

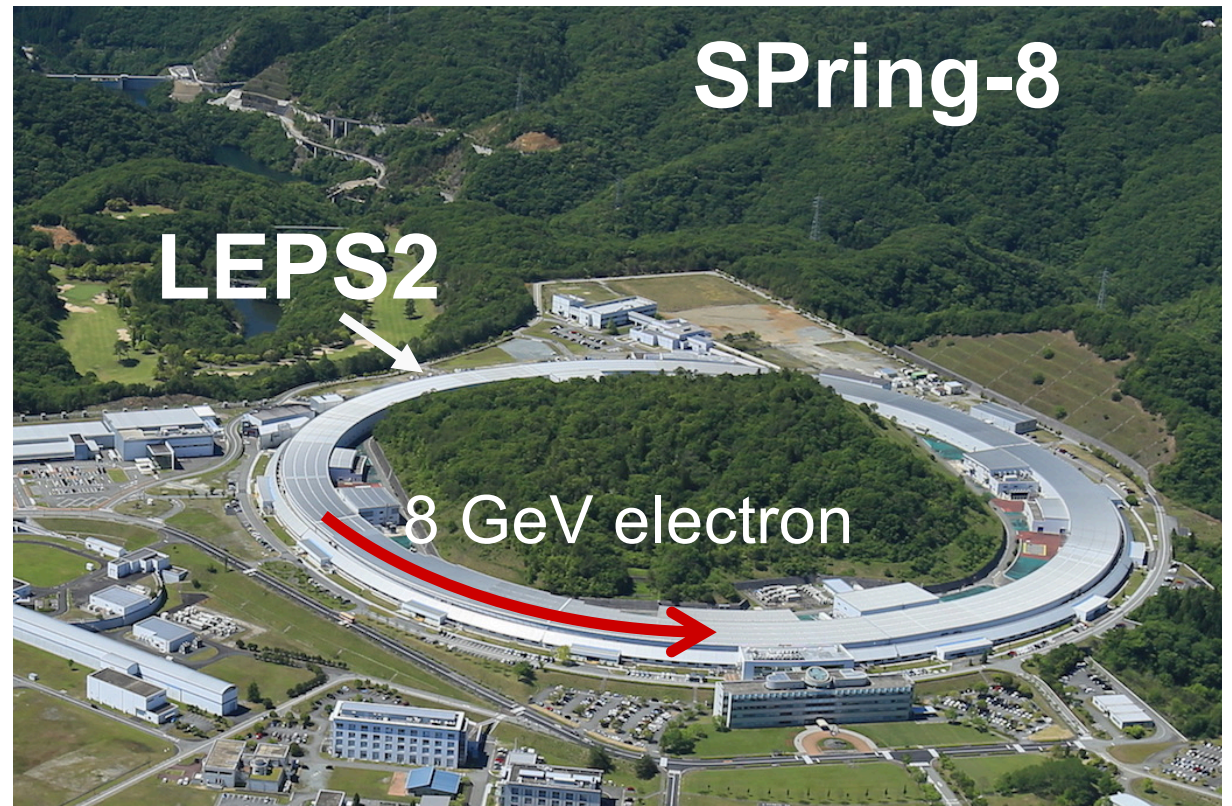
Status and Prospects of the LEPS2 Solenoid Spectrometer

M. Niyama (Kyoto Sangyo Univ.)

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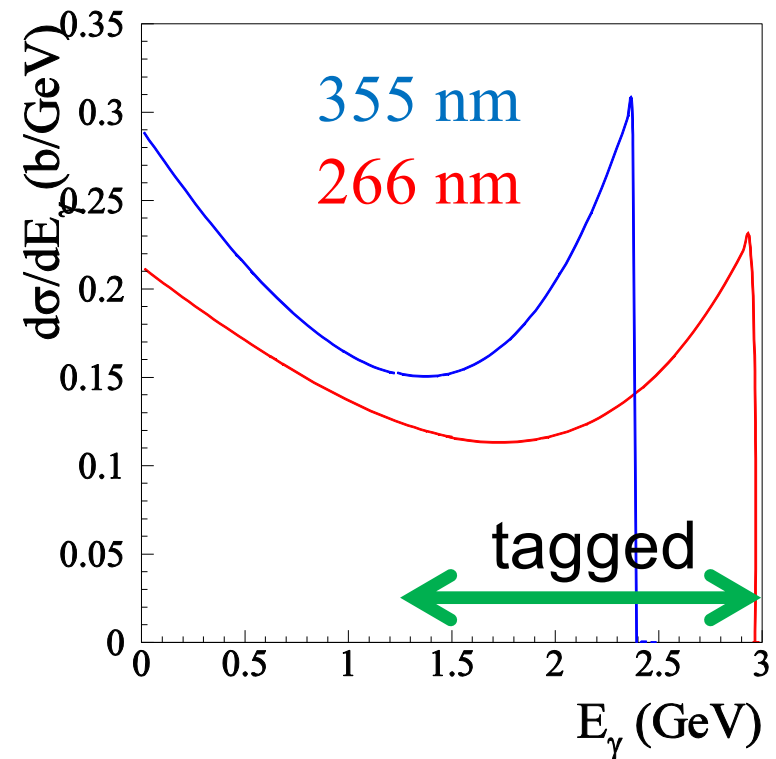
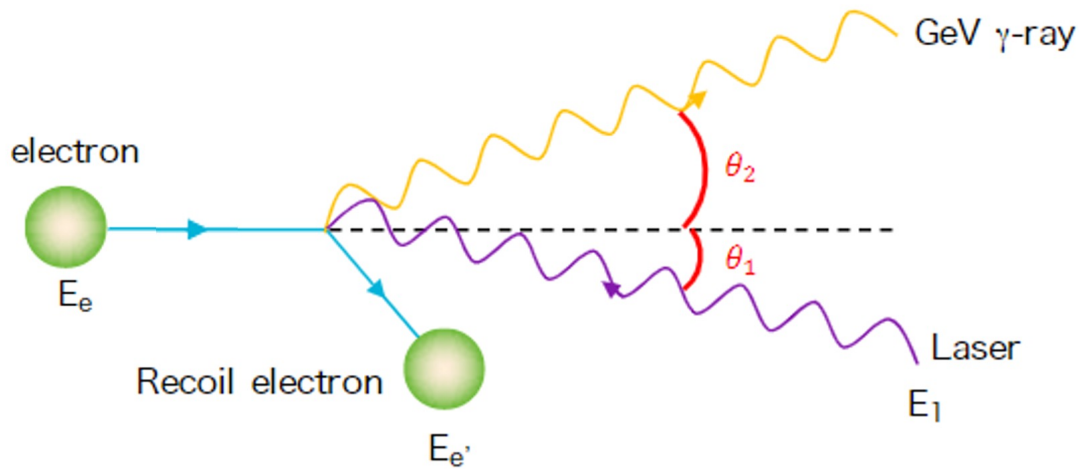
- SPring-8/LEPS2
- Physics motivations
- Solenoid spectrometer
- First physics runs
- Summary

Super Photon Ring 8 GeV (SPring-8)



