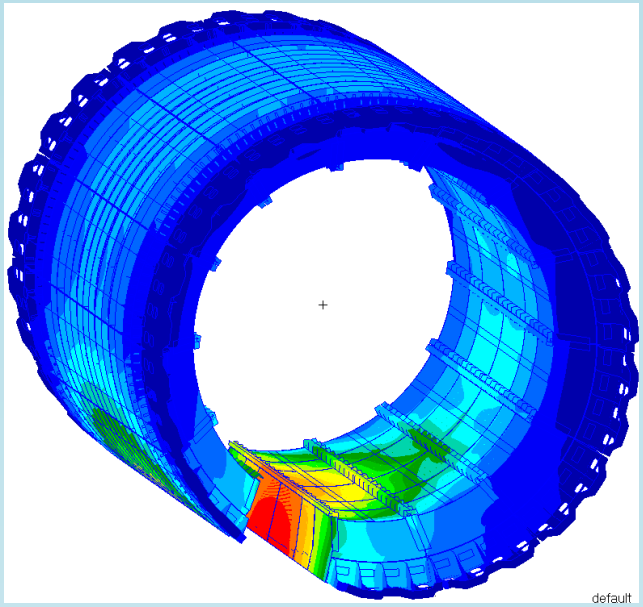
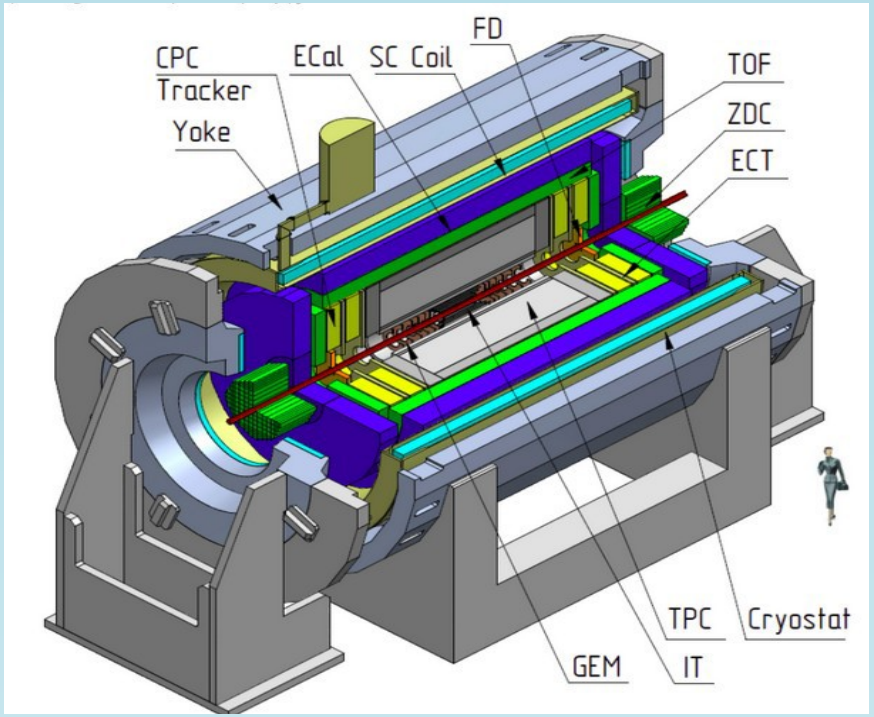
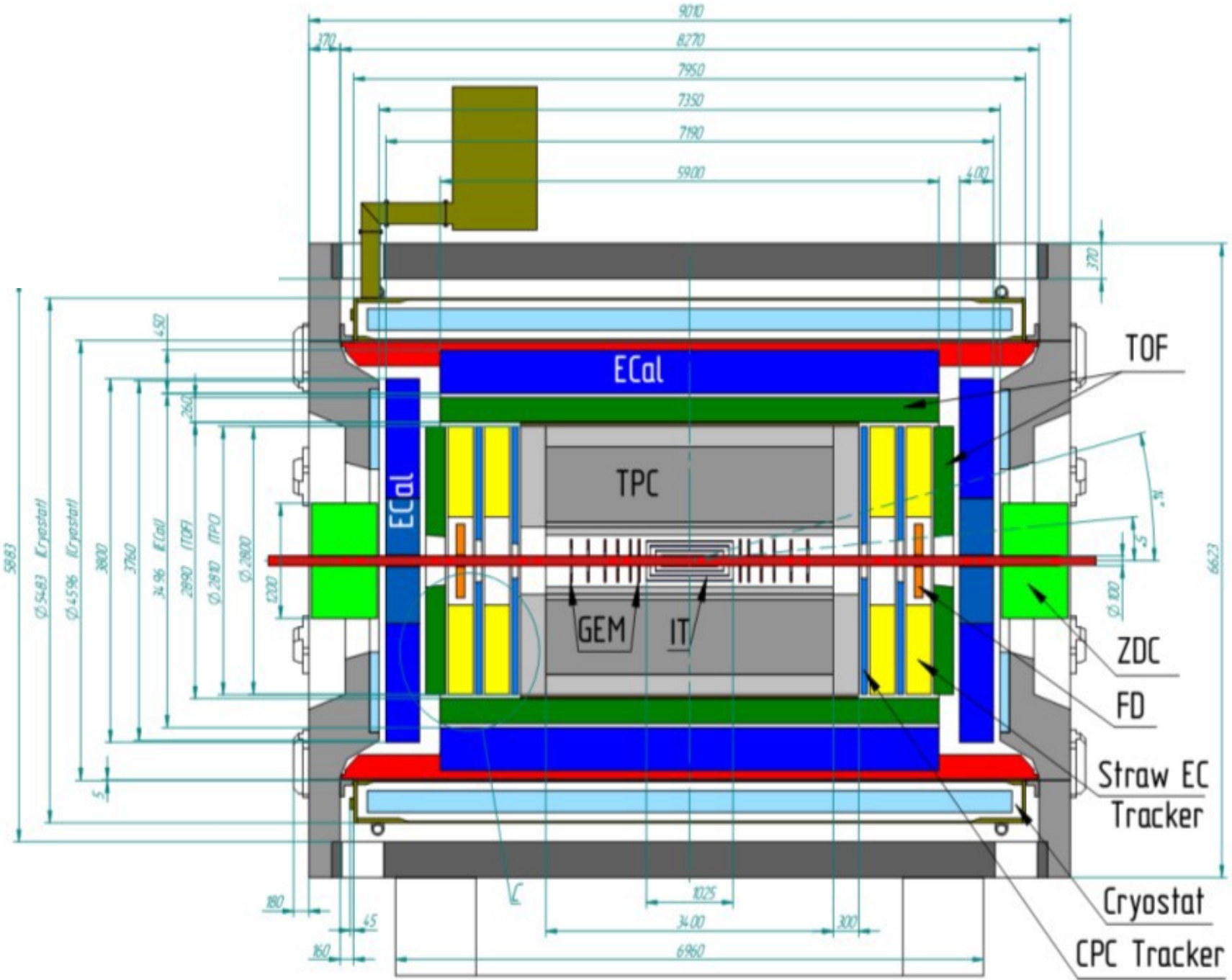
Electromagnetic calorimeter for MPD

Igor Tyapkin





JINR
Dubna 2018


ECal
TPC
ECal
GEM
IT
TOF
ZDC
FD
Straw EC
Tracker
Cryostat
CPC Tracker

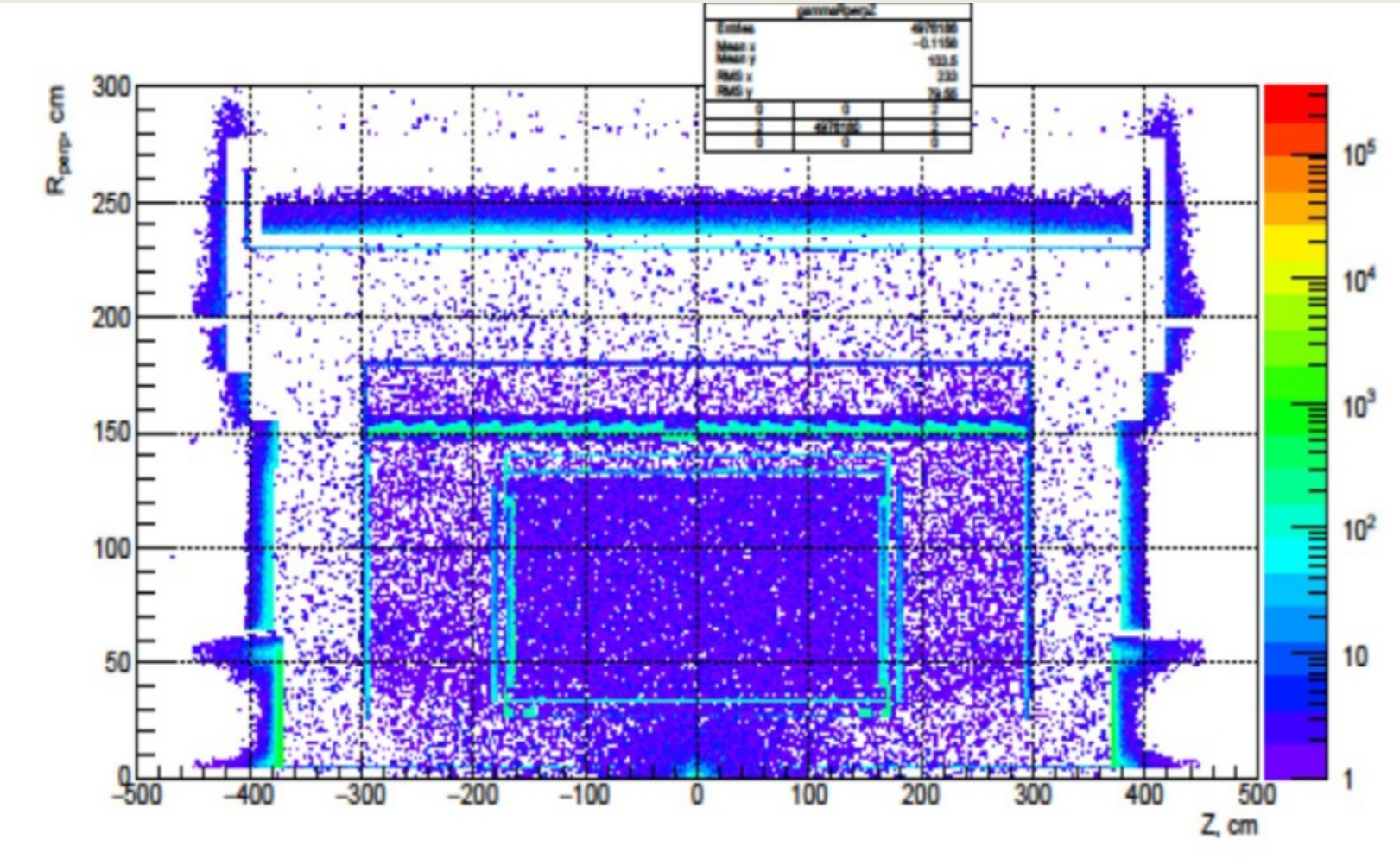
Time resolution

1.~10nsec – to reduce random background and noise;

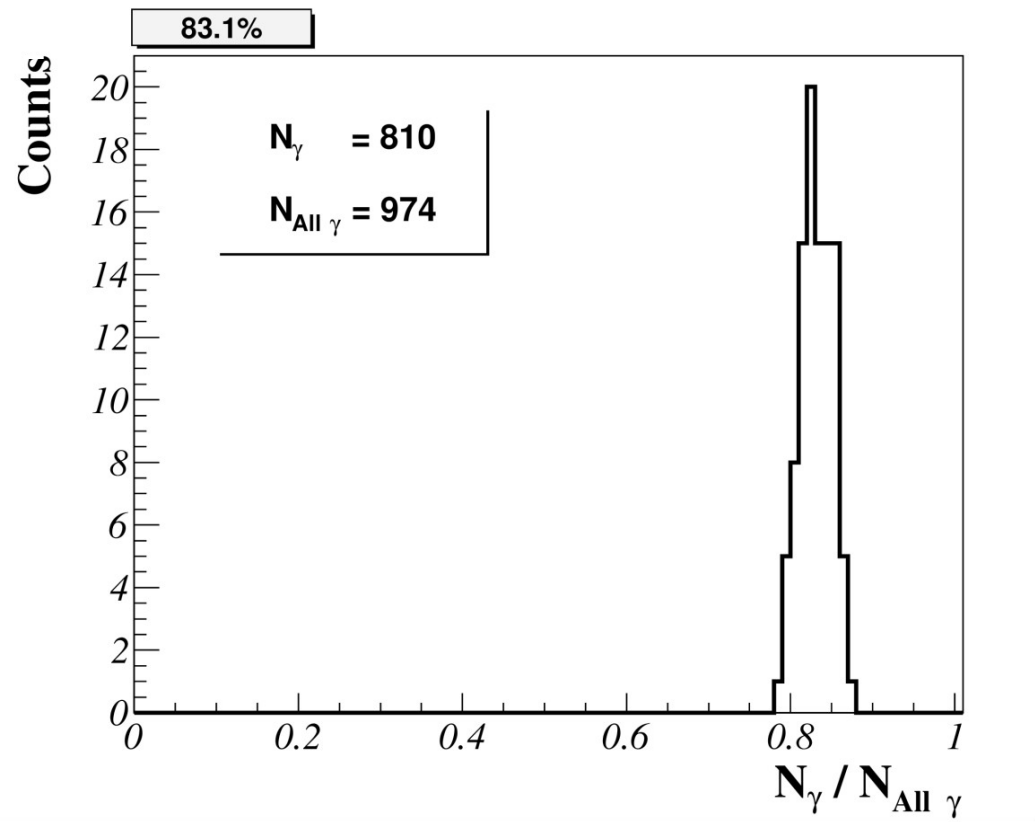
2.<1 nsec – to suppress secondary photons from the interactions in the material of the MPD detector;

3.~100 psec – TOF;

