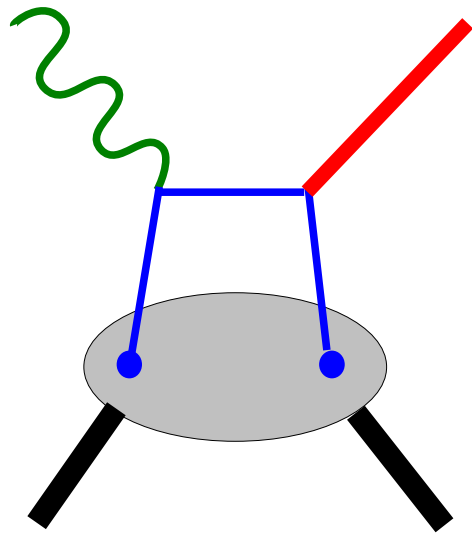


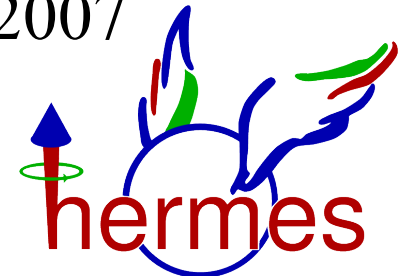
HERMES での反跳粒子検出器を用いた 一般化されたパートン分布関数の研究

Study of GPD with Recoil Detector at HERMES

東工大理 宮地義之, 今津義充, 小林慶鑑, 長谷川大樹,
Lu Xiaorui, 柴田利明, 他 HERMES Collaboration

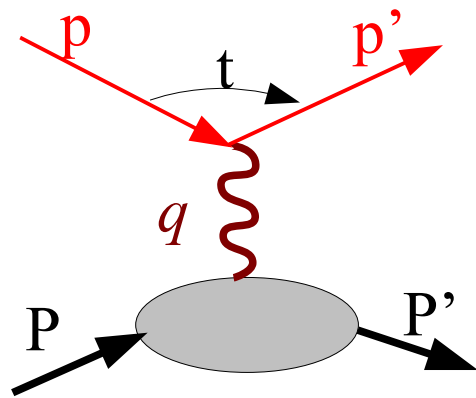


- Generalized Parton Distribution
- Measurement of DVCS at HERMES
 - without Recoil Detector: 1996 ~ 2005
 - with Recoil Detector: 2006 ~ 2007
- Summary



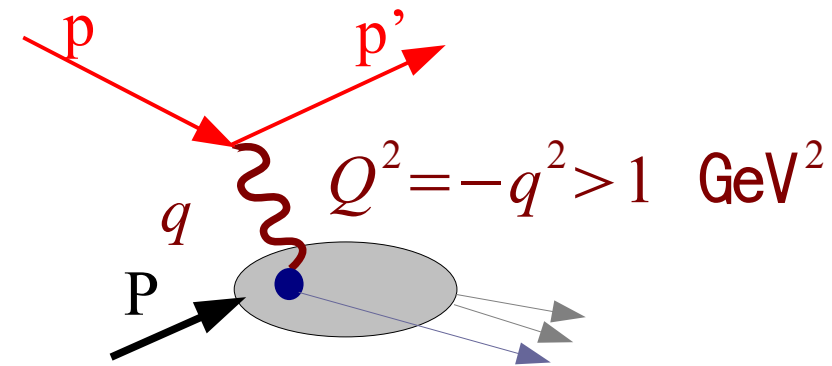
Generalized Parton Distribution

Elastic scattering



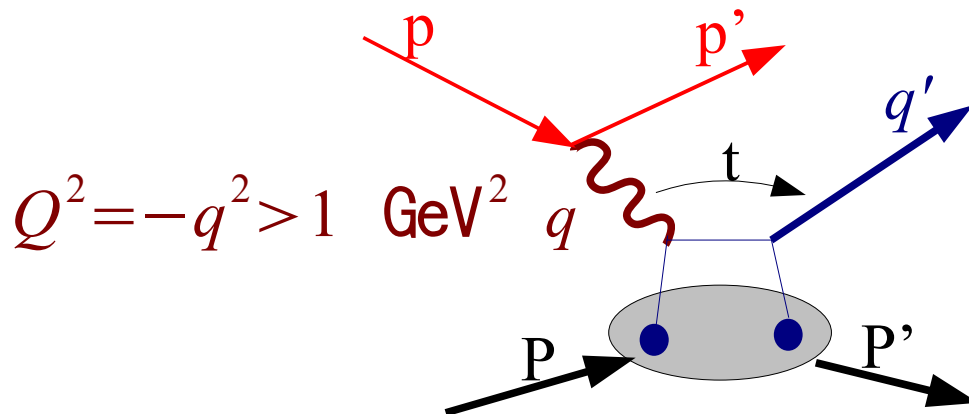
Form Factor: $F(t), G(t)$

Deep Inelastic Scattering



Parton distribution: $q(x), \Delta q(x), \delta q(x)$

Hard Exclusive Production:



$e + N \rightarrow e' + N' + \{\gamma, \rho, \pi, \dots\}$

Generalized Parton Distribution:

$H, E, \tilde{H}, \tilde{E}$

Generalized Parton Distribution

Generalized Parton Distributions

Vector	$H(x, \xi, t)$
Tensor	$E(x, \xi, t)$
Axial vector	$\tilde{H}(x, \xi, t)$
Pseudo scalar	$\tilde{E}(x, \xi, t)$ for quarks and gluon