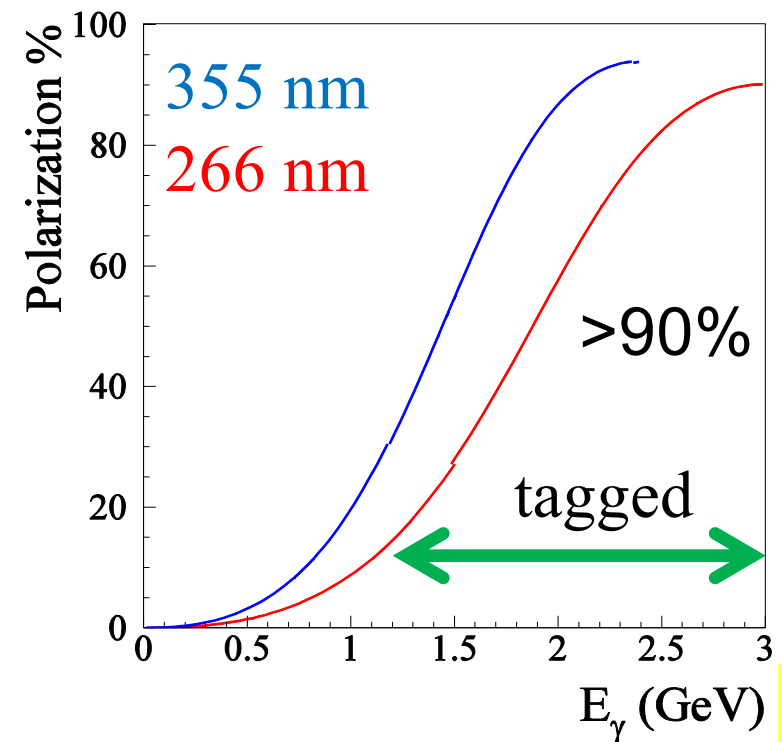
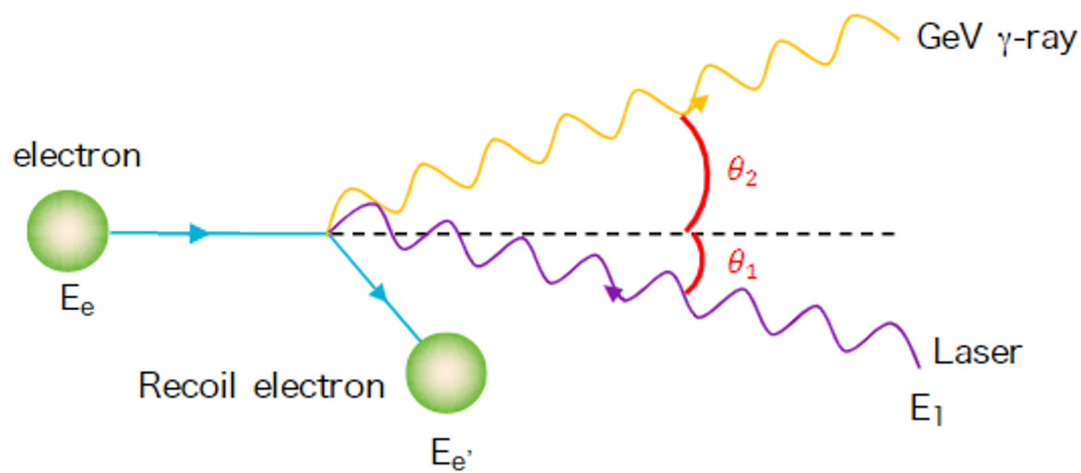
Backward Compton Scattered Photon

- ◆ 8-GeV electrons in SPring-8
 - ◆ 355 nm laser → 1.3- **2.4 GeV** tagged photon
 - ◆ 266 nm laser → 1.3- **2.9 GeV** tagged photon
- ◆ Beam intensity ~1.5-2 Mcps (2.4 GeV)
- ◆ E_γ by tagging a recoil electron **E_γ resolution 10~12 MeV**



Backward Compton Scattered Photon

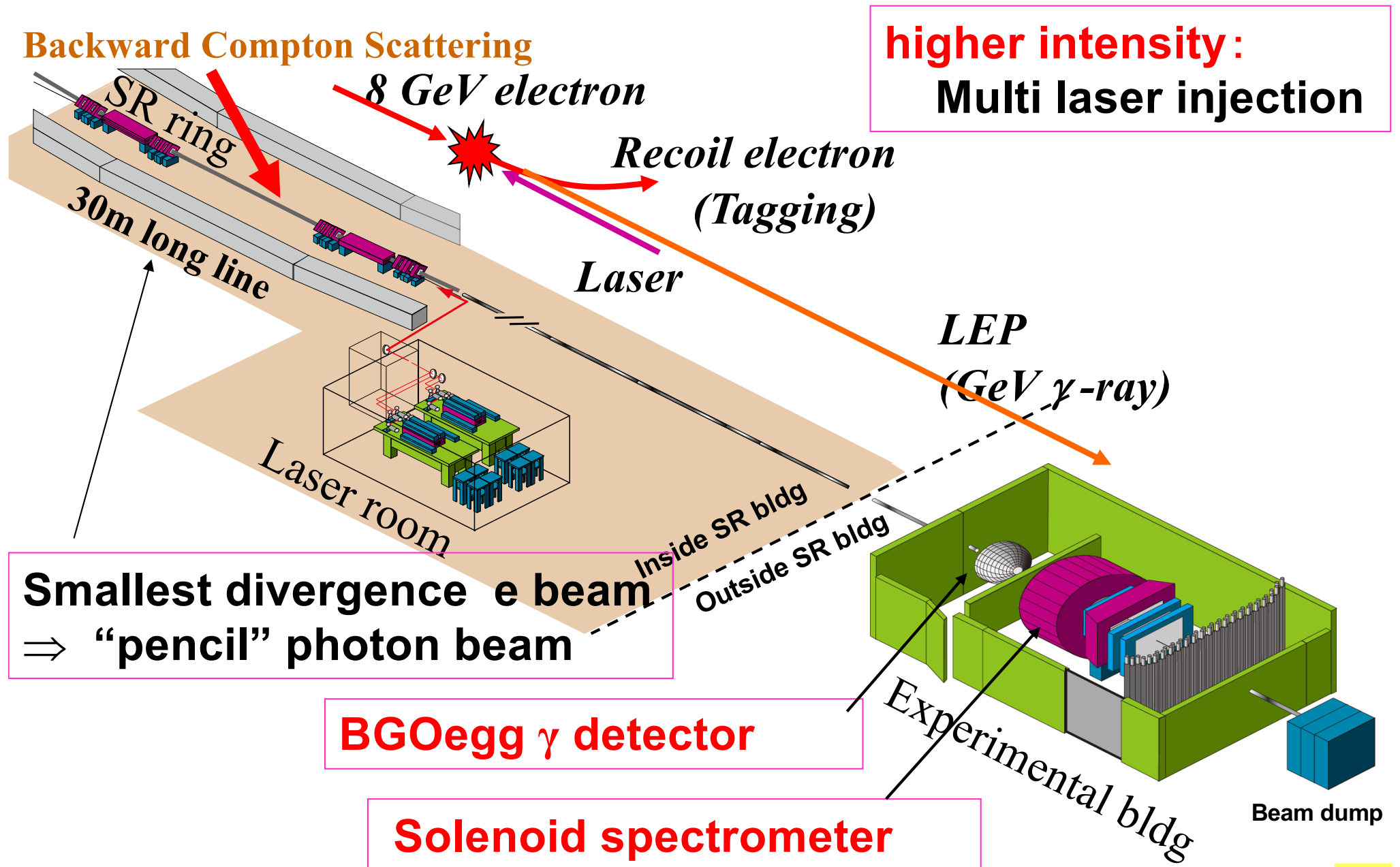
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- ◆ Beam intensity ~1.5-2 Mcps (2.4 GeV)
- ◆ E_γ by tagging a recoil electron **E_γ resolution 10~12 MeV**
- ◆ Laser polarization 95-100% ⇒ **Highly polarized γ beam**