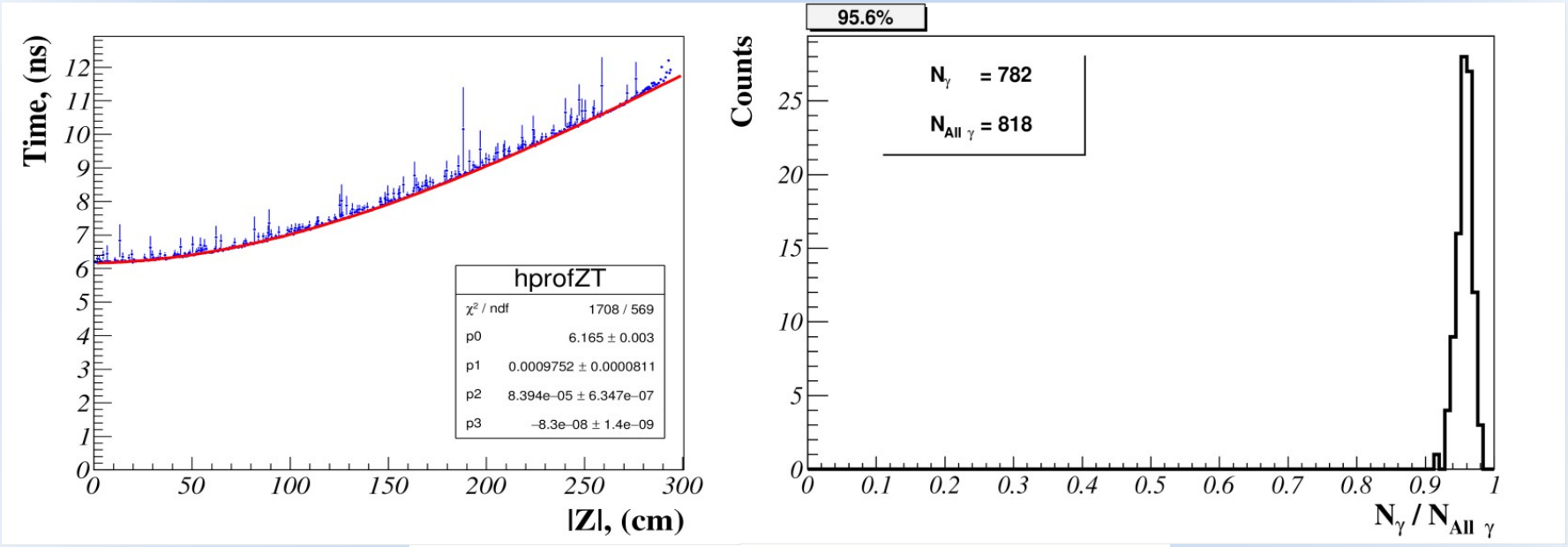
Secondary photons suppression

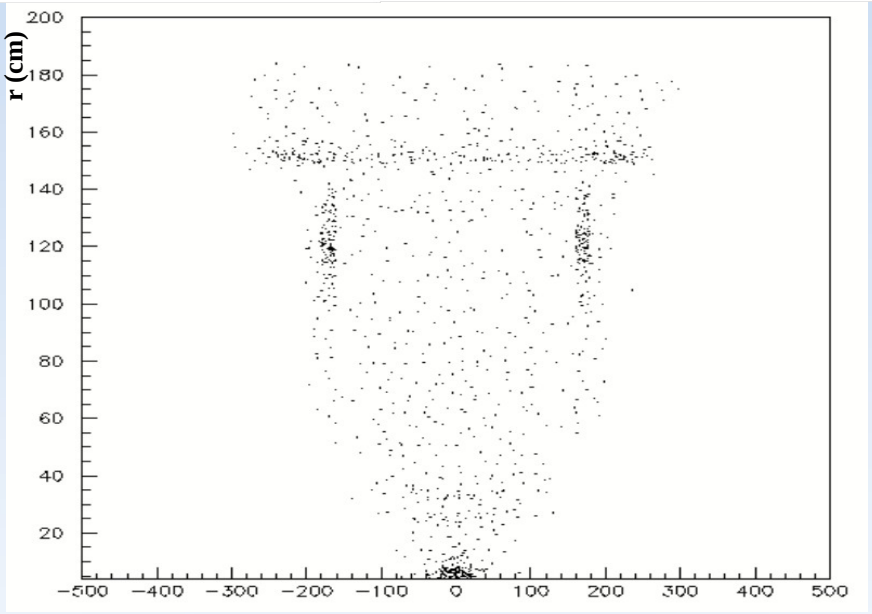


- **UrQMD** (AuAu 11GeV, 100 central events);
- Energy cut > 10MeV for all photons;
- Nγ – detected photons from the vertex < 4cm (in pape);
- Nall – total number of photons detected;



