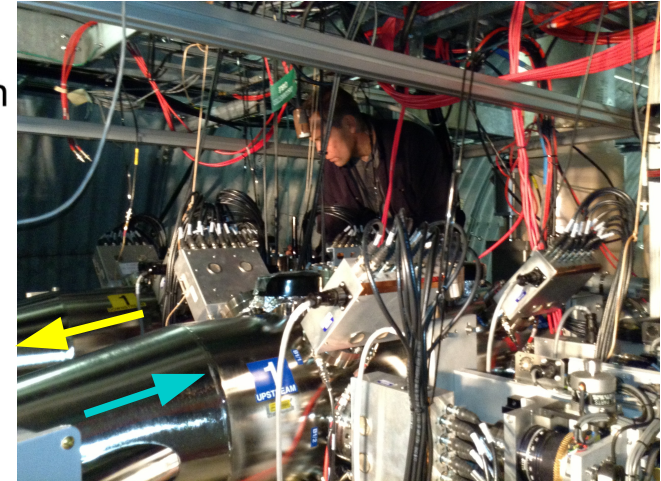
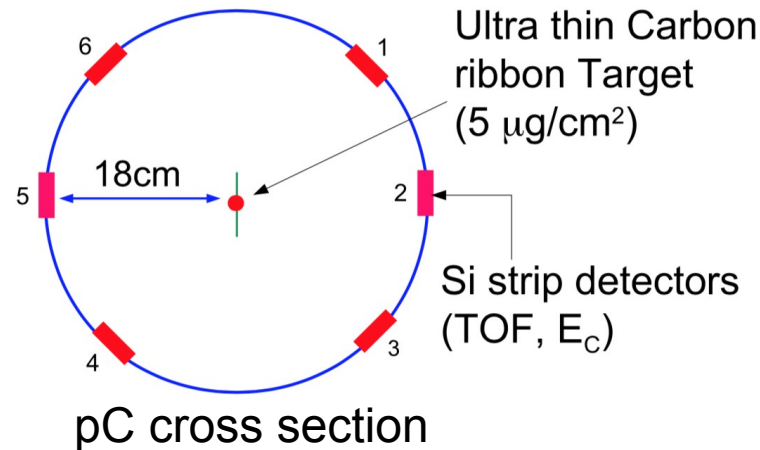


Polarimetry status & plans Run22

W. Schmidke
(for polarimetry group)
RHIC retreat 16.09.21

proton-Carbon (pC) polarimeter → Run22:

- detectors & targets
- preps so far
- status & plans



2 pC each in Blu, Yel

Some polarimeter R&D for EIC:

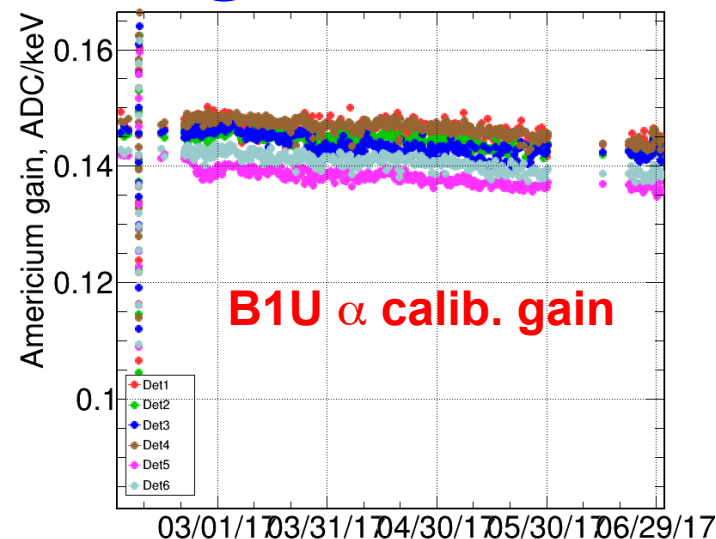
- pC 2nd detector layer test
- ^3He beam breakup tagging test

Hjet polarimeter status & developments: A Zelenski next talk

Detectors & Targets

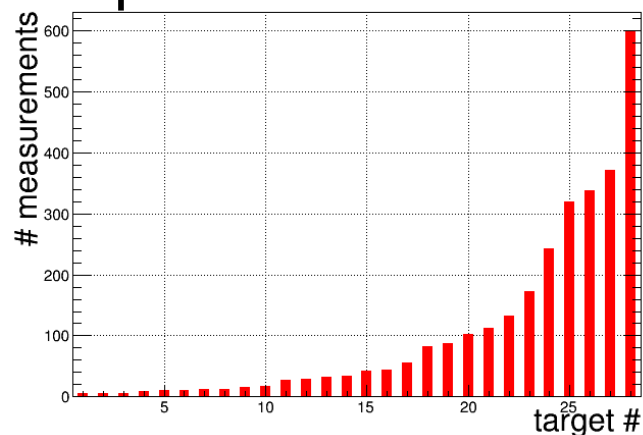
Detectors:

- New from BNL Inst. late 2016
- Tested ~35 w/ α source Dec. 2016
29 OK, 24 used for Run17
- Detectors showed minor gain drop throughout run, here e.g. B1U:
- Stored in dry box 2017-2021
- Reuse for Run22



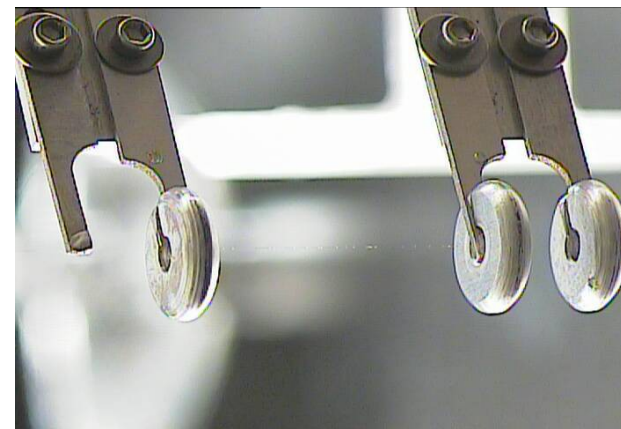
Targets (D. Steski):

- Good performance Run17:



many targets
survived >100
measurements

- Same specs/ for Run22: 50 nm \times 10 μ m
- ~180 ready, need 48 to fill pC polarims.
- Field smoothing disks on target frames:



pC preps so far

coordination:
Instr. Syst.
Tech. Support
T. Curcio, S. Jao, ...

