Polarization Update

Justin Stevens

GlueX Bi-weekly: March 16

Jefferson Lab

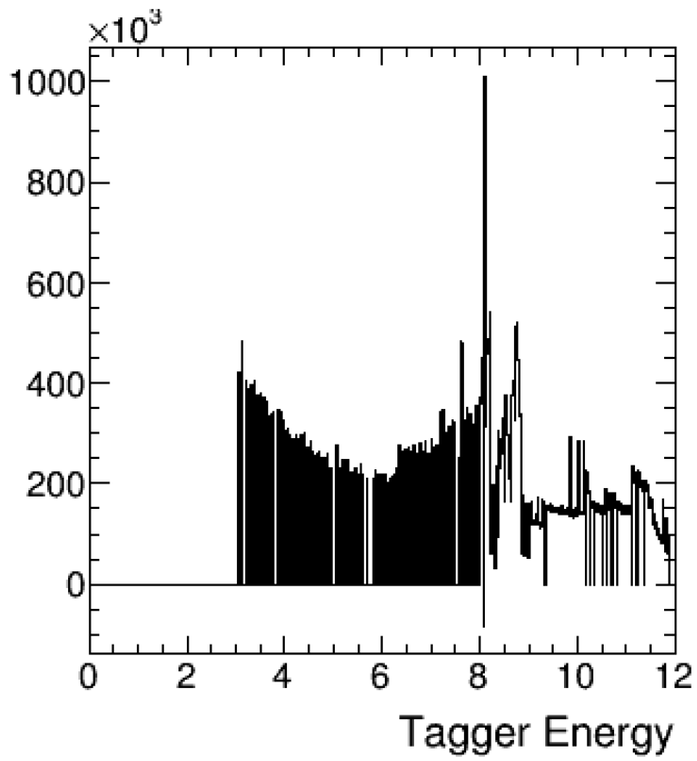
Photon polarization studies

- Methods for measuring polarization:
  - Coherent Bremsstrahlung Shape Analysis (CBSA)
  - Triplet Polarimeter (TPOL)
  - Asymmetry for ρ production
- 3 diamonds used this spring:
  - J1A50: 50 μm diamond used for the last ~year in Hall D
  - JD70-118 and 119: 20 μm diamonds delivered in March
- All relevant data collected so far with 5 mm collimator hole

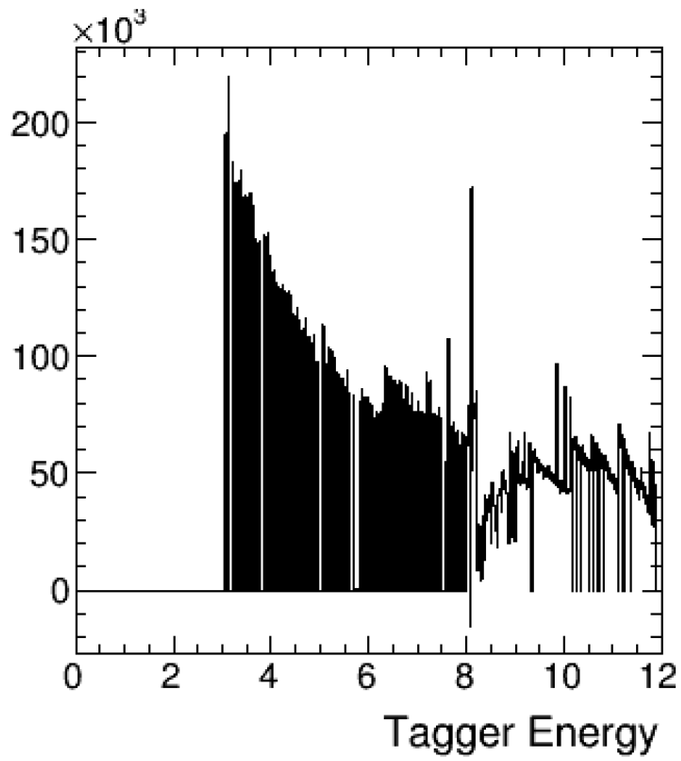
Coherent Bremsstrahlung Shape Analysis (CBSA)

- Determine enhancement = diamond/amorphous using accidental subtracted Tagger-SC coincidences or PS triggered events
- Fit enhancement data to phenomenological model including diamond and collimation characteristics to extract polarization (**Ken Livingston**)

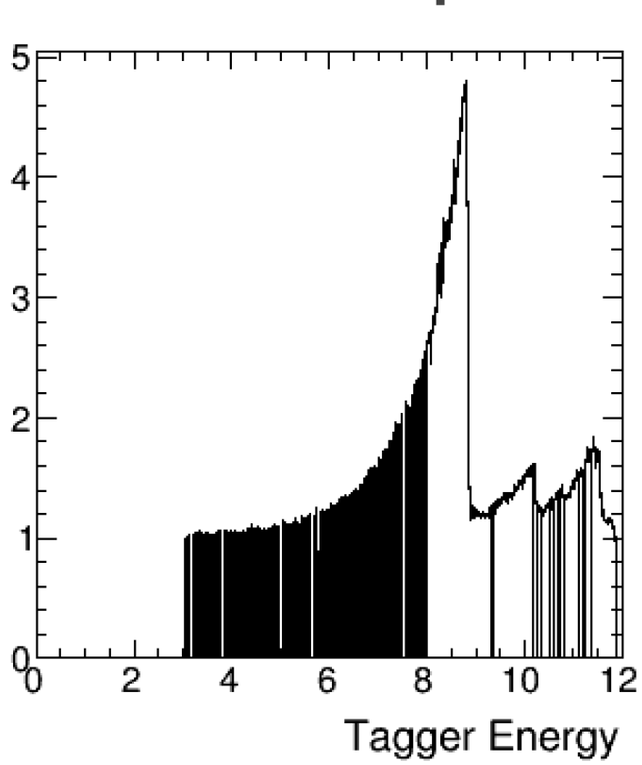
Run 10492: 50 µm diamond



Run 10491: Amorphous

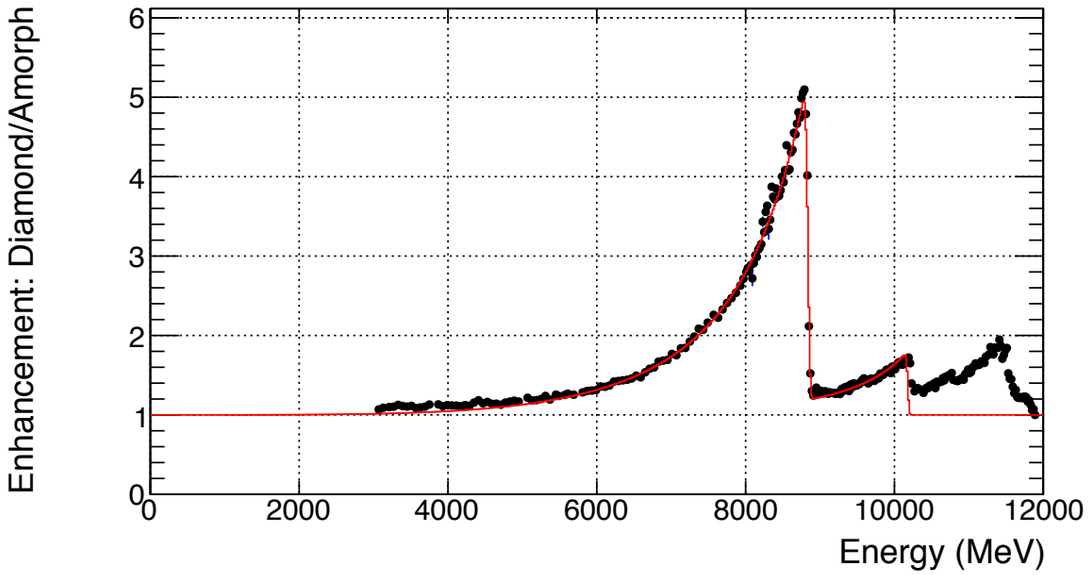


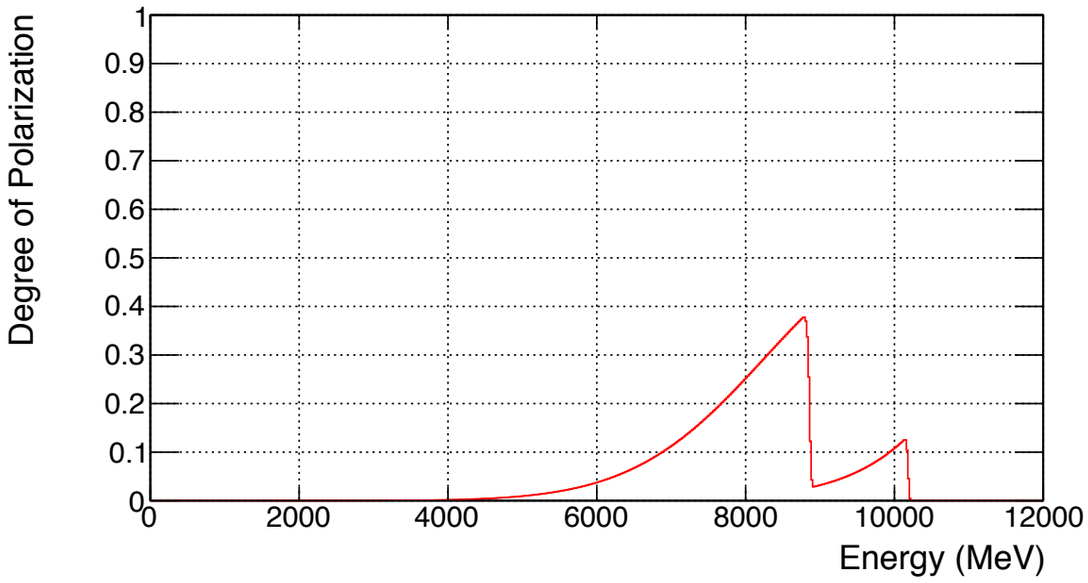
Enhancement: Diamond/Amorphous



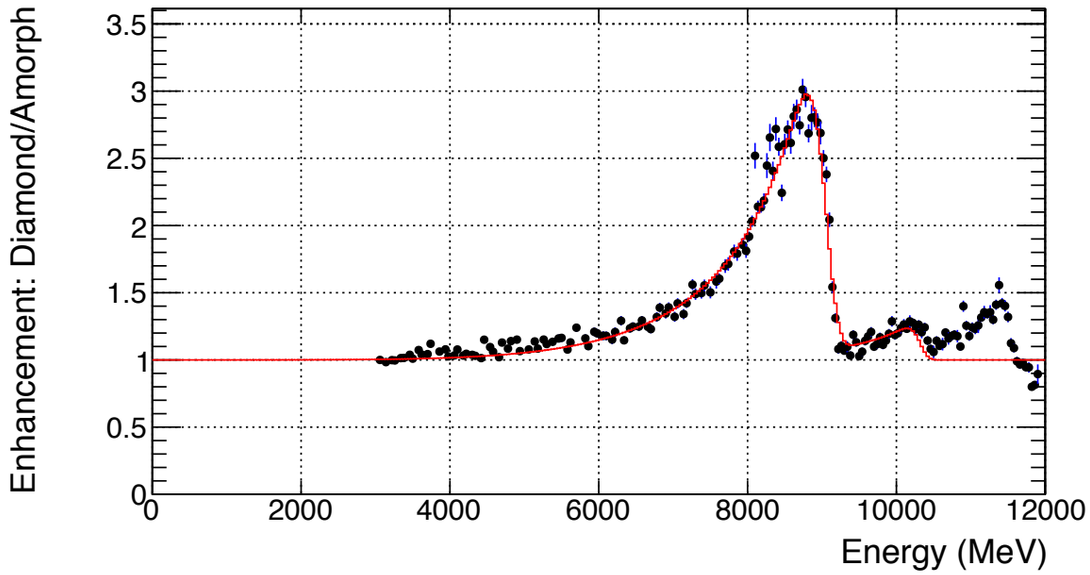
Coherent Bremsstrahlung Shape Analysis (CBSA)