Laser injection system



Schematic view of the LEPS2 facility

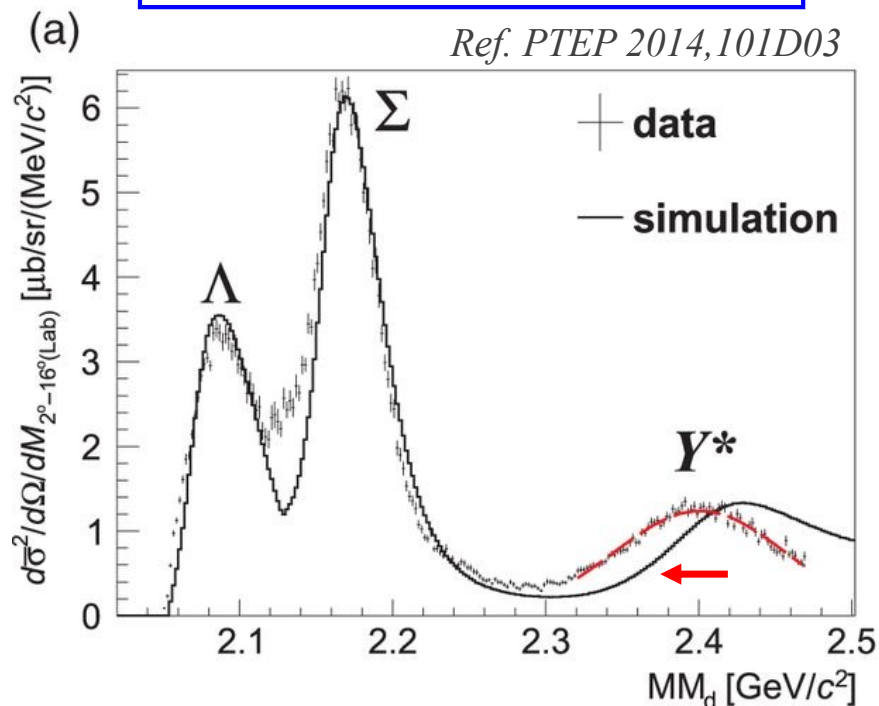


Physics motivations

Physics motivation I

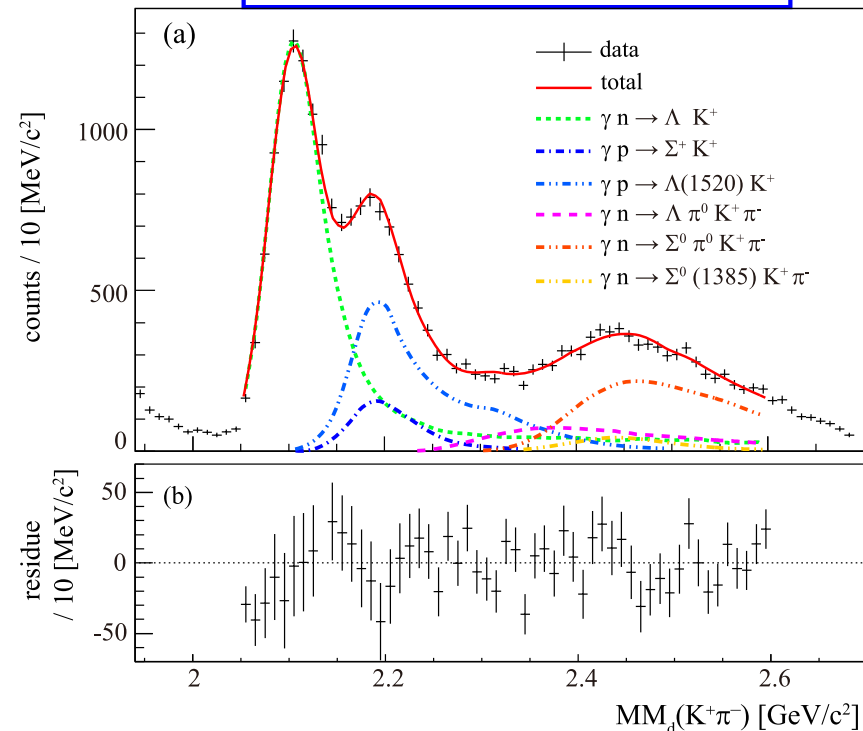
deeply bound $\bar{K}NN$ state

MM $d(\pi^+, K^+)$ *J-PARC E27*



30 MeV shift was observed
in Y^* region
(caused by Y^*N interaction?)

MM $d(\gamma, K^+\pi^-)$ *LEPS*



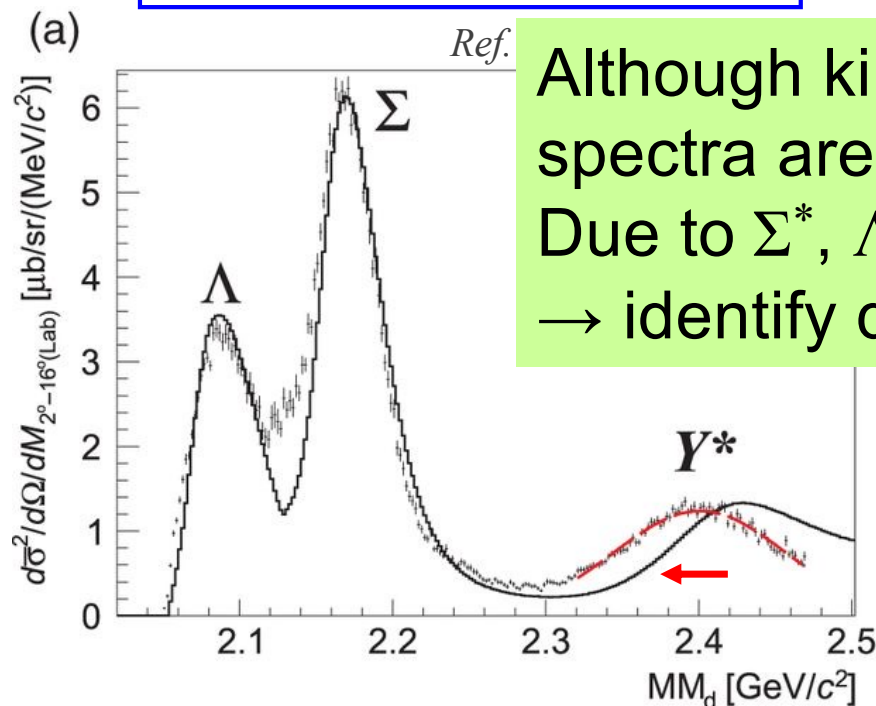
no shift was observed in Y^*
region

Physics motivation I

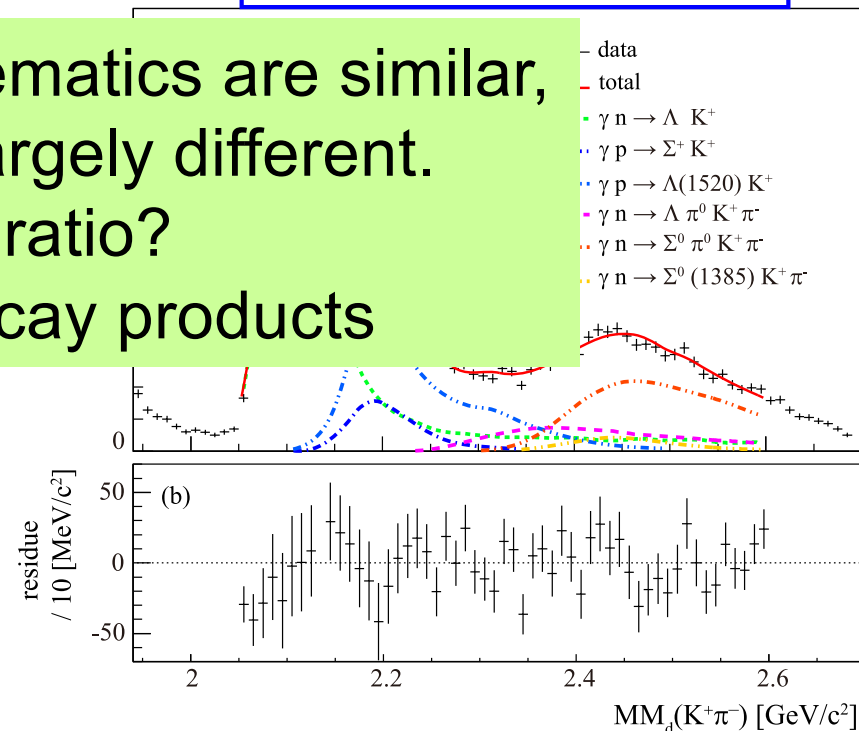
deeply bound $\bar{K}NN$ state

MM $d(\pi^+, K^+)$ *J-PARC E27*

MM $d(\gamma, K^+\pi^-)$ *LEPS*



Although kinematics are similar,
spectra are largely different.
Due to Σ^* , Λ^* ratio?
→ identify decay products



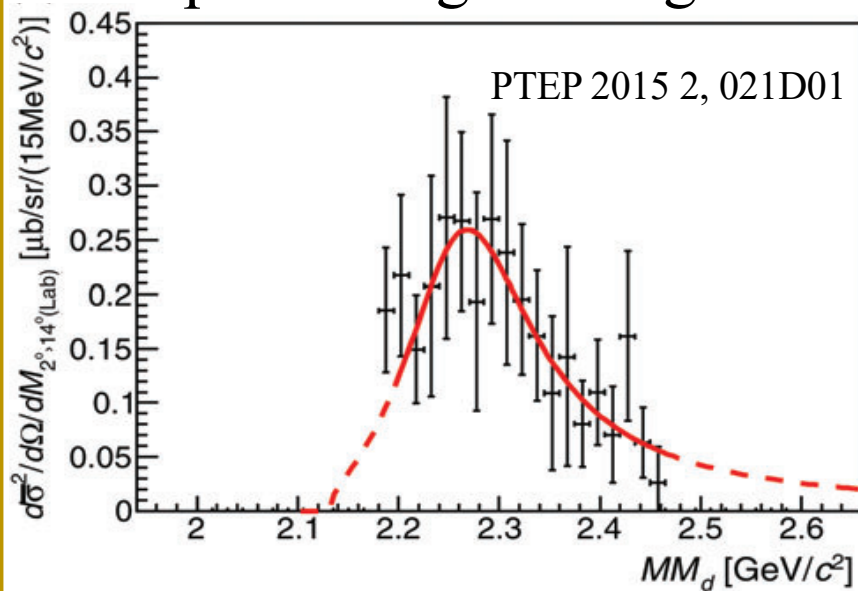
30 MeV shift was observed
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region

