Hyperon-Nucleon Spectrometer at HIAF

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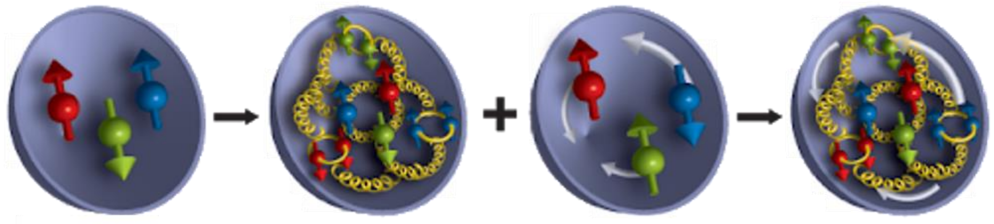
Outline

- Introduction of physics
- H-NS at HIAF
- Summary and Outlook

About nucleon spin structure

1988 EMC experiment → “Spin crisis”



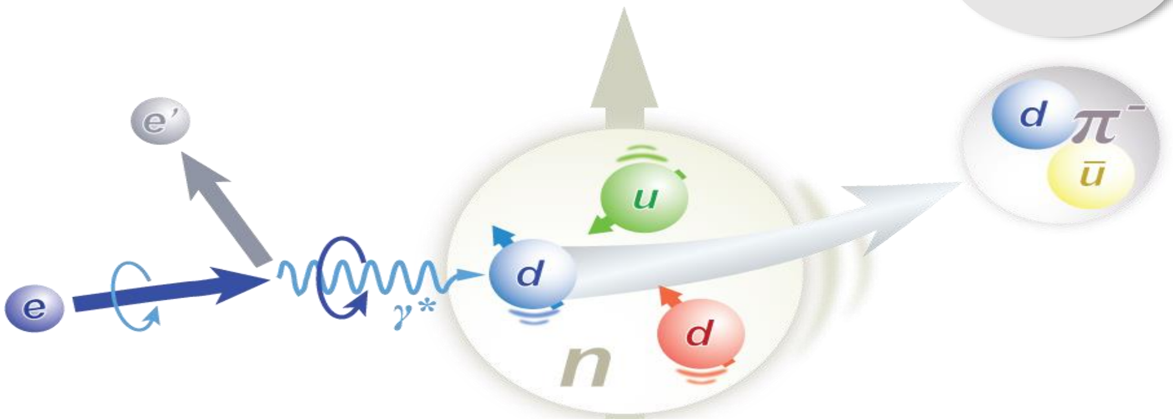
1970s　　1980s/2000s　　Now

Spin decomposition:

$$S_{tot} = \frac{1}{2} = \underbrace{\frac{1}{2}\Delta\Sigma}_{\text{Quark spin}} + \underbrace{\Delta G}_{\text{Gluon Spin}} + \underbrace{\mathcal{L}_q}_{\text{Quark OAM}} + \underbrace{\mathcal{L}_g}_{\text{Gluon OAM}}$$

Electron-ion scatering process

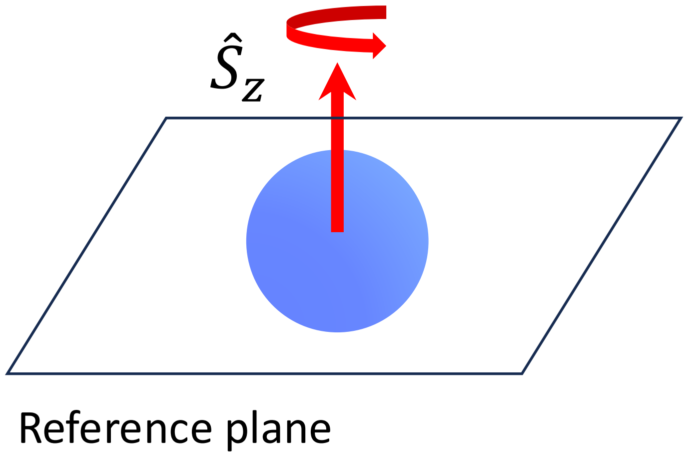
Pion/Kaon



- We have a framework for the understanding of the spin structure of the nucleon

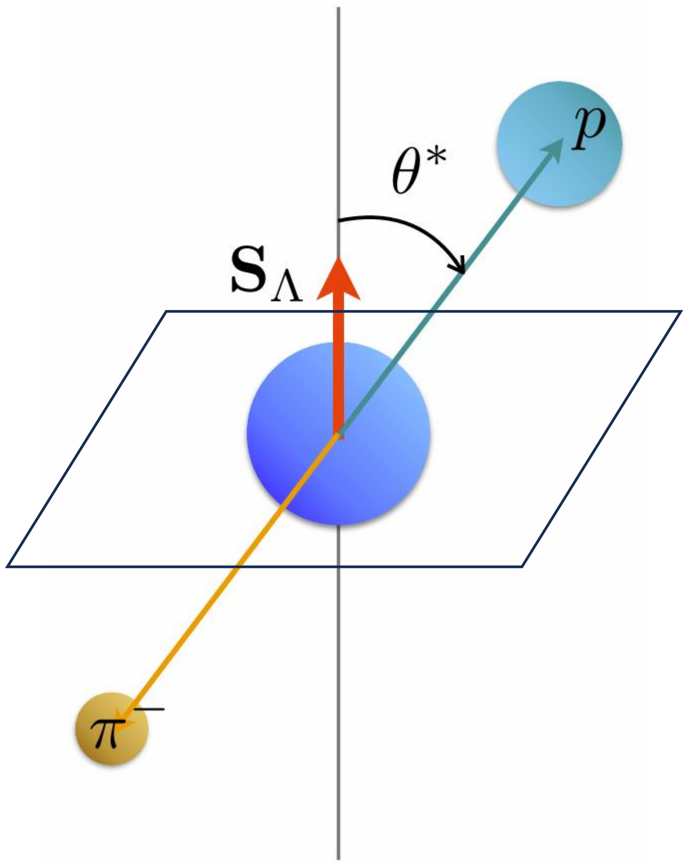
Spin and its polarization

Polarization: spin of particles in a system is aligned in a preferred direction.



Spin and its polarization

Λ^0 serves as its own spin analyzer through the decay $\Lambda^0 \to p + \pi^-$



Decay channel: $\Lambda \to p\pi^-$

branch ratio: $64.1 \pm 0.5\%$

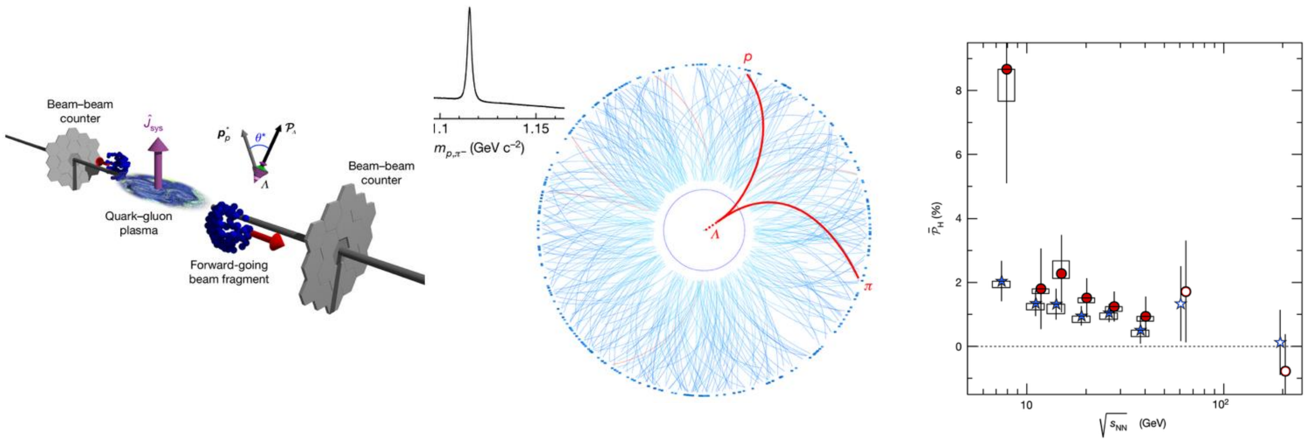
parity violating weak decay

$$\frac{\mathrm{d}N}{\mathrm{d}\cos\theta^*} \propto \mathcal{A}\left(1 + \alpha_\Lambda P_\Lambda \cos\theta^*\right)$$

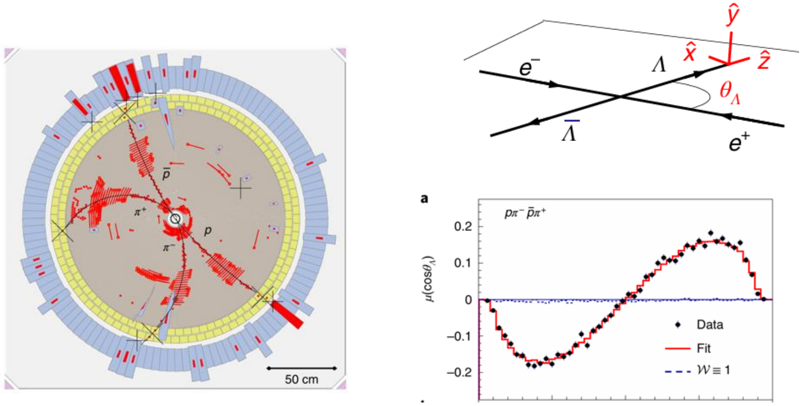
decay parameter: $\alpha_\Lambda = 0.748 \pm 0.007$

[Current PDG value]

Polarization with valuable information

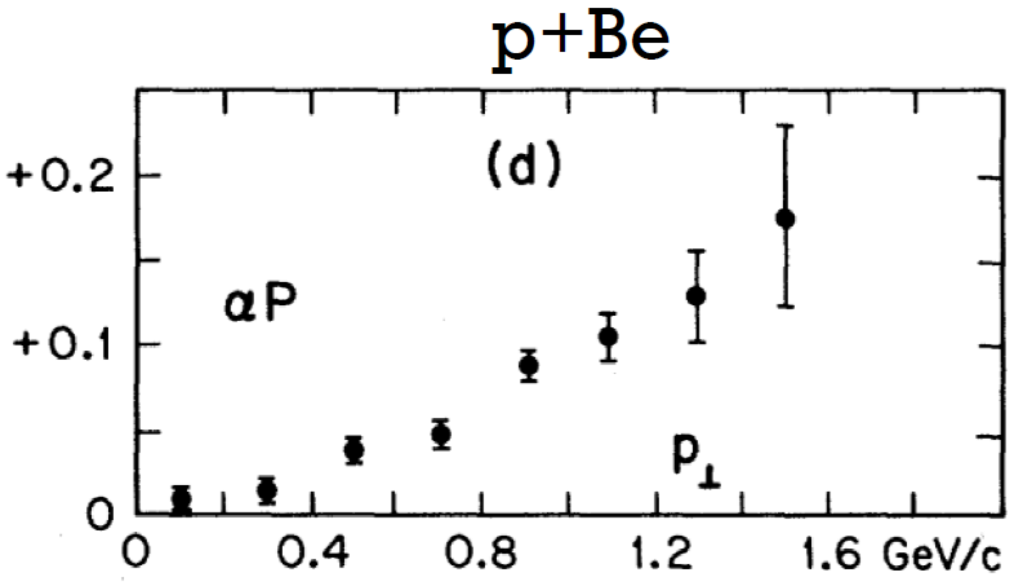


STAR, Nature 548, 62 (2017)



BESIII, Nature Physics, 15, 631 (2019)

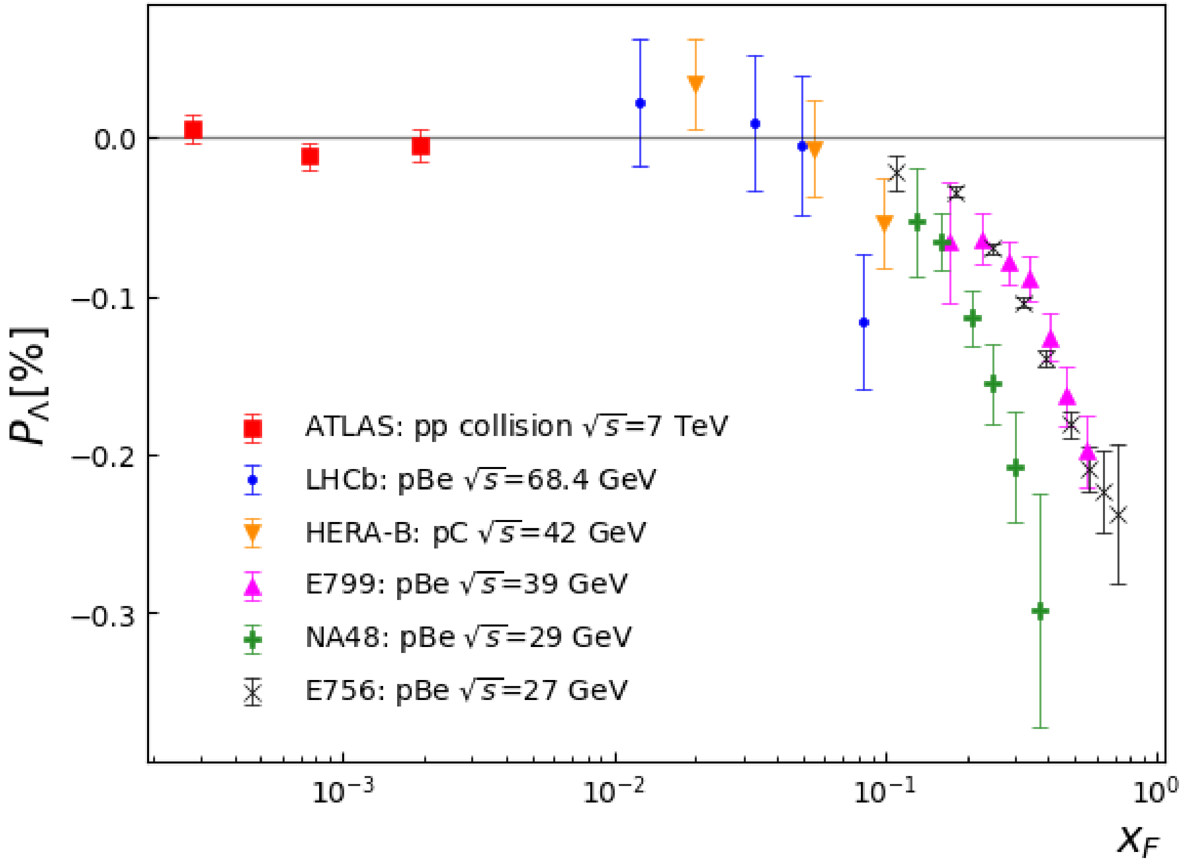
First observation of Λ^0 polarization in the 1970's

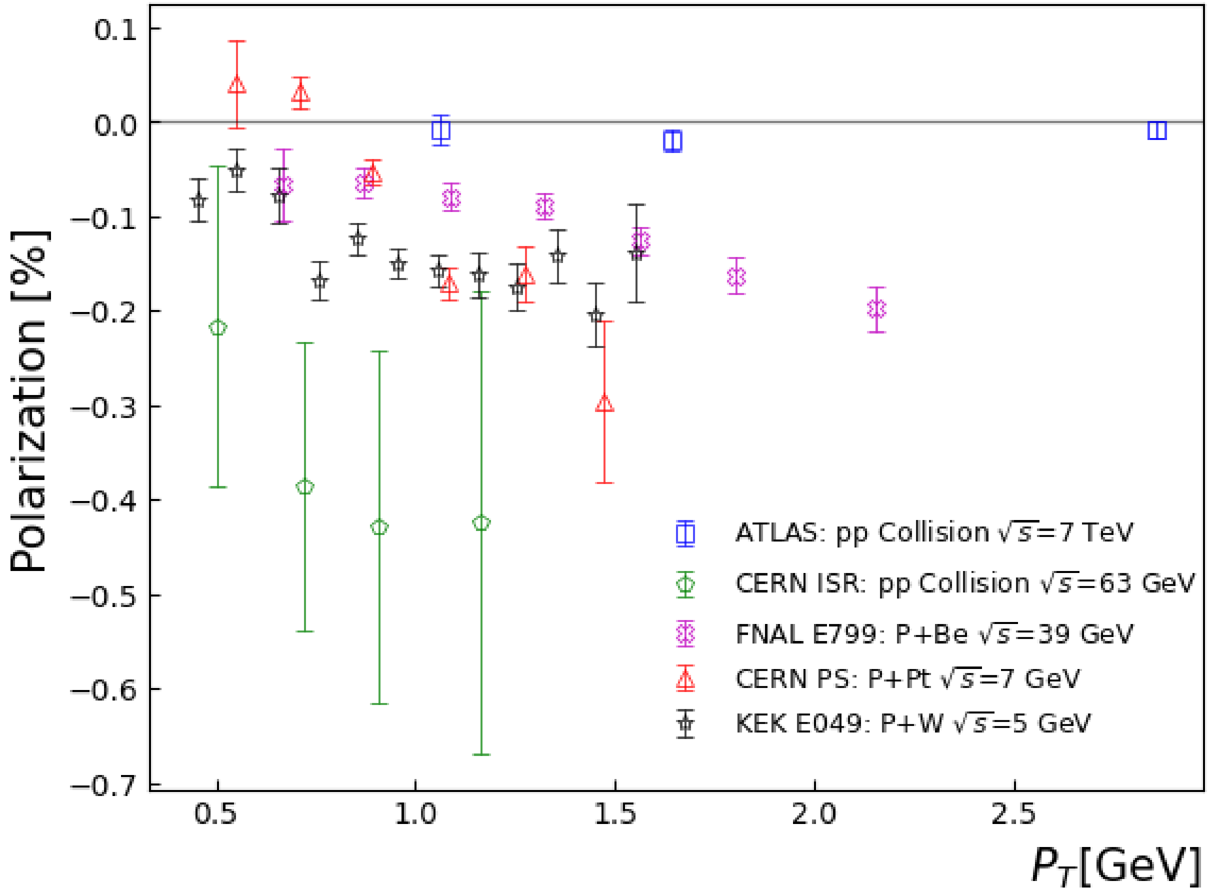


G.Bunce, *et al*.: Phys.Rev.Lett. 36, 1113-1116 (1976)

- Hyperons can be produced polarized in collisions of **unpolarized particles**
- Discovered at Fermilab in the 1970's in p + Be collisions: 300 GeV protons on Beryllium

Λ^0 polarization measurements





Origin of Λ^0 polarization?

$$P_H = \Delta\sigma / \sigma_{unp}$$

$$\sigma_{unp} \sim f_{1A}(x_a, k_{\perp a}) f_{1B}(x_b, k_{\perp b}) \otimes \hat{\sigma}(ab \to cX) \otimes D_1(z_c, k_{Fc}) \Rightarrow pp \to qq \to hX$$

$$\Delta\sigma \sim h_{1A}^{\perp}(x_a, k_{\perp a}) f_{1B}(x_b, k_{\perp b}) \otimes \delta\hat{\sigma}(a^{\uparrow} b \to c^{\uparrow} X) \otimes H_{1T}^{c \to H}(z_H, k_{FH}) \Rightarrow pp \to q(\uparrow) q \to h(\uparrow) X$$

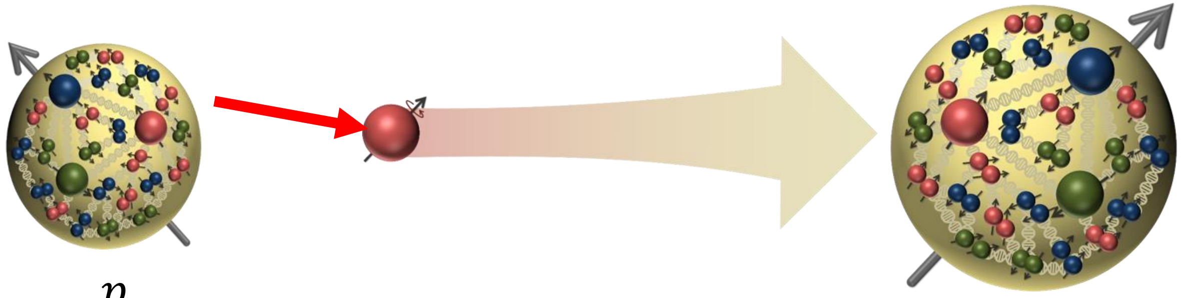
$$+ f_{1A}(x_a, k_{\perp a}) f_{1B}(x_b, k_{\perp b}) \otimes \hat{\sigma}(ab \to cX) \otimes D_{1T}^{\perp c \to H}(z_H, k_{FH}) \Rightarrow pp \to qq \to h(\uparrow) X$$

spin transfer

Boer-Mulders

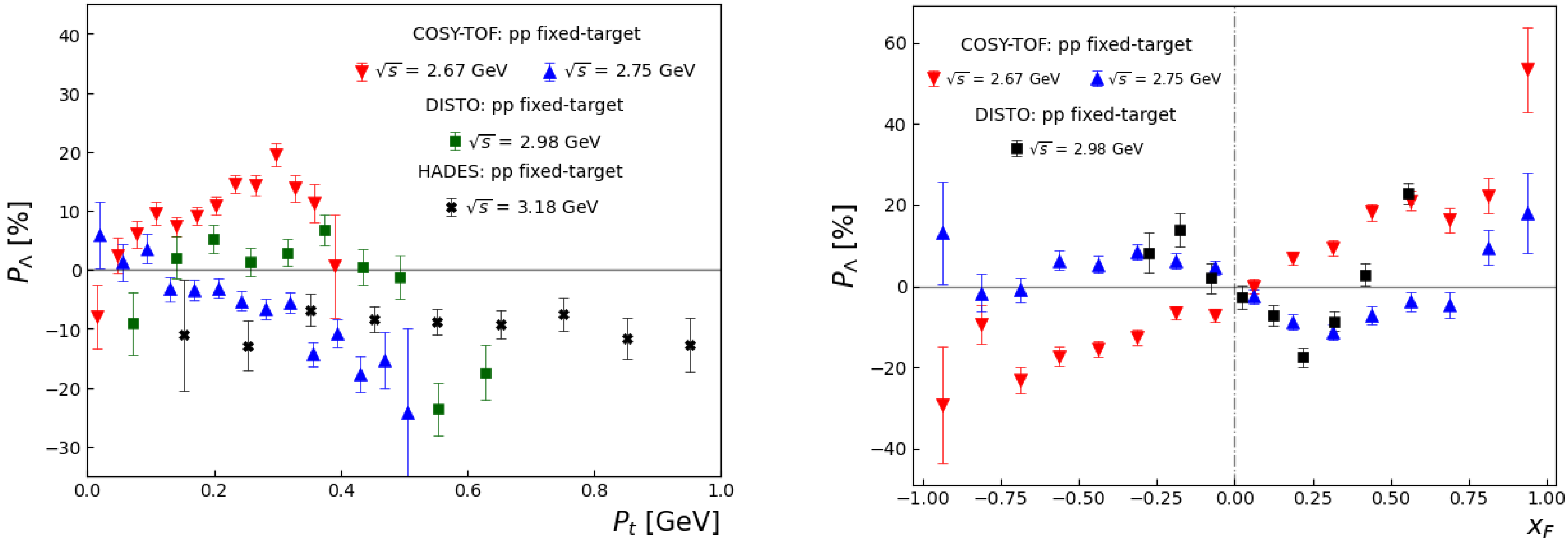
transverse polarization in fragmentation of unpolarized quark (Belle data)

- The origin of polarization **cannot** be explained under perturbative QCD
- Possible explanation:
  - Fragmentation?
  - Spin transfer?

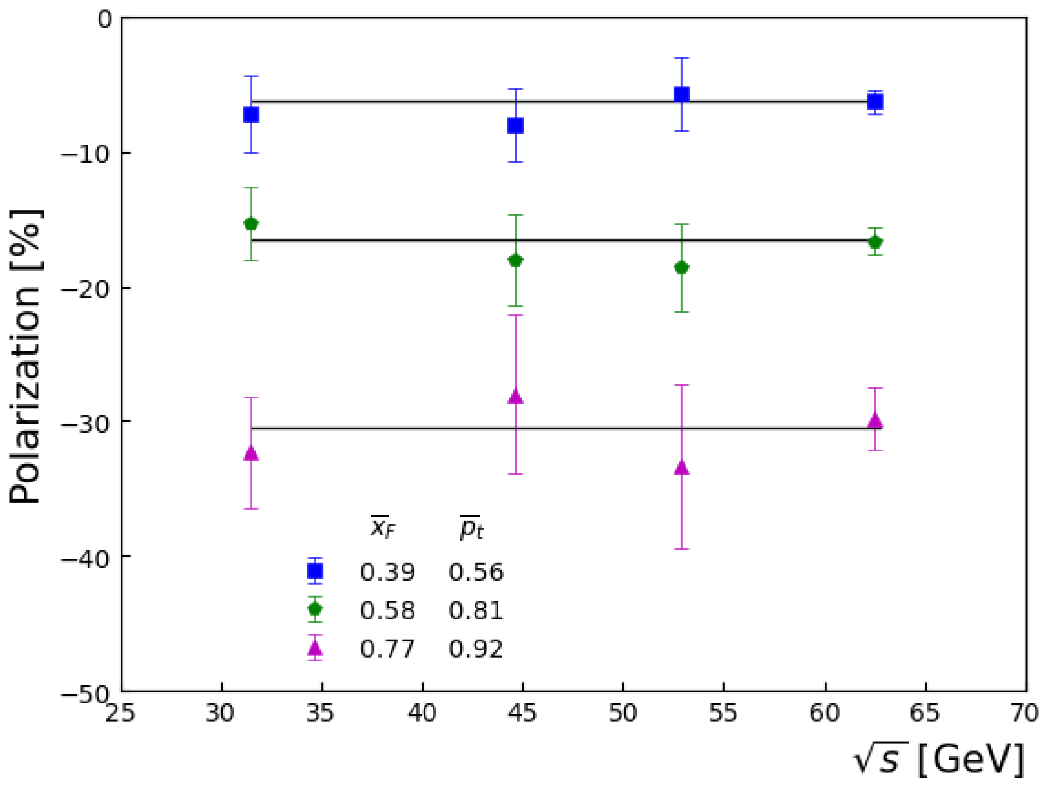


p Λ

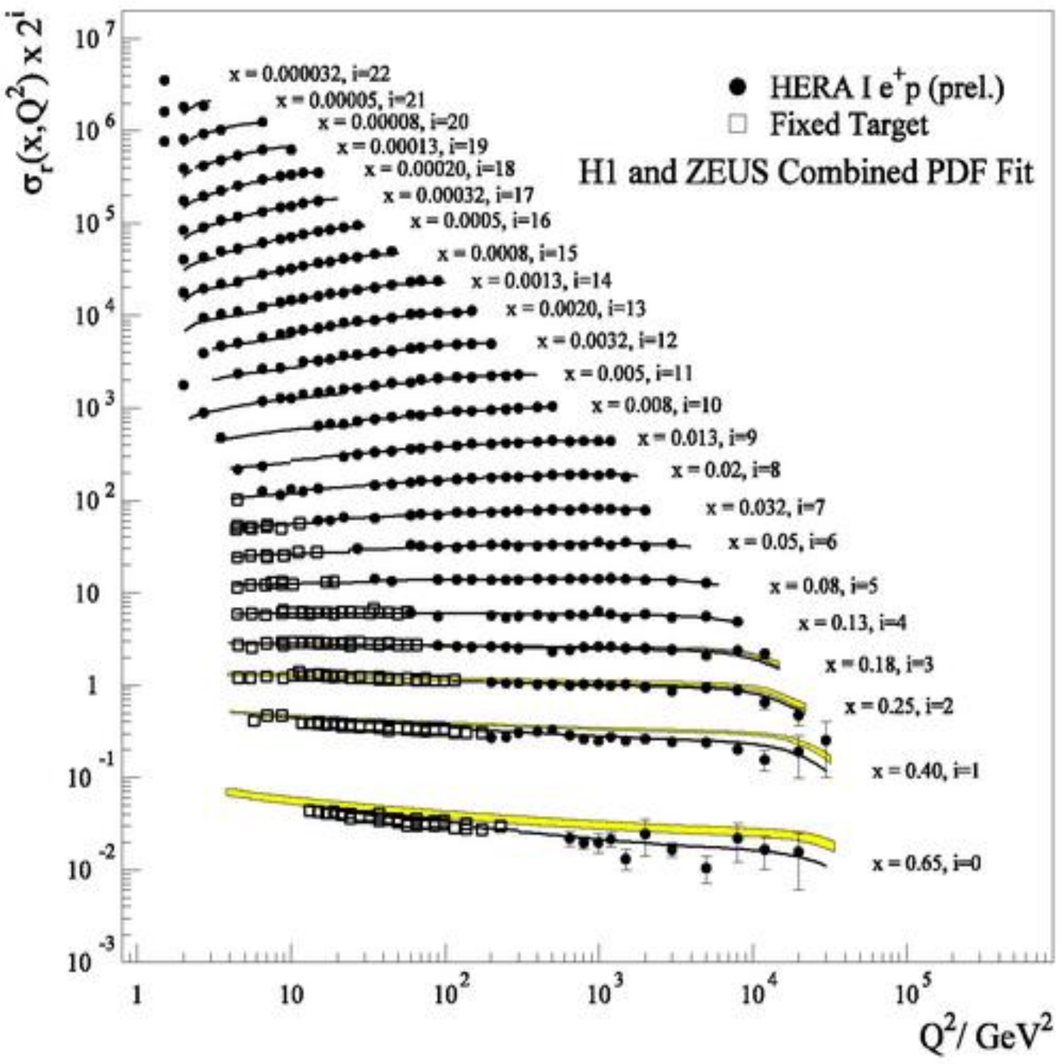
Puzzle in low energy collisions



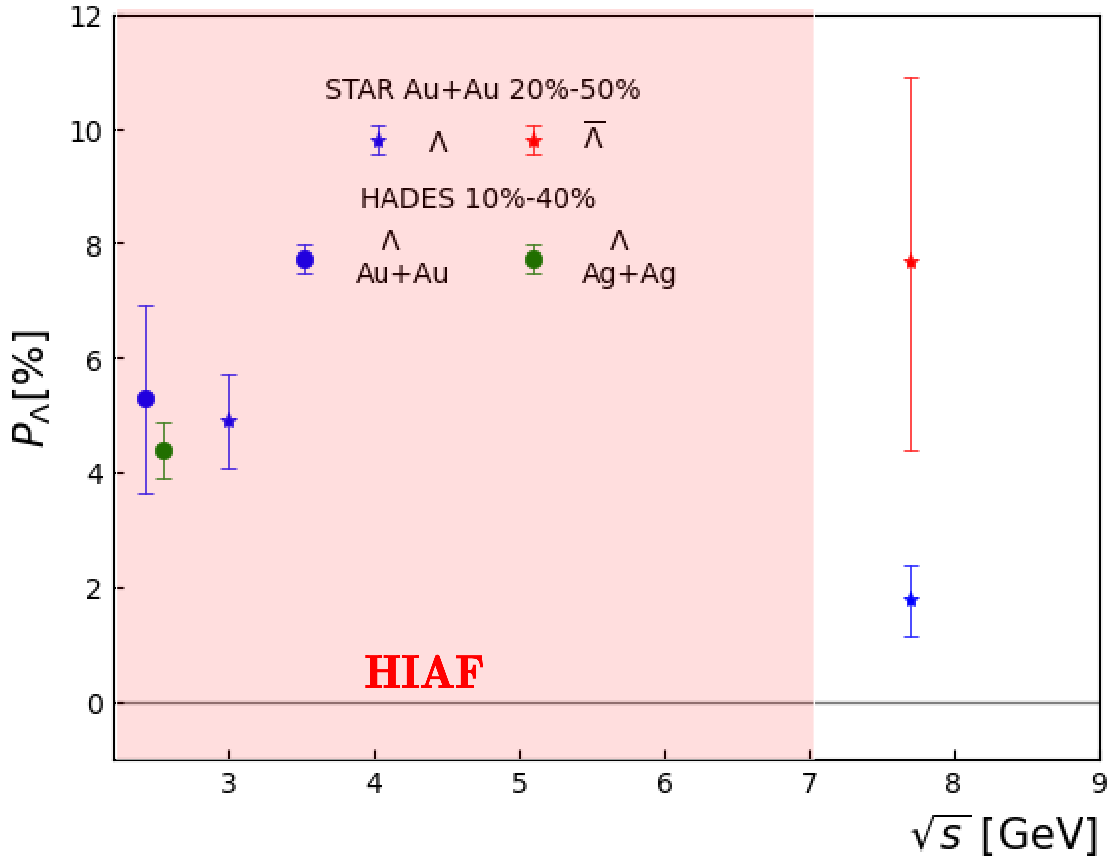
“Scaling” of Λ^0 polarization ?

