LEPS II GeV photons at SPring-8

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2. Physics motivation at LEPS II
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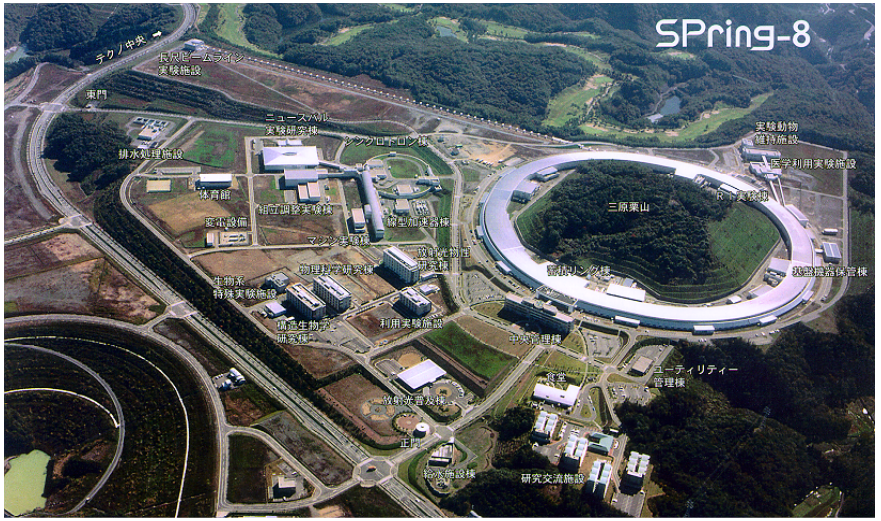
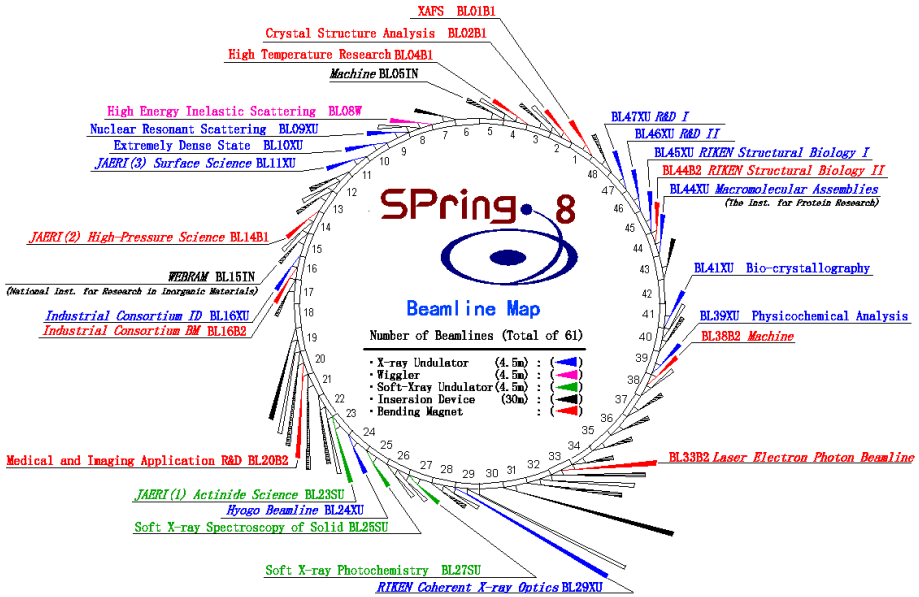
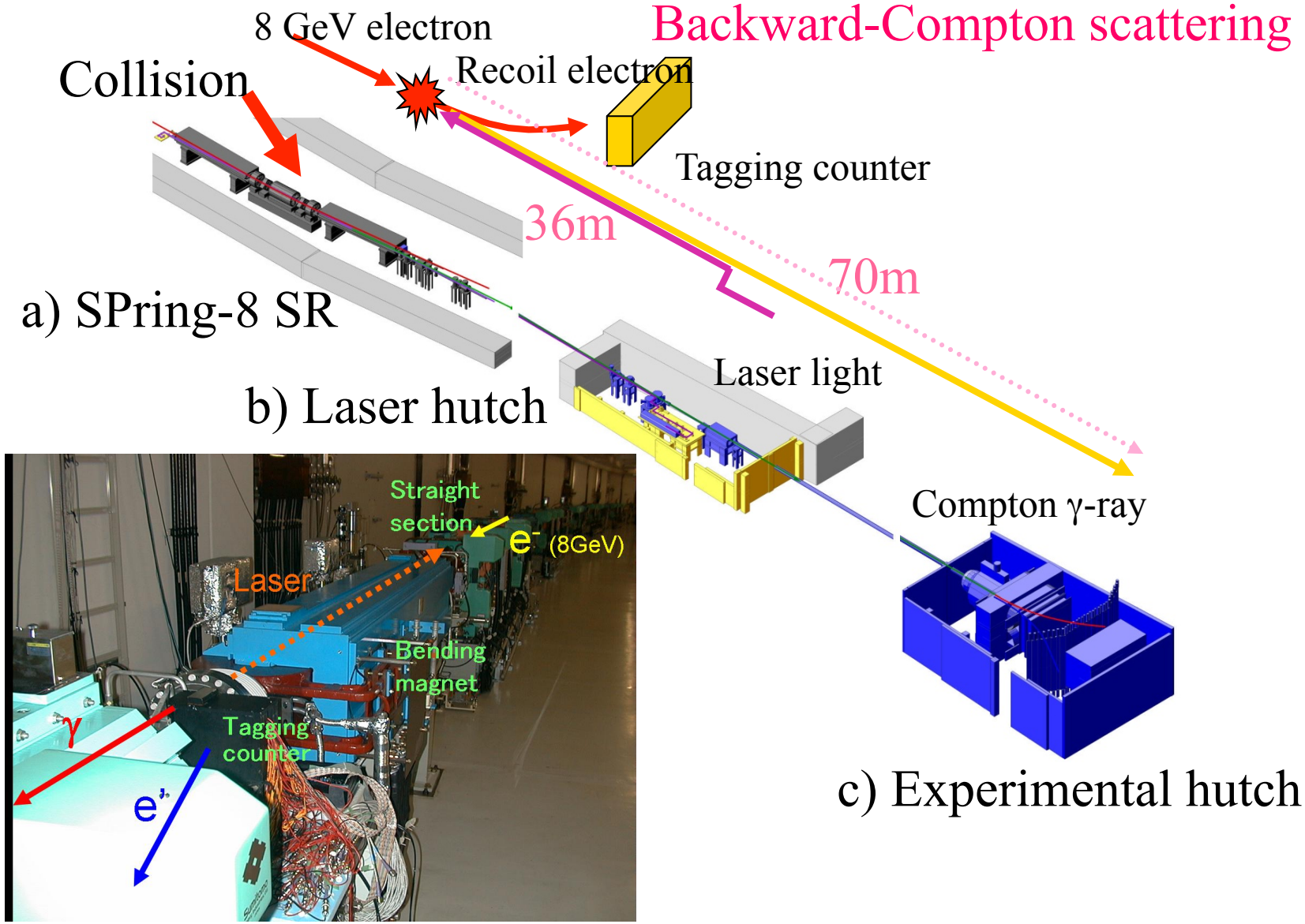
Super Photon Ring 8 GeV (SPring-8)





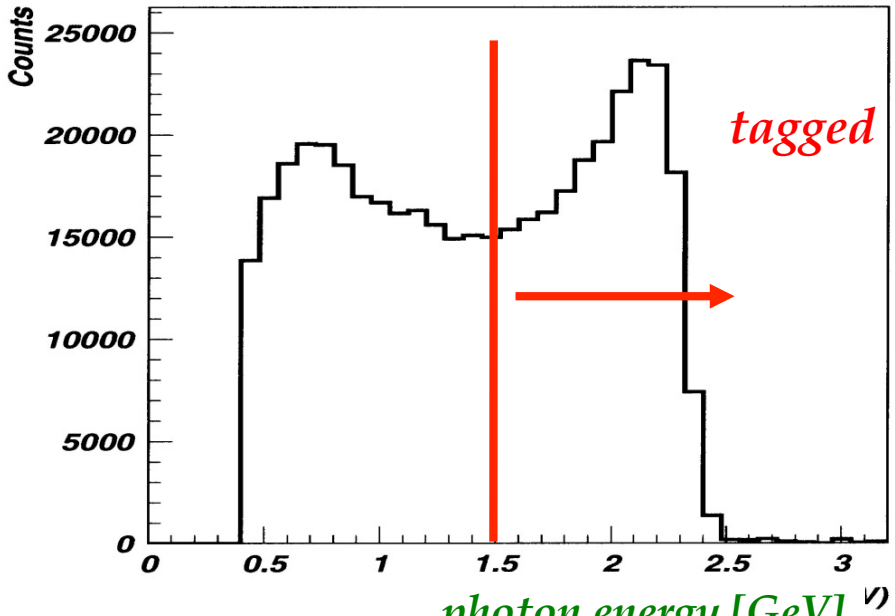
Schematic View of LEPS I Facility



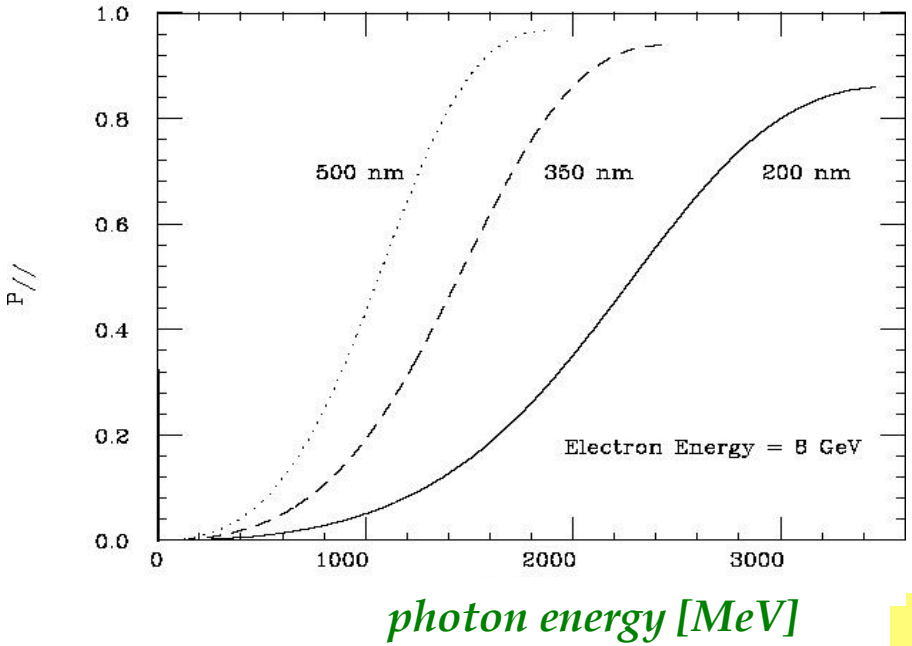
Backward-Compton Scattered Photon

- 8 GeV electrons in SPring-8
  - + 351nm Ar laser (3.5eV) 8W➔ ~ **2.4 GeV** photon
  - + 266nm Solid+BBO (4.6eV) 1W➔ +**3.0 GeV** photon
- Laser Power ~6 W (351nm) ➔ Photon Flux ~1 Mcps (2.4 GeV)
- Eγ measured by tagging a recoil electron ➔ Eγ>1.5 GeV, **ΔEγ ~10 MeV**
- Laser linear polarization 95-100% ⇒ **Highly polarized γ beam**