- Last polarized proton Run17 → 4 years HI operation
- After Run17: every pC component not welded in place removed from tunnel → safe storage
pC chamber wrapped → bake out

Last few months start reassembly, **highlights:**

- Bake out equipment removed
- **Step motors** (target movement) reinstalled, tested & lubricated, one balky motor replaced, all working OK now
- **Detectors** (24) on flanges reinstalled, RF screens in place
- **Preamps** (24) tested & reinstalled (1 flange pins bent, replaced)
- Am & Gd α **calibration sources** reinstalled
- HV & LV supplies, test pulse fanout reinstalled; HV comm. restored
- All power & signal cables connected
- **Vacuum:** shutter valve leaked (target material?)
reassembled bake out again required:
Blue finished, Yellow this week
- Target video cameras reinstalled,
will align & focus after targets in:



frame from
old video:
target in beam

pC status & plans

- Blue bakeout finished, detector bias on & α signals OK
- Yellow bakeout finishing now, bias & α tests next
- Install targets mid-October, slow pumpdown...

DAQ readout system: (usual experts in Moscow, consulting)

- Blue working w/ internal clocks,
test pulse & α data \Rightarrow preamps & detectors all OK
- Yellow not working yet, debugging
- No RHIC clocks (from V124), are these available yet?

Offline \rightarrow Results:

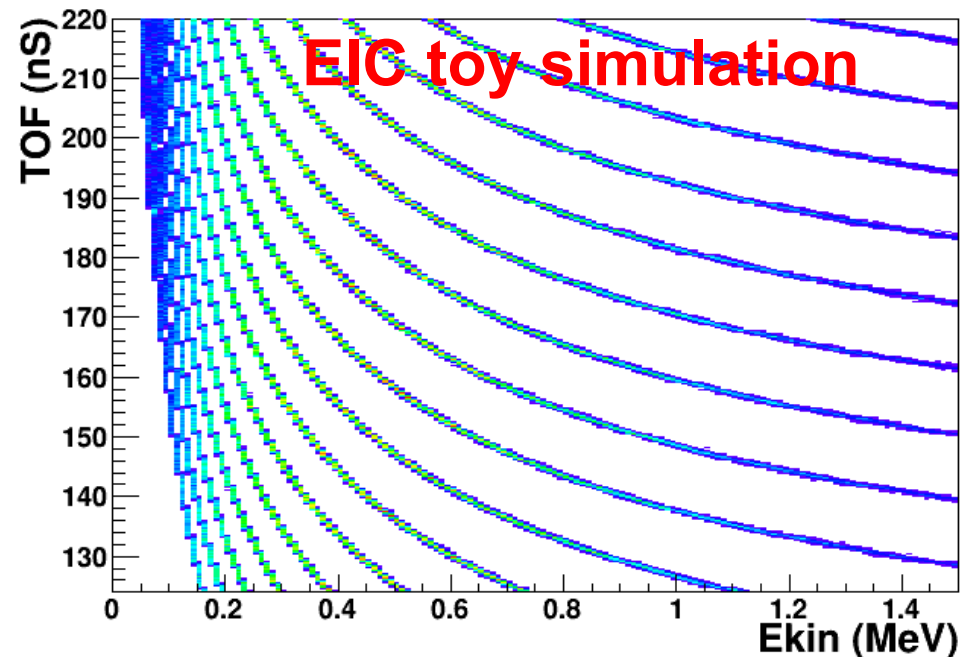
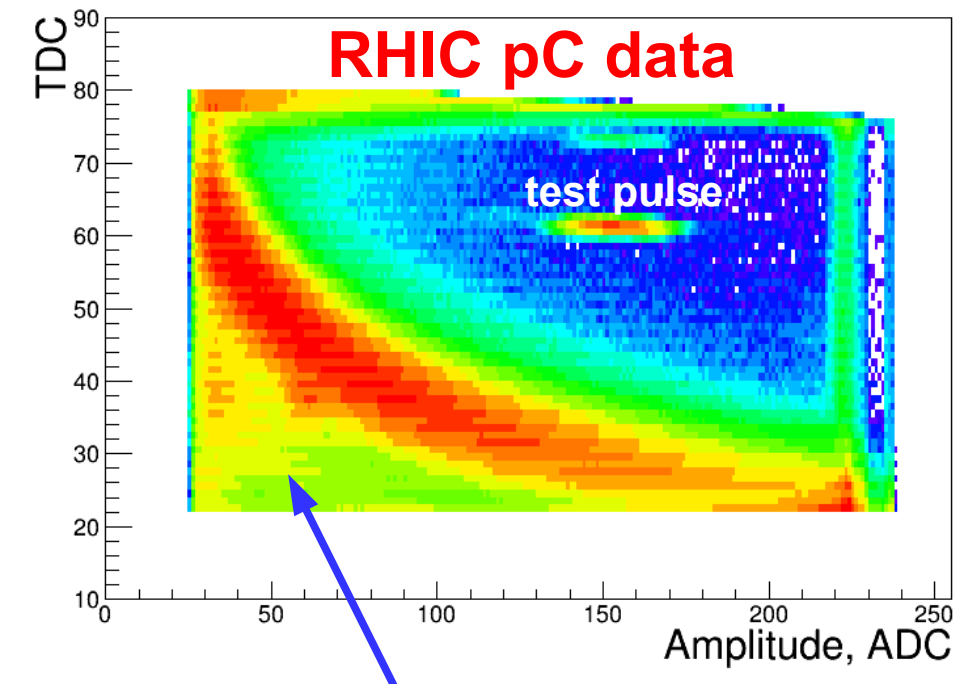
- Next: reestablish offline analysis chain
rapid (few min.) pC results on web page
- Follow analysis procedures developed recent years
 - normalize pC/Hjet results
 - best values P & uncertainties for physics experiments