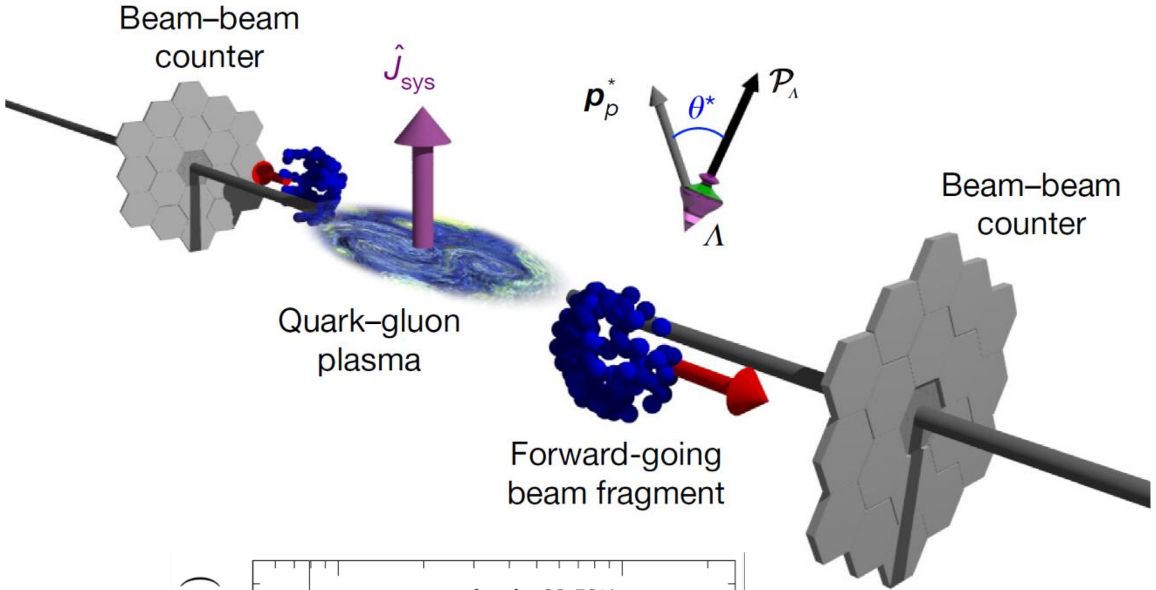


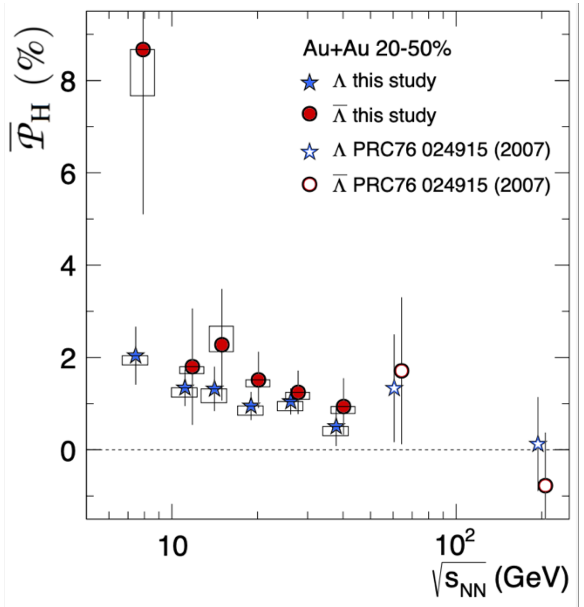
R608: 10.1016/0370-2693(87)91556-5



What's more?　with A-A



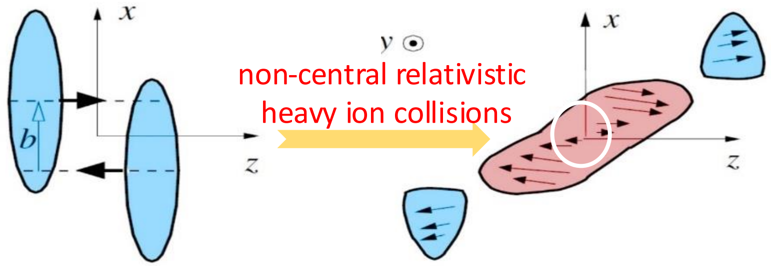




STAR实验证实Λ超子整体极化[Nature 548 (2017) 62]

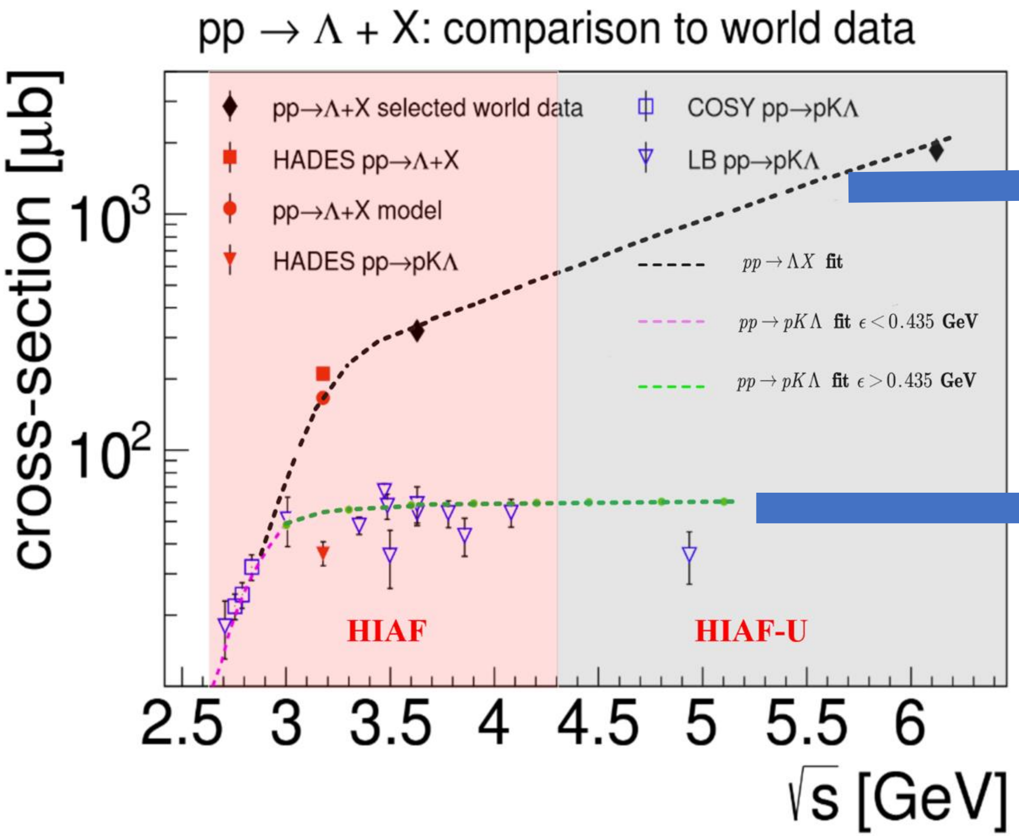
One has to take into account the production mechanism

- across energy region and collision system



① $AA \to \Lambda X$ **Global polarization**

Zuo-Tang Liang, Xin-Nian Wang, PRL 94,102301 (2005); PLB 629, 20 (2005).
Jian-Hua Gao, Shou-Wan Chen, Wei-tian Deng, Zuo-Tang Liang, Qun Wang, Xin-Nian Wang, PRC 77, 044902 (2008).



② $pp\,(A) \to \Lambda X$ **polarization through hadronization**

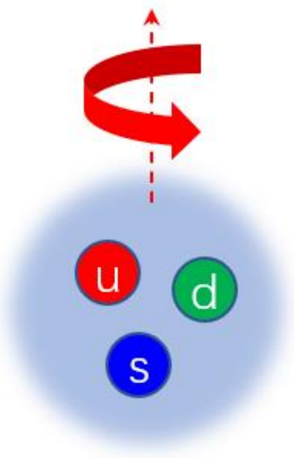
Zuo-tang Liang, and C. Boros, Phys. Rev. Lett. 79, 3608 (1997); PRD 61, 117503 (2000).
H. Dong and Zuo-tang Liang, PRD 70, 014019 (2004); PRD 72, 033006 (2005).

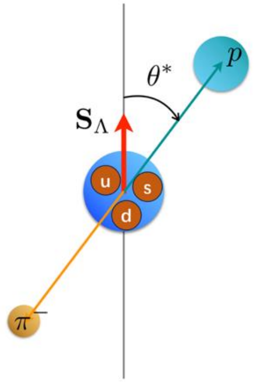
③ $pp \to pK\Lambda$ **Λ polarization in exclusive processes**

R. Machleidt, K. Holinde and C. Elster, Phys. Rept. 149, 1 (1987).
B. C. Liu, B. S. Zou, PRL 96, 042002 (2006).

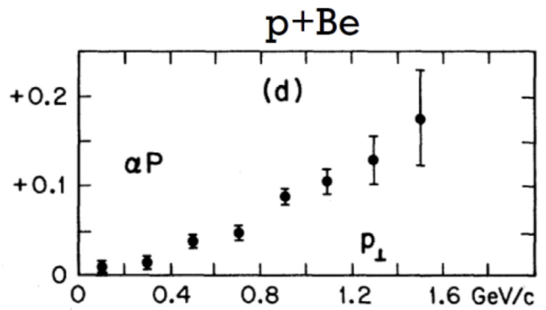
An interesting question: Is proton polarized as well?

$pp \rightarrow p\,K\,\Lambda$





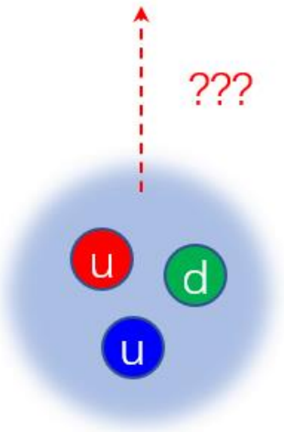
超子弱衰变角分布测量超子极化

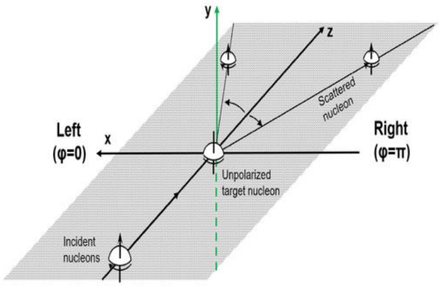


G.Bunce, *et al.*: Phys.Rev.Lett. 36, 1113-1116 (1976)

14

$pp \rightarrow p + X$



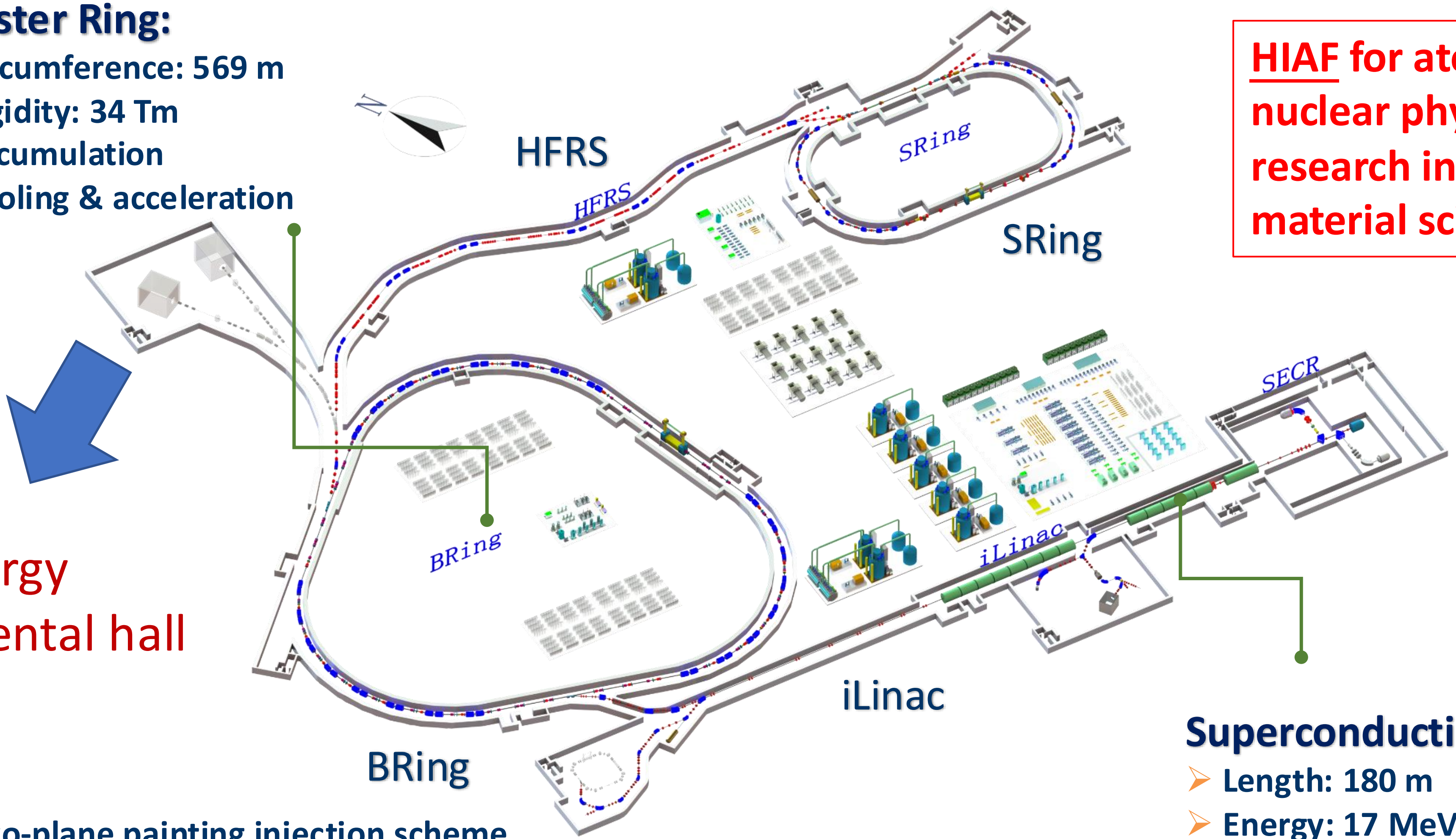


核核弹性散射测量核子极化

???

High Intensity heavy-ion Accelerator Facility (HIAF)

Booster Ring:
- Circumference: 569 m
- Rigidity: 34 Tm
- Accumulation
- Cooling & acceleration



HIAF for atomic physics, nuclear physics, applied research in biology and material science etc.

High energy experimental hall

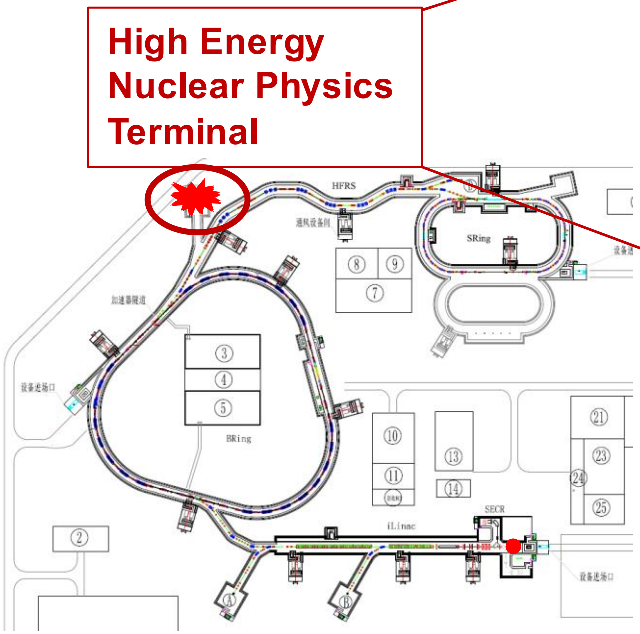
- Two-plane painting injection scheme
- Fast ramping rate operation

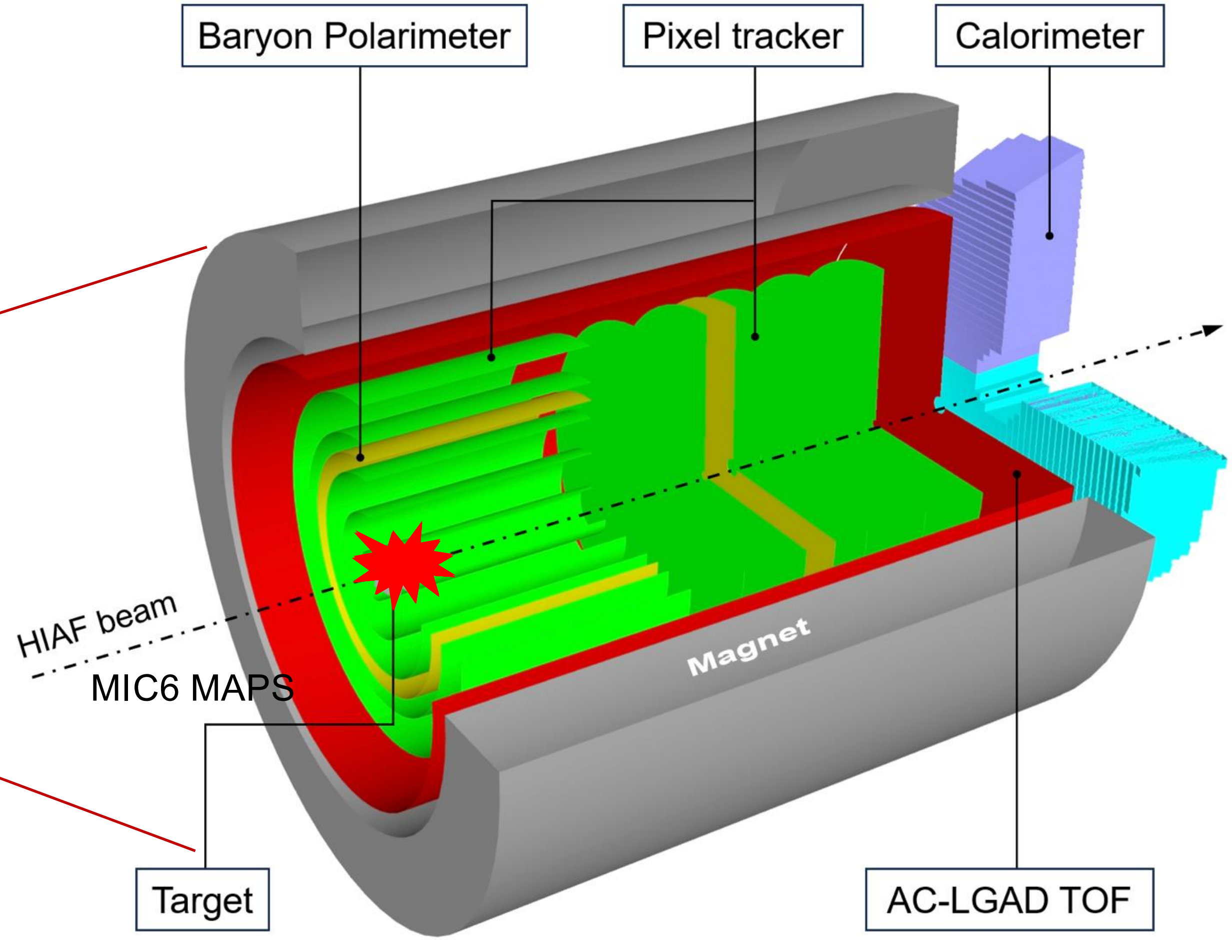
Superconducting Ion Linac:
- Length: 180 m
- Energy: 17 MeV/u (U^{34+})
- CW and pulse modes

Hyperon Nucleon Spectrometer (H-NS)

proton beam up to 9.3 GeV
ion beam up to 4.25 GeV/u

- p + p
- p + A
- A + A



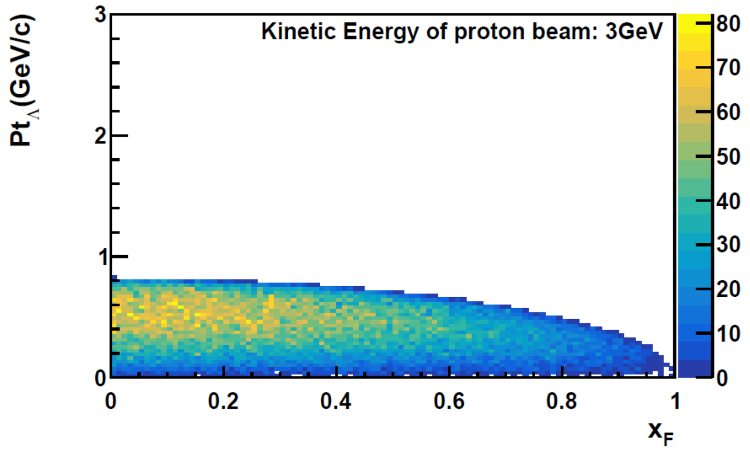


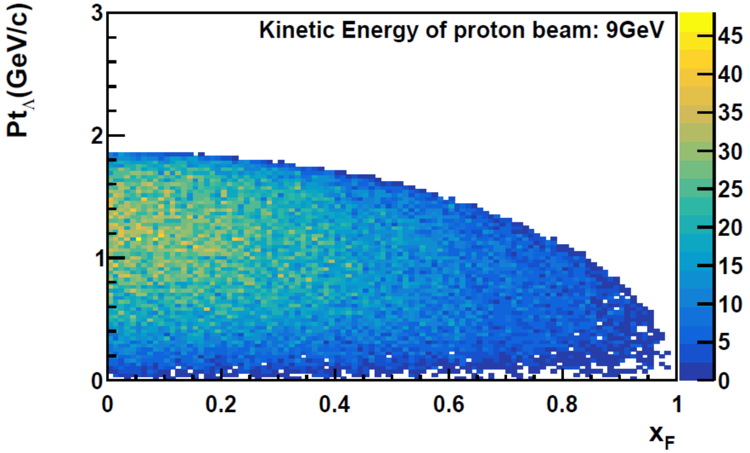
10:45 Oct. 28 Aiqiang Guo's talk

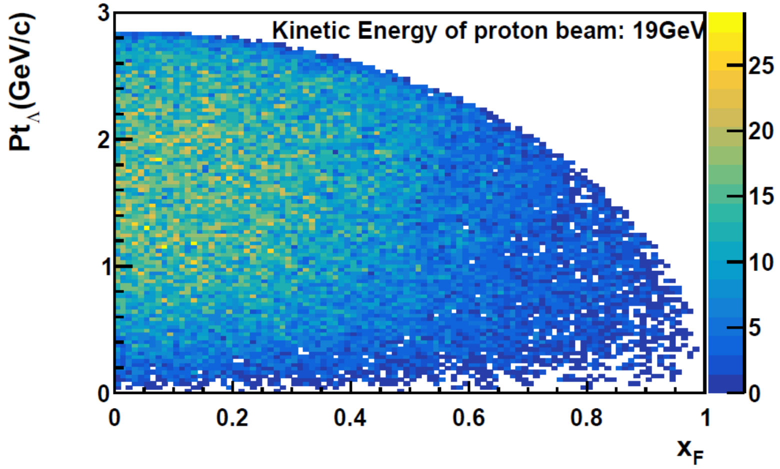
HIAF beam parameters

Ion	Intensity (ppp)	Kine_Energy (GeV/u)
$^{238}U^{35+}$	2.0×10^{11}	0.84
$^{238}U^{76+}$	5.0×10^{10}	2.5
$^{129}Xe^{27+}$	3.6×10^{11}	1.4
$^{78}Kr^{19+}$	5.0×10^{11}	1.7
$^{40}Ar^{12+}$	7.0×10^{11}	2.3
$^{18}O^{6+}$	8.0×10^{11}	2.6
p	5.0×10^{12}	9.3

HIAF kinematics coverage







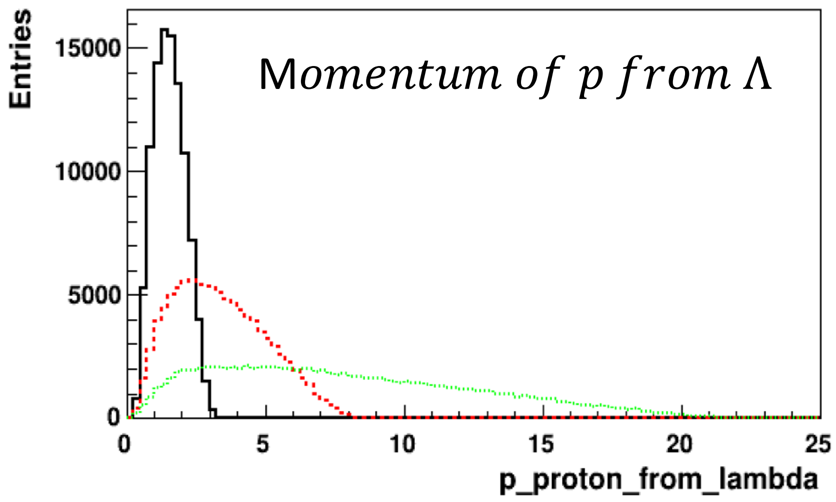
3 GeV → 9 GeV → 20 GeV

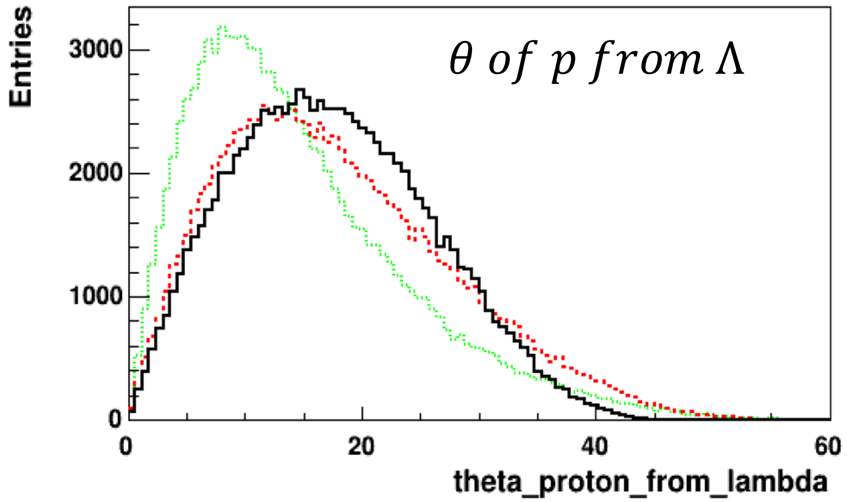
Allow for a multi-dimensional mapping of the Λ^0 polarization and production

