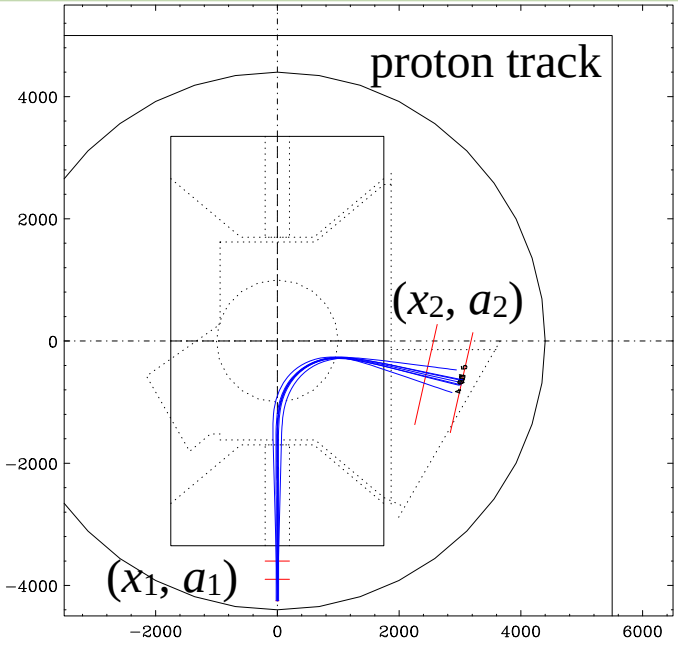
Memo
on
Setup for proton in (γ,p)-type exp

Proton detection setup

- Setup (mostly from Panin's proposal)
  - B= 2.9 T
  - E_B= 250 MeV/u
  - Z_T= -4250 mm



- Resolution estimated from simple transfer matrix

$$\begin{pmatrix} x_2 \\ a_2 \\ \delta_2 \end{pmatrix}_{\text{PDC}} = \begin{pmatrix} (x|x) & (x|a) & (x|\delta) \\ (a|x) & (a|a) & (a|\delta) \\ 0 & 0 & (\delta|\delta) \end{pmatrix} \begin{pmatrix} x_1 \\ a_1 \\ \delta_1 \end{pmatrix}_{\text{target}}$$

$$\begin{pmatrix} -1.86 & -5.37 & -21.42 \\ 1.15 & 3.84 & 8.71 \\ 0 & 0 & 1 \end{pmatrix}$$

x [mm], a [mrad], δ [%]

2 analysis/setup methods

- BDC, SSD & PDC : $(x_1, a_1, x_2) \rightarrow \delta$

$$\delta = -\frac{(x|x)}{(x|\delta)}x_1 - \frac{(x|a)}{(x|\delta)}a_1 + \frac{1}{(x|\delta)}x_2$$

coef:	0.087	0.25	-0.047	
σ(δ):	0.03	0.30	0.02	→ σ(δ) = 0.30 %

- assumed resolution
  - σ(x_1)~ 0.3 mm ; BDC's
  - σ(a_1)~ 1.2 mrad ; SSD's
  - σ(x_2)~ 0.5 mm ; PDC's
  - σ(a_2)~ 2 mrad ; PDC's

- BDC & PDC w/o SSD : $(x_1, x_2, a_2) \rightarrow (\delta, a_1)$

$$\delta = -\frac{(x|a)(a|x) - (a|a)(x|x)}{D_{eff}}x_1 + \frac{(a|a)}{D_{eff}}x_2 - \frac{(x|a)}{D_{eff}}a_2 \qquad D_{eff} = (a|a)(x|\delta) - (x|a)(a|\delta)$$

coef:	-0.03	-0.11	0.15	-35.6 [mm/%]
σ(δ):	0.01	0.05	0.30	→ σ(δ)= 0.31 %

$$a_1 = \frac{(x|x)(a|\delta) - (a|x)(x|\delta)}{D_{eff}}x_1 - \frac{(a|\delta)}{D_{eff}}x_2 + \frac{(x|\delta)}{D_{eff}}a_2$$

coef:	0.24	-0.24	-0.60	
σ(a_2):	0.07	0.12	1.20	→ σ(a_2) = 1.21 [mrad]

Tentative summary

- momentum (δ) & emission angle (a_1) resolution of proton in (γ,p)-typw experiment
  - estimated using simple transfer matrix : geometry shown in page 2
  - w/o multiple scattering effect in target, SSD's, He in gap chamber, & PDC's
- 2 possible setups
  - original setup (setup1) : using BDC, SSD, & PDC's
    - x_1 (from BDC's), a_1 (from SSD's), x_2 (from PDC's) → δ

$$\delta \approx -\frac{(x|a)}{(x|\delta)} a_1 \qquad \sigma(\delta) \sim 0.3\ \%$$

  - alternative setup (setup2) : using BDC & PDC's without using SSD's
    - x_1 (from BDC's), x_2 & a_2 (from PDC's) → a_1, δ

$$\delta \approx -\frac{(x|a)}{D_{eff}} a_2 \qquad \sigma(\delta) = 0.3\ \%$$

$$a_1 \approx \frac{(x|\delta)}{D_{eff}} a_2 \qquad \sigma(a_2) = 1.2\ [\text{mrad}]$$

- assumed resolution
  - σ(x_1)~ 0.3 mm ; BDC's
  - σ(a_1)~ 1.2 mrad ; SSD's
  - σ(x_2)~ 0.5 mm ; PDC's
  - σ(a_2)~ 2 mrad ; PDC's

- momentum resolution for proton is comparable between setup1 & setup2
- proton emission angle (a_1) resolution, important for relative energy analysis, in setup2 without using SSD's is comparable to the direct measurement using SSD's

- From those simple estimate, (γ,p)-type experiment can be performed without SSD's
- Is conclusion different from full simulation?