Hadron Programs at HIRFL-CSR

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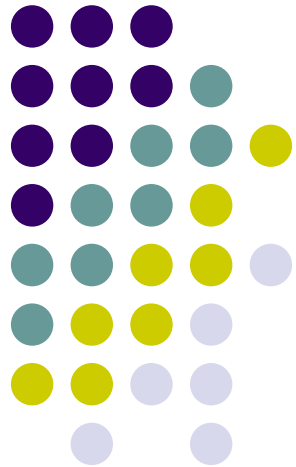
1 Status of the HIRFL-CSR complex

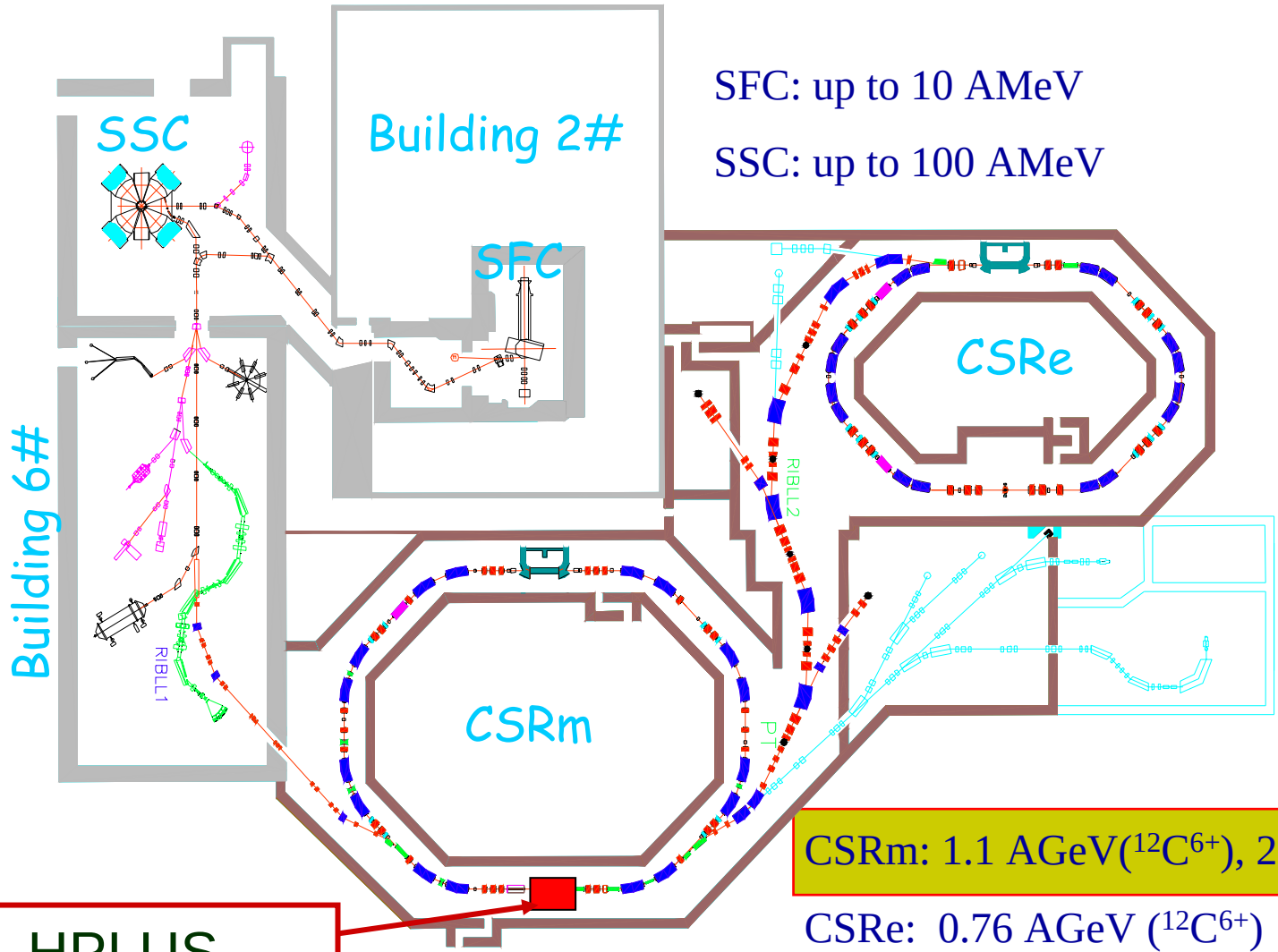
2 Hadron Physics program planned at CSR

3 Status of HPLUS

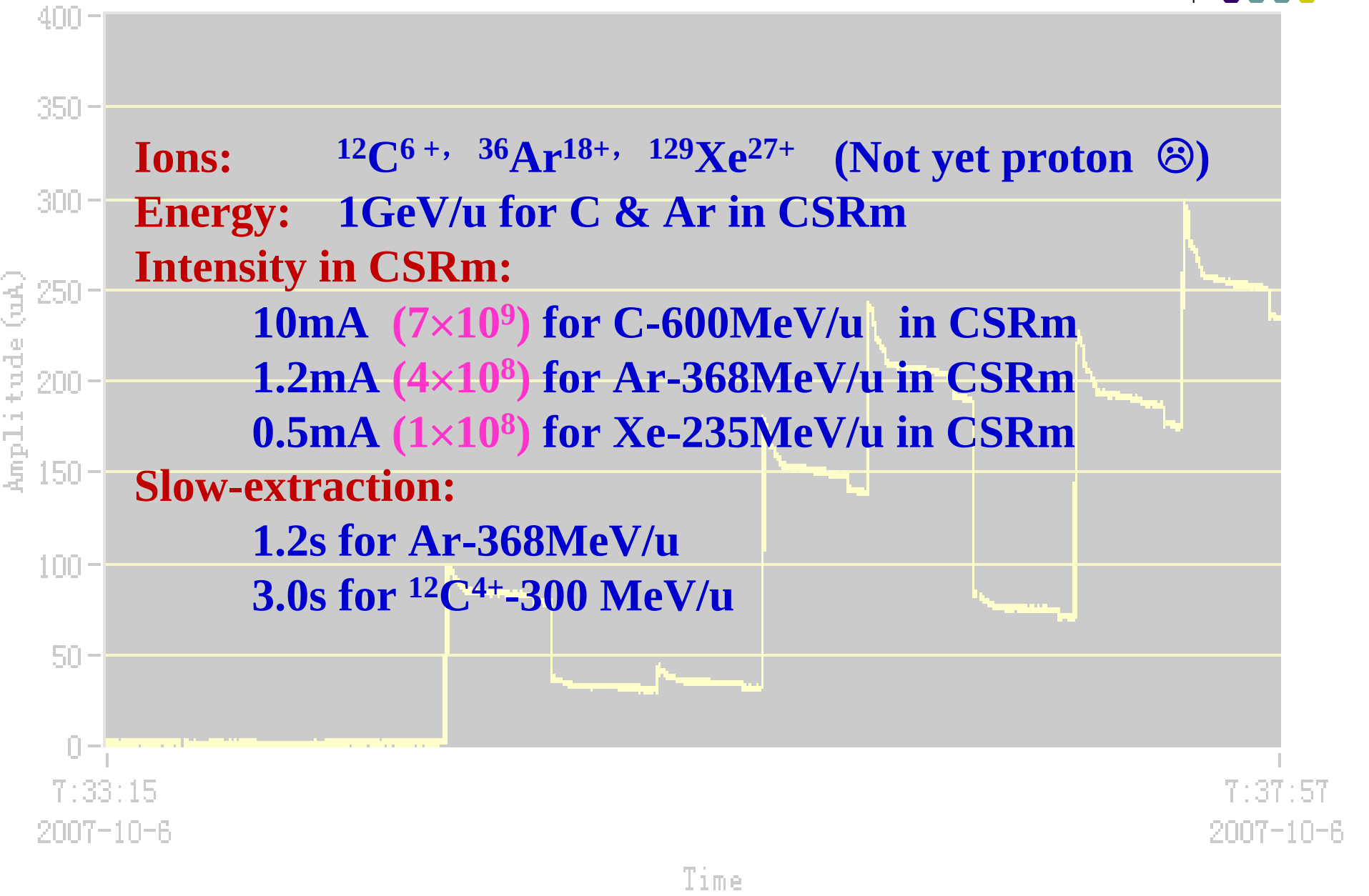
4 Summary



1 Status of the HIRFL-CSR complex



Commissioning of HIRFL-CSR



Ions: $^{12}C^{6+}$, $^{36}Ar^{18+}$, $^{129}Xe^{27+}$ (Not yet proton ☹)

Energy: 1GeV/u for C & Ar in CSRm

Intensity in CSRm:

10mA (7×10^{9}) for C-600MeV/u in CSRm

1.2mA (4×10^{8}) for Ar-368MeV/u in CSRm

0.5mA (1×10^{8}) for Xe-235MeV/u in CSRm

Slow-extraction:

1.2s for Ar-368MeV/u

3.0s for $^{12}C^{4+}$-300 MeV/u

2 Hadron Physics program planned at HIRFL-CSR

- Hadron spectroscopy / Symmetry / Spin/isospin physics

Channels	Threshold （GeV）	Physical interest
$pp \rightarrow pp\phi \rightarrow ppK^+K^-$	2.59	Internal strange quark distribution and violation of symmetry
$pp \rightarrow pK^+\Sigma$ $(\Lambda \rightarrow n+\gamma)$	1.79(1.58)	Multi-quark states and strange constituent
$pp \rightarrow da_0(980)$ $(f_0(980))$	2.48	Mesons a_0/f_0 & internal quark-gluon structure
$pp \rightarrow pp\eta$ (η') $pp \rightarrow pp\omega$	1.26(2.4) 1.89	Isospin symmetry violation
$pp \rightarrow N^*, \Delta^{++}(\rightarrow K\Lambda\ldots)$	~1.38	Baryon resonance
$p\alpha \rightarrow N^*\alpha$	0.795	Baryon excited states with Big σN coupling
$pA \rightarrow \rho(\omega, \eta)$ $pA \rightarrow \phi \rightarrow K^+K^-$	Sub-threhold	Light Meson in Medium

