Forward Wall status and options.

M.Golubeva, F.Guber, A.Ivashkin, S.Morozov
INR RAS, Moscow

Use of present FW for experiments at SIS18

- problems;
- options;
- performance at Ag-beam.

Construction of new FW:

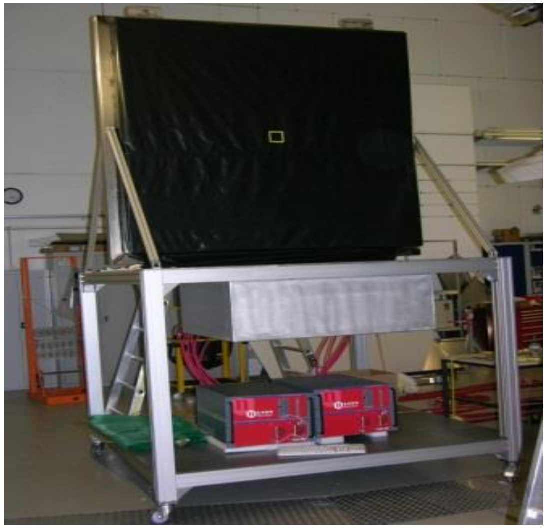
- scintillator cells with WLS-fiber and SiPM readout;
- direct PMT readout;
- direct SiPM readout.

FW vs hadron calorimeter at SIS100.

Outlook.

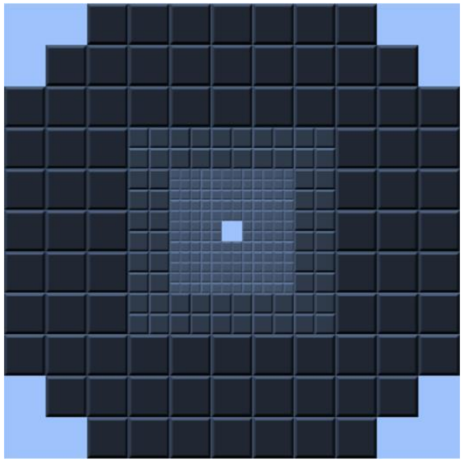
The tasks for FW:

- Measurement of the reaction plane.
- Measurement of the reaction centrality.
- Measurement of the hit multiplicity.
- Identification of the fragments (Z^2 measurements).
- Particle identification in forward rapidity (needs TOF with good time resolution).



The problems with current FW.

- It is too old - PMTs in central part are not working properly.
- Occupancies in large outer cells are around 30% for Au+Au (Ag+Ag) reaction.
- Time resolution is about 400 – 700 psec.
- FW support structure should fit FD and ECAL

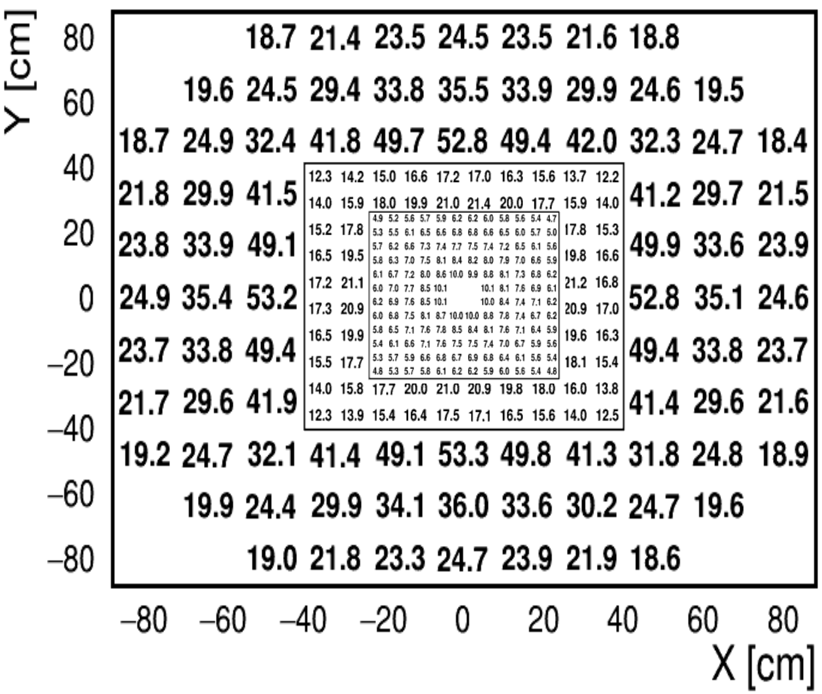


288 cells:
140 central,
64 middle,
84 outer.

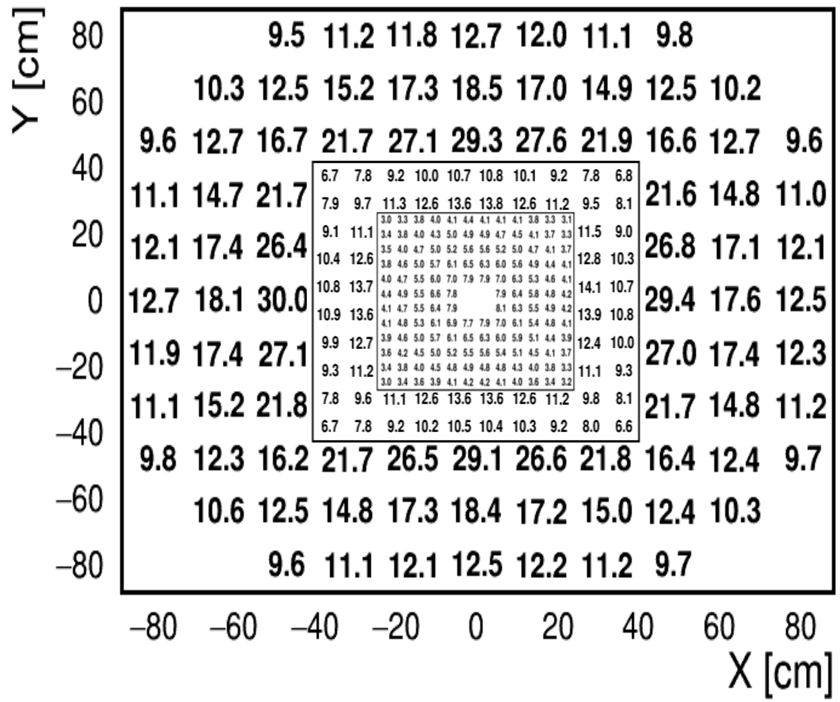
What performance of present FW is expected?

Occupancy (%) for FW at 7.5 m from target.