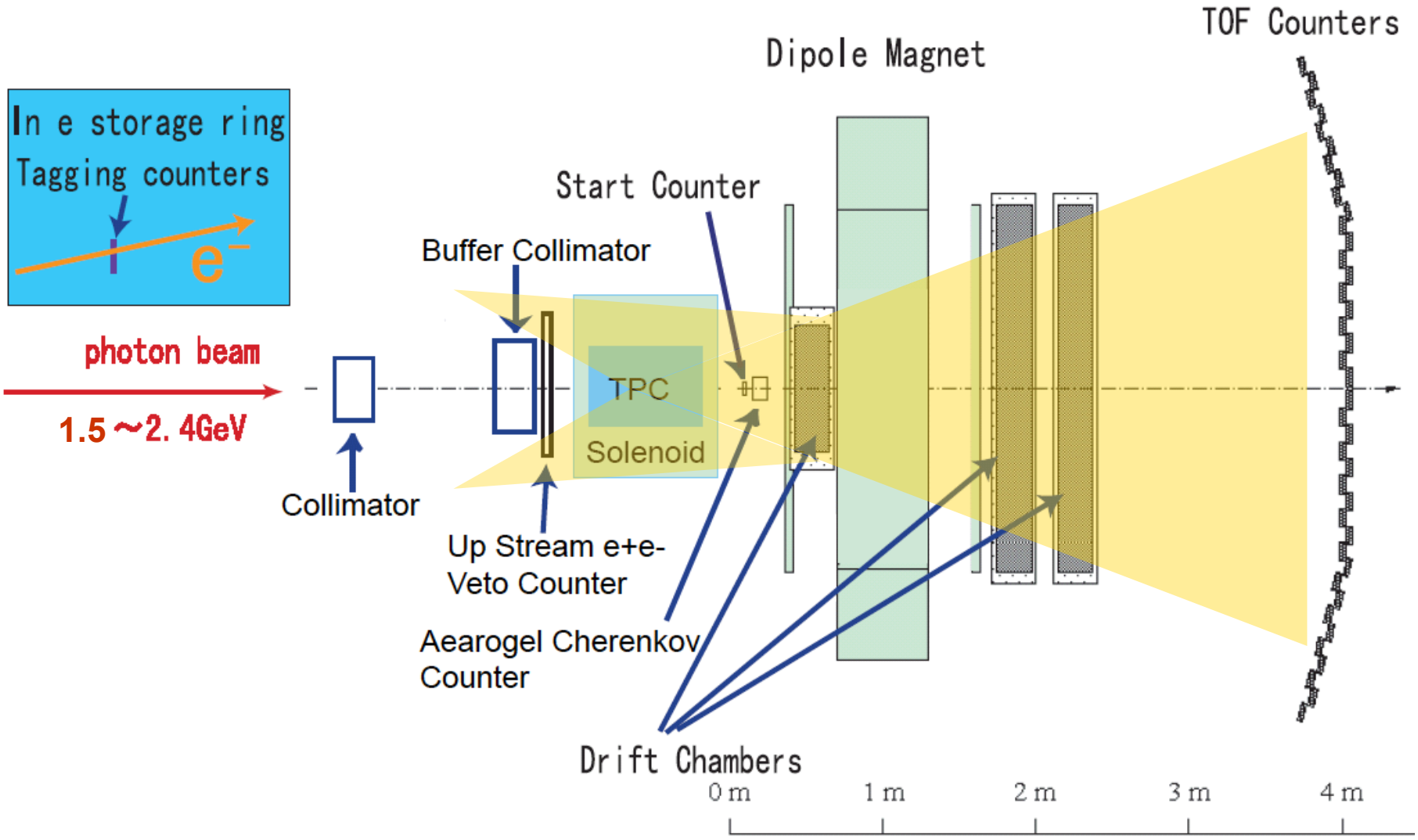
PWO measurement

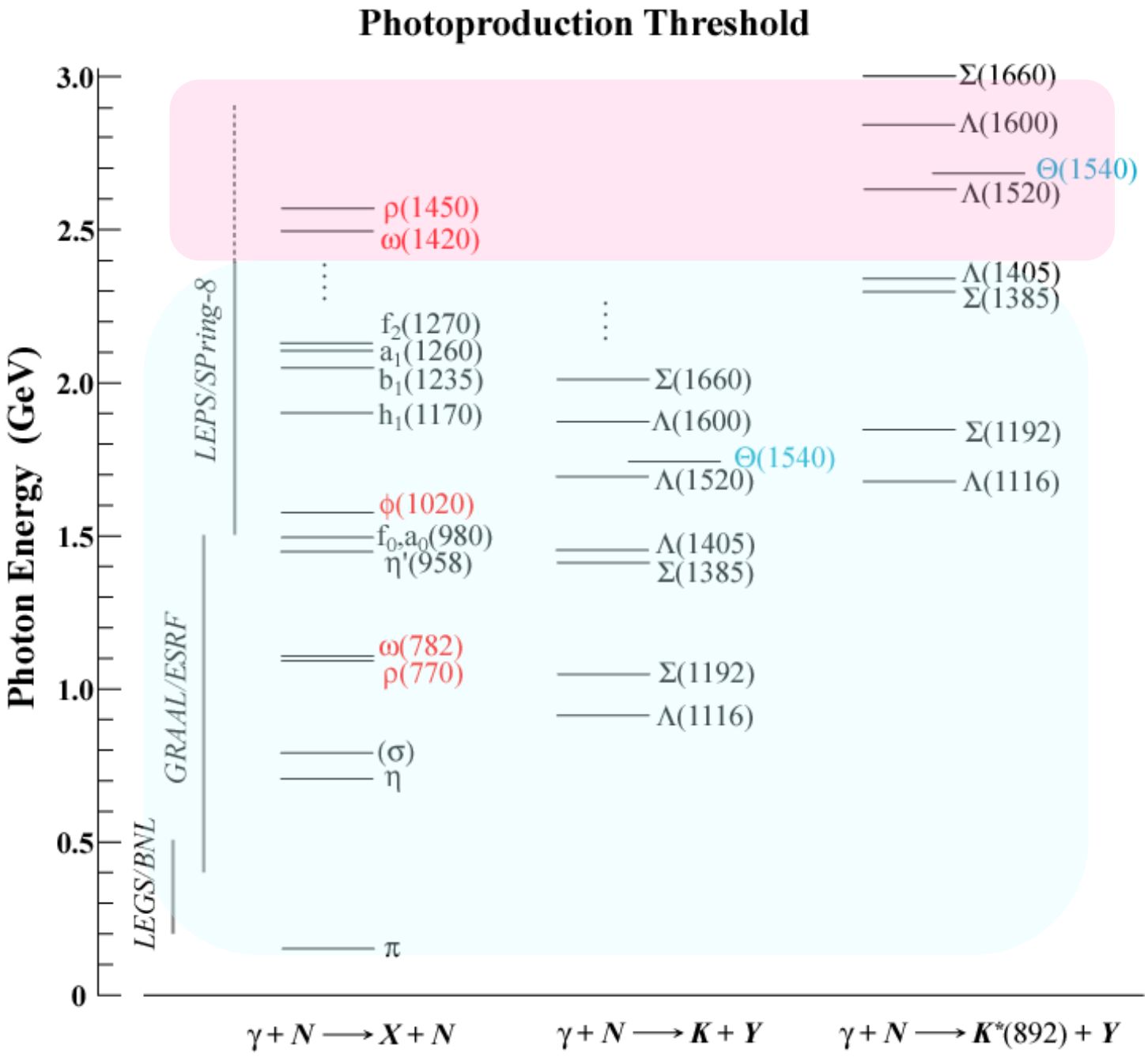


Linear Polarization of γ beam



Setup of LEPS I





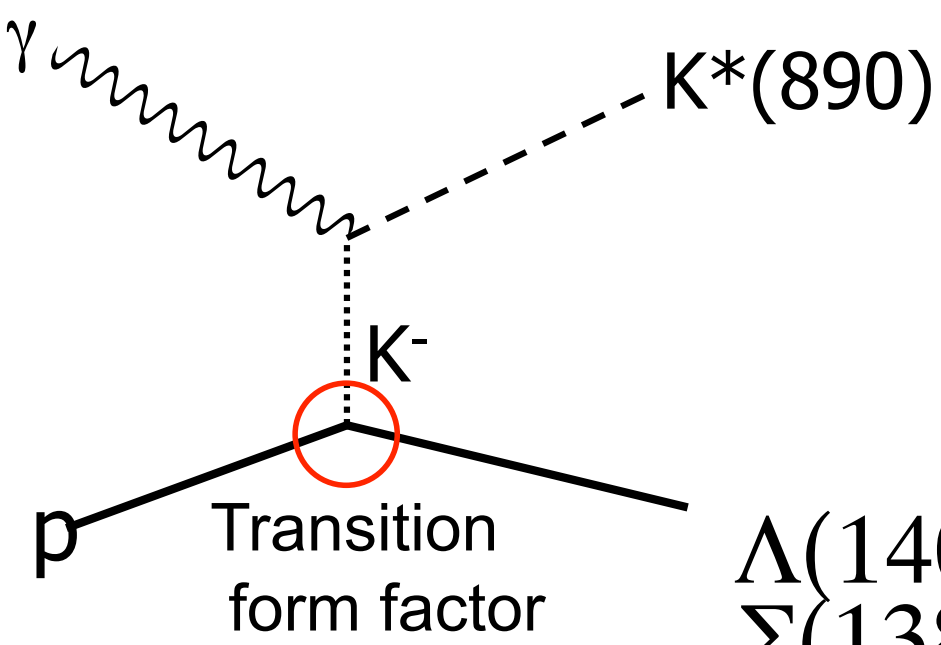
Near threshold production

- No higher resonance. Free from kinematical reflection.
- Small combinatorial background