2 Concept design of HPLUS (Hadron Physics LanzhoU Spectrometer)

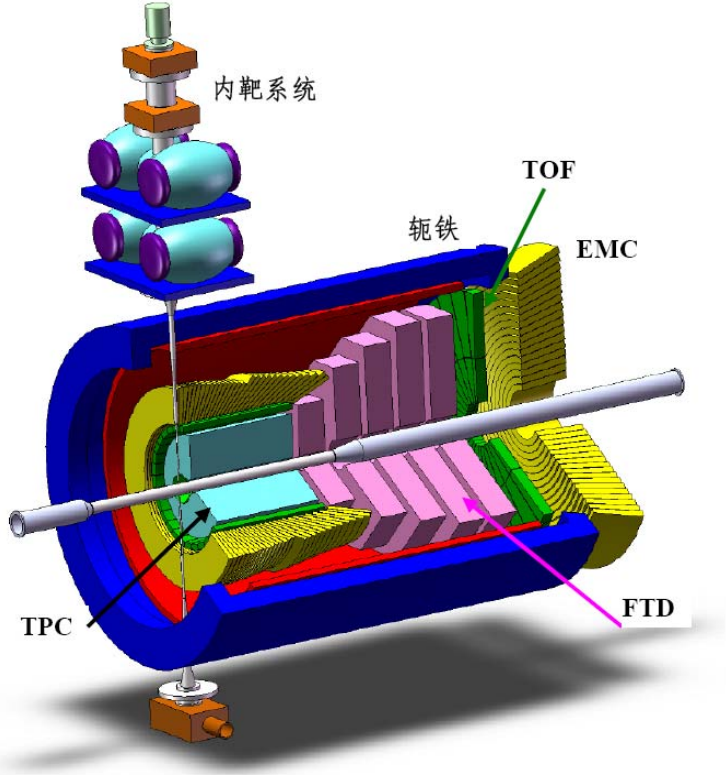
Some basics related to the design

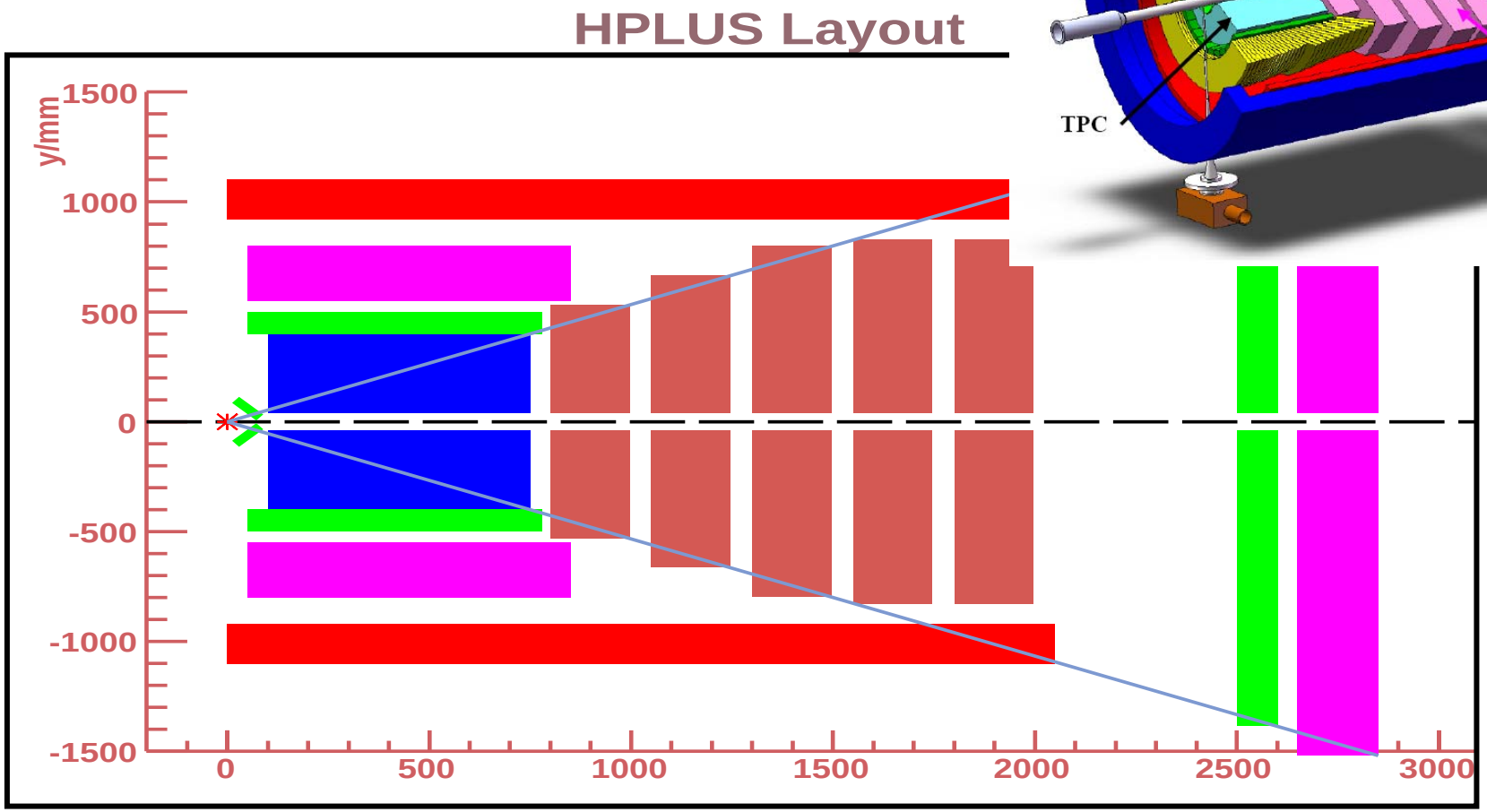
- Luminosity estimation: 10^{31}/s/cm^{-1};
- Event Rate estimation: 10^{5}/s {50mb} / 10/s {1μb}
- Total Space length: ~3.5m
- Life time of beam estimation:

Some Fast Simulations Results

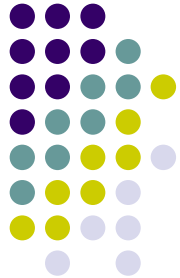
- Charged particles distribution: >85% in 90°, For φ and N* channels, >90% charged products dominated within 30 °;
- TPC only insufficient for PID and p measurement, >5 single forward tracking detectors required;
- For π/K identification at <1.5 GeV, Flight path length up to 2.5m+;
- >1000 blocks of CsI crystals needed, totally 2m^3;

Concept design of HPLUS





3 Status of HPLUS



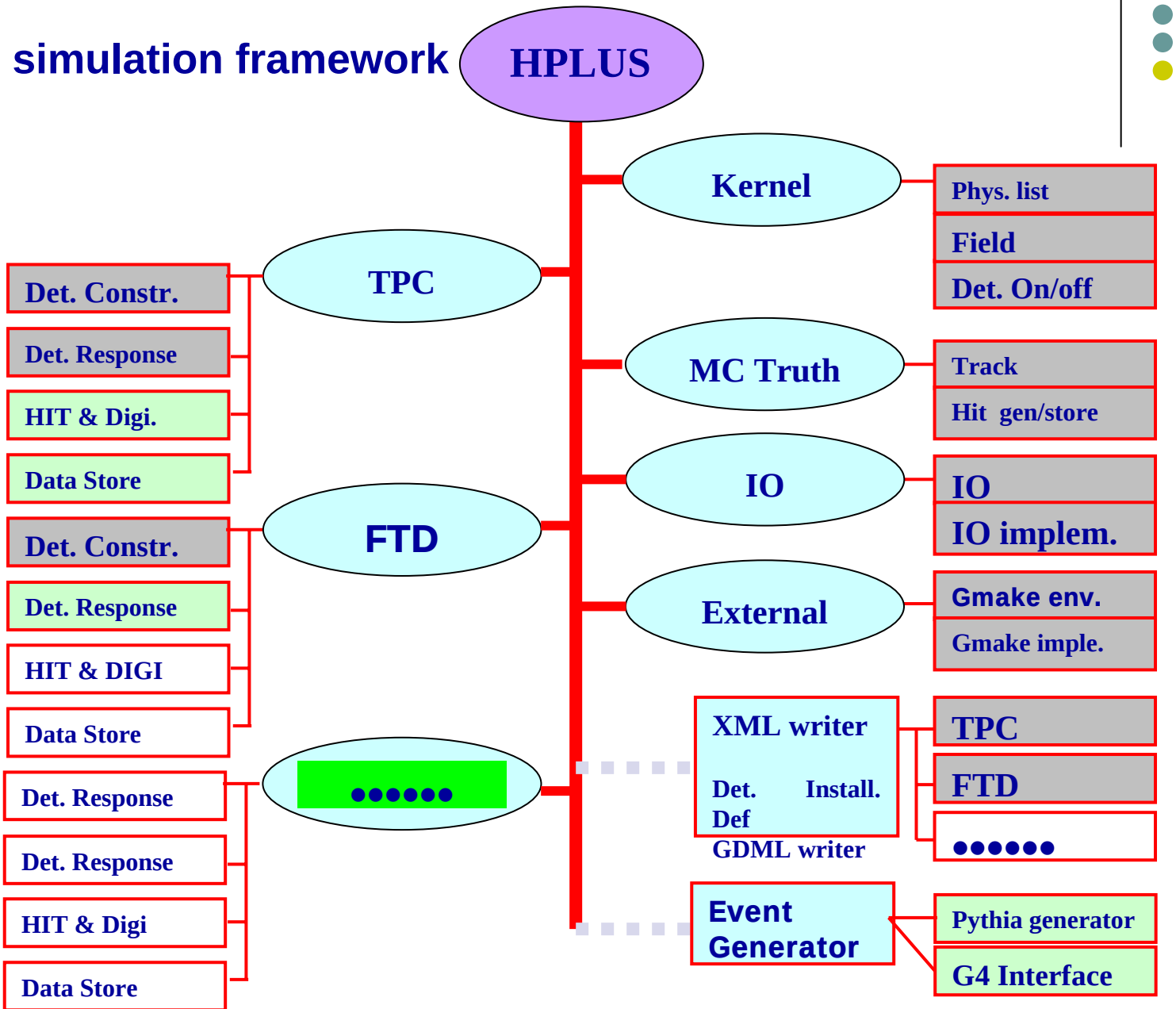
3.1 MC Simulation

3.2 Detector components R&D

Simulation and Detector R&D is distributed in various institution in China.