With beams:

- Target conditioning start of run period
- Fill operation: pC measurements before/after ramp,
middle & end fill, α calib. runs post-dump

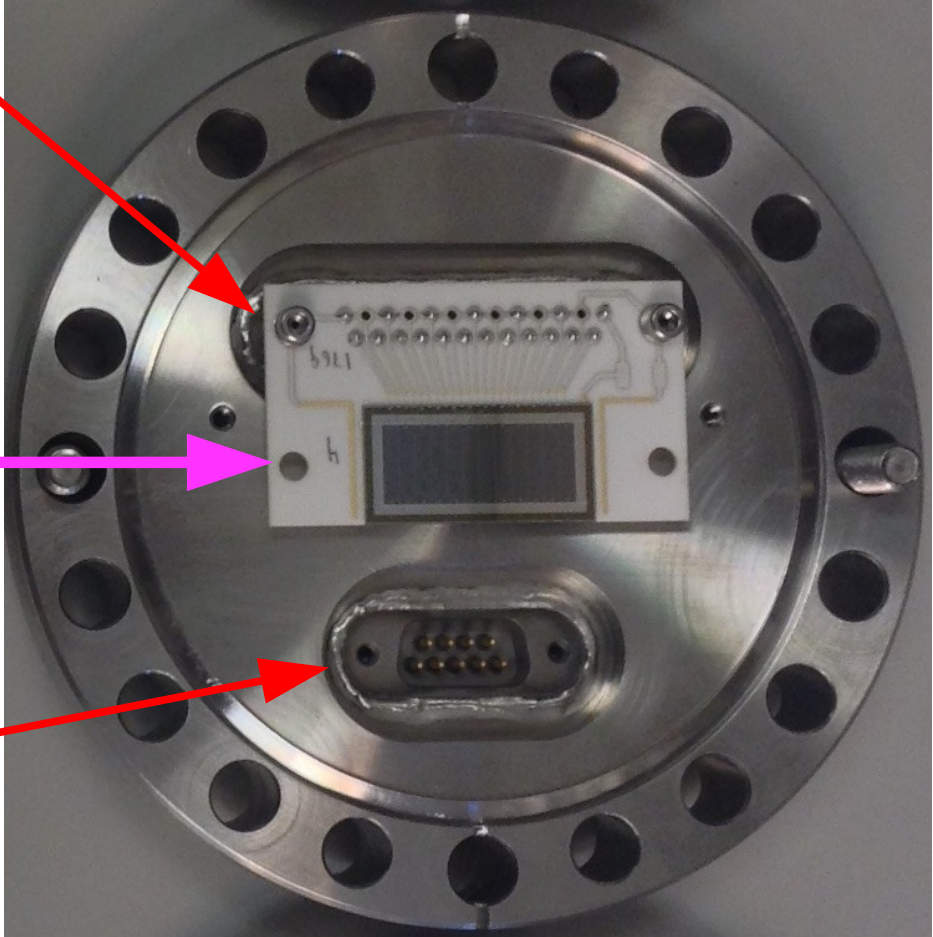
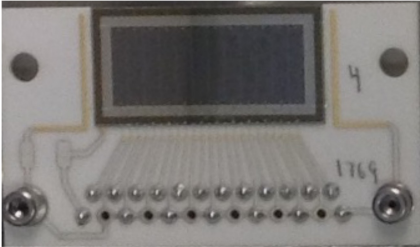

pC 2nd det. layer test: motivation

- Select recoil C nuclei TOF vs E_{kin} : signal TOF $\propto 1/\sqrt{E_{\text{kin}}}$ “banana” curve:



- Clear backgrounds under signal
- @RHIC: signal dilution calibrated out in pC/Hjet normalization
- @EIC: bunch spacing RHIC 106 nS \rightarrow EIC 11 nS
 - background overlaps w/ adjacent bunches
 - background small but $\neq 0$ asym., may dilute/enhance signal asym.
 - a real mess; need way to minimize backgrounds
- Simulation: backgrounds fast α, p, π punch through Si det.
- Tag in 2nd detector layer?

pC 2nd det. layer test: implementation

- Detector on existing flange: signal & bias feedthrough
 - Make new flange: replace unused feedthrough: with 25-pin feedthrough
 - Mount 2nd det. (rotated 180°) above 1st (on extender pins)
 - Det. back: no ceramic
- 
- 
- 
- 2nd preamp behind flange: new box for 2 preamp boards
 - Preamps each 12 BNC outputs: select any 12 of 24 for readout
⇒ no new cables/chan. needed downstream: MUX, DAQ, software, ...
 - Readout: - use middle 6 chan. from each detector
- lose ½ chan., statistics one port for polarimetry
minimal loss precision
 - Try in 2 ports: 2 spare detectors & preamps, available from pool

pC 2nd det. layer test: status & plans

Status

- 2 new flanges each w/ 2 feedthroughs welded
- Delay: unfortunately leaks, pursuing re-welding...
- Preamps ready, 2 preamp boxes planning, fitting