Kaonic nuclei search at LEPS2

J-PARC E27

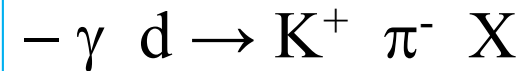
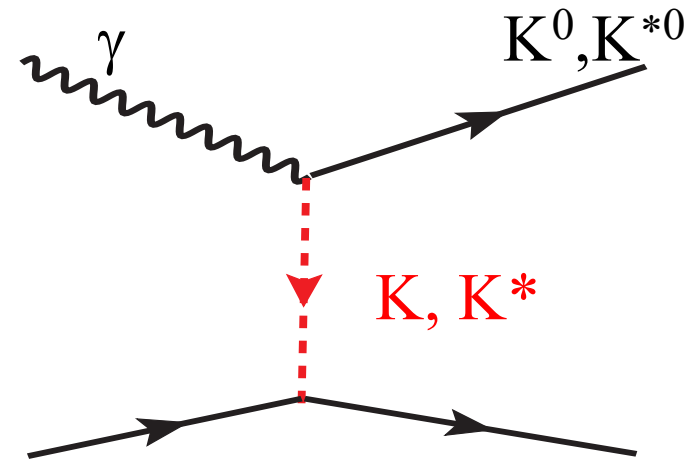
$d(\pi^+, K^+)X$
decay proton-tagged
 $\Sigma^0 p$ ID using missing mass.



$$B.E. = 95^{+18}_{-17} \text{ } ^{+30}_{-21} \text{ MeV}$$

$$\Gamma = 162^{+87}_{-45} \text{ } ^{+66}_{-78} \text{ MeV}$$

LEPS2



☆ detect decay products

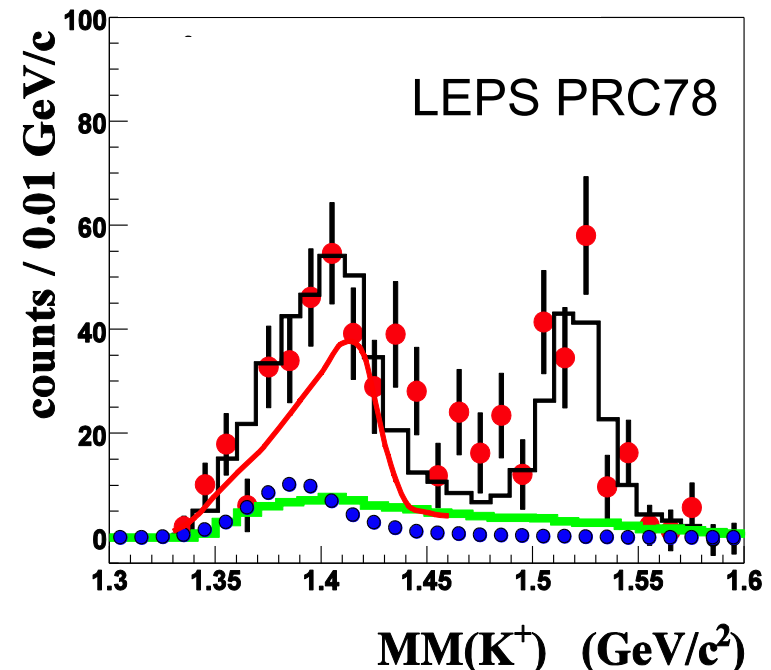
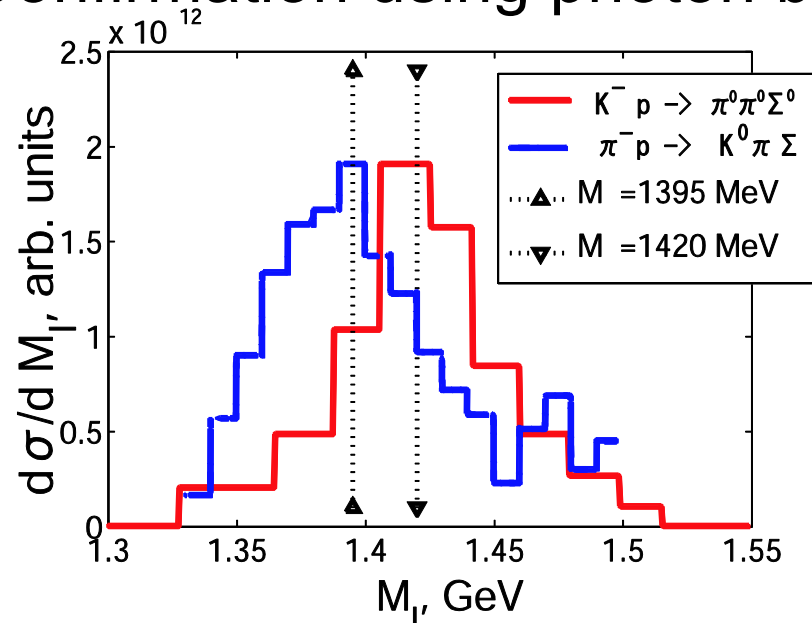
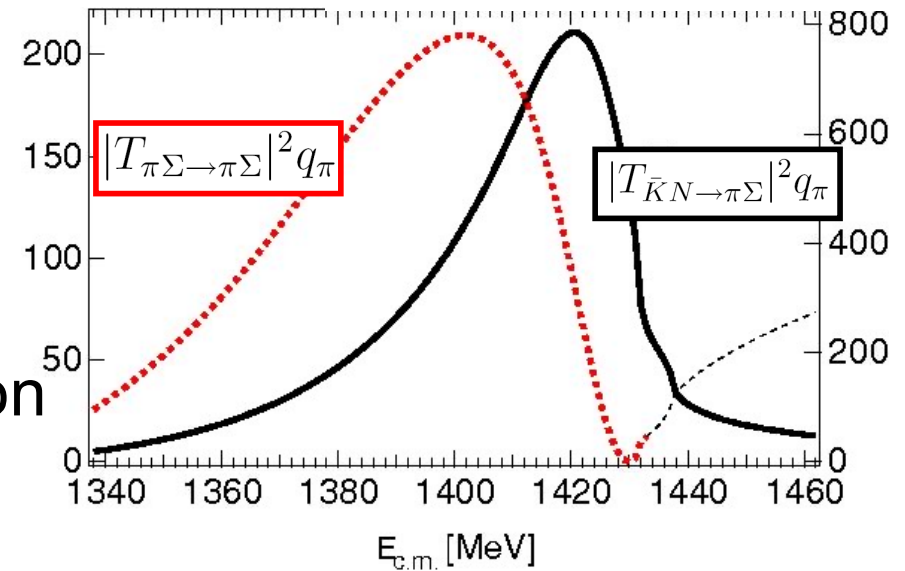
$$X = \Lambda p, \Sigma^0 p$$