φ meson hyperon resonances

Physics motivation for LEPS II

- **K*(890) Y* photoproduction with linearly polarized photon**



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

Parity filter

Decay plane // $\vec{\gamma}$
natural parity exchange
$P = (-)^J$

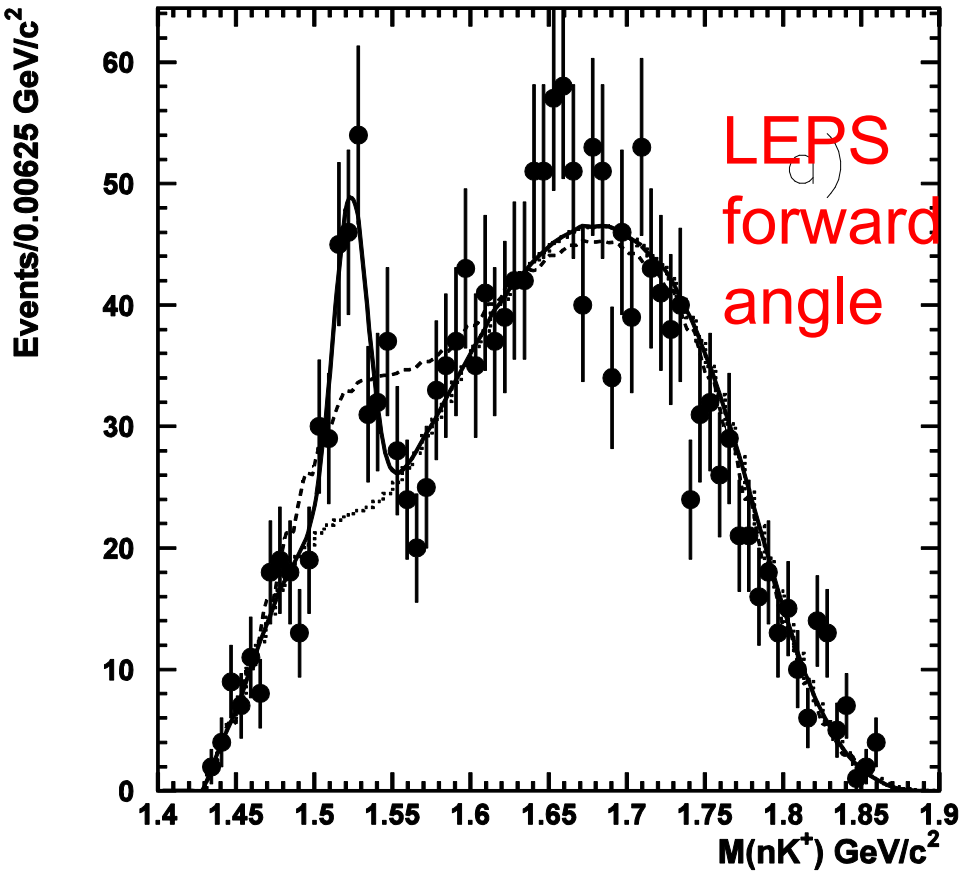
Decay plane $\perp \vec{\gamma}$
unnatural parity exchange
$P = -(-)^J$

Λ(1405)

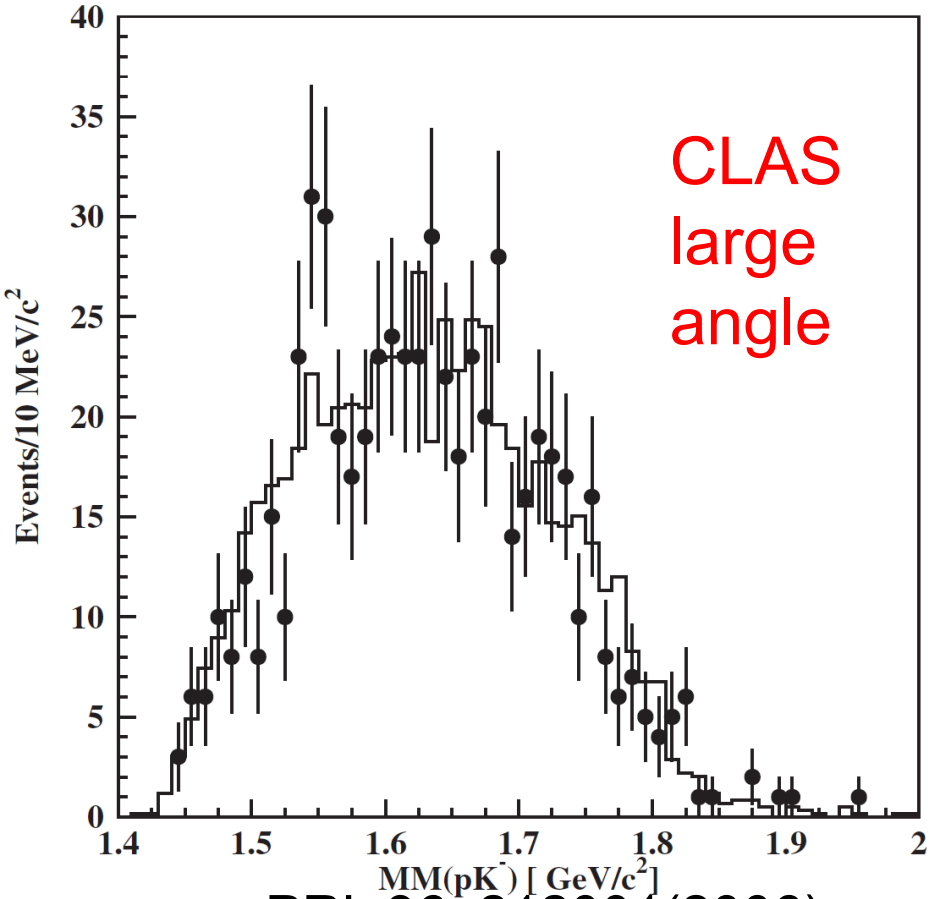
Physics motivation for LEPS II

Θ^+ LEPS vs CLAS

Strong angular dependence of production rate?



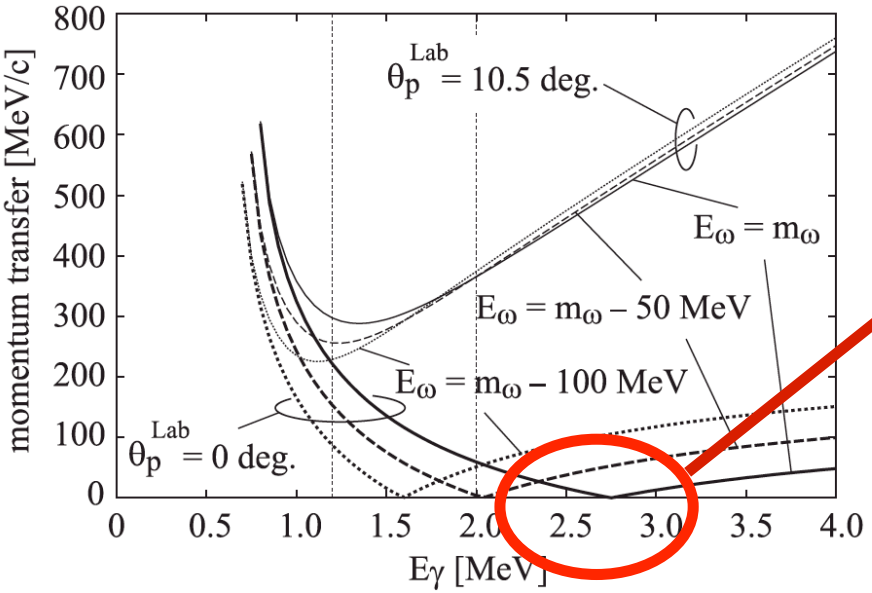
PRC **79**, 025210 (2009)



PRL **96**, 212001(2006)