Forward Limit: $\xi \rightarrow 0, t \rightarrow 0$

$$H^q(x, 0, 0) = q(x)$$

$$\tilde{H}^q(x, 0, 0) = \Delta q(x)$$

Form Factors:

$$\int_{-1}^{+1} dx H^q(x, \xi, t) = F_1^q(t) \text{ Dirac}$$

$$\int_{-1}^{+1} dx E^q(x, \xi, t) = F_2^q(t) \text{ Pauli}$$

$$\int_{-1}^{+1} dx \tilde{H}^q(x, \xi, t) = g_A^q(t) \text{ Axial vector}$$

$$\int_{-1}^{+1} dx \tilde{E}^q(x, \xi, t) = h_A^q(t) \text{ Pseudoscalar}$$

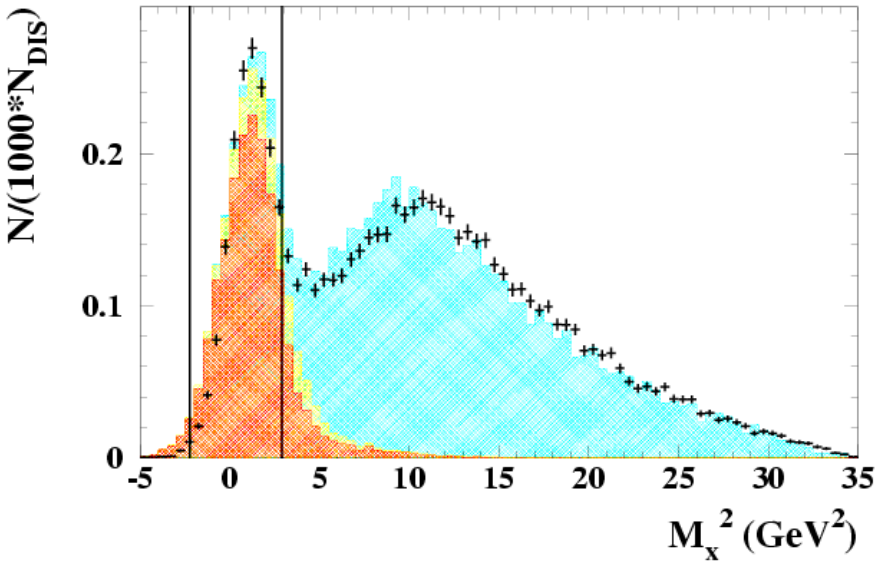
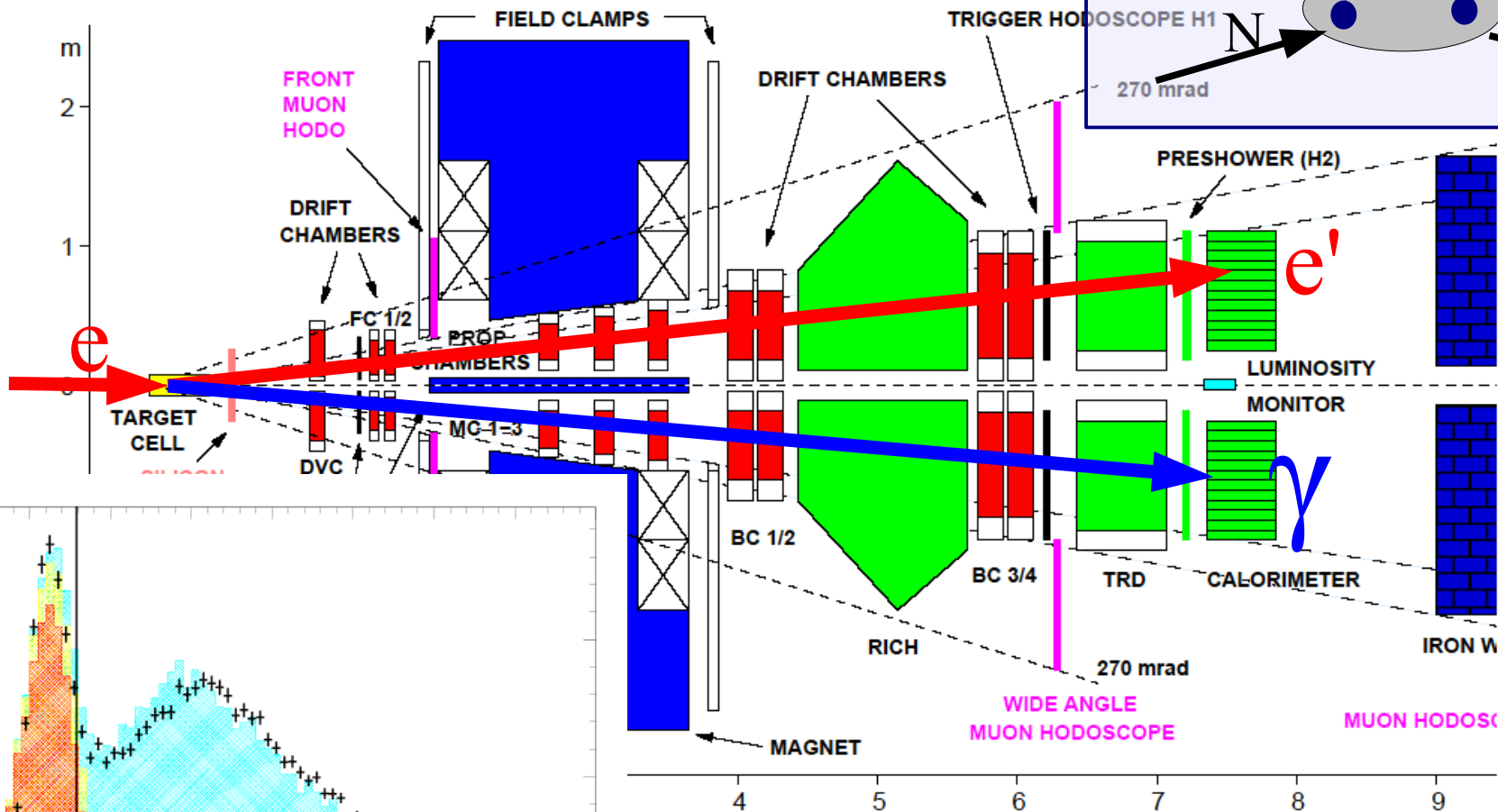
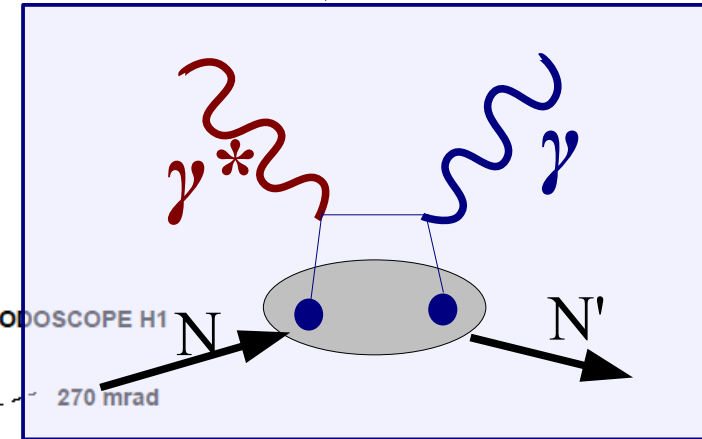
GPD and total angular momentum of parton