Physics motivation II

Two pole structure of $\frac{1}{2}^- \Lambda$'s

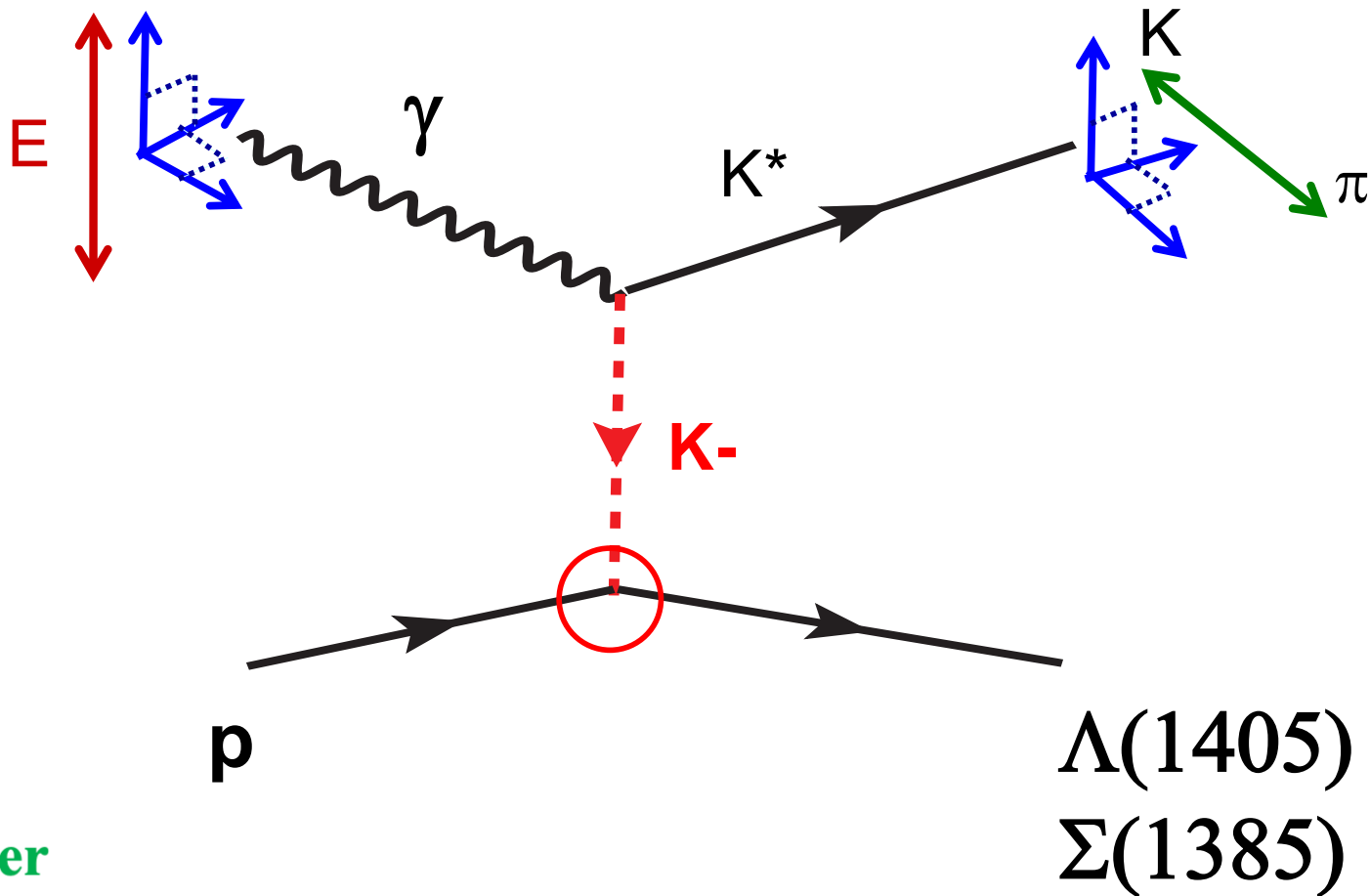
- lower pole : $\Lambda(1380)$
 - dominantly : $\pi\Sigma$
- higher pole : $\Lambda(1405)$
 - dominantly : $\bar{K}N$
- Peak positions of $M(\pi\Sigma)$ depend on reactions?
- Confirmation using photon beam

D. Jido, et al. NPA725(2003)



V.K. Magas, E. Oset and A. Ramos, PRL 95

$K^*(890) \Lambda(1405)$ photoproduction with linearly polarized photon

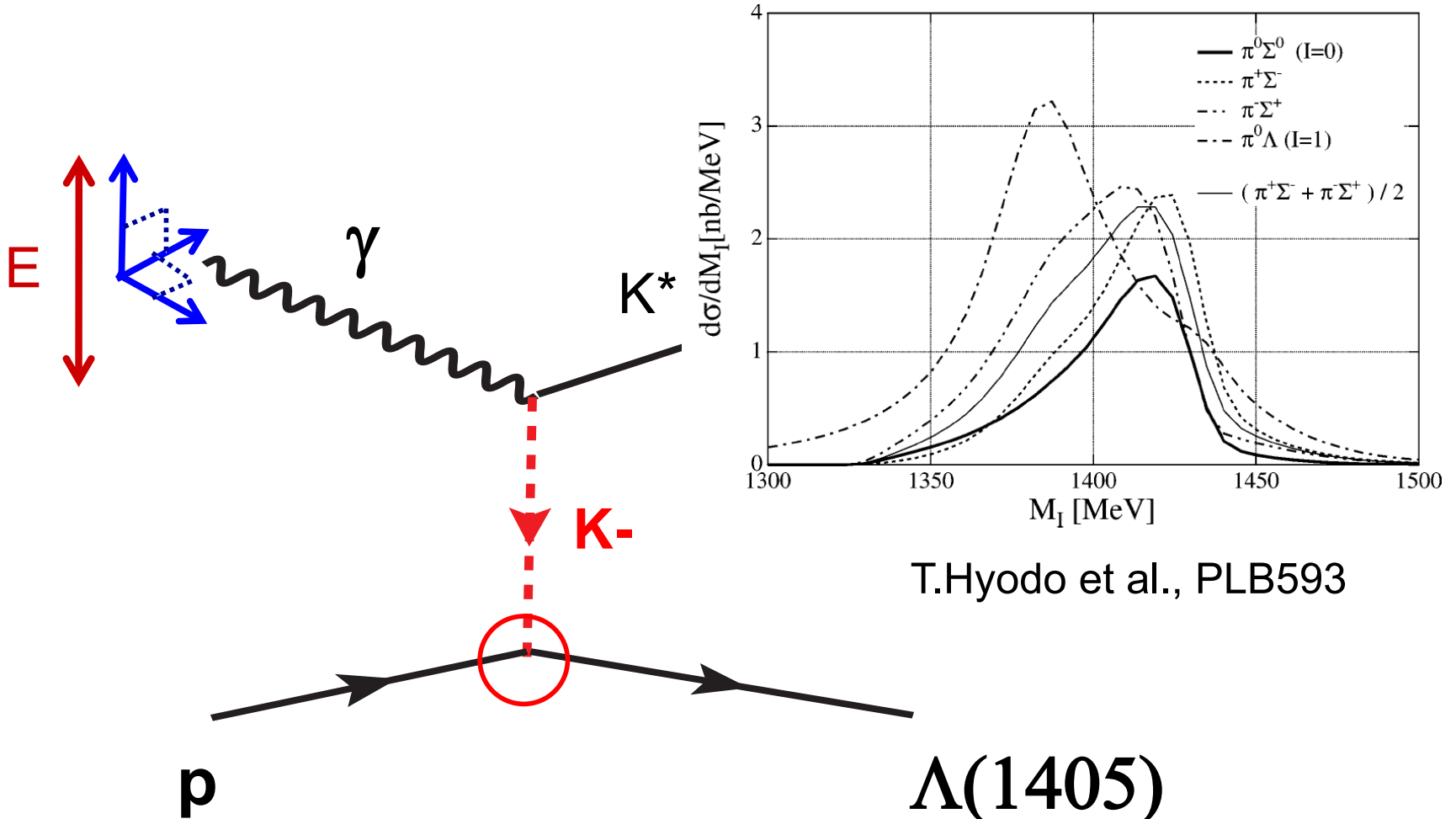


Parity Filter

$E_\gamma // K\pi$: natural parity ex. (K^* , κ)

$E_\gamma \perp K\pi$:unnatural parity ex. (K)