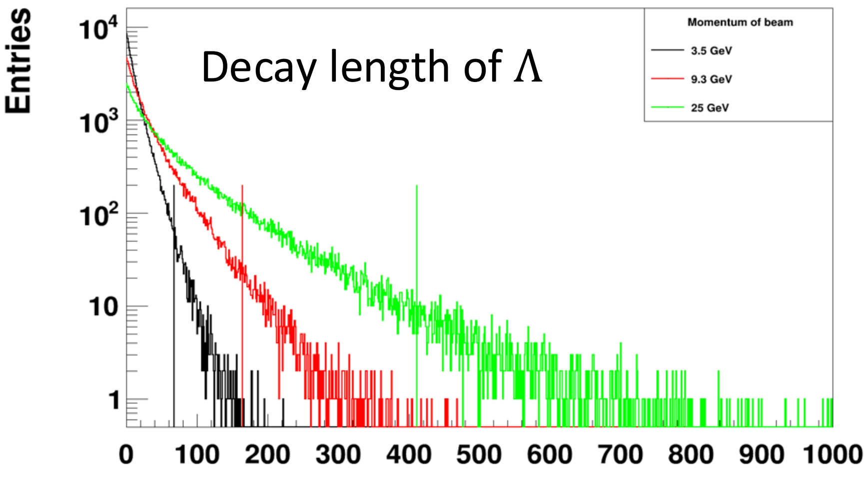
- Beam energy scan
- p→p, p→A, A→A data taking

The challenge

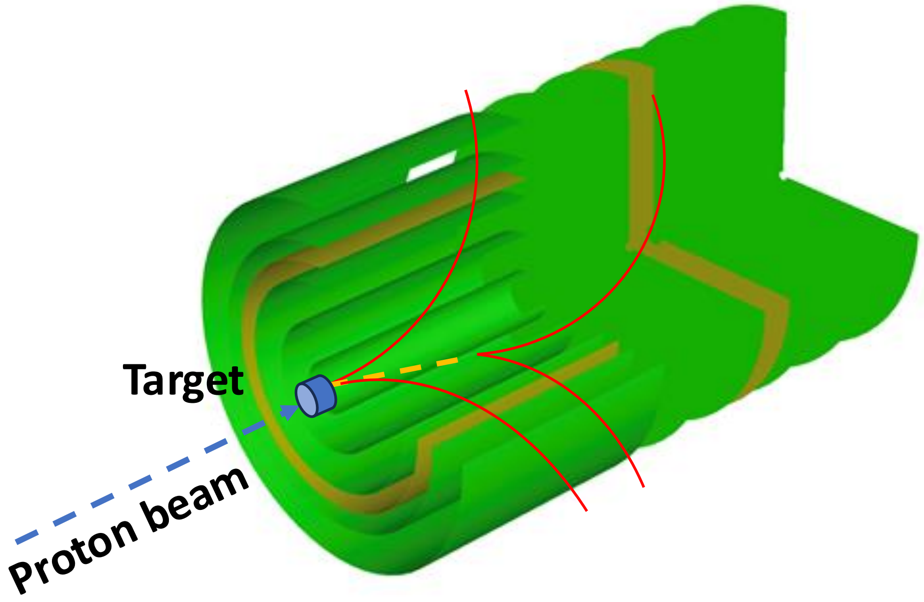
All the momentum, angular distributions and the Λ decay length are beam energy-dependent





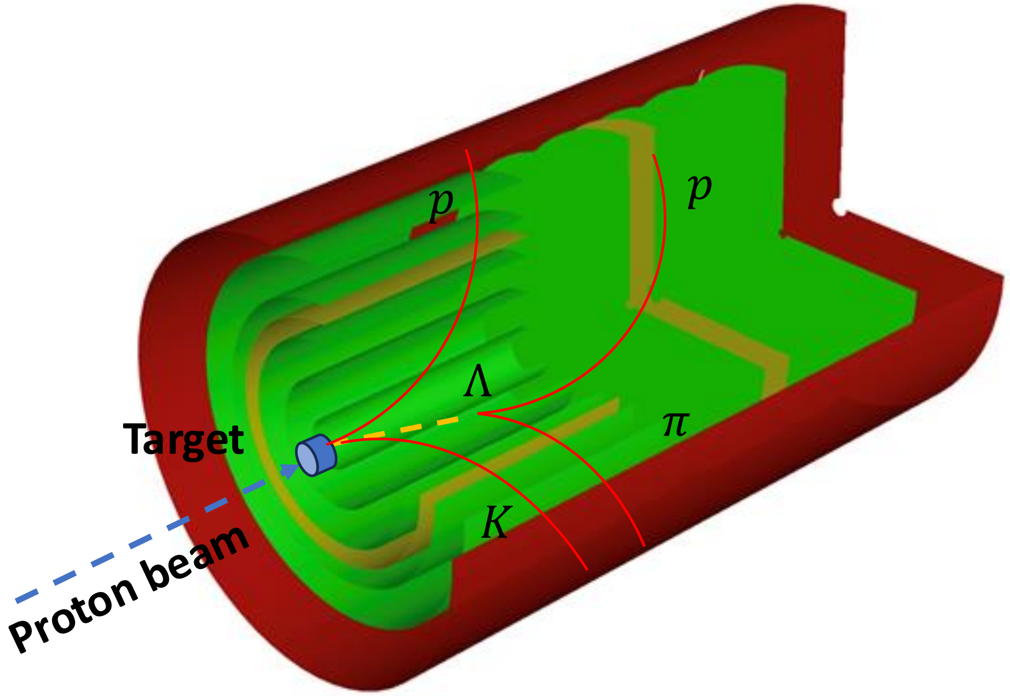


The conceptual design of H-NS detector



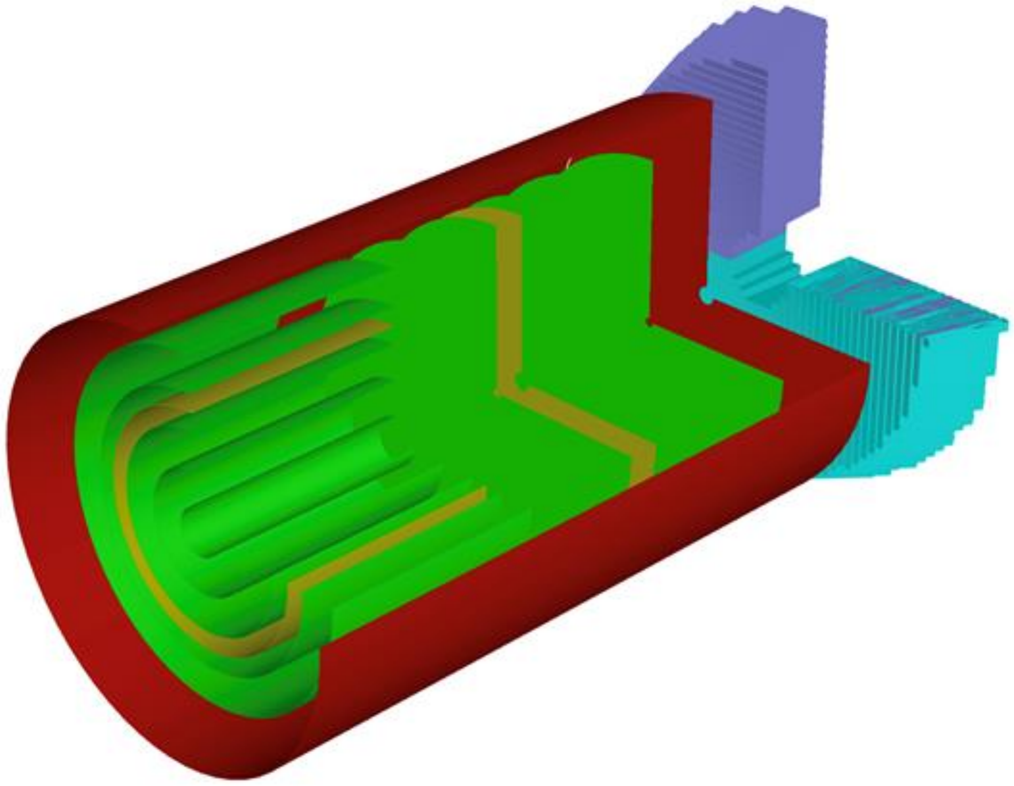
- **Good tracking/vertexing detector:**
  - Good granularity
    - Compact design ~0.5m in radius
    - Measure the vertex precisely
  - Low material
    - **Vertex** resolution is crutial for BG suppression
    - Good **angular resolution** is the key requirement for proton polarization measurement
  - Fast
    - Handle the event rate ~1MHz
- **Tech. choice:**
  - MAPS
    - Pixel size: 30 micron
    - Material budget: 0.4 % X/X_0
    - Integration time: 5-10 μs

The conceptual design of H-NS detector



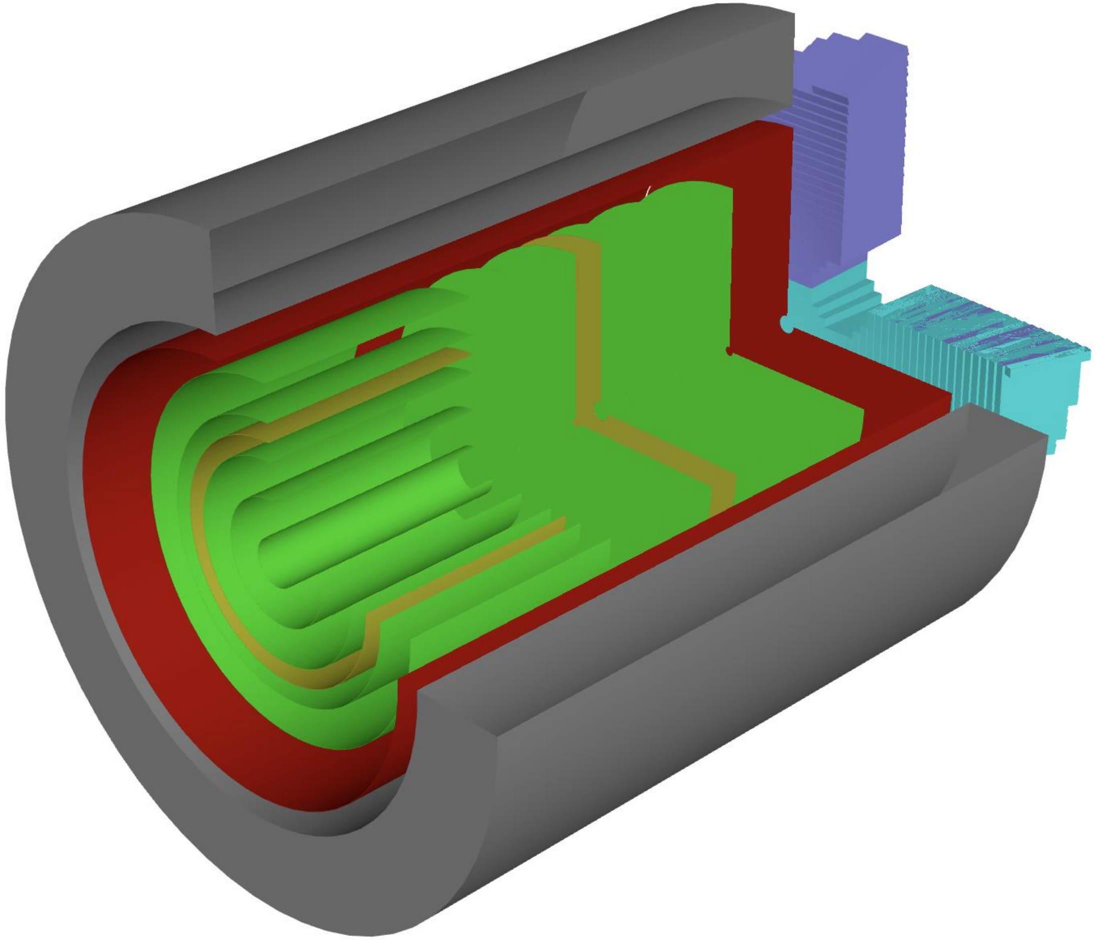
- **PID:**
  - Compact design
  - Wide range of momentum coverage
    - K, π separation (~3σ) up to 2 GeV/c .
    - K, p separation (~3σ) up to 5 GeV/c
- **Tech. choice:**
  - LGAD
    - Time resolution: 20~30 ps
    - Spatial resolution: ~100 micron

The conceptual design of H-NS detector



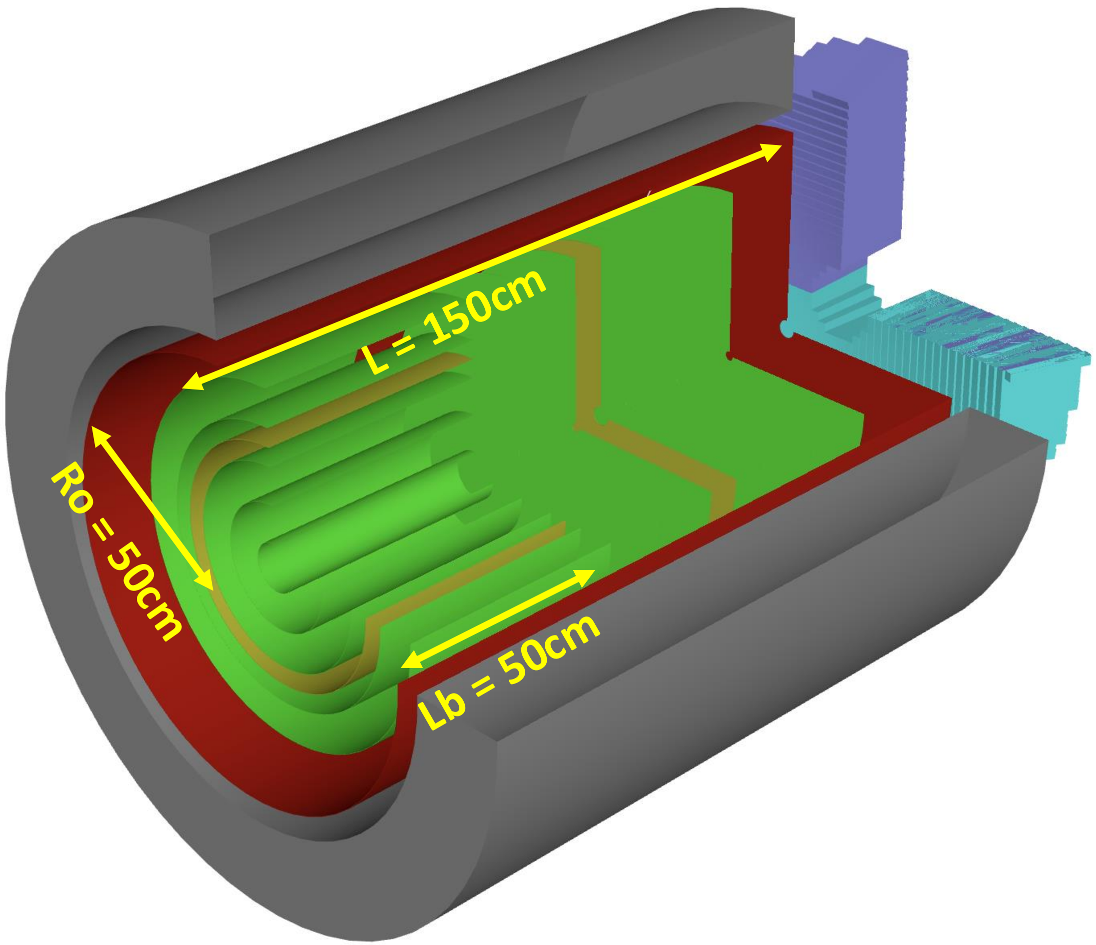
- **Calorimeter for Σ, Ξ rec.:**
  - Good spatial and energy resolution
  - Fast
  - Radiation hardness
- **Tech. choice:**
  - PbWO4 crystal
    - Energy resolution: $3\%/\sqrt{E}$
    - Spatial resolution: 3mm/ $\sqrt{E}$ (20X20 mm)
  - Dual readout sampling type calorimeter
    - Energy resolution: $5\%/\sqrt{E}$

The conceptual design of H-NS detector



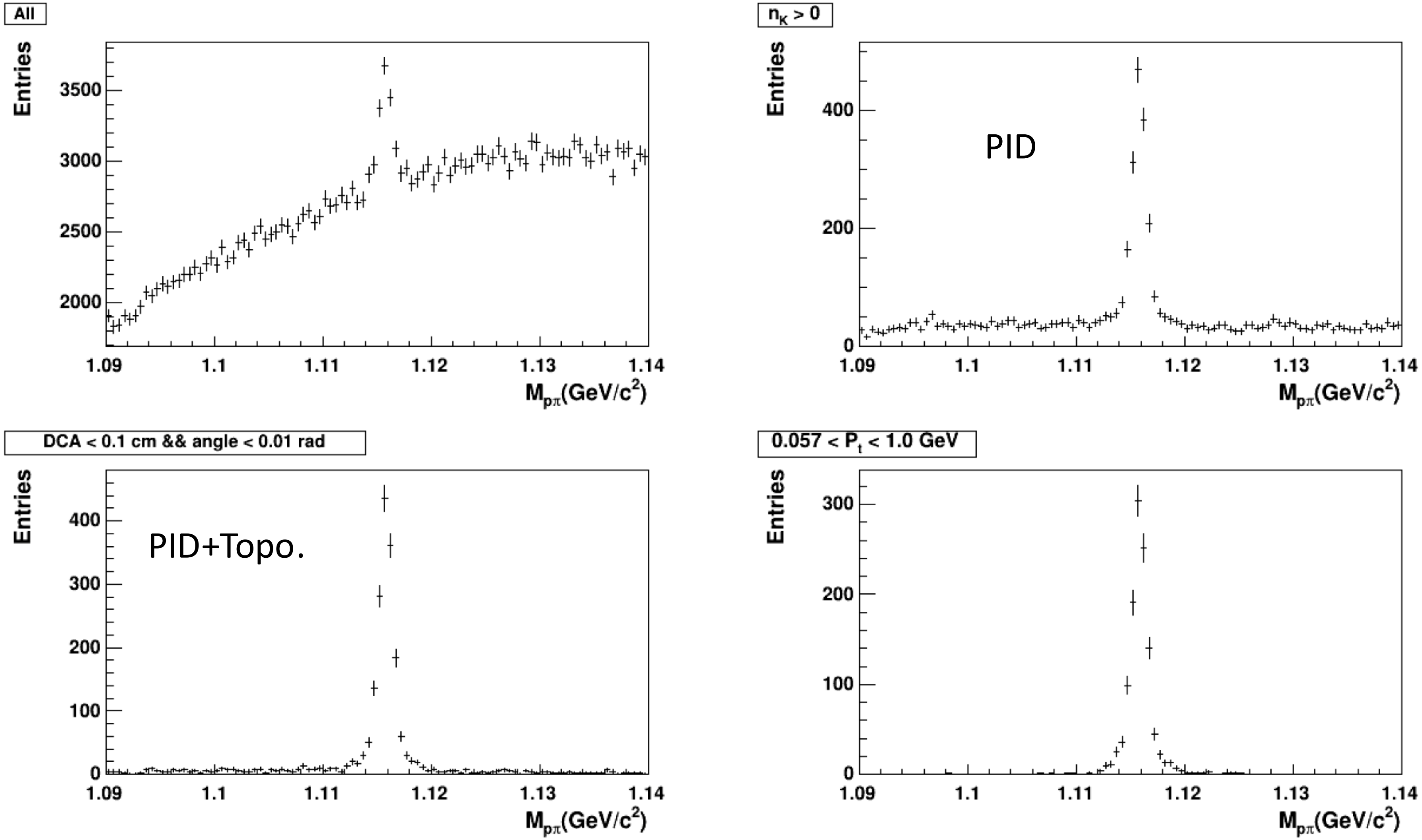
- **Magnet:**
  - Be able to measure the track with high Pz and low Pt
- **Tech. choice:**
  - Superconducting Solenoid @ Bz = 1.5T
  - Or dipole @ By = 1.5 T

The conceptual design of H-NS detector



- **Momentum resolution:**
  - ~2%@1GeV when η<2.5
- **PID:**
  - K, π separation (~3σ) up to 2 GeV/c
  - K, p separation (~3σ) up to 5 GeV/c
- **Vertex resolution:**
  - Excellent vertex resolution for background suppression
  - Material budget (<10%)
- **Acceptance:**
  - 5 to 100 degree
- **High event rate**
  - 1MHz
- **Baryon Polarimeter → determine final state proton's polarization**

$\mathbf{\Lambda^0}$ reconstruction in H-NS



Uncertainty projection of the polarization measurement

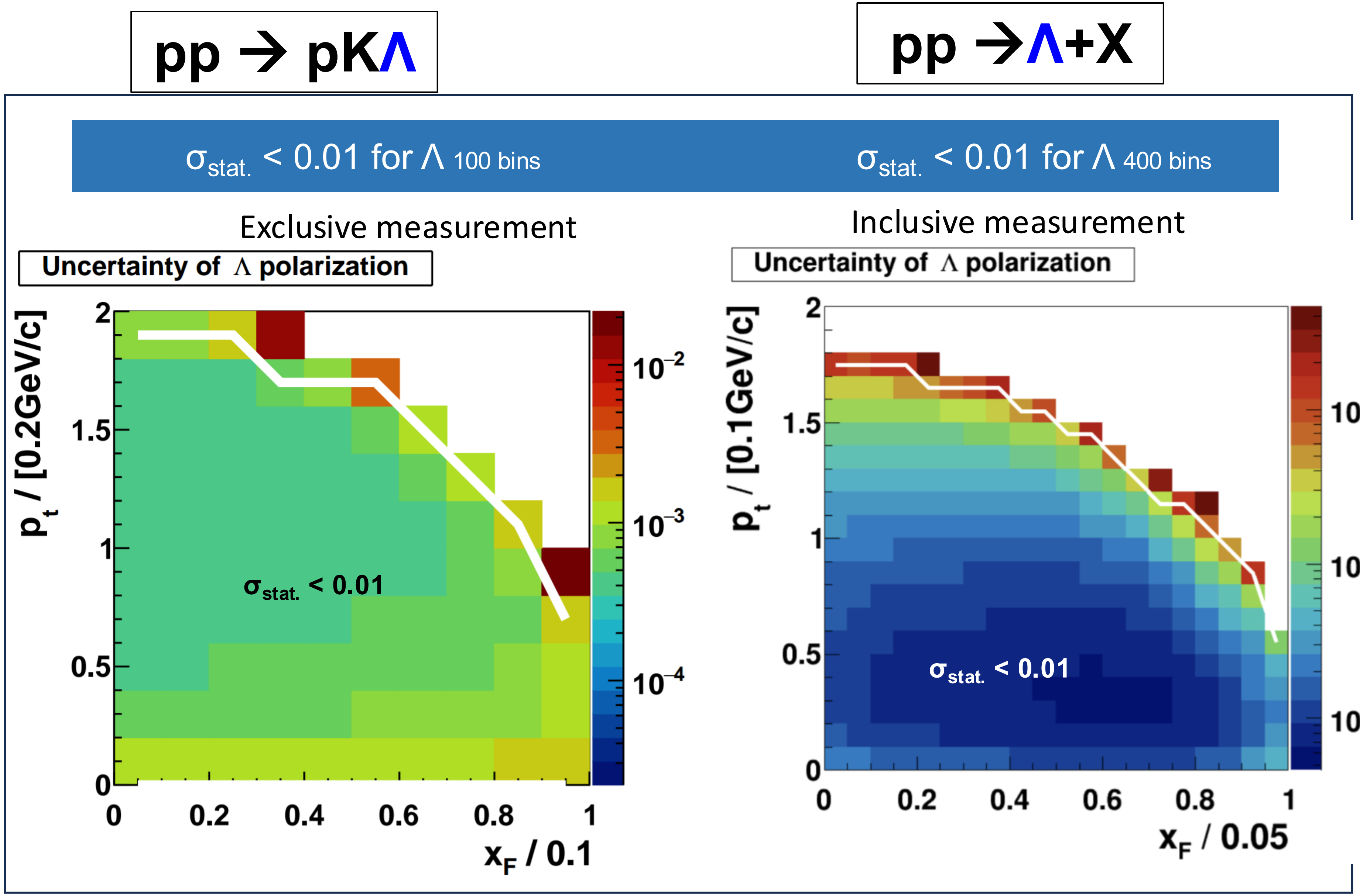
H-NS

Reaction: p+p

Event rate:1MHz

Time: 3 months

- pp →Λ+X   N ~ 10^{11}
- pp → p+X   N ~ 10^{13}
- pp → pKΛ   N ~ 10^{10}



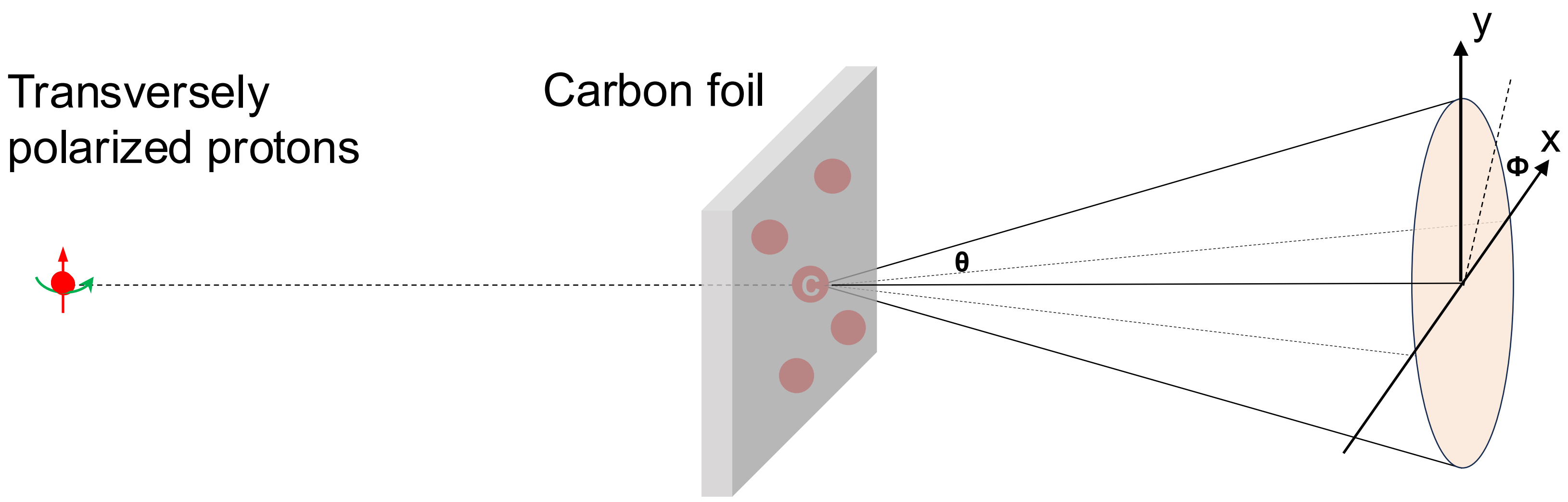
New concept of general-purpose spectrometer

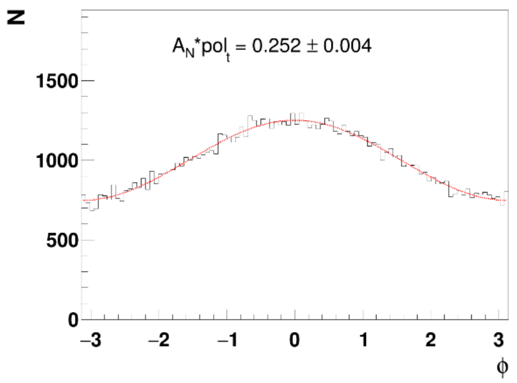
--with polarimeter function

Principle of proton polarimeter

Relation between the **spin-dependent cross-section** of p + p/C scattering and the **asymmetries**

$$\frac{d\sigma}{d\phi d\cos\theta} = \frac{1}{2\pi}\frac{d\sigma_0}{d\cos\theta}\left[1 + P_y A_N(\theta)\cos\phi\right]$$

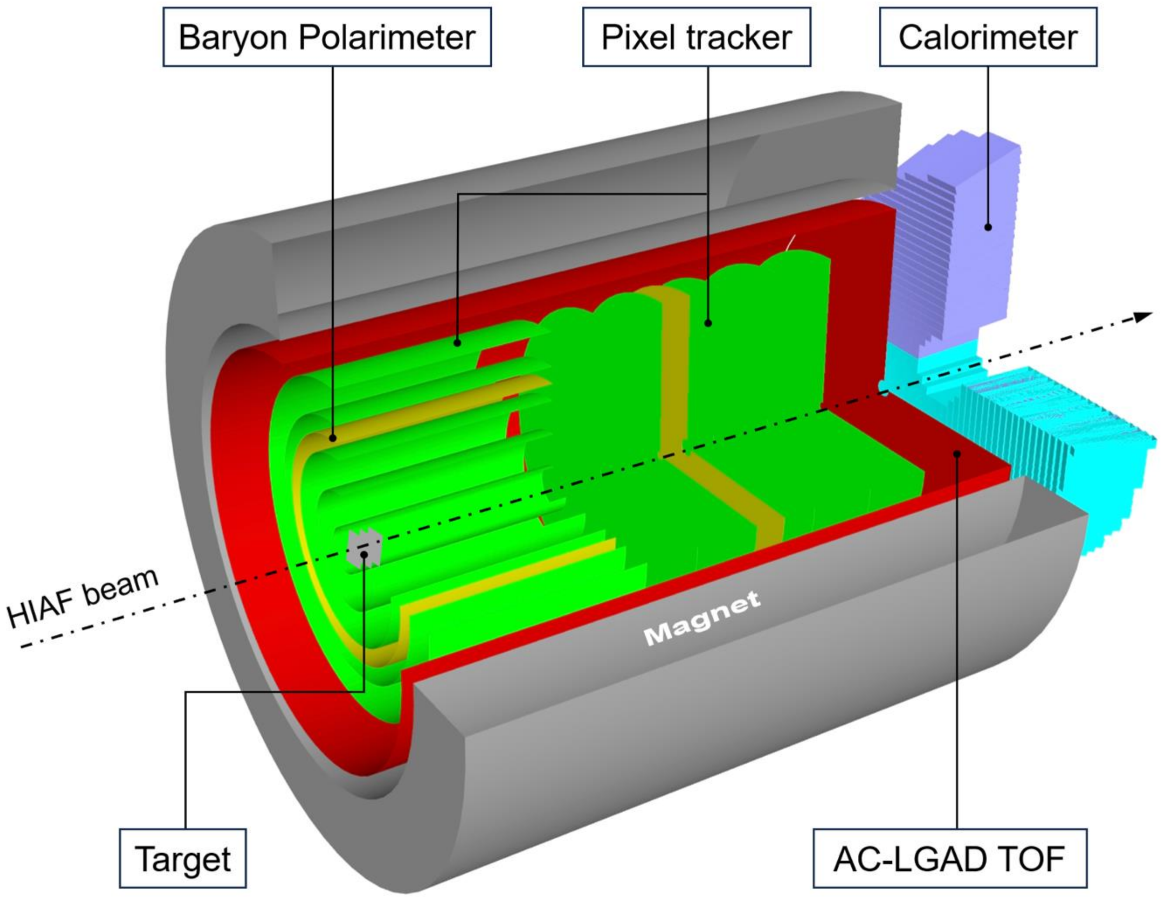




More protons to the left:
Left-right asymmetry

Widely used as polarimetric reaction to measure proton beam polarization (PSI, TRIMUF, LAMPF, COSY, SATURNE, ZGS, KEK-PS, AGS, RHIC …)

Proton polarimeter in general-purpose detector ?



