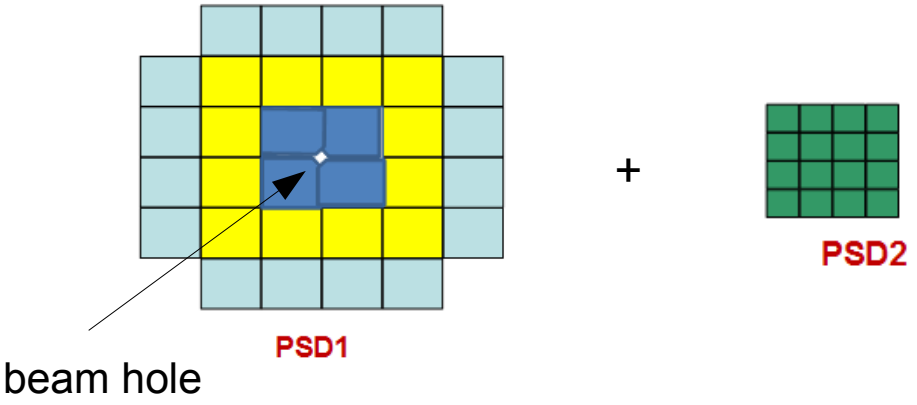
Hadron calorimeter (PSD) at NA61/SHINE

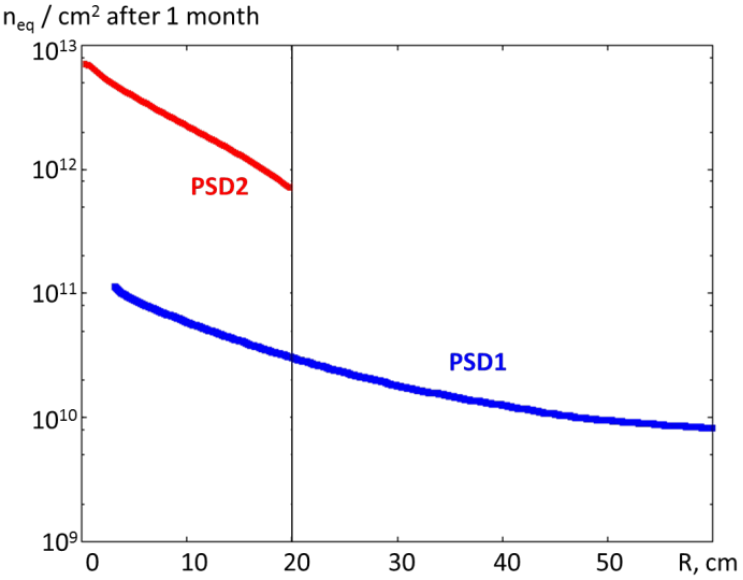
A.Senger
Fluka simulation for
Pb beam at rate 5×10^4 ions /sec



PSD at future (NA61 beyond 2020)

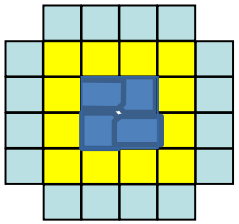
Radiation problem



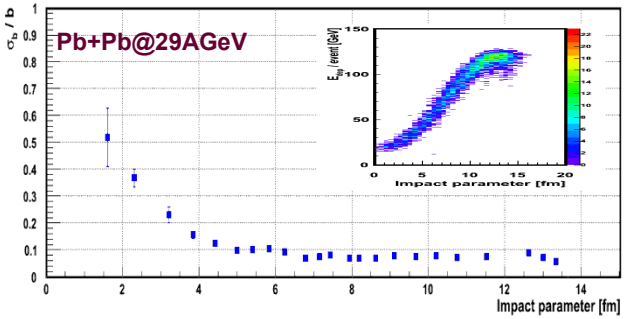


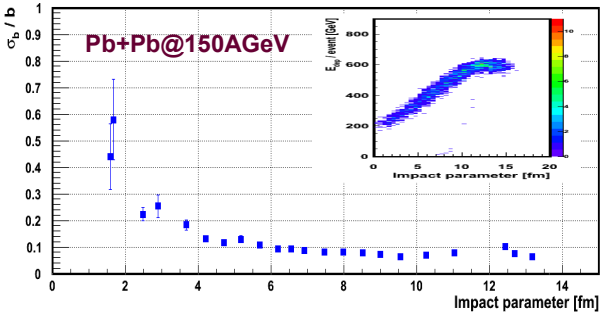
PSD at future (NA61 beyond 2020)

Centrality determination with new PSD schematics..

