What performance of new FW is needed?

- **Determination of the particle multiplicity:**

If accuracy ~1% - one needs occupancy ~10% in one cell.

If accuracy ~0.1% - additionally the identification of double hits in one cell is needed (Z and 2Z – separation) – challenging task.

➡ **FW Cell size ??**
Highest Z for identification ??
Dynamic range of light yield detection??

- **Separation of spectators and produced particles?**

Old FW had ~700 ps resolution that allows the suppression of low momentum particles.

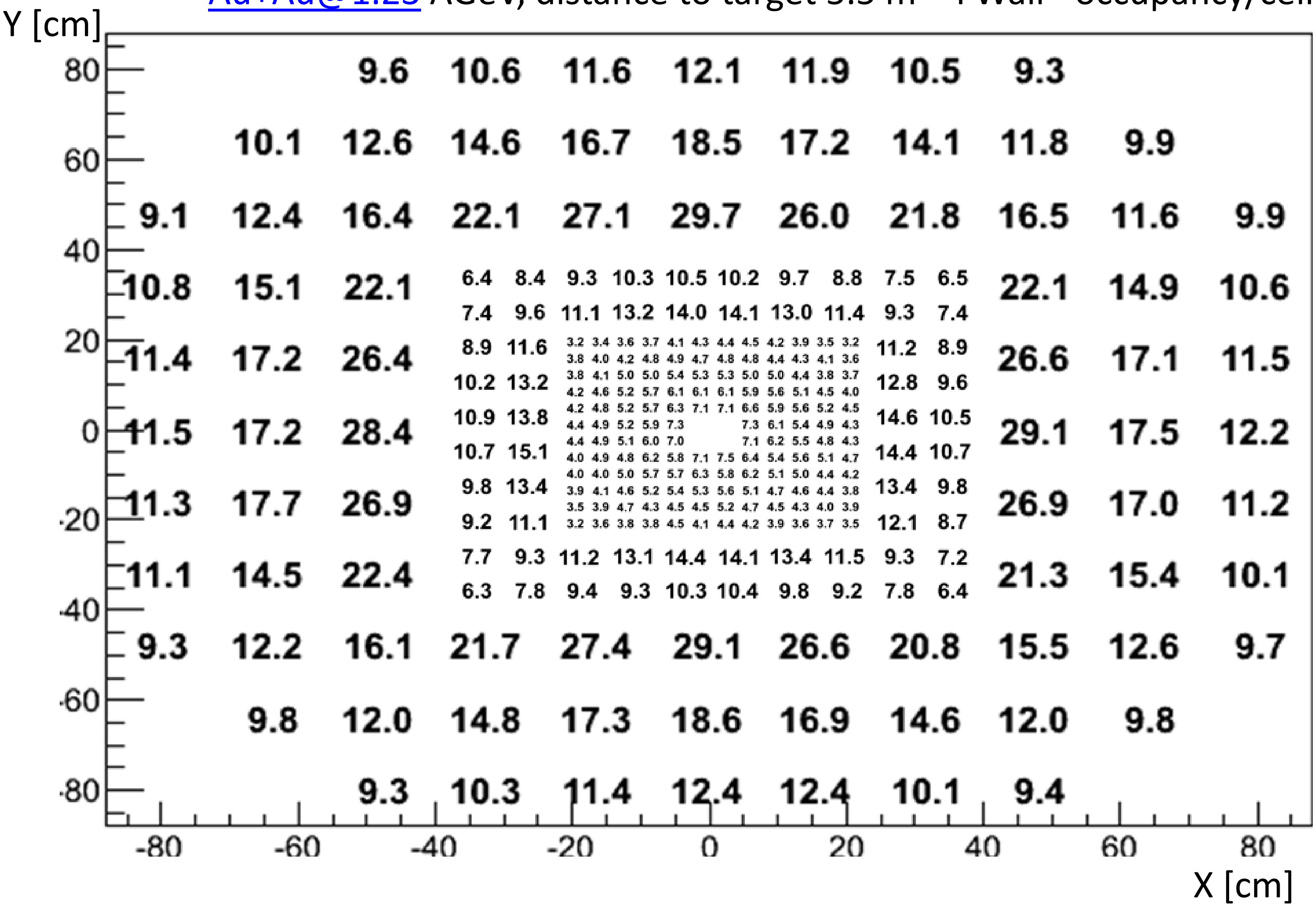
➡ **Time resolution of FW cells??**

*** Identification of fragments (Z^2 separation) – needs moderate light yield – old FW allows to do that!**

- **??**

Occupancy in old FW

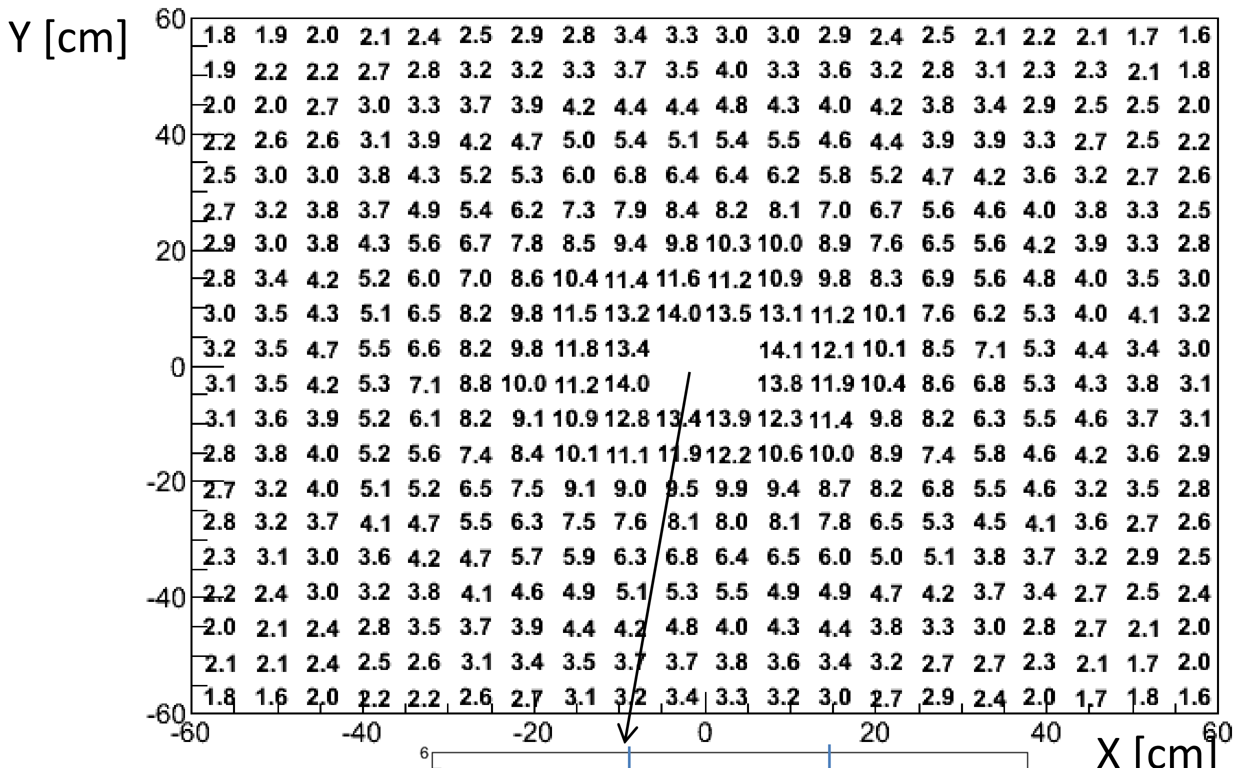
Au+Au@1.23 AGeV, distance to target 5.5 m - FWall - occupancy/cell (%)