MC Simulation started

G4 based simulation framework

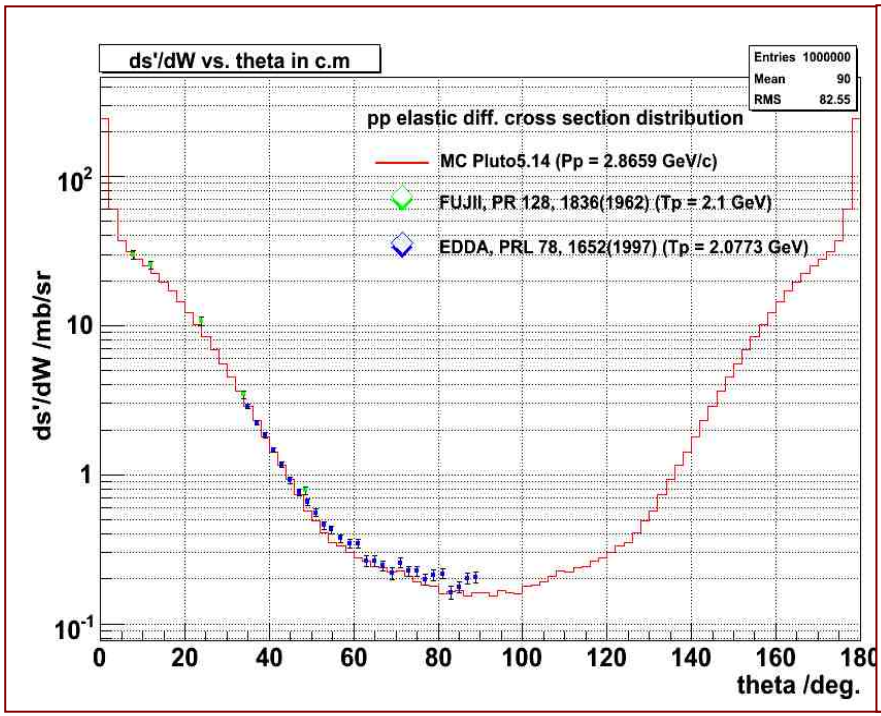


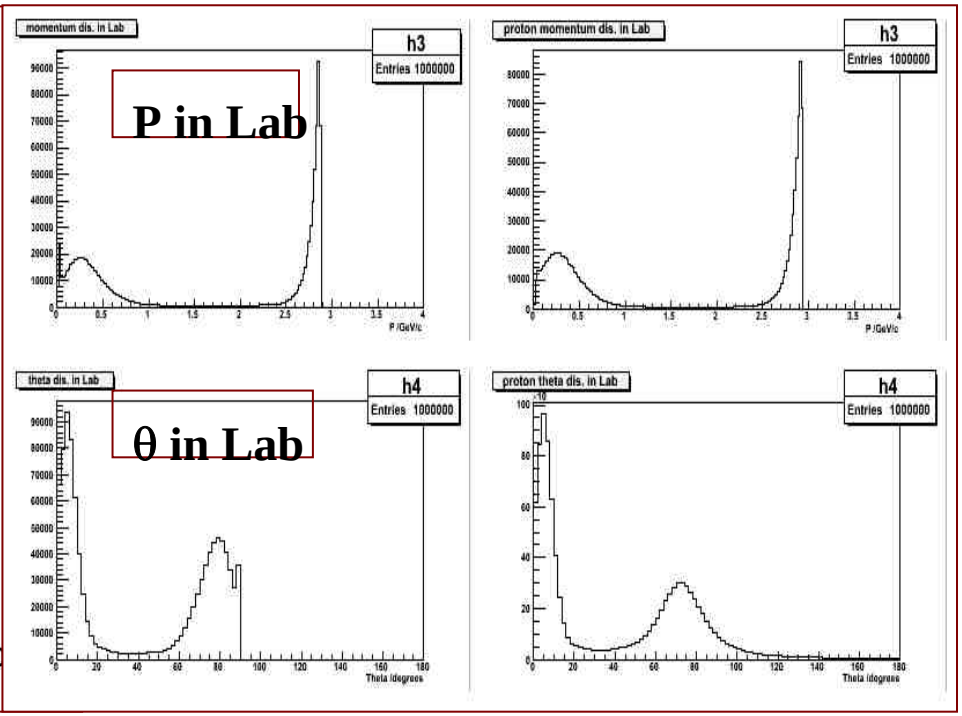
Event Generator = Pluto^{++} + Single Channel simu.

pp elastic ds/dΩ in c.m.

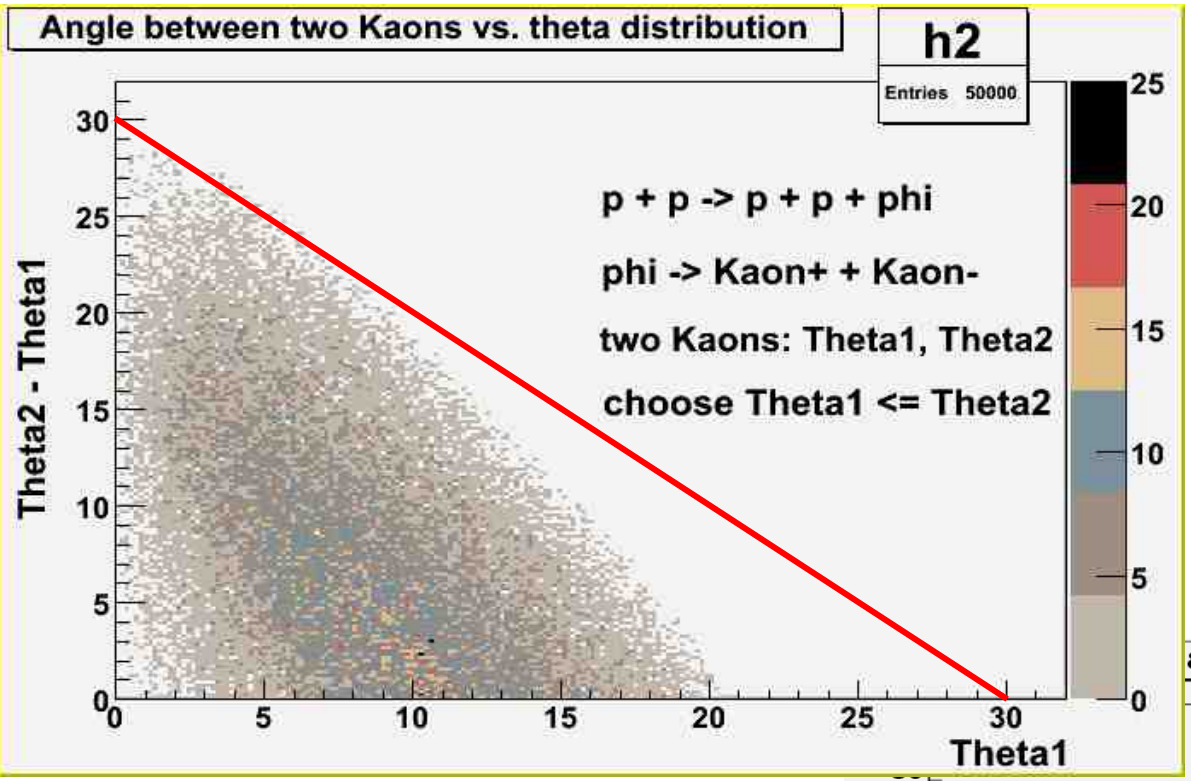
pp→pp

pd→pp(n)