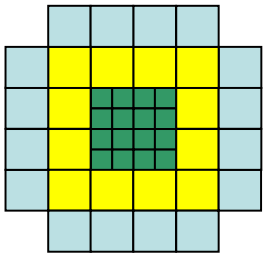


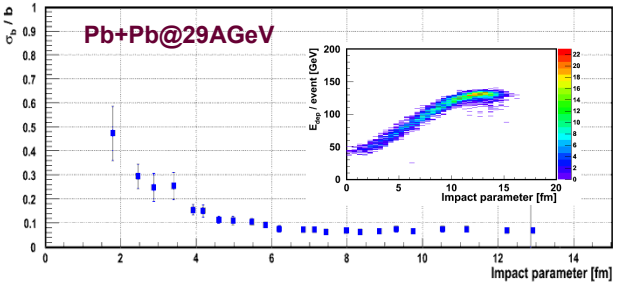
PSD1 + PSD2

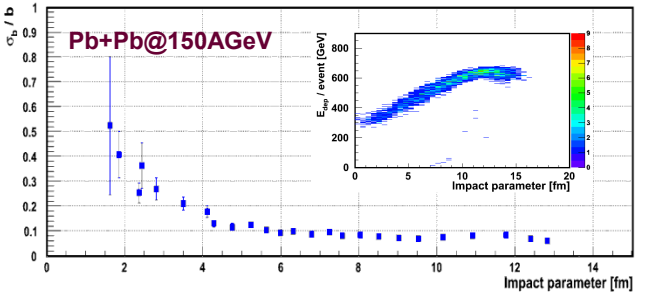




…. and comparison with present PSD

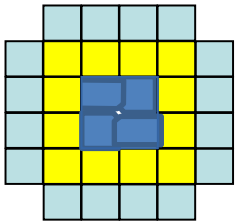




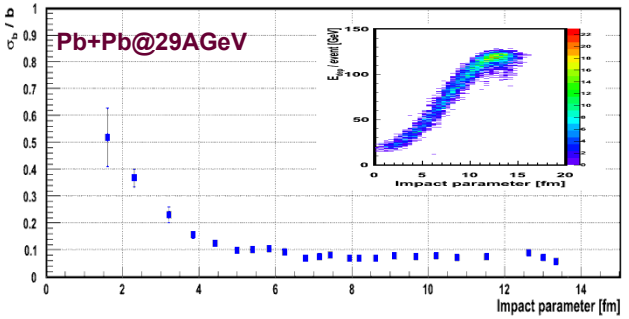


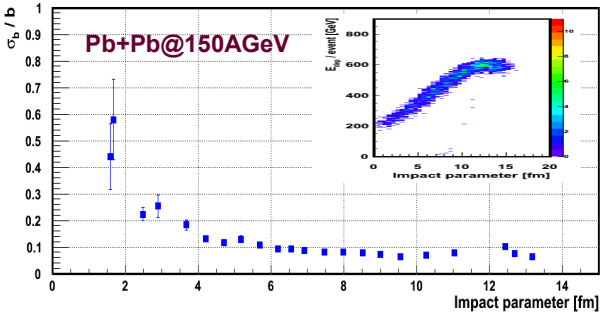
PSD at future (NA61 beyond 2020)

Centrality determination with new PSD schematics..