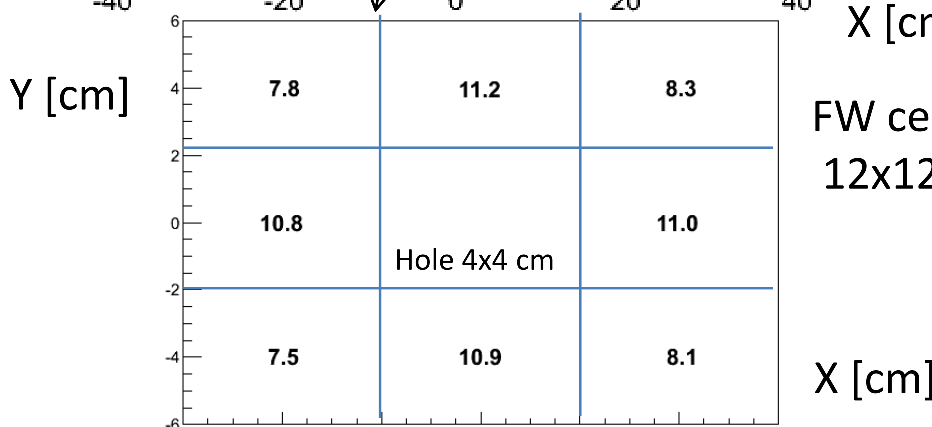
Old FW allows the determination of the multiplicity at ~10% level. (0.3x0.3=9%)
Too high occupancy – too rough segmentation in outer FW part.

Occupancy in new FW with cells 6x6 cm^2.

Au+Au@1.23 AGeV (min. bias) , distance to target 5.5 m - Wall – occupancy/cell (%)