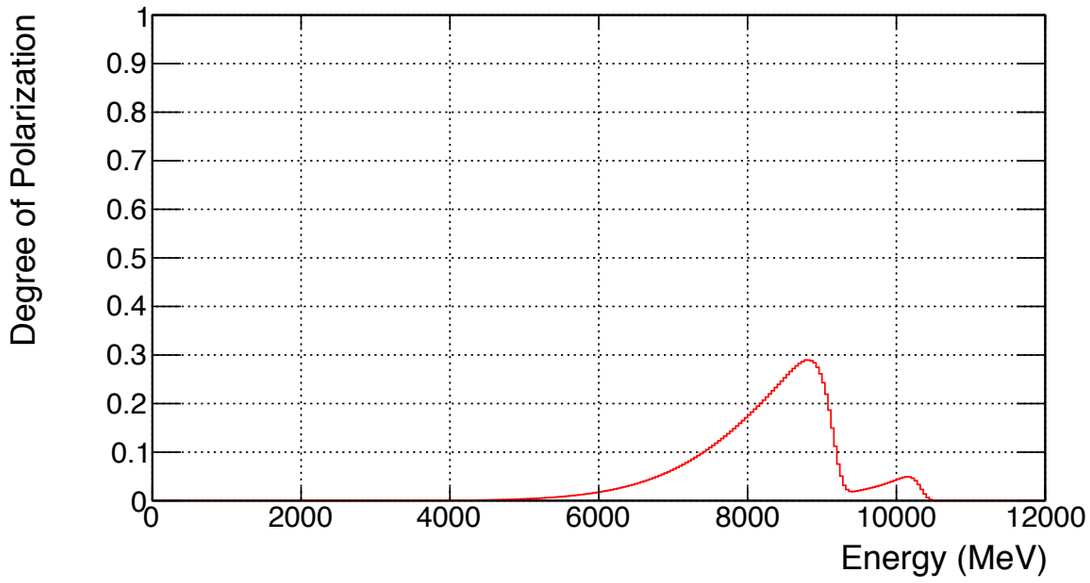
Run 10492: 50 µm diamond





Run 10782: 20 µm diamond



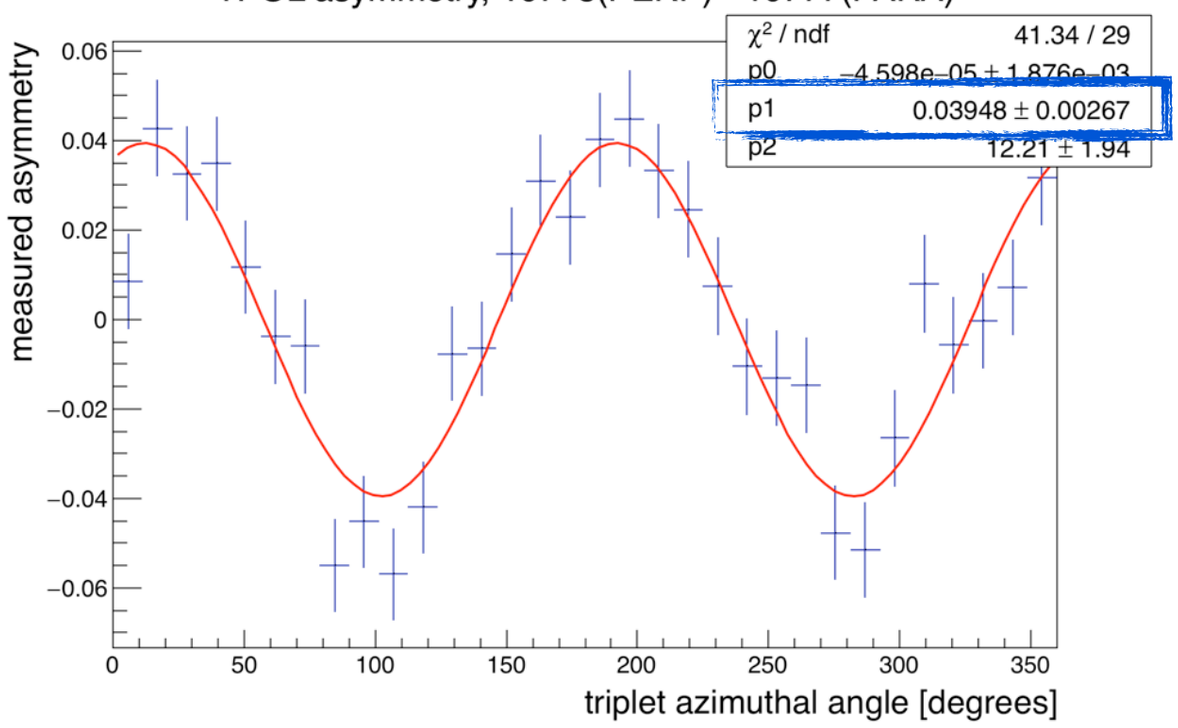


- Work ongoing to better understand accidental subtraction, especially at high rates
- Could be causing reduced enhancements at high rate with 20 µm diamond

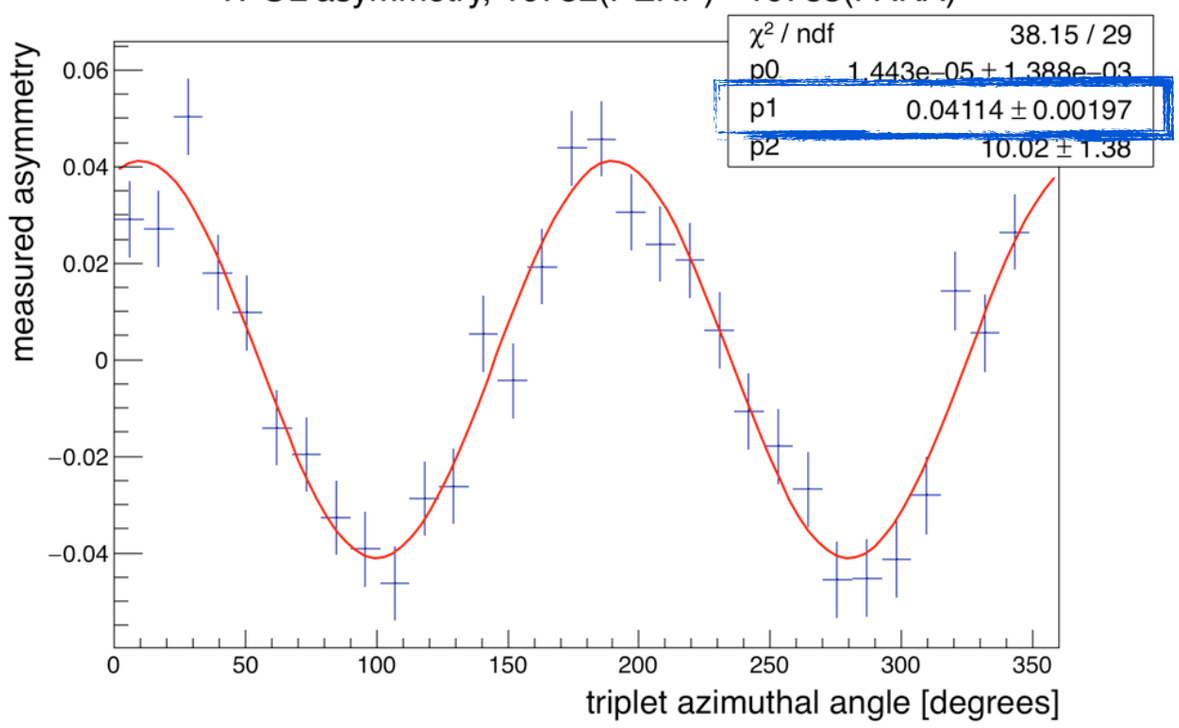
Triplet polarimeter (TPOL) asymmetry

- Triplet production ϕ_e asymmetry: $\gamma e^- \rightarrow e^- e^+ e^-$
- Independent analyses ongoing by Nathan and Mike
- **Nathan:** comparison of 20 and 50 μm diamonds with 750 μm converter

50 μm diamond (J1A50)



20 μm diamond (JD70-118)

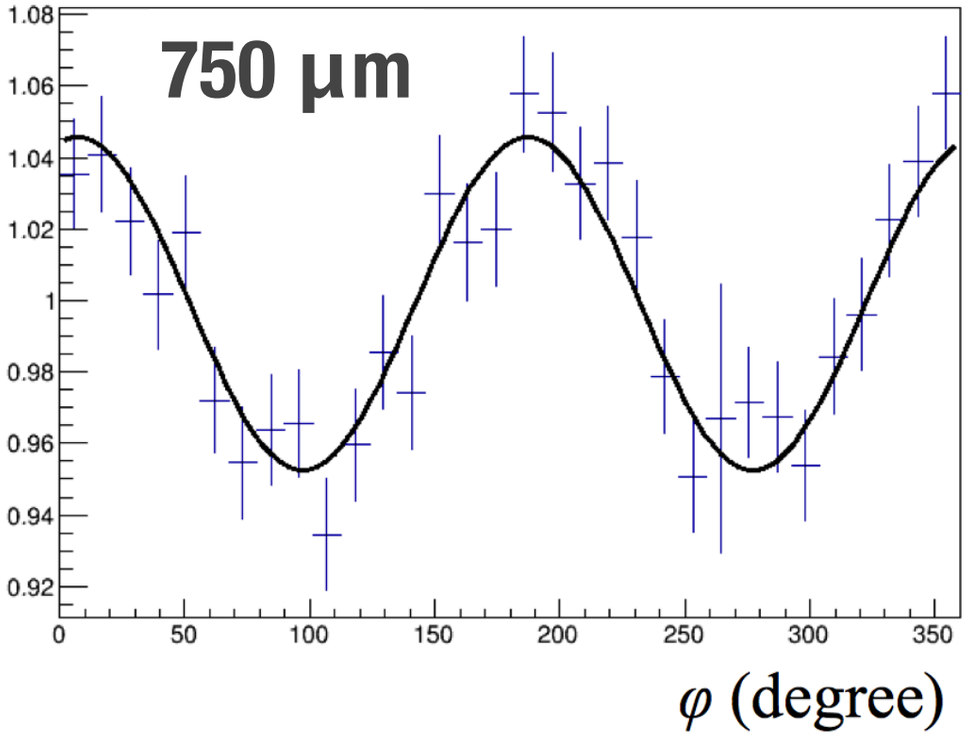


Require PS pair energy between 8.4 and 9.2 GeV

https://logbooks.jlab.org/entry/3390445

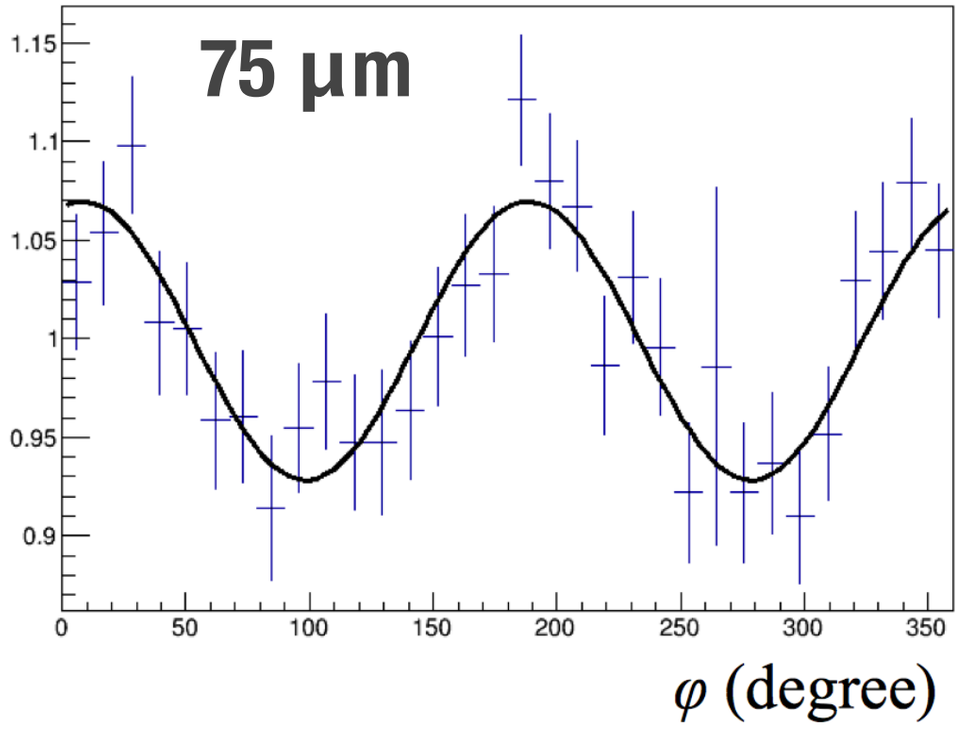
Triplet polarimeter (TPOL) asymmetry

- Triplet production ϕ_e asymmetry: $\gamma e^- \rightarrow e^- e^+ e^-$
- Independent analyses ongoing by Nathan and Mike
- **Mike:** comparison of 75 and 750 μm converter with 50 μm diamond



Raw asymmetry = 0.047(4)

Preliminary polarization = 0.36(3)



Raw asymmetry = 0.071(9)

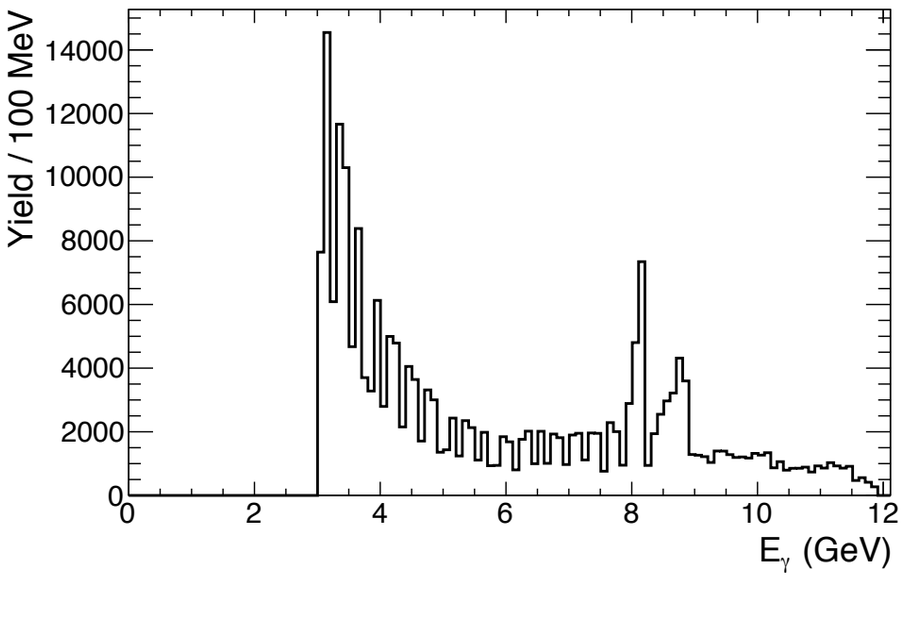
Preliminary polarization = 0.36(4)