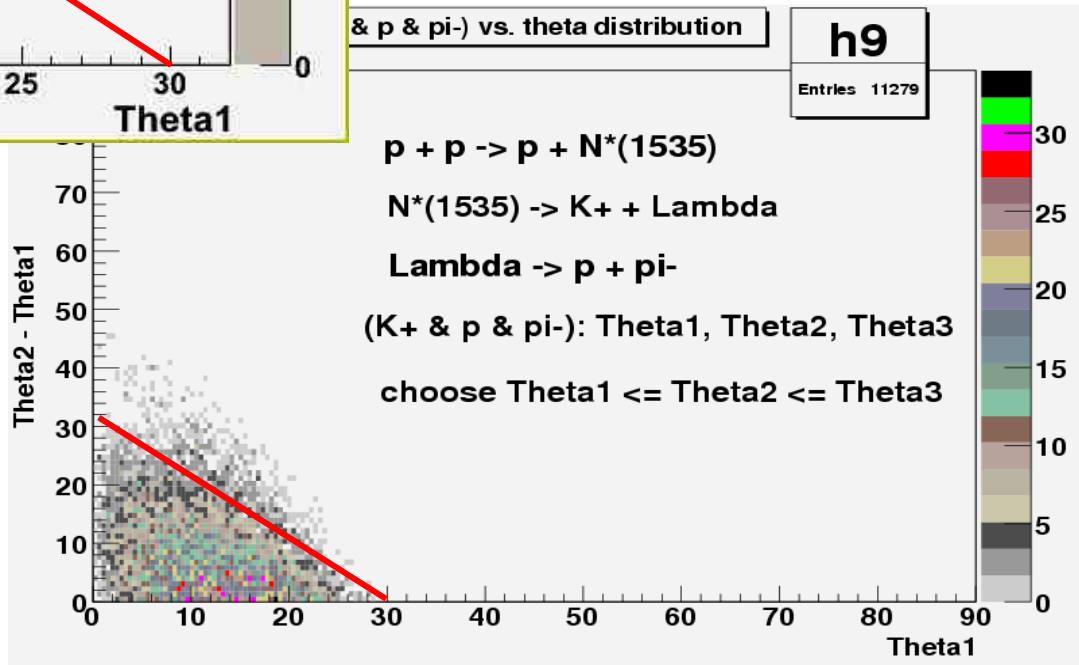


Feasibility Study of $pp \rightarrow pp\phi \rightarrow ppK^+K^-$ in FTD

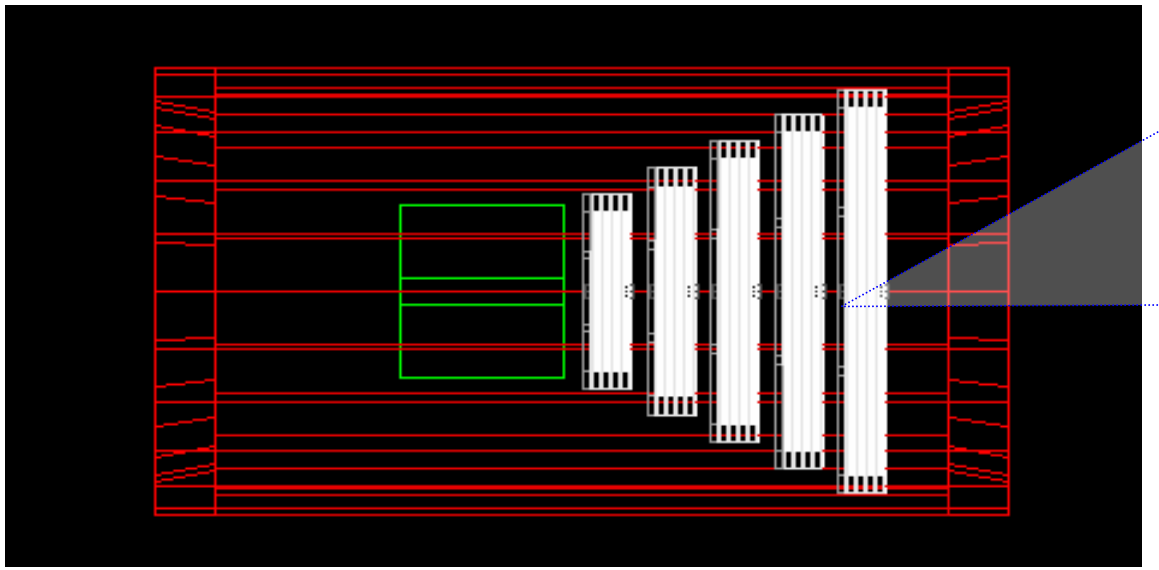


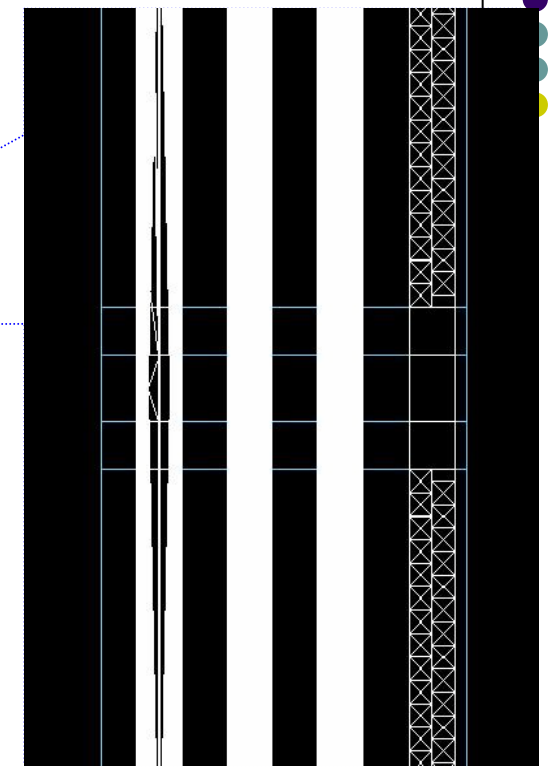
$pp \rightarrow pp\phi^*(\rightarrow K^+K^-)$

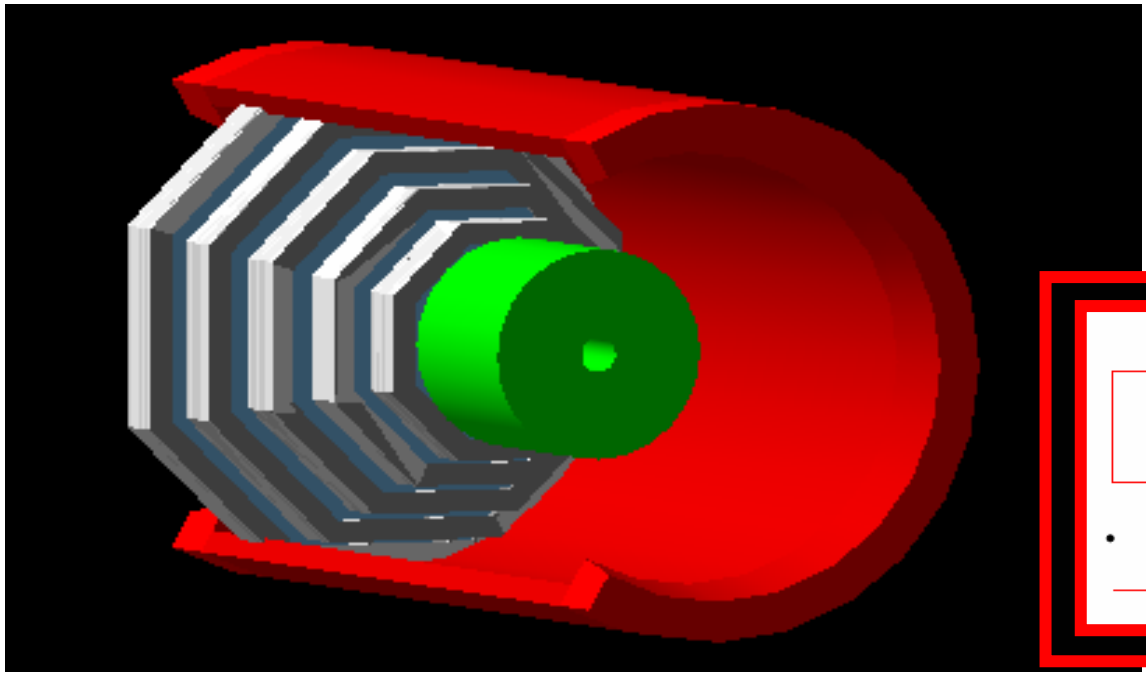
$pp \rightarrow pN^*(\rightarrow K^+\Lambda)$