Au+Au@1.23 AGeV



Ag+Ag@1.65 AGeV

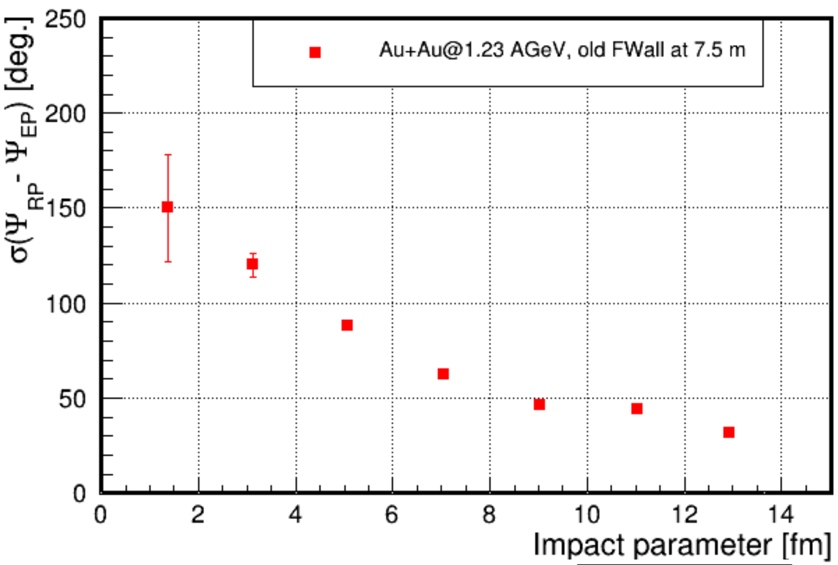


Result of simulation in HGEANT framework. Occupancy for Ag-beam is a factor ~1.7 lower than for Au-beam, but achieves 30% in large cells.

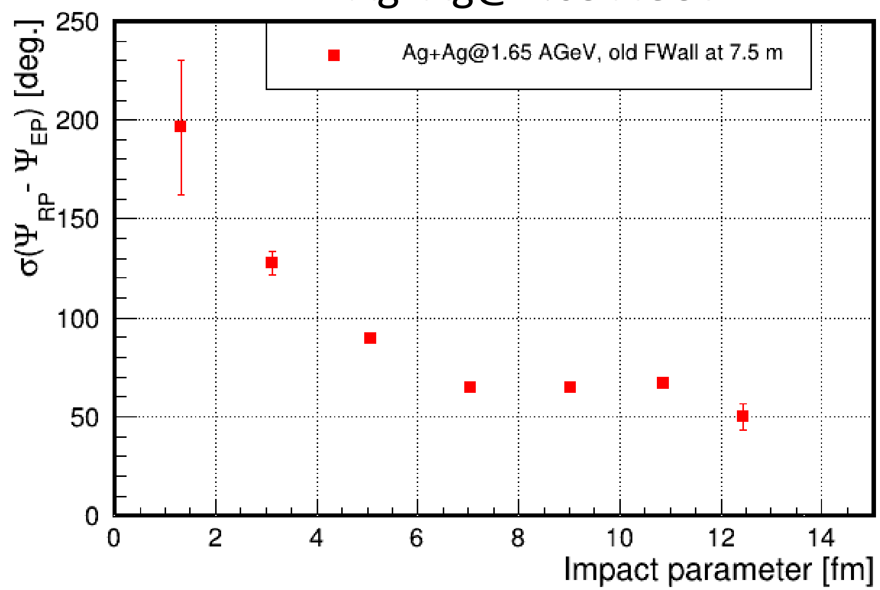
Reconstruction of reaction plane.

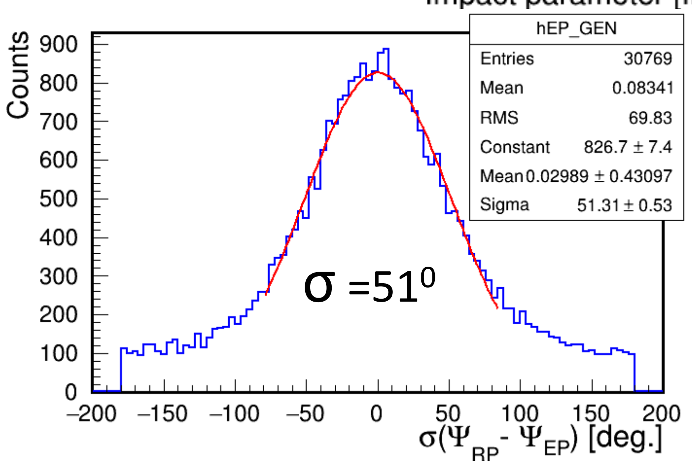
FW at 7.5 m.