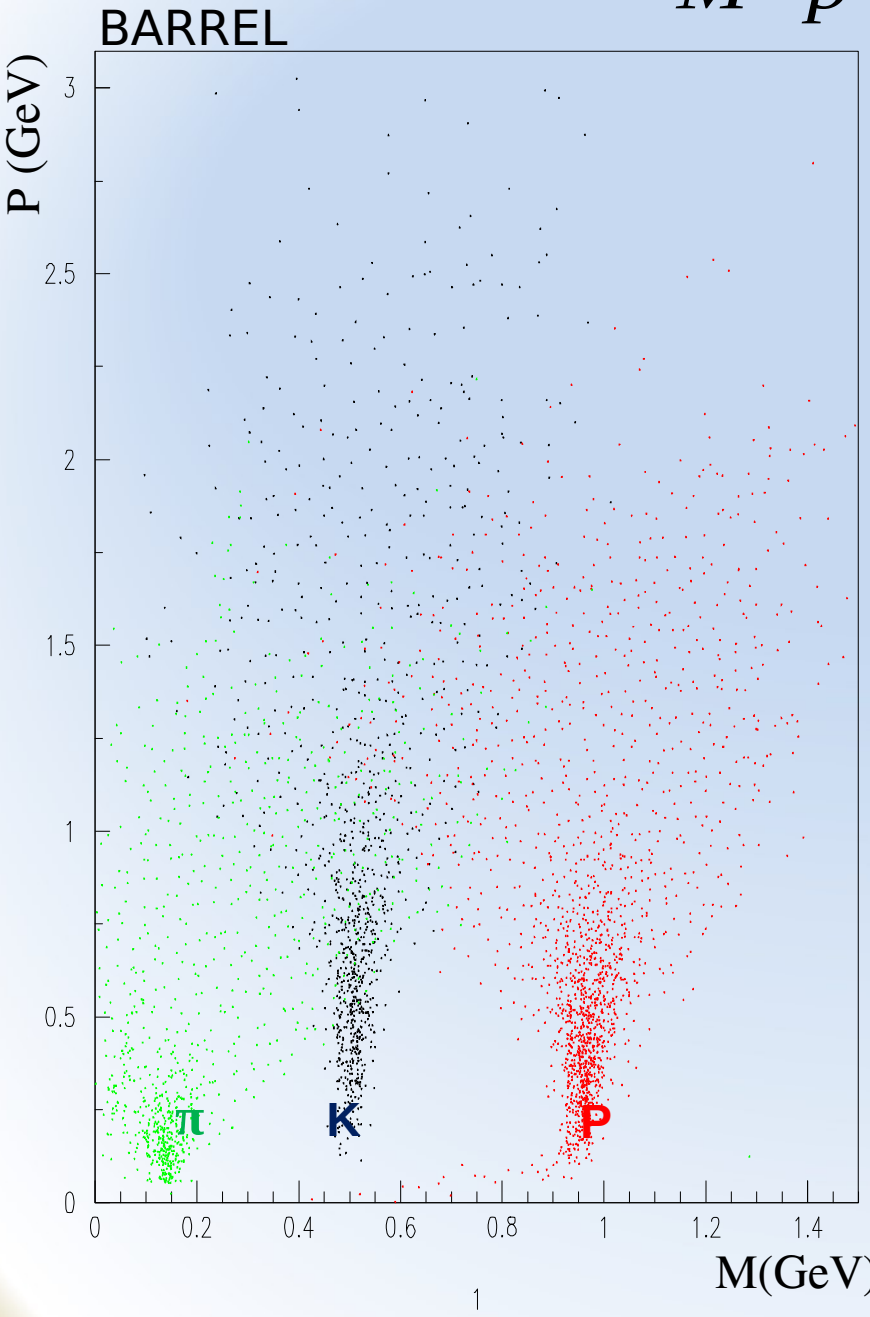
cut dTime < 0.5ns

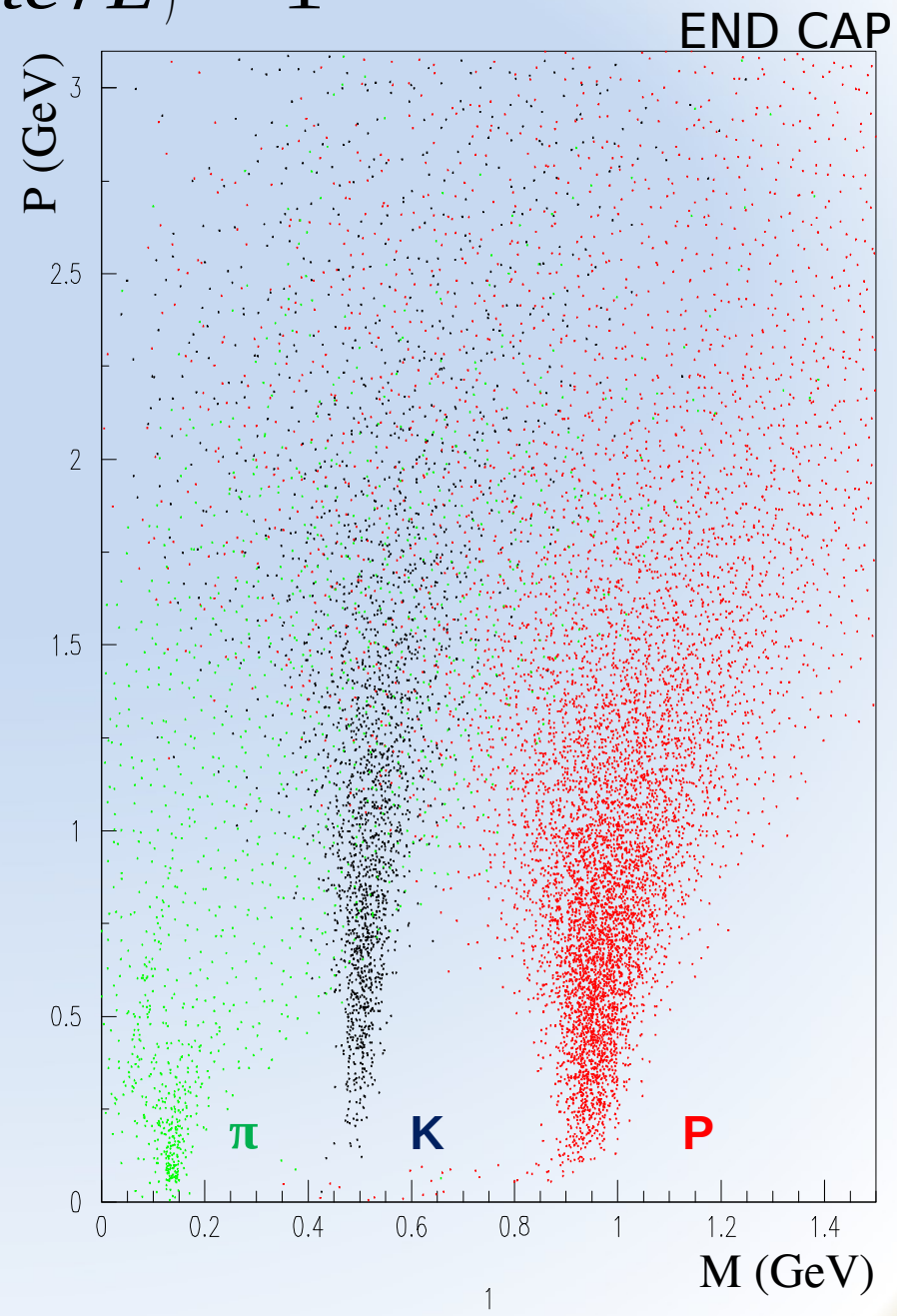


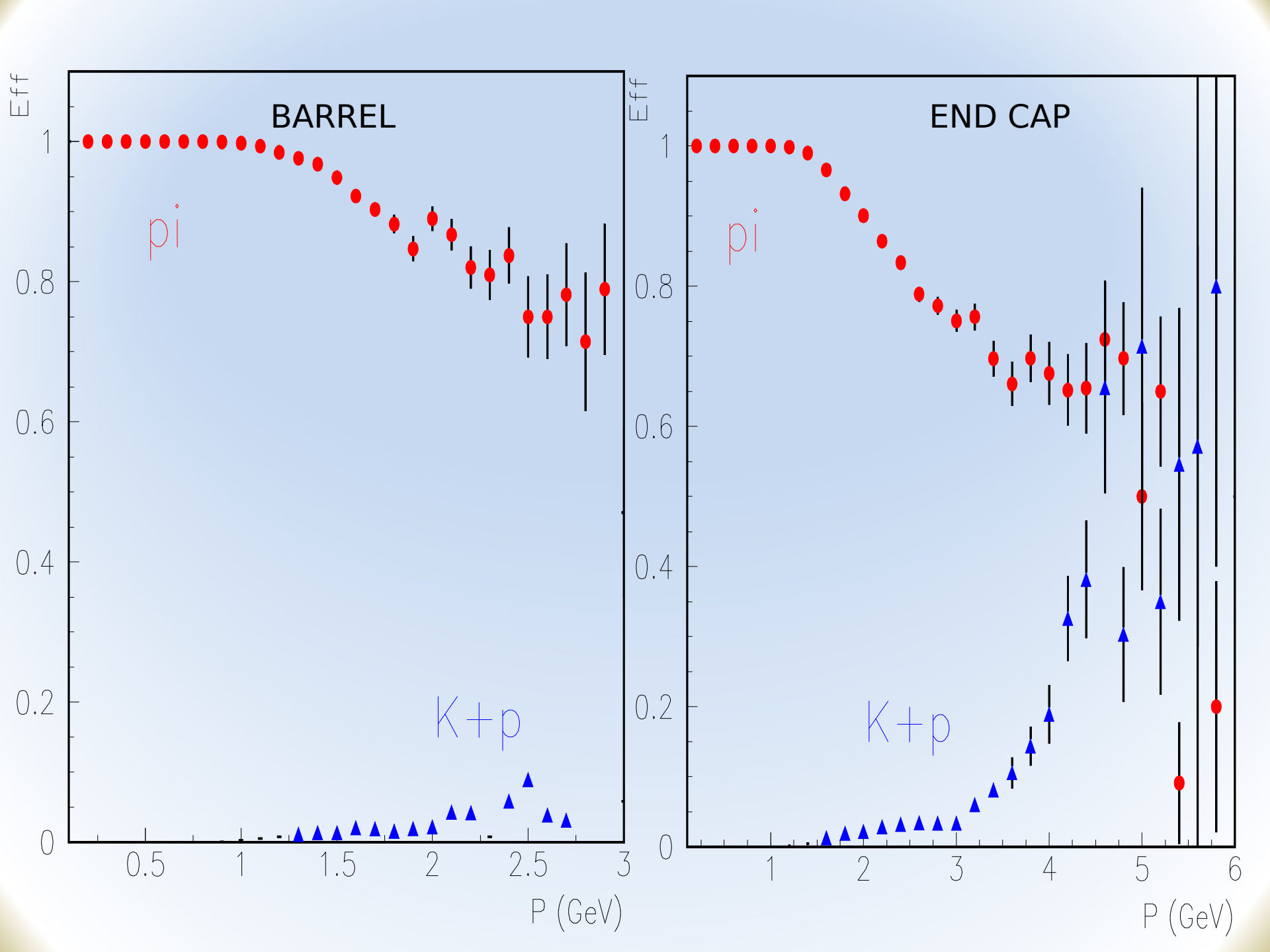


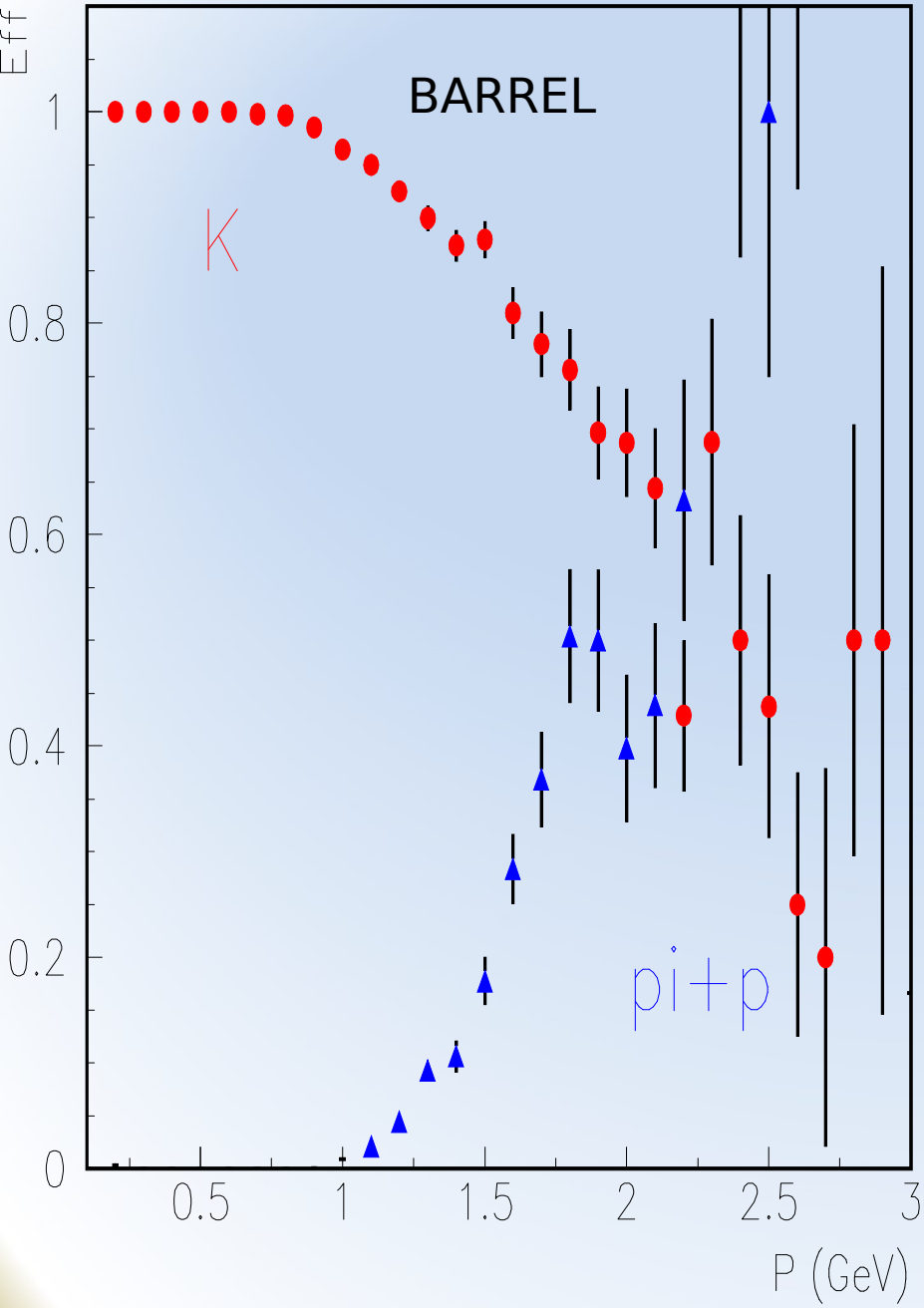
TOF

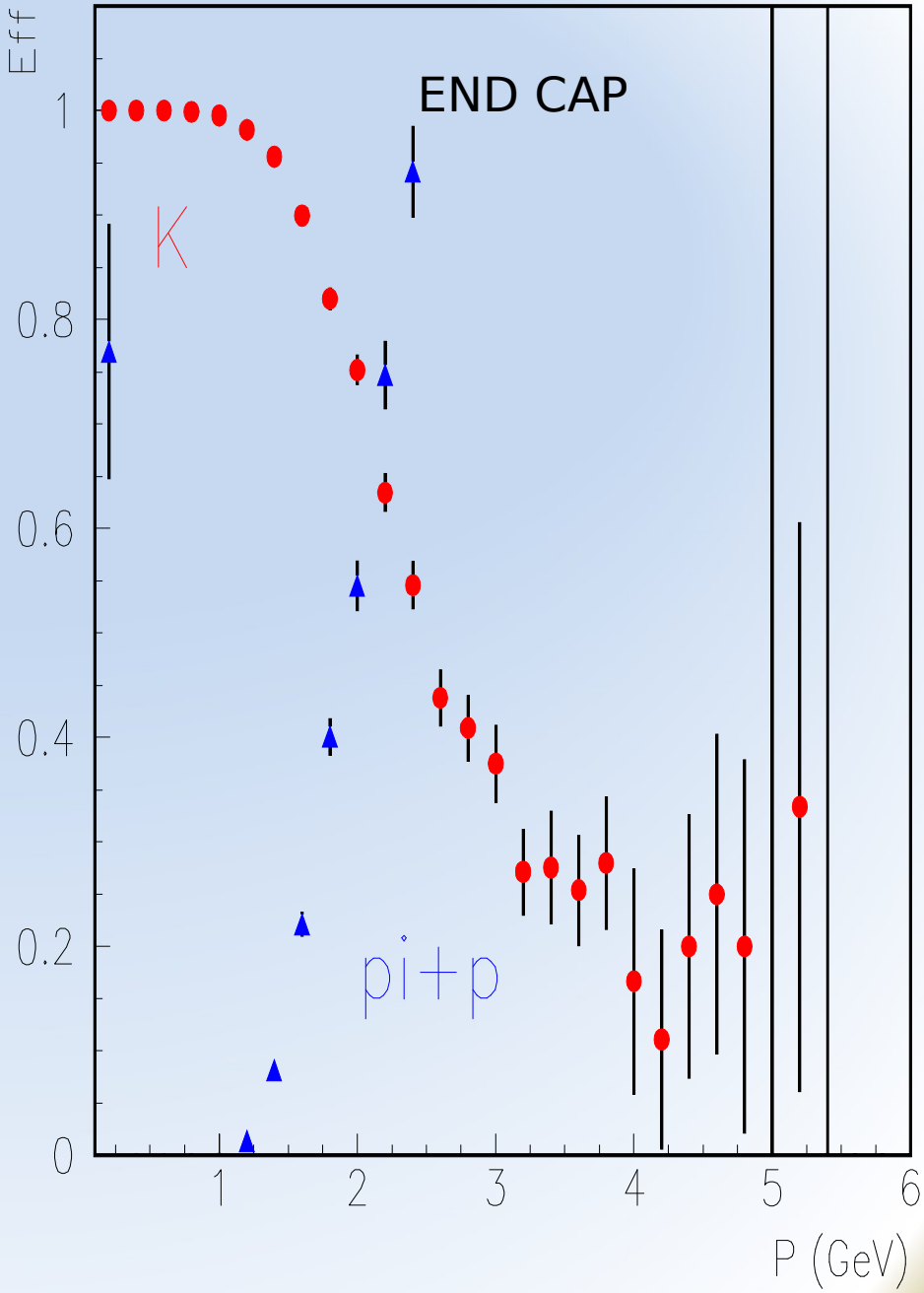
$$M = p\sqrt{(tc/L)^2 - 1}$$

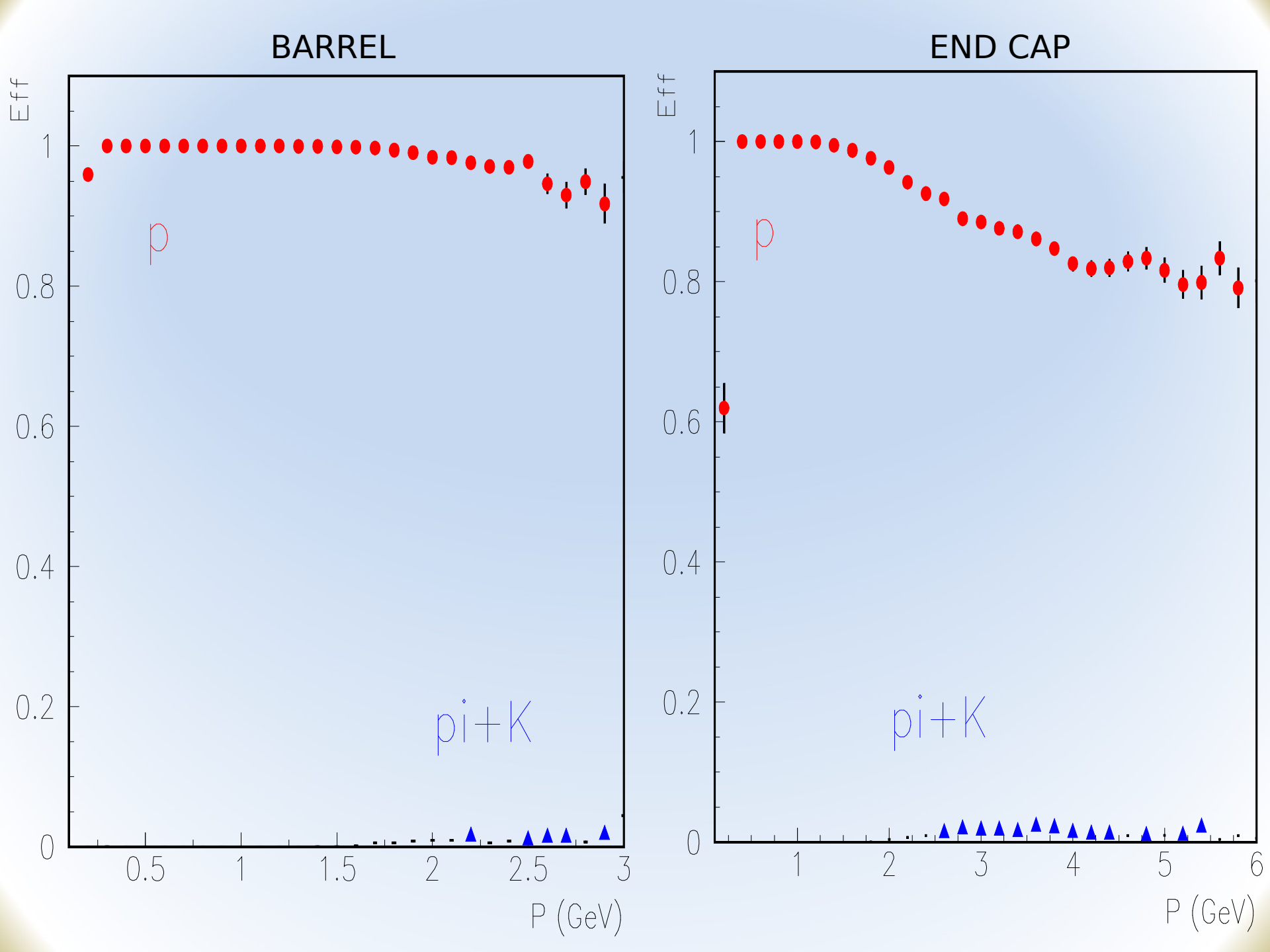




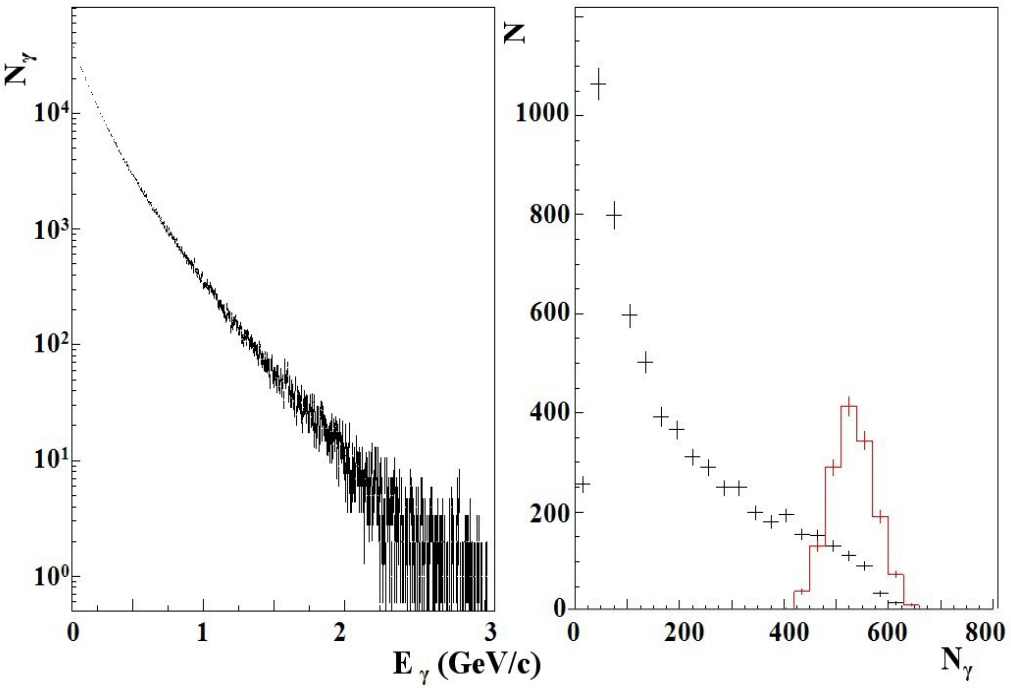

BARREL
Eff
pi
K+p
P (GeV)
END CAP
Eff
pi
K+p
P (GeV)