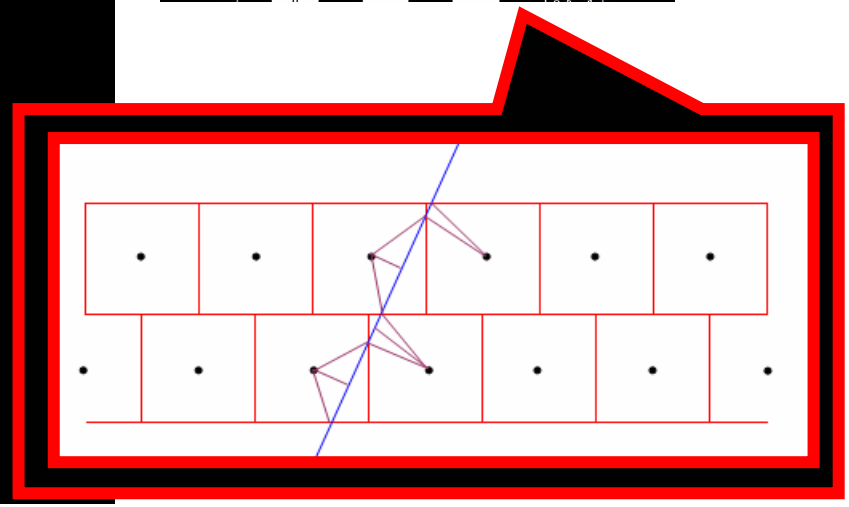


FTD Construction in Geant4

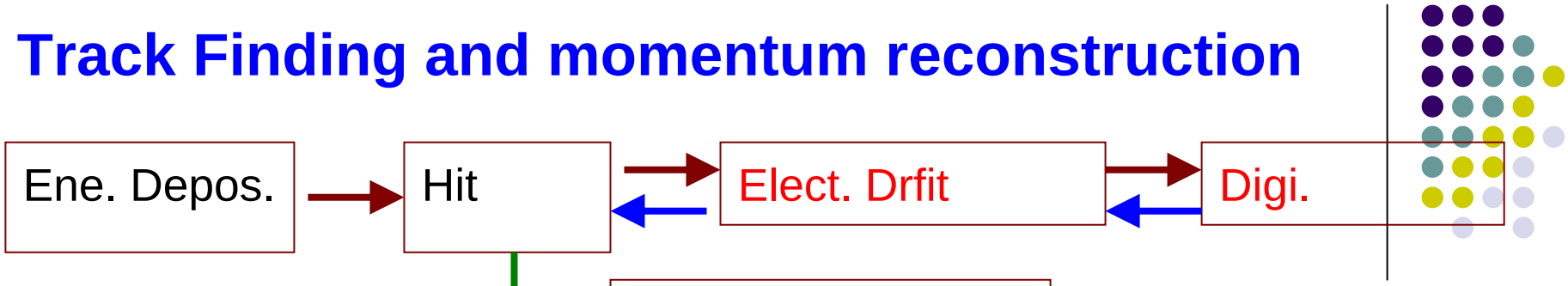


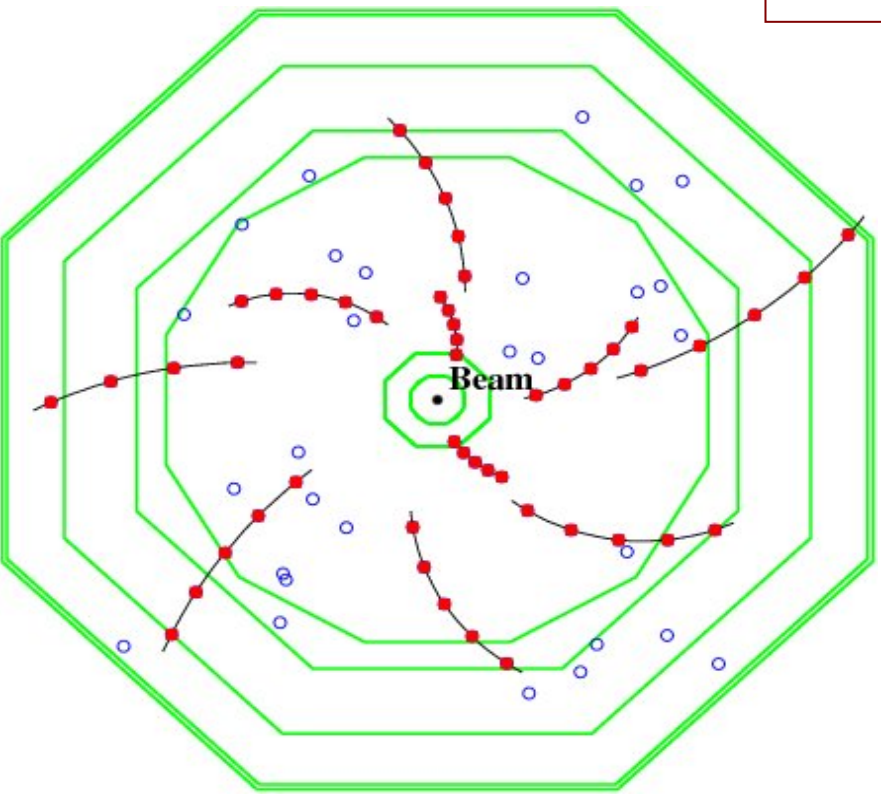


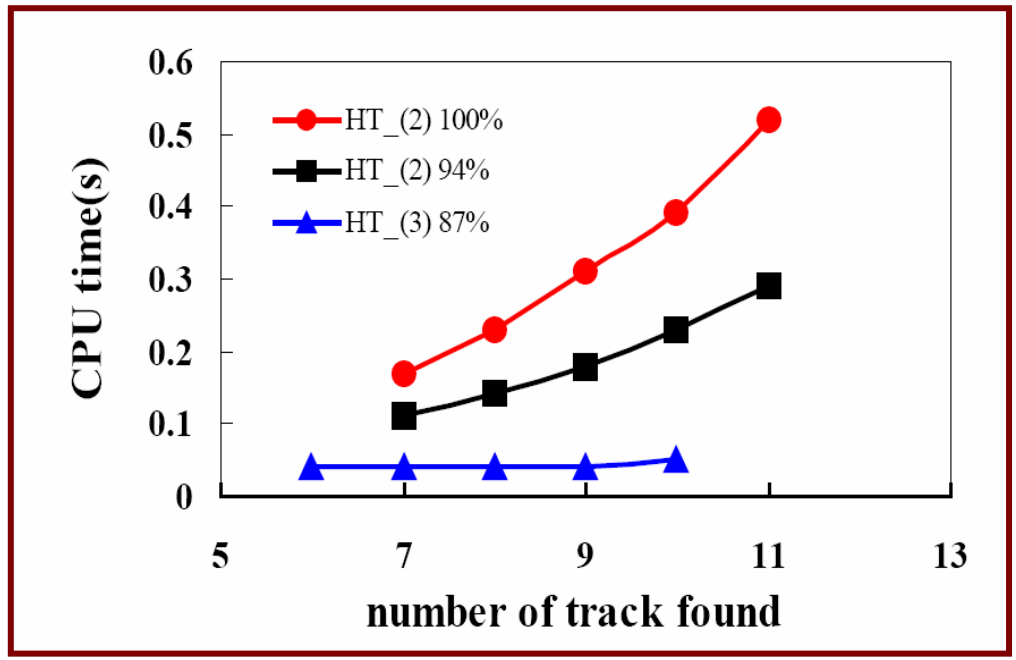


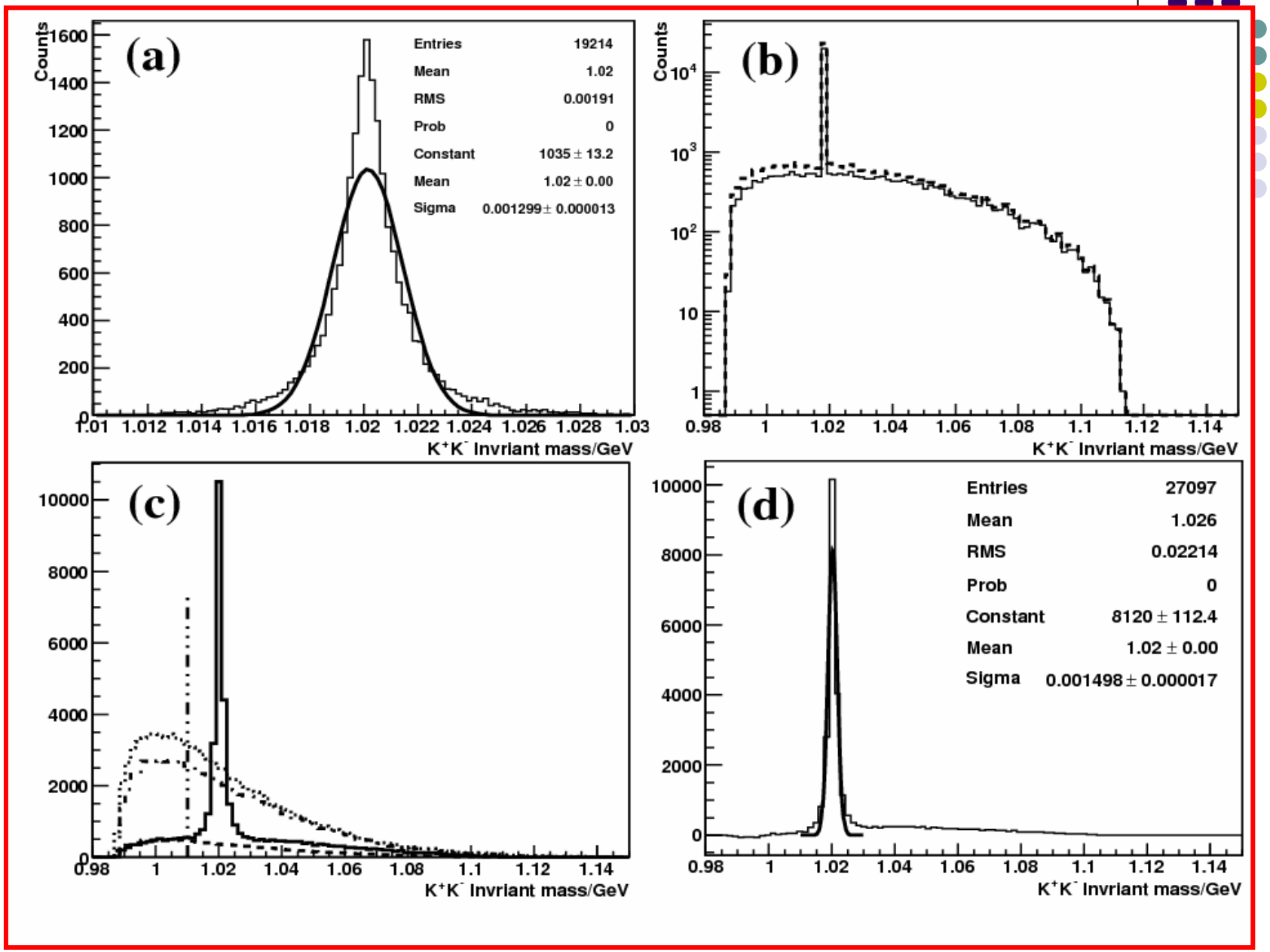


Track Finding and momentum reconstruction







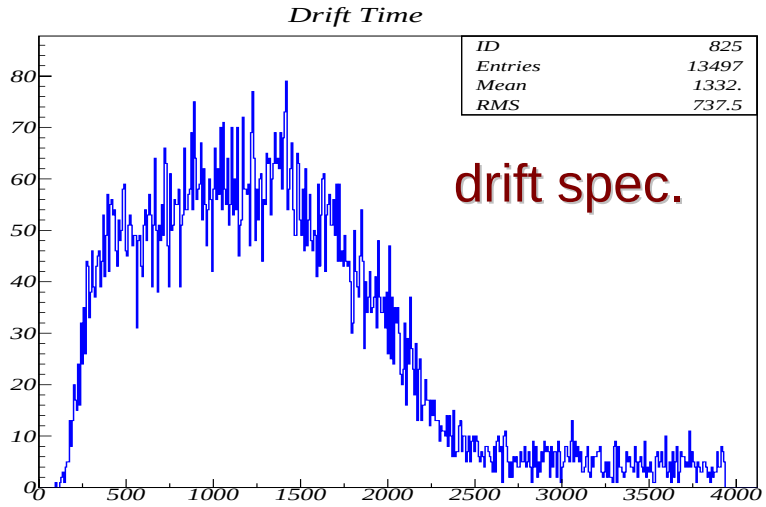


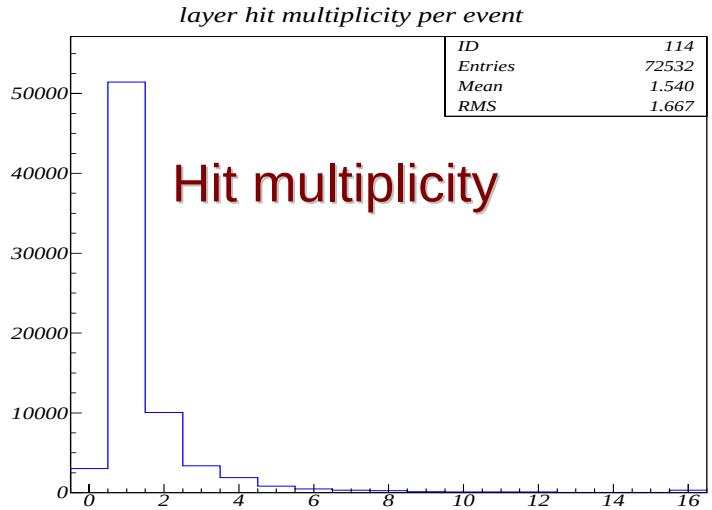
Invariant mass spectrum of K^+ K^-。

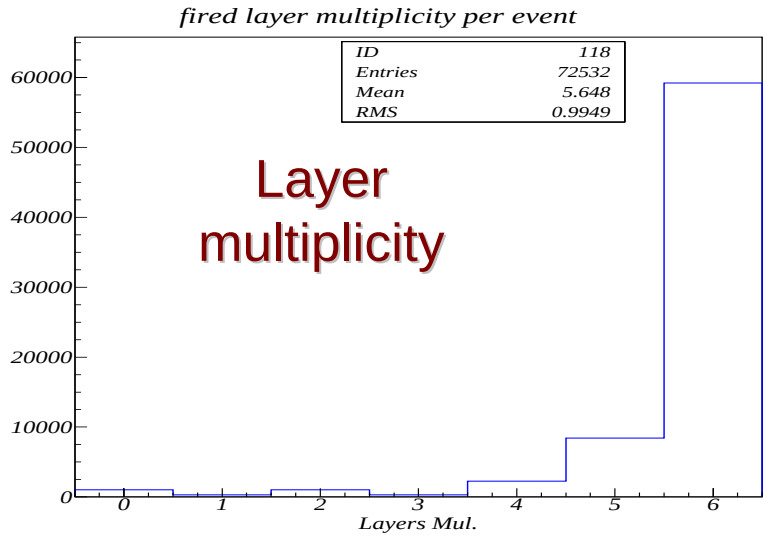
FTD: MWDC Prototype

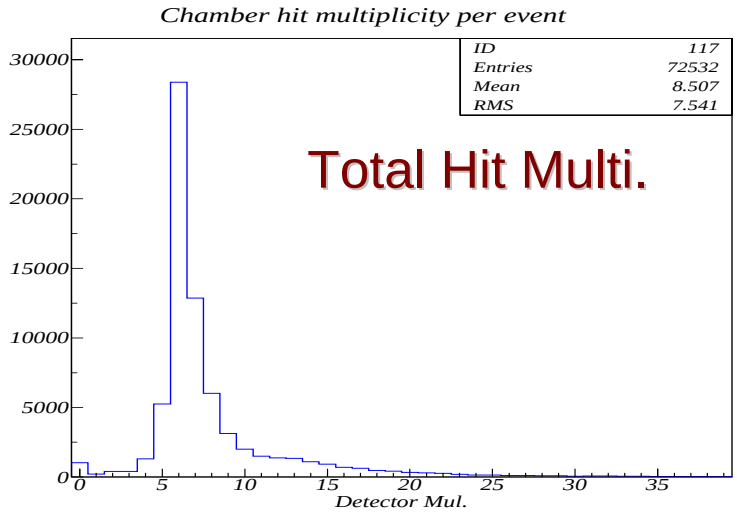
- Able to assemble large area MWDC。
- Various MWDC Prototypes have been made and the performance have been tested.