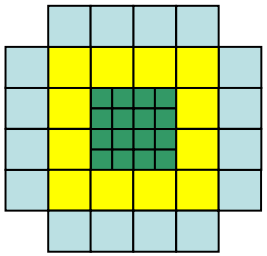


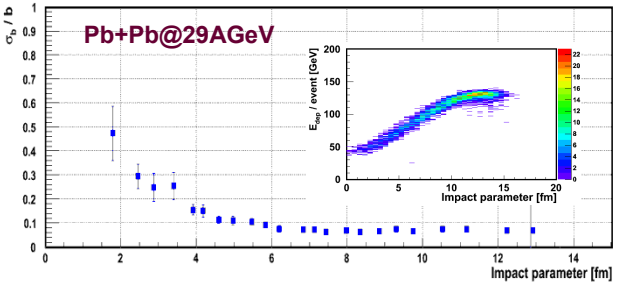
PSD1 + PSD2

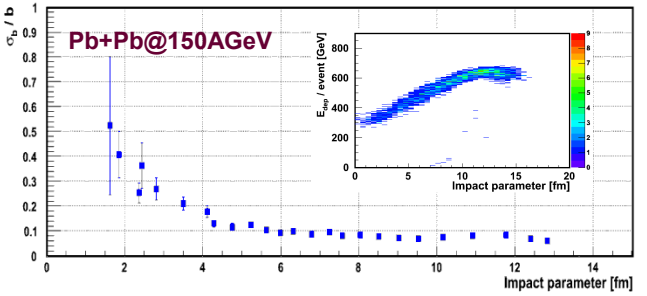




…. and comparison with present PSD

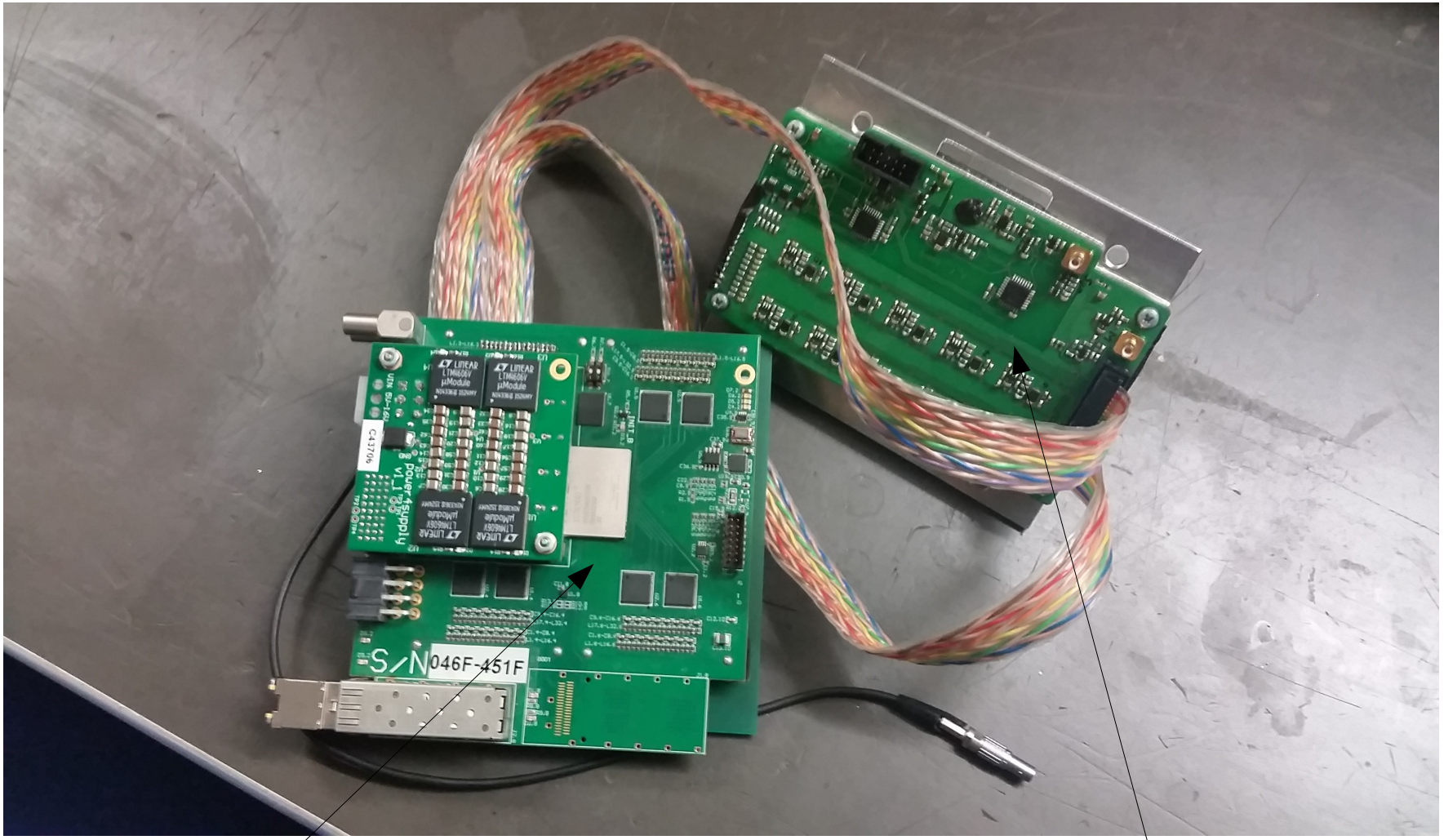






PSD at future (NA61 beyond 2020)