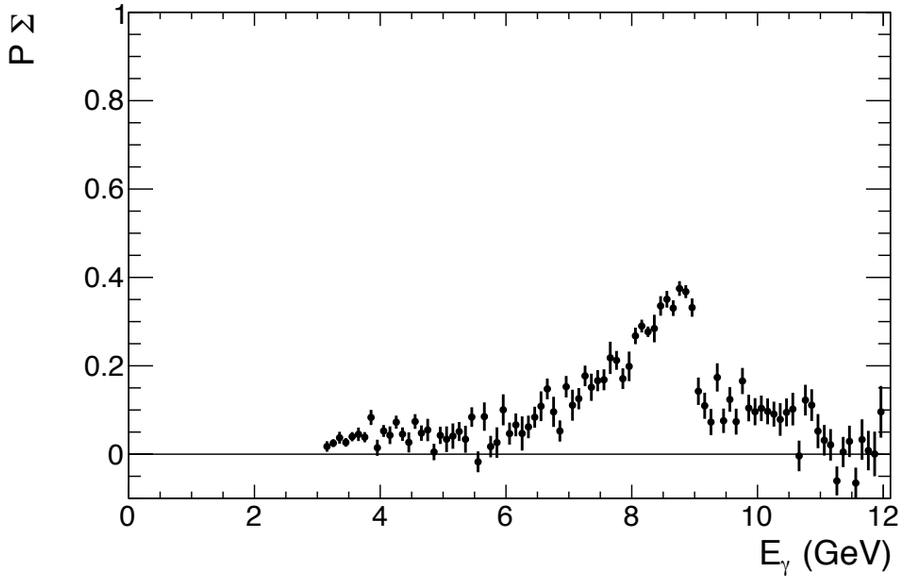
Require PS pair energy between 8.4 and 9.2 GeV

http://lc.asu.edu/~dugger/TPOL/polUpdate3-14-2016.pdf

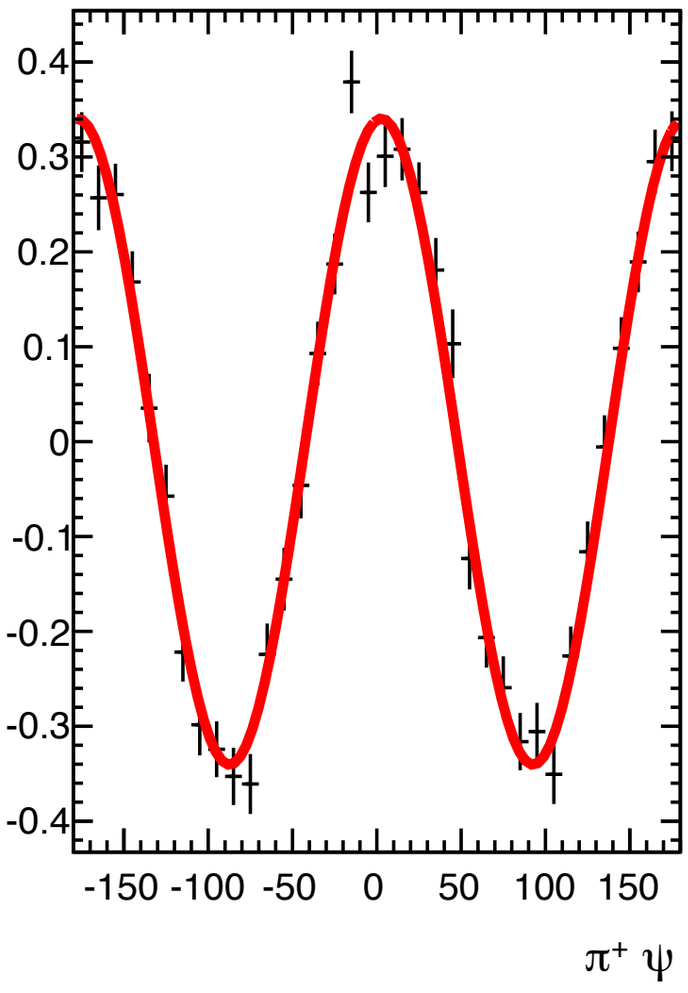
ρ asymmetry: 50 μm diamond (J1A50)

- **Runs 10491-10498**: ~38K ρ events in 8.4 < E_γ < 9 GeV
- Fit asymmetry in bins of E_γ





$$\frac{N_{||} - N_{\perp}}{N_{||} + N_{\perp}} = P\Sigma \cdot cos2\psi$$



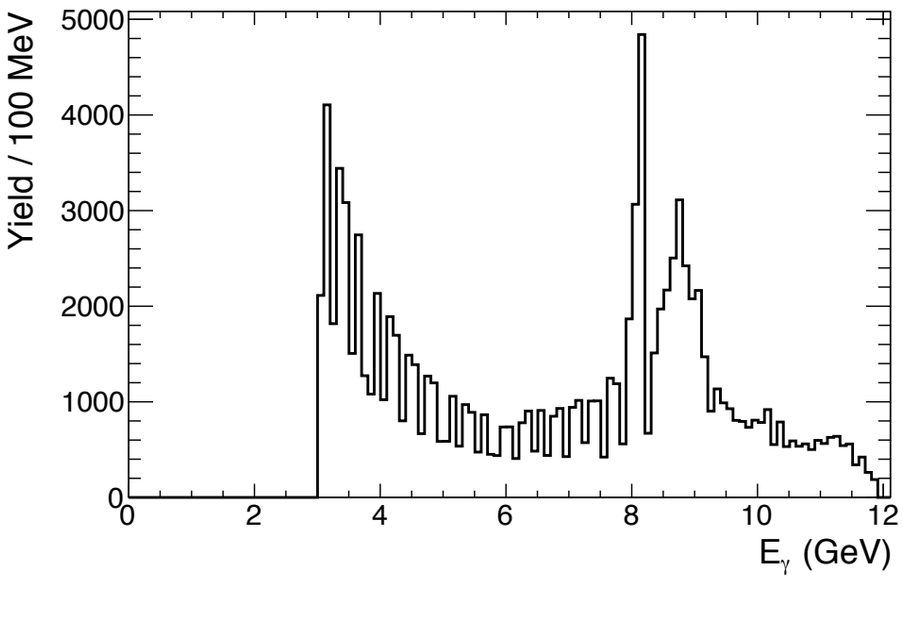
Integrated over 8.4 < E_γ < 9 GeV:

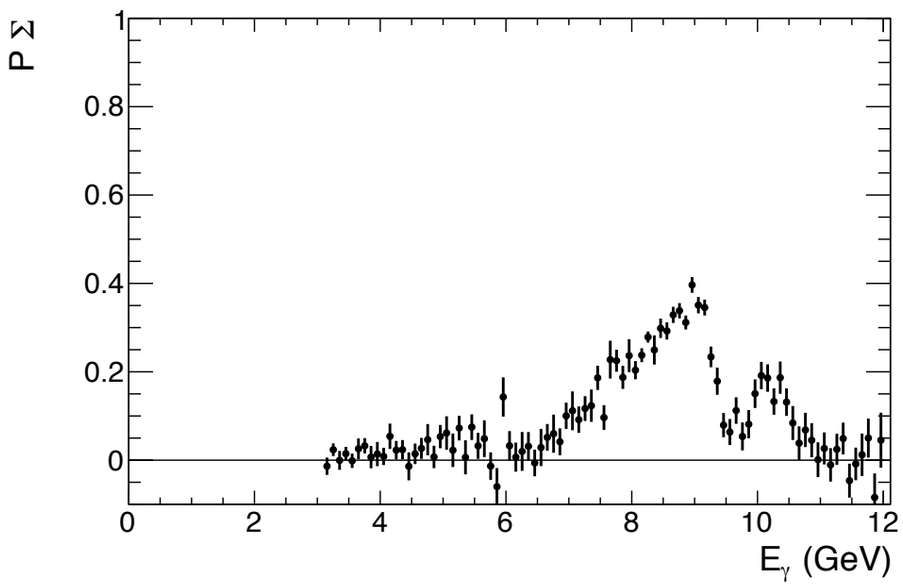
PΣ = 0.341 ± 0.007

ρ asymmetry: 20 μm diamond (JD70-118)

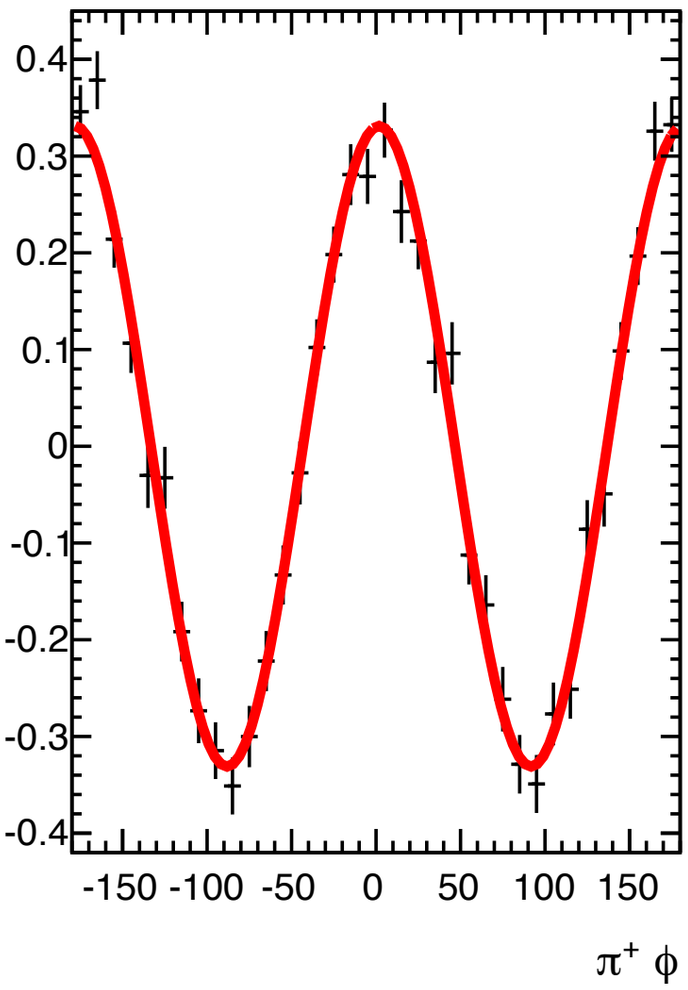
- **Runs 10782-10783**: ~30K ρ events in 8.4 < E_γ < 9 GeV
- Fit asymmetry in bins of E_γ

More statistics available





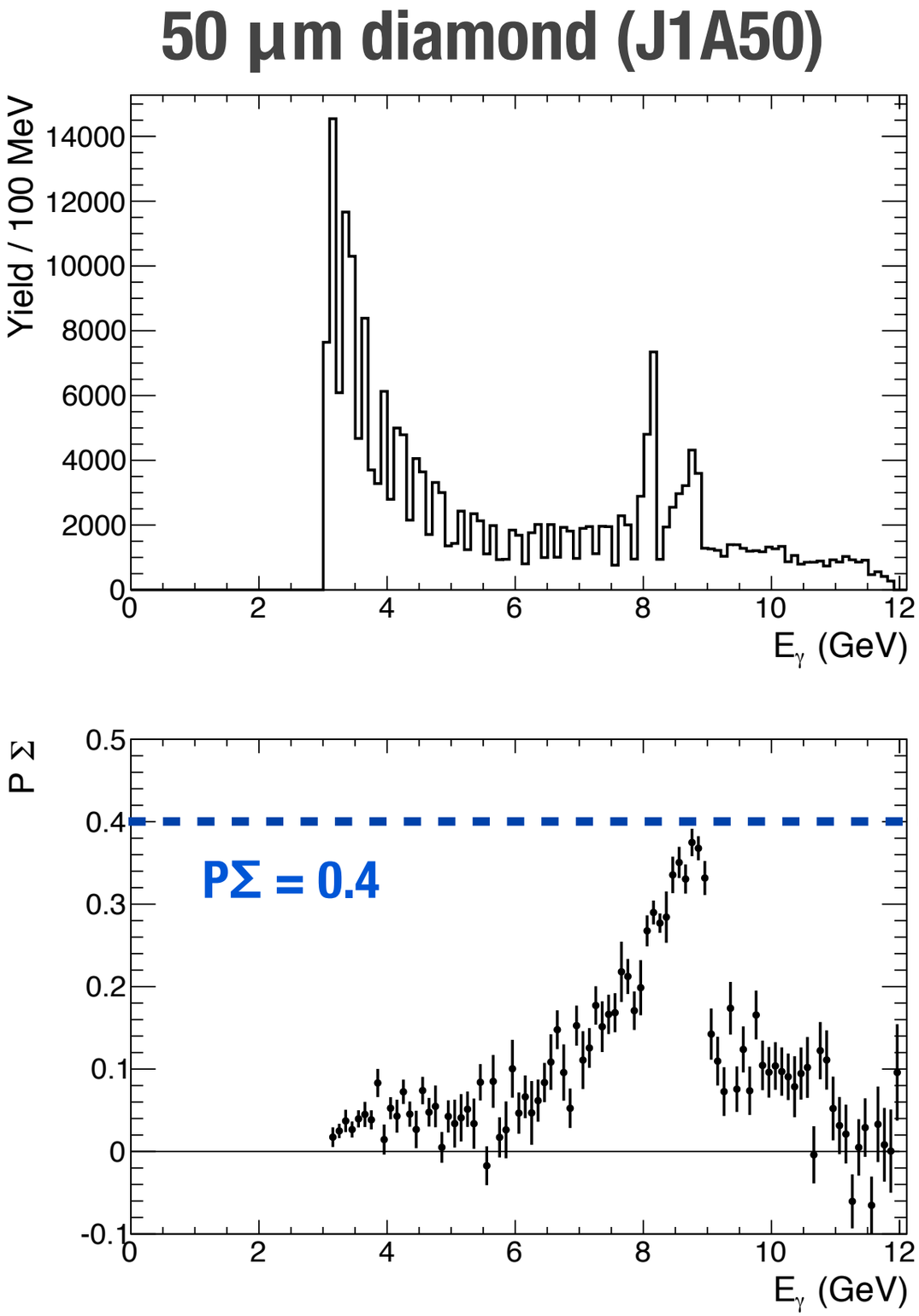
$$\frac{N_{||} - N_{\perp}}{N_{||} + N_{\perp}} = P\Sigma \cdot cos2\psi$$