Cell 6x6 cm

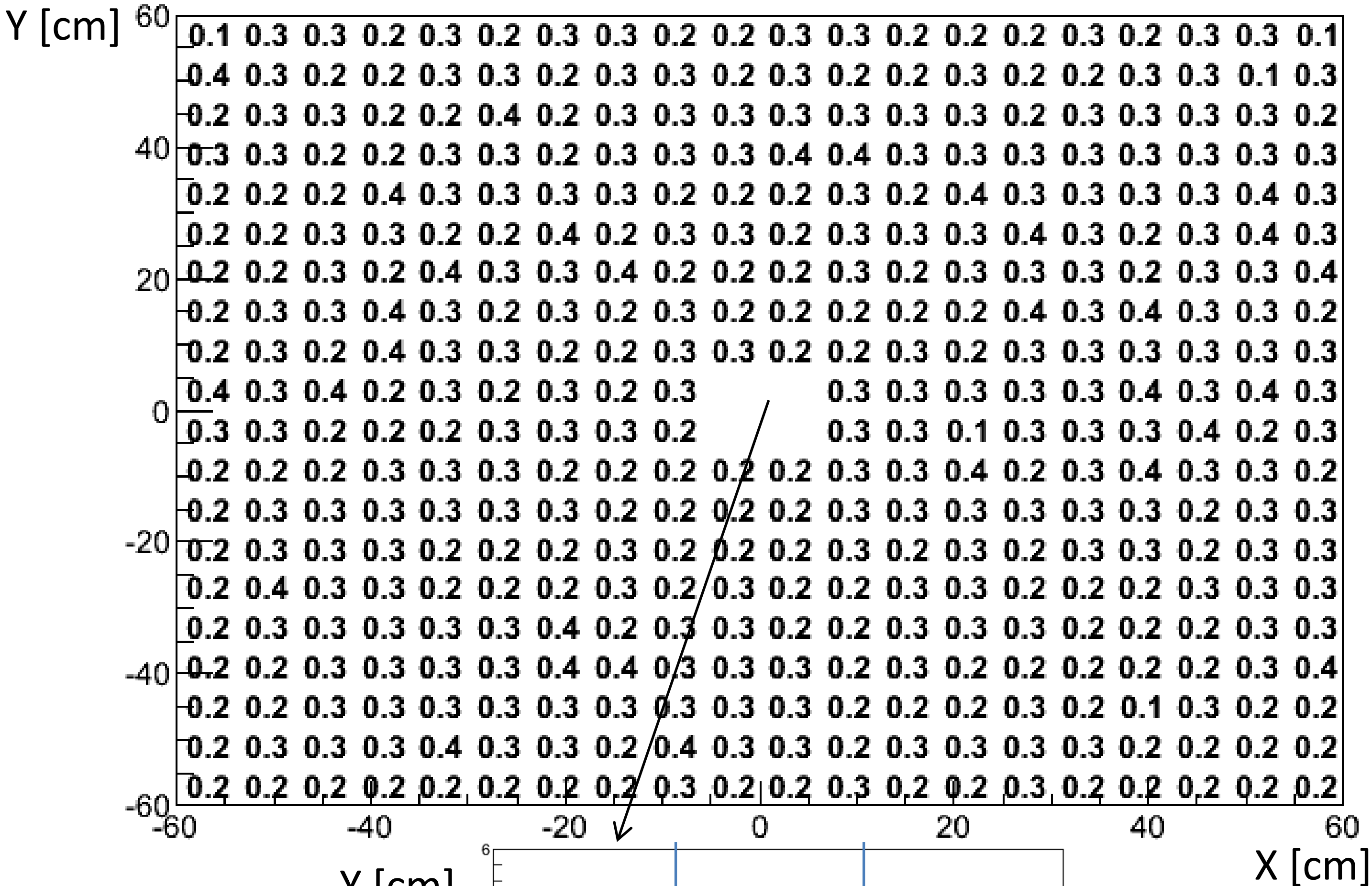


FW central part- 12x12 cm

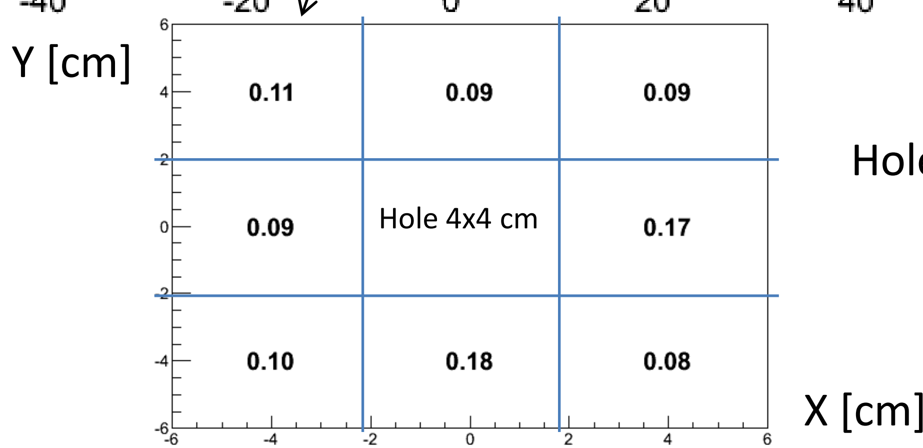
New FW allows the determination of the multiplicity at ~1% level. (0.1x0.1=1%)

Do we need higher accuracy?

Au+Au@1.23 AGeV, for events with b < 3.5 fm (6.6% centrality)
distance to target 5.5 m - Wall – occupancy/cell (%)