$K^*(890) \Lambda(1405)$ photoproduction with linearly polarized photon



T.Hyodo et al., PLB593

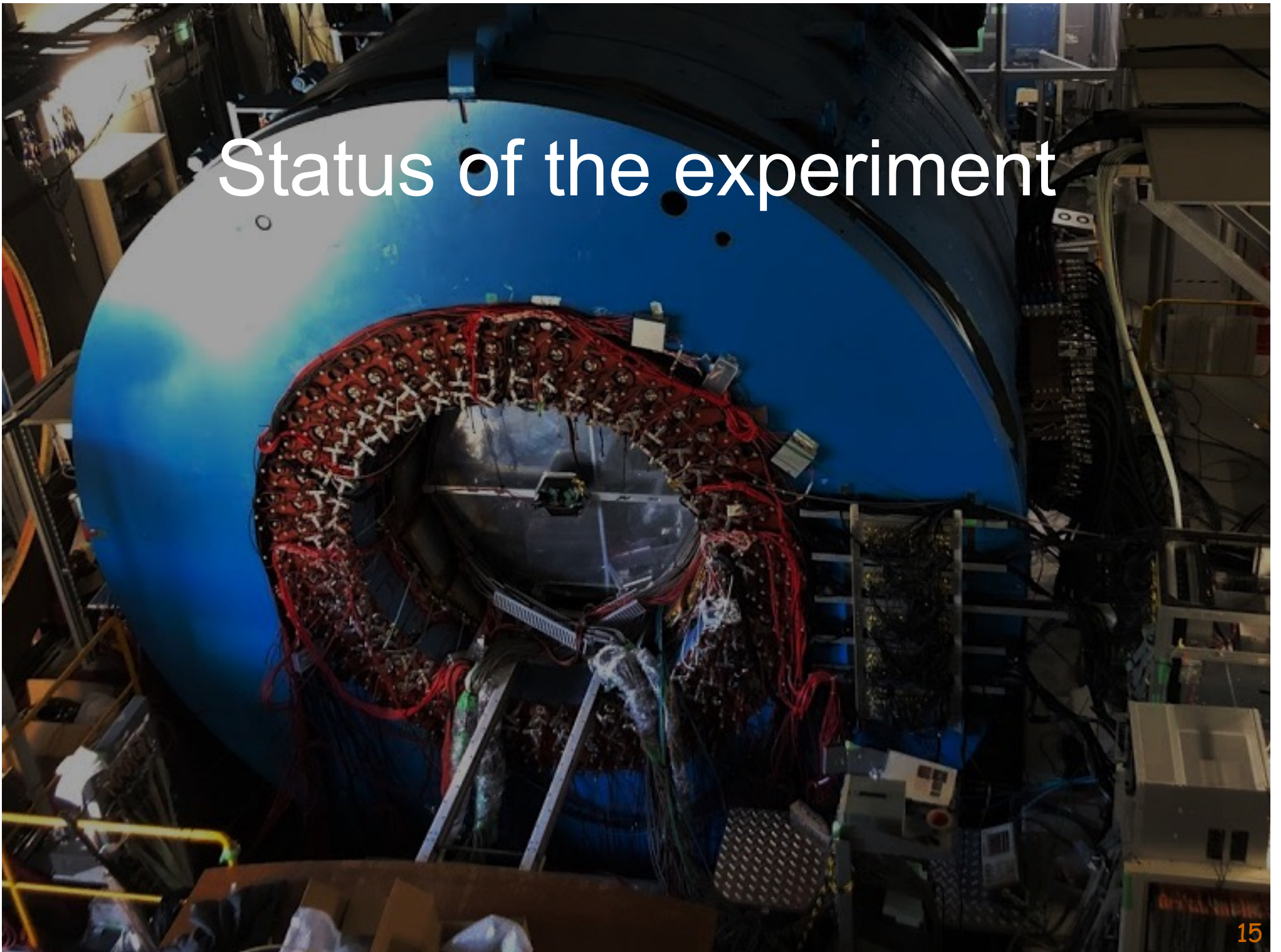
$\Lambda(1405)$
 $\Sigma(1385)$

Parity Filter

$E_\gamma // K\pi$: natural parity ex. (K^* , κ)

$E_\gamma \perp K\pi$:unnatural parity ex. (K)