BARREL
K
pi+p
Eff
P (GeV)
0
0.2
0.4
0.6
0.8
1
0.5
1
1.5
2
2.5
3


END CAP
K
pi+p
Eff
P (GeV)
0
0.2
0.4
0.6
0.8
1
1
2
3
4
5
6

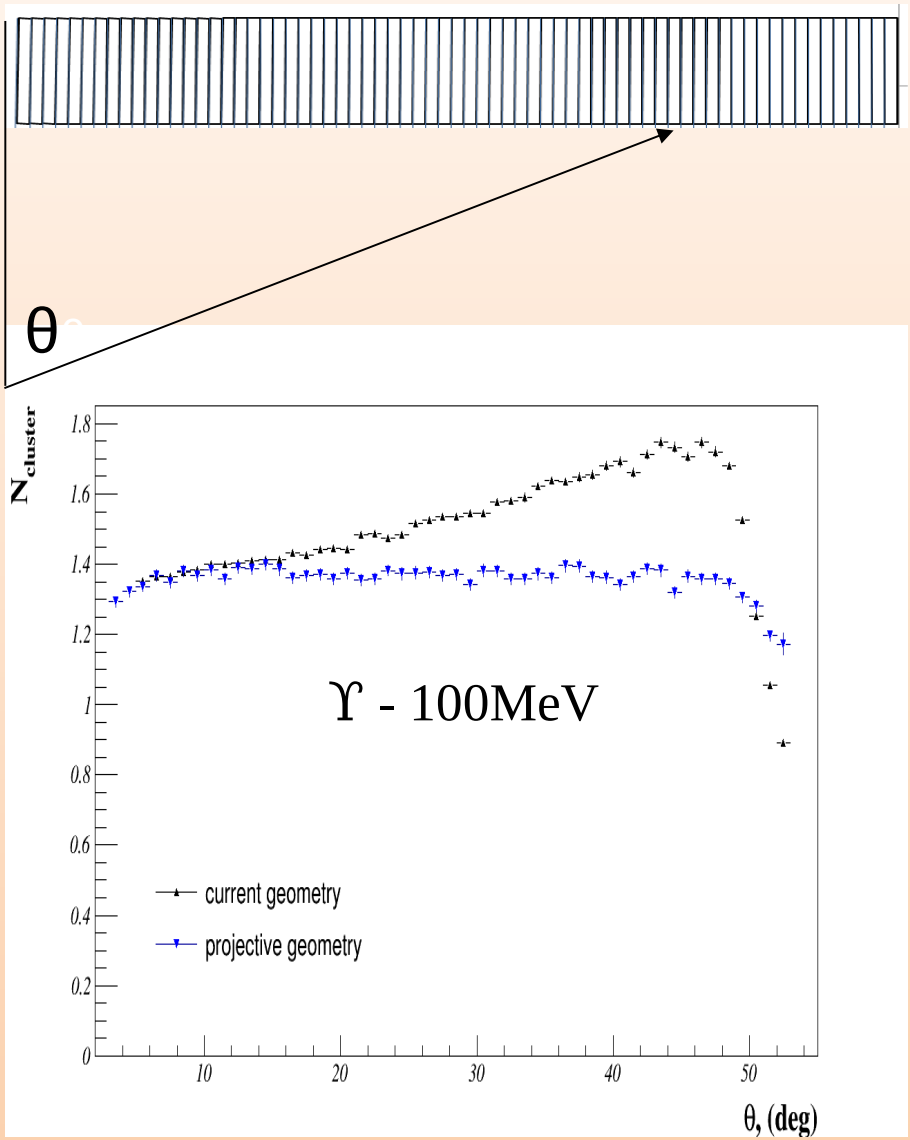

BARREL
Eff
1
0.8
0.6
0.4
0.2
0
p
pi+K
0.5
1
1.5
2
2.5
3
P (GeV)
END CAP
Eff
1
0.8
0.6
0.4
0.2
0
p
pi+K
1
2
3
4
5
6
P (GeV)

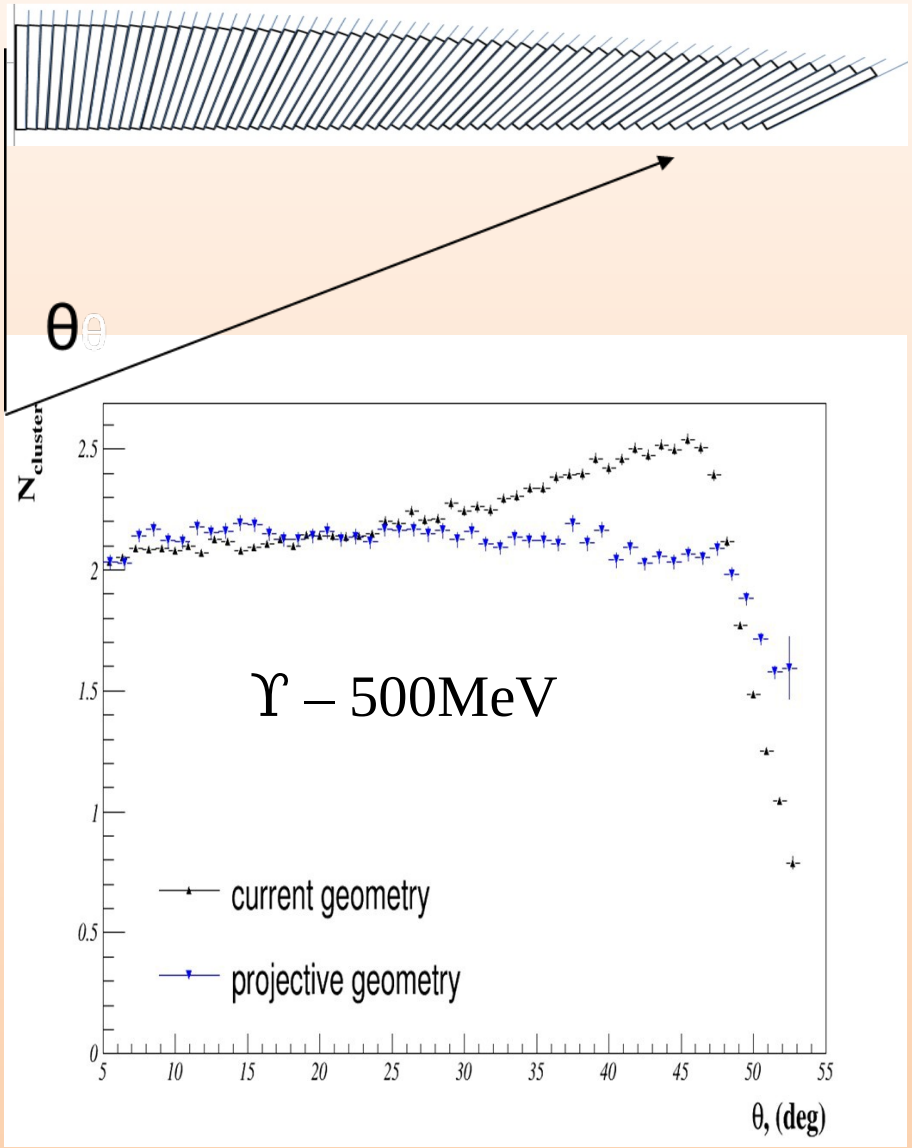
AuAu collisions at $\sqrt{S_{NN}}$ 9GeV

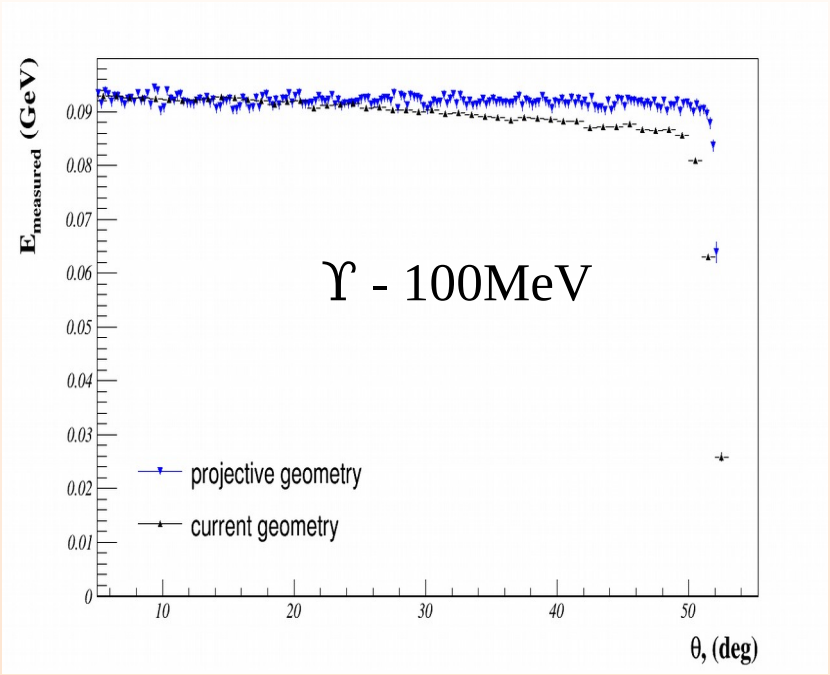


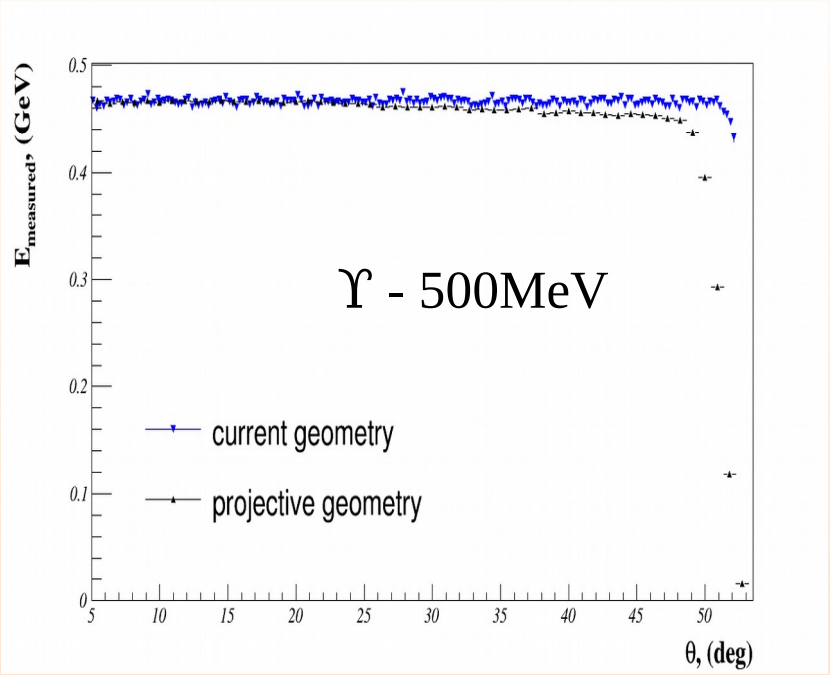
Parameters	
Transverse size, mm^2	40x40
Module size, mm^2	40x40
Number of layers	220
Lead absorber thickness, mm	0.3
Thickness of Scintillator, mm	1.5
Effective radiation length, mm	32.4
Moliere radius, mm	62
Radiation length, X_0	11.8