New fast and low noise read-out



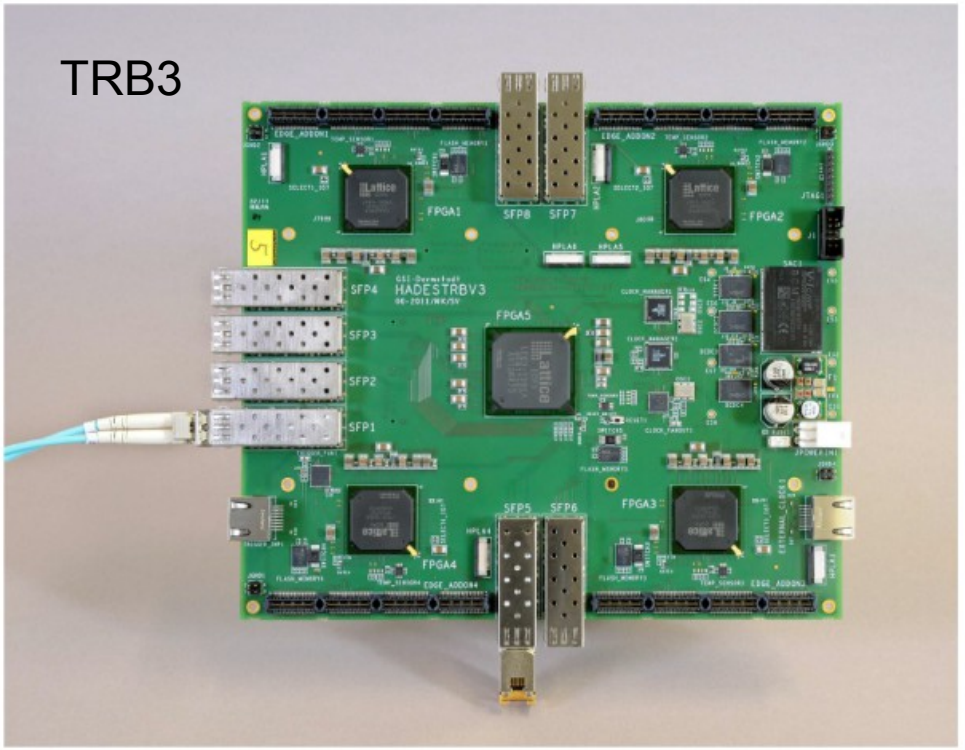
ADC64s electronics

FEE with new differential outputs

64 channels FPGA based read-out board

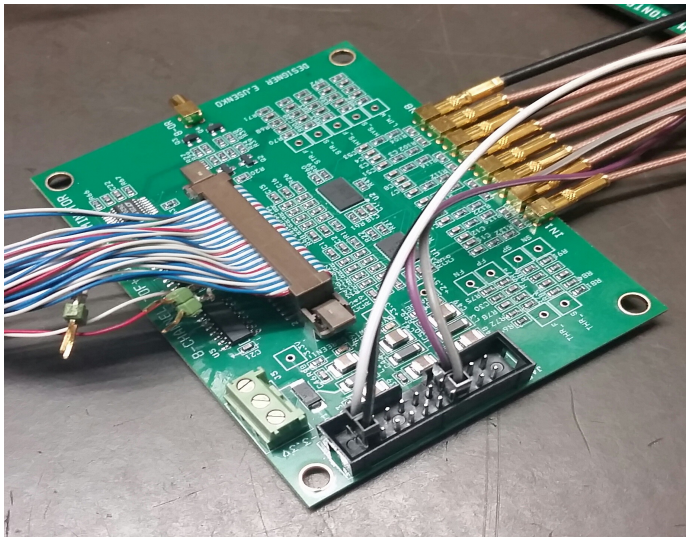
PSD at future (NA61 beyond 2020)