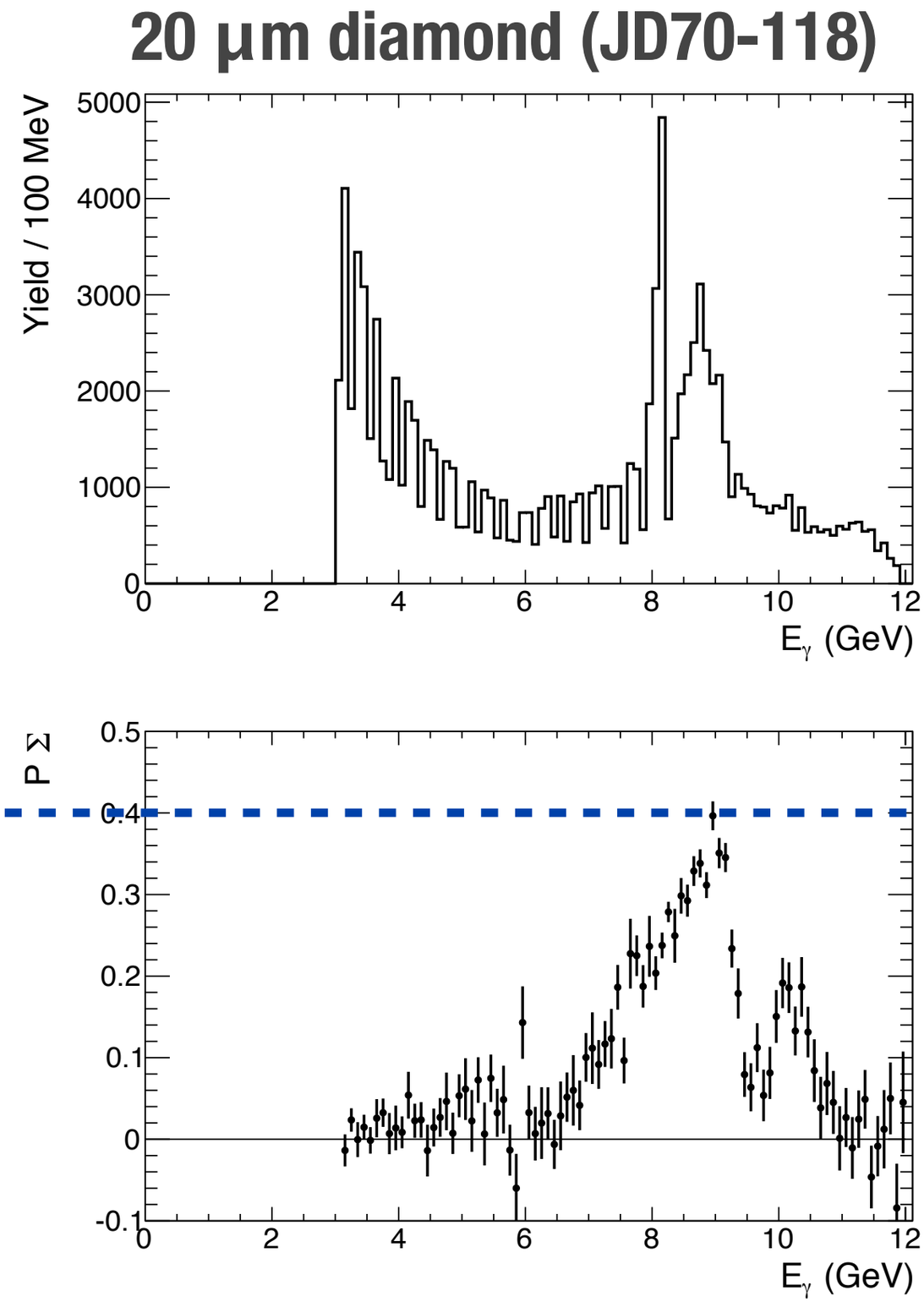


Integrated over 8.4 < E_γ < 9 GeV:

PΣ = 0.331 ± 0.007

ρ asymmetry: 50 vs 20 μm (JD70-118)



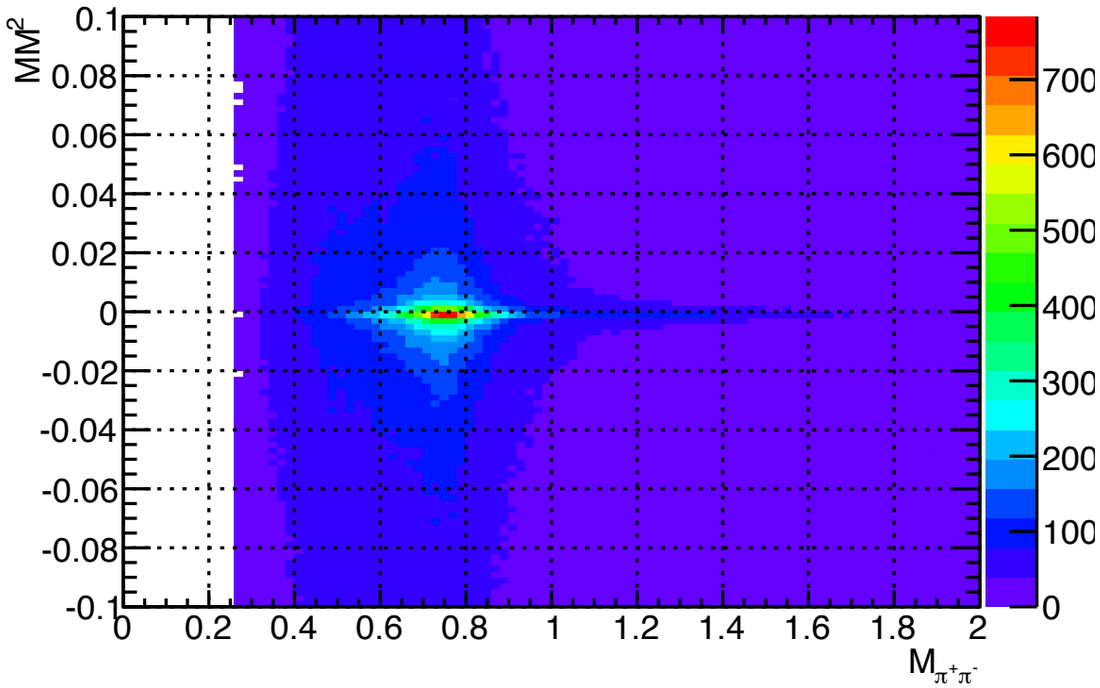


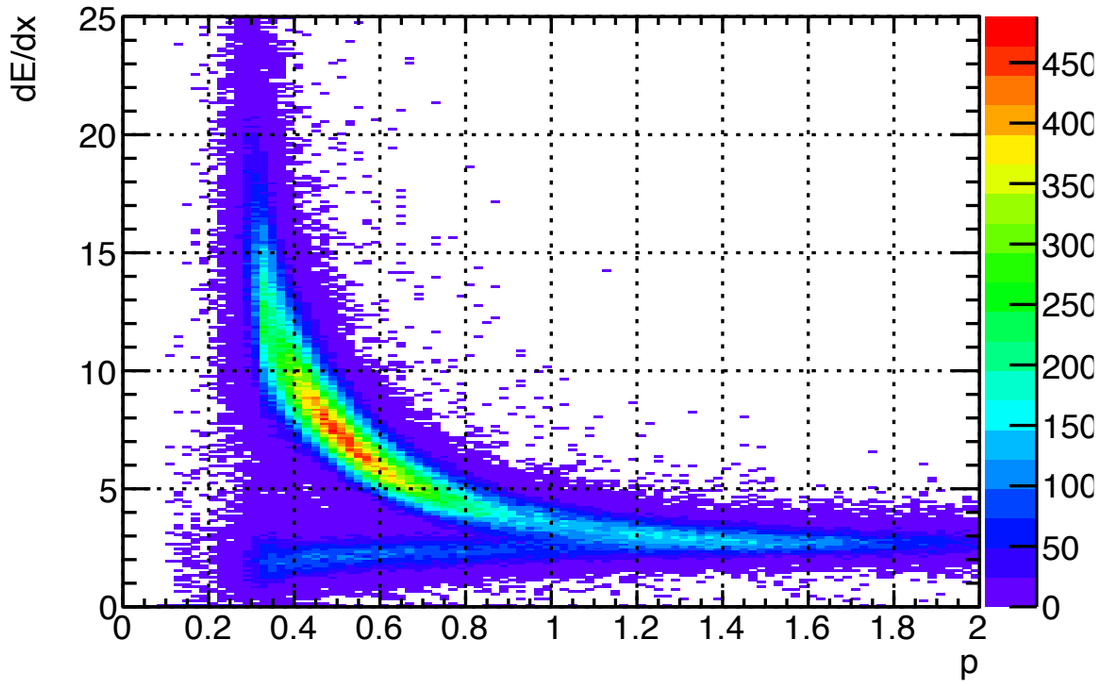
Summary

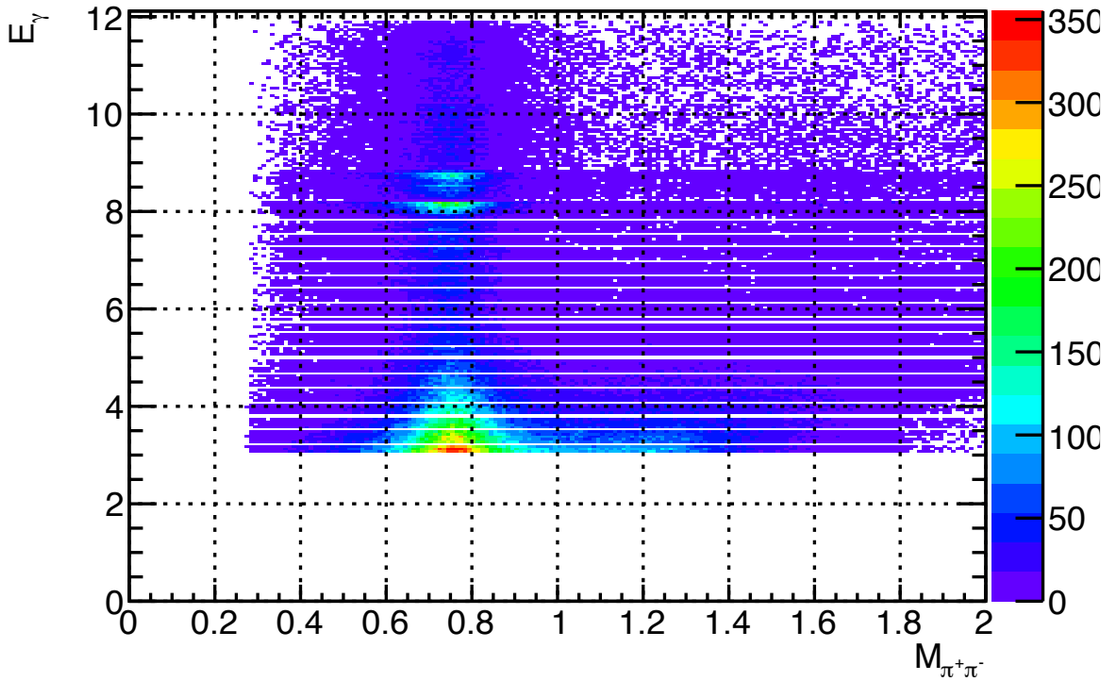
- We have three independent methods for evaluating the photon beam polarization which all have some benefits and limitations
- The observed asymmetries are consistent between the three diamonds we're currently using with the 5 mm hole
  - When beam comes back we will use the tighter 3.4 mm collimator to study it's impact on polarization; some benefit expected for 20 um diamonds
- Continue parallel analyses to continue understanding polarization systematics over the range of beam conditions we've seen so far this spring