$$J_{q,g} = \frac{1}{2} \int_{-1}^1 dx x [H^{q,g}(x, \xi, t \rightarrow 0) + E^{q,g}(x, \xi, t \rightarrow 0)]$$

DVCS at HERMES (1996 ~ 2005)

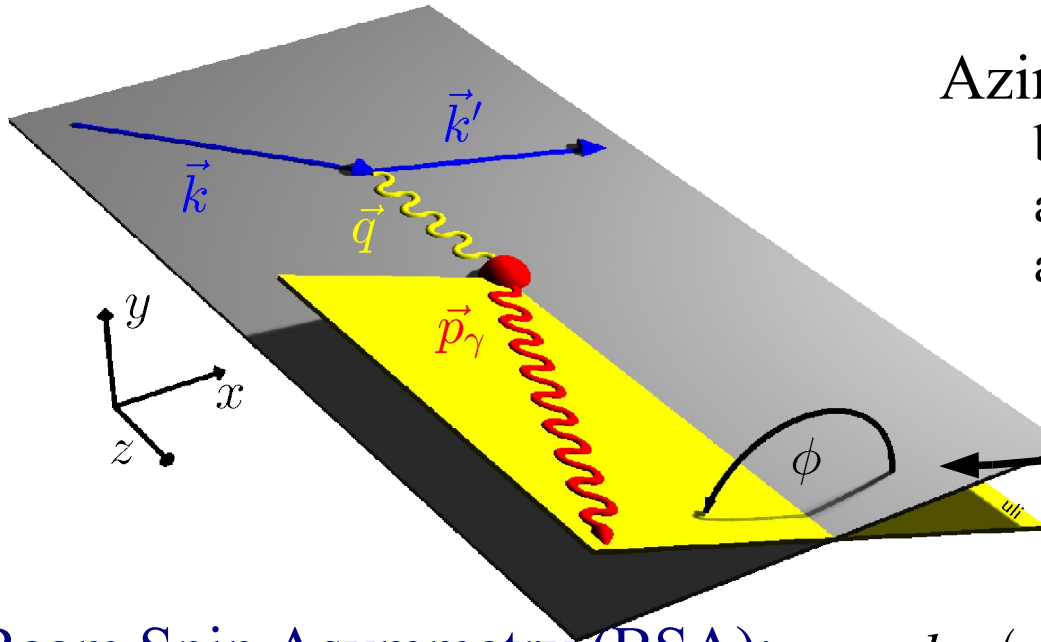
Deeply Virtual Compton Scattering:

$$e + N \rightarrow e' + N' + \gamma$$



Missing mass technique
to determine exclusive events

DVCS and azimuthal asymmetries



Azimuthal Angle: ϕ

between the lepton scattering plane
and the photon production plane
around the virtual photon momentum

$$A(\phi) = \frac{d\sigma^+(\phi) - d\sigma^-(\phi)}{d\sigma^+(\phi) + d\sigma^-(\phi)}$$

Beam Spin Asymmetry (BSA):

$$d\sigma(e^+p) - d\sigma(e^-p) \propto \text{Im} H \cdot \sin \phi$$

HERMES Collaboration, PRL87(2001)182001

Beam Charge Asymmetry (BCA):

$$d\sigma(e^+p) + d\sigma(e^-p) \propto \text{Re} H \cdot \cos \phi$$

HERMES Collaboration, PRD75(2007)011103

“unique feature of HERA”

Target Spin Asymmetry (TSA):

with longitudinal target
(H:1996~1997, D:1998 ~ 2000)

$$d\sigma(ep^{\rightarrow}) - d\sigma(ep^{\leftarrow}) \propto \text{Im} \tilde{H} \cdot \sin \phi$$

with transverse target
(H:2002~2005)