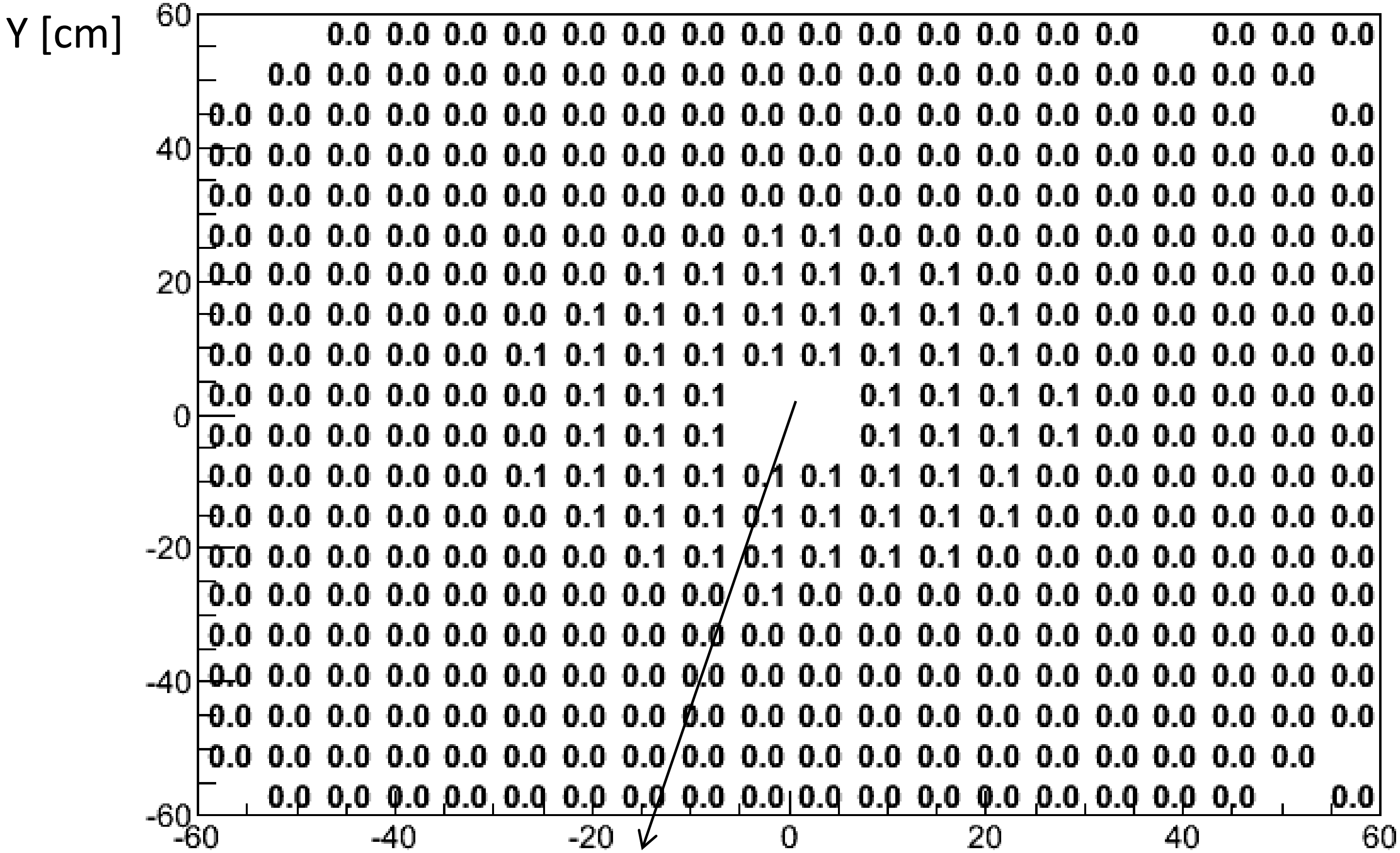
Cell 6x6 cm

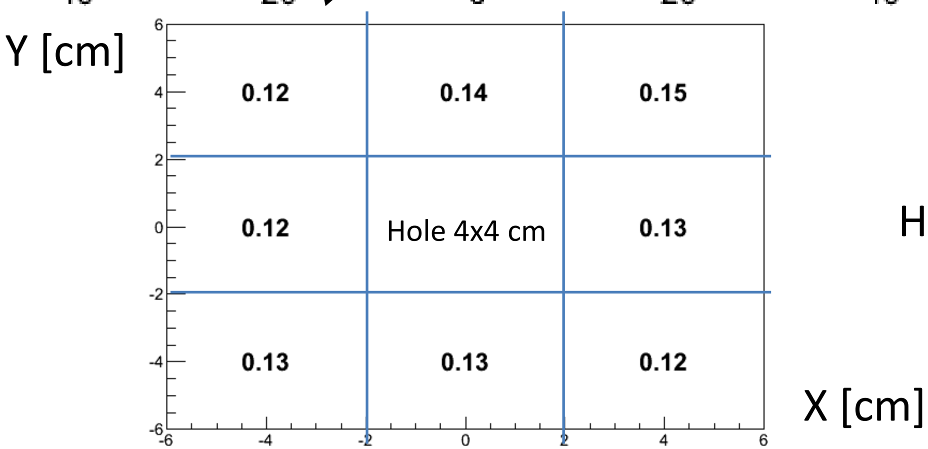


Hole 12x12 cm

Au+Au@1.23 AGeV, distance to target 5.5 m - Wall – occupancy/cm^2 (%) for fragments with 1 < Z <= 4