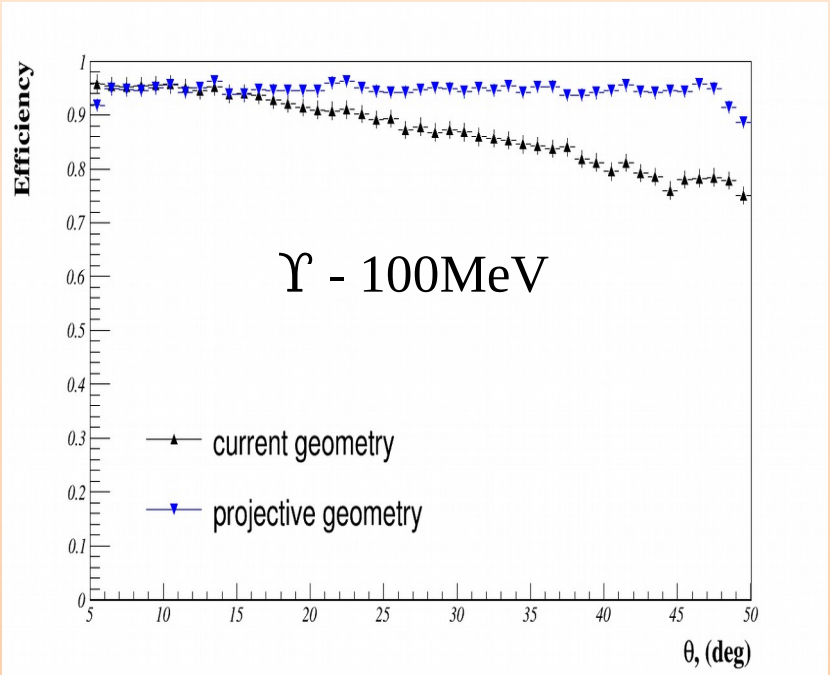
Calorimeter geometry

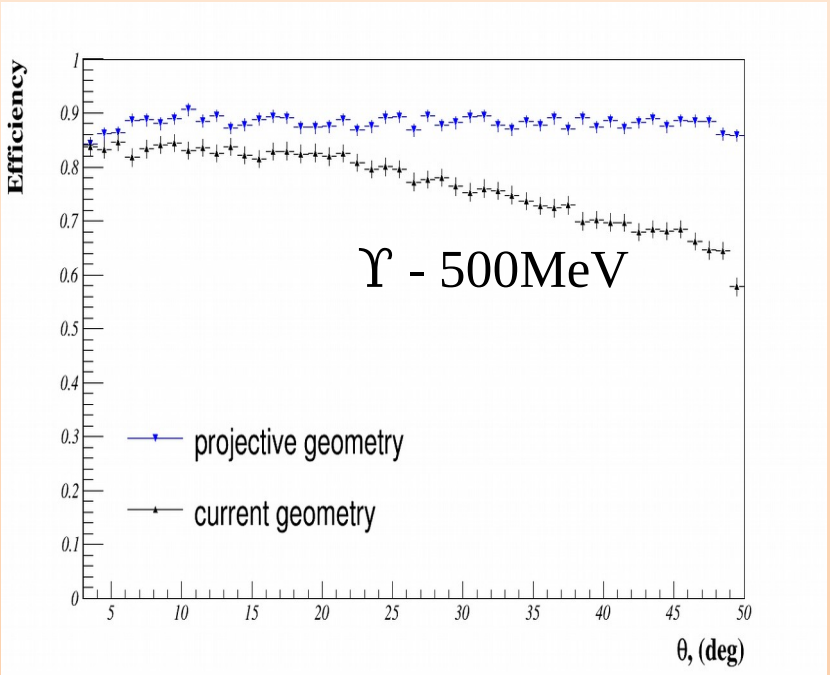




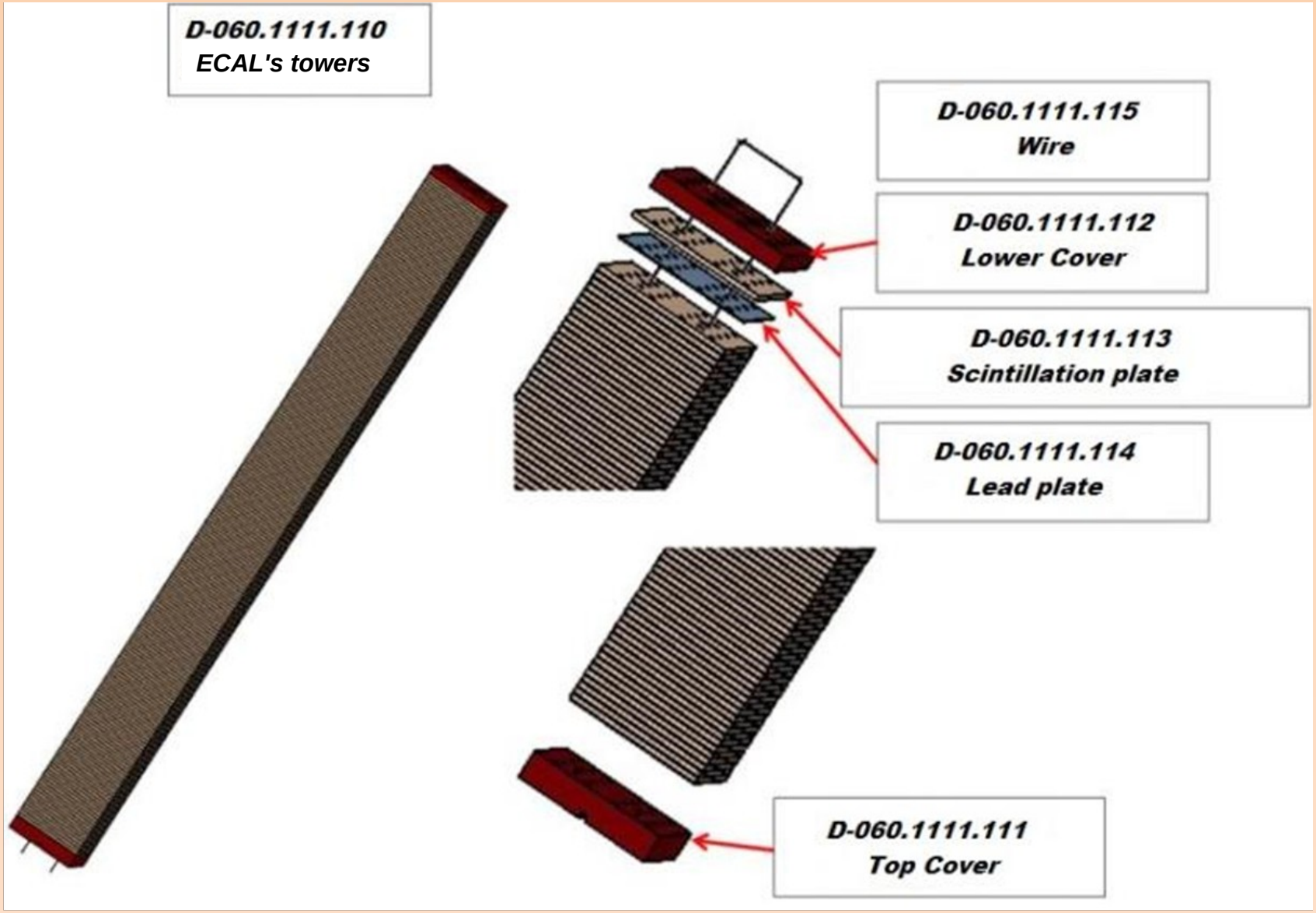

$E_{measured}$ (GeV)
Υ - 100MeV
projective geometry
current geometry
θ, (deg)


$E_{measured}$, (GeV)
Υ - 500MeV
current geometry
projective geometry
θ, (deg)

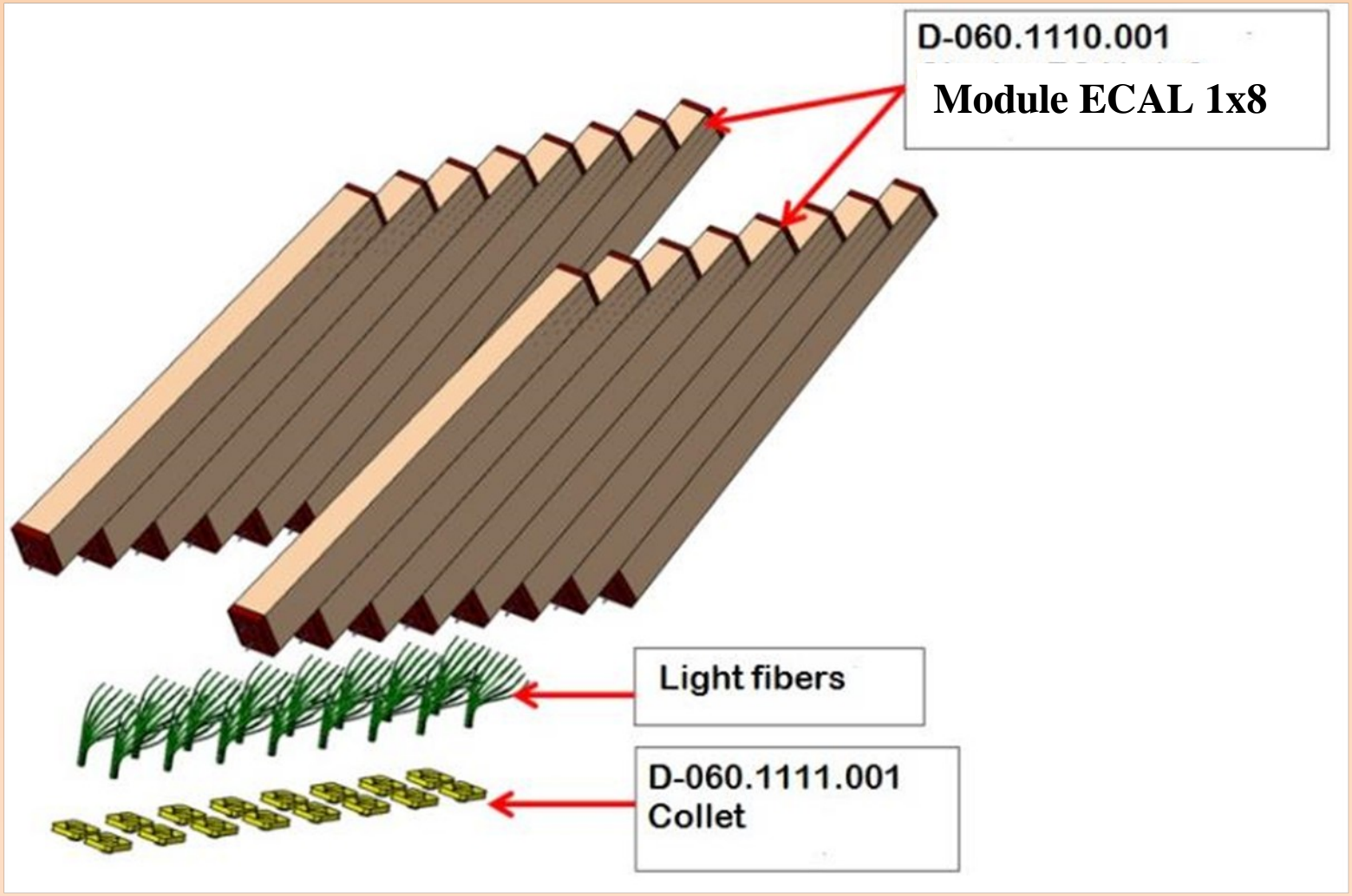

Efficiency
Υ - 100MeV
current geometry
projective geometry
θ, (deg)


Efficiency
Υ - 500MeV
projective geometry
current geometry
θ, (deg)

ECAL tower


D-060.1111.110
ECAL's towers
D-060.1111.115
Wire
D-060.1111.112
Lower Cover
D-060.1111.113
Scintillation plate
D-060.1111.114
Lead plate
D-060.1111.111
Top Cover