MWDC tested by cosmic

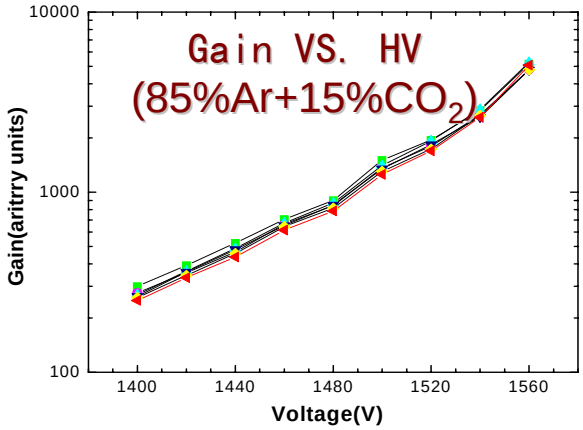


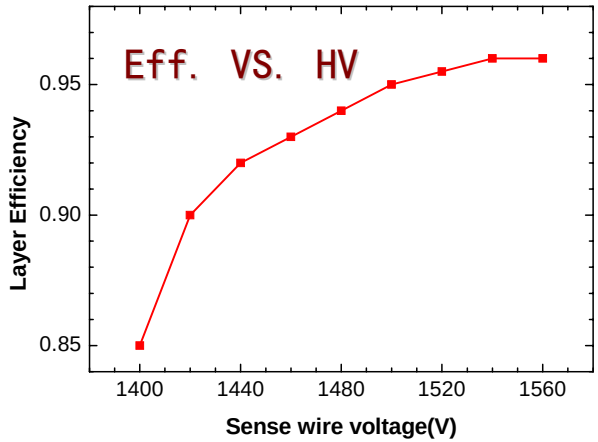


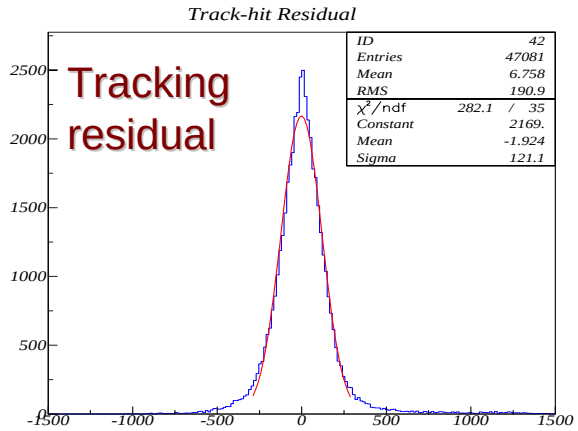


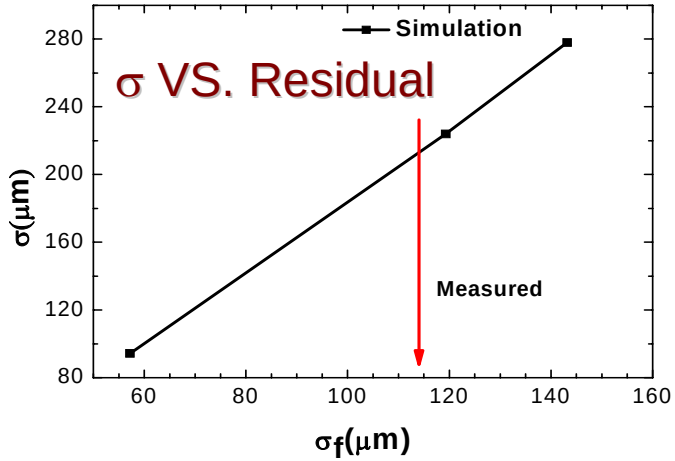


MWDC tested by cosmic



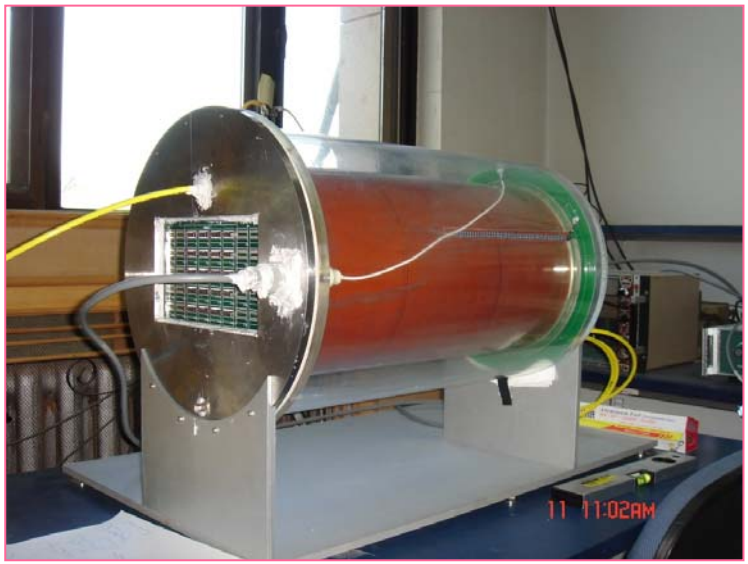


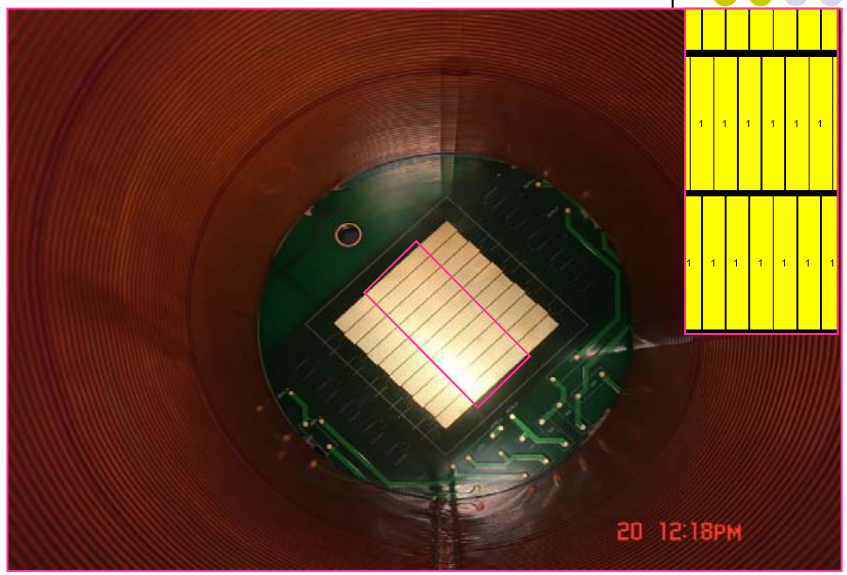


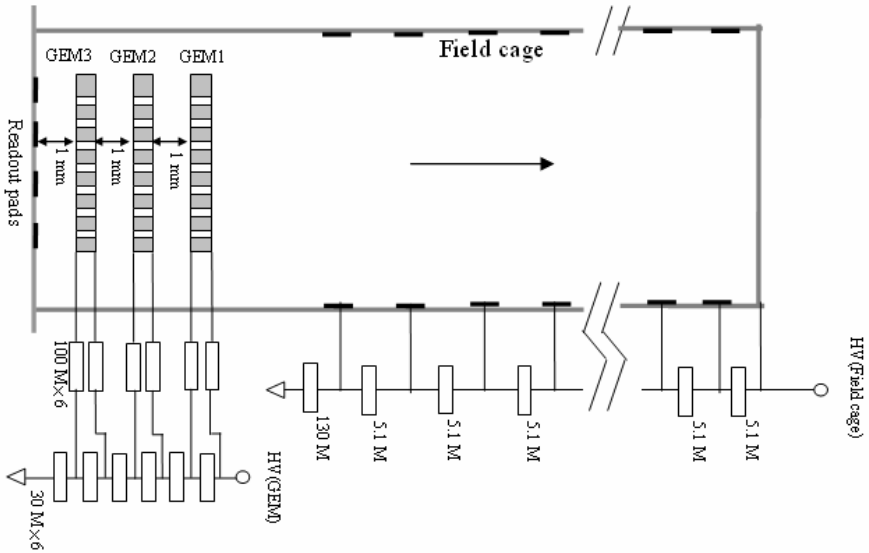


Position Resolution σ=210μm

TPC Prototype （R&D in Tsinghua Univ.）



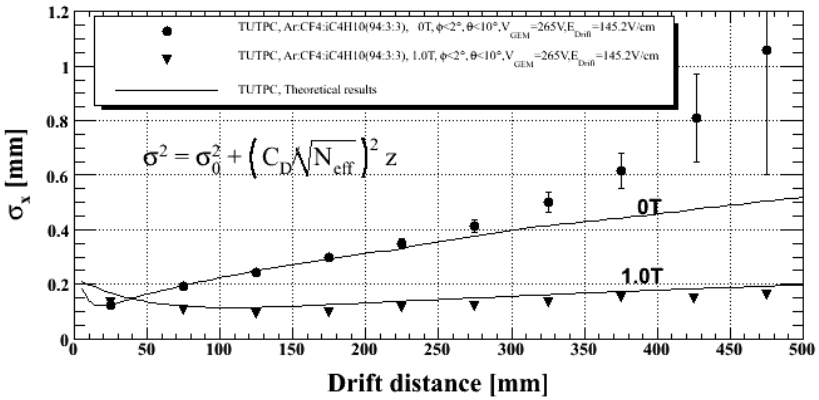




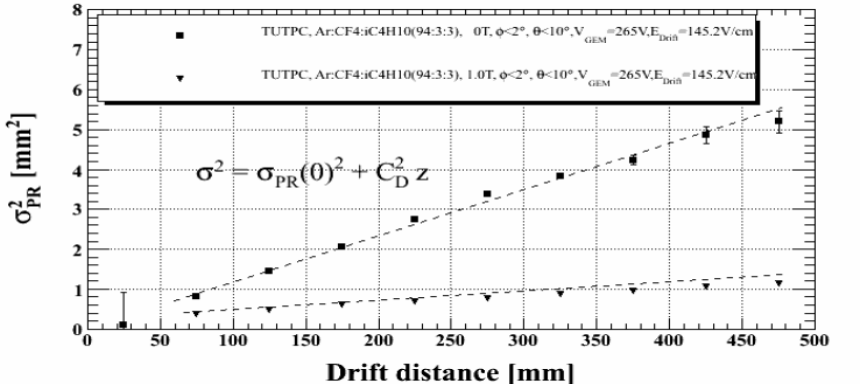
TPC Test results (provided by Y. L. Li)