Plans

- Assemble / fit parts when all ready
- Install in 2 pC ports when targets installed (mid-October)
- If leak-tight flanges not ready, install next opportunity

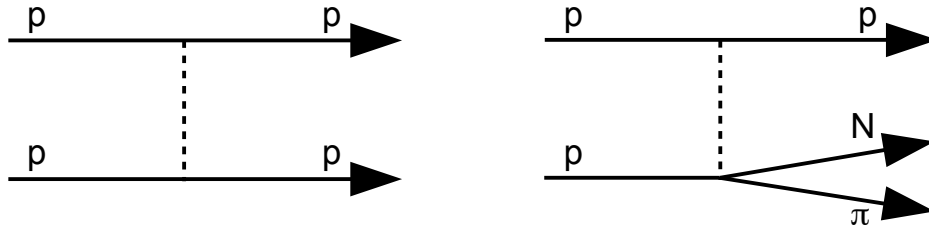
Data analysis

- 2nd layer data will come with usual pC measurements
i.e. by the 100's
- Correlate 2nd layer hits \leftrightarrow front layer TOF vs. E_{kin}

can we tag non-carbon backgrounds?

^3He breakup tag test: motivation

- Absolute polarimetry requires elastic scattering
- Proton polarim. elastic $pp \rightarrow pp$ versus $pp \rightarrow pX$



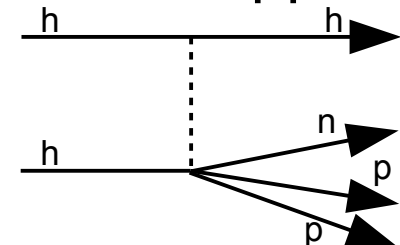
- Lowest lying p breakup state is $p \rightarrow N\pi$, $\Delta m = m_\pi \sim 140 \text{ MeV}$
- Hjet detectors have E, θ resolution sufficient to separate elastic/inelastic
- $^3\text{He} \equiv h$ polarim.

elastic $hh \rightarrow hh$ versus inelastic $hh \rightarrow hdp$



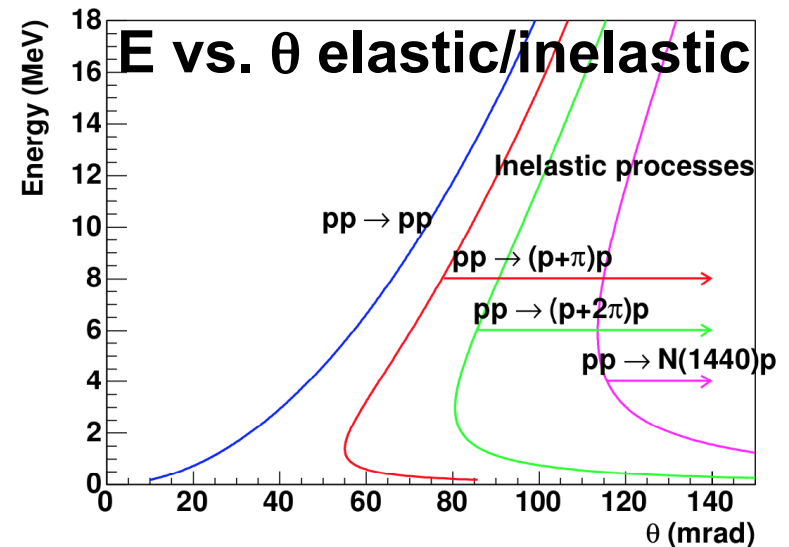
$$\Delta m = 5.5 \text{ MeV}$$

or $hh \rightarrow npp$



$$\Delta m = 7.7 \text{ MeV}$$

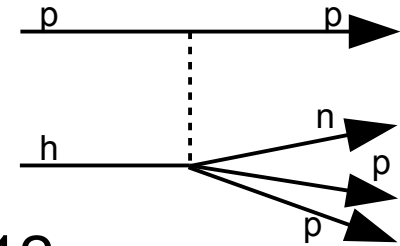
- Hjet detectors lack E, θ resolution to distinguish few MeV Δm



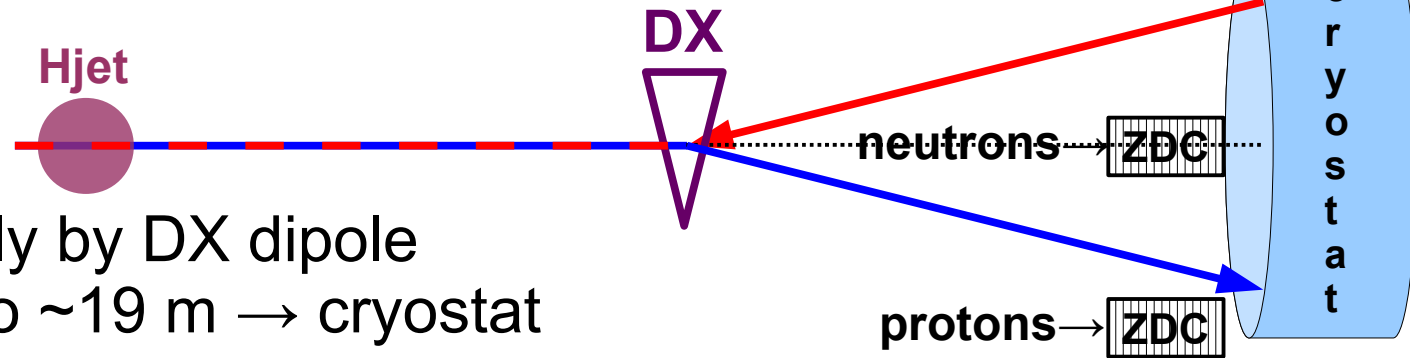
Can we directly tag ^3He breakup fragments?