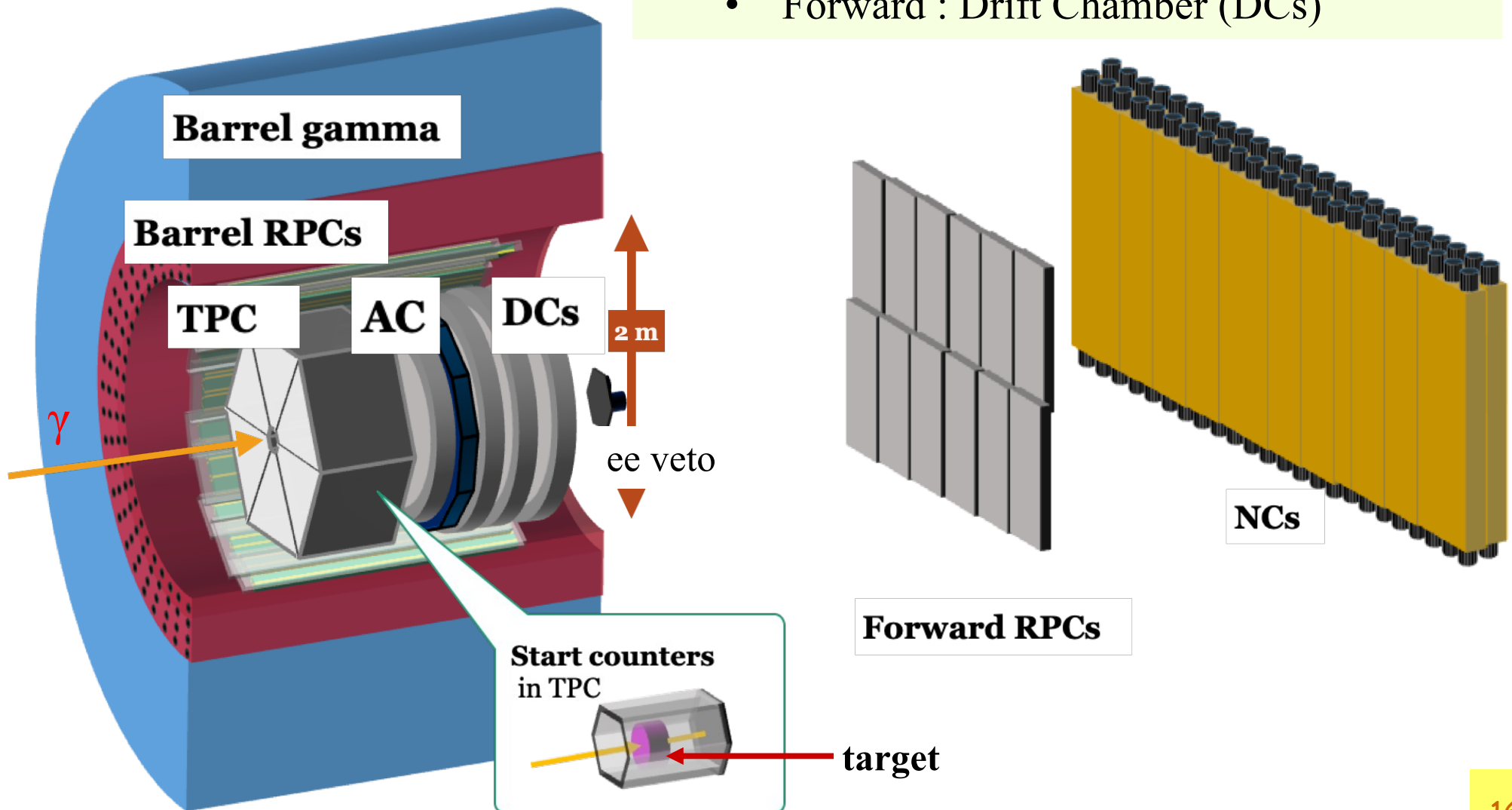
Status of the experiment



Solenoid spectrometer

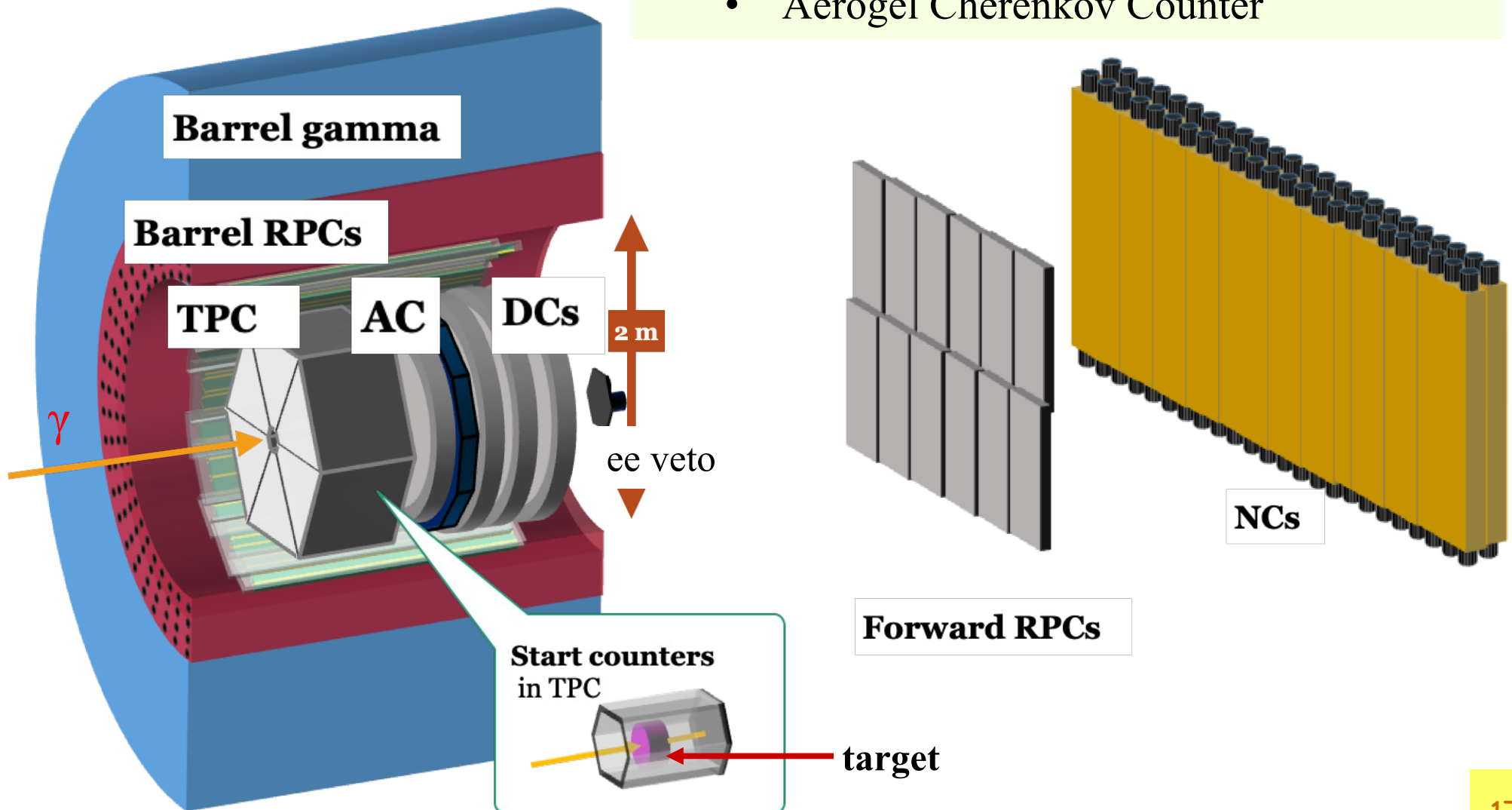
Magnet : BNL-E949
0.9 T

- Charged particles tracking:
 - Acceptance : $7 - 110^\circ$
 - Side: Time Projection Chamber (TPC)
 - Forward : Drift Chamber (DCs)



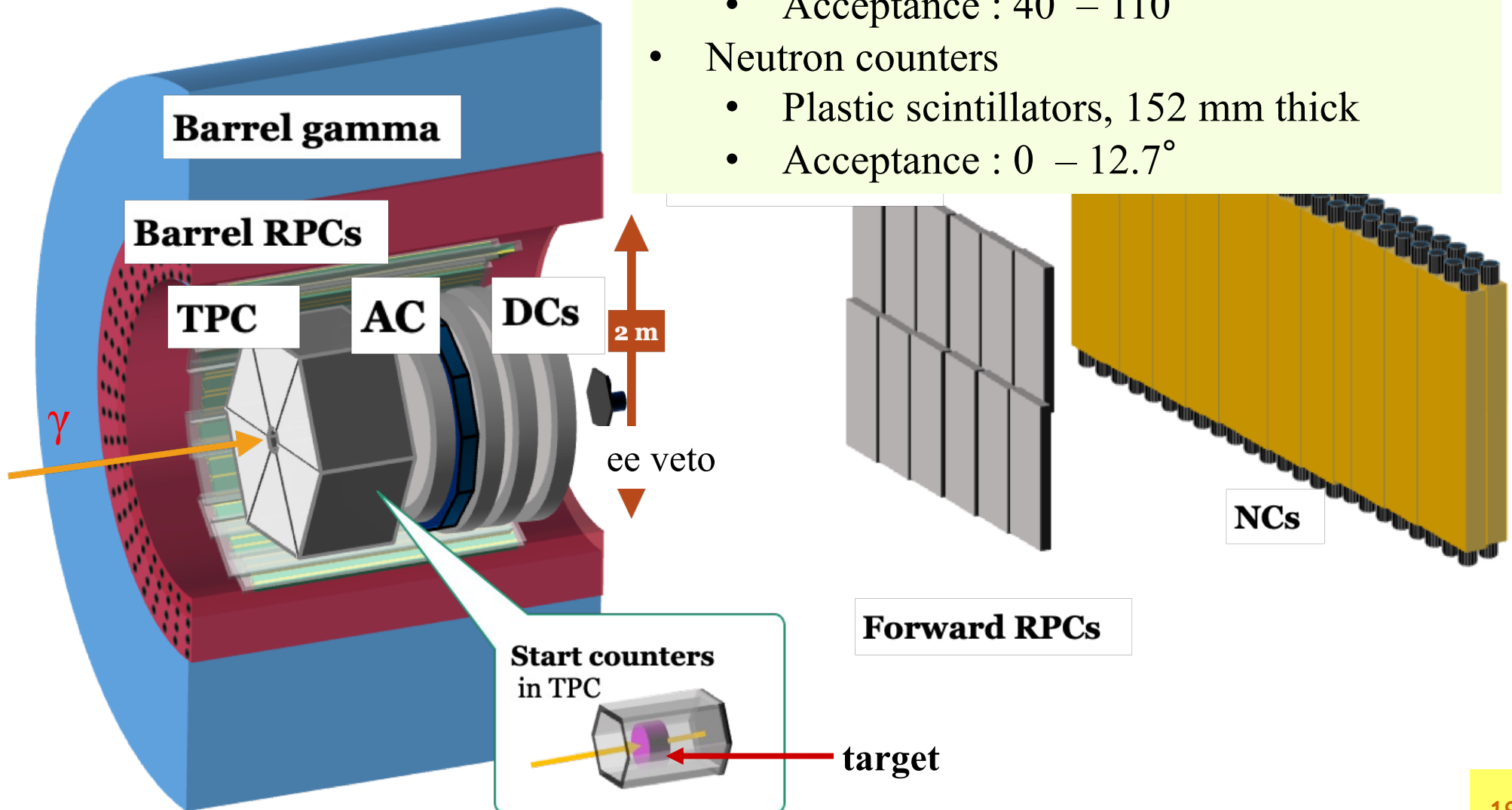
Solenoid spectrometer

- Particle Identification (p/K/ π)
 - Barrel Resistive Plate Chamber (BRPC)
 - Forward RPC
 - Aerogel Cherenkov Counter



Solenoid spectrometer

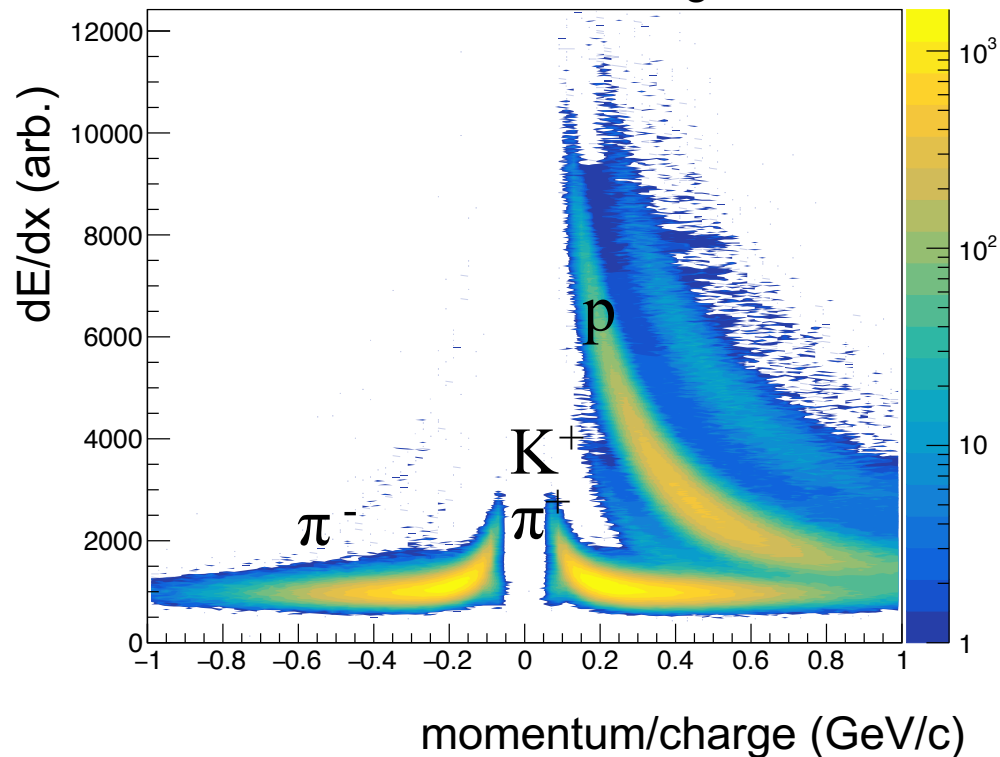
- EM calorimeter
 - Lead-Plastic sandwich
 - 3 layers $\sim 9.7X_0$ (full FEE \rightarrow 4 layers)
 - Acceptance : $40 - 110^\circ$
- Neutron counters
 - Plastic scintillators, 152 mm thick
 - Acceptance : $0 - 12.7^\circ$