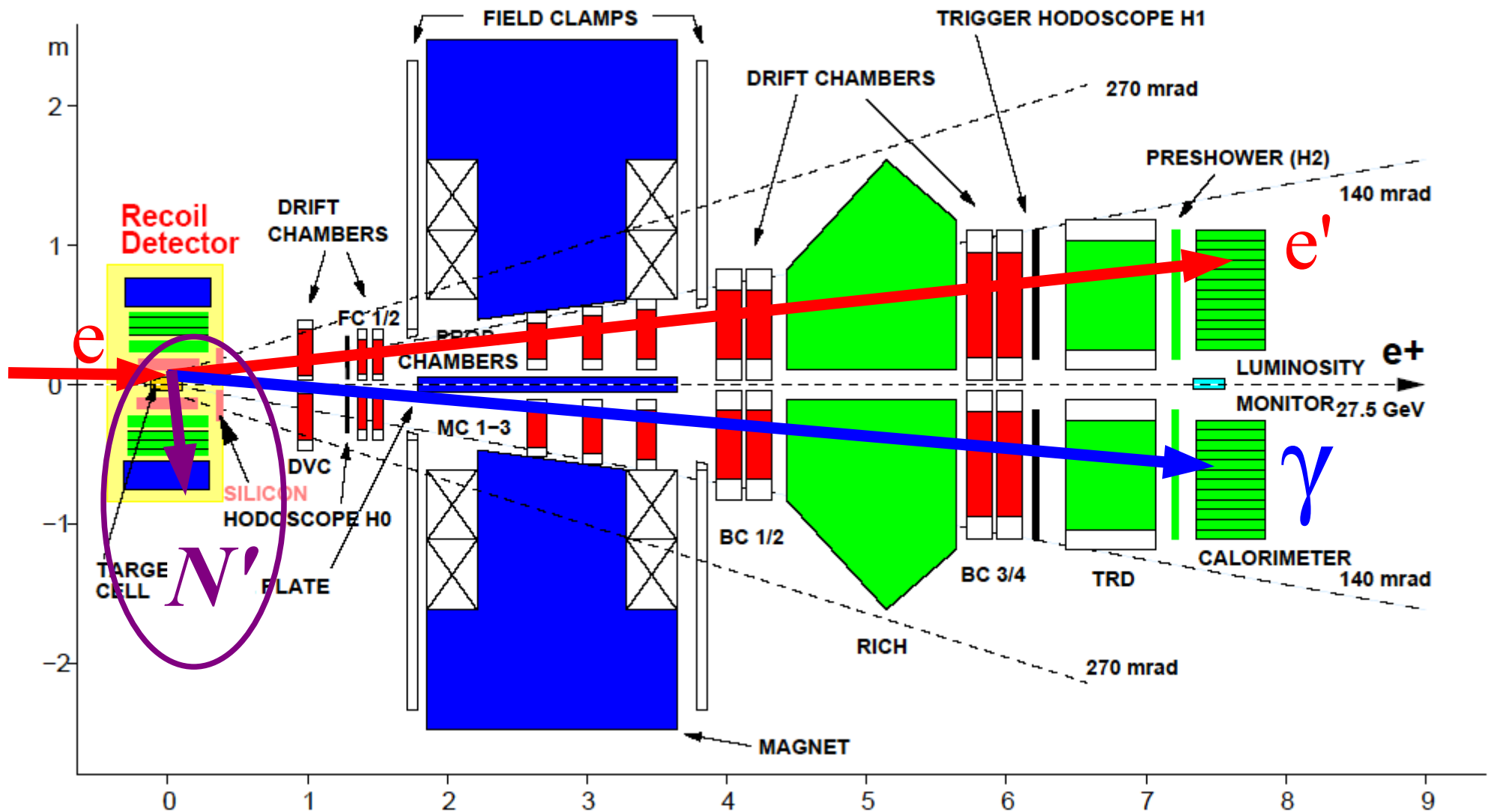
$$H, E, \tilde{H}, \tilde{E} \rightarrow J$$

HERMES Collaboration, arXiv:0802.2499

DVCS at HERMES with Recoil Detector:

2006 ~ 2007

$$e + N \rightarrow e' + N' + \gamma$$



- Sub-detectors in 1 T Solenoid Magnet

- Photon Detector

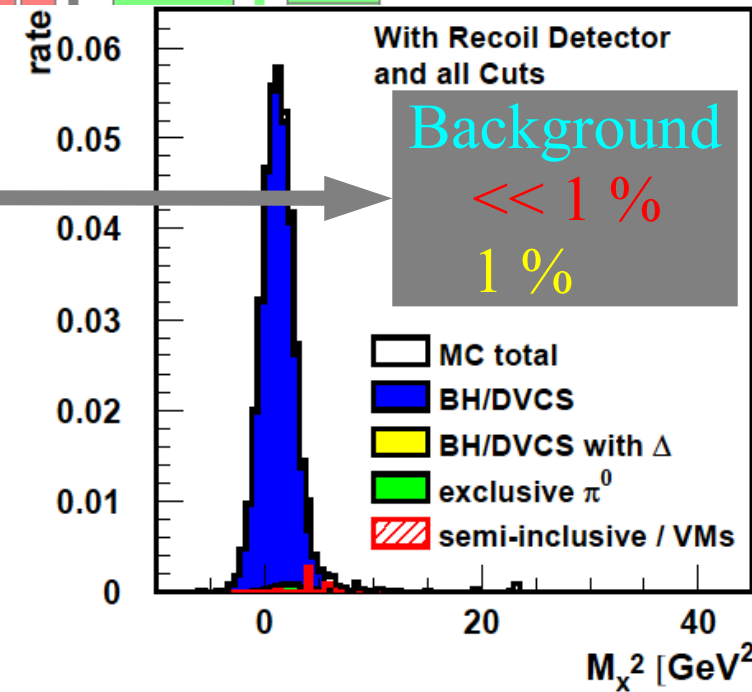
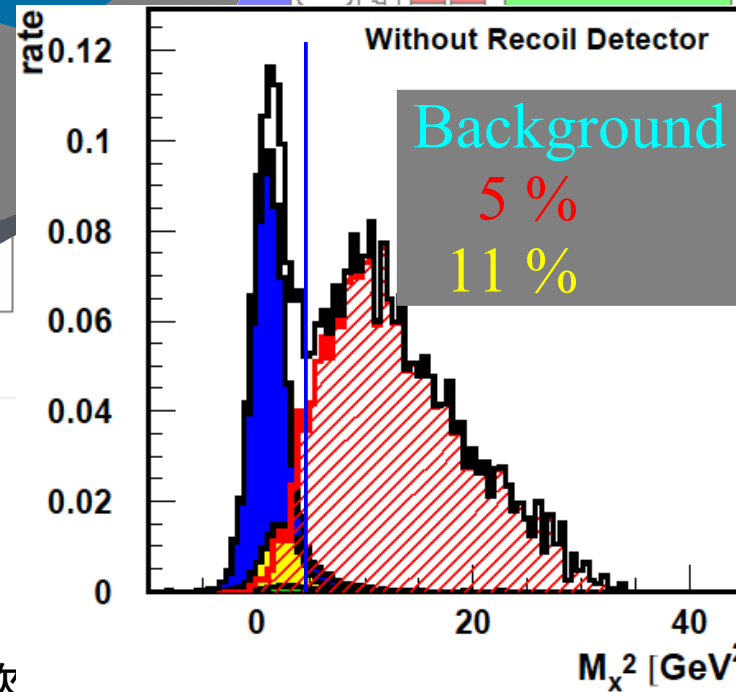
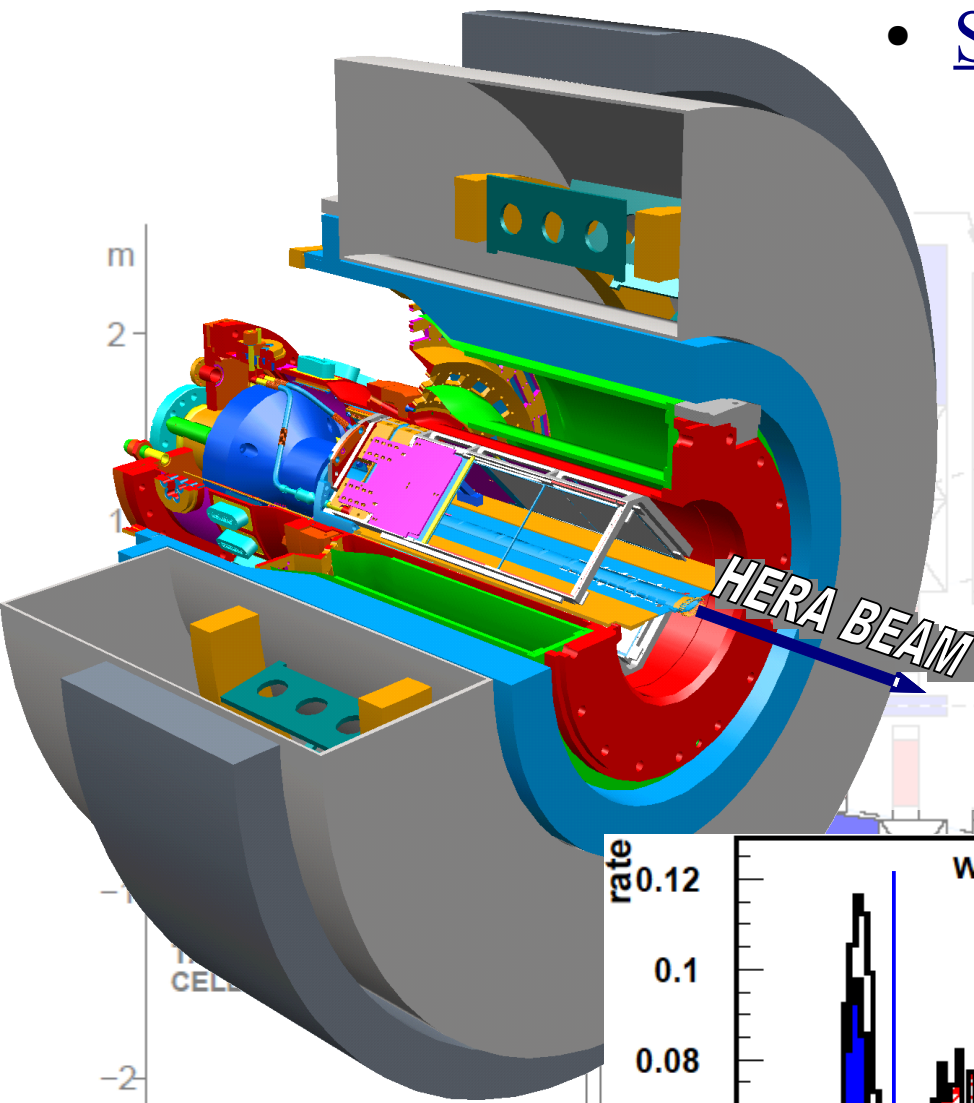
- 3 Tungsten/Scintillator layers, π^0 , π/p