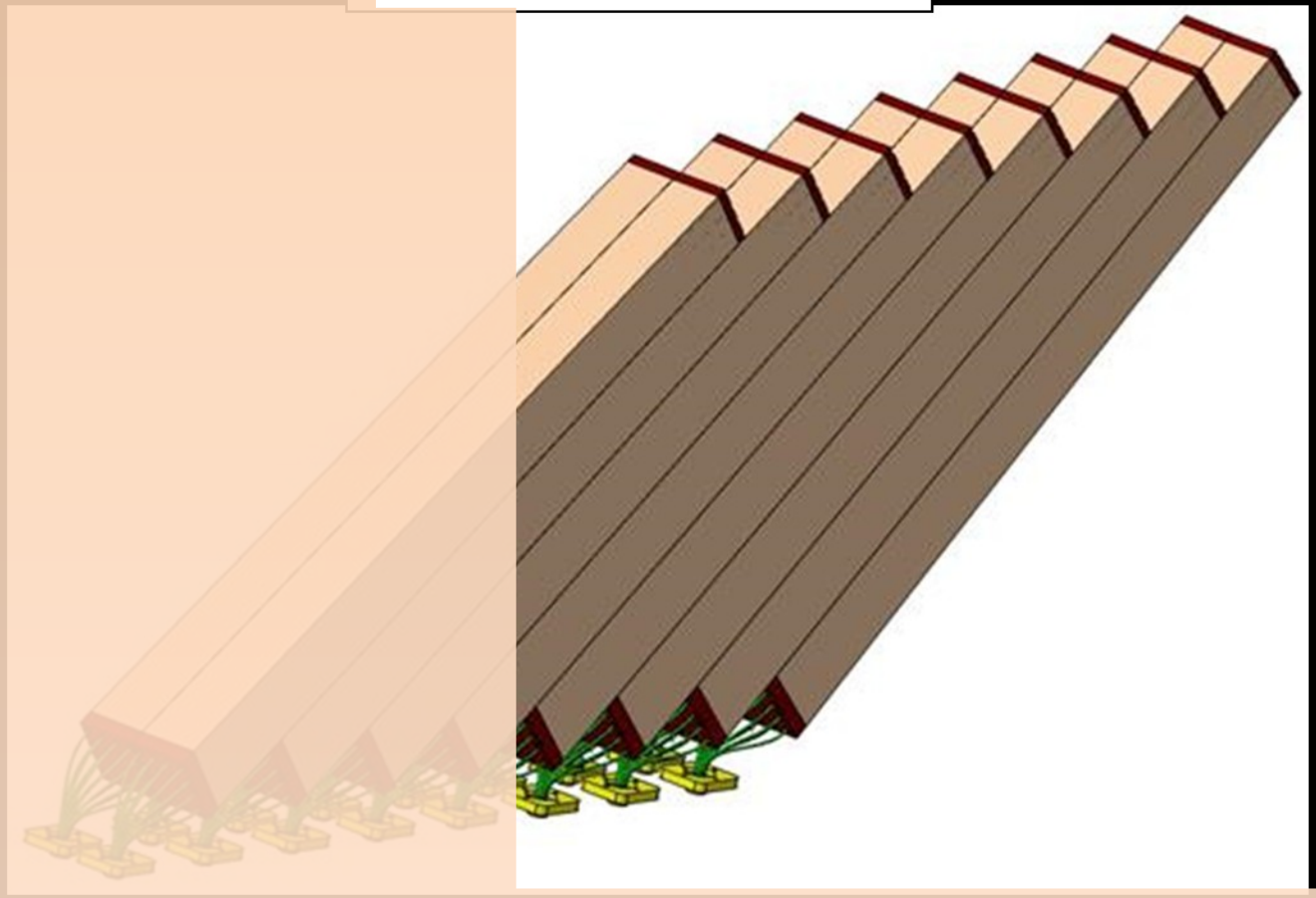
Main parts of the module



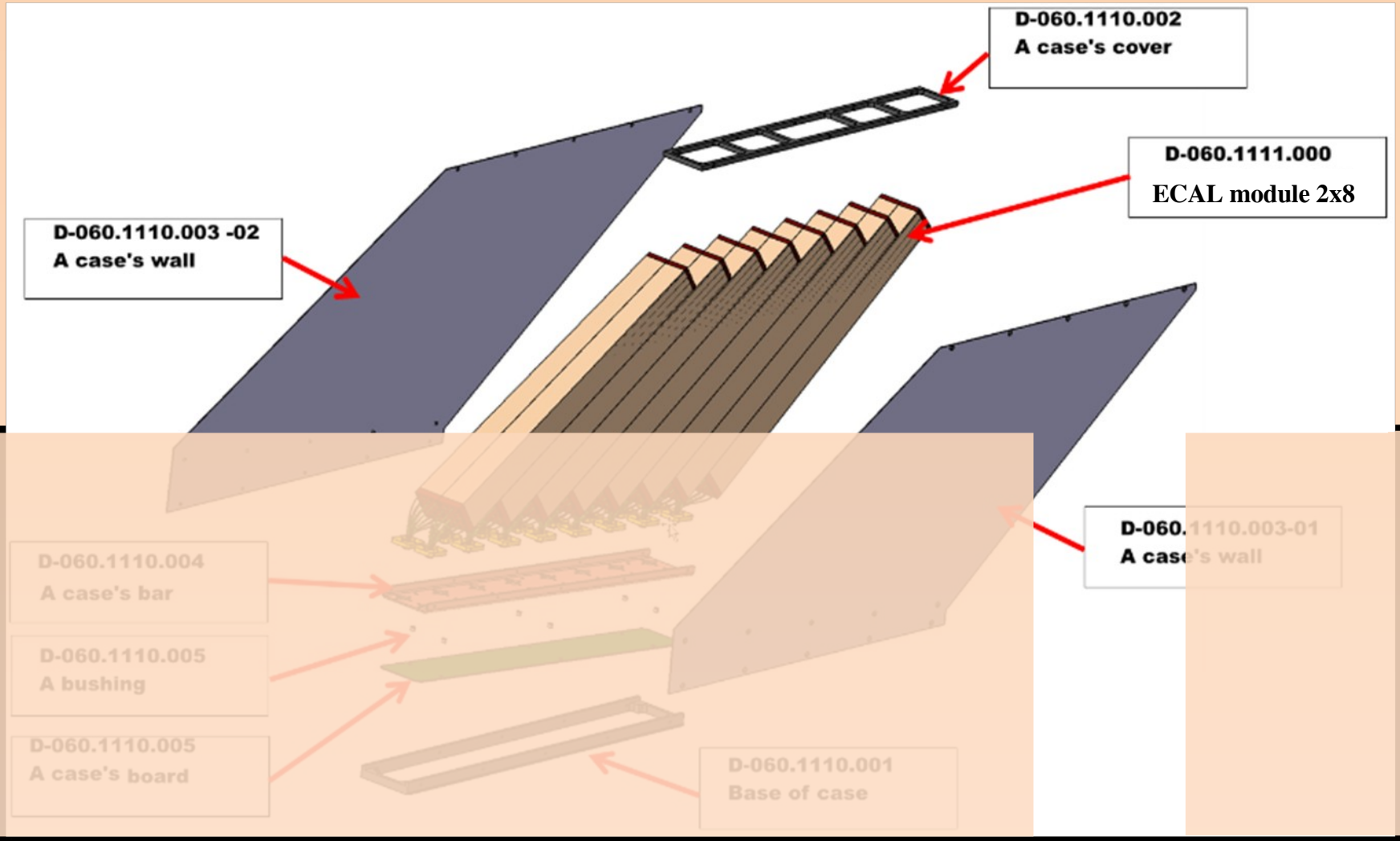
Assembled module 2x8

D-060.1111.000-01

Module ECAL 2x8

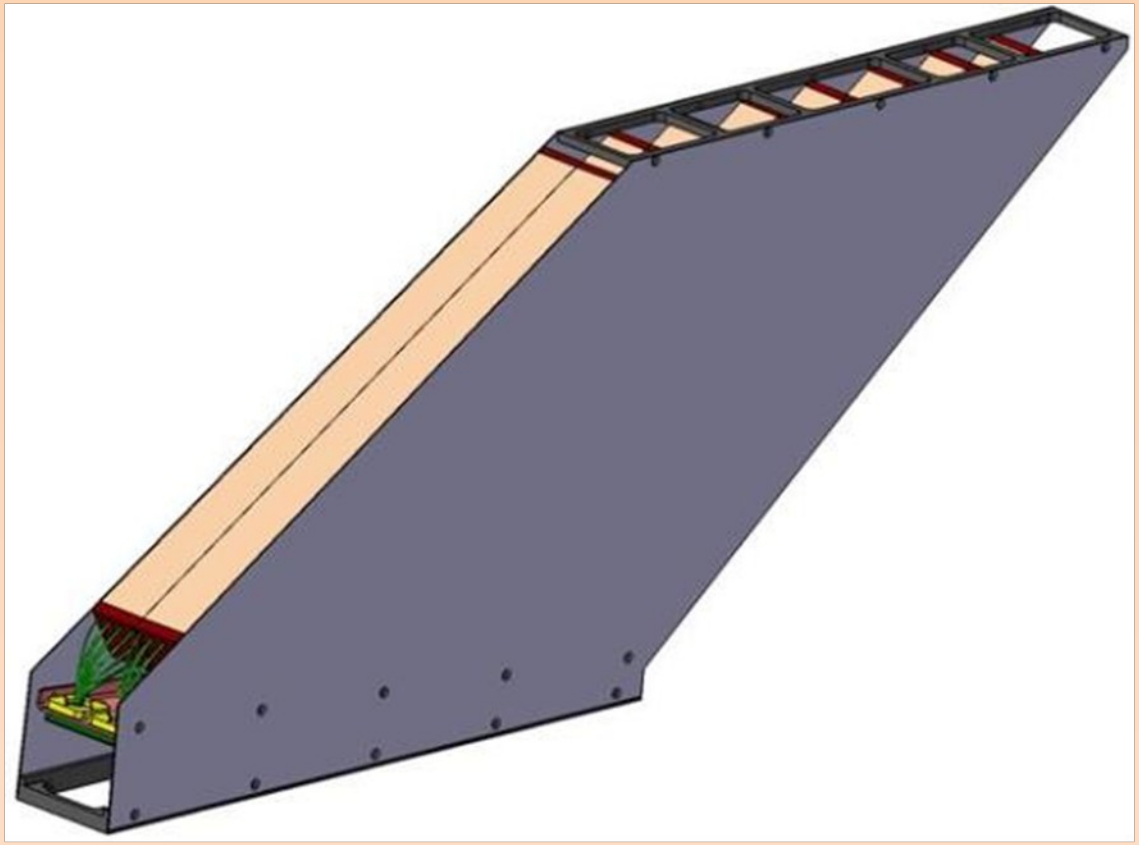


Main parts of the cassette

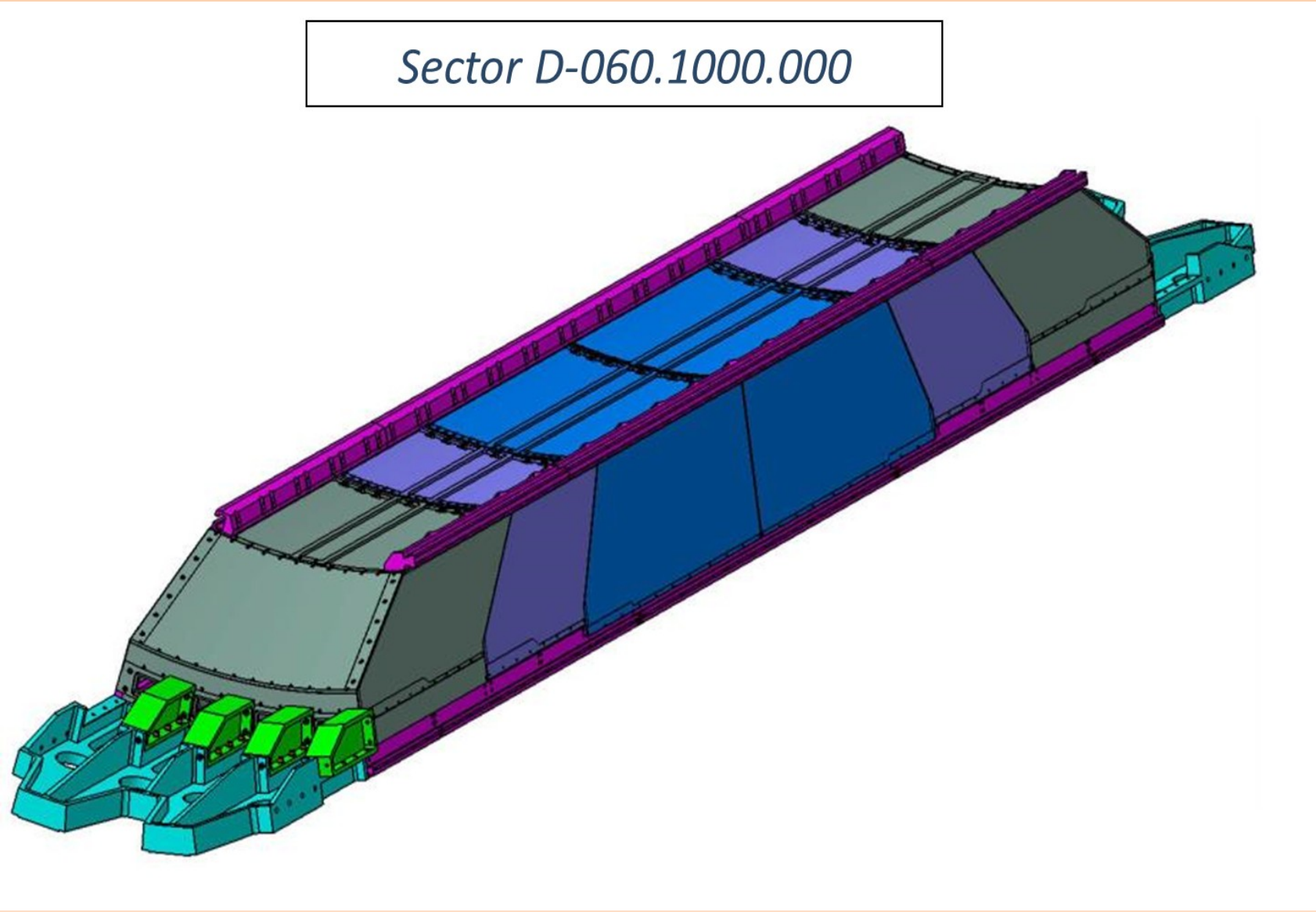


Assembled module

D-060.1110.000 Assembled case



ECAL's sector



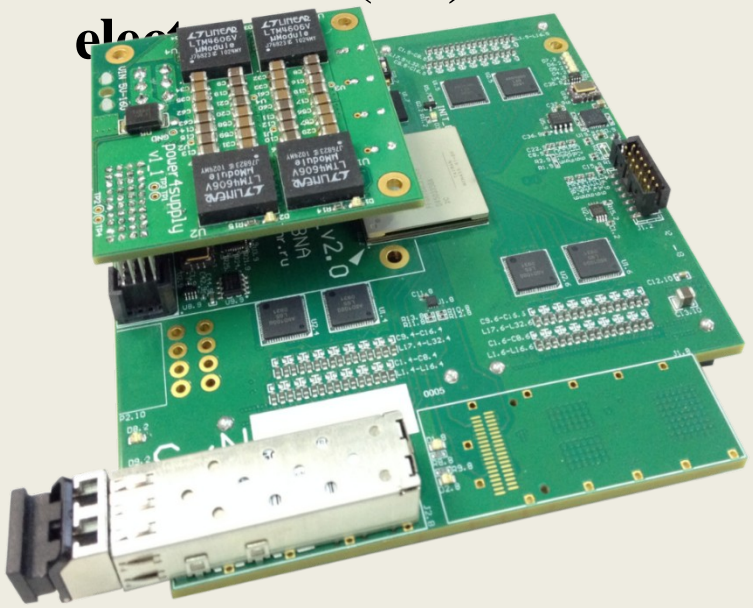
Detecting head

HAMAMATSU S13360-6025PE
MAPD counter

Slow Control

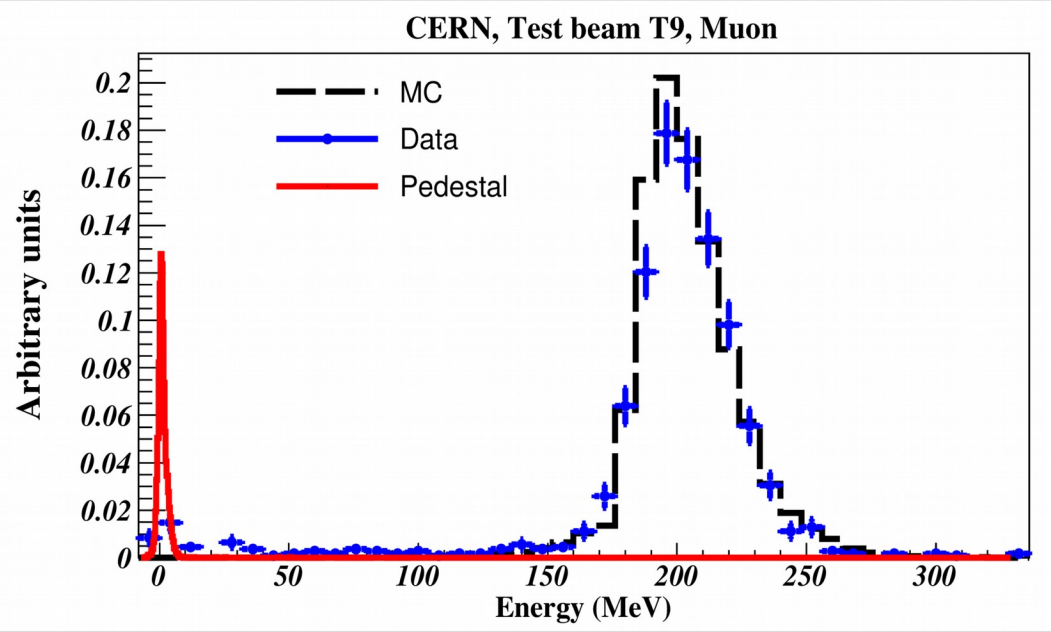
- High Voltage with temperature measurement and correction;
- LED Generator - for the continuous monitoring;
- Temperature and pressure - Temperature sensors will be located along the ECal sectors. Through these sensors Slow Control system will take temperature conditions around ECal under constant attention.