^3He breakup tag test: implementation

- Can test w/ ^3He beam, Hjet proton target:

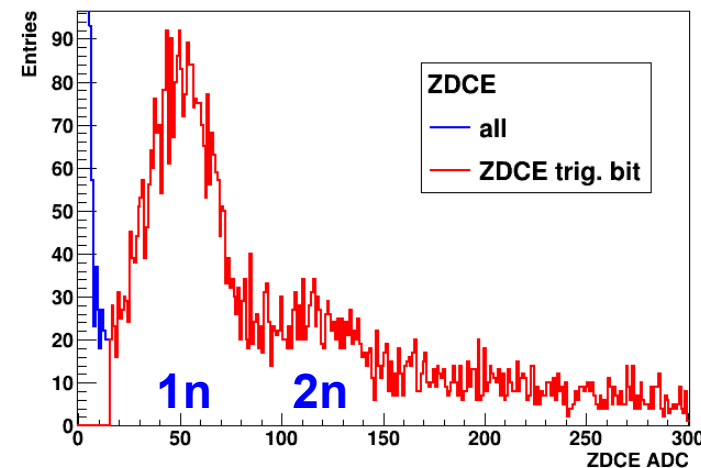


- Downstream (Blue beam direction) from Hjet @ IP12:



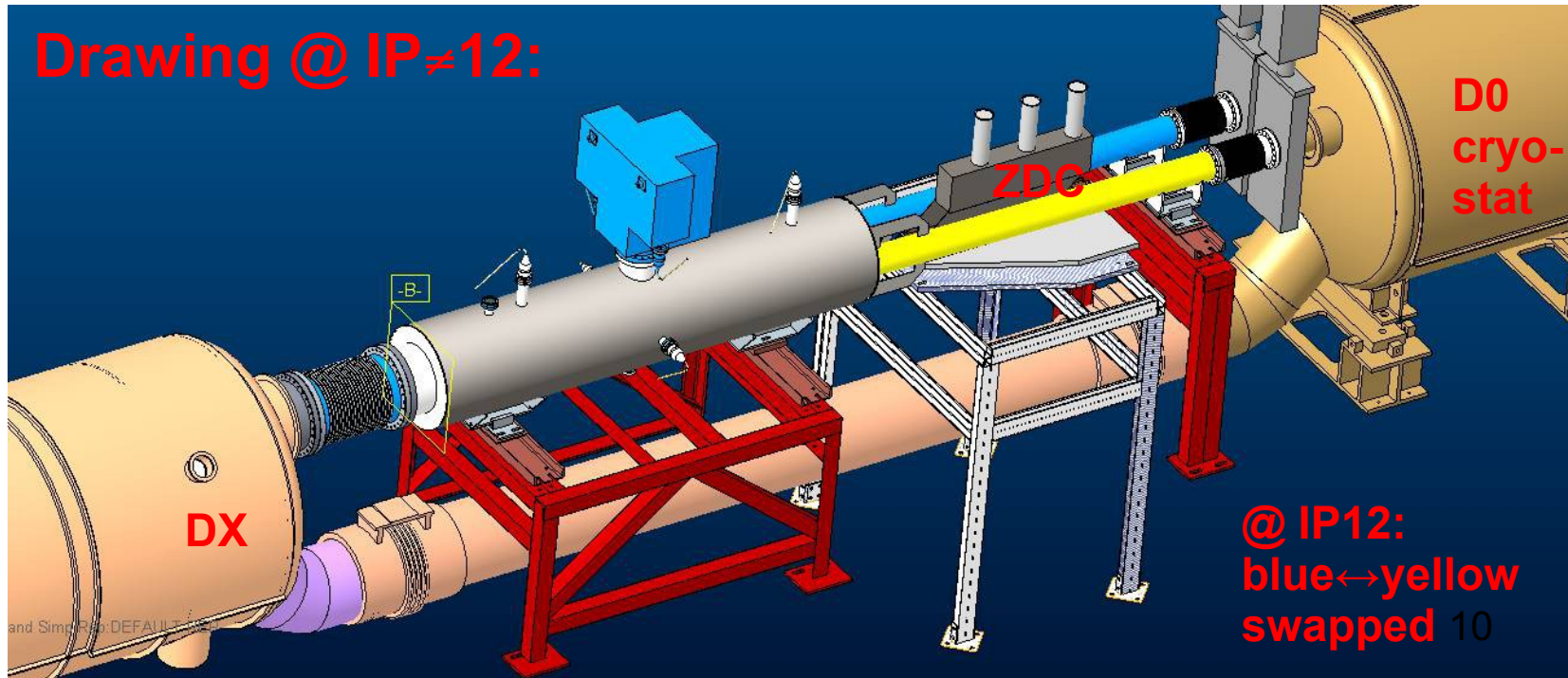
- Beams bent horizontally by DX dipole
- Space for taggers up to ~ 19 m \rightarrow cryostat
- ^3He fragments swept out of beam, different rigidities:
 - neutrons @ 0° (usual ZDC location collider expts.)
 - protons barely leave beampipe < 19 m, scraping, hard to tag
 - deuterons leave beampipe > 19 m

- 2 Zero Degree Calorimeters (ZDCs) from old Phobos experiment in hand
 - mediocre hadronic calorimeter
 - adequate for tagging
- ZDC signals \rightarrow Hjet readout correlate w/ recoil protons