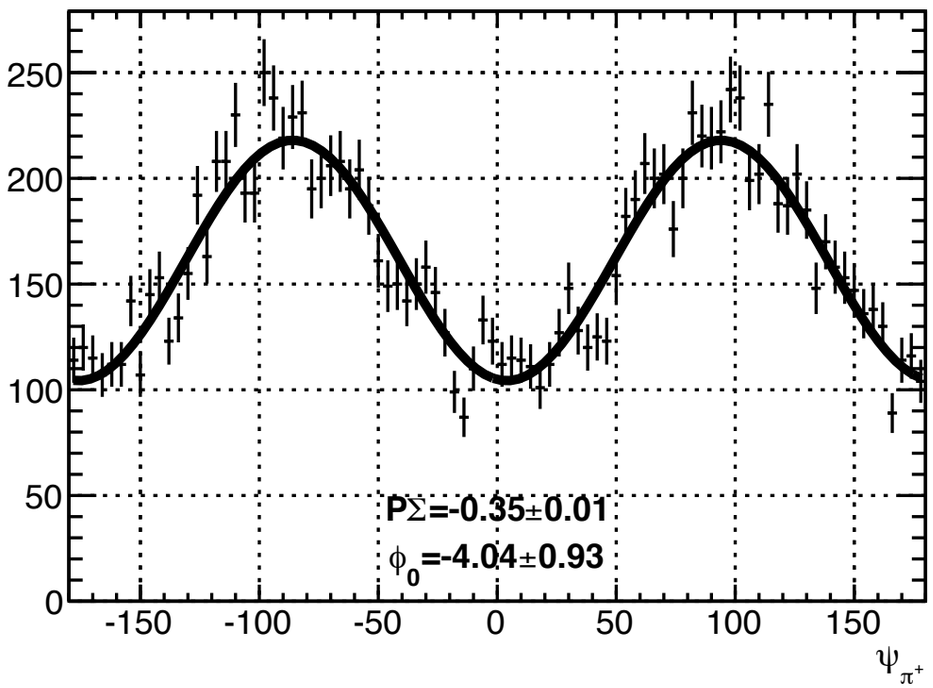
Backup

ρ event selection





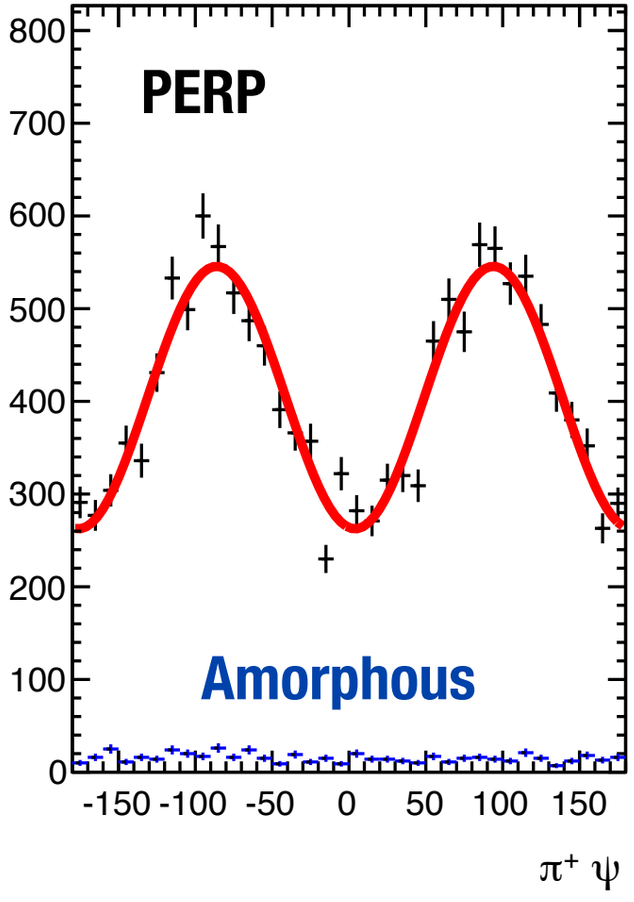


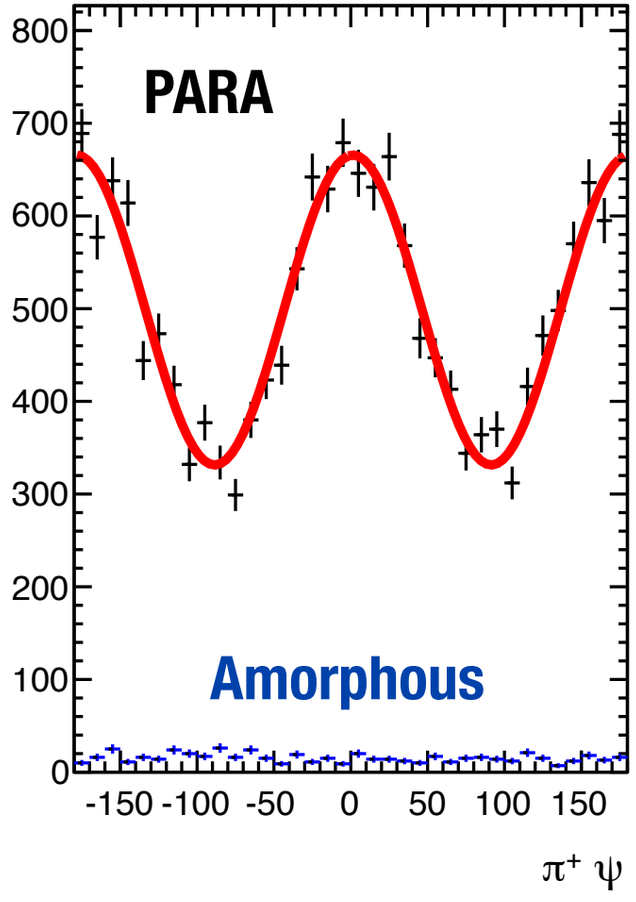


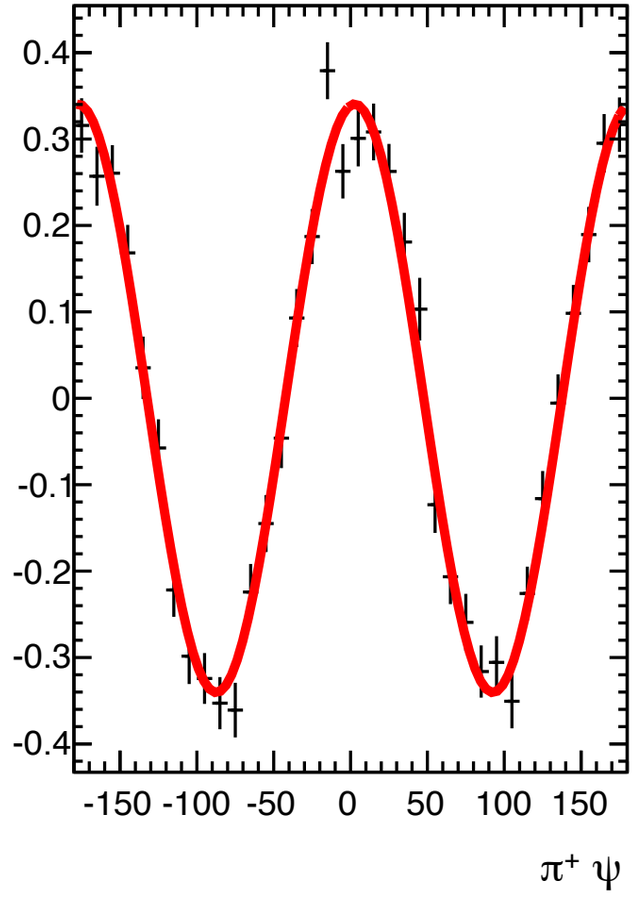
ρ asymmetry: 50 μm diamond (J1A50)

- **Runs 10491-10498**: 12 hours of wall time, ~500M events
  - 30-50 nA average current, 50 μm diamond
- ~38K ρ events in 8.4 < E_γ < 9 GeV

$$d\sigma_\perp \sim 1 - P_\perp \Sigma \cdot cos2\psi \qquad d\sigma_{||} \sim 1 + P_{||} \Sigma \cdot cos2\psi \qquad \frac{N_{||} - N_\perp}{N_{||} + N_\perp} = P\Sigma \cdot cos2\psi$$

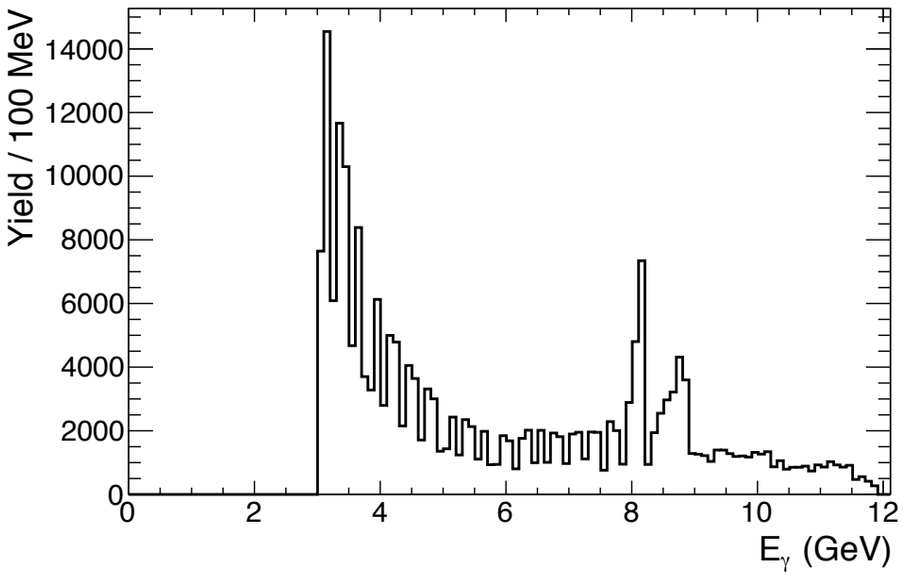


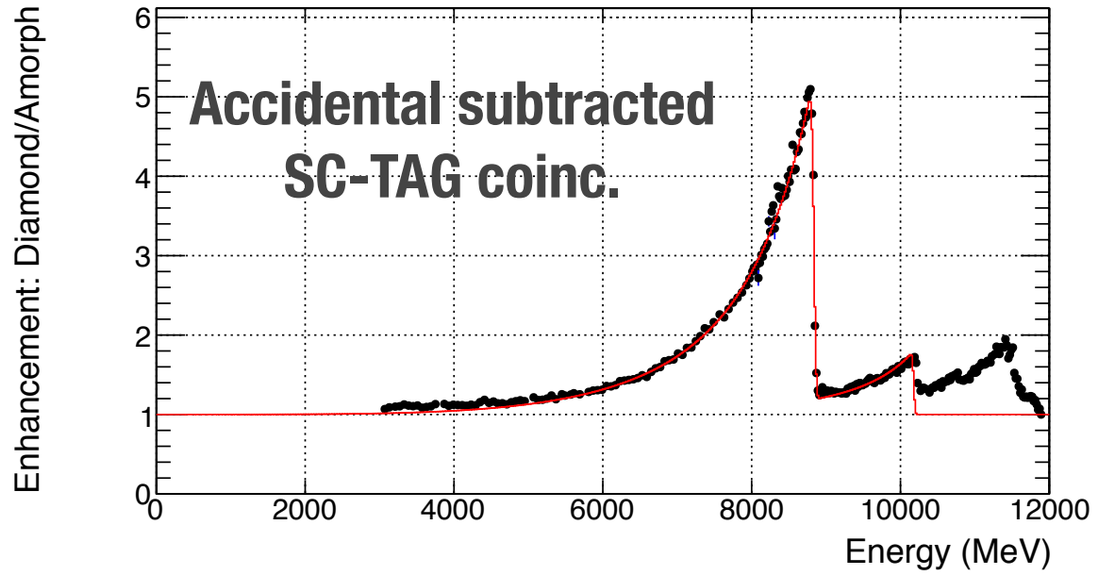


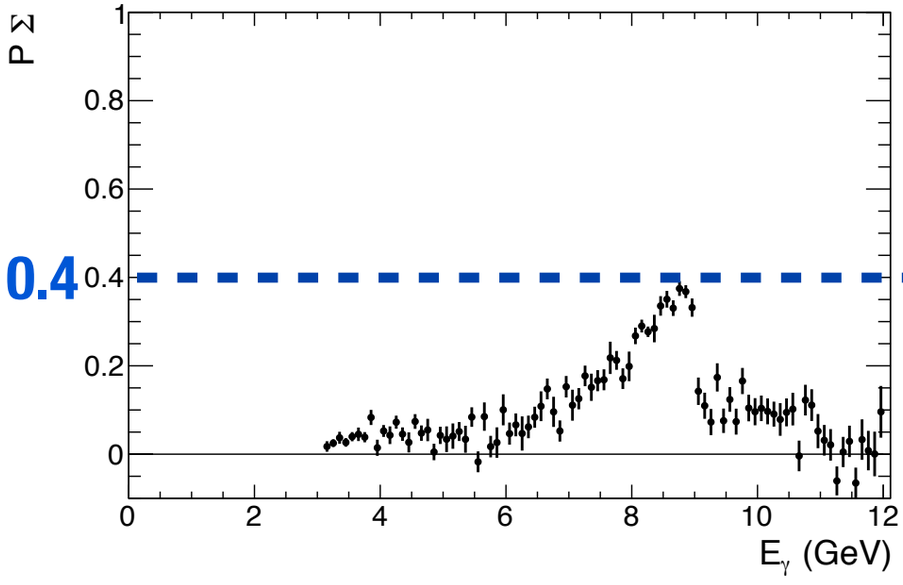


ρ asymmetry: 50 μm diamond (J1A50)

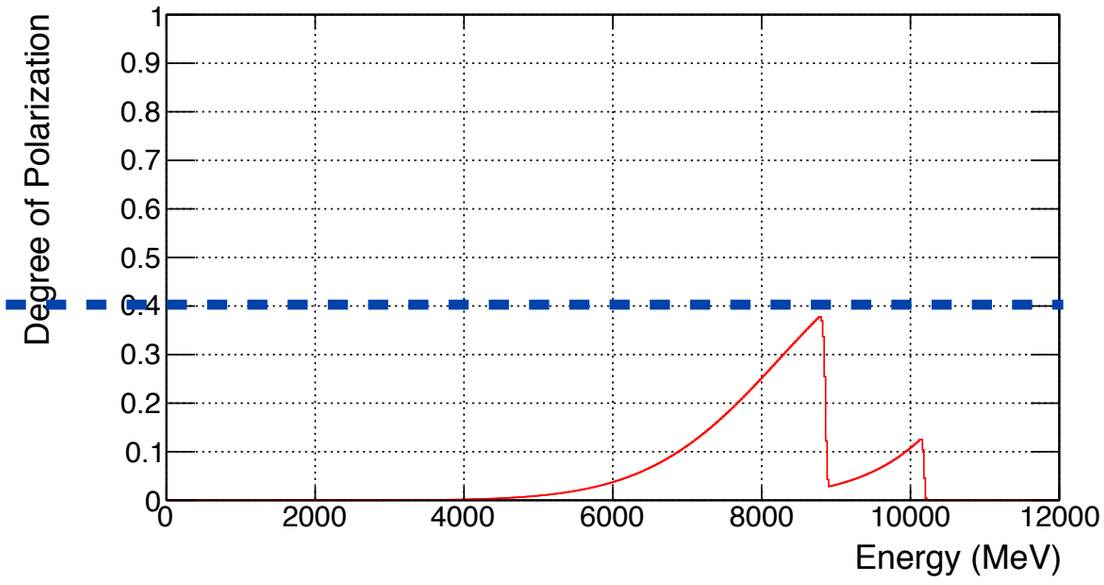
- **Runs 10491-10498**: ~38K ρ events in 8.4 < E_γ < 9 GeV
- Fit asymmetry in bins of E_γ + compare with enhancement fit