- General-use detector requirements:

  $e^{\pm}$ $\mu^{\pm}$ $\pi^{\pm}$ $K^{\pm}$ $p^{\pm}$ γ

1) Good tracking efficiency
2) Good momentum resolution
3) Good energy resolution

- Secondary interaction

tracking || target || tracking

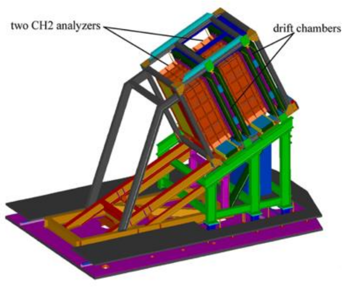


Figure 5: The FPP in the HMS in Hall C as currently designed.

target || tracking

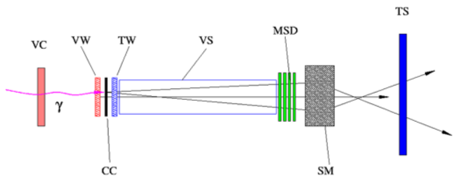
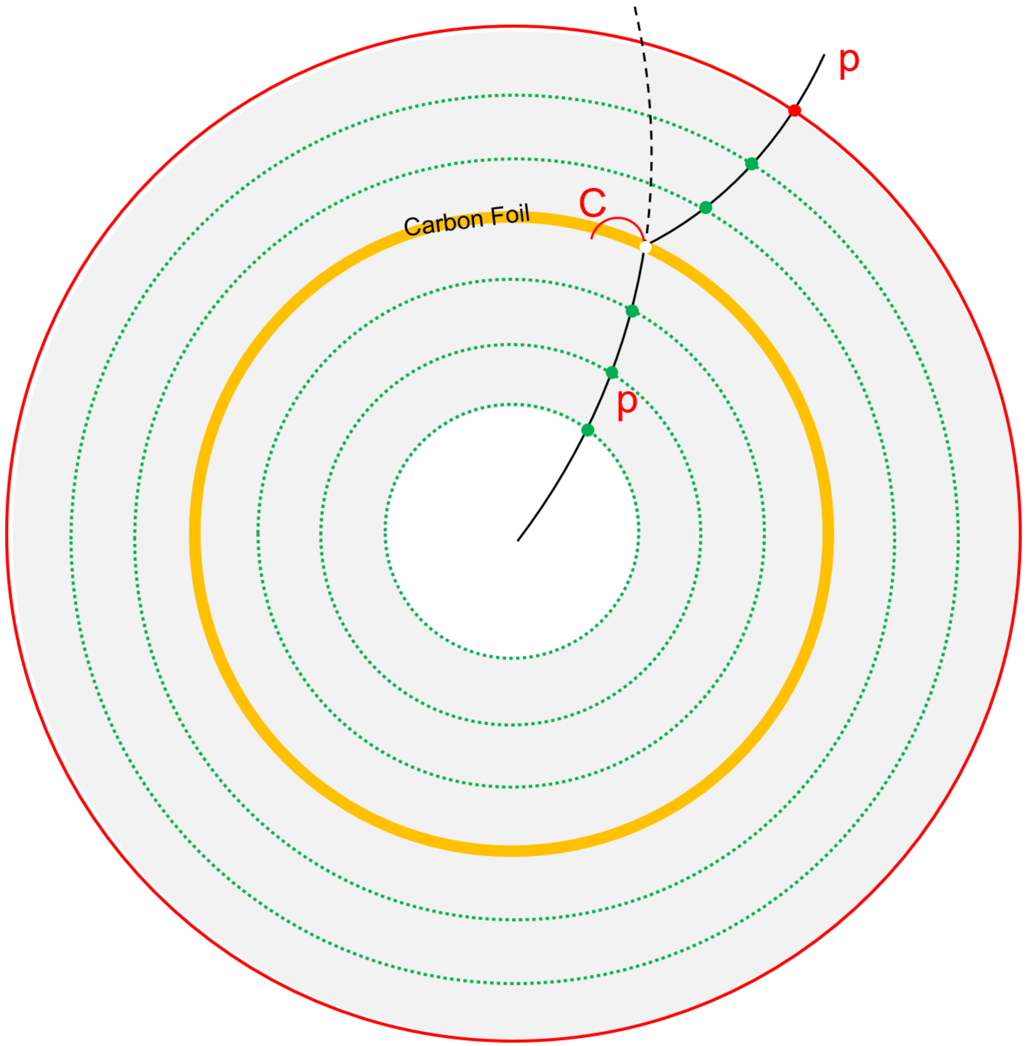


Fig. 3. The layout of the photon polarimeter. The photon arrives from the left. The veto detector is marked as VC, the veto wire chamber as VW, the converter as CC, the trigger wire chamber as TW, the vacuum straight section as VS, the set of micro-strip detectors as MSD, the separation magnet as SM, and the trigger scintillator counter as TS

- **High luminosity machine?**

An extra scattering layer serve as baryon polarimeter



- Carbon foil / Polyethylene foil
  - ~1 mm thickness
  - Material budget: <1% X/X_0
  - Probability: pC / pp (1E-3)
  - Tiny influence to the conventional performance
- Position : in-between the tracking devices
  - Appliable in all reactions: ee/ep/pp/pA/AA
  - Appliable in high energy machines

Yutie Liang, et. al., Phys. Rev. D 112, L031502

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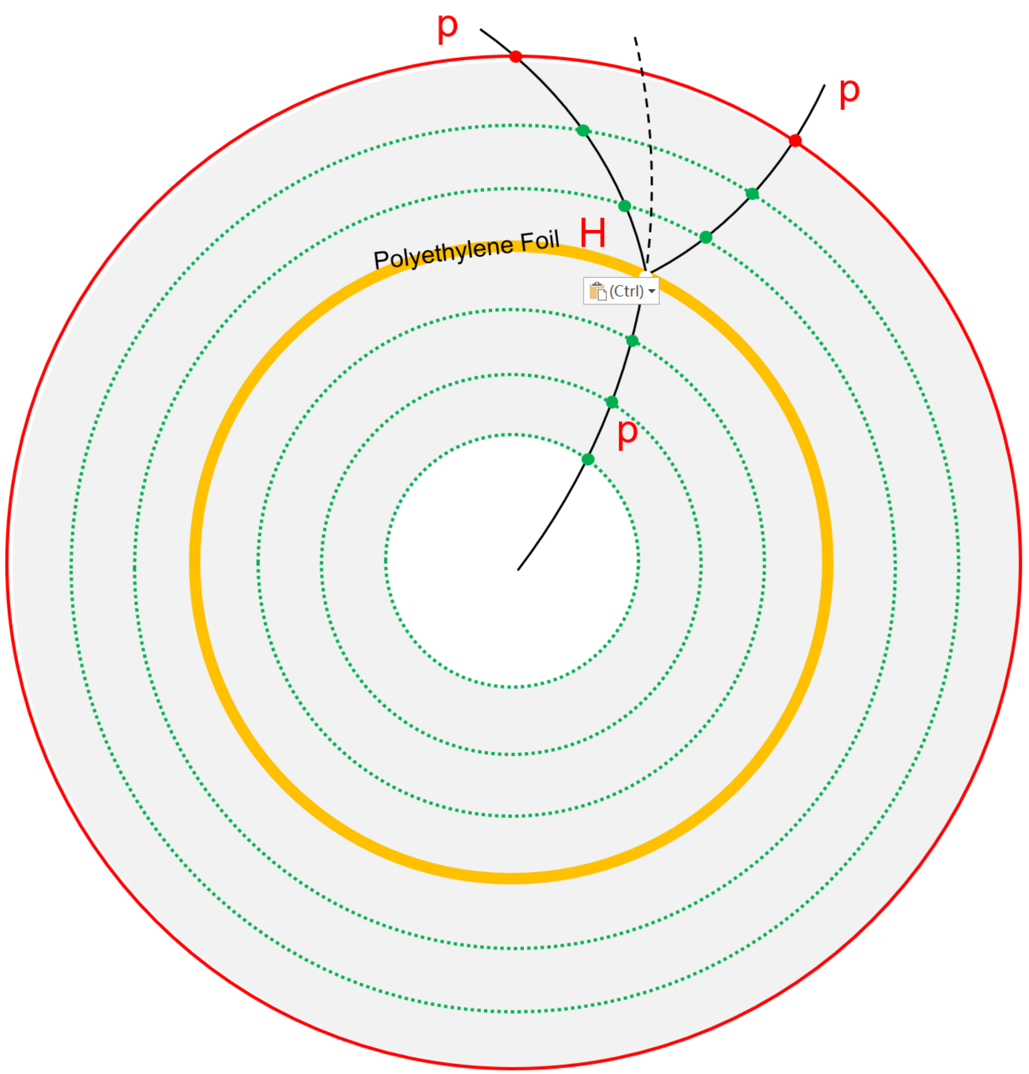

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  - **Appliable in high energy machines**

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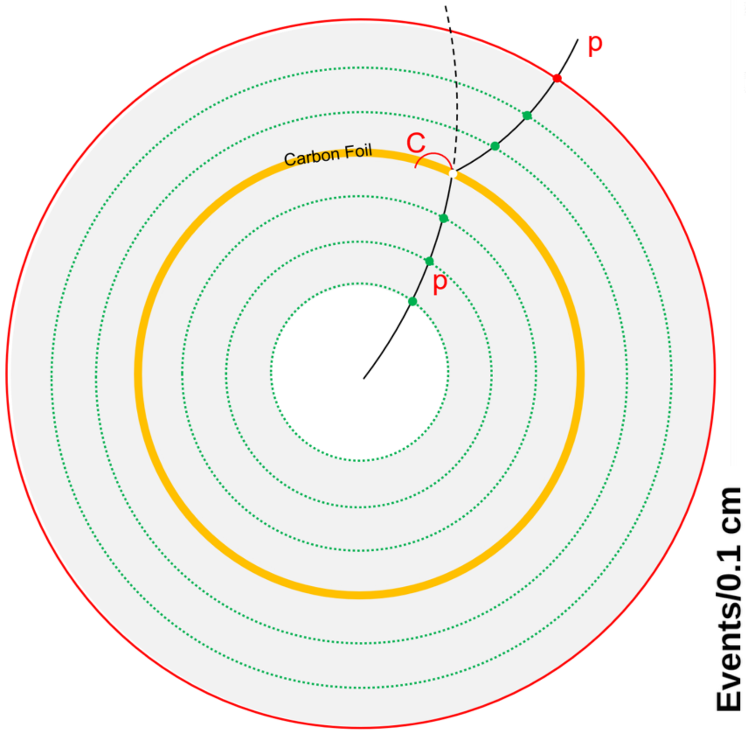
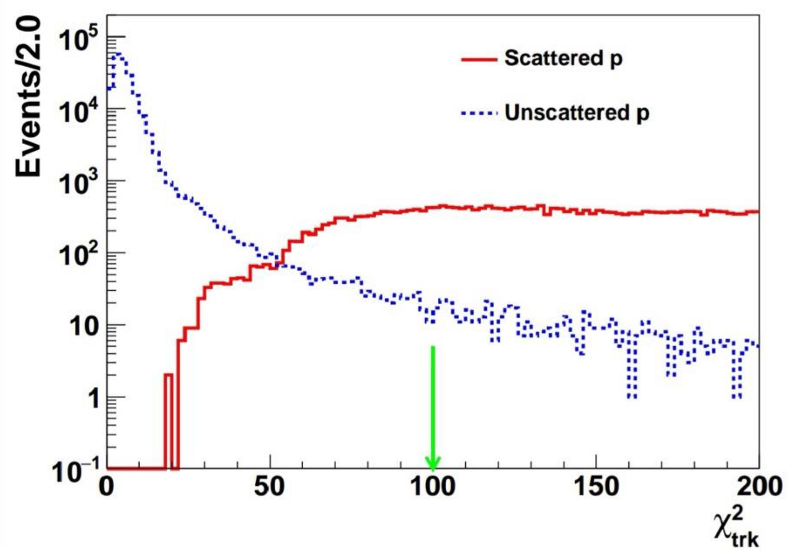
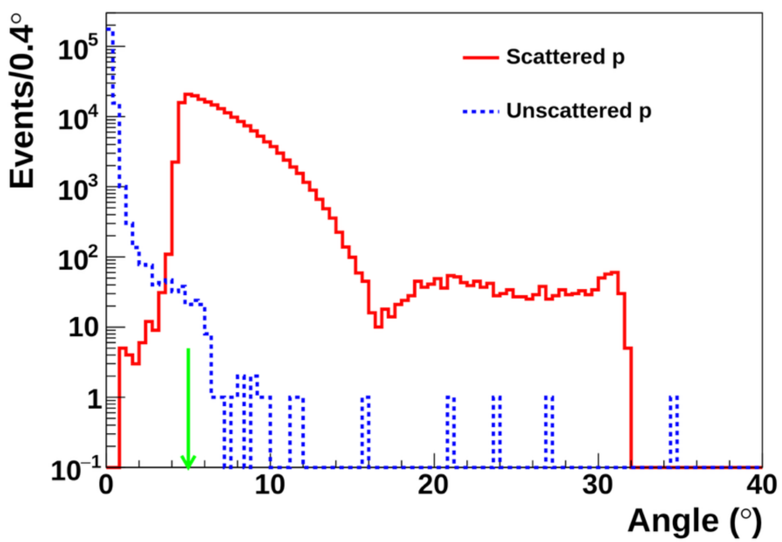
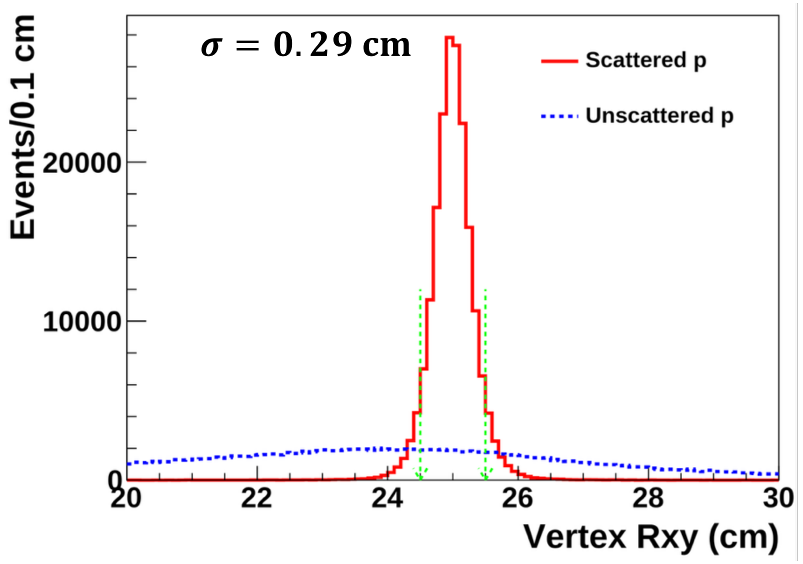
Polarimeter performance at H-NS

Non-scattering tracks suppression





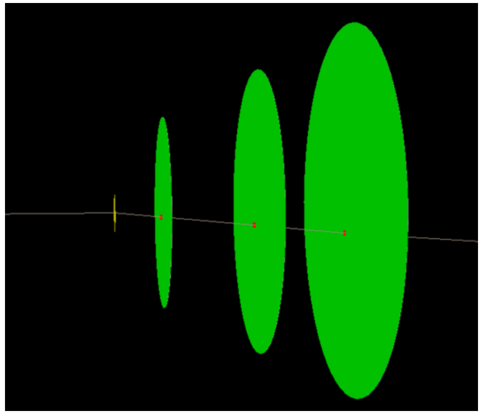




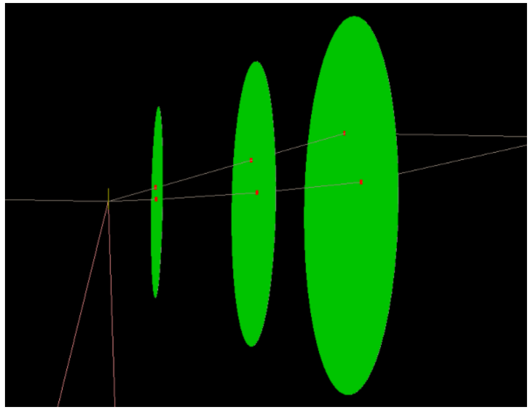
- ✓ Reconstruction effi: > 70%
- ✓ Bkg. contimation: <1%

Background from inelastic scattering

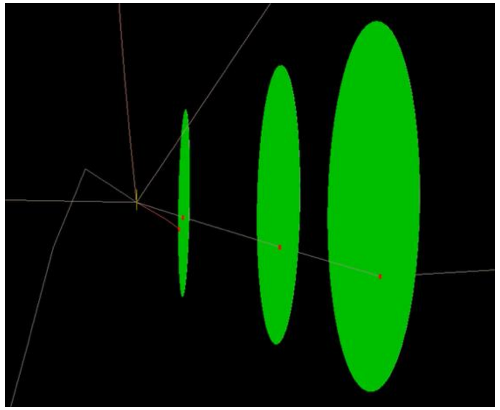
Signal: p + C → p+C



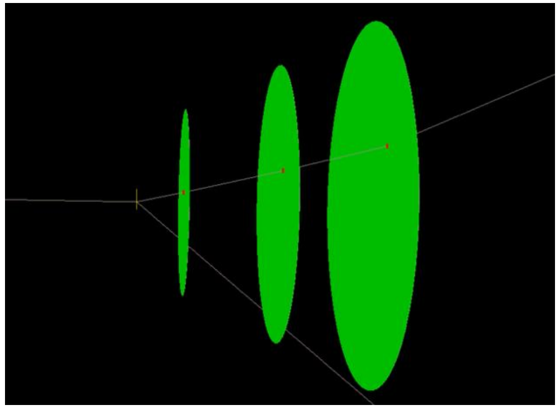
Bkg: p + C → p + p + ...

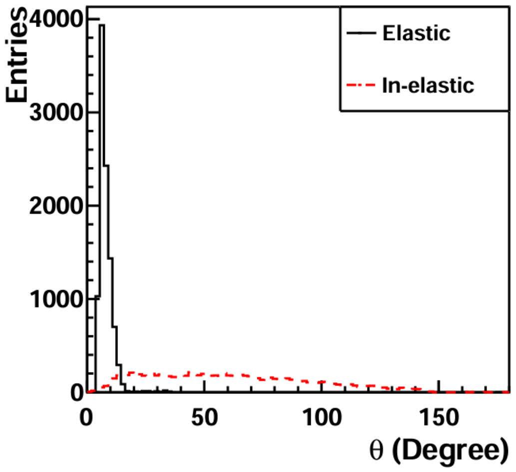


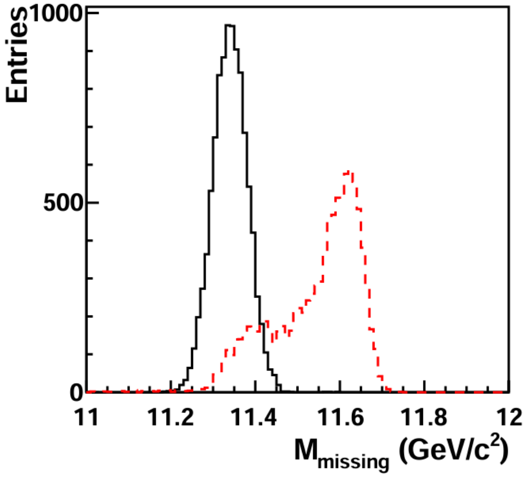
p + C → p + d + α + He^3

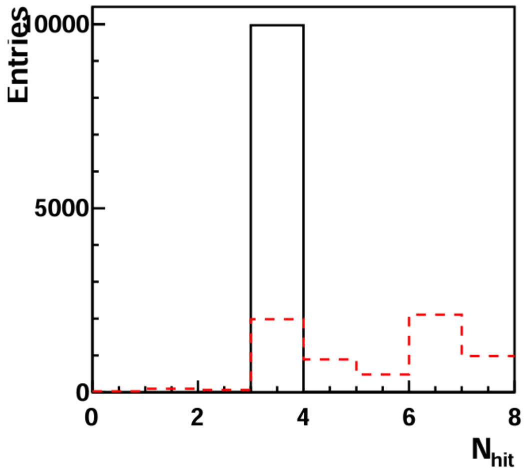


p + C → p + n + C^{11}





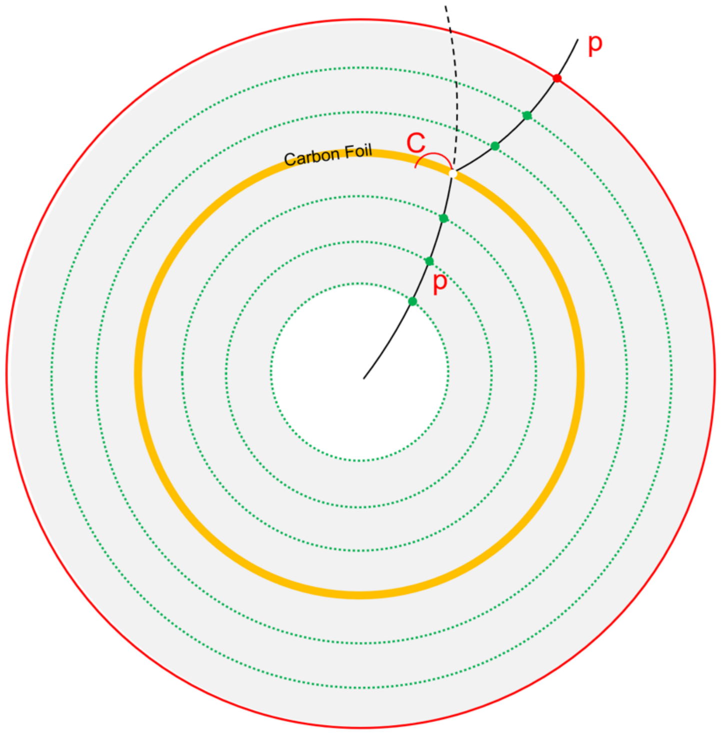




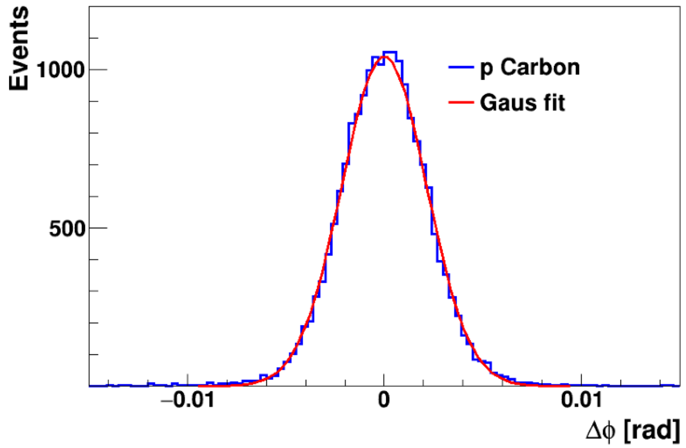
p + C → p + d + α + He^3
p + C → p + n + C^{11}
p + C → p + p + B^{11}
…

Background level: 2-5%

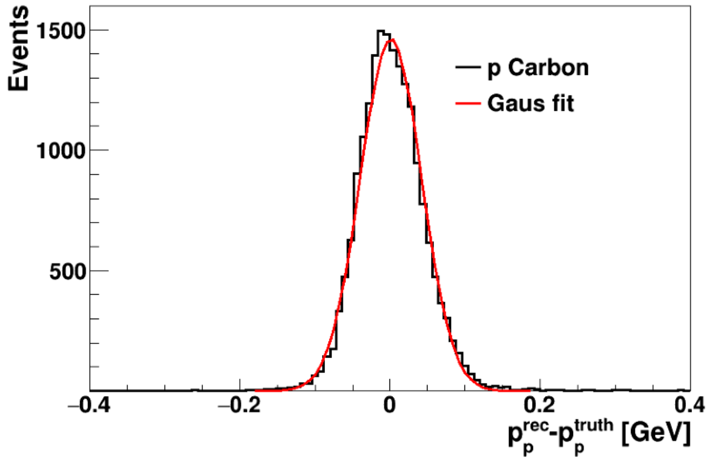
Precision measurement of proton polarization



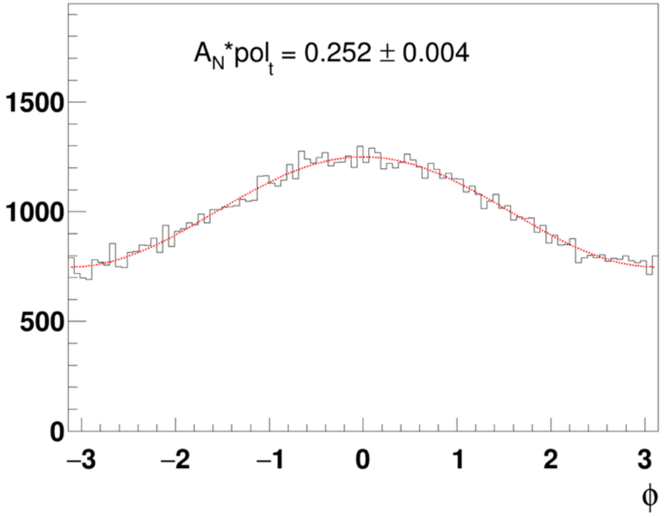
$\sigma = 2.16$ mrad



$\sigma = 0.041$ GeV

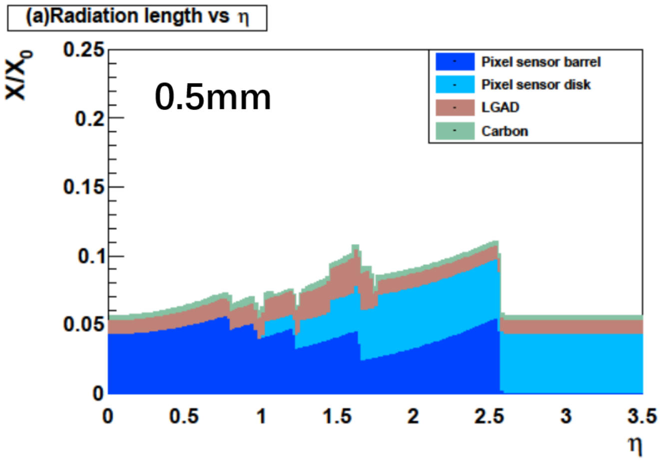


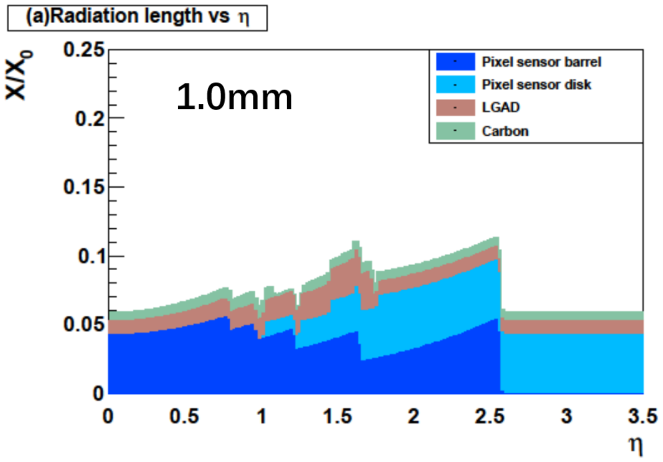
Input: 0.250

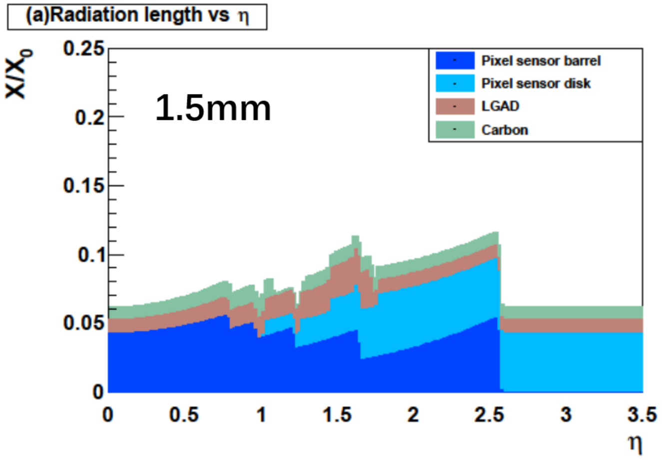


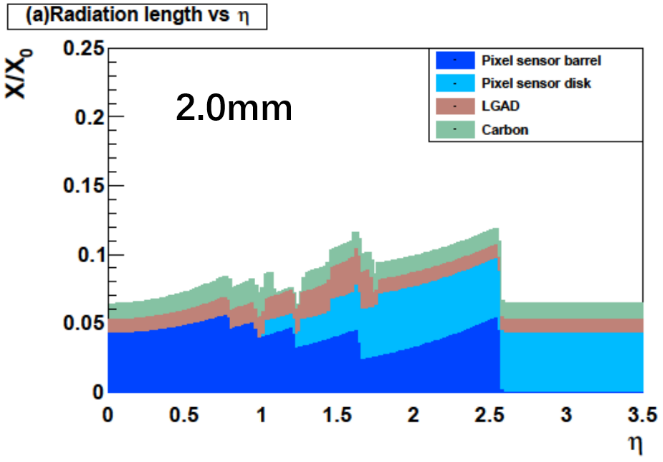
- ✓ Reconstruction effi: > 70%
- ➢ Low background contamination!
- ➢ High precision measurement!