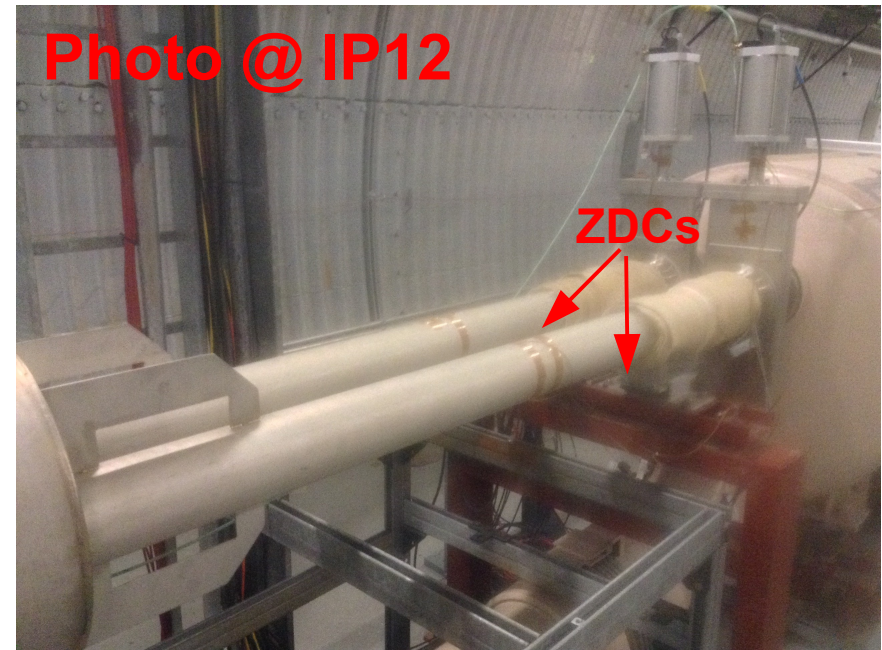


**STAR AuAu
100 GeV
neutrons**

^3He breakup tag test: implementation



- Spare ZDCs between/outside beampipes after DX
- Support structure is there
- Need:
 - table top
 - ZDC positioning structures
 - ~10 signal/HV cables→Hjet racks
- Installation planned...

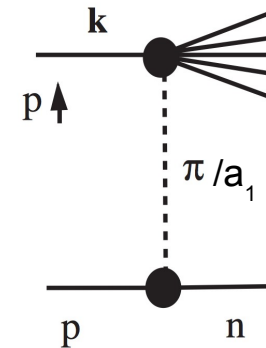


^3He breakup tag test: plans

Commissioning

- Can use normal p beam, Hjet:
- Time in readout, pulse height adjust
- Hjet target off: beam-gas background
- E_n spectrum known, compare, calibrate ZDCs
- Correlate tags w/Hjet recoil p:

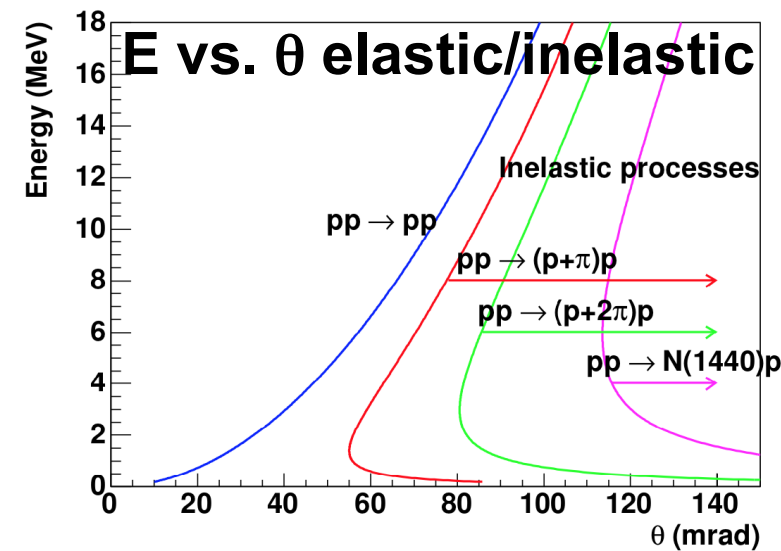
E vs θ , mass gap?



- well known π/a_1 exchange process
- studied/used by PHENIX, STAR
- high rate

^3He data (APEX proposal, w/ Haixin et al)

- ^3He beam in Blue, 100 GeV/A (unpolarized)
 - Acquire data few hours
 - rate unclear, Hjet correlated 0.1-1 Hz?
 - some time Hjet target off: b.g. background
 - Goals:
 - breakup rate
 - correlate tags w/Hjet recoil p:
- E vs θ , see mass gap?



Summary

Run22 polarimetry

- pC (& Hjet) should be ready by November
- Follow best procedures developed last years:
 results (P & uncertainties) for experiments
- Hoping for a smooth run

Polarimeter R&D for EIC

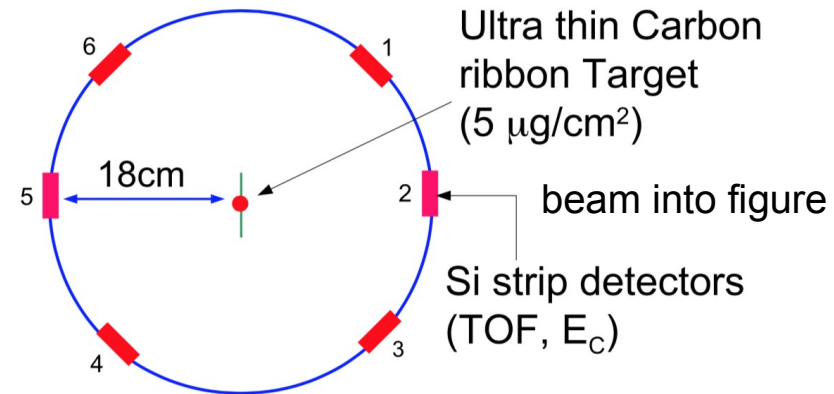
- Two topics: 2nd detector layer, ³He breakup tagging
- Minimal new hardware:
 - 2 detector flanges, housing for preamps
 - ZDC support structures, cable
- & Tech. Support from Instr. Systems
 (T. Curcio, S. Jao, ...)
- Important results for EIC polarimetry at minimal cost