Physics motivation for LEPS II

- **η, ω, η' meson in nuclear medium**

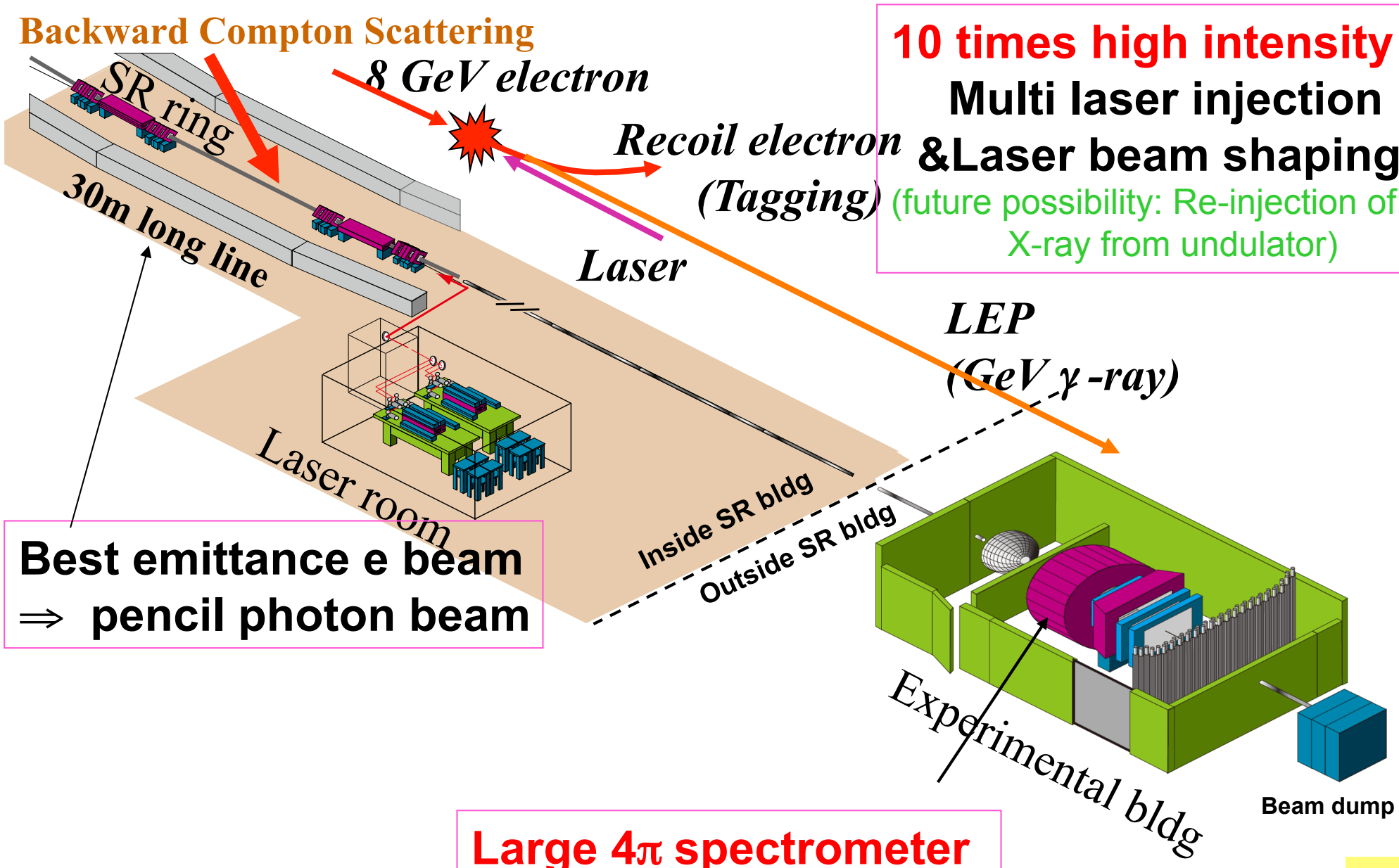


Magic momentum
~2.7 GeV, 0 degree

M.Kaskulov,
PRC75,064616

- **Detection of scattered and decay particles**
  - **4π acceptance forward to backward**
- **Detection of charged particles and photons**

Schematic view of the LEPS2 facility

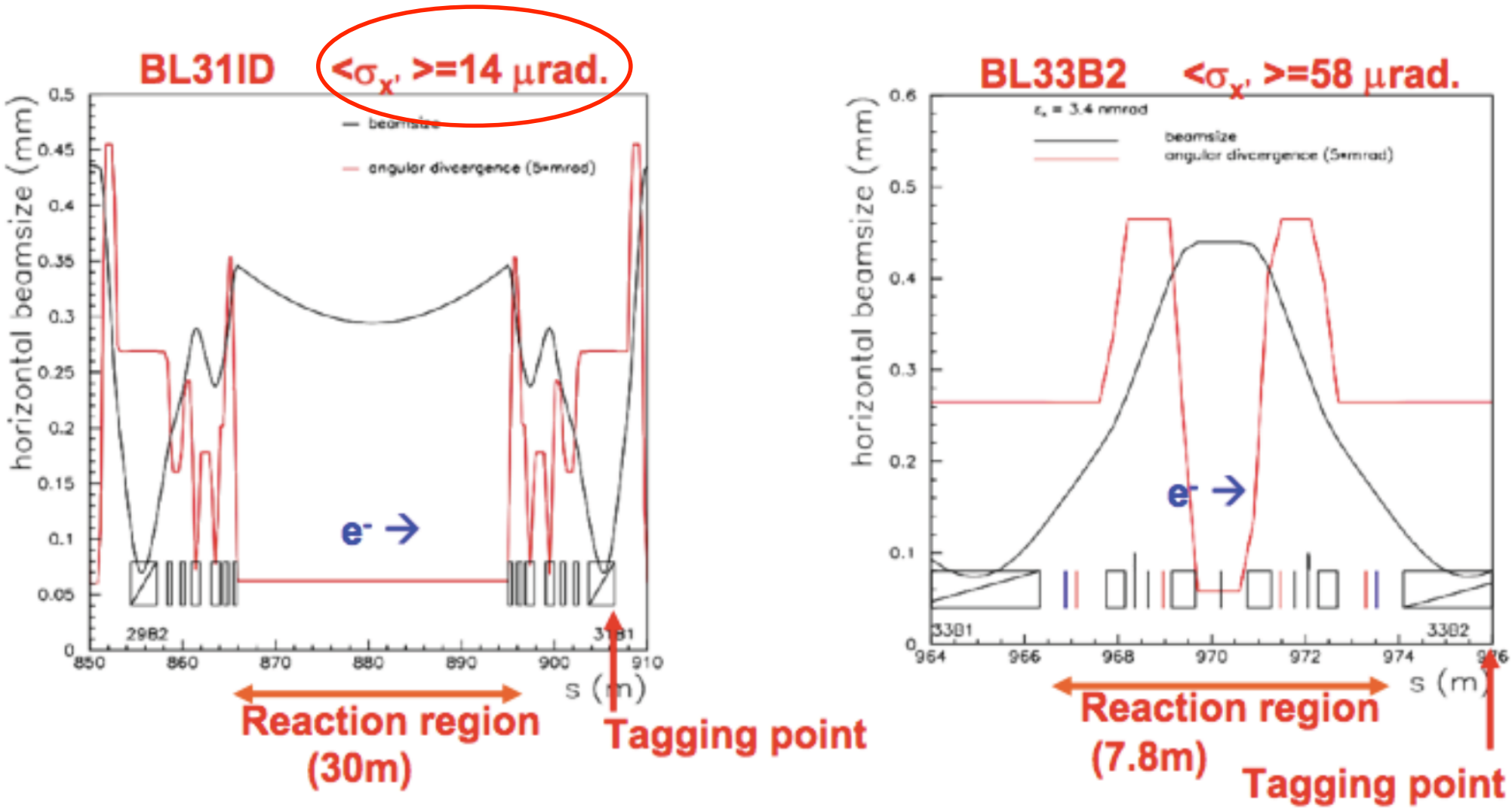


10 times high intensity:
Multi laser injection
&Laser beam shaping
(future possibility: Re-injection of X-ray from undulator)

Best emittance e beam
⇒ pencil photon beam

Large 4π spectrometer

Good beam emittance

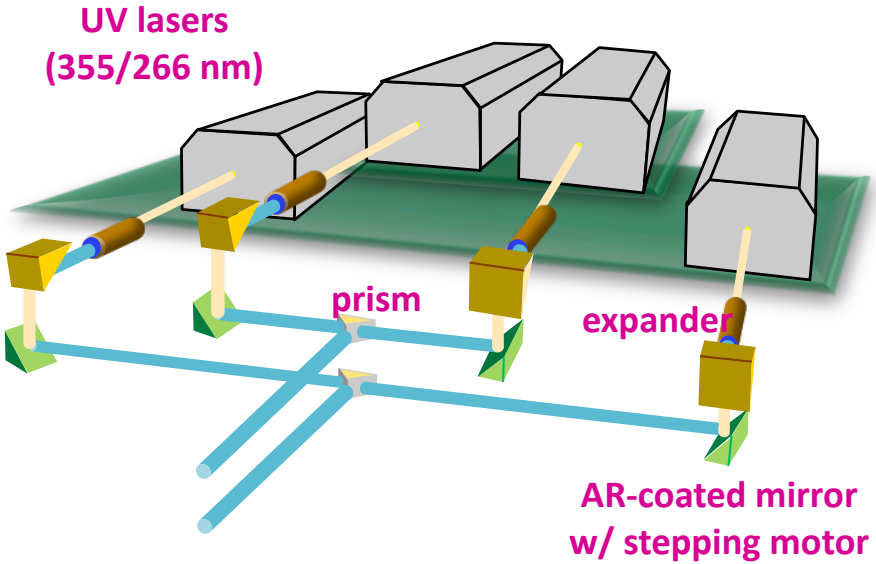


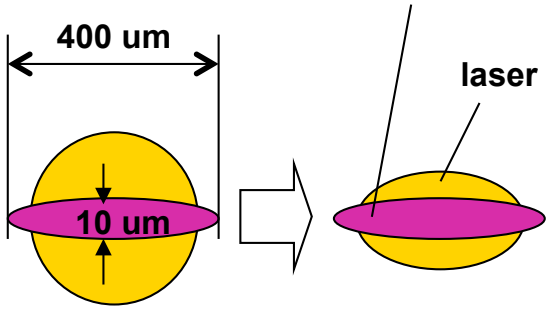
Beam size @ target (RMS): x ~2cm, y~1cm

High Beam Intensity

LEP intensity ≥ 10^7 cps for E_γ<2.4 GeV beam (355 nm)
≥ 10^6 cps for E_γ<2.9 GeV beam (266 nm)

- 4-laser injection [x4]
- Higher power CW lasers.
  355 nm (for 2.4 GeV) 8 W→16 W, 266 nm (for 2.9 GeV) 1 W→2 W [x2]
- Laser beam shaping with cylindrical expander [x2]