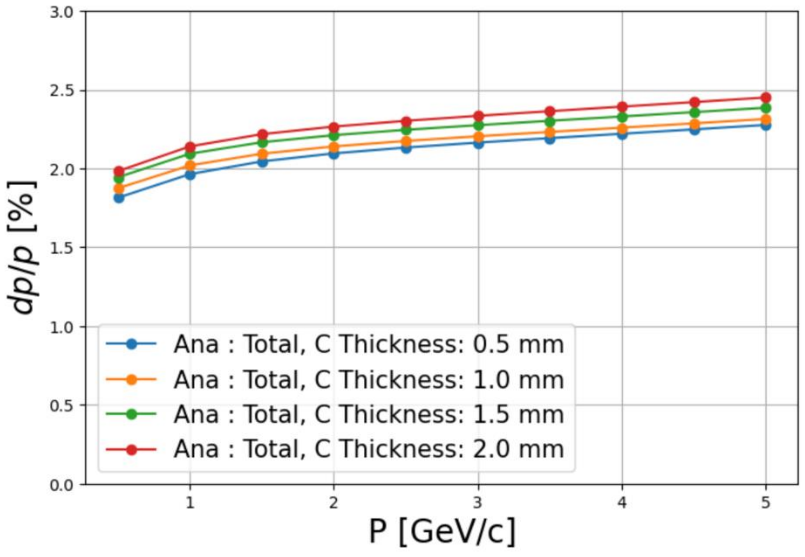
Material budget of carbon layer









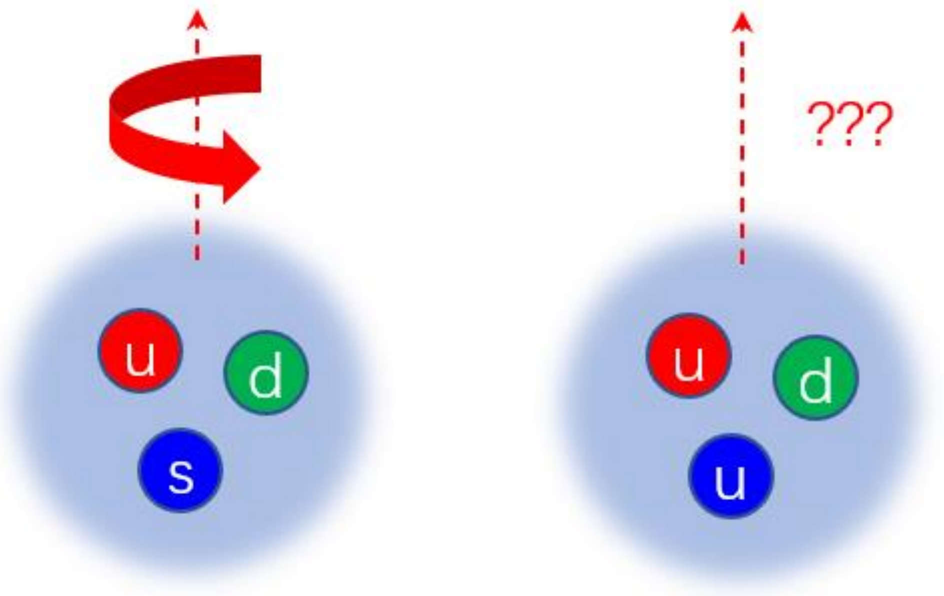


- Tiny influence on the conventional performance

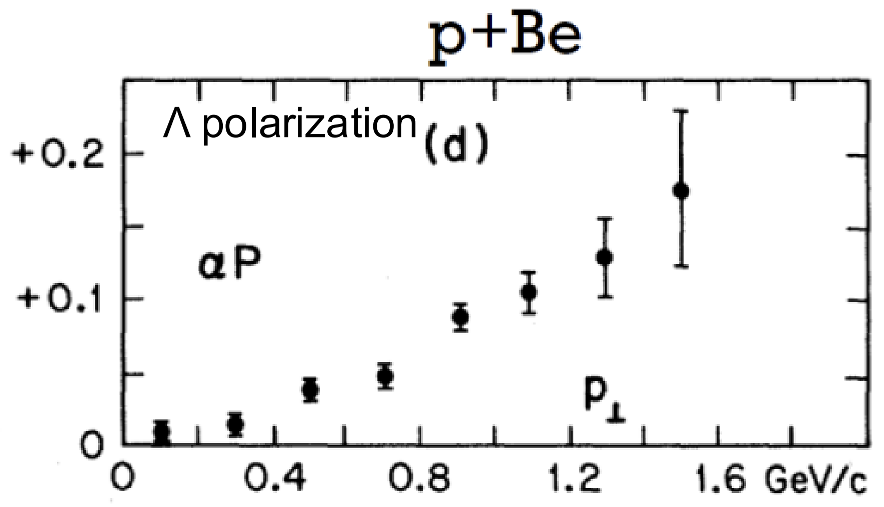
Physics potentials at H-NS

Baryon spin structure -- inclusive production of p/Λ

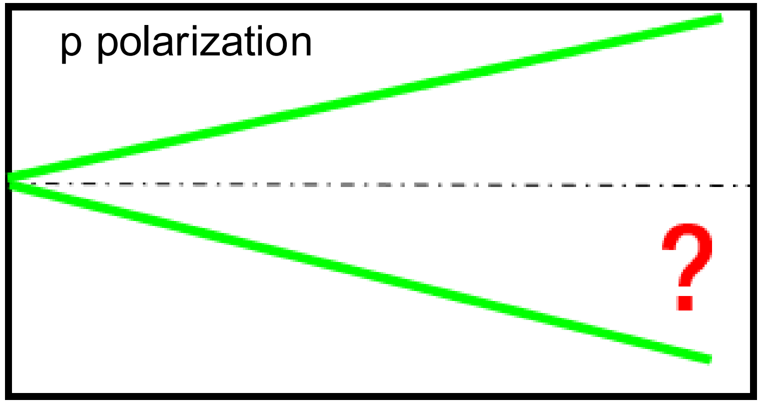
pp → p/Λ + X



p+Be → Λ + X



G.Bunce, *et al.*: Phys.Rev.Lett. 36, 1113-1116 (1976)



Uncertainty projection of the polarization measurement

H-NS

Reaction: p+p

Event rate:1MHz

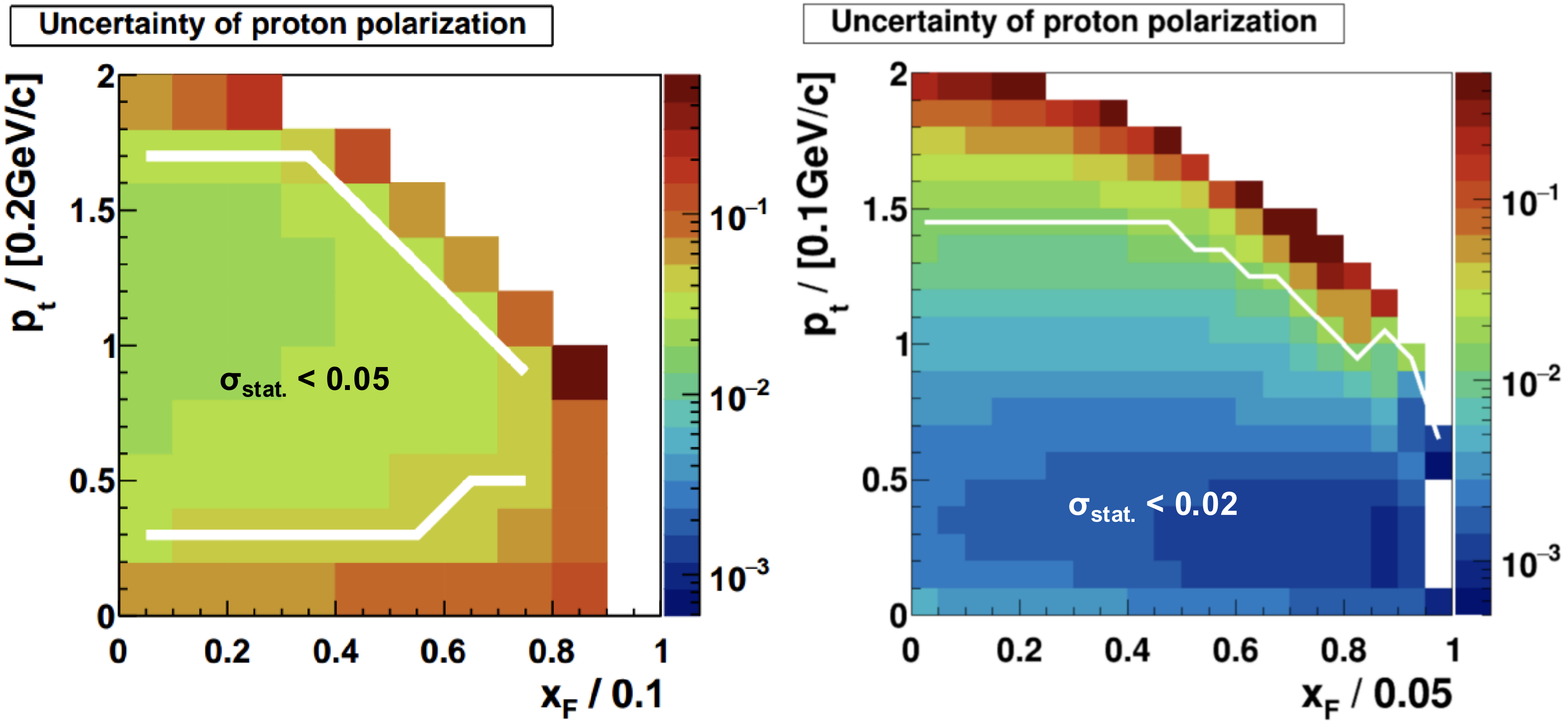
Time: 3 months

- pp →Λ+X N ~ 10^{11}
- pp → p+X N ~ 10^{13}
- pp → pKΛ N ~ 10^{10}

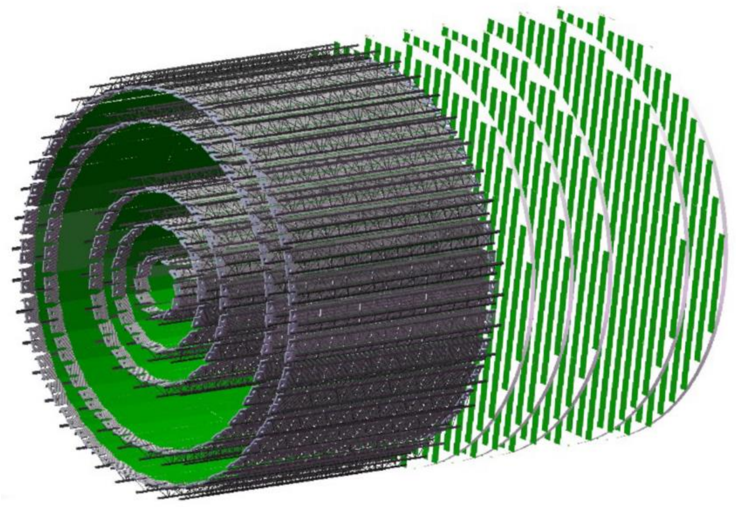
pp → pKΛ | **pp → p + X**

$\sigma_{stat.}$ < 0.05 for p 100 bins | $\sigma_{stat.}$ < 0.02 for p 400 bins

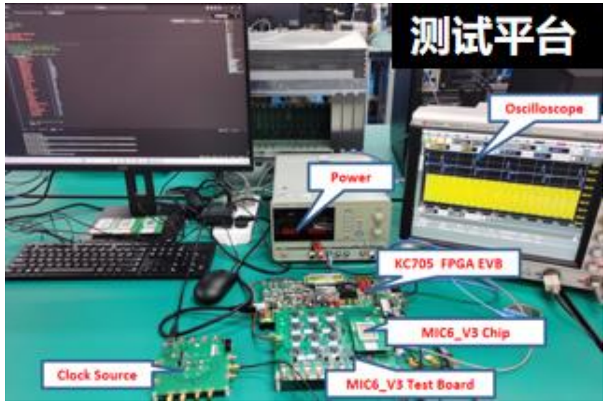
Exclusive measurement | Inclusive measurement

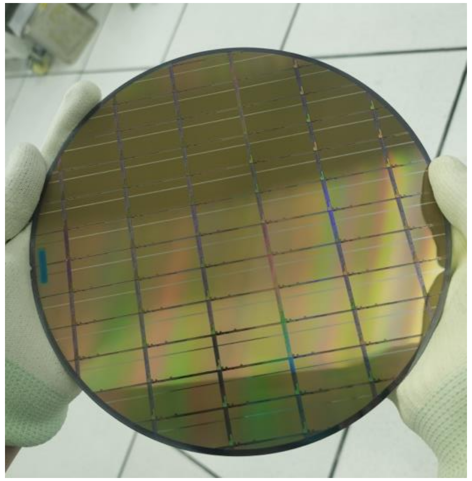


Silicon tracker at H-NS



MIC6 development at CCNU

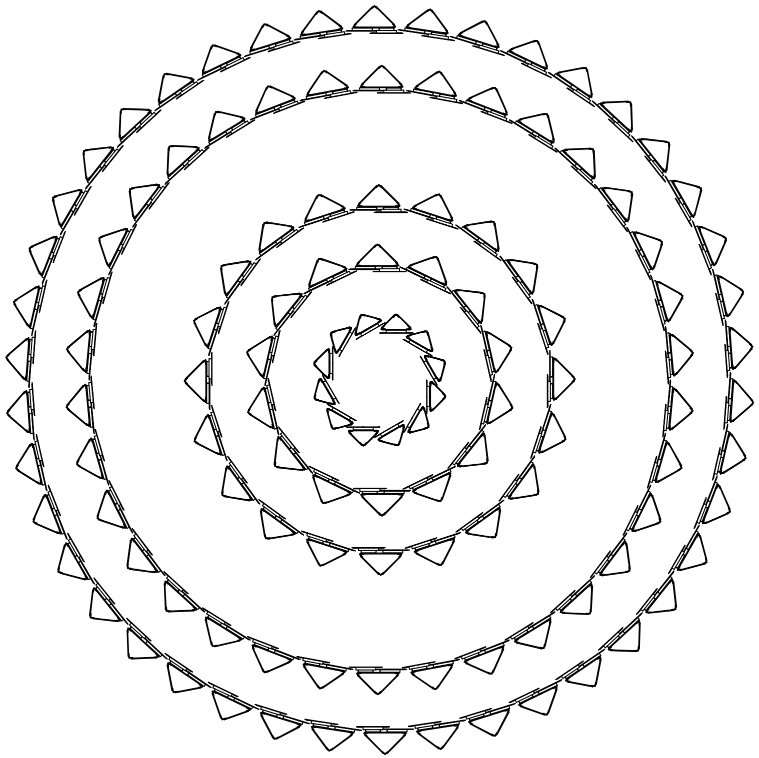


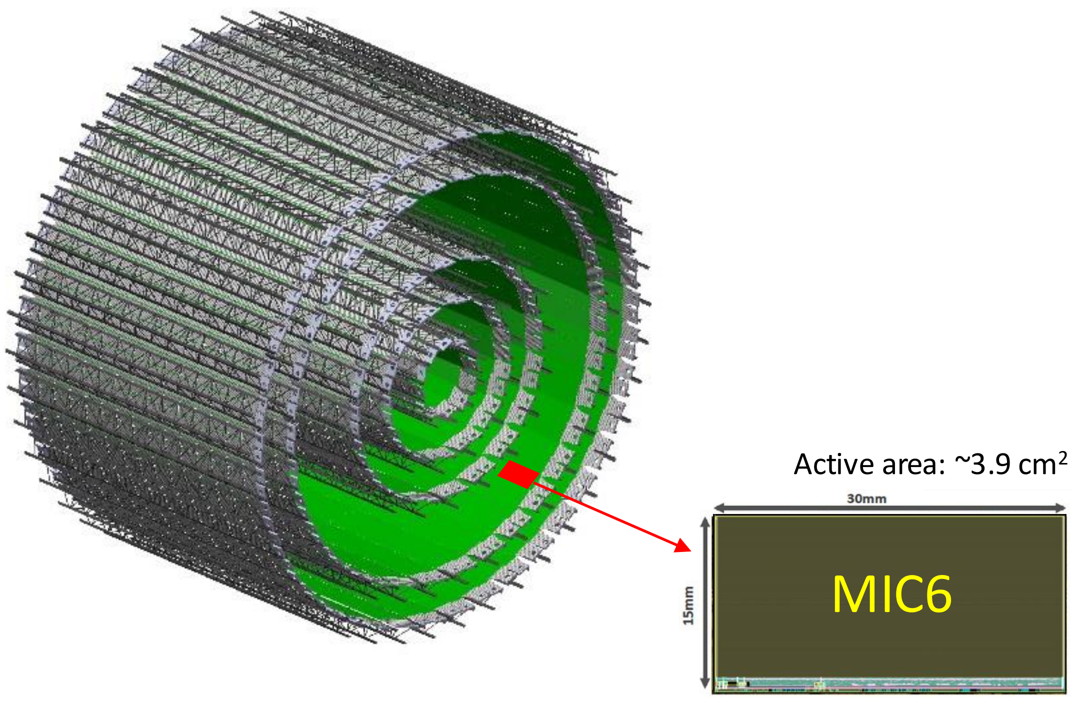


- **MIC6 MAPS pixel chip:** development and manufacture with the domestic process
- **Readout electronics** (ITS2 based design) **and DAQ** (ALICE CRU/FELIX protocol, GBTx, …)
- **Detector assembly and integration:**
  - **Vertex detector:** Stave module design (spatial resolution: ~ 5 μm with pixel size 30 μm, total material < 0.35%X/X_0 per layer)
  - **Forward tracker:** Ladder module aligned to disc super-module (spatial resolution: ~ 5 μm with pixel size 30 μm, total material < 0.45%X/X_0 per layer)

Conceptual design of HNS silicon pixel detector

桶部:

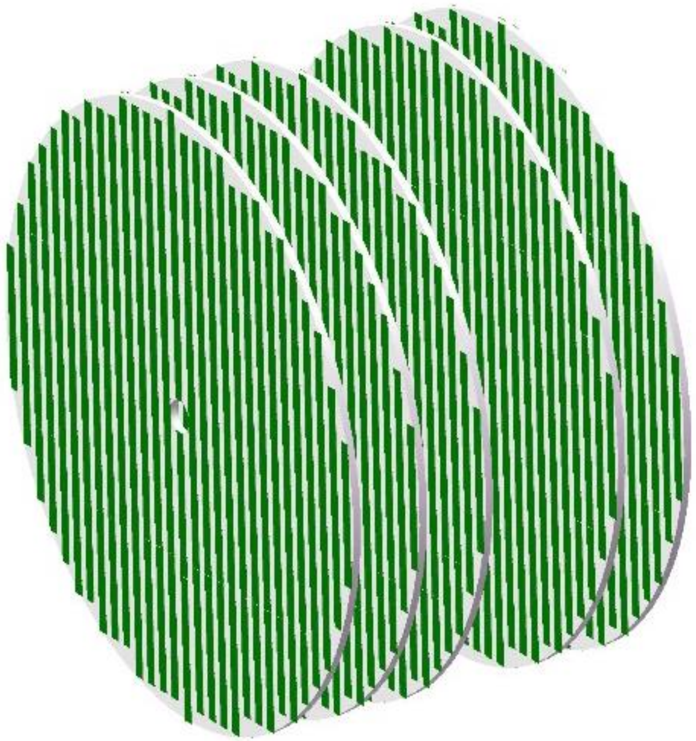


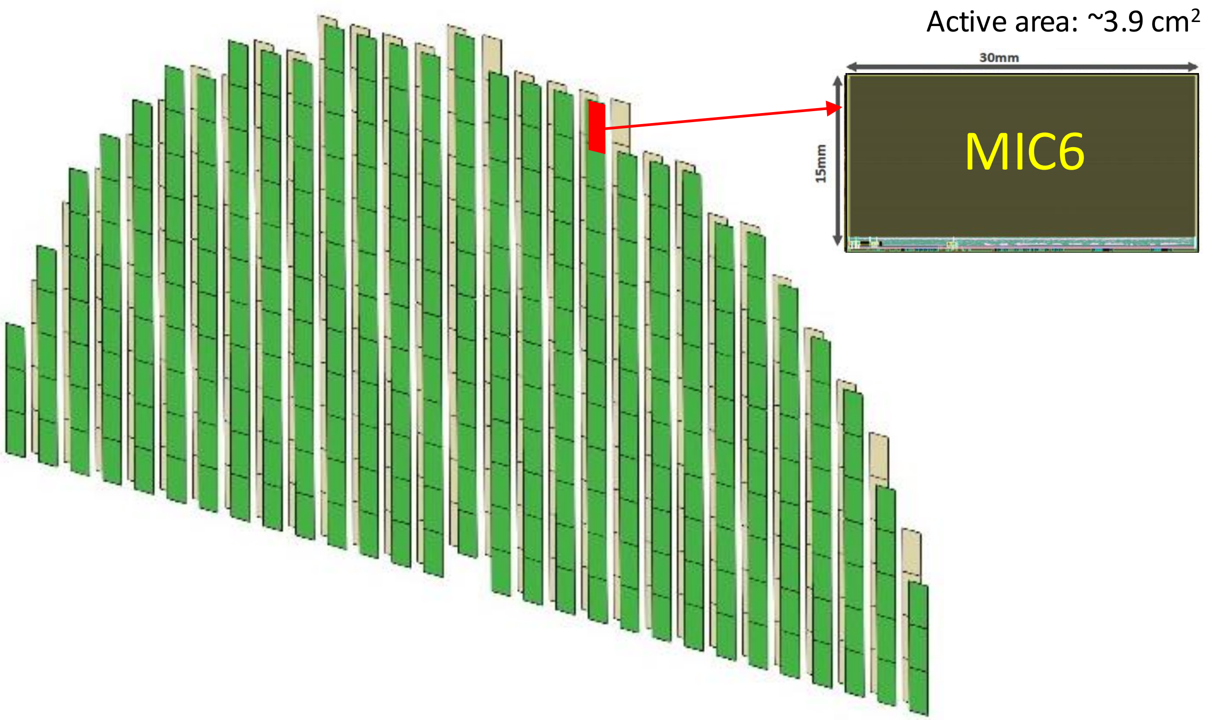


Layer No.	No. of MIC6 chips	MIC6 dimensions (mm^2)	Nr. Of Staves	Stave overlap in rϕ (mm)	Active area (cm^2)
L0	336	15×30	12	2.35	1310.4
L1	784		14	3.37	3057.6
L2	1120		20	3.37	4368.0
L3	1904		34	3.37	7425.6
L4	2352		42	3.37	9172.8

Conceptual design of HNS silicon pixel detector

端盖:



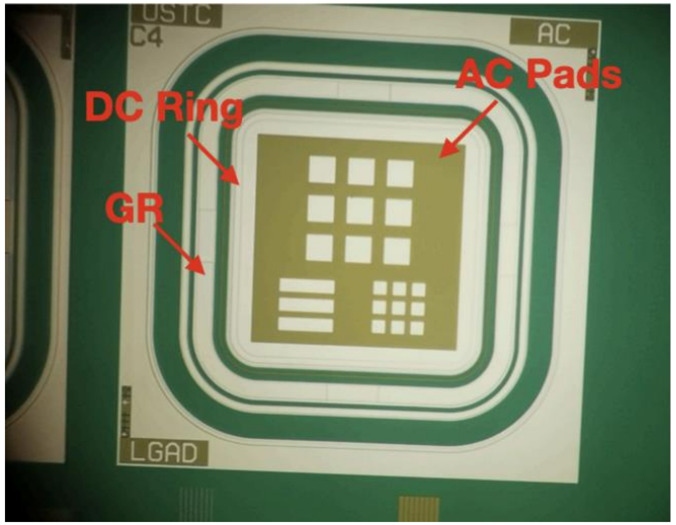


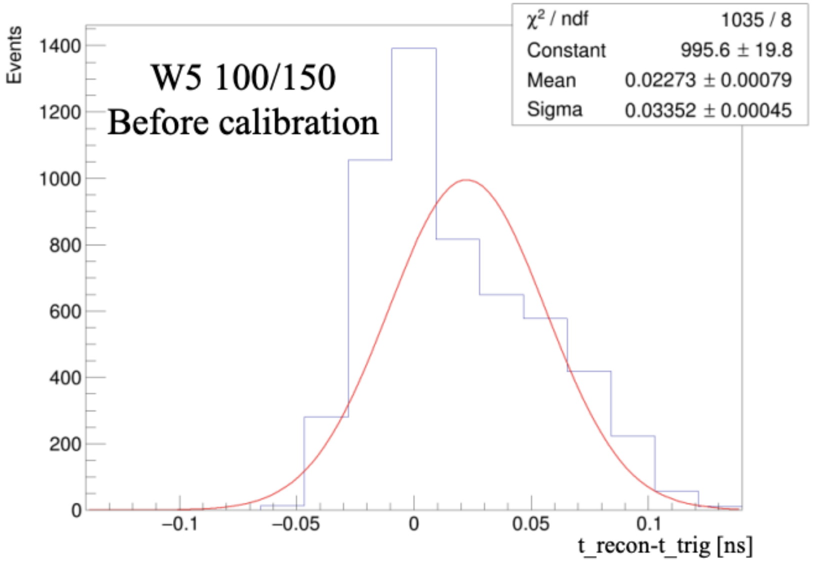
Layer No.	No. of MIC6 chips	MIC6 dimensions (mm^2)	Nr. of ladders	ladder overlap (mm)	Active area (cm^2)
D0	1028		114	2.0	4009.2
D1	1028		114	2.0	4009.2
D2	1028	15×30	114	2.0	4009.2
D3	1028		114	2.0	4009.2
D4	1028		114	2.0	4009.2

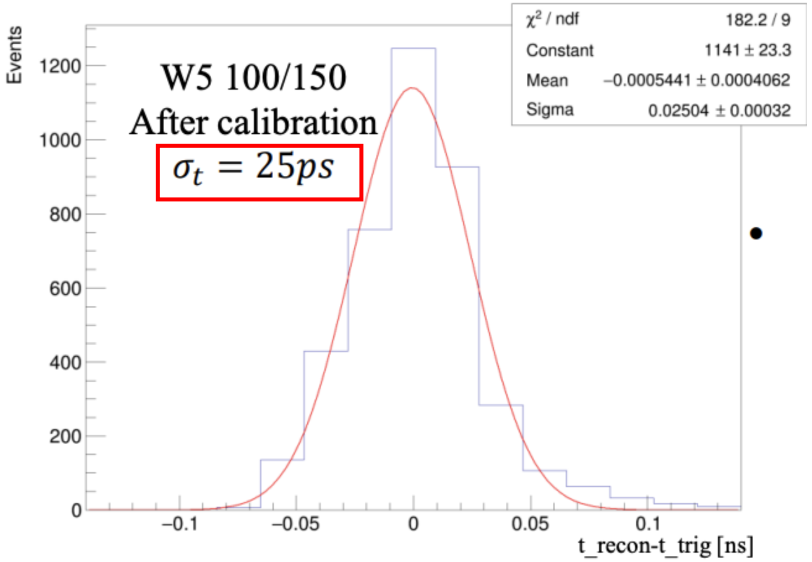
AC-LGAD at H-NS

Recent development at USTC:

- Two wafers with different n+ dose: W5 high n+ dose and W6 low n+ dose.
- Sensor size : 1300×1300×50 μm.
- Sensor with different pad-pitch size: Large pad size/pitch: 100/150 μm, Small pad (Strip) size/pitch: 50/75 μm.