Front-End (FE) elect



- ADC 64 channel board.
- It quantizes the analog input signal;;
- Zero suppression logic;
- ADC board allows to be integrated to the White Rabbit synchronization system.

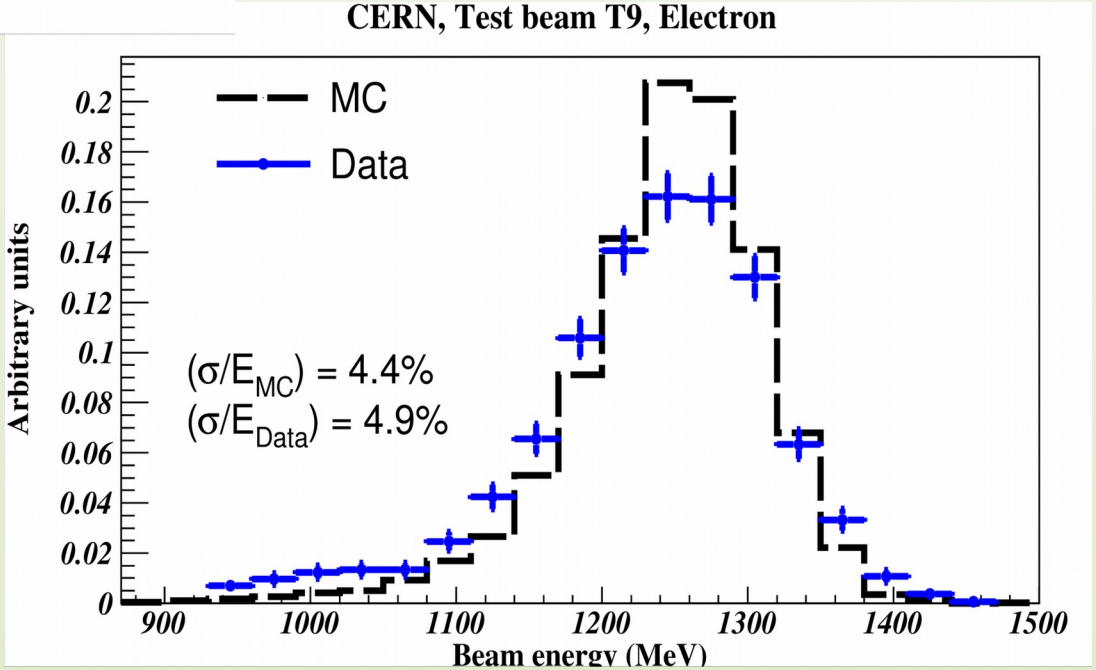
Test results

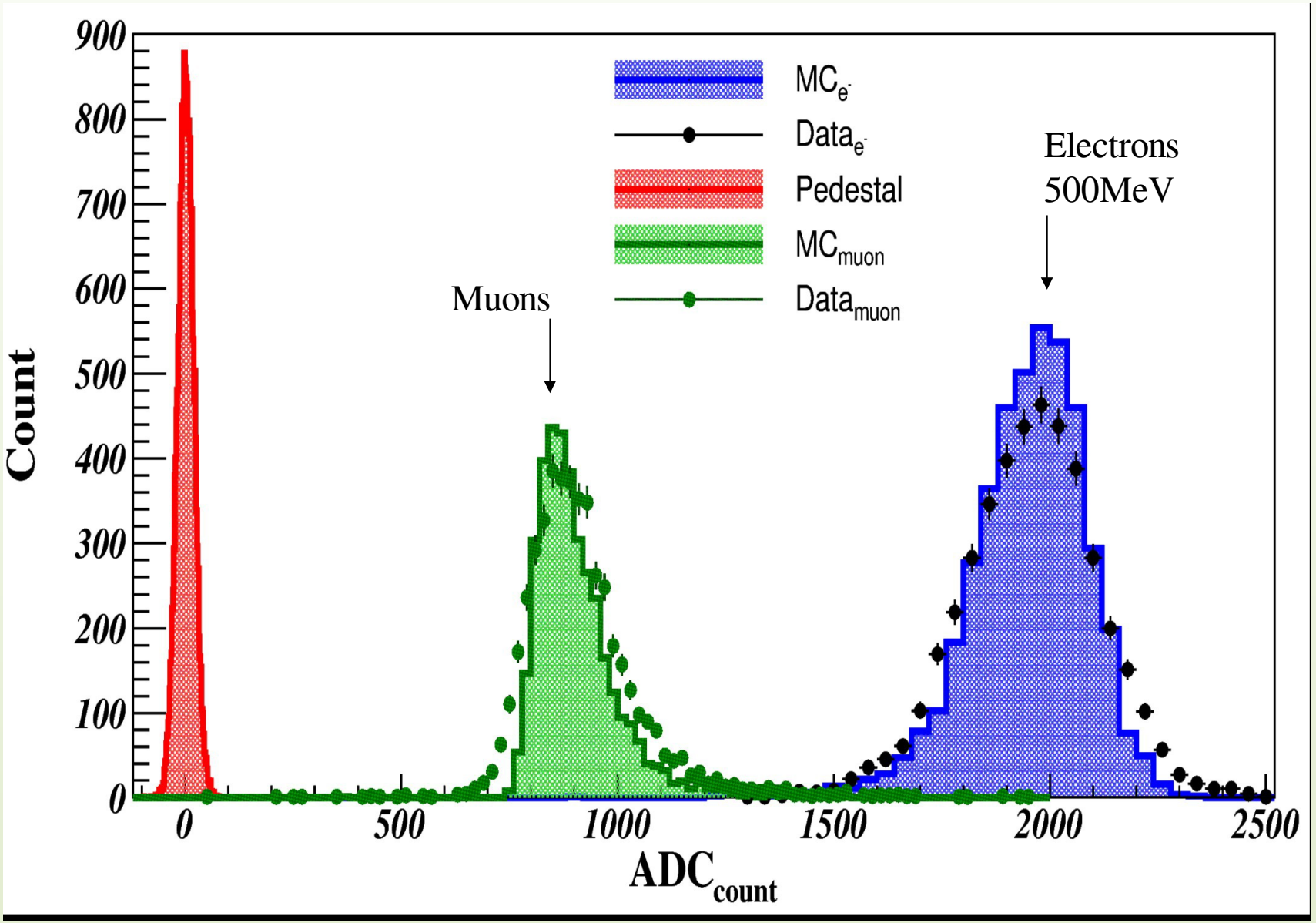


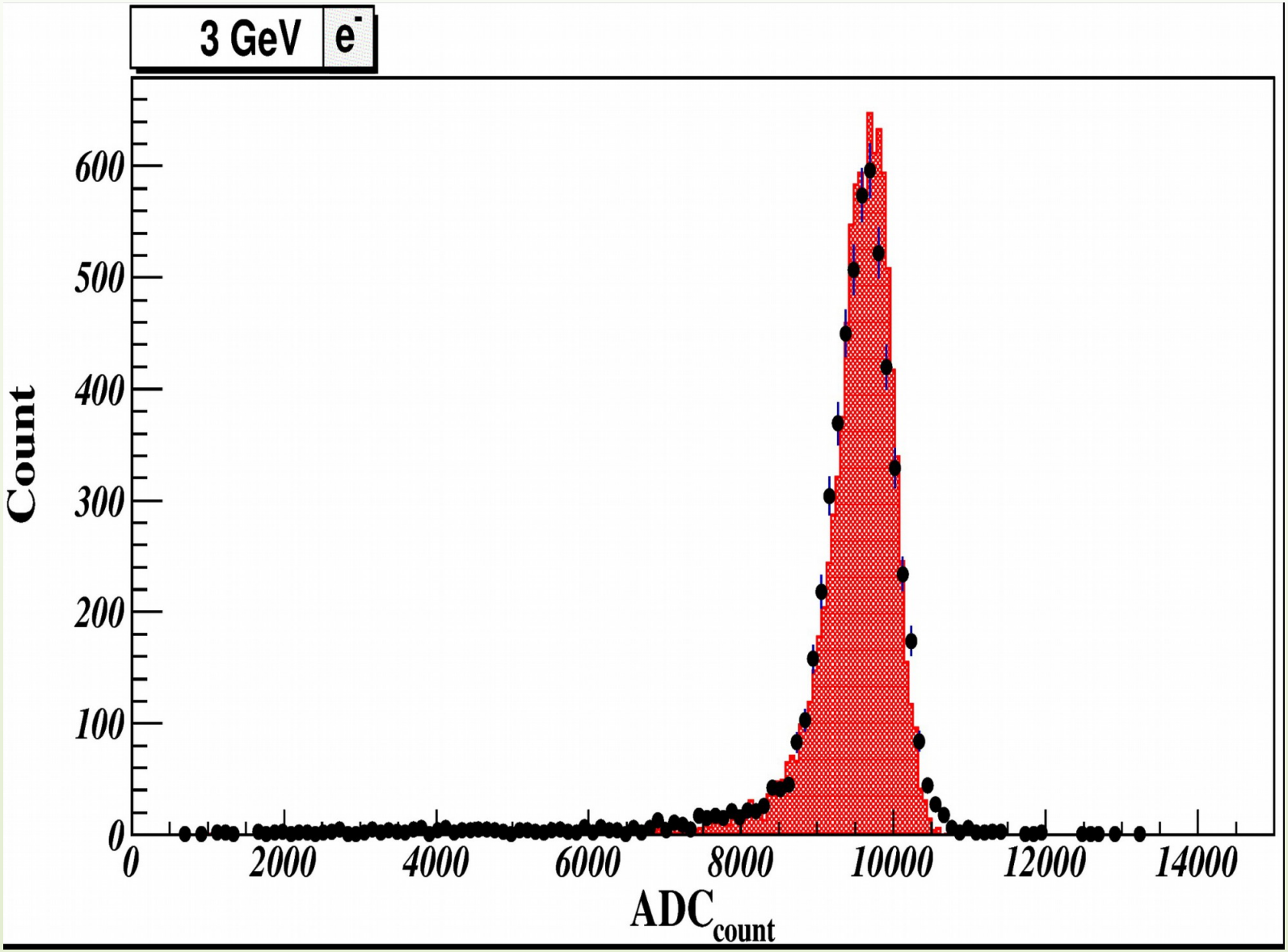
CERN 2014

MC predictions are in reasonable agreement with data.
(For the muons and for the electrons)

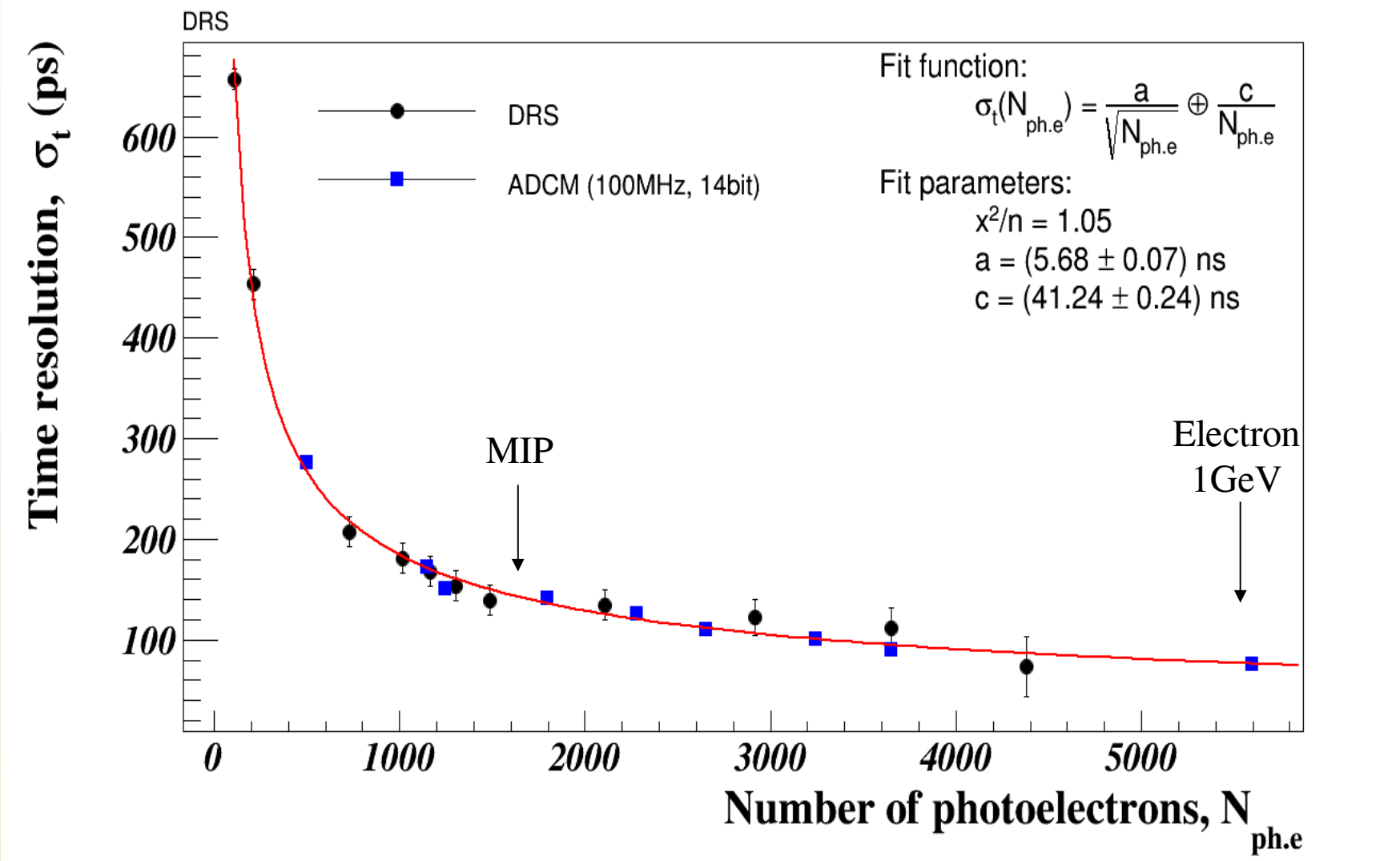
Low noise – possibility to make measurements starting from very low energy (at least from 10MeV)