Cell 6x6 cm



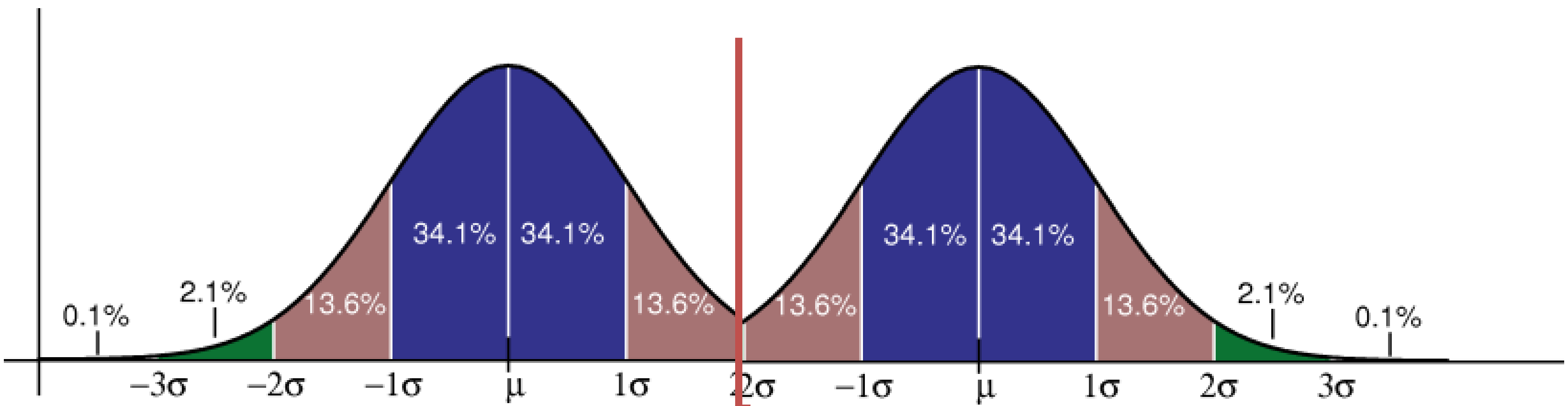


Hole 12x12 cm

If we need higher accuracy in multiplicity determination, a Z^2 and $2xZ^2$ identification is each cell is needed

What light yield (LY) for MIP is needed to separate Z^2 and $2xZ^2$?

Let's assume that signal from scintillator has a Poisson distribution with mean number of detected photoelectrons N and sigma $\sqrt{N}$.



25 ph.e.
2σ=10 ph.e

35 ph.e.

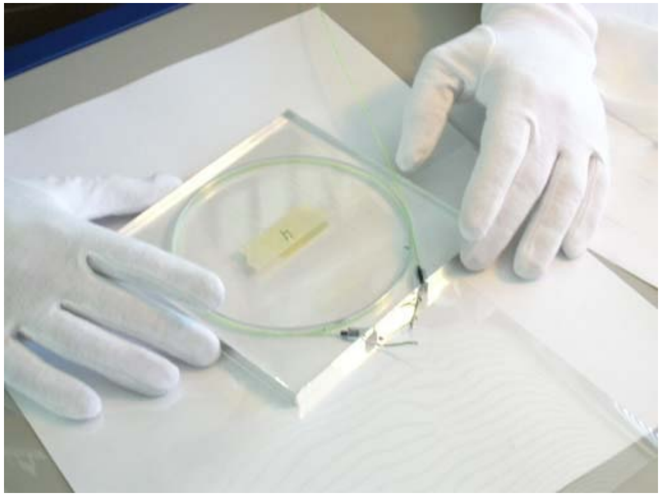
50 ph.e.
2σ=15 ph.e

With LY=25 ph.e./Z^2 the separation of Z^2 and $2xZ^2$ would be at 95% level.
But fraction of $2xZ^2$ events – only 1%. Probably we need 3 sigma separation and LY=55 ph.e.

What scintillator light readout might be used?