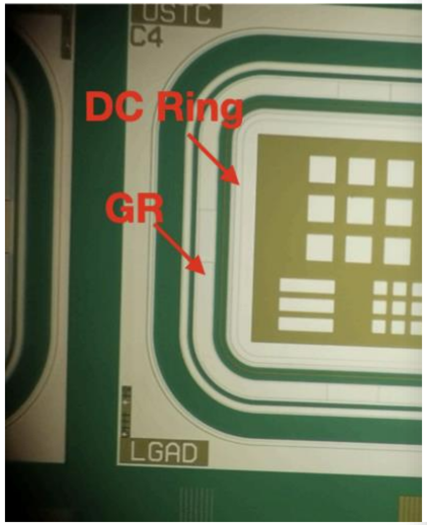


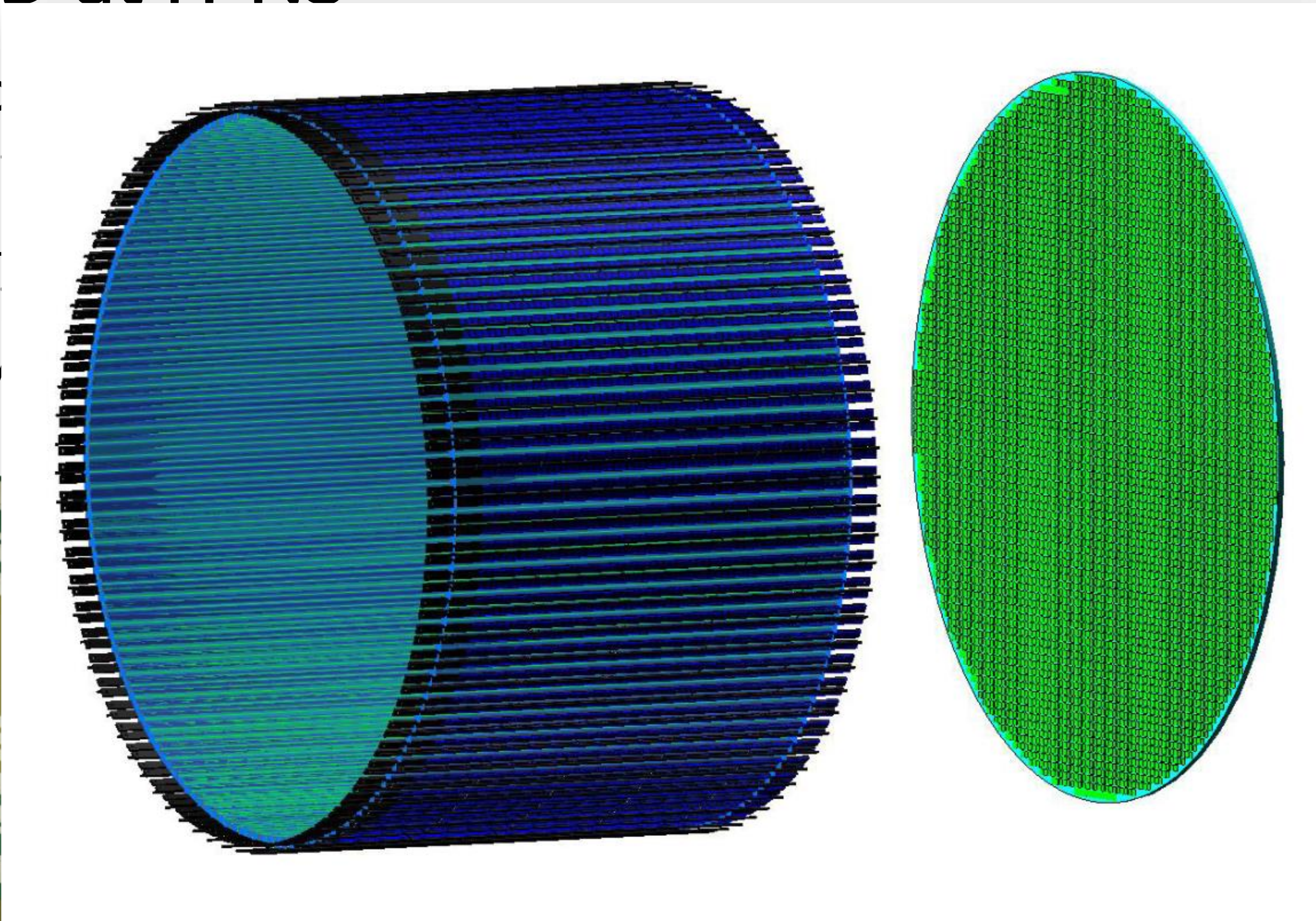


AC-LGAD at H-NS

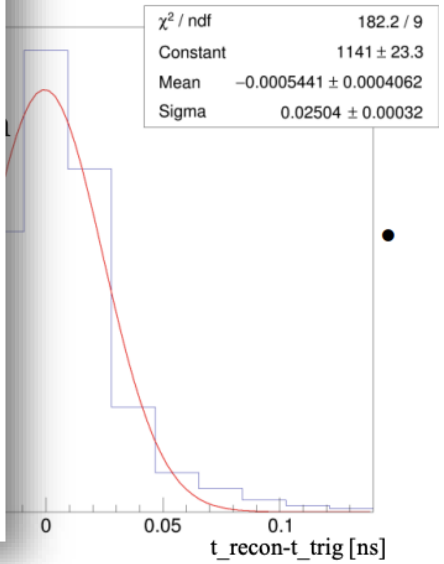
Recent develo

- Two wafers w… e.
- Sensor size : 1
- Sensor with d… mall pad (Strip) size/pitch: 50/



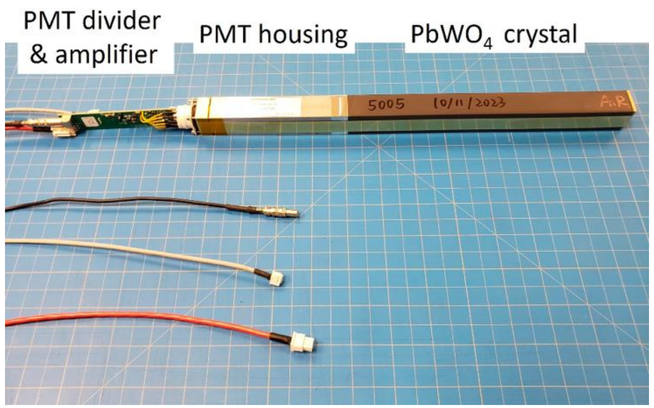


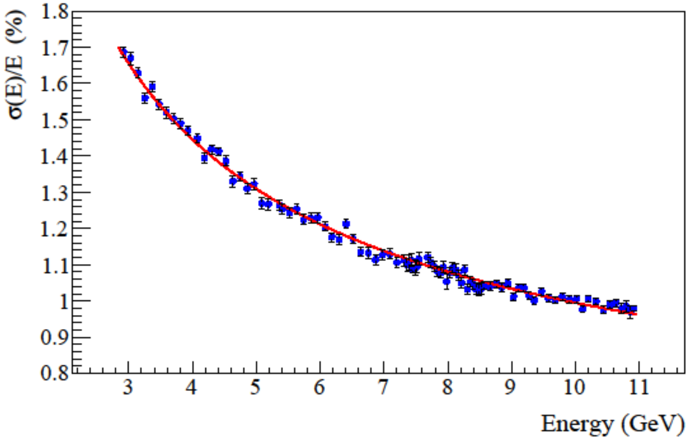
t_recon-t_trig [ns]

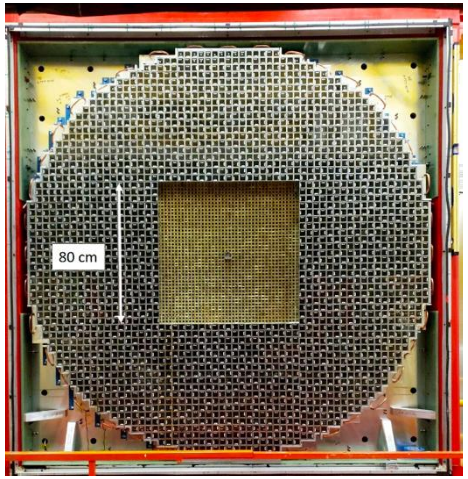


End cap energy meter design

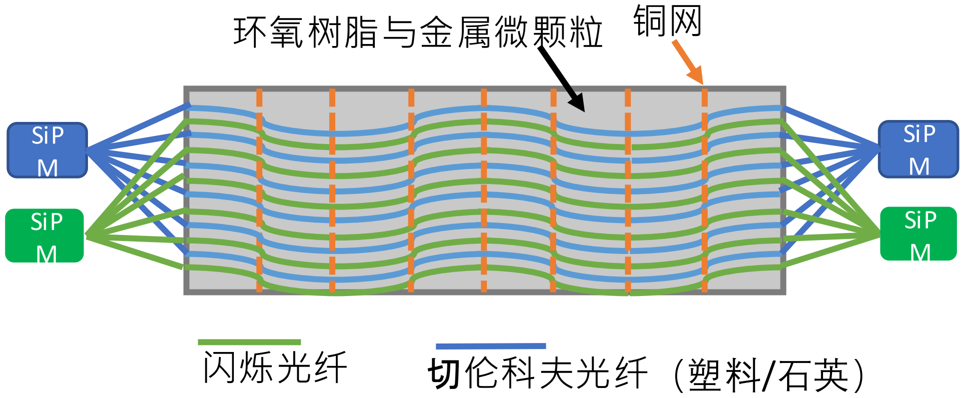
- **PbWO4 crystal**: compact size, good energy resolution

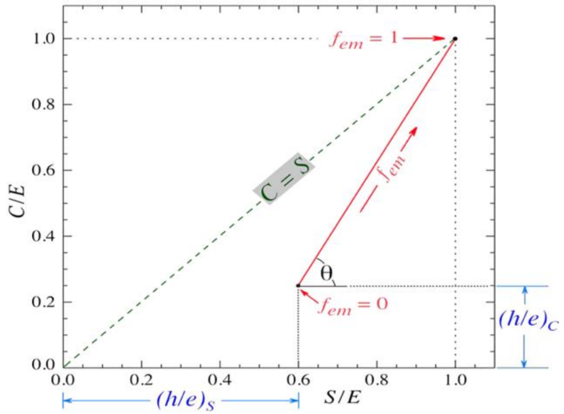


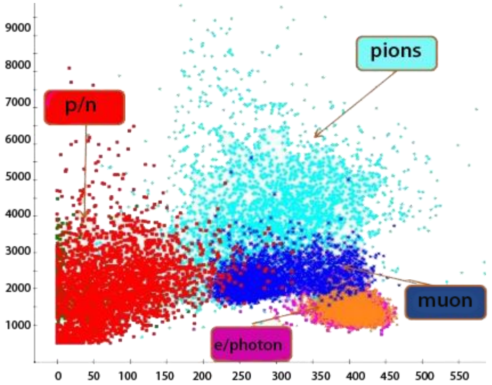




- **Dual-Read out**: better hadron shower resolution, PID capability



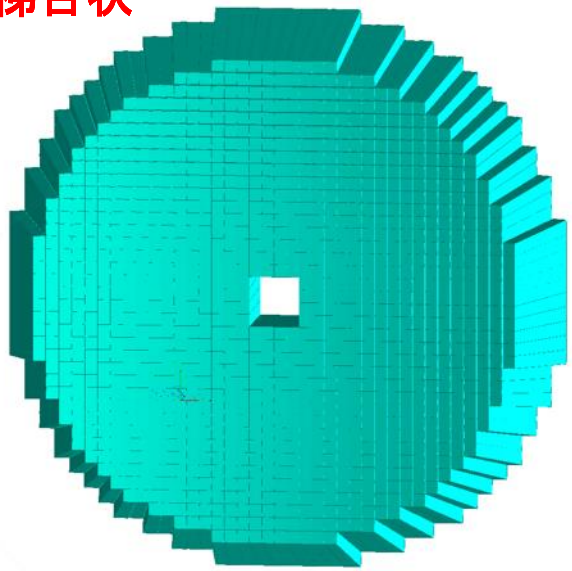




End cap energy meter design

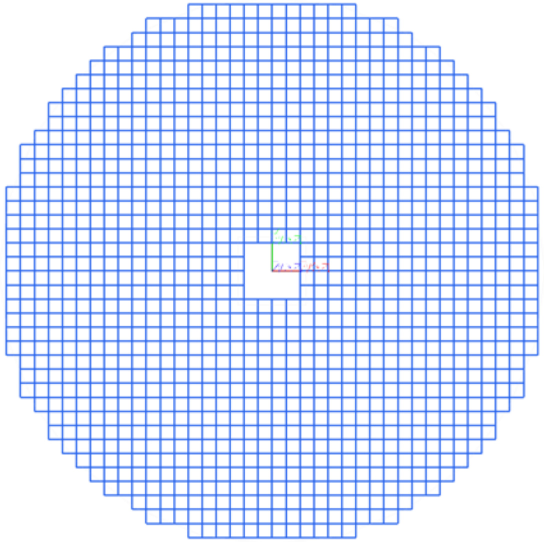
- Σ+ and Σ0 generation process γ/π0 detection, etc
- The expected number of modules is 1225
- Analog detector setup:
- Front end size: 2.05x2.05 cm^2
- The length is 18cm
- The detector is located at ~140 cm
- Beam hole radius is 5 cm, outer diameter is 45 cm (maximum angle 18 degrees)
- Two different design arrangements are simulated

梯台状



半径 [cm]	PbWO4数量
40	1152
43	1324
45	1436
50	1764

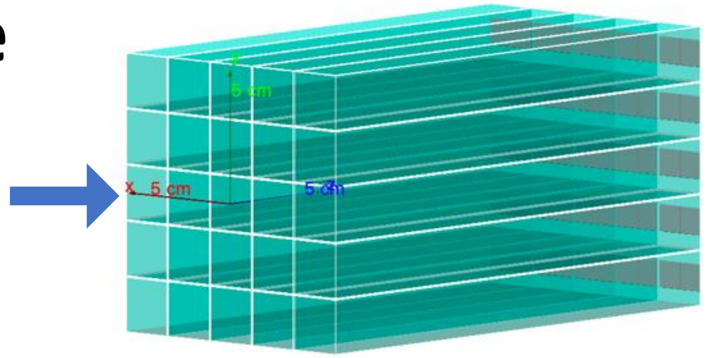
长方体



40 cm 设计

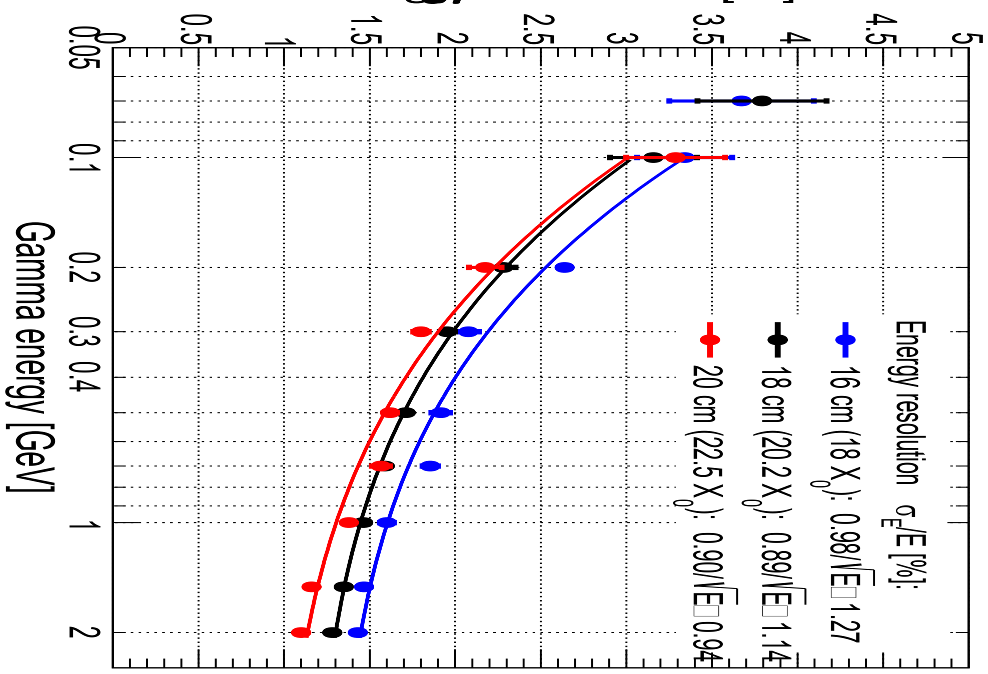
半径 [cm]	PbWO4数量
40	1244
43	1340
45	1464
50	1852

The effect of PWO length on performance

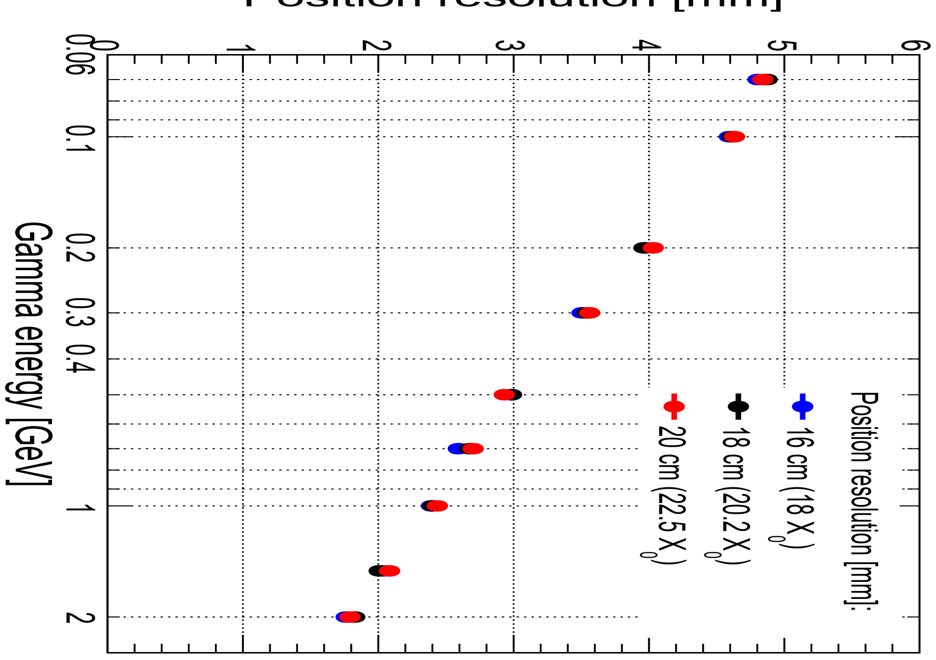


- A 5x5 array simulation is used, and the simulation only considers energy deposition
- At present, the irradiation length of detectors using PWO crystals is generally about 20cm (=22.5X0, X0=0.89cm), and the length can be optimized to reduce the cost.

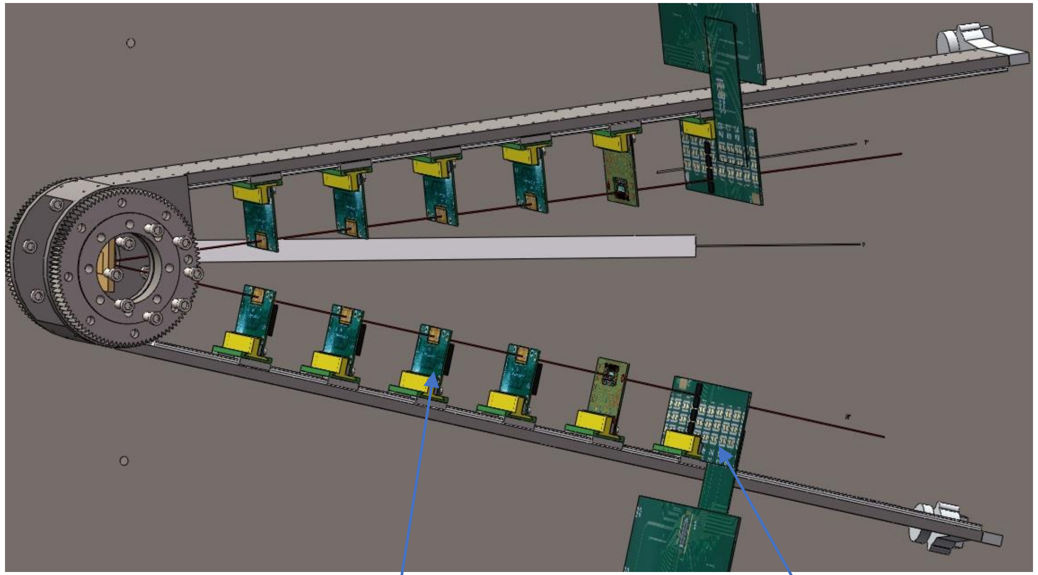
Energy resolution

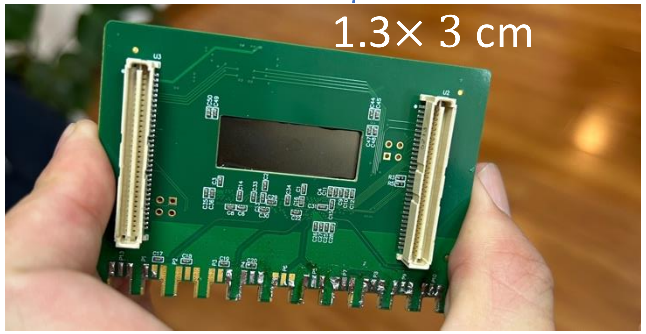


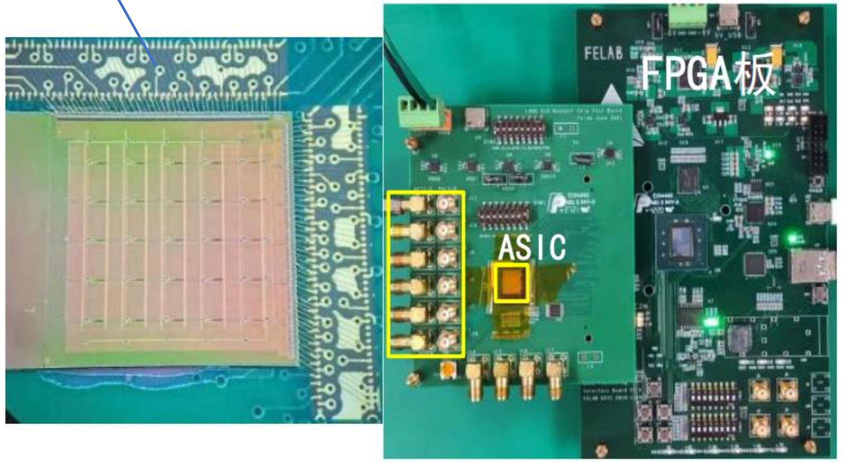
Position resolution



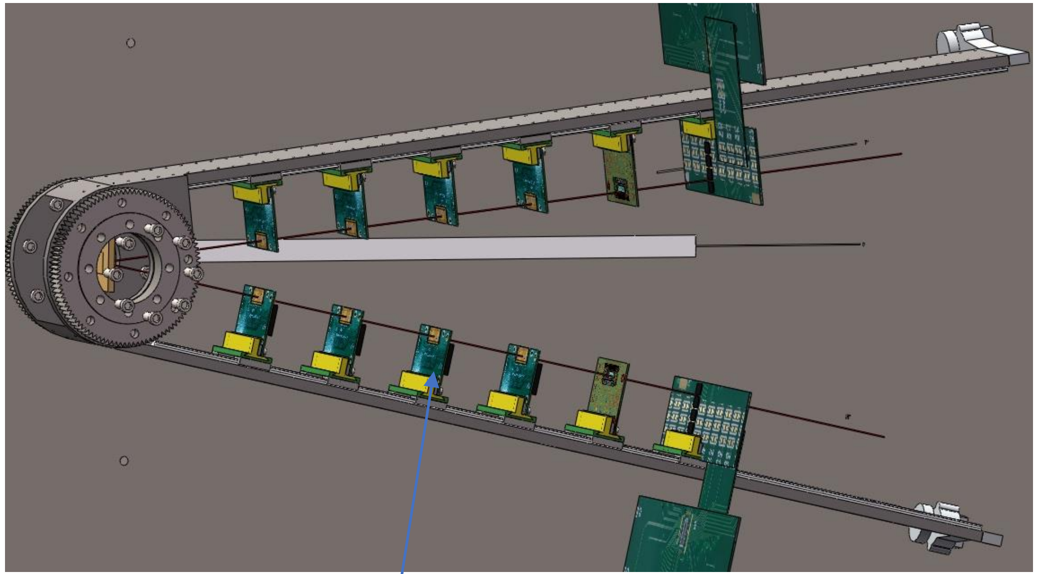
The mechanical design of $\boldsymbol{HNS\emptyset}$

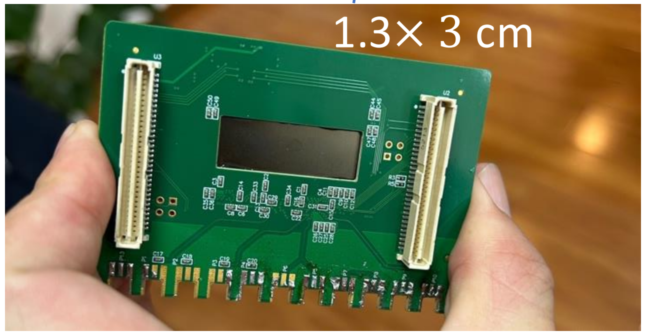






The mechanical design of ***HNSØ***





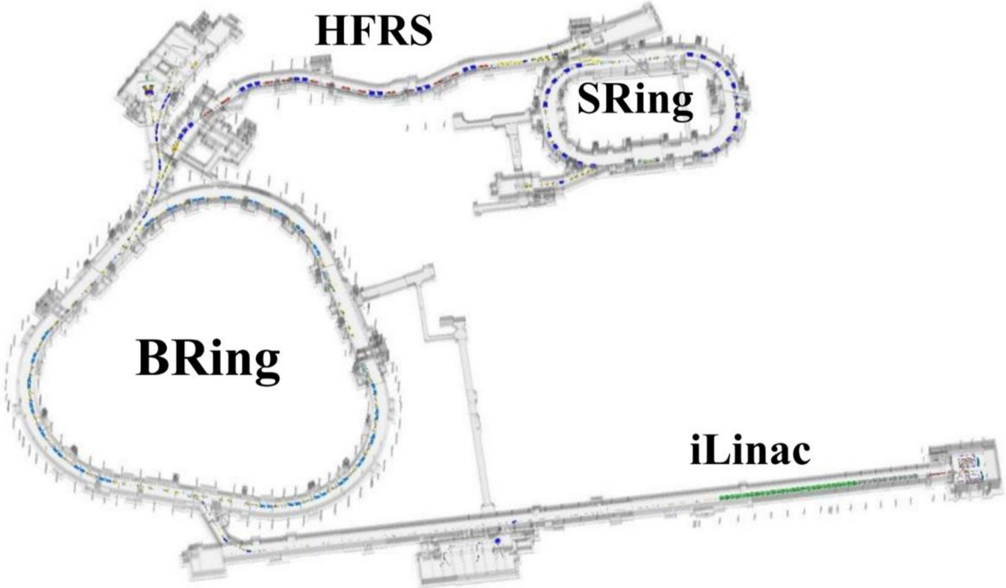
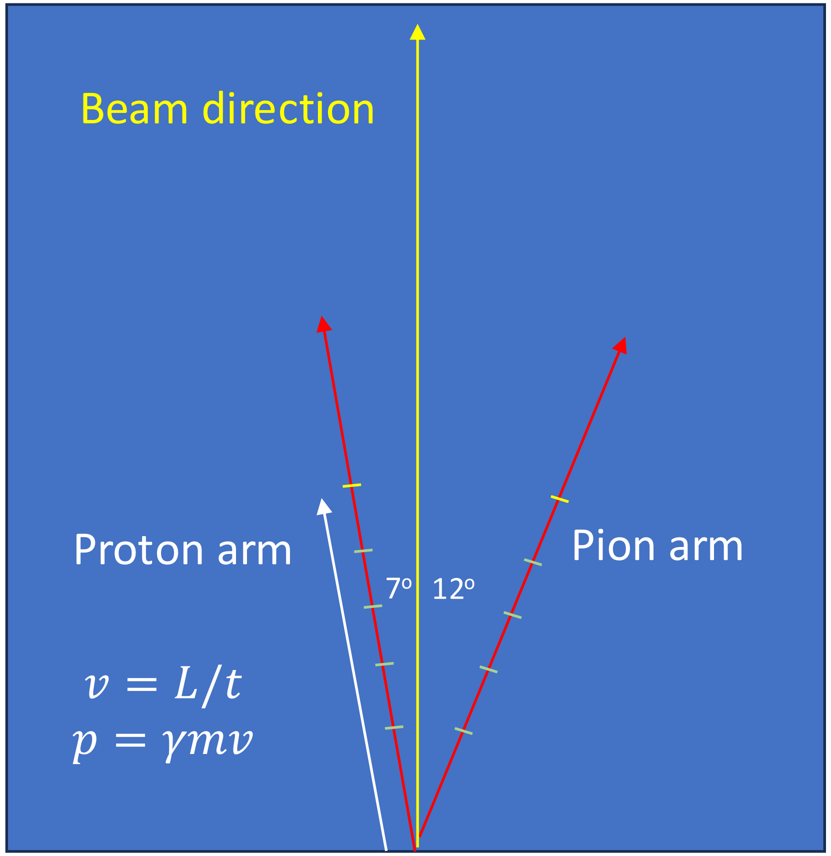


表 1-3·HIAF 验收束流指标

离子		最高能量(GeV/u)	脉冲流强(ppp)
非金属 $^{18}O^{6+}$或 $^{78}Kr^{19+}$任选一	$^{18}O^{6+}$	2.6	1.0×10^{10}
	$^{78}Kr^{19+}$	1.7	7.5×10^{9}
金属 $^{209}Bi^{31+}$或 $^{238}U^{35+}$任选一	$^{209}Bi^{31+}$	0.85	3.0×10^{9}
	$^{238}U^{35+}$	0.8	3.0×10^{9}

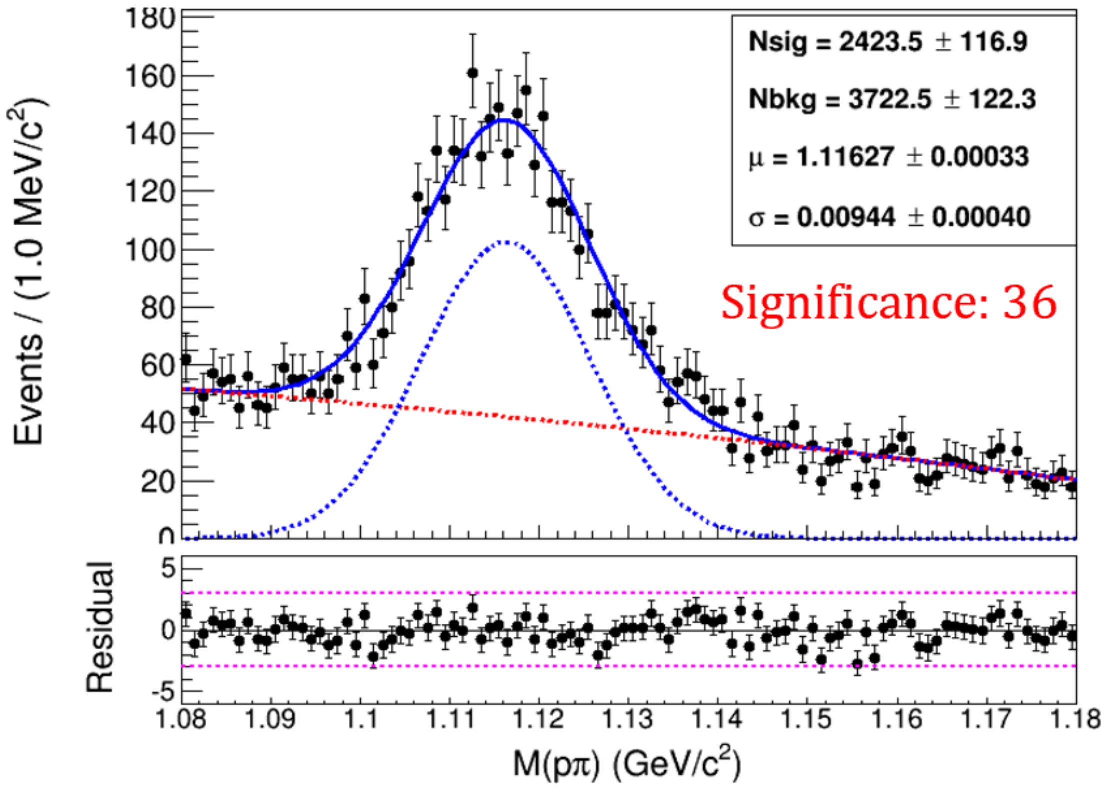
Procedure of Λ reconstruction

- Select the event, in which there are track on both the proton and pion arm
- Assume the track on proton arm is proton, and pion on another arm
- Determine the momentum according to the measured velocity by LGAD
- Calcaulate the invariant mass of the found two particles