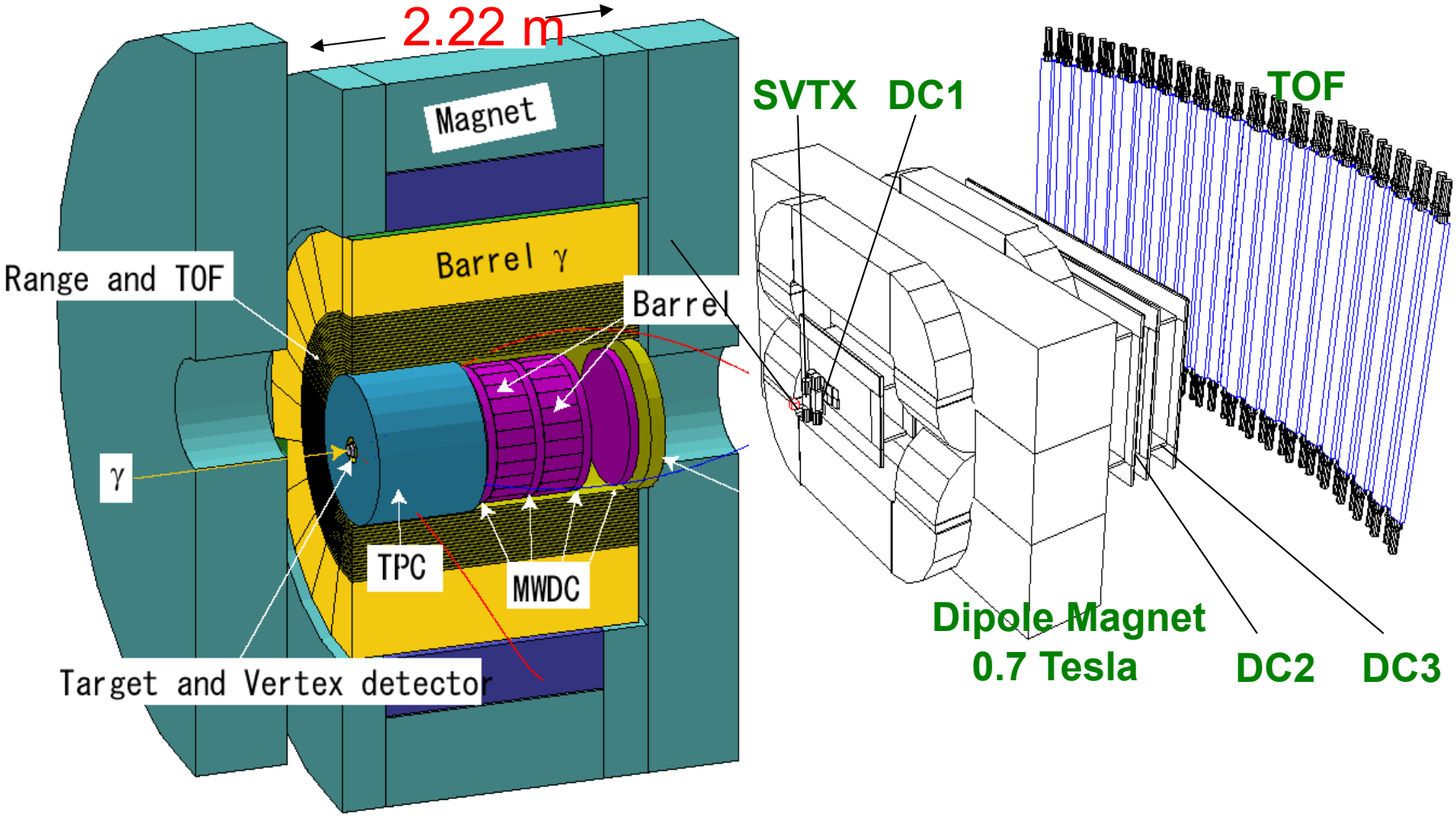




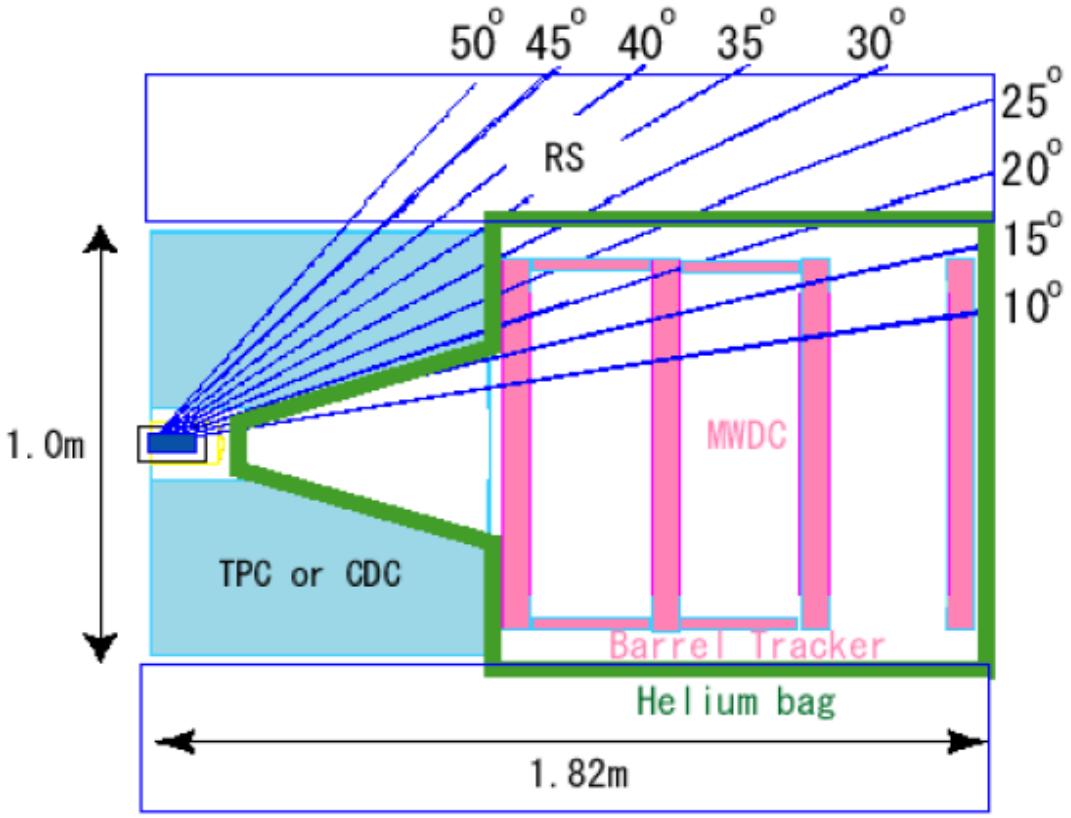
• Electron beam is horizontally wide.
⇒ BCS efficiency will be increased by elliptical laser beam.

Need large aperture of the laser injection line
→ construct new BL chambers

LEPS II detector setup



Solenoid tracking system



- PID

  sideway: TOF (Δt =50 psec)

  forward: TOP (quarts Cerenkov)

- Side way tracker (TPC)

  R = 500 mm (24-26 layer),

  $\sigma_{r\phi}$ =150um, σ_z =2mm,

- Forward MWDC chamber(450mm)

  ^{4}He+Ethane ($X/X_0 = 1.1\times10^{-3}$)

  6 plane (x,x', u(45) u'(-45), y y')

  σ_{xy} =**150um,**

- Barrel tracker

  Cathode strip + Anode wire

  $\sigma_{r\phi}$ = 250um, σ_z = 2-3 mm

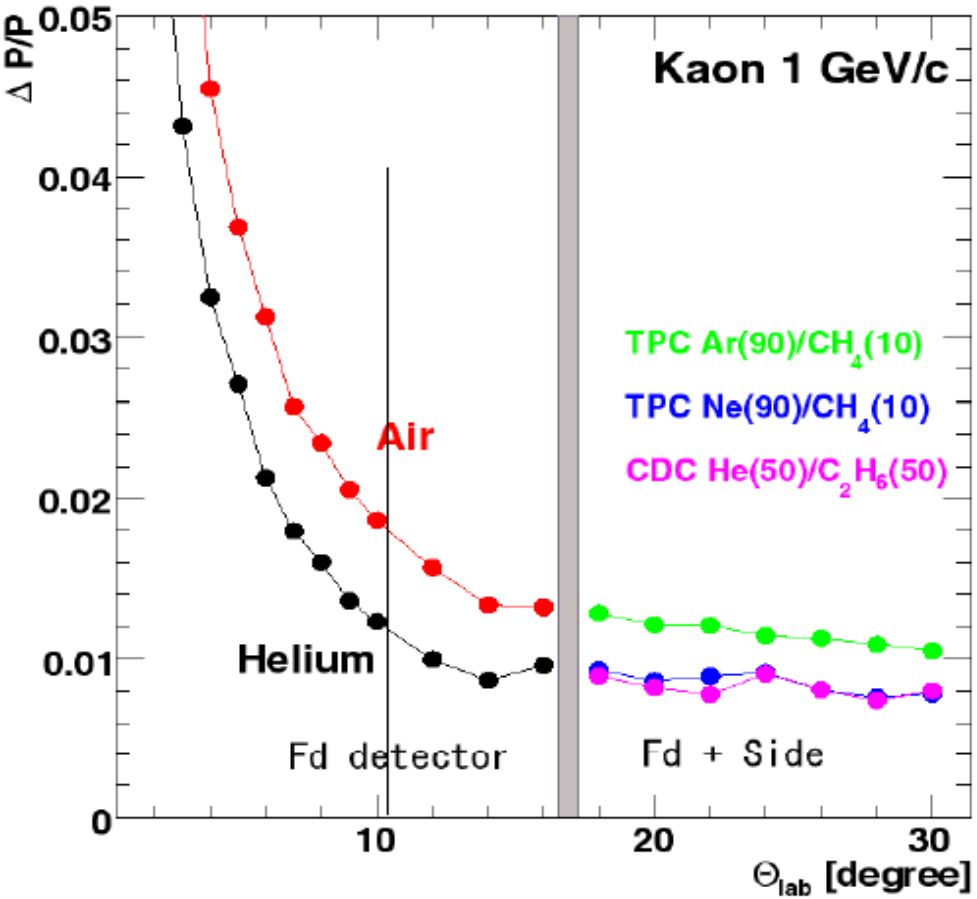
- SSD (Cylindrical+ Disk)