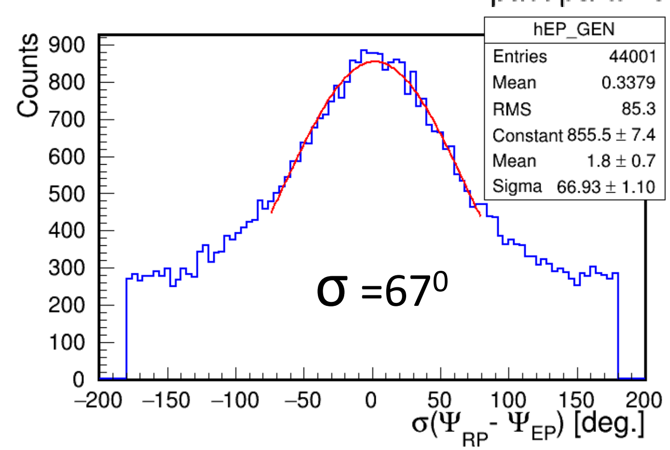
Au+Au@1.23 AGeV



Ag+Ag@1.65 AGeV

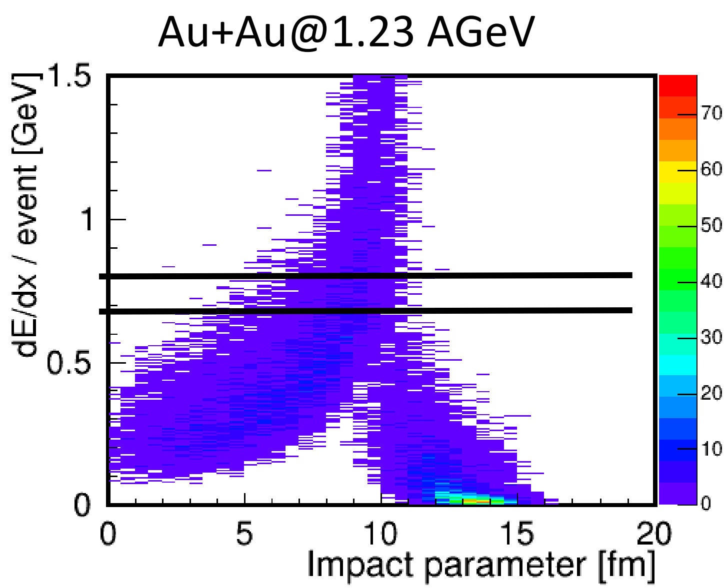


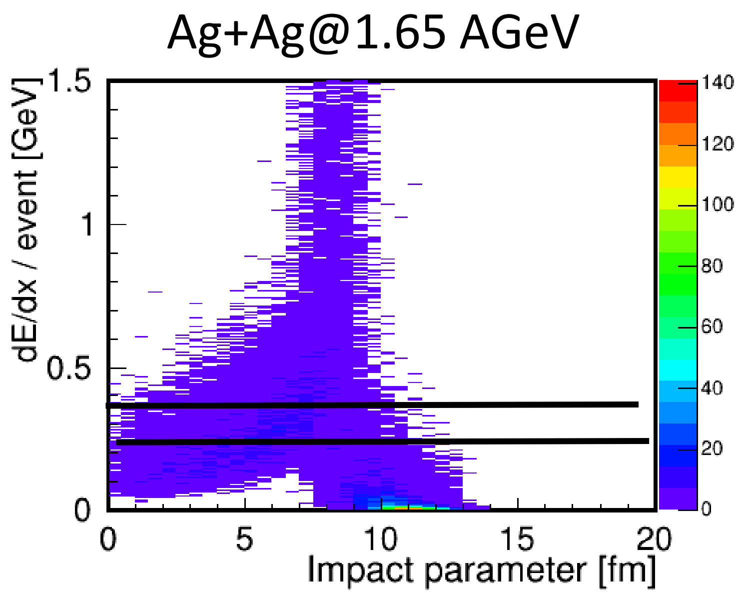


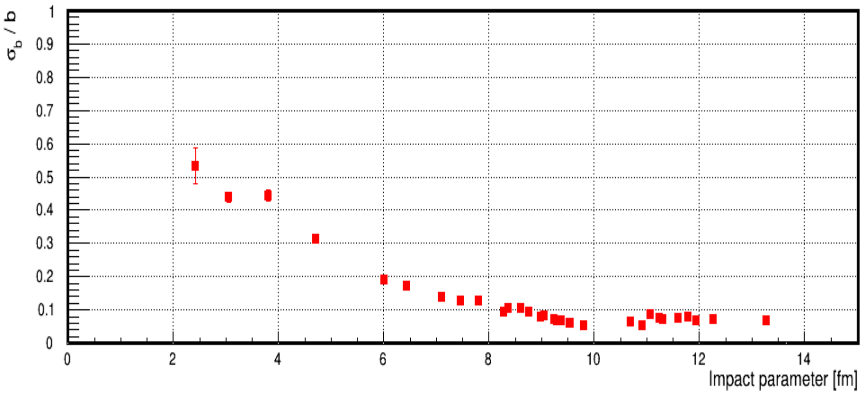


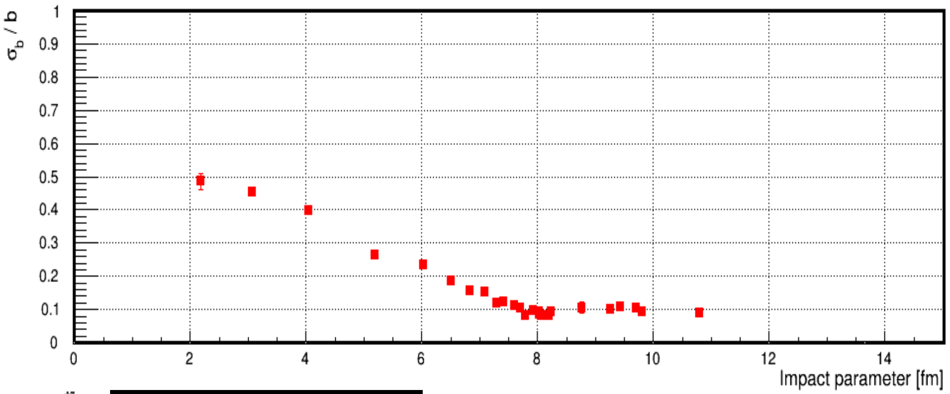
Difference between generated and reconstructed event planes (b < 11 fm)

Centrality determination from the energy depositions in FW.

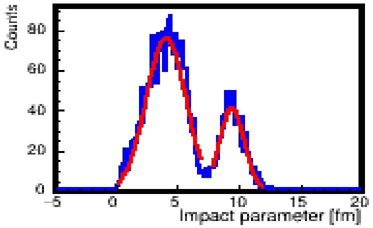






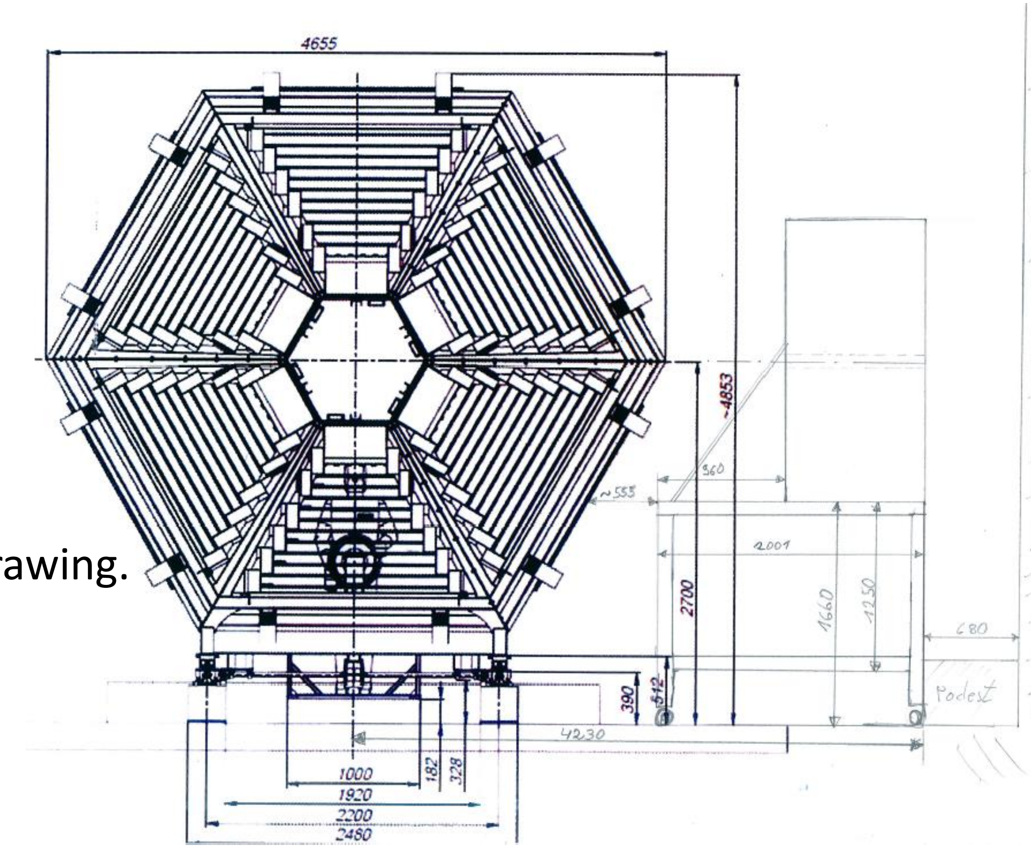


Ambiguity in energy deposition for central and peripheral events exists.



Present Forward Wall frame vs ECAL frame and FD

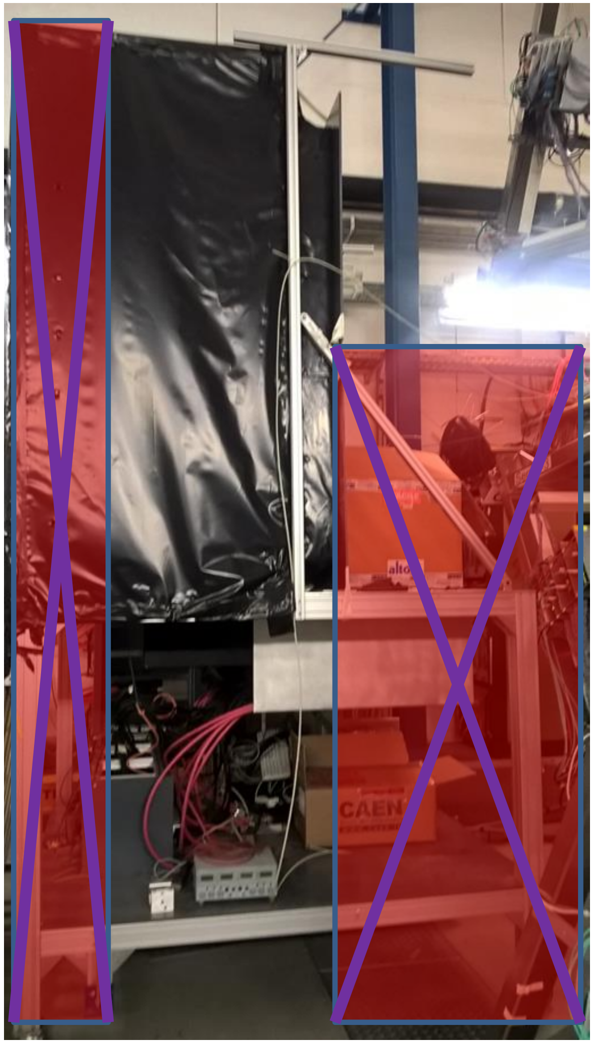
Erwin showed recently that the current FW frame in service position is not in conflict with ECAL.