Couple of homework problems

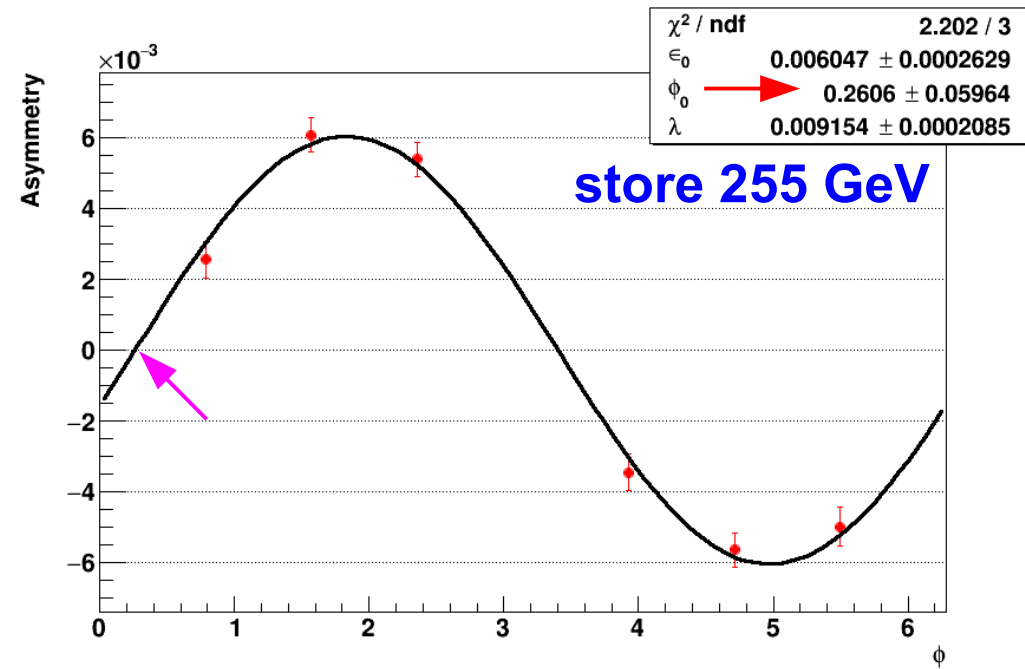
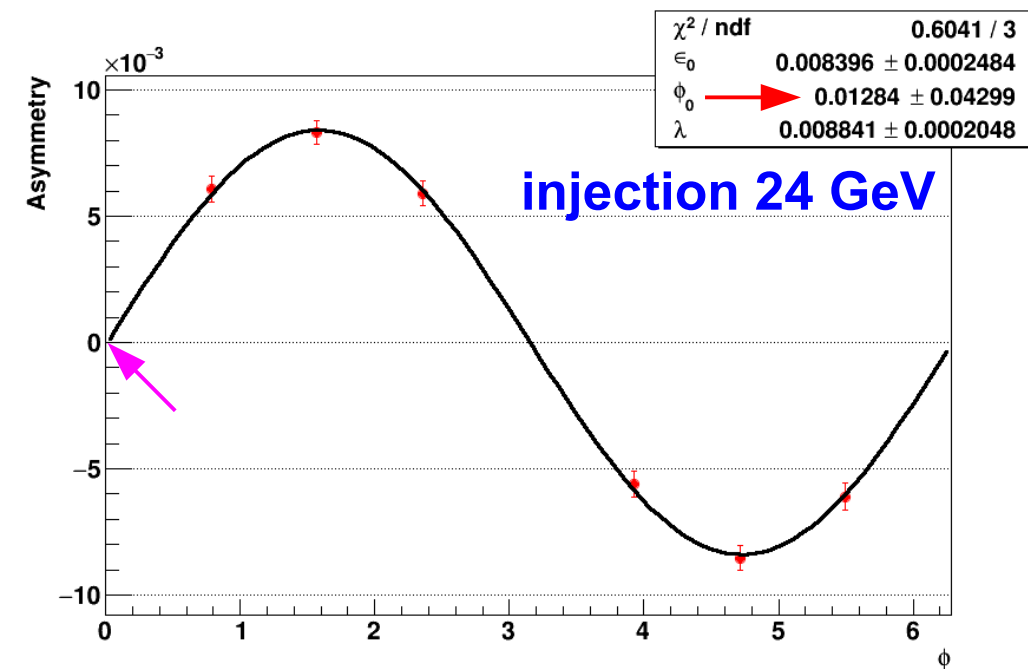
- Puzzles @ RHIC impacting RHIC→EIC polarimetry
 & EIC spin experiments ➡

Spin Vector Tilt Measurement

- pC polarimeter near IP12:
 - 6 detectors around beam
 - measure asymmetry vs. azimuthal ϕ
 - \Rightarrow transverse magnitude $|P|$ & tilt ϕ_0 from vertical



- Measurements same fill, injection & store energies:



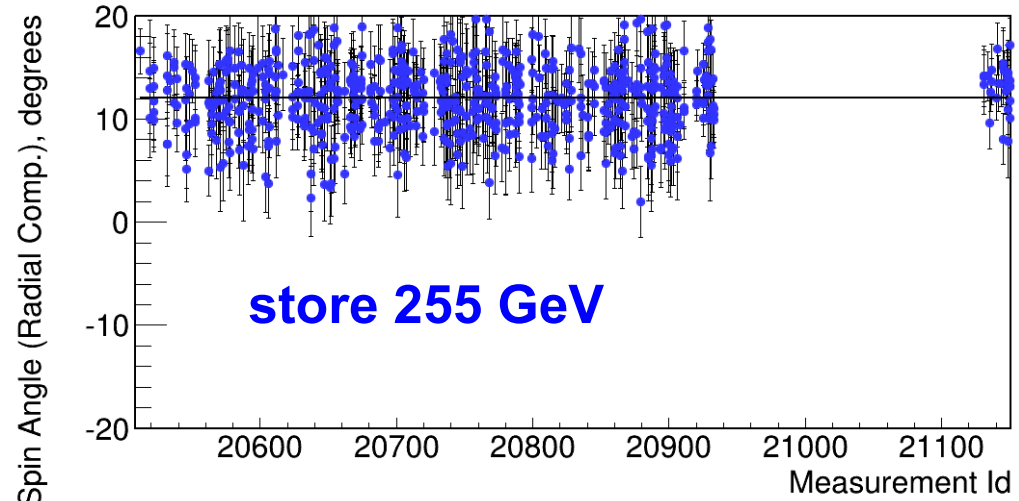
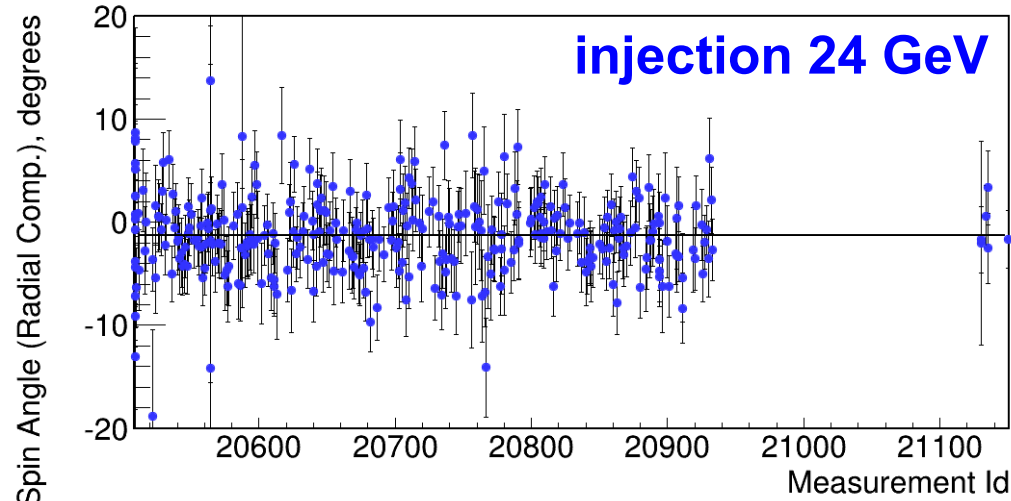
- No tilt ($<1^\circ$) @ 24 GeV, significant tilt ($\sim 15^\circ$) @ 255 GeV

Spin Vector Tilt History

- Spin tilts stable through run period, e.g. 2017:

Fills 20509--21150, Analyzed Fri Jun 22 17:42:15

Fills 20509--21150, Analyzed Fri Jun 22 17:42:15



Summary

- Negligible tilt @ 24 GeV
- Small tilt @ 100, 250 GeV
- Significant tilt @ 255 GeV
- Tilt in Blue larger than Yellow
- Blue & Yellow spin vectors both *tilted toward RHIC ring center*

Impacts

- Hjet measures vertical P, correct to pC tilt
- Tilt @ collider experiments?

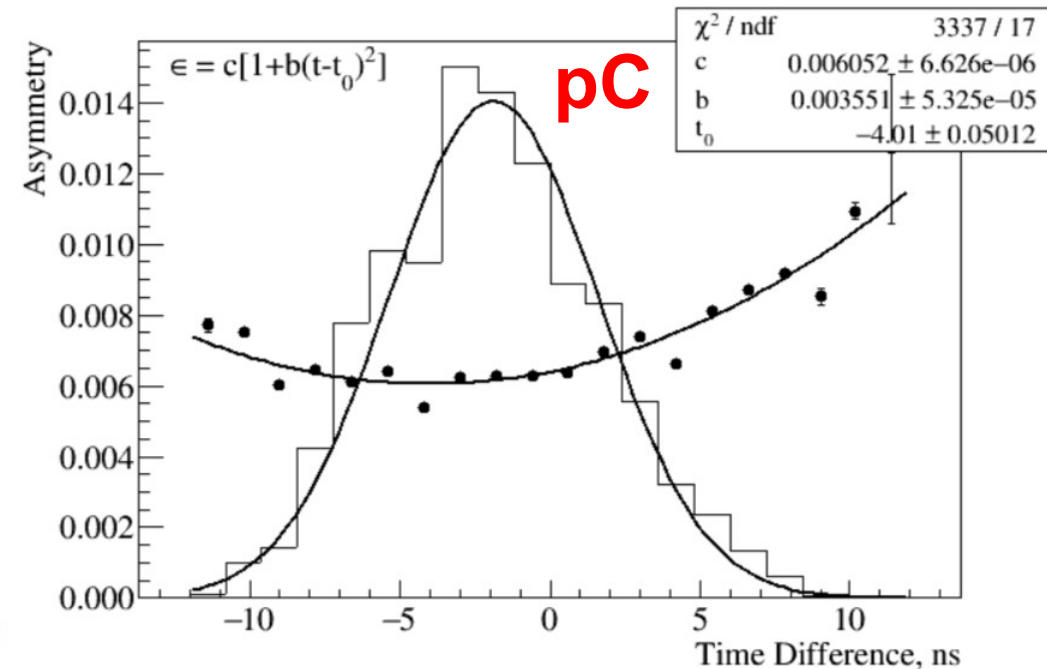