  Double side strip sensor

  σ=35um,

  $\Delta Z < 1$ mm at $\theta > 20^0$

Solenoid tracking system



- $2^{o} < \theta < 17^{o}$

  Vertex + Fd MWDC
  No SW tracker

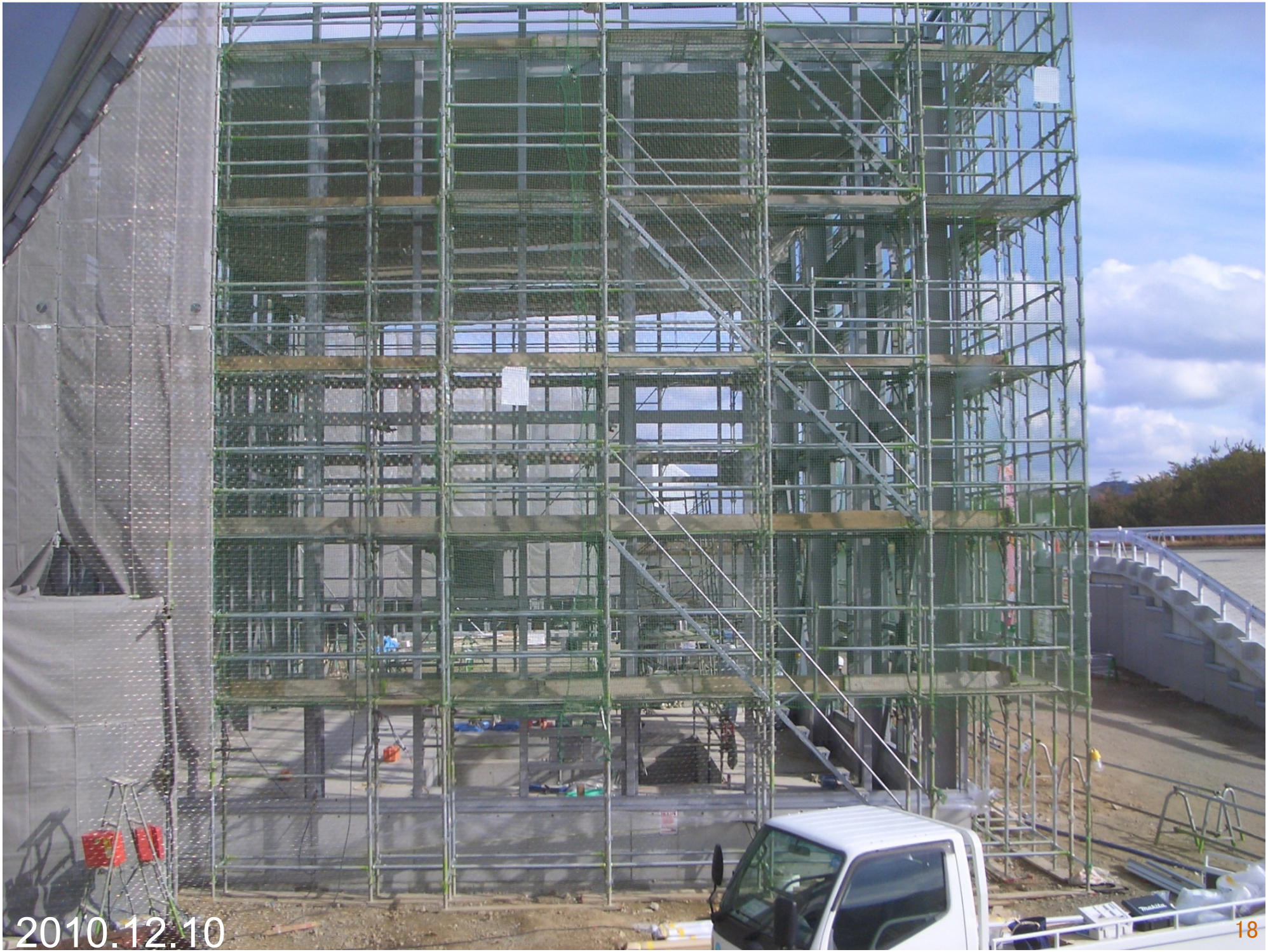
  At 10 degree
  $\Delta P/P$ = 1.3% (He4 gas)
  1.9% (Air)

- $\theta > 17^{o}$

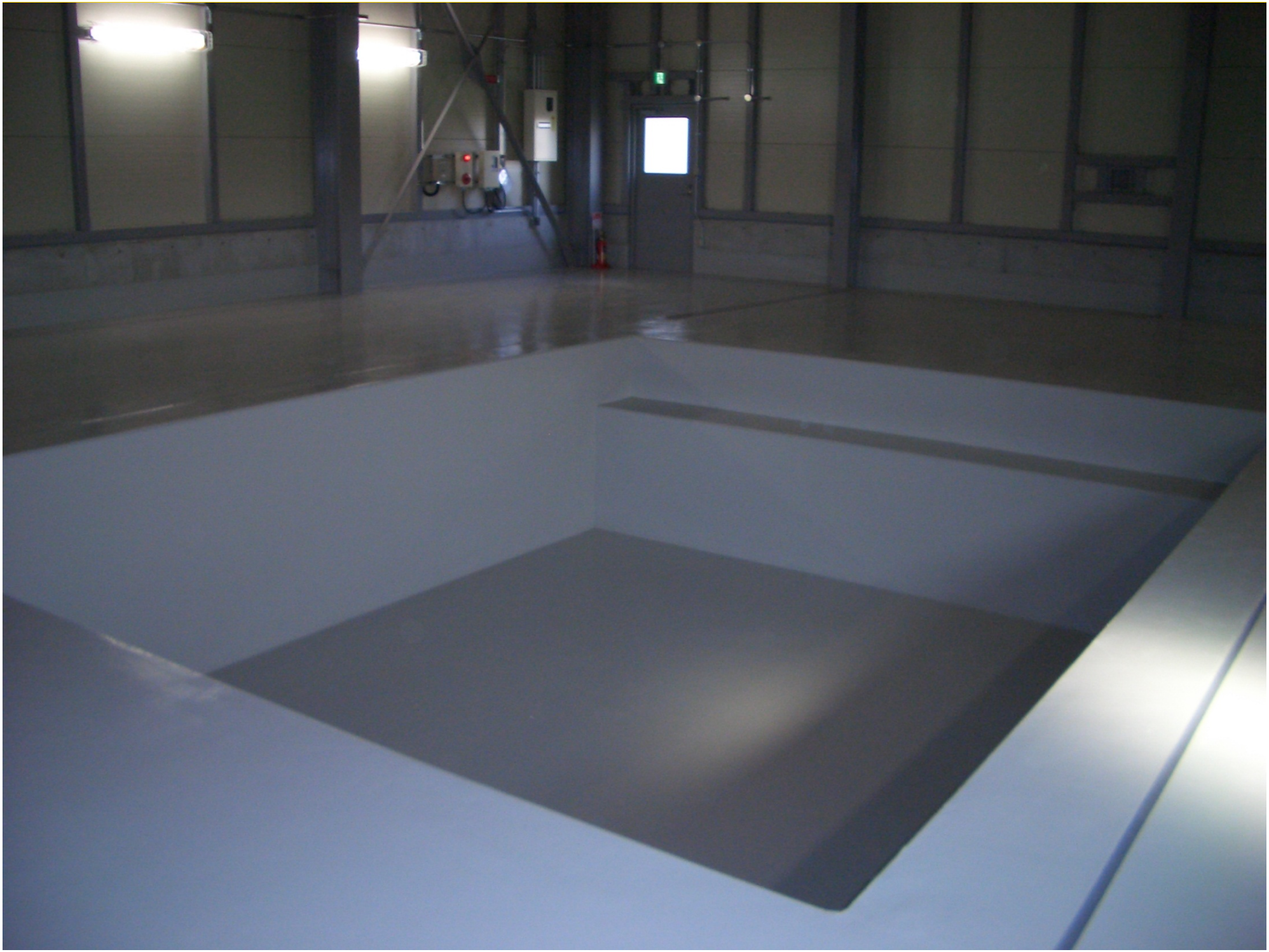
  MS effect in SW tracker
  TPC $\Rightarrow$ Ar/CH_4 or Ne/CH_4