- Scintillation Fiber Tracker (SFT)

- 2 x (2 Parallel and 2 Stereo layers), momentum reconstruction and π/p

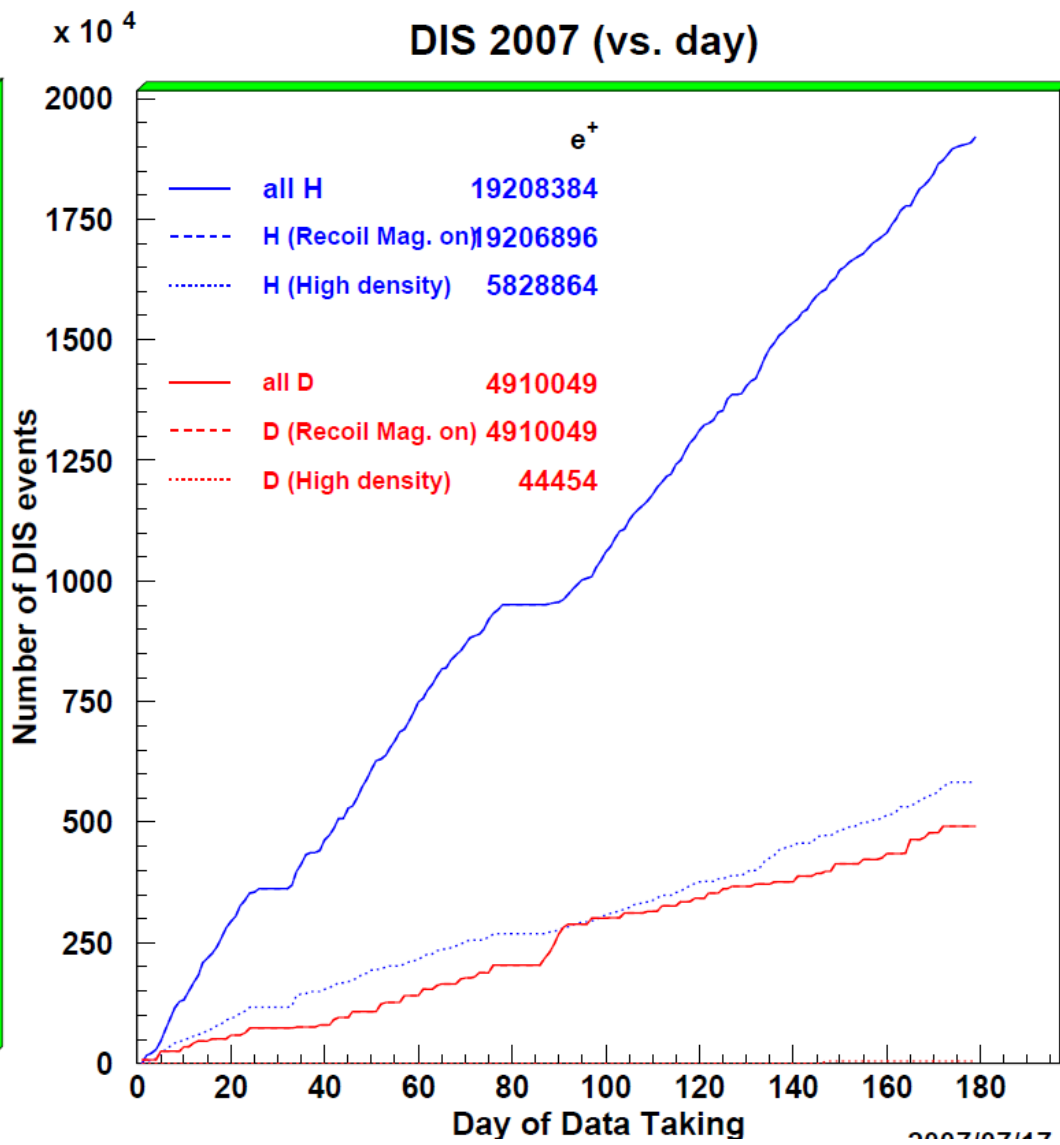
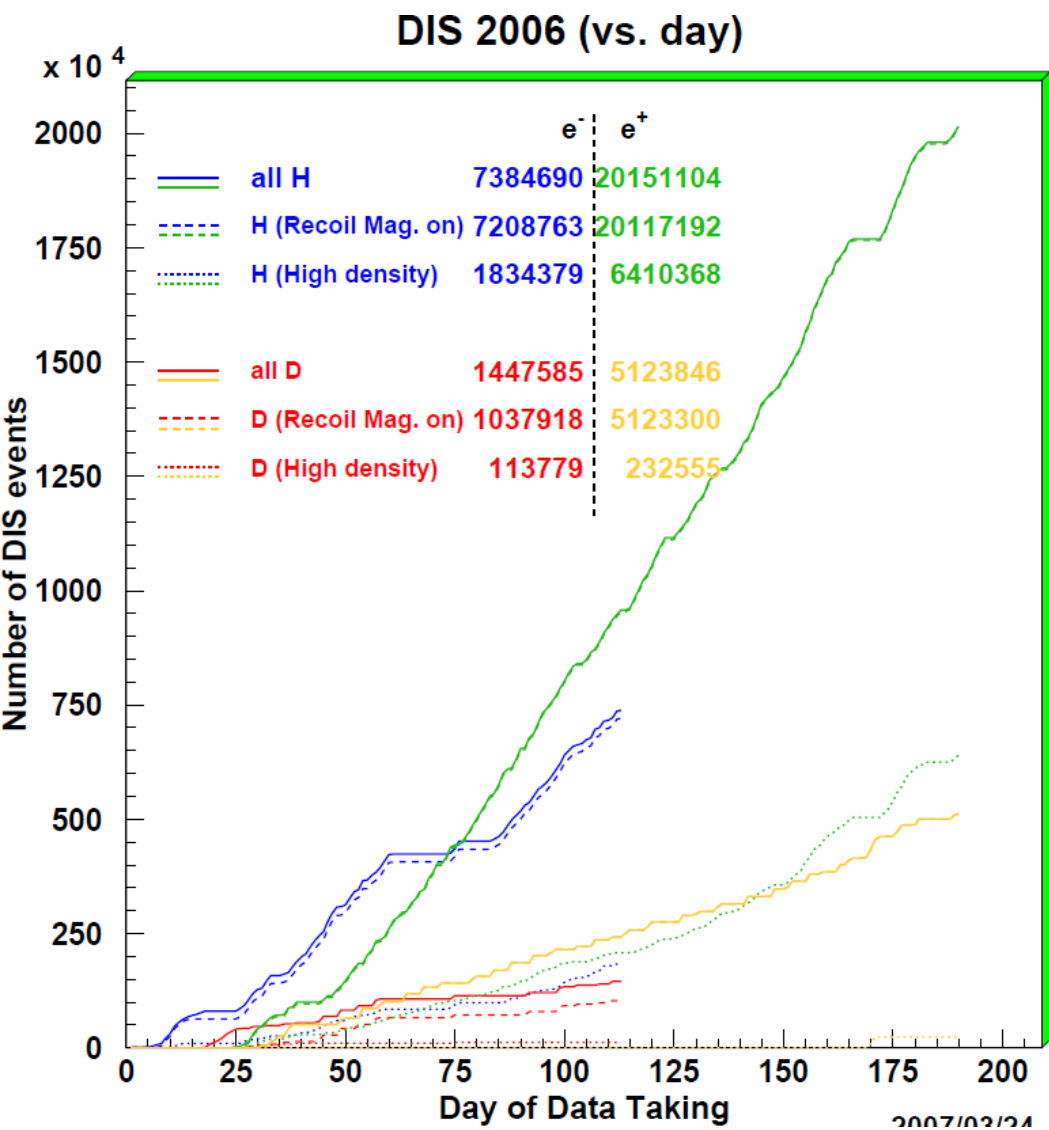
- Silicon Strip Detector (SSD)