Erwin's drawing.

Technically the present FW can be used with ECAL.
Probably, small modification should be done to put the FW on the railway system of calorimeter with roller linear guide.

Spare variant with present FW frame.



At present, FW frame has dimensions:

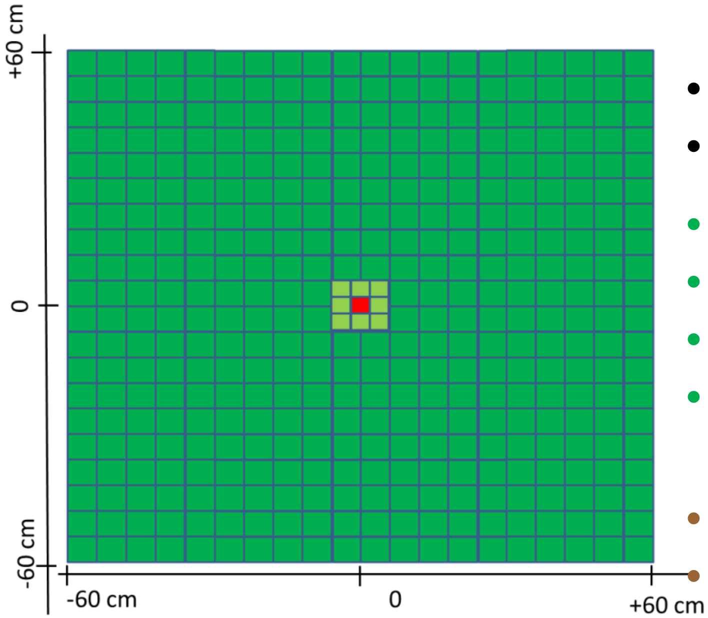
2x2 m^2

(width and depth).

If necessary, the FW frame depths can be reduced for about 70 cm upstream and 30 cm downstream. The mechanical work can be done without dismounting of FW.

1 m depth is rather safe to store FW in the cone of HADES cave.

New FW – scintillator cells WLS-fiber and SiPM-readout.

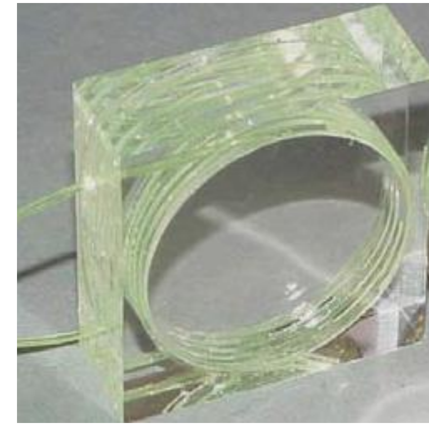


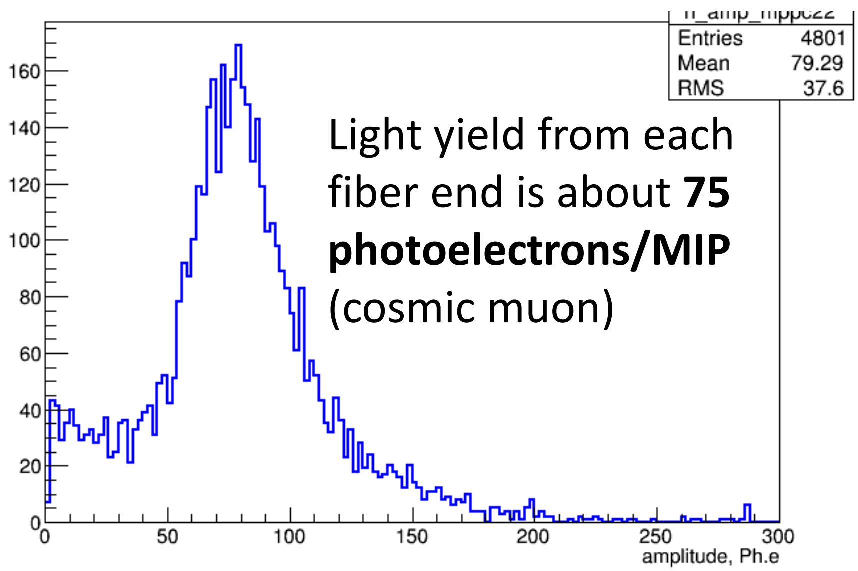
- **cell size 6x6x1.5 cm^3.**
- **Total number of cells ~400**

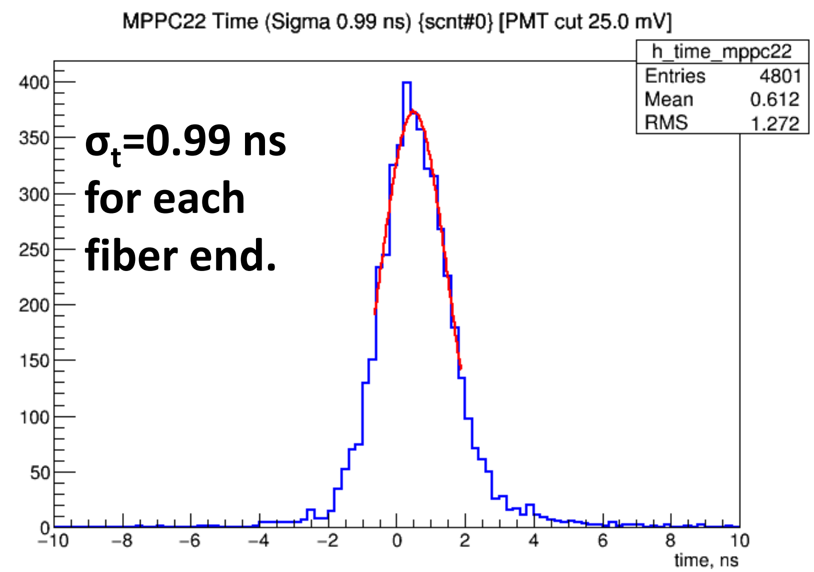
- **High light yield,**
- **Identification of double hits ,**
- **Low occupancy ~10%,**
- **Compact, weight~20 kg,**

but :

- **Time resolution is only 1 ns – bad TOF capability,**
- **New FEE, Slow control,**
- **Cost?**