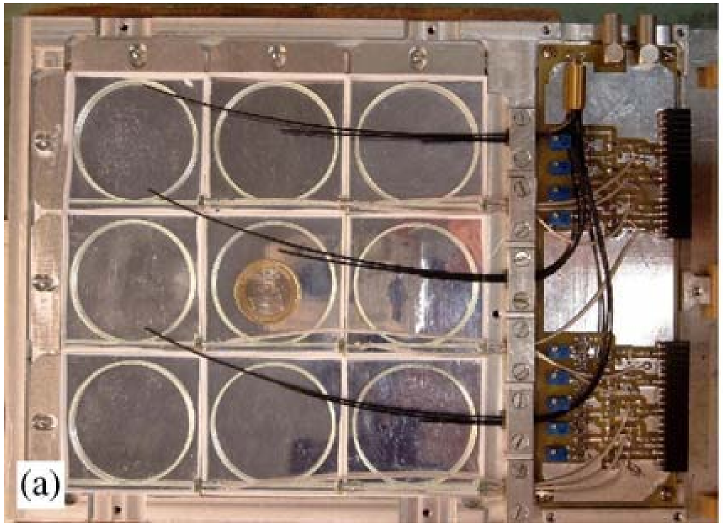
Most common technics now is readout with WLS-fiber +SiPM (silicon photomultiplier or micropixel avalanche photodiode).

One example:
15x15x1 cm^3 tile has
LY=16 ph.e. for single SiPM.



ALICE start calibration system

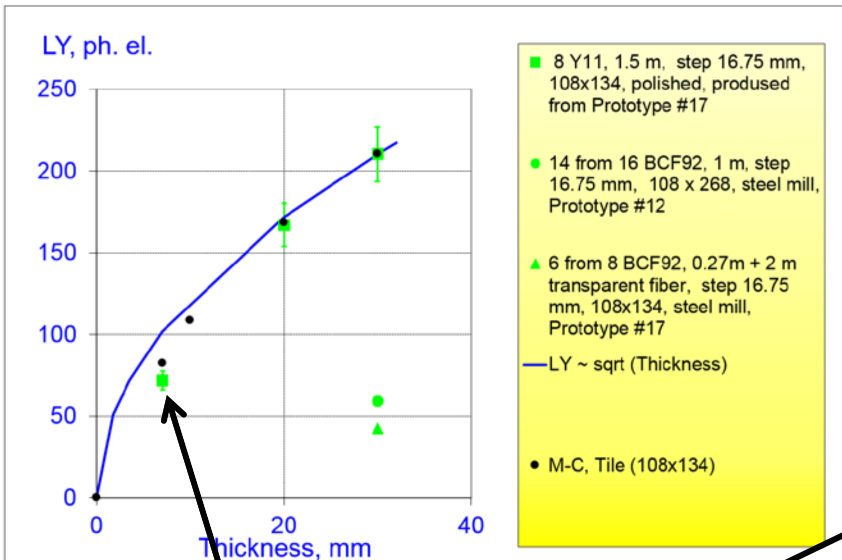
Another example:
5x5x0.5 cm^3 tile has
LY=25 ph.e. for single SiPM.