CBM: 10 MHz trigger rate



TRBv3 - multi purpose time digitization board:

- 23 ps RMS TDC (FPGAs)
- up to 256 channels
- DAQ functionality
- fast data transfer via gigabit Ethernet



ToT board - front-end charge-to-Time-Over-Threshold conversion:

- 8 MMCX inputs → 32 TDC channels on TRBv3 needed
- NINO chip based design
- threshold settings through TRB3 SPI protocol

Hadron calorimeter (PSD) at NA61/SHINE

Summary:

- PSD has been designed and (will be) used at heavy ion experiments

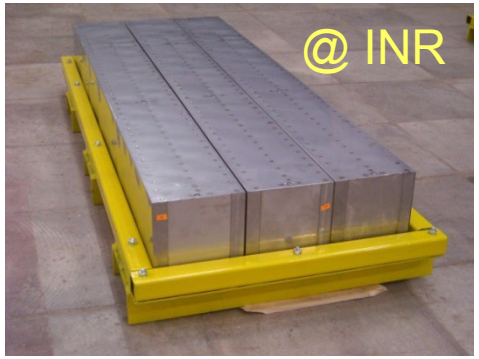
- performance of PSD calorimeter has been tested widely at CERN SPS

- new fast electronics has been developed and tested with PSD:

  1) ADC64s board (JINR, Dubna) + new FEE

  2) ToT board (INR, Moscow) + TRB3 read-out

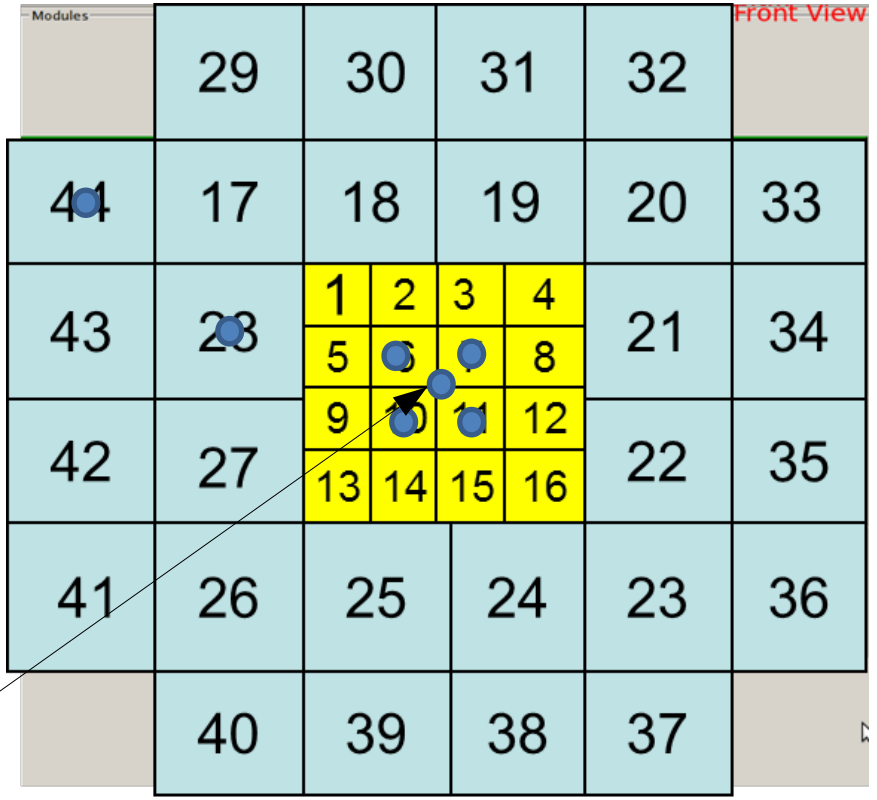
- future PSD modifications are under discussions now



Backup slides

Hadron calorimeter (PSD) at NA61/SHINE

Energy scan of modules:



beam centered on mod#45 (short) before the center of PSD