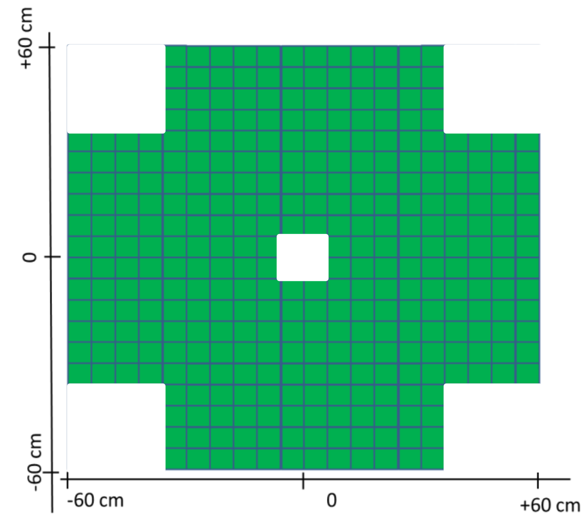




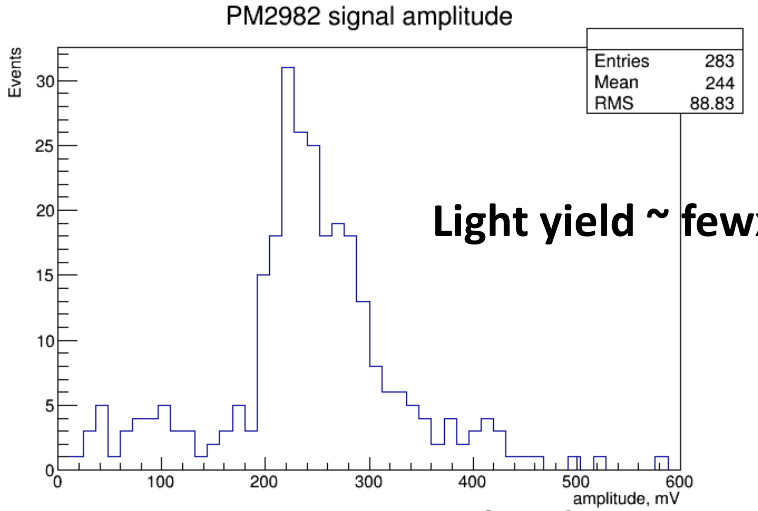


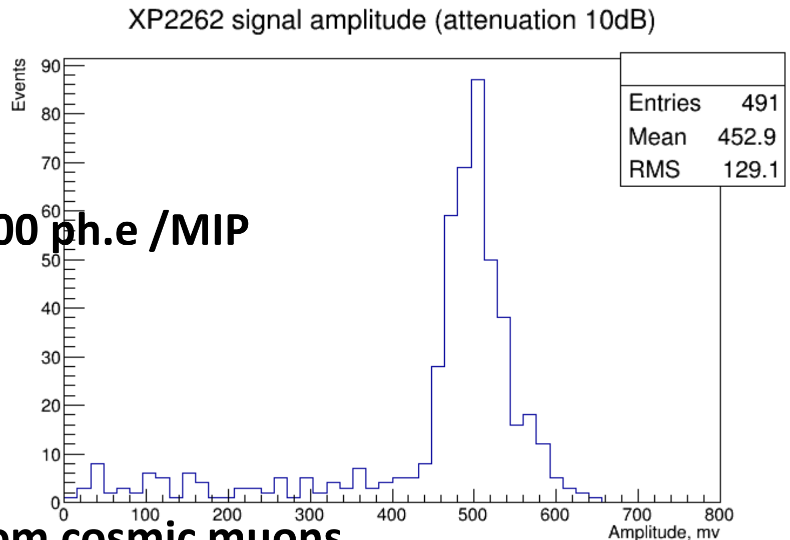
Another option - with existing PMT direct readout.

- PMT is attached to cell directly without lightguide.
- Much more light.
- Better time resolution.
- Use of existing electronics - lower cost.



- cell size 6x6x1.5 cm^3.
- Total number of cells ~300
- Photodetectors – existing FW PMTs:
- XP2982 -1 inch
- XP2262 -2 inch

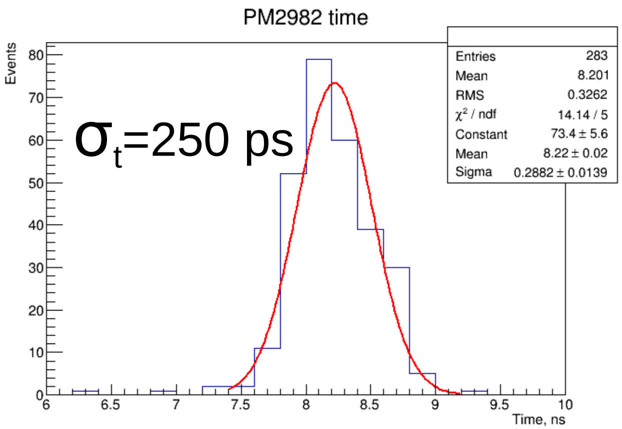


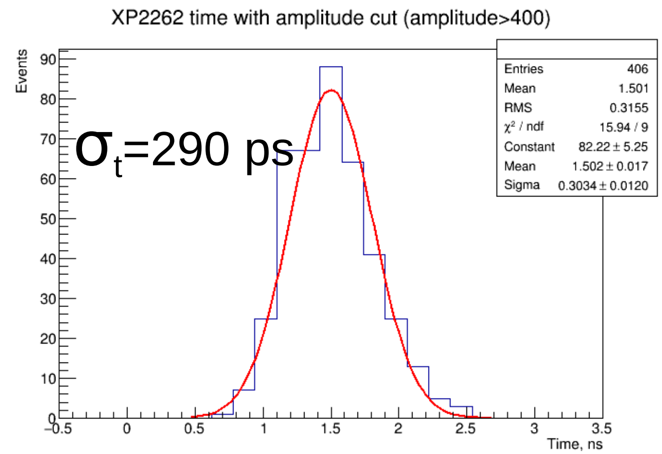


Light yield ~ fewx100 ph.e /MIP

Amplitude spectra from cosmic muons

Time resolution with direct PMT readout





- **The time resolution is a factor of 2 better than that of present FW.**
- **Larger PMT provides worse time resolution.**
- **It seams that cell size 6x6 cm^2 can not provide better time resolution due to spread of light propagation inside scintillator.**
- **Suggested option does not provide good TOF capability**.

Is there reason to build new FW with only slightly better performance?

Note, that FW PMTs are rather bad!

Can we construct new FW with good TOF (<100 ps time resolution)?

Recently NeuLAND detector at FAIR constructed 3 m long scintillator bar with direct SiPM readout at both ends.