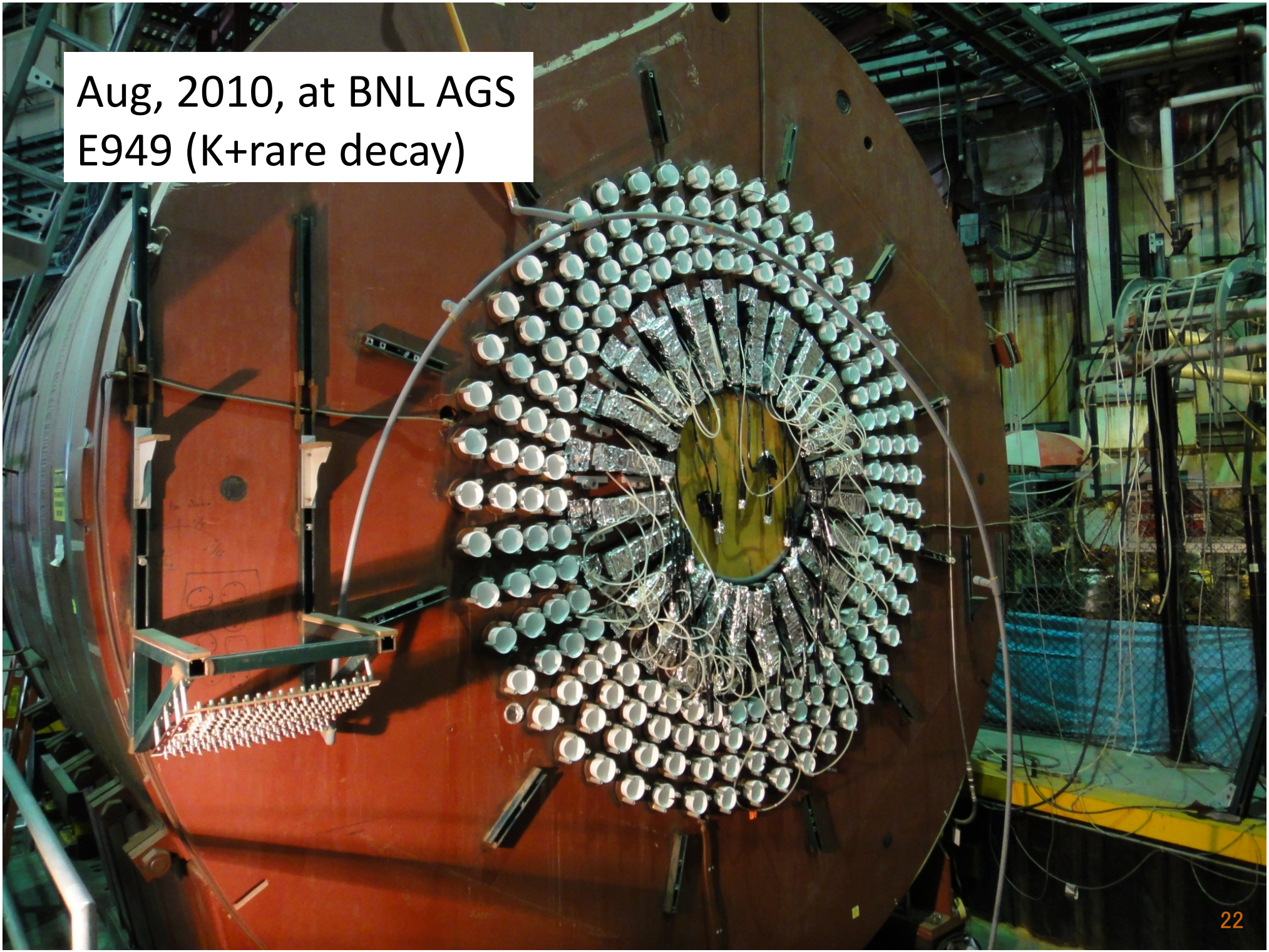

2010.10.11

2010.11.10

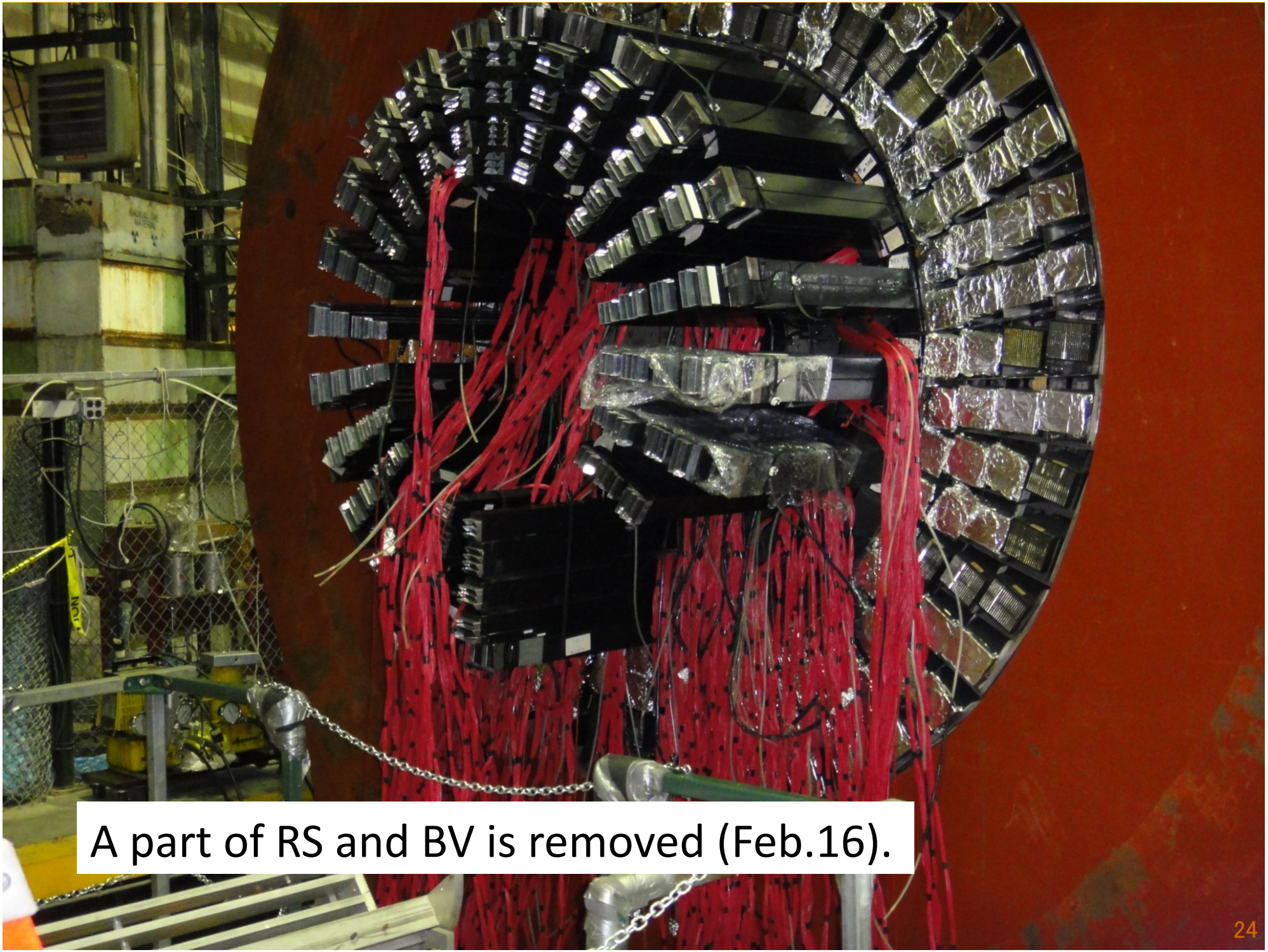

2010.12.10


2011.1.31



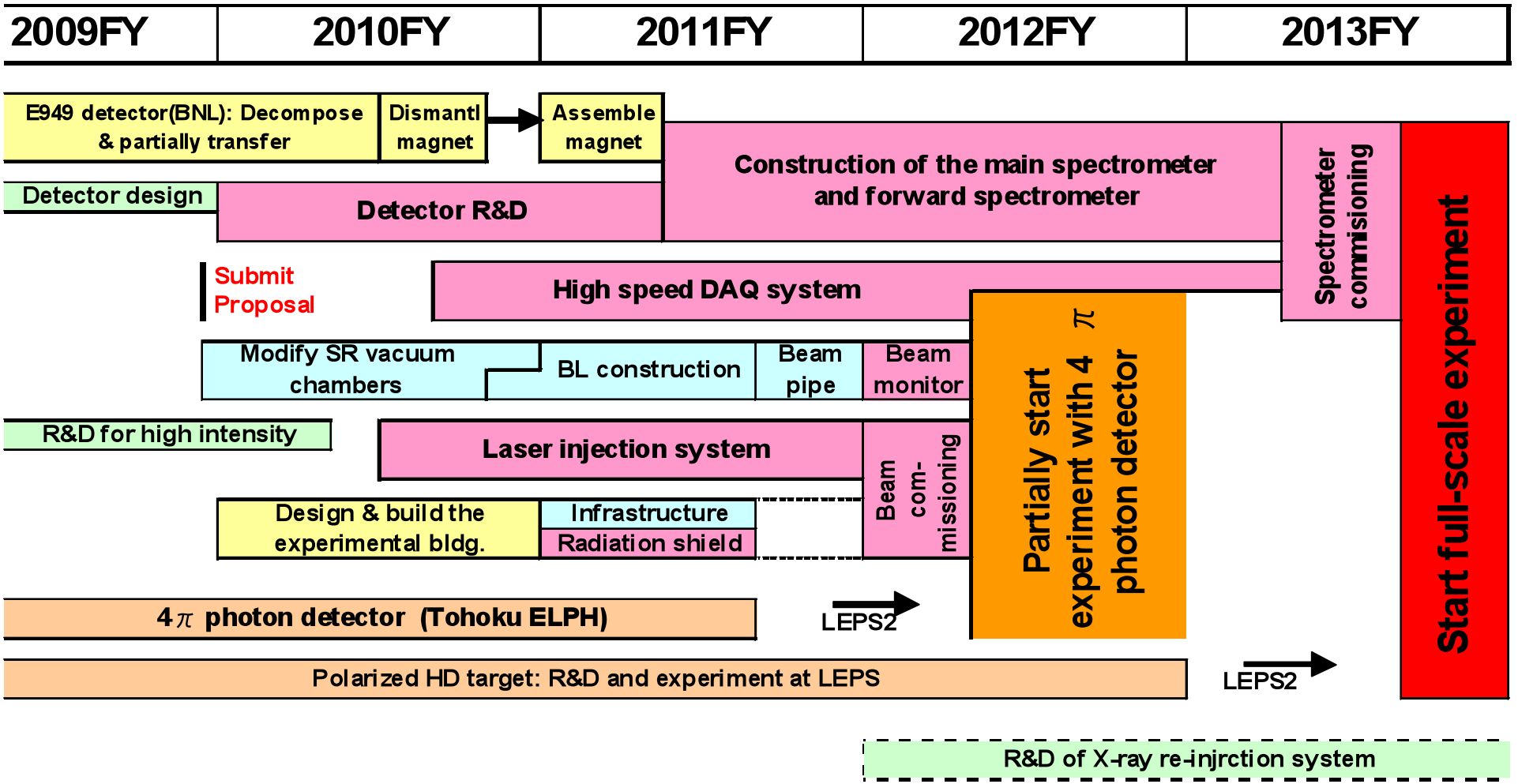

Aug, 2010, at BNL AGS
E949 (K+rare decay)

Opened the downstream endplate. (Jan. 14)



A part of RS and BV is removed (Feb.16).

LEPS2 roadmap



Summary

- Backward Compton γ beam line for hadron physics.
  - Hadrons with s-quark.
  - Recoilless production of light mesons in nucleus.
- **Highly polarized** photon beam up to 3 GeV.
- **x10 luminosity.**
- **4π detector** with solenoid + dipole magnet which cover from very forward to backward.
- Photon and charged particle detection simultaneously.

- Beam will be ready in 2012.
- Physics data taking from 2013.