- Spatial Resolution and Working Gas

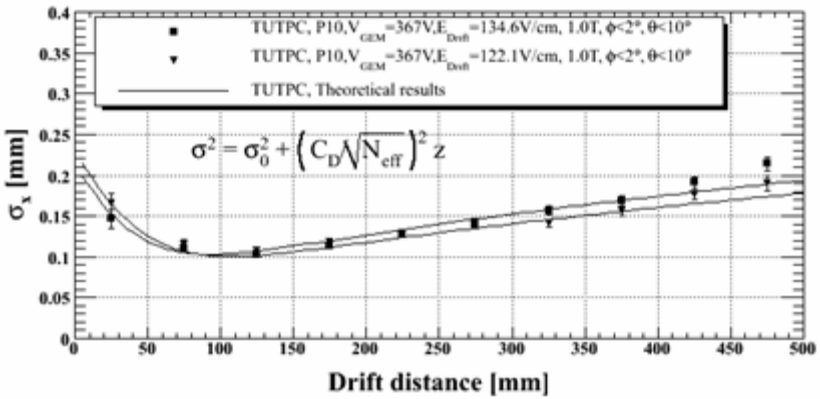
Transverse resolution with $Ar:CF_4:i\text{-}C_4H_{10}=94:3:3$ gas



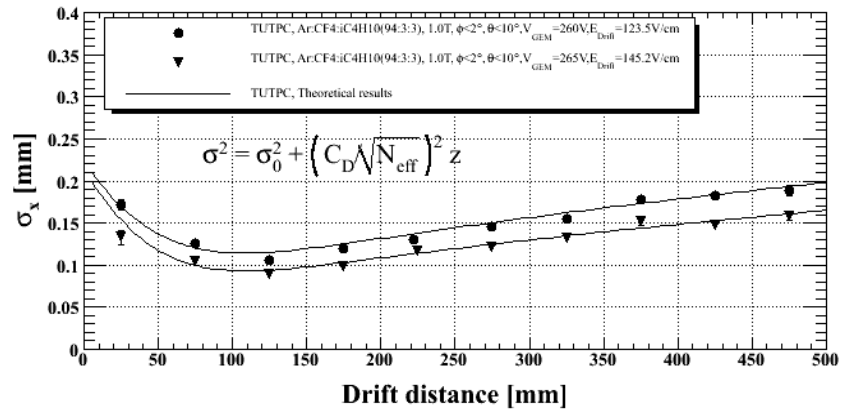
Width of pad response with $Ar:CF_4:i\text{-}C_4H_{10}=94:3:3$ gas



Transverse resolution with P10 gas at B = 1.0 T



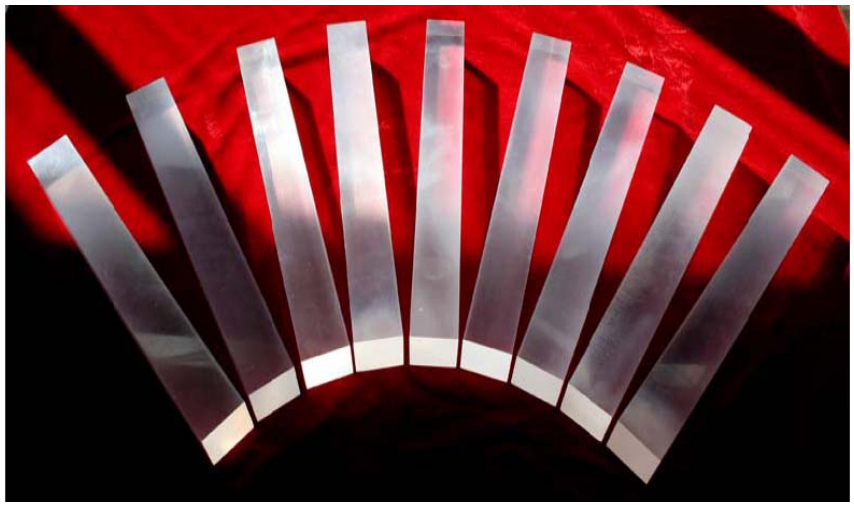
Transverse resolution with $Ar:CF_4:i\text{-}C_4H_{10}=94:3:3$ gas at 1 T

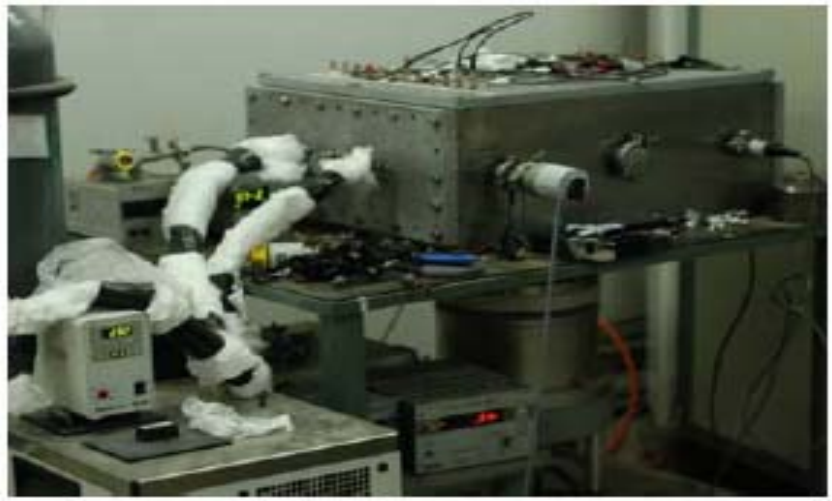


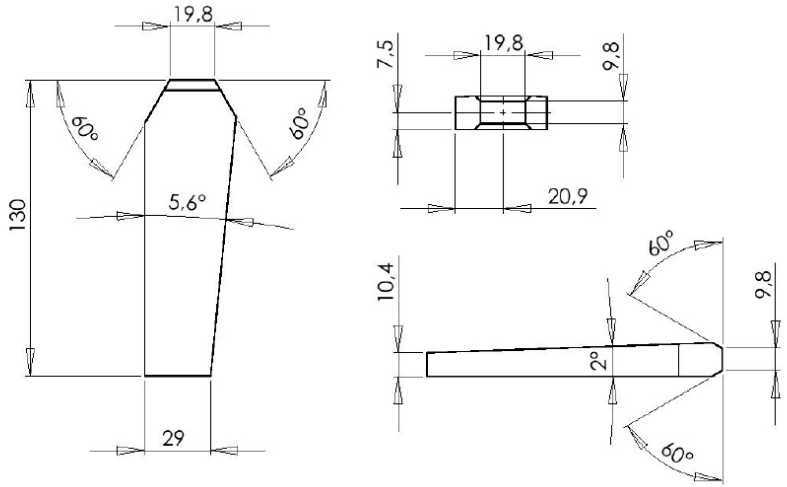
Resolution achieved: 100 μm @ 1T & 10 cm drift distance