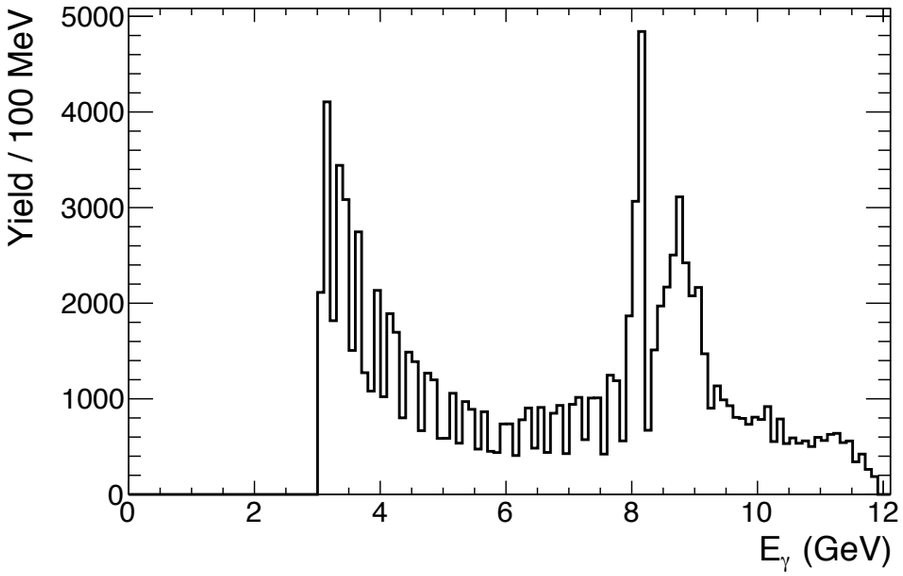


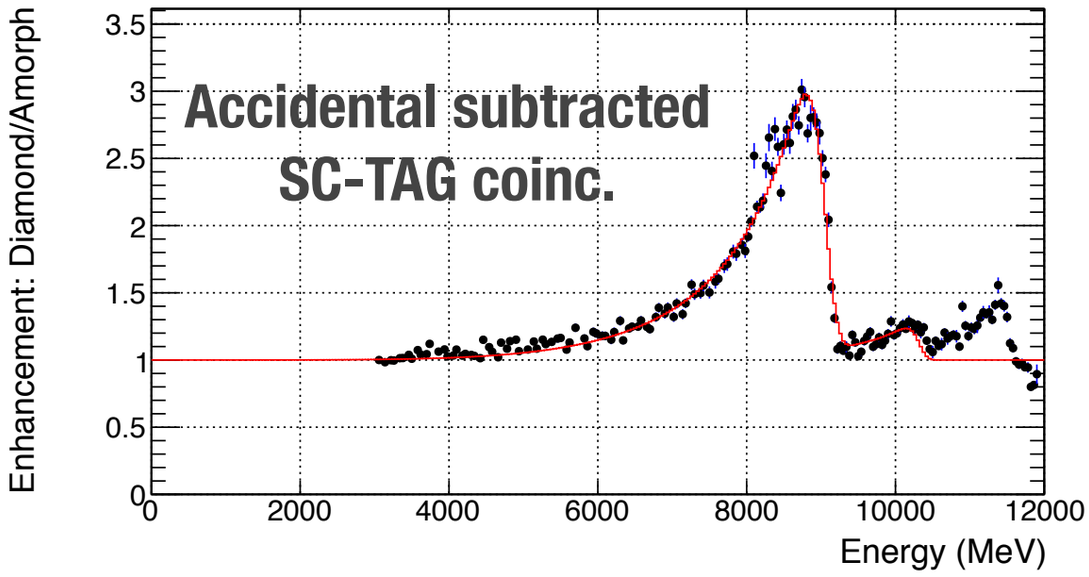
PΣ = 0.4

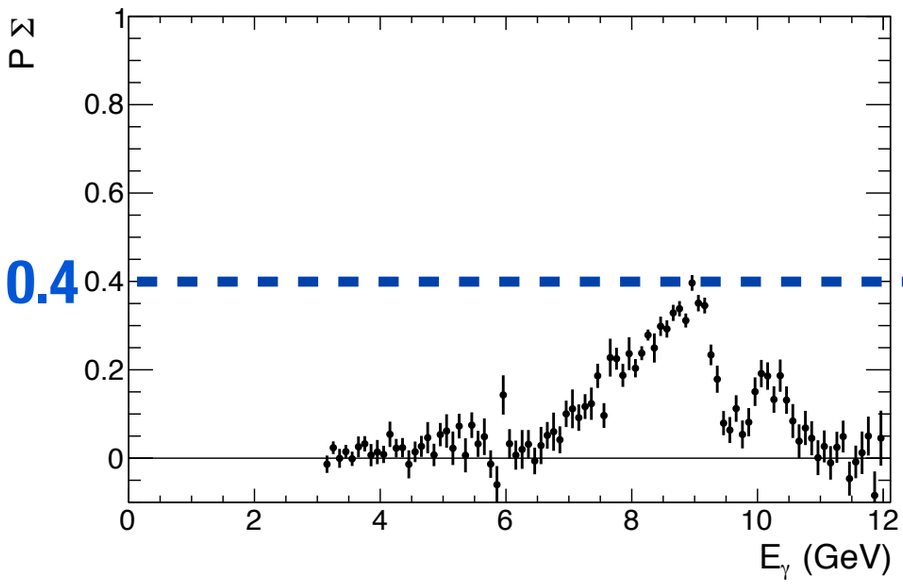


ρ asymmetry: 20 μm diamond (JD70-118)

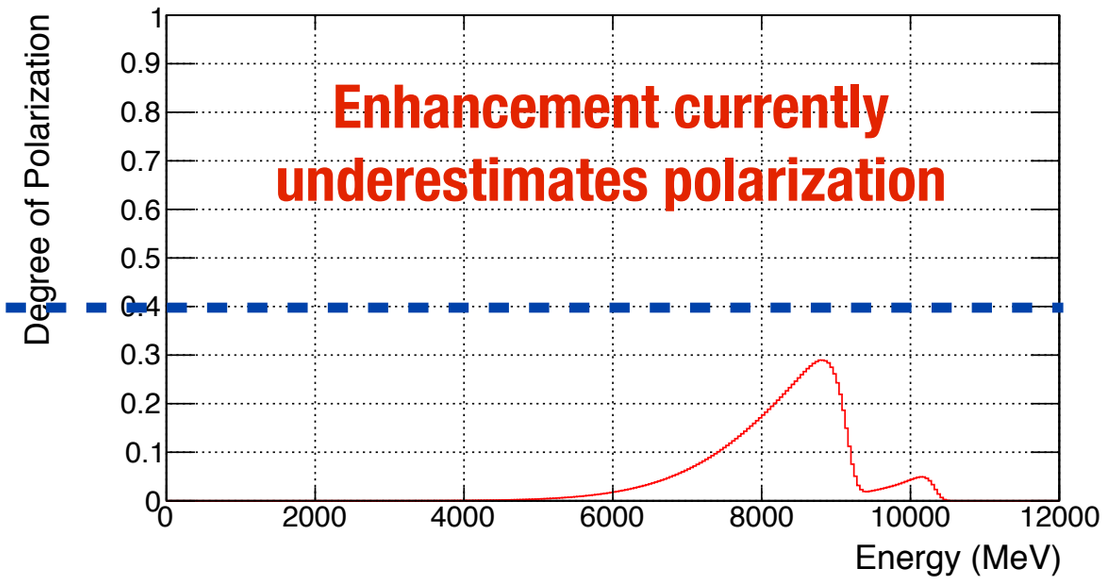
- **Runs 10782-10783**: ~30K ρ events in 8.4 < E_γ < 9 GeV
- Fit asymmetry in bins of E_γ + compare with enhancement fit







PΣ = 0.4

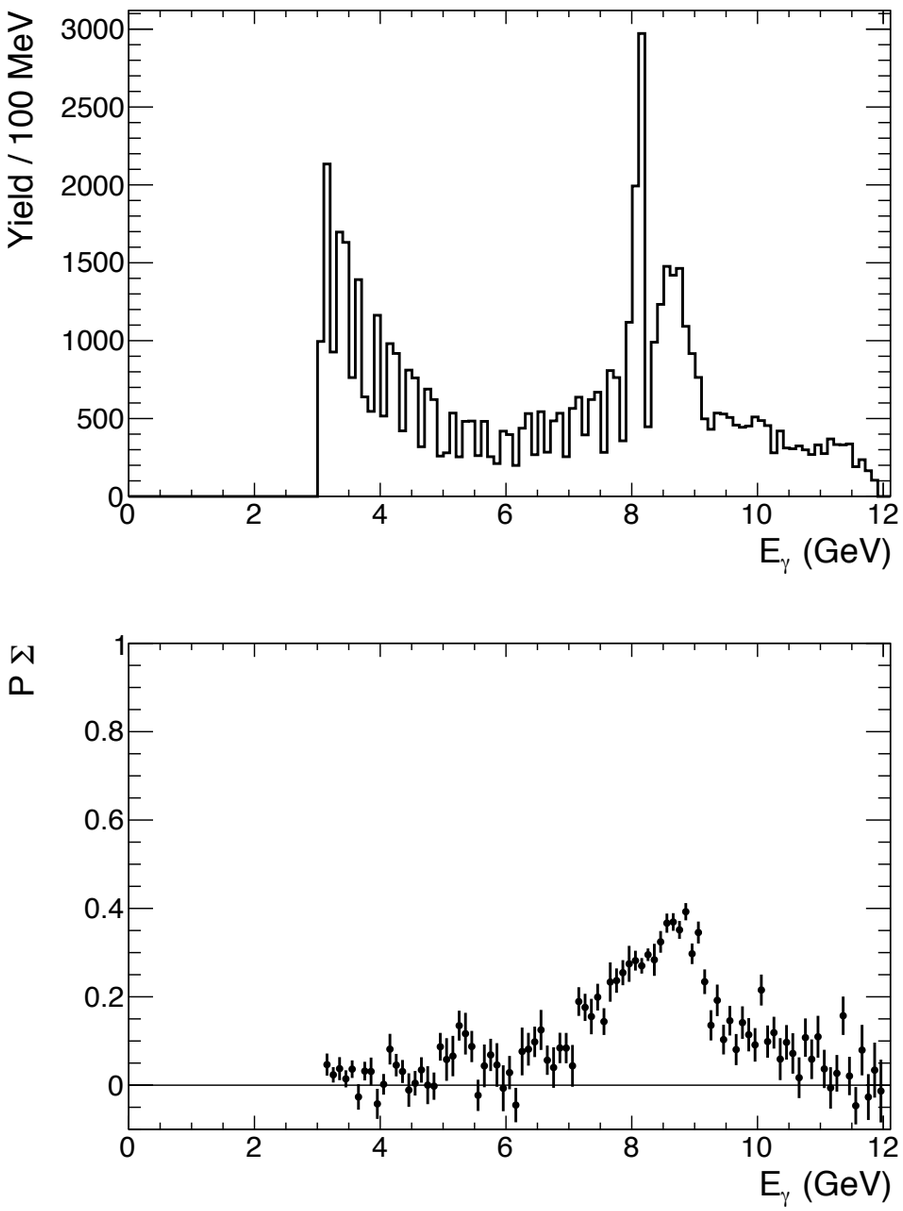


ρ asymmetry: 20 μm diamond (JD70-119)

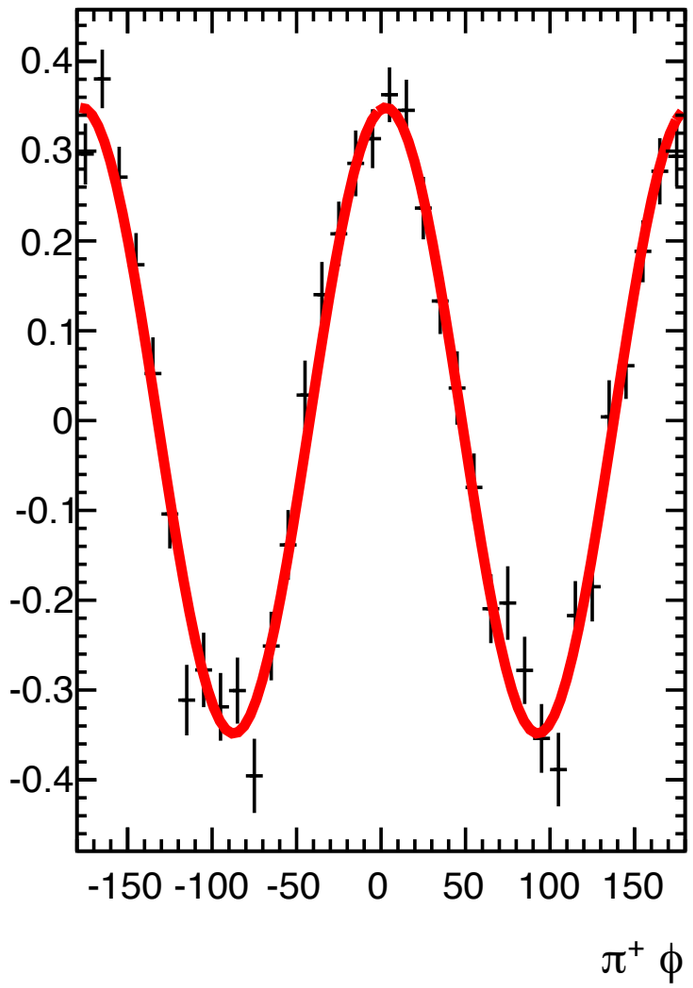
- **Runs 10873-10875**: ~20K ρ events in 8.4 < E_γ < 9 GeV