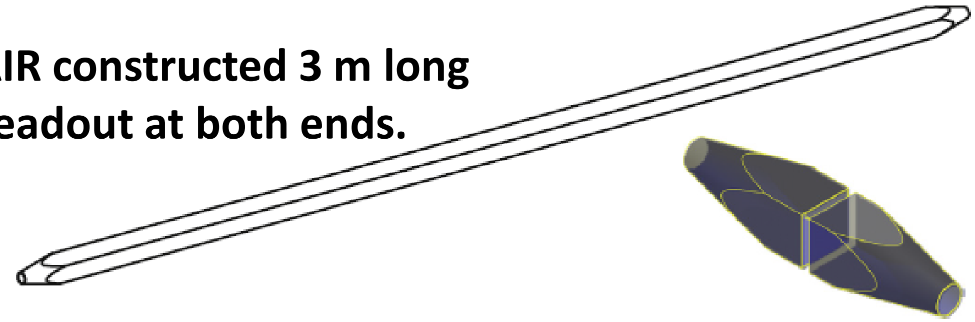
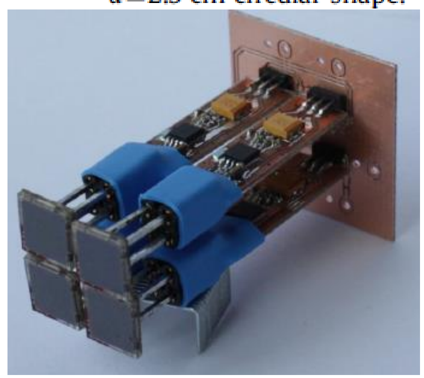
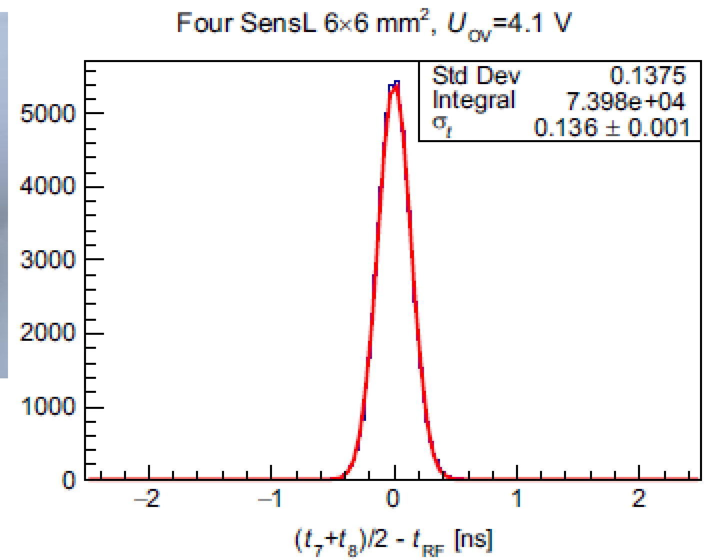


Fig. 1. NeuLAND bar. The left side shows the entire, 270 cm long NeuLAND bar. The right side shows the two tapered sides converting from 5×5 cm^2 square shape to $d = 2.5$ cm circular shape.

Array of 4 SiPMs, 6x6 mm^2 each





The time resolution 136 ps was obtained .

It seams that the scintillator bar is the best geometry for the time measurements due to the compensation of the time of light propagation to both end.

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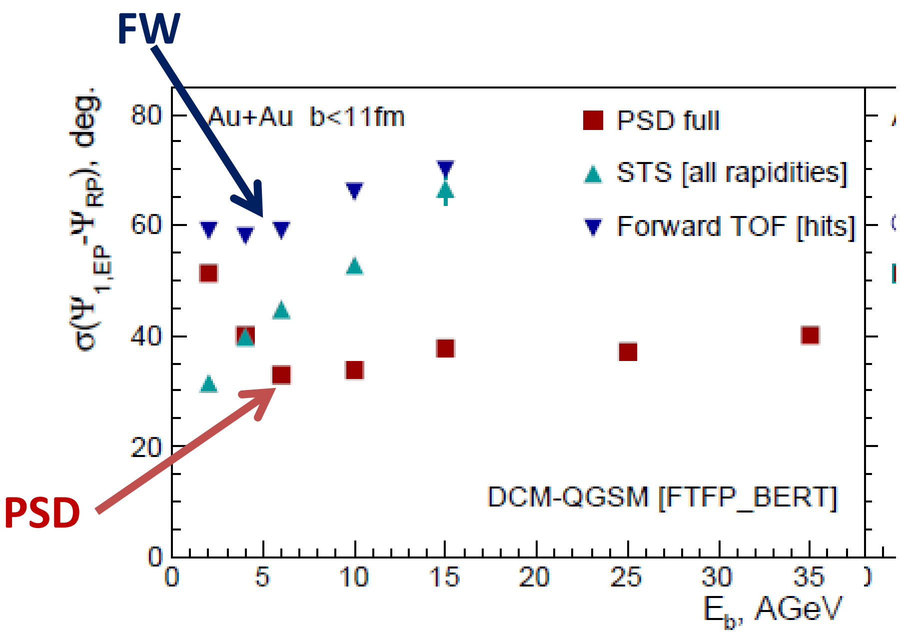
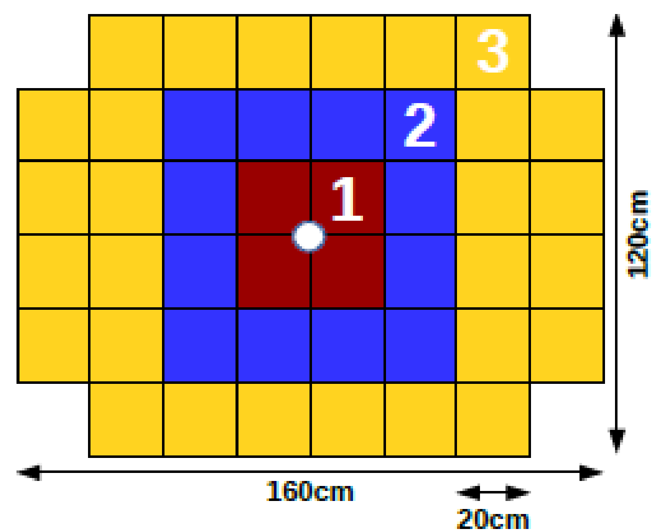
Option for SIS100

We propose to use PSD CBM hadron calorimeter for centrality and reaction plane determination at SIS 100.

Significantly better performance in comparison with FW can be obtained.





Event plane reconstruction with different detectors

Outlook

- **A different options of FW are considered.**

- **Present FW seams to be able to work in HADES with ECAL at SIS18. Probably, small modifications of the frame could be requested.**

- **The option of highly granulated FW with WLS-fiber and SiPM light readout is rather attractive due to compactness and high light yield. But it requires new FEE, Slow Control and resources. Time resolution of 1 ns is a factor of 2 worse than in existing FW.**

- **The highly granulated FW option with direct PMT readout provides excellent light yield and a factor of 2 better time resolution <300 ps. New detector requires resources while the TOF capability is rather limited.**

- **One can consider other design of FW, consisting of the scintillator bars with direct SiPM readout instead of cell structure. Time resolution ~100 ps can be expected if to use the light readout from both ends. But some R&D are requested.**

- **Use PSD CBM hadron calorimeter for centrality and reaction plane determination at SIS 100 will significantly improve performance in comparison with FW. Combination of PSD and FW with good time resolution extend physics study in forward rapidity.**

Conclusion

Our proposal:

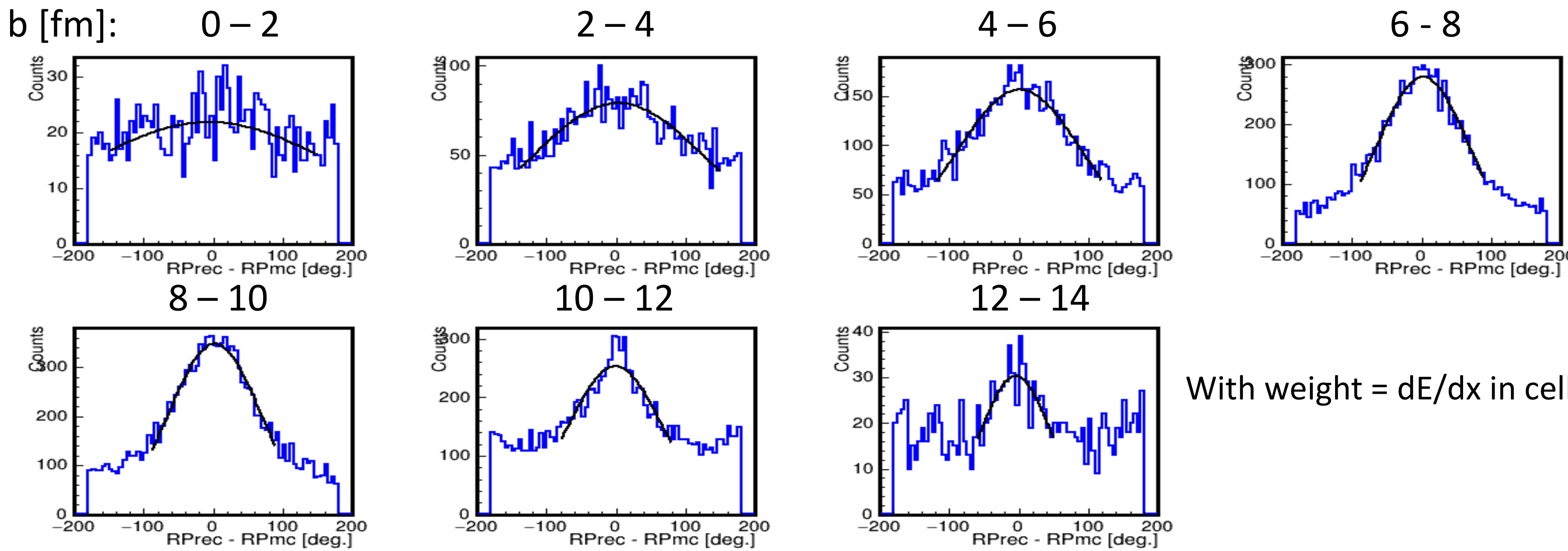
1. Use present FW with slightly modified support frame for forthcoming Ag+Ag run at SIS100 .

2. Consider the possibility of use the forward hadron calorimeter (PSD) from the CBM at HADES@SIS100. PSD would improve significantly the characterization of ion collisions

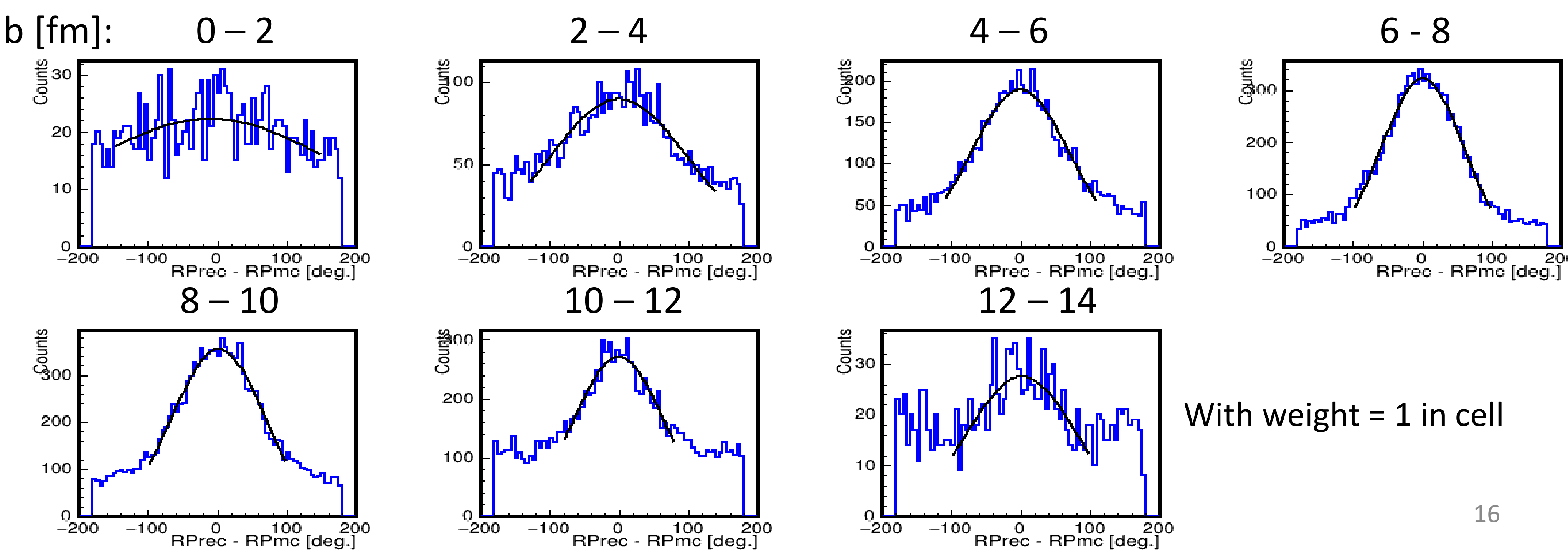
3. Start R&D for scintillator bars with SiPMs readout to get time resolution ~100 psec. New FW in combination with the PSD can improve significantly the PID and extend the physics study at forward rapidity range.

Thank You!

Difference between reconstructed and generated EP in different impact parameter bins