EMC Calorimeter R&D

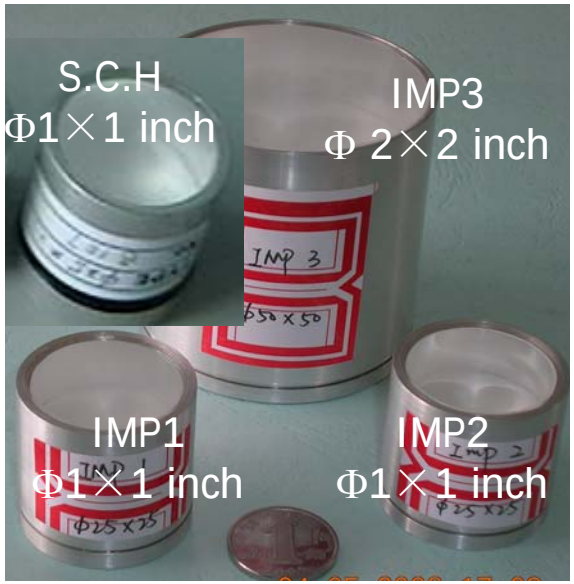
CsI crystal grown in IMP. Performance ensured.







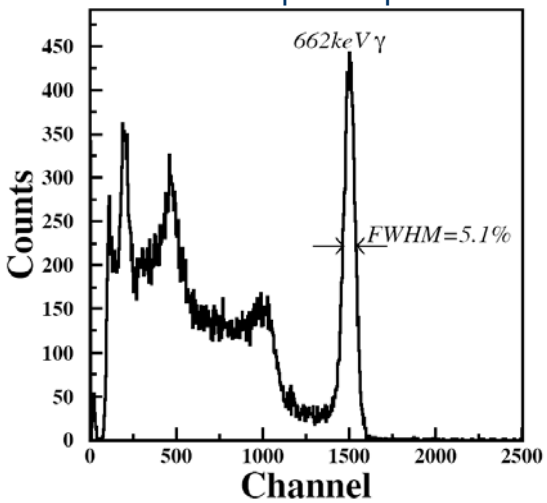
CsI single unit tested with heavy ion beam



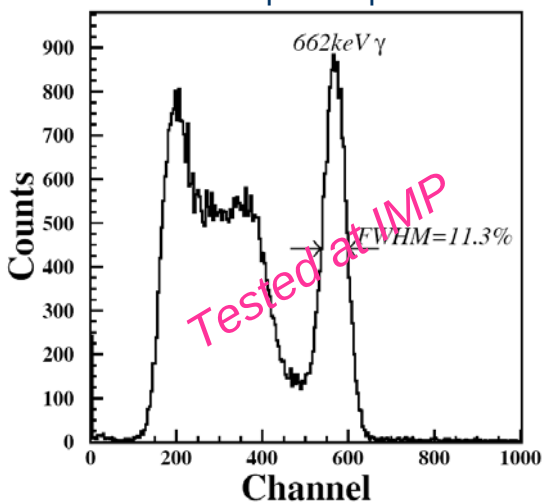
sample	Peak channels		
IMP1	1836.6	1835.0	1836.0
IMP2	1788.2	1791.7	1788.0
IMP3	1729.2	1728.3	1729.0
S.C.H	1463.7	1463.5	1464.0

	Peak channel	Increment
Before irradiation	1730.0	
After 100 rad	1696.9	-1.9%
After 1000 rad	1611.6	-6.8%

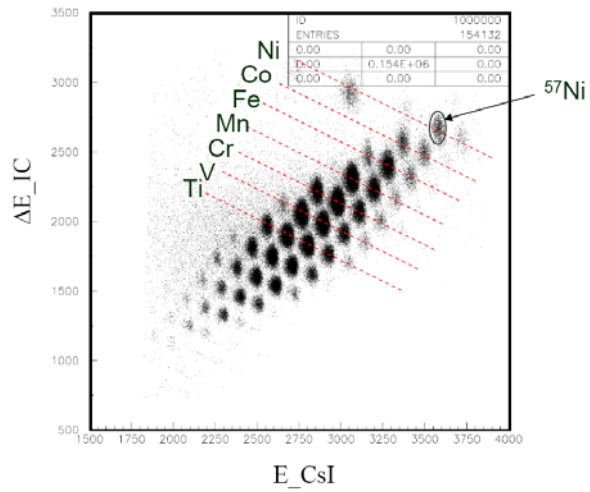
10×10×10 sample coupled to APD



10×10×10 sample coupled to PD



20×20×20 sample coupled to PD

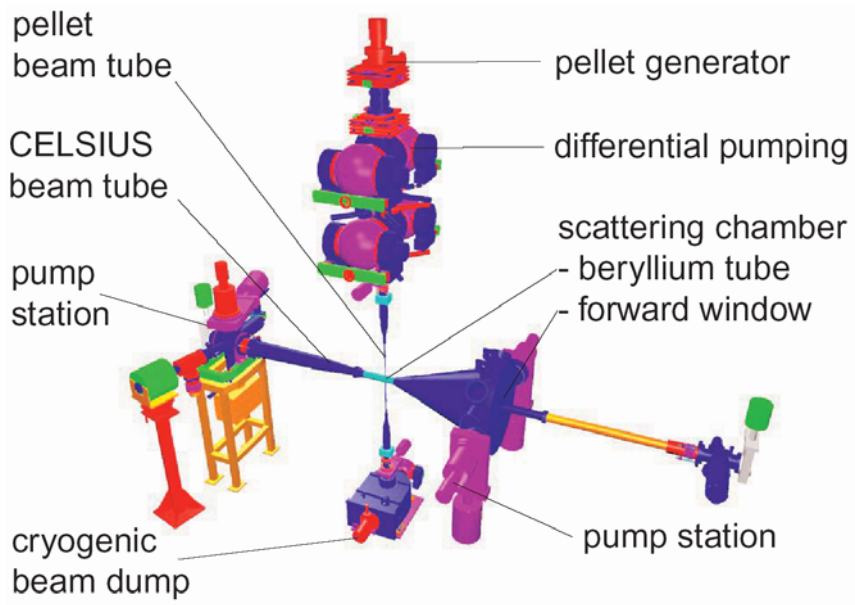


R&D of the target

- Pellet
- LDPT

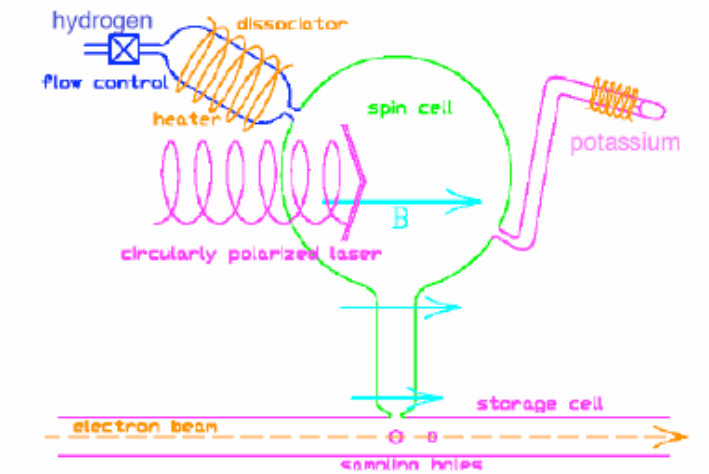
Pellet

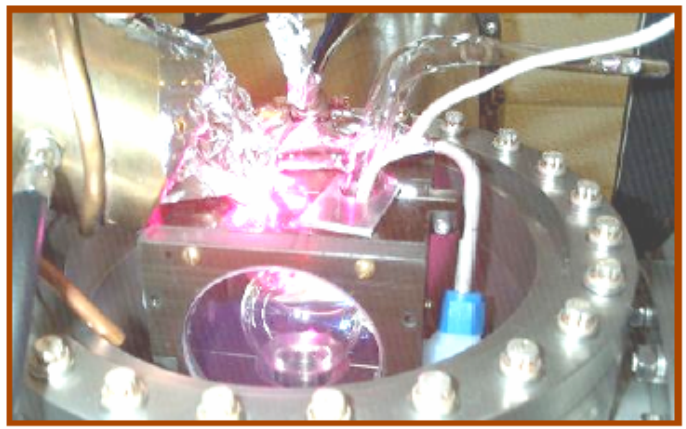
(in collaboration with Upp. & COSY)



LDPT

(in collaboration with Duke)





Summary

HIRFL-CSR provides an opportunity to open hadron physics program in <3AGeV region. HPLUS is on the R&D stage. The geometry design and sub-detector configuration are preliminarily advised according to the fast simulation results. R&D of various sub-detectors are ongoing. We call for any collaborations from outside.