More statistics available

- Fit asymmetry in bins of E_γ



$$\frac{N_{||} - N_{\perp}}{N_{||} + N_{\perp}} = P\Sigma \cdot cos2\psi$$

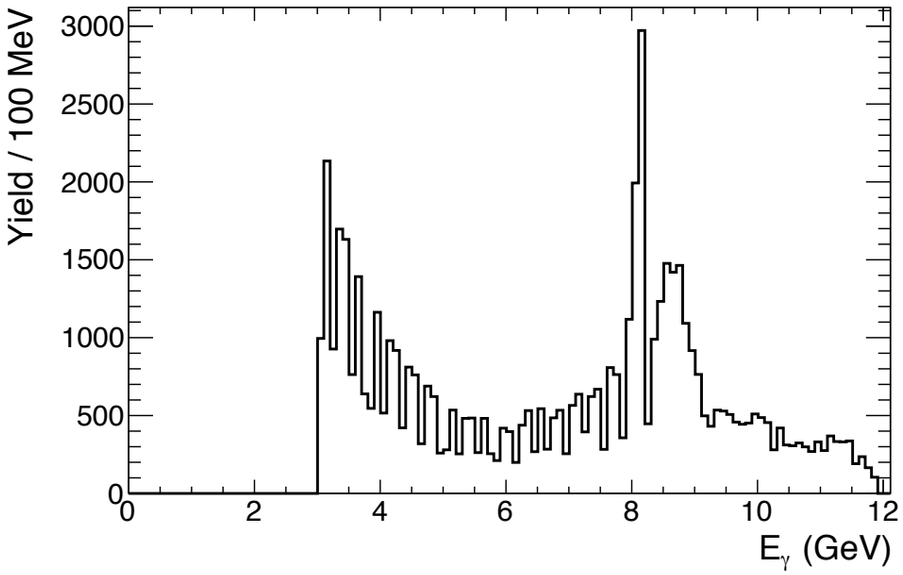


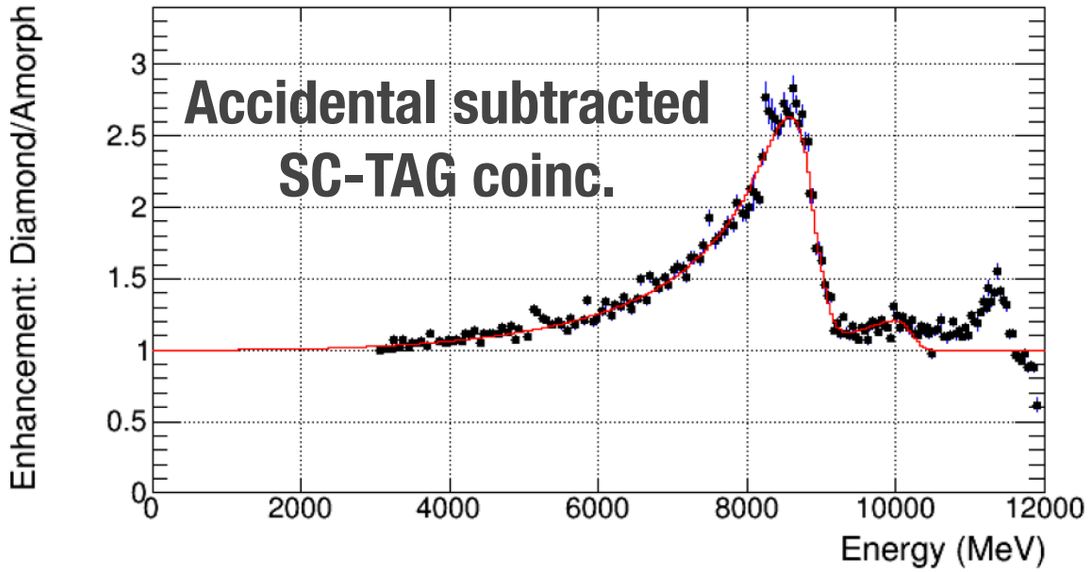
Integrated over
8.4 < E_γ < 9 GeV:

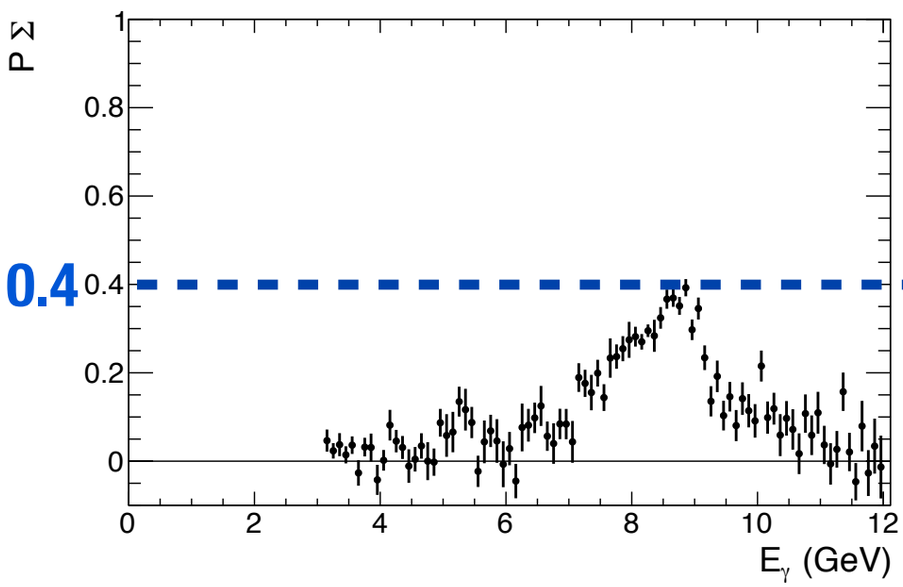
PΣ = 0.348 ± 0.009

ρ asymmetry: 20 μm diamond (JD70-119)

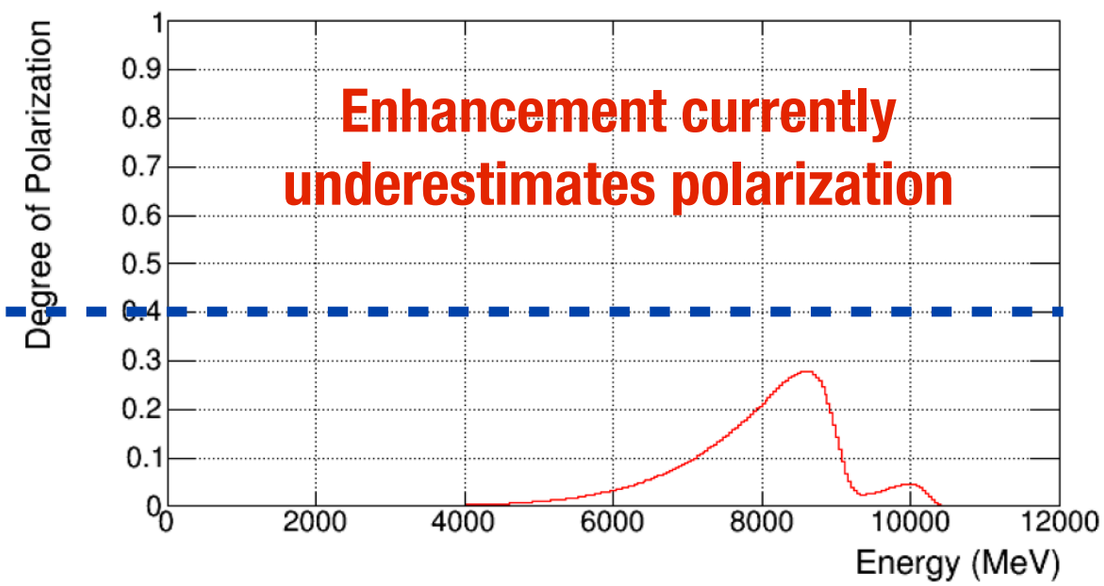
- **Runs 10873-10875**: ~30K ρ events in 8.4 < E_γ < 9 GeV
- Fit asymmetry in bins of E_γ + compare with enhancement fit





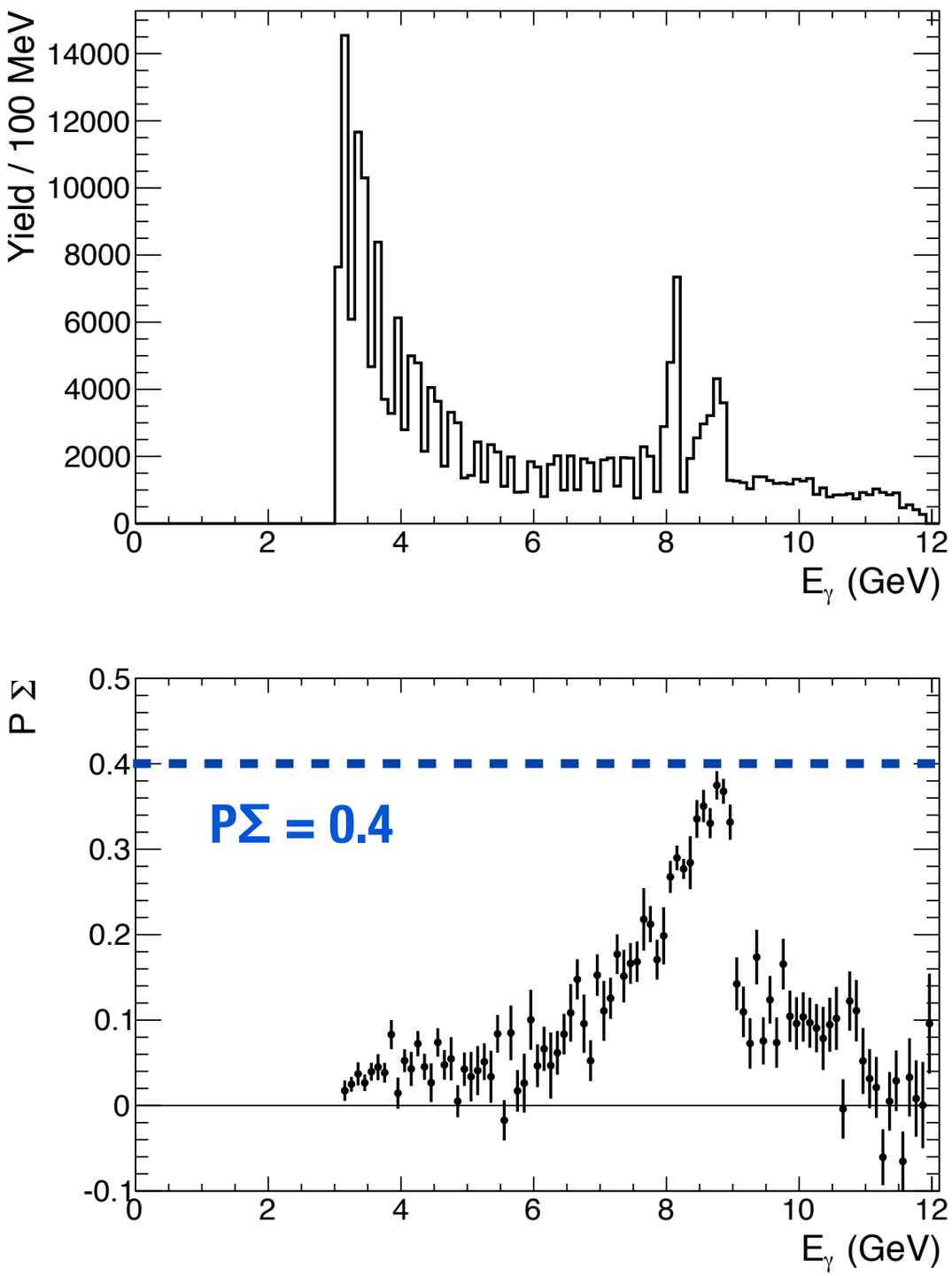


PΣ = 0.4

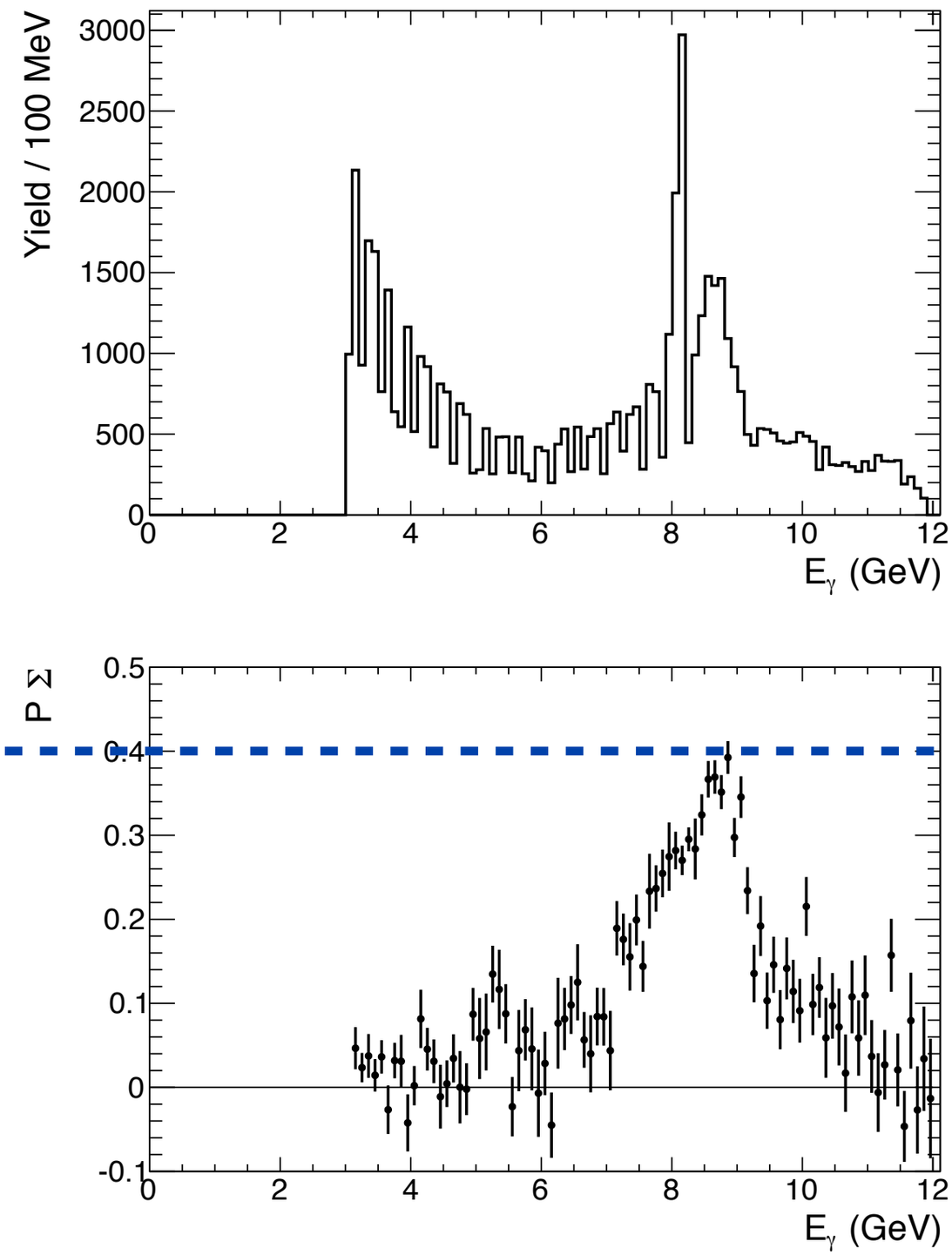


ρ asymmetry: 50 vs 20 μm (JD70-119)