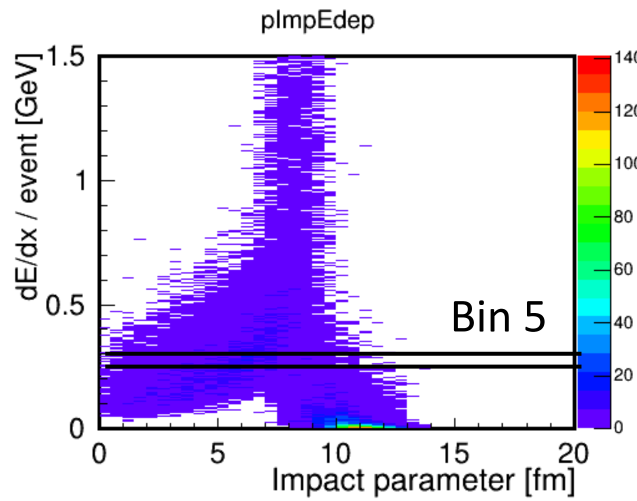


With weight = dE/dx in cell

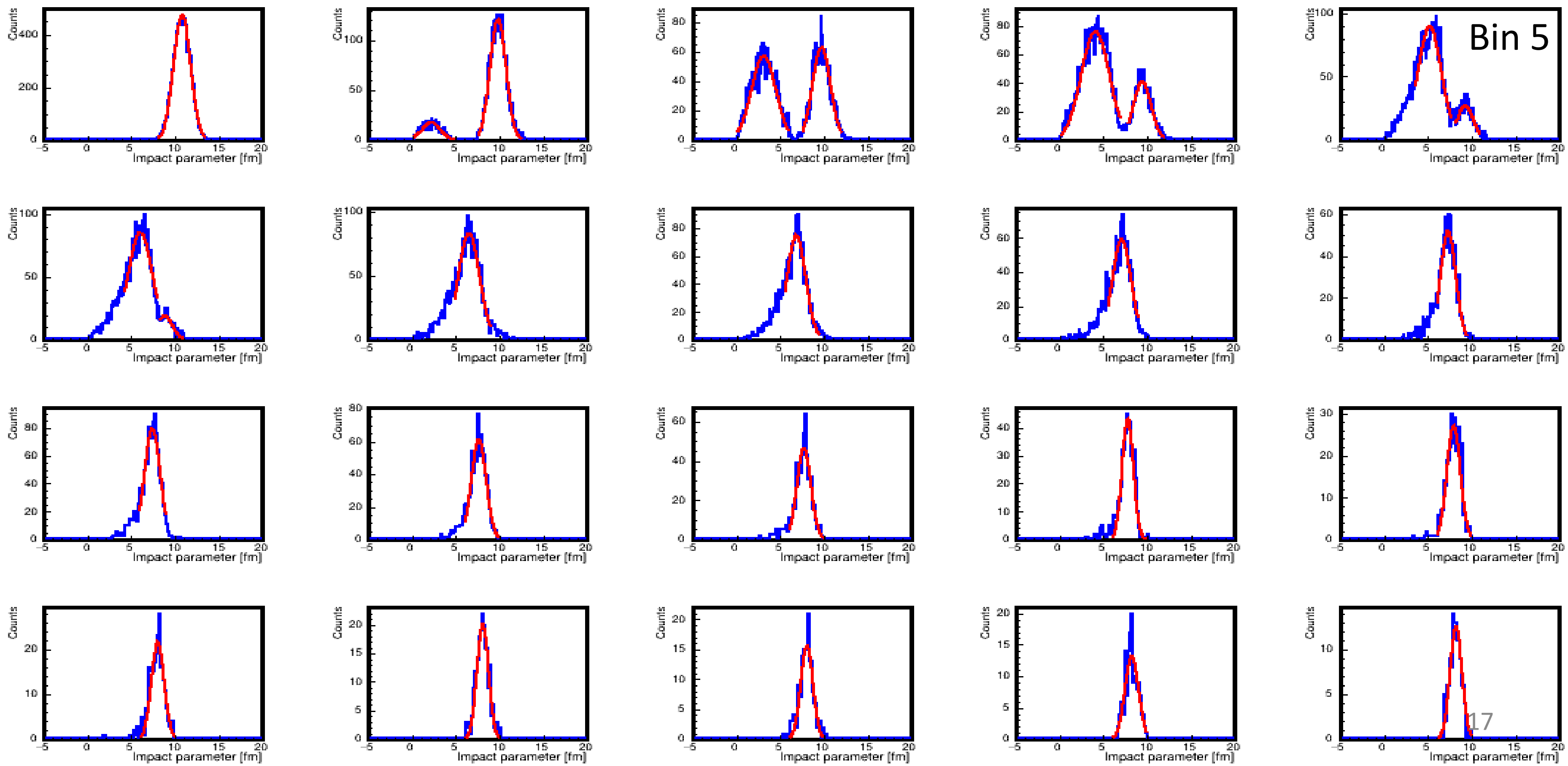


With weight = 1 in cell

dE/dx in event as a function of impact parameter

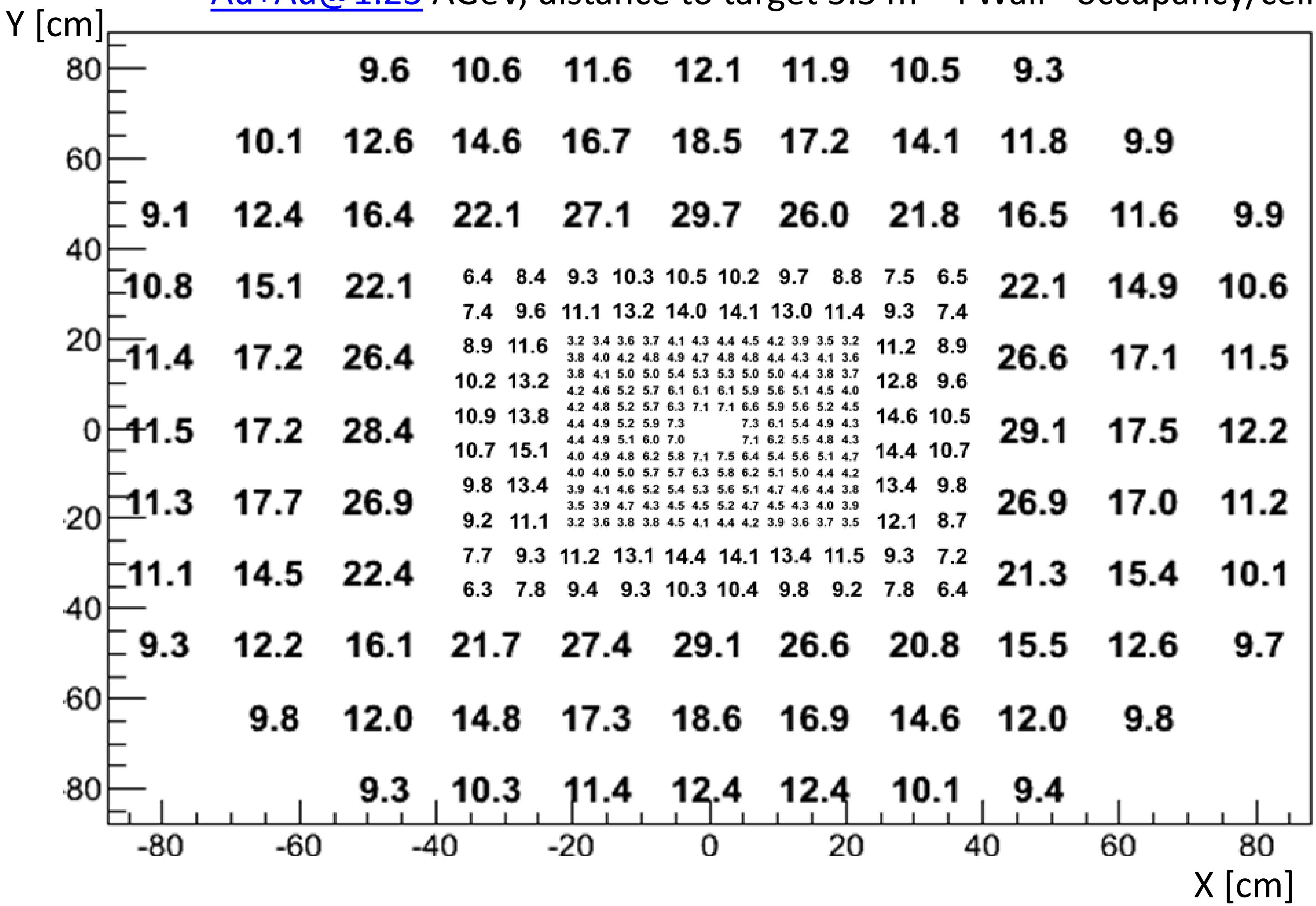


Impact parameter distributions for different dE/dx bins



Occupancy in old FW (only SHIELD generator)

Au+Au@1.23 AGeV, distance to target 5.5 m - FWall - occupancy/cell (%)



Old FW allows the determination of the multiplicity at ~10% level. (0.3x0.3=9%)
Too high occupancy – too rough segmentation in outer FW part.