- 2 layers of 16 double sided sensor, momentum reconstruction and π/p



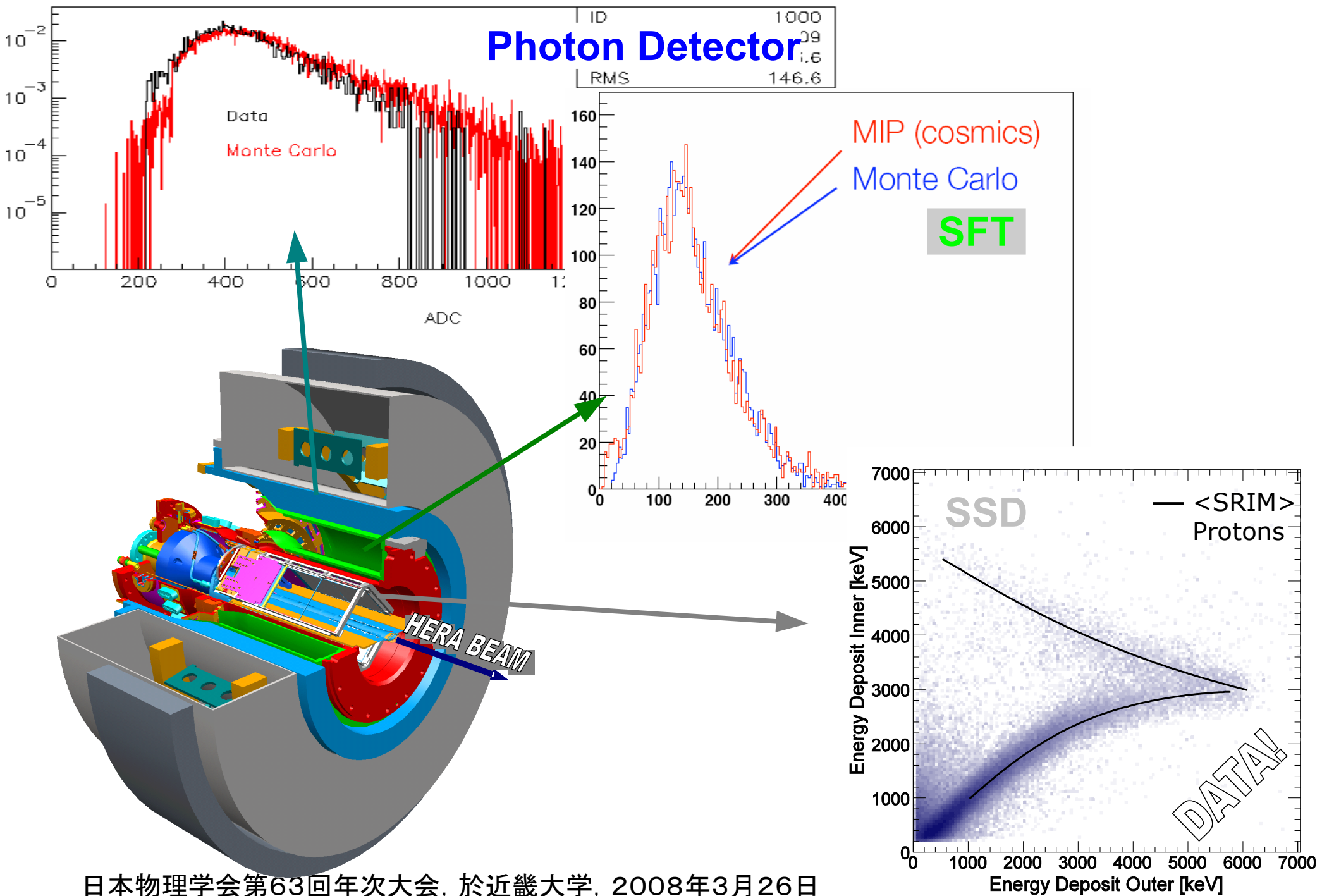
- Target

- Unpol. H, D

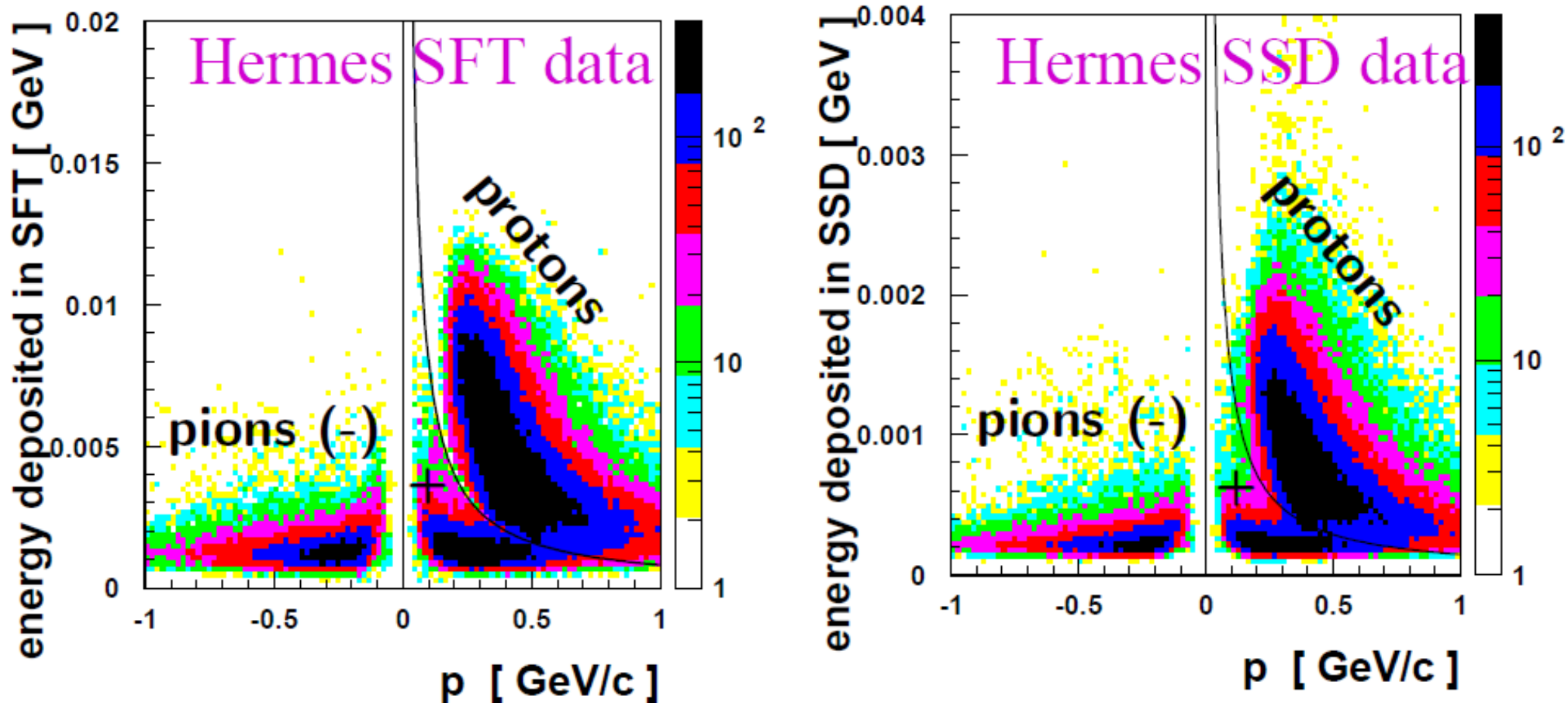


H data for BSA: 2006: e^- 7 M, e^+ 20 M DIS
 2007: e^+ 19 M DIS
 (2000: \sim 7 M)

Data from Recoil Detector



Tracking: SSD and SFT



Momentum reconstruction : $135 < p < 1200$ MeV/c

PID (π/p): $p < 700$ MeV (SFT & SSD)

$p > 650$ MeV (Photon detector)

Summary

- Generalized Parton Distribution
 - Access to total angular momentum of parton
- HERMES
 - Single Spin/Charge Asymmetries in DVCS
 - without Recoil detector: 1996 ~ 2005
 - Missing mass technique to select exclusive events
 - BSA, BCA, LTSA, and **TTSA**
 - Recoil detector: 2006 ~ 2007
 - Reduced background:
 - SIDIS (**5%** → **<< 1%**), Resonance (**11%** → **1%**)
 - With unpol targets: 50M DIS (H)
 - Detector calibration, tracking improvement, and alignment
 - Physics analysis (**BSA and BCA**)

End