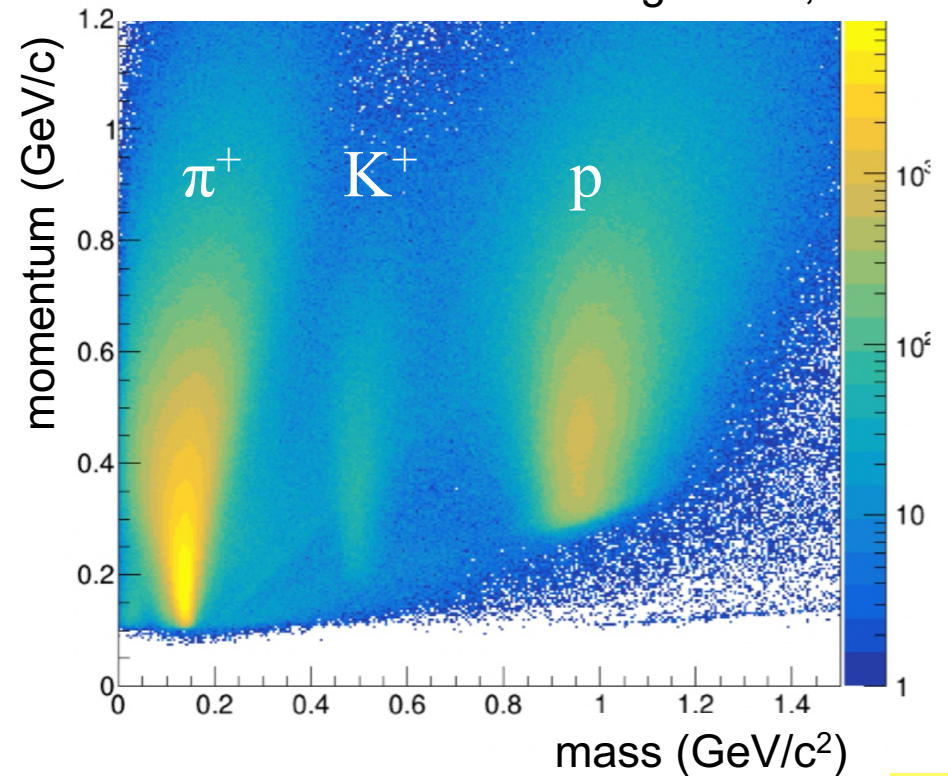
1st physics data taking

- We started physics runs in Oct. 2021!
- 1.3-2.4 GeV beam
- Number of photons in 2021-2022:
 - liquid H₂ : $\sim 1.5 \times 10^{12}$
 - liquid D₂ : $\sim 4.0 \times 10^{12}$

Particle identification using TPC

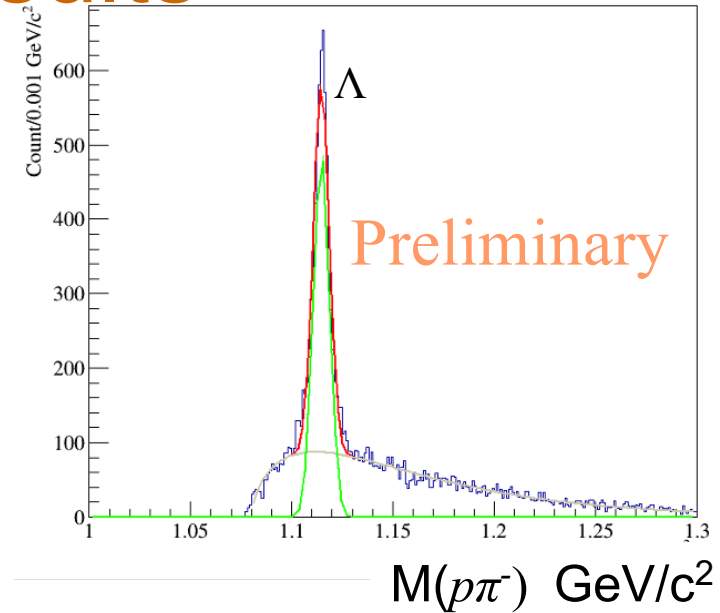


Particle identification using BRPC, TPC

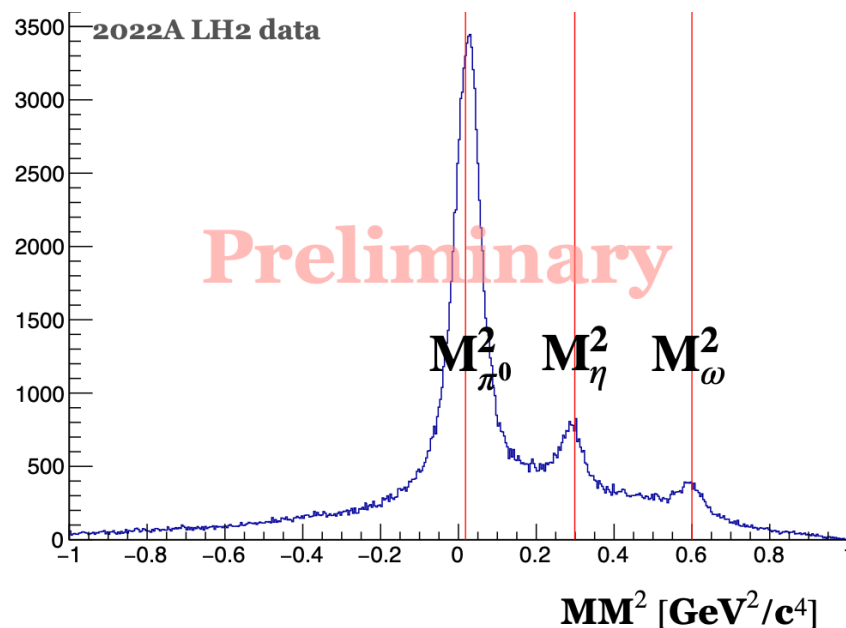


Preliminary results

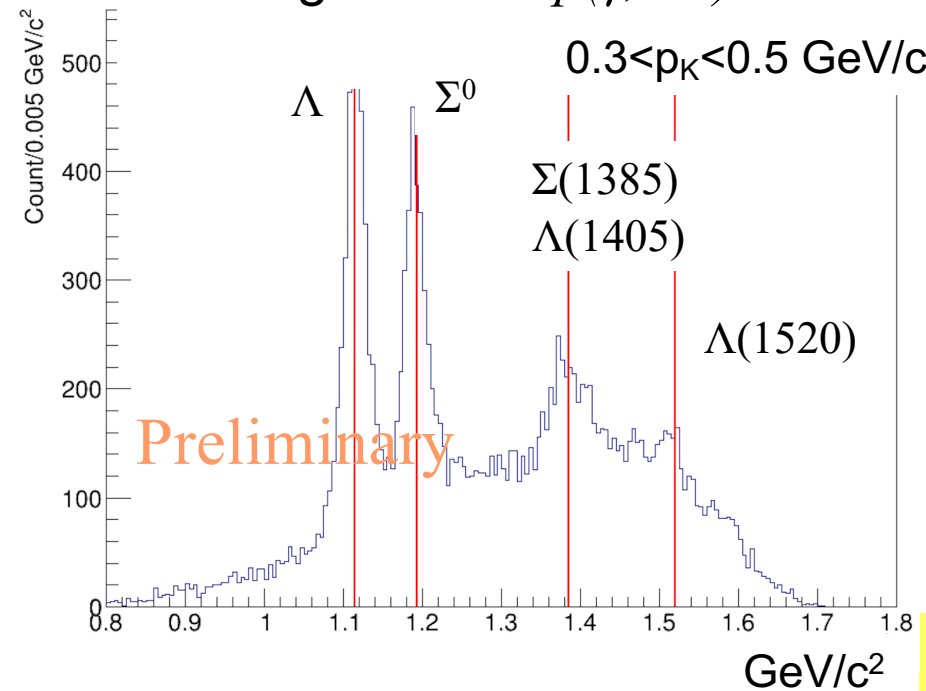
- Analysis is on-going
- Momentum measurement : TPC
- Time-of-flight : BRPC



Missing mass of $p(\gamma, p)$ reaction



Missing mass of $p(\gamma, K^+)$ reaction



Summary

- LEPS2
 - Backward Compton γ beam line for hadron physics.
 - High linear polarization photon beam
 - 1.3-2.4 GeV or 1.3-2.9 GeV
- Solenoid spectator
 - Simultaneous detection of charged particle, neutrons, and photons
- We started physics runs from 2021 with liquid H₂/D₂
 - 1.3-2.4 GeV beam
 - main physics purpose : $\bar{K}NN$