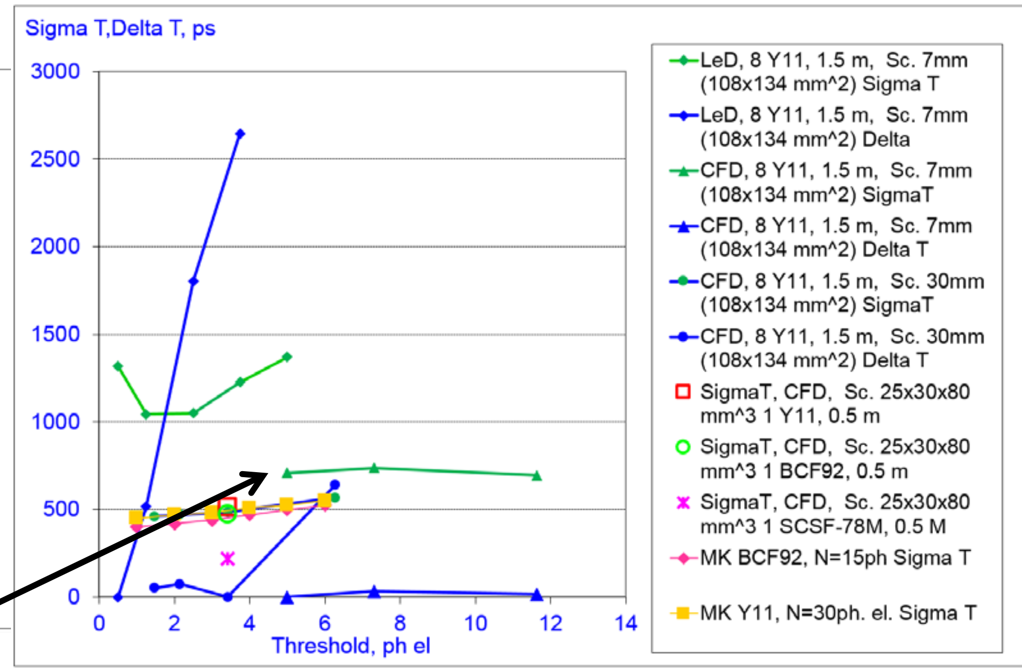


CALICE digital calorimeter (ILC project)

LY of about 25 ph.e. can be obtained without significant efforts.
LY of about 55 ph.e. needs some R&D.

Do we need time resolution to separate spectators and produced particles?





NA62 hodoscope prototypes:
https://indico.inr.ru/event/4/session/12/#20150708

For LY=70 ph.e. people got σ_t=700 ps for single SiPM. If to use two SiPM and thick scintillator (~2 cm) one can try to get time resolution below 500 ps.

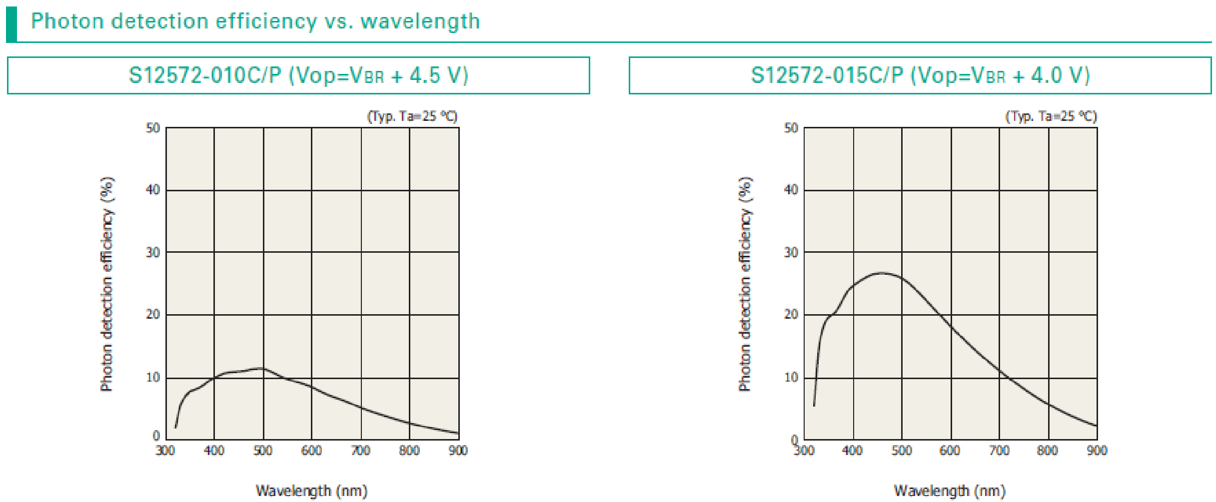
What SiPM can be used?

For good dynamic range a factor of 36 (Z=1, … Z=6) the detected signal could achieve 1000 ph.e. or even a few x 1000 ph.e. (for high LY option).

One needs a lot (a few x 1000 ph.e.) of pixels in small 1x1 mm^2 active area.

Only a few variants:

Hamamatsu MPPC:
4500 pixels PSD=25%
10000 pixels PDE=11%



New SensL Red-series: PDE ~35-40%
5000 pixels for 1x1 mm^2.