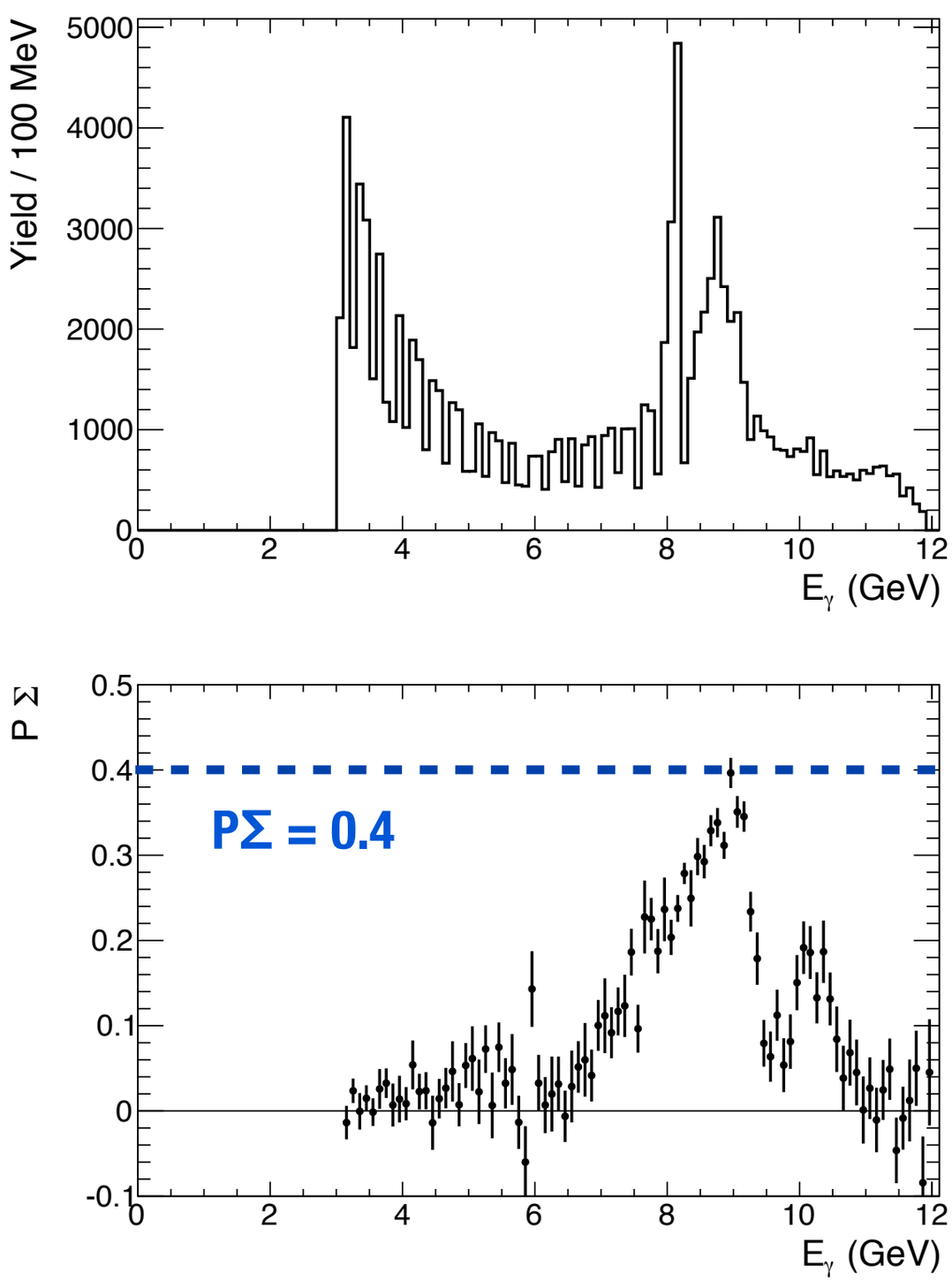
50 μm diamond (J1A50)

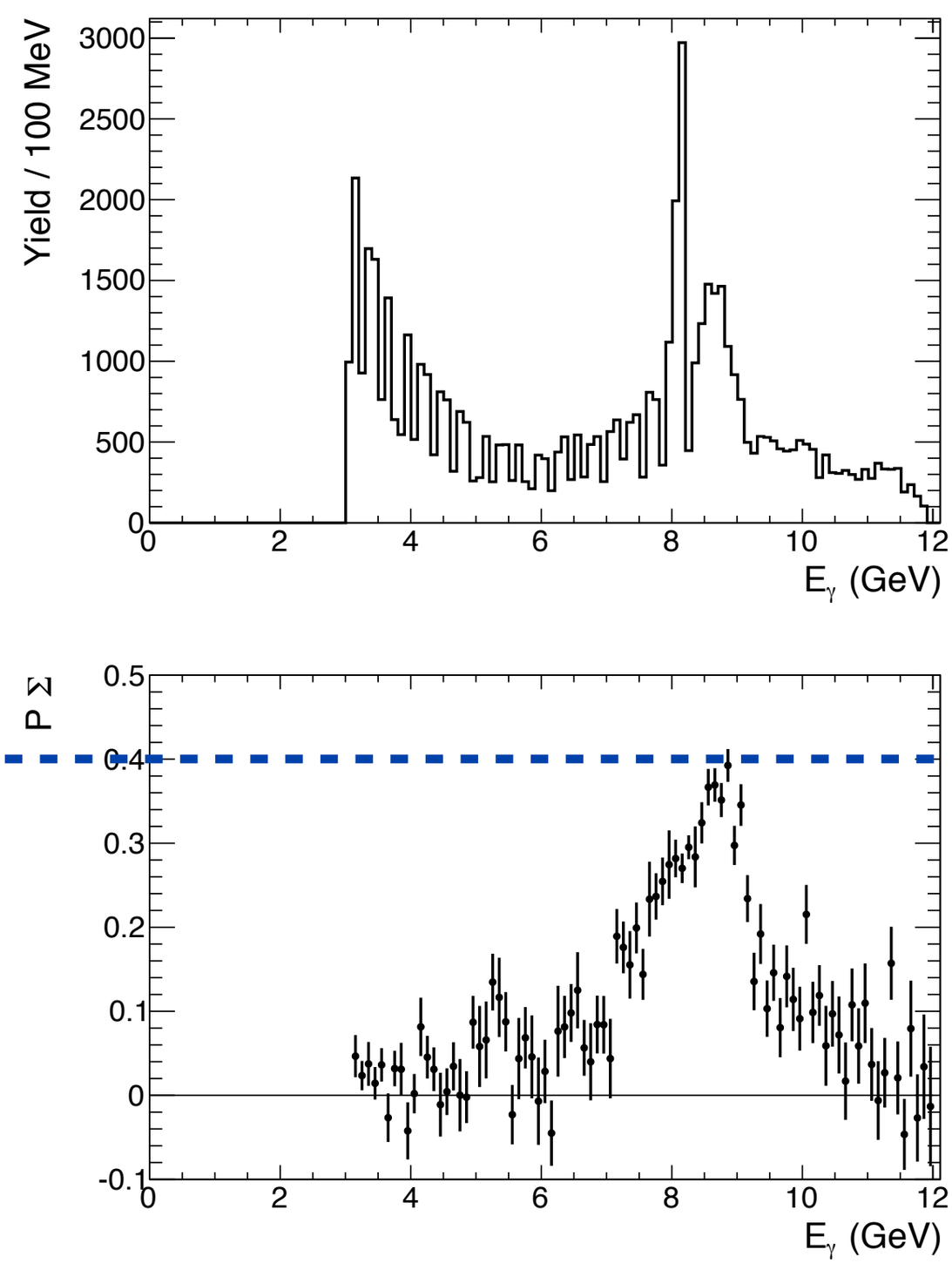


20 μm diamond (JD70-119)

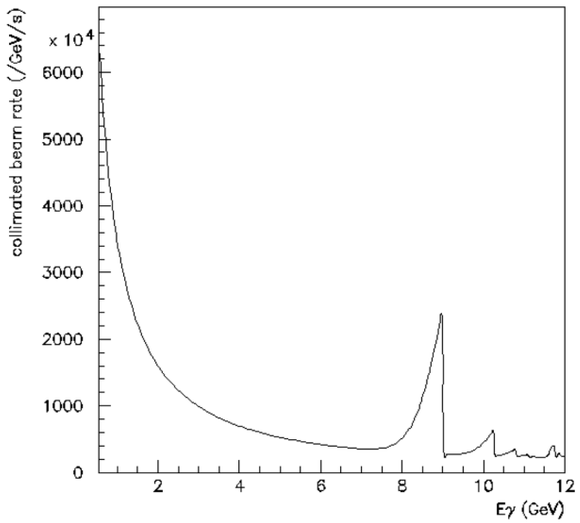


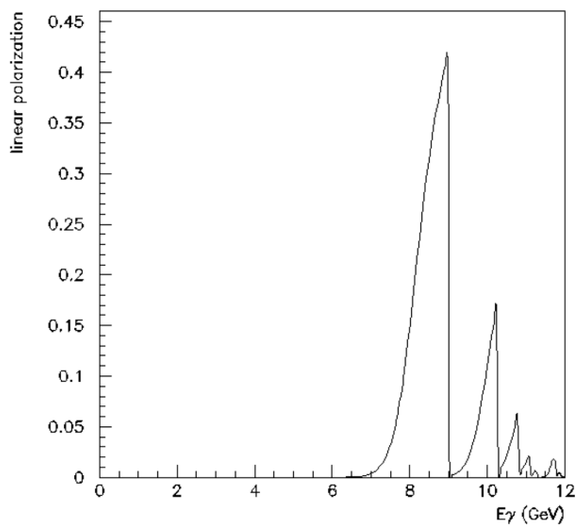
ρ asymmetry: 20 μm comparison





Collimation





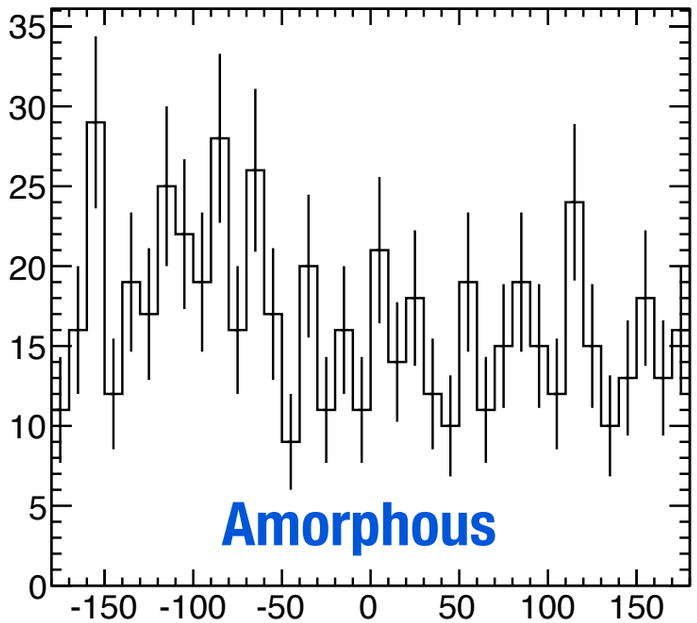
Diamond (μm)	20		50	
Collimator (mm)	3.4	5	3.4	5
Flux (220 nA)	1	1.4	2	3.2
Peak Polarization	0.42	0.39	0.41	0.39
Peak Tag. Effic.	0.55	0.66	0.48	0.62

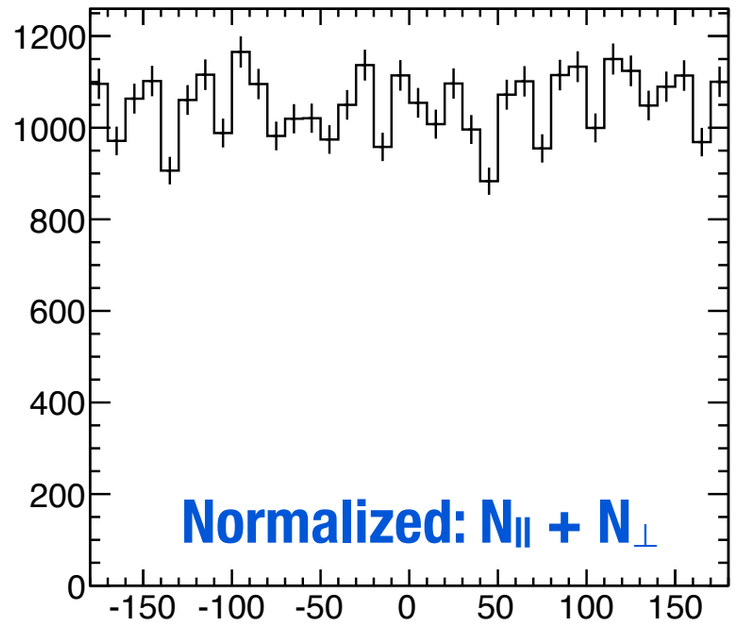
http://zeus.phys.uconn.edu/halld/cobrems/ratetool.cgi

- Peak polarization increase from 5.0 → 3.4 mm collimator for idealized case is similar for 50 and 20 μm diamonds

ρ asymmetry control samples

50 μm diamond (J1A50)





20 μm diamond (JD70-119)