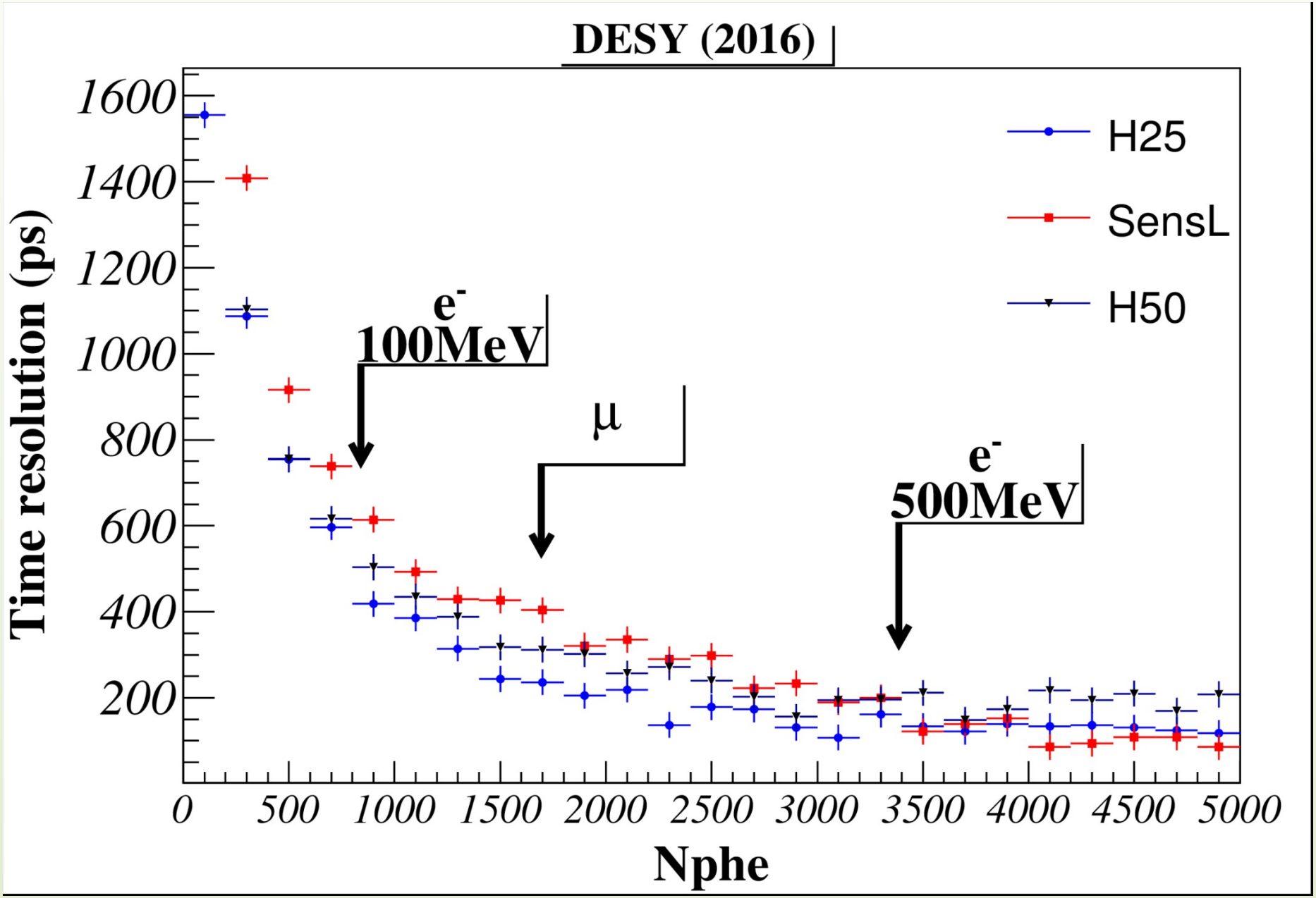

Count
900
800
700
600
500
400
300
200
100
0
0
500
1000
1500
2000
2500
ADC count
MC e-
Data e-
Pedestal
MC muon
Data muon
Muons
Electrons
500MeV


3 GeV e-
Count
600
500
400
300
200
100
0
0
2000
4000
6000
8000
10000
12000
14000
ADC count

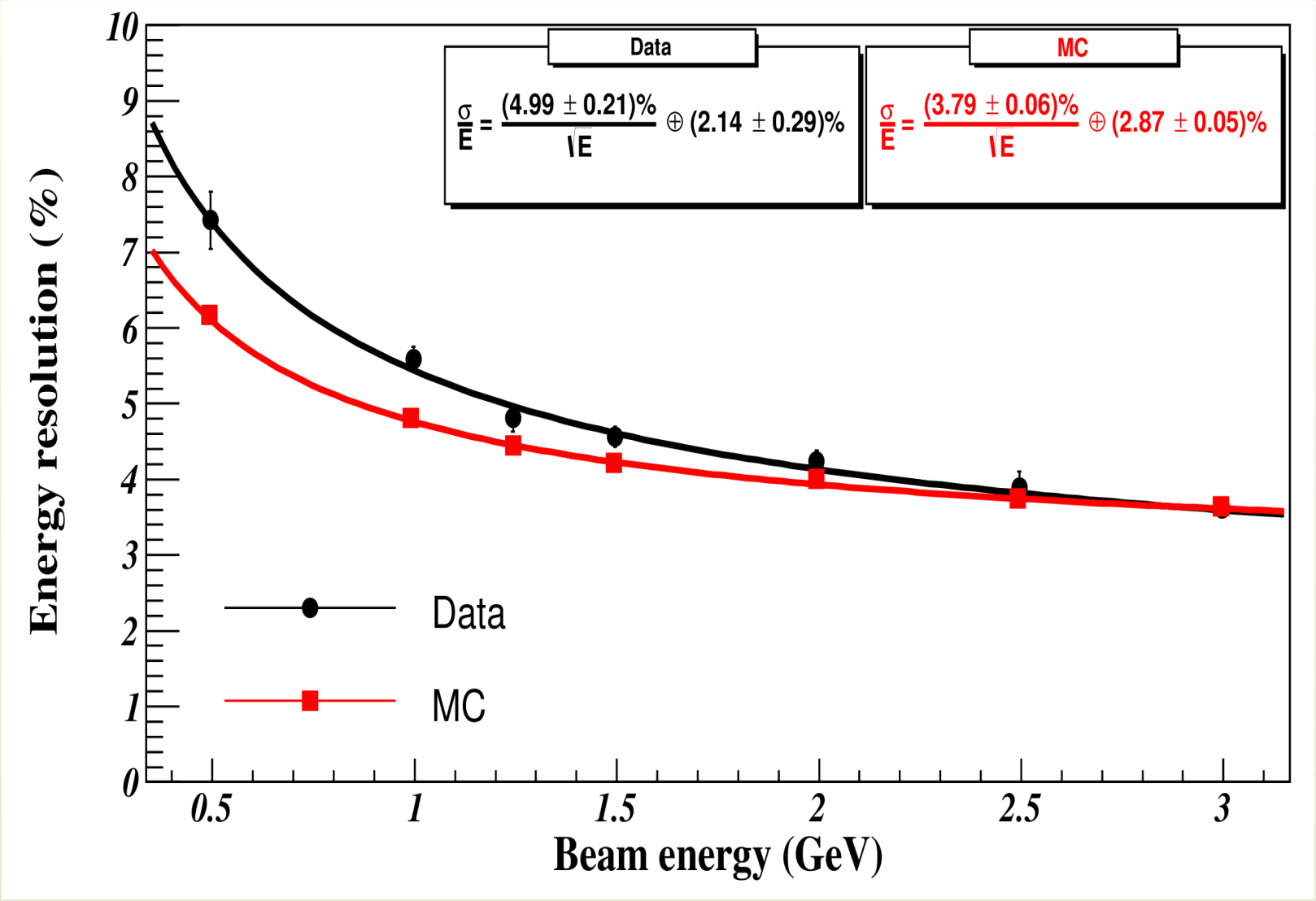
Time resolution

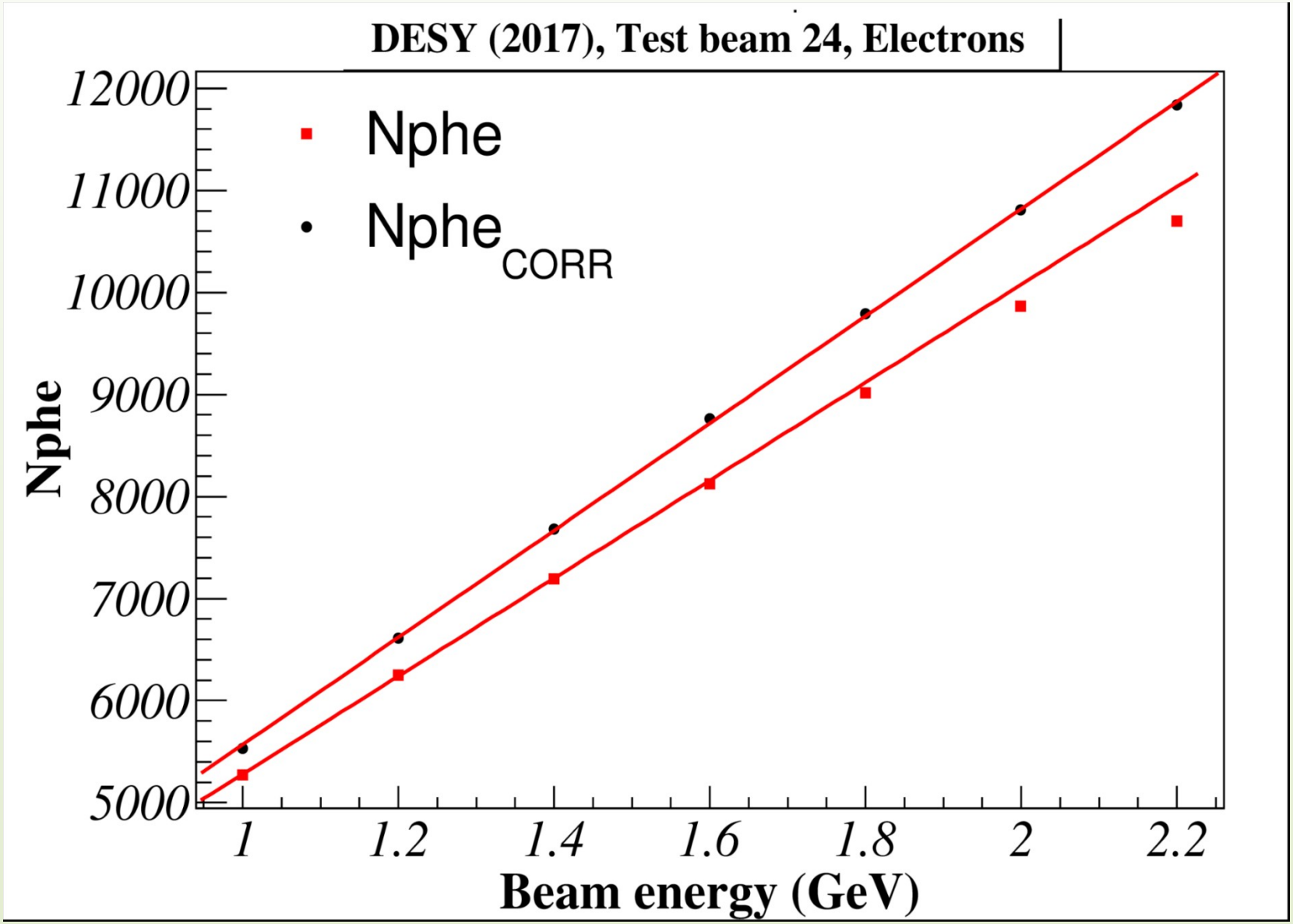


Measurements of time resolution done by the different methods with completely different electronics shows perfect agreement.


DESY (2016)
Time resolution (ps)
1600
1400
1200
1000
800
600
400
200
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
Nphe
H25
SensL
H50
e-
100MeV
μ
e-
500MeV

Energy reoslution




DESY (2017), Test beam 24, Electrons
Nphe
Nphe_CORR
12000
11000
10000
9000
8000
7000
6000
5000
Nphe
1
1.2
1.4
1.6
1.8
2
2.2
Beam energy (GeV)

Conclusions

1. Calorimeter modules design is completed.
2. Technology of the modules production is developed
   Production will start in few months.
3. Design of the calorimeter sectors with technological procedures is close to the completion.
4. Electronics developed and tested.
5. Prototypes are tested and good performance is shown.
6. Much more efforts needed in simulation – interface between detector simulation and physics analysis.

Thank you!