Back up

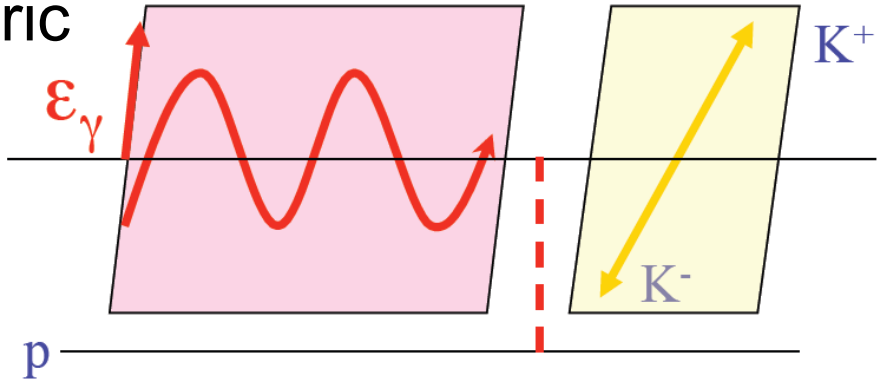
Why Photon beam ?

- Electro-magnetic coupling : complementary to hadron beam experiment
- Backward Compton
  - Narrow beam : Forward angle measurement
  - Polarization : Parity filter for exchanged particle

Parity filter for exchanged particle in t-channel

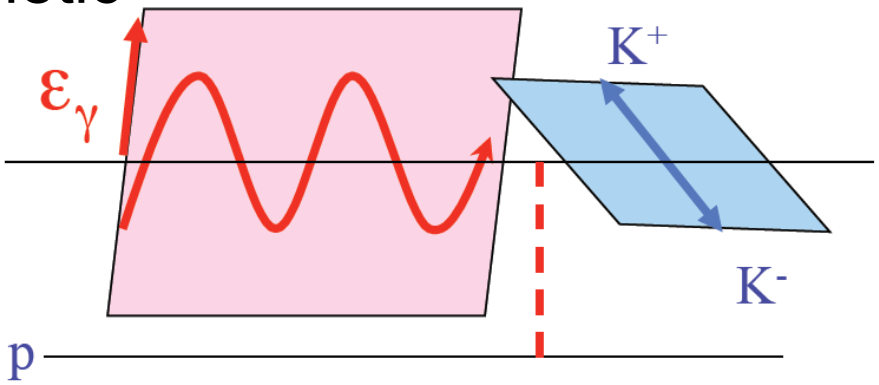
ϕ meson rest frame

Electric



Decay Plane // $\vec{\gamma}$
natural parity exchange $(-1)^J$
(Pomeron, Scalar Glueball,
Scalar mesons)

Magnetic



Decay Plane $\perp$ $\vec{\gamma}$
unnatural parity exchange $-(-1)^J$
(Pseudoscalar mesons π,η)

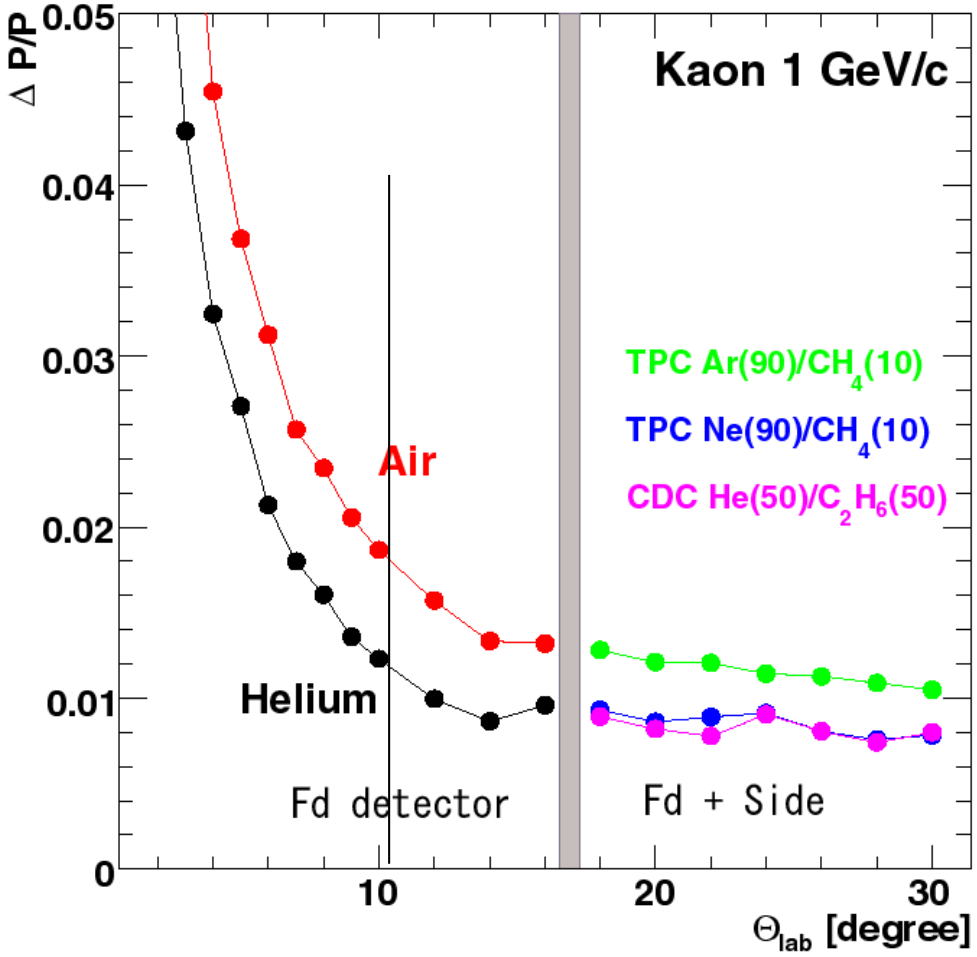
Decay angular distribution of ϕ → Relative contributions from natural, unnatural parity exchanges

Why Photon beam ?

- Electro-magnetic coupling : complementary to hadron beam experiment
- Backward Compton
  - Narrow beam : Forward angle measurement
  - Polarization : Parity filter for exchanged particle

- Small production cross section
  → High intensity & large acceptance

ΔP/P at forward region



- $2^o < \theta < 17^o$

  Vertex + Fd MWDC

  No SW tracker

  At 10 degree

  ΔP/P = 1.3% (He4 gas)

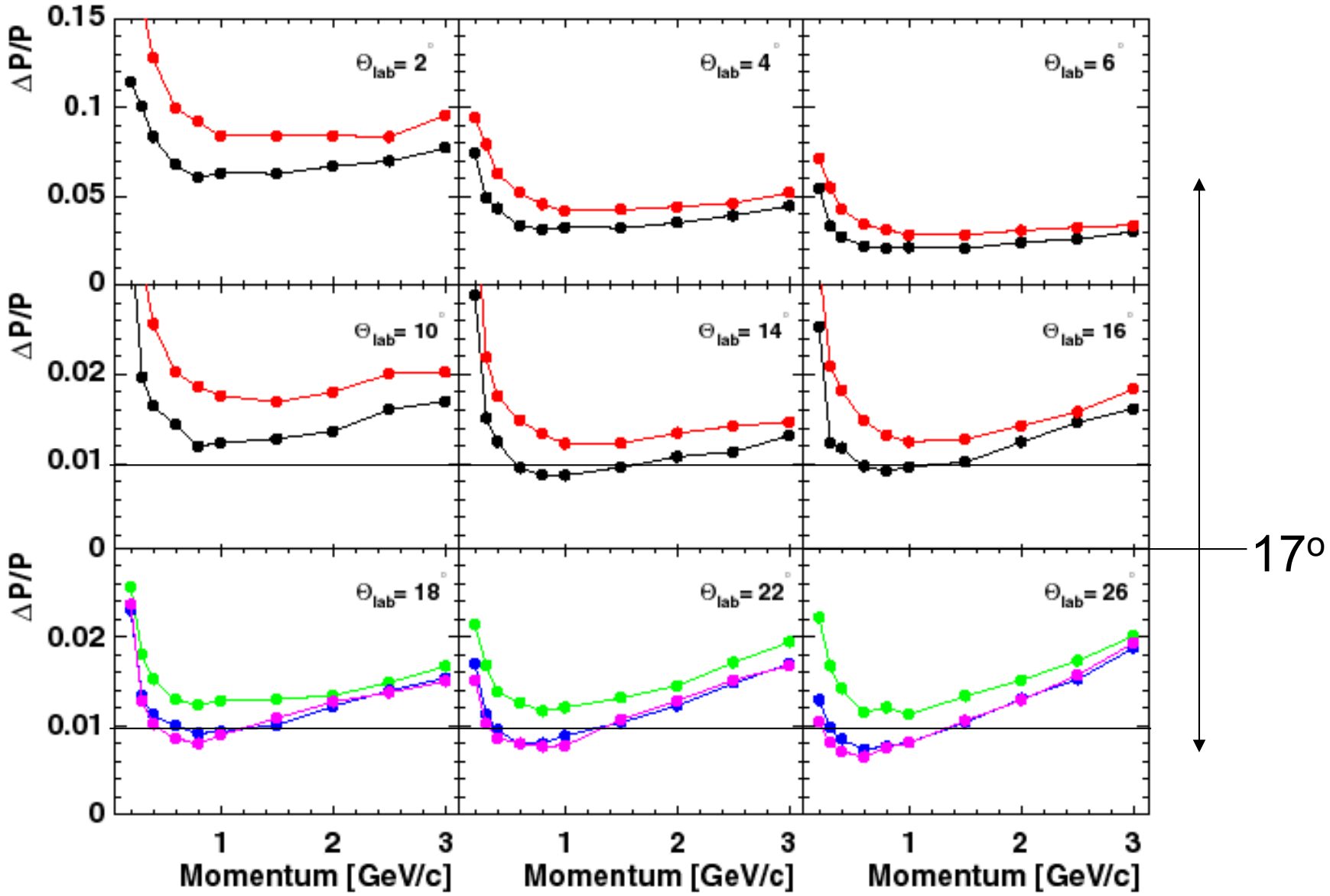
  1.9% (Air)

- $\theta > 17^o$

  MS effect in SW tracker

  TPC ⇒ Ar/CH_4 or Ne/CH_4

Momentum dep. of ΔP/P



Requirement

- Detection of the multi-charged particles and neutral particles
  - Reaction (MM) $\Rightarrow$ $\Delta P/P \sim 1\%$ for 1GeV/c kaon
    at forward θ
    + π/K separation.
  - Decay (IM) $\Rightarrow$ Low momentum down to 0.1GeV/c
- Wide polar angle, smooth and full acceptance for azimuthal direction
  - Coplanarity
  - Decay distribution
  - Polarization measurement