Invariant mass of $p\pi$

Flight distance **0.5m**

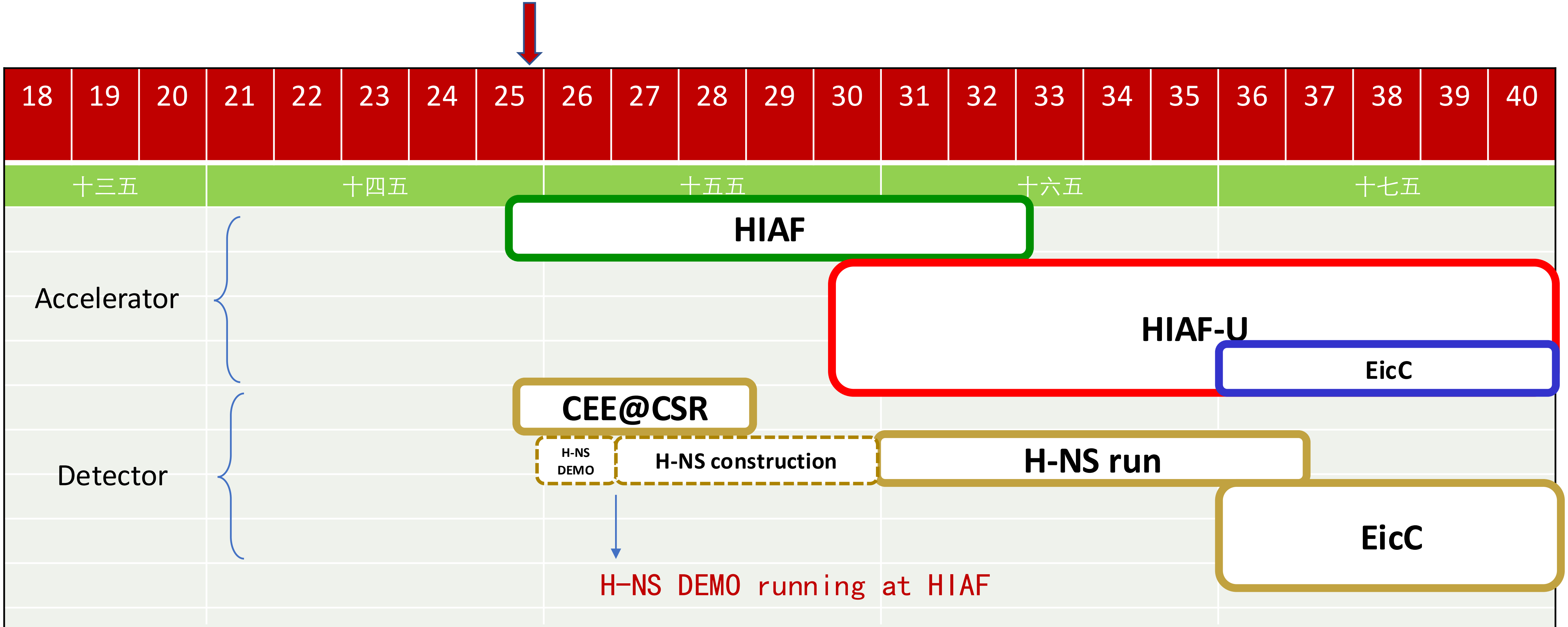


Beam:	$1X10^8$ (pps)
Target:	1% C target
Cross section ratio σ(Λ)/σ(tot):	~ 0.1 %

- Acceptance is enlarged by **a factor of 10**
- 700~800 Lambda in 820M O+C Events(2.6GeV)
- ~Total 0.2 M Lambda in 10M Events
- Efficiency ~ **5 * 10^{-6}**

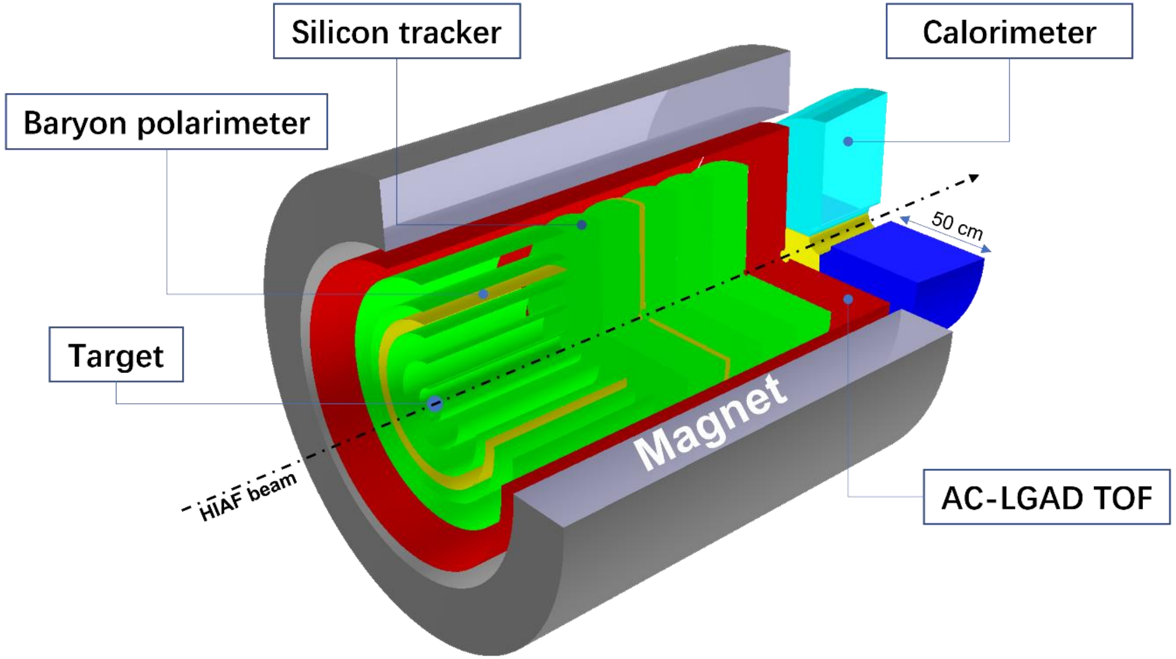
- 10000 Lambda ~ 23 Days

Timeline



A smooth transition from H-NS to EicC, in terms of both physics and hardware

Summary



Institutes in China: 北京航空航天大学、复旦大学、国科大、华中师范大学、华南师范大学、近代物理研究所、清华大学、山东大学、香港中文大学（深圳）、中科大

Subsystems: Silicon tracker, AC-LGAD, Target, Baryon polarimeter, Calorimeter, Electronics, DAQ, Magnet, Beamline, Mechanics + Engineering

I. Physics:

- Λ production and polarization (*p+p*)
  - Medium effect (*p+A*)
  - Global polarization of Λ hyperon (*A+A*)
- Hadron physics via *p+p*

II. Community:

- Supports both communities of hadron structure and heavy-ion physics
- International interests are expected: Japan

III. Detector R&D

- Many parts are similar for CEPC, EicC, H-NS and STCF. Save resources.
- HNS: a detector R&D platform for EicC, ½ EicC

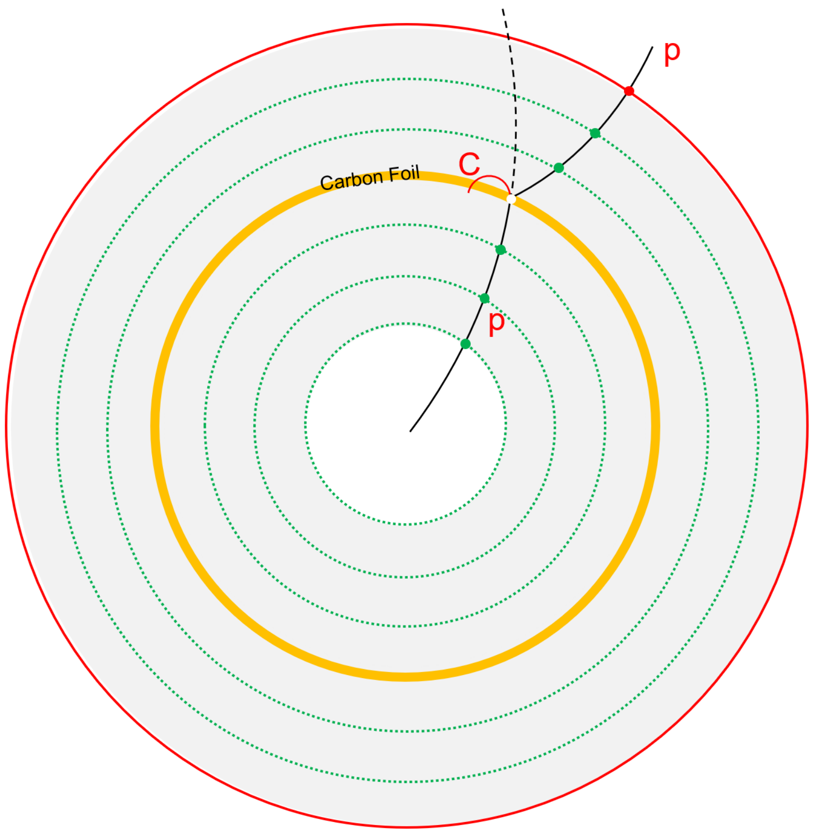
Thank you !

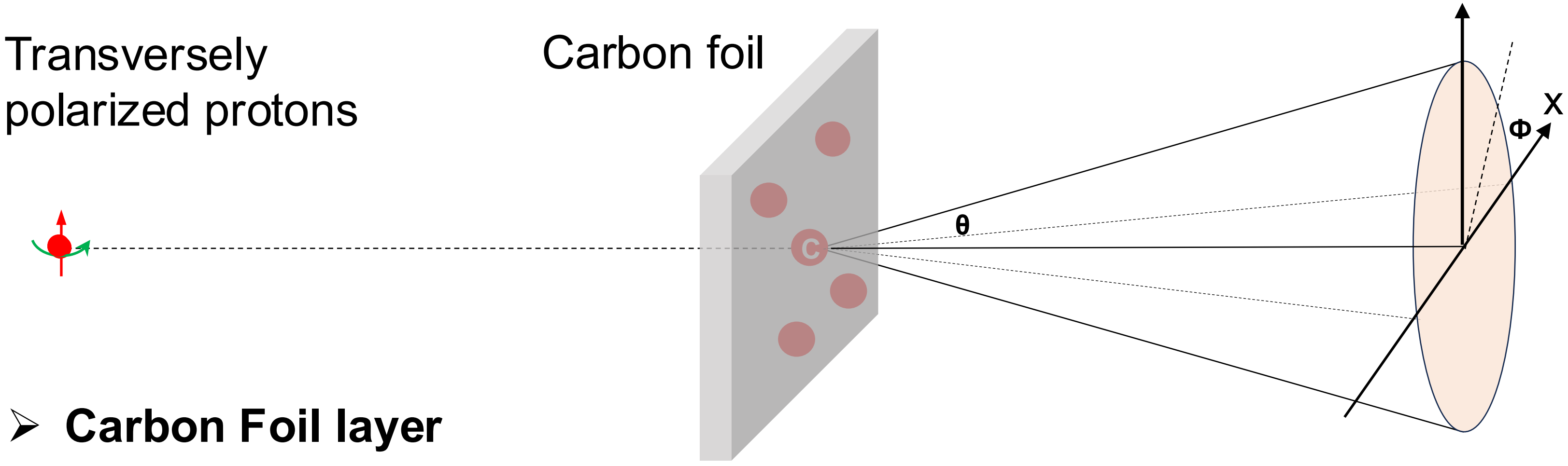
backups

Baryon polarimeter

Determining proton polarization via elastic scattering

$$\frac{d\sigma}{d\phi d\cos\theta} = \frac{1}{2\pi}\frac{d\sigma_0}{d\cos\theta}\left[1 + \underline{P_y A_N(\theta)}\cos\phi\right]$$



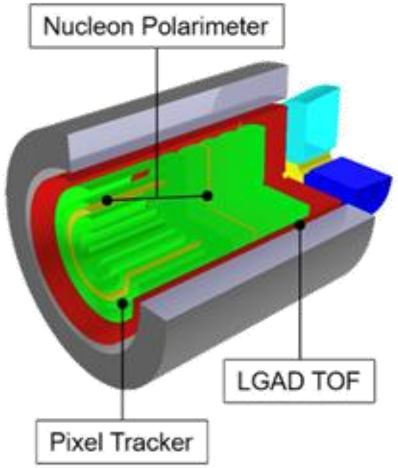


- **Carbon Foil layer**
  - **~1 mm thickness**
  - **Material budget: <1% X/X_0**
  - **Probability: pC (1E-3)**
- **Position : in-between the tracking devices**

Detailed in YuTie's talk on 26th!

Y. T. Liang et. al. Phys. Rev. D 112, L031502 (2025)

Projection of Λ and proton polarization



H-NS

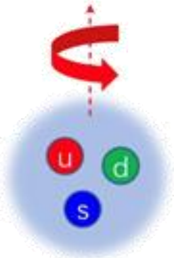
Reaction: p+p

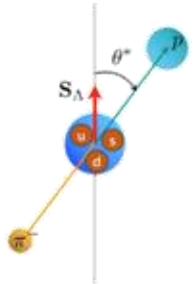
Event rate:1MHz

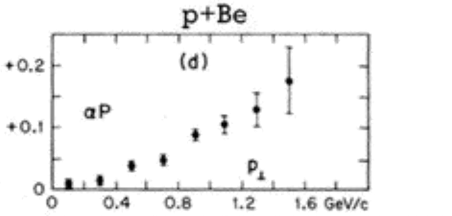
Time: 3 months

- pp → Λ+X N ~ 10^{11}
- pp → p+X N ~ 10^{13}
- pp → pKΛ N ~ 10^{10}

$pp \to \Lambda + X$ $\sigma_{stat.} < 0.01$ 2D:400 bins

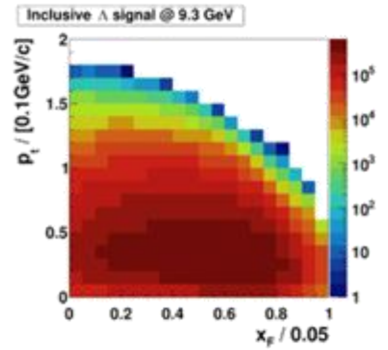


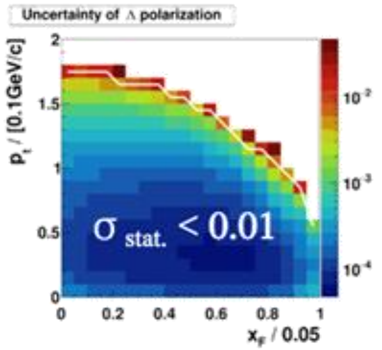




G.Bunce, *et al.*: Phys.Rev.Lett. 36, 1113-1116 (1976)

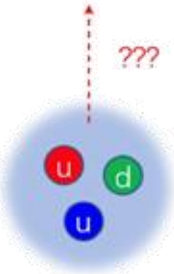
Λ polarization

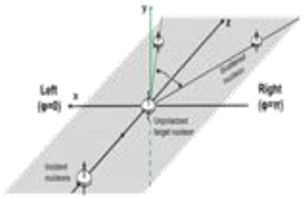


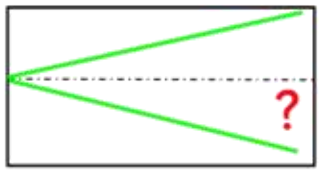


$pp \to p + X$ $\sigma_{stat.} < 0.02$ 2D:400 bins

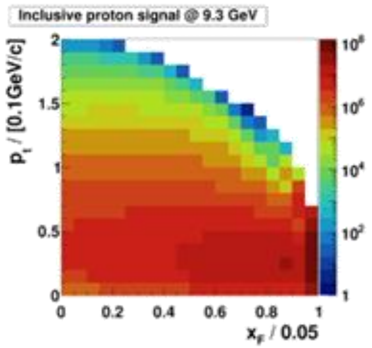
pC scattering ~ 10^{13} * $4*10^{-4}$ = $4*10^{9}$

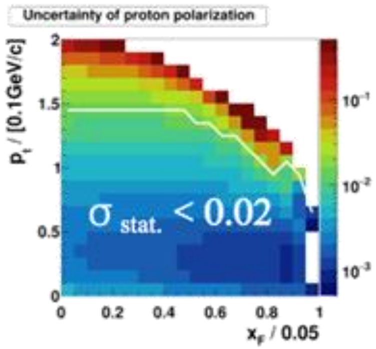




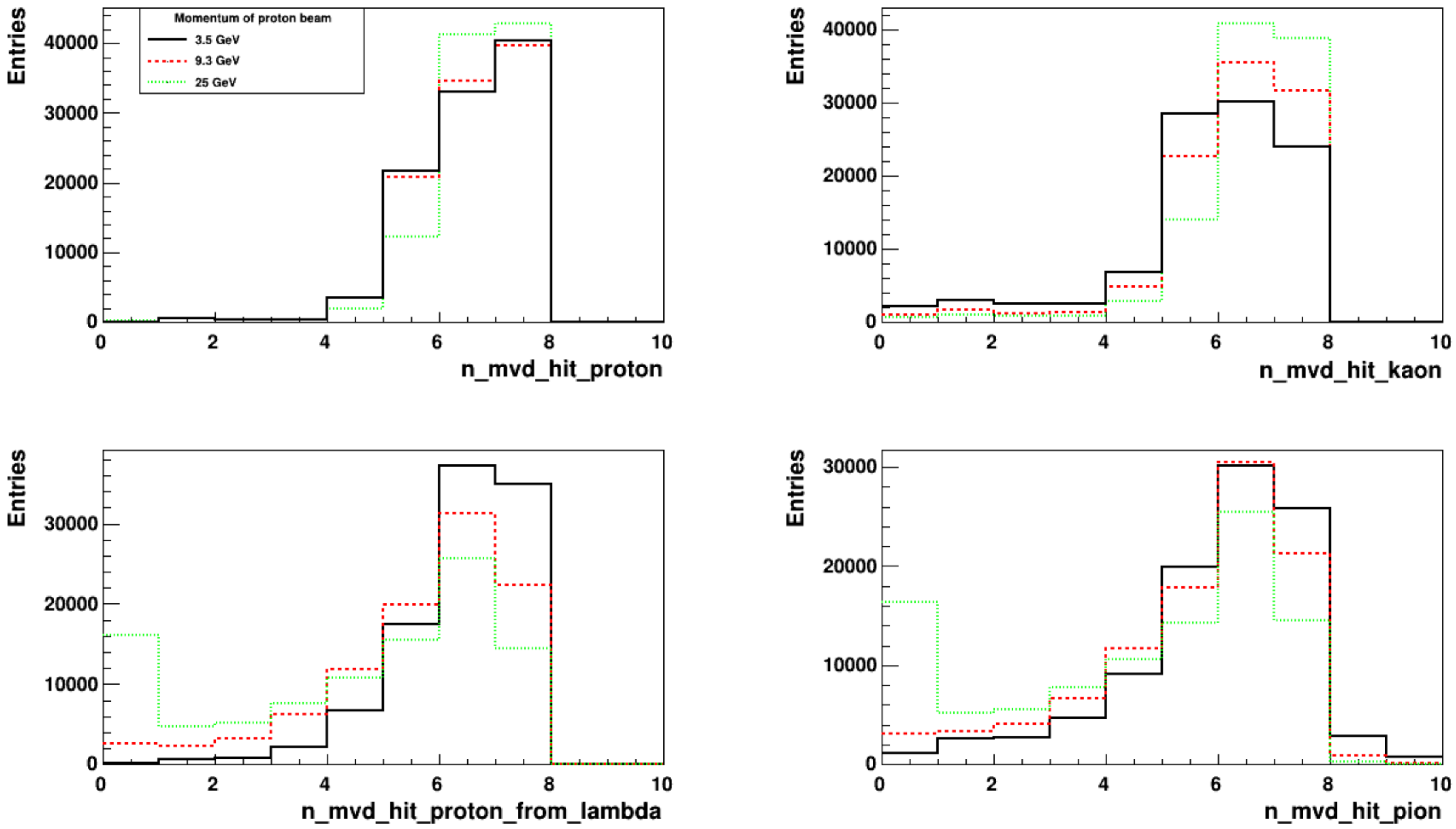


proton polarization

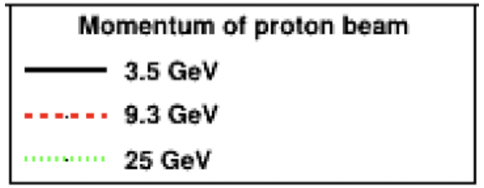




Efficiency due to tracking

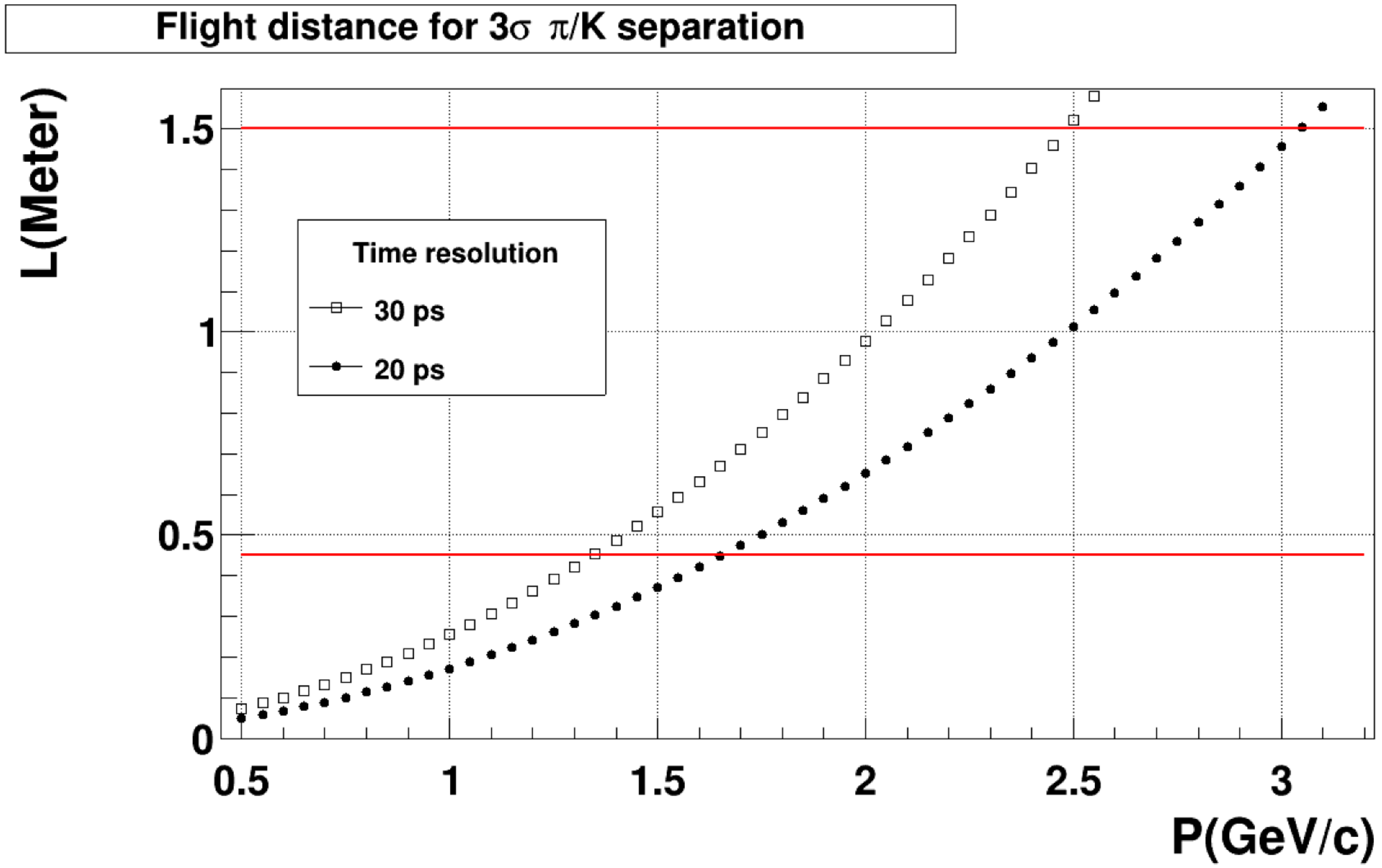


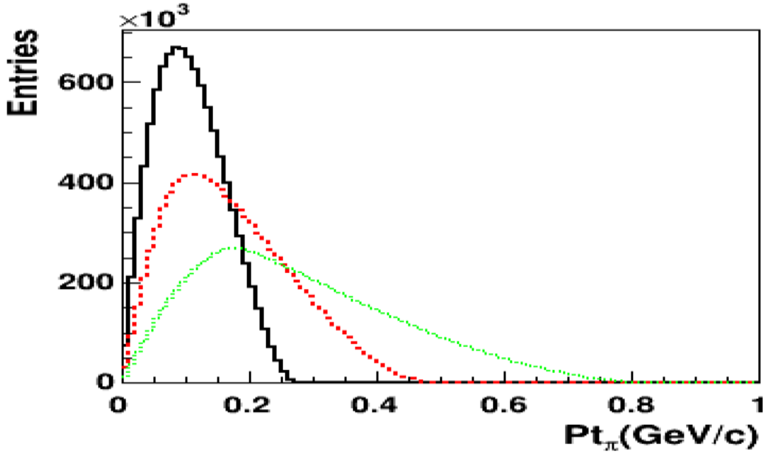
$$\varepsilon = \frac{N_{\mathrm{hits}\geq 4}}{N_{\mathrm{all}}}$$

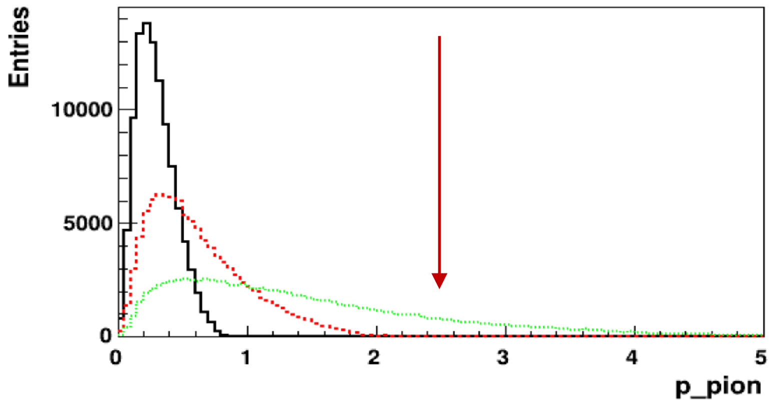


E beam	$\varepsilon(p)$	ε(K)	$\varepsilon(\pi)$ (Λ)	$\varepsilon(p)$ (Λ)	$\varepsilon(Event)$
3.5GeV	98%	89%	88%	96%	76%
9.3GeV	98%	95%	82%	86%	74%
25GeV	98%	96%	65%	66%	60%

PID performance: pion/kaon

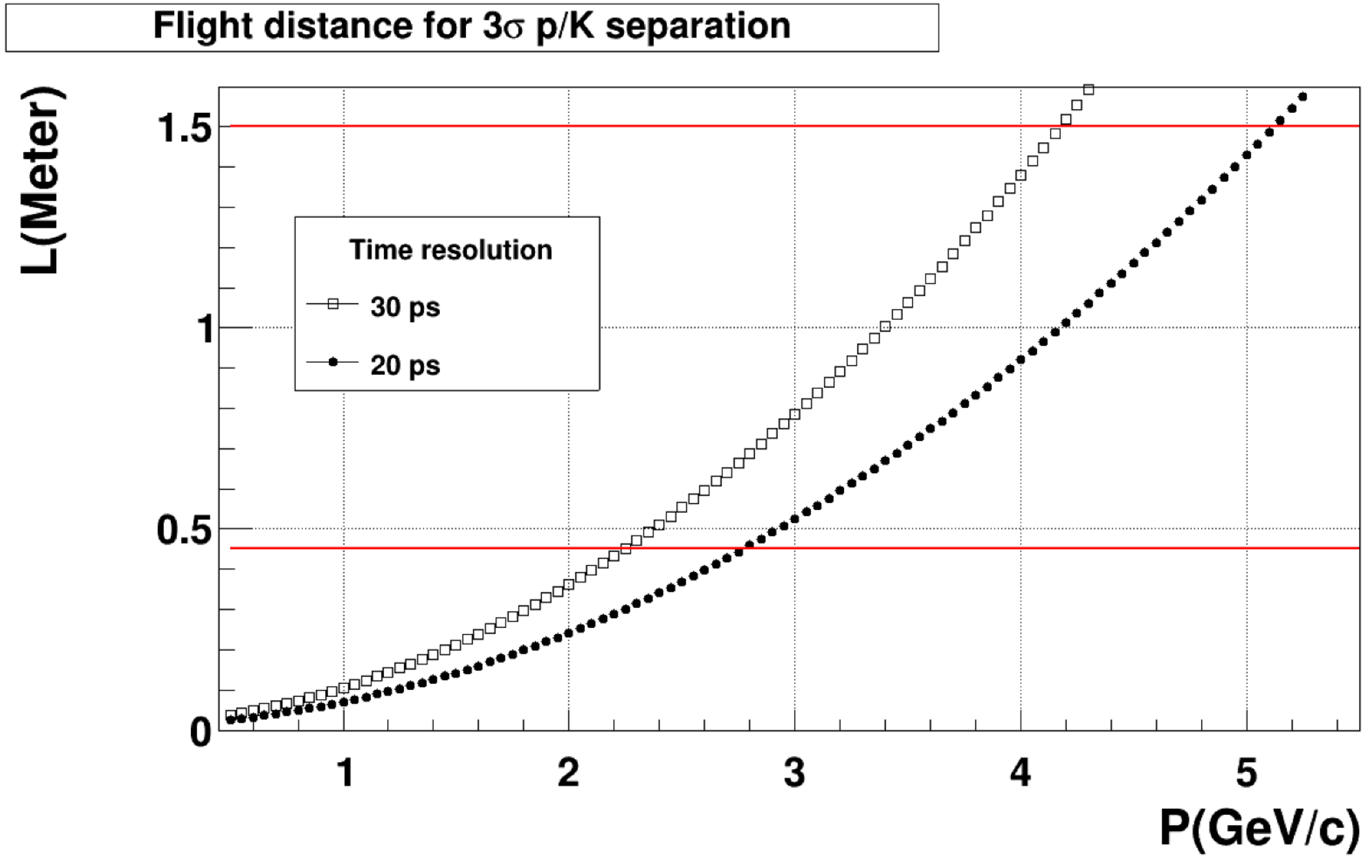


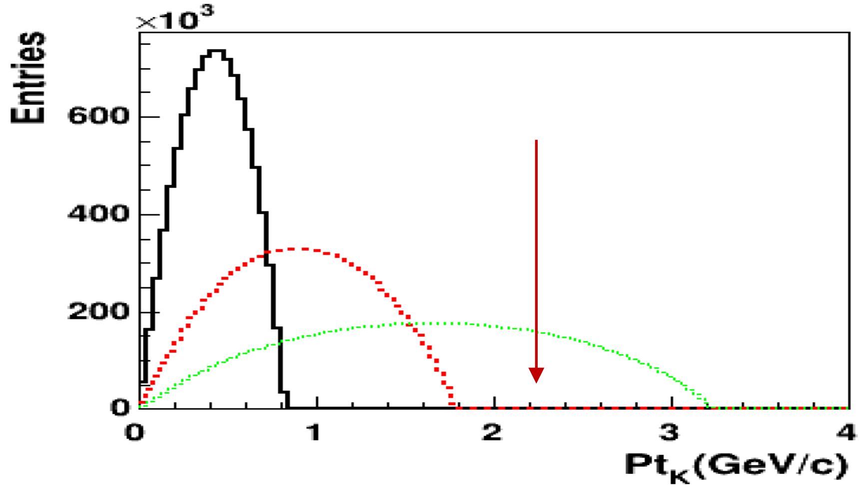


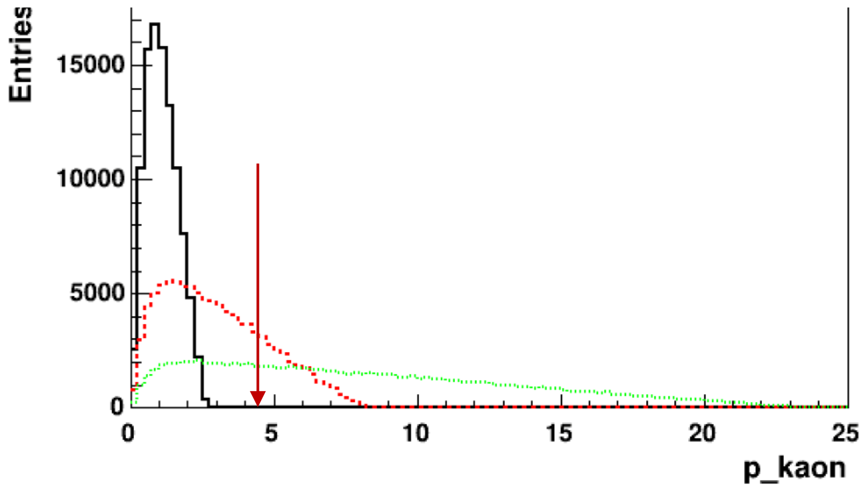


Assume a resolution of 30 ps:
LGAD barrel (R=45cm), can cover a Pt up to 1.35 GeV/c
LGAD endcap (Z=150) can up to 2.5 GeV/c

PID performance: proton/kaon

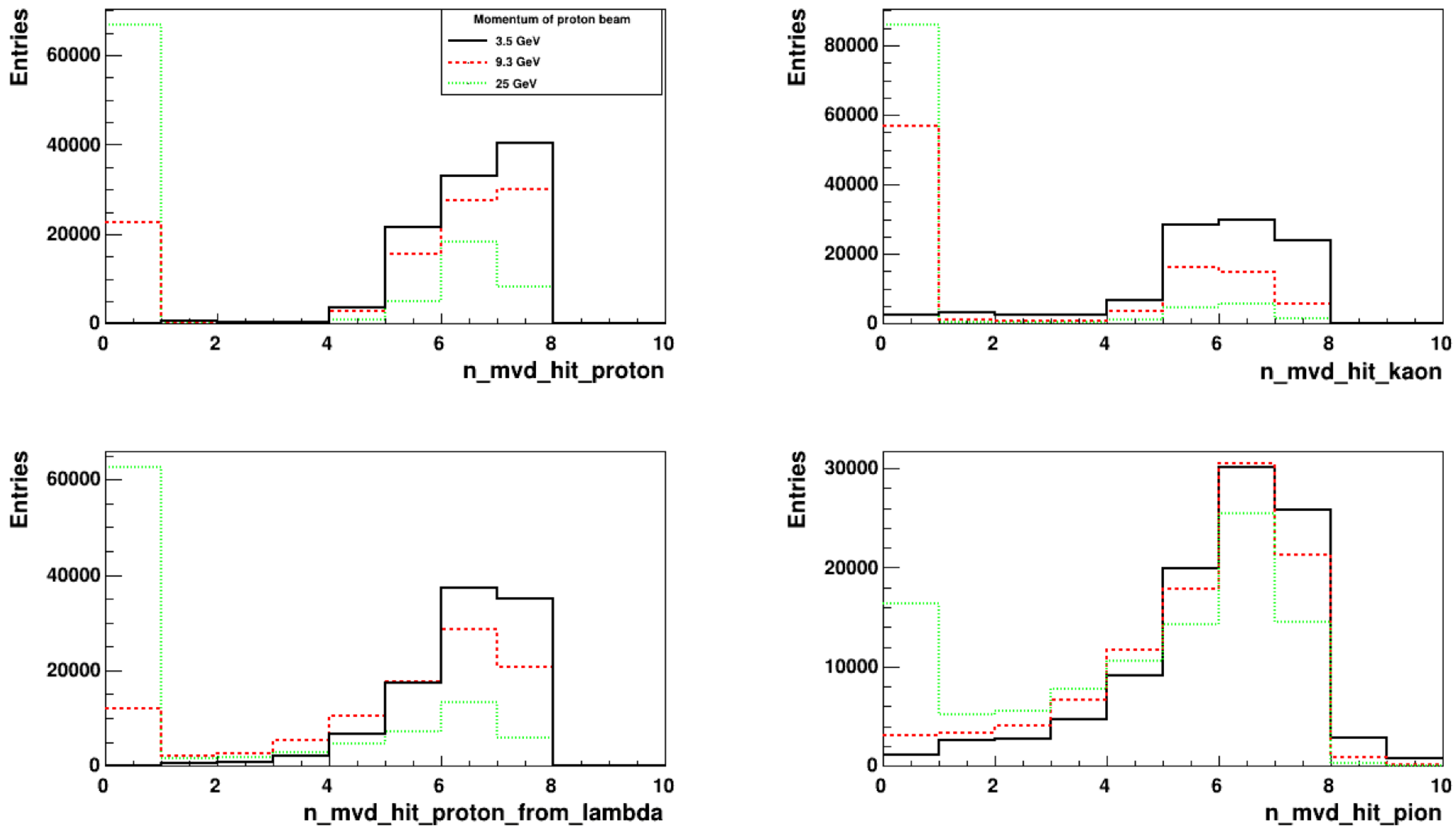






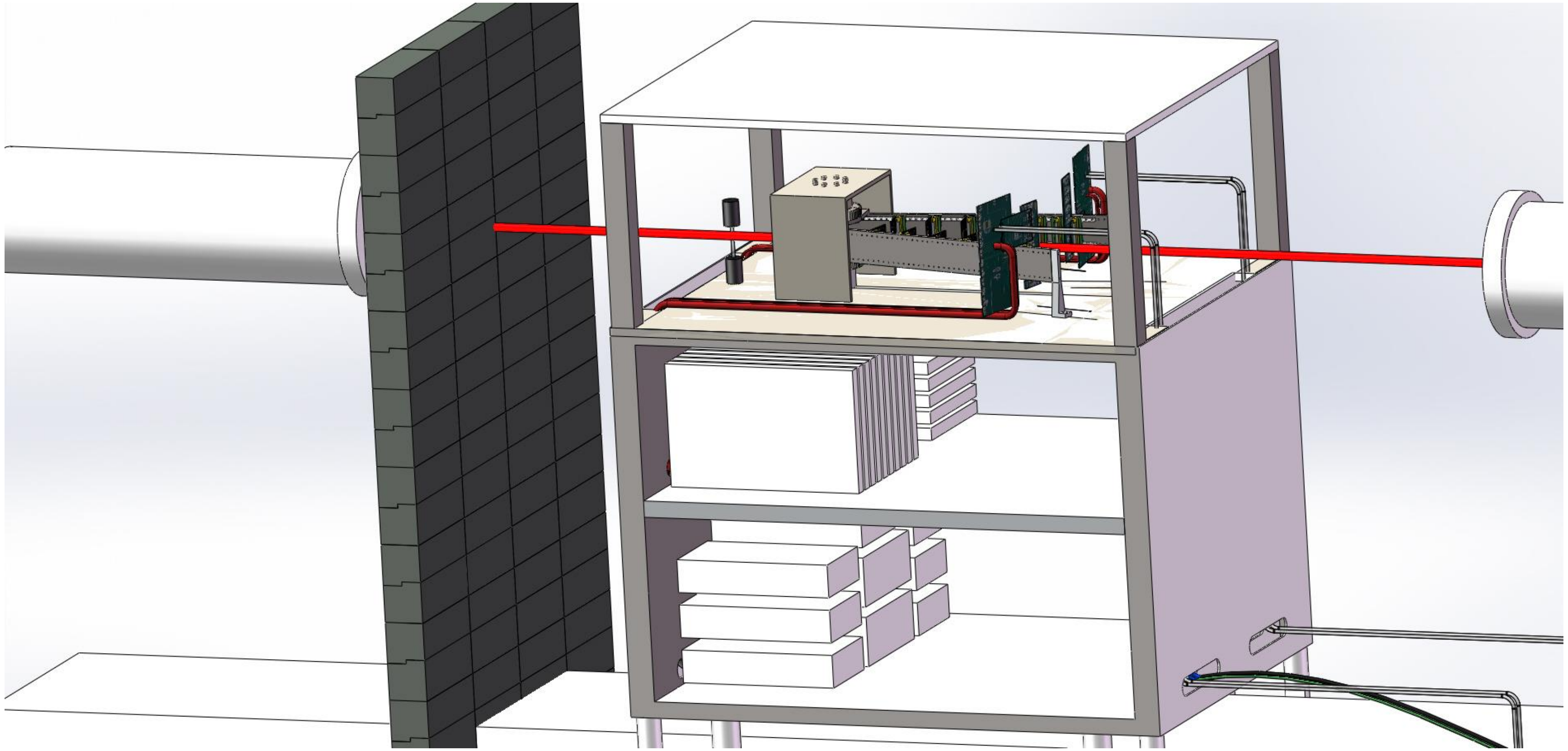
Assume a resolution of 30 ps:
LGAD barrel, (R=45cm), can cover a Pt up to 2.25 GeV/c
LGAD endcap, (Z=150) can up to 4.2 GeV/c

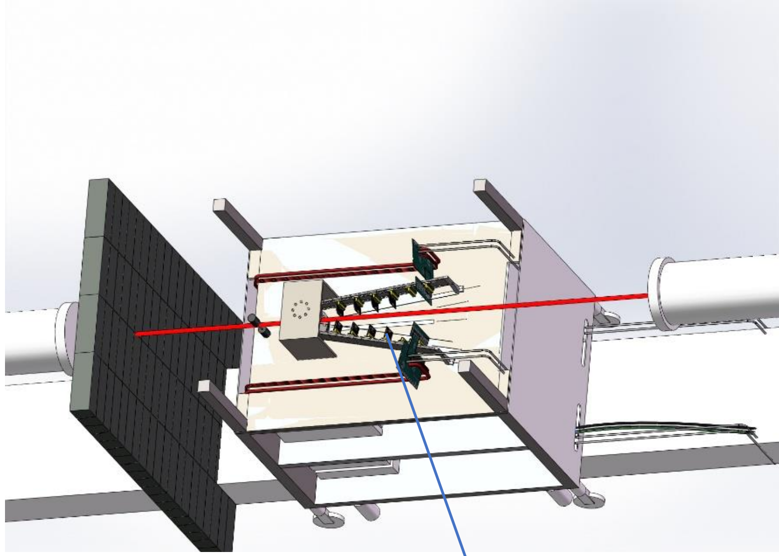
Efficiency due to PID+tracking

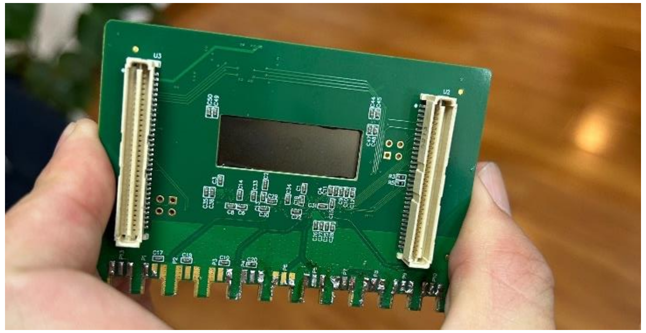


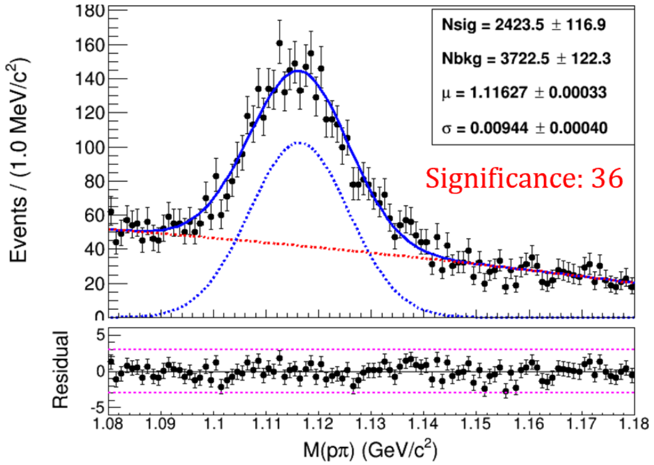
E beam	$\varepsilon(p)$	ε(K)	$\varepsilon(\pi)$ (Λ)	$\varepsilon(p)$ (Λ)	$\varepsilon(Event)$
3.5GeV	98%→98%	89%→89%	88%→88%	96%→96%	76%→76%
9.3GeV	98%→76%	95%→40%	82%→82%	86%→77%	74%→20%
25GeV	98%→32%	96%→13%	65%→65%	66%→31%	60%→1.5%

H-NS demo: H-NS0



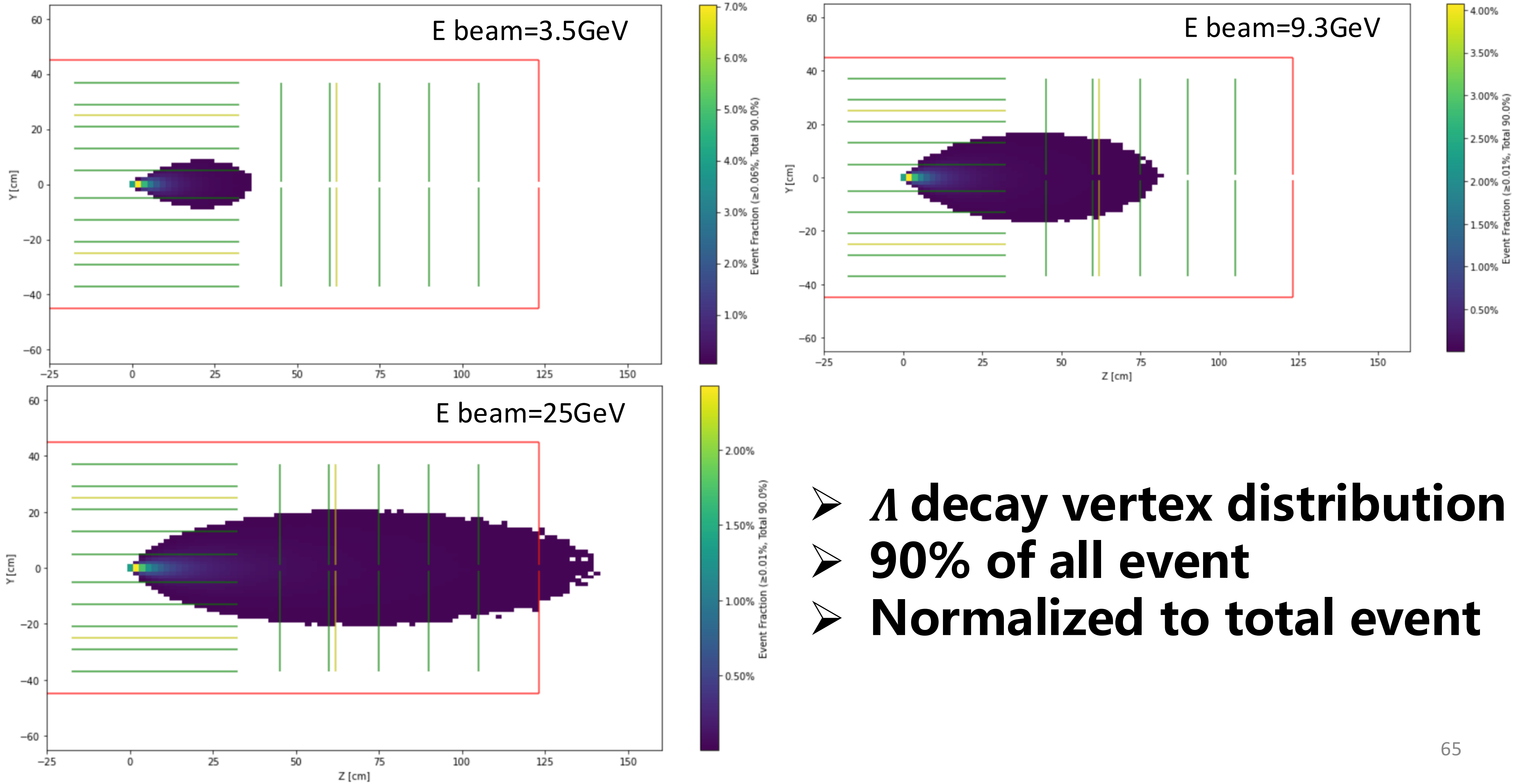






H-NS0 will be ready and tested at HIAF next year

Efficiency due to tracking

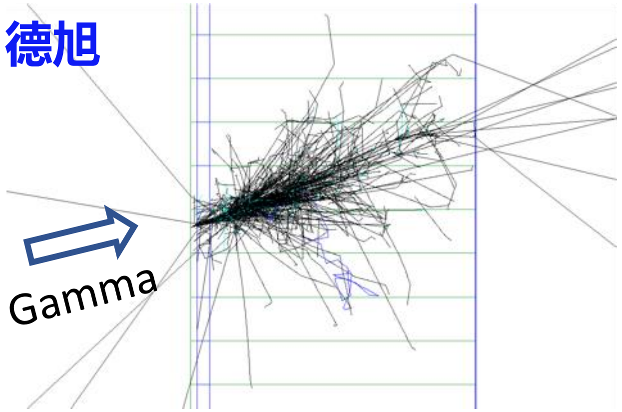


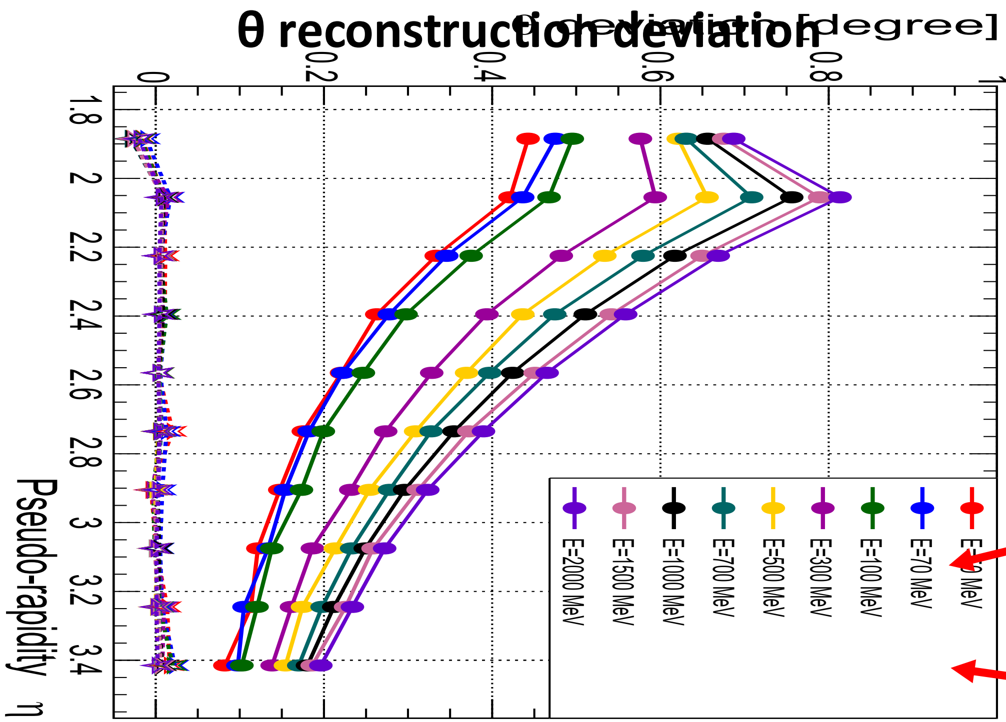
- ➢ ***Λ* decay vertex distribution**
- ➢ **90% of all event**
- ➢ **Normalized to total event**

Comparison of angular reconstructions of the two detector settings

田野，德旭

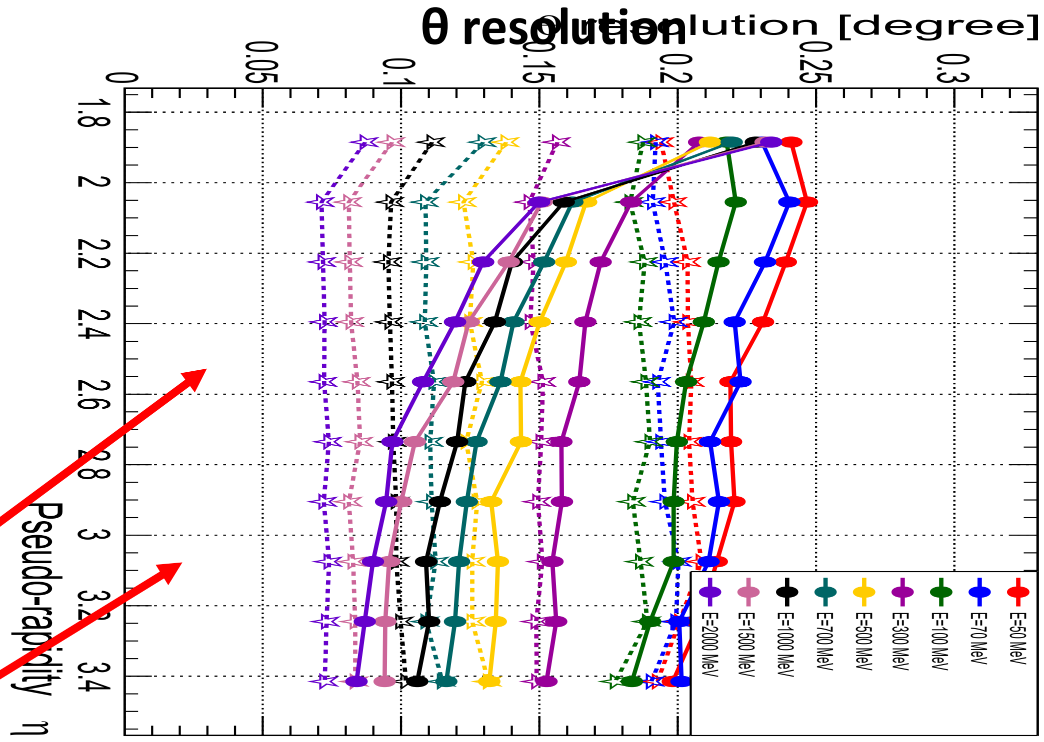
梯台状	优势	**角度重建更好**
	缺点	阵列的1/4模块形状不同，**加工难度大**，没有类似成熟设计
长方体	优势	**加工**简便
	缺点	**角分辨率差**，角度重建有偏差（可以修正）



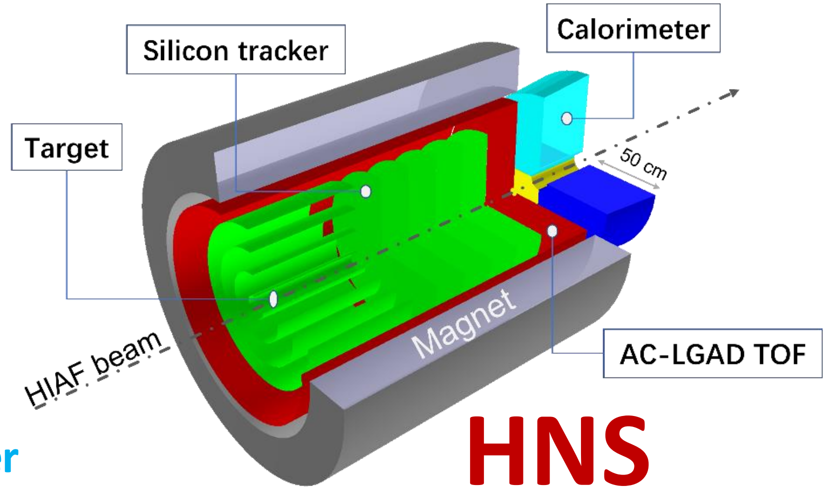


长方体

梯台状



ϑ 定义为粒子与束流间的夹角



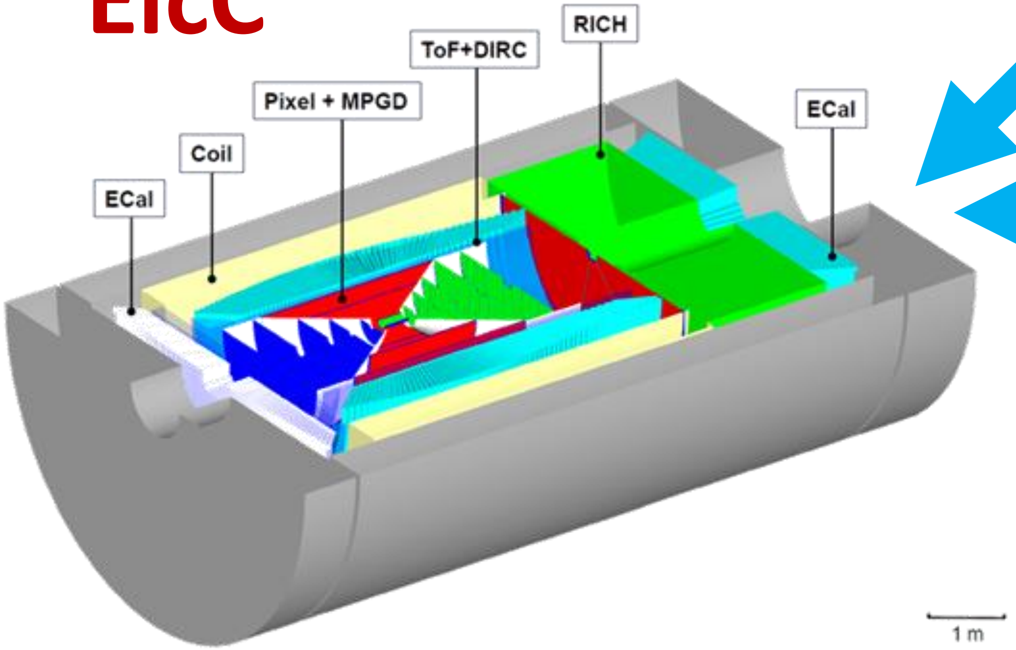
HNS

Silicon tracker
AC-LGAD (PID)
Ecal.
Super-conducting Solenoid

Silicon tracker
Ecal.
Super-conducting Solenoid

STCF

EicC



Silicon tracker
MPGD tracker
DIRC (PID)
RICH (PID)
Ecal
Super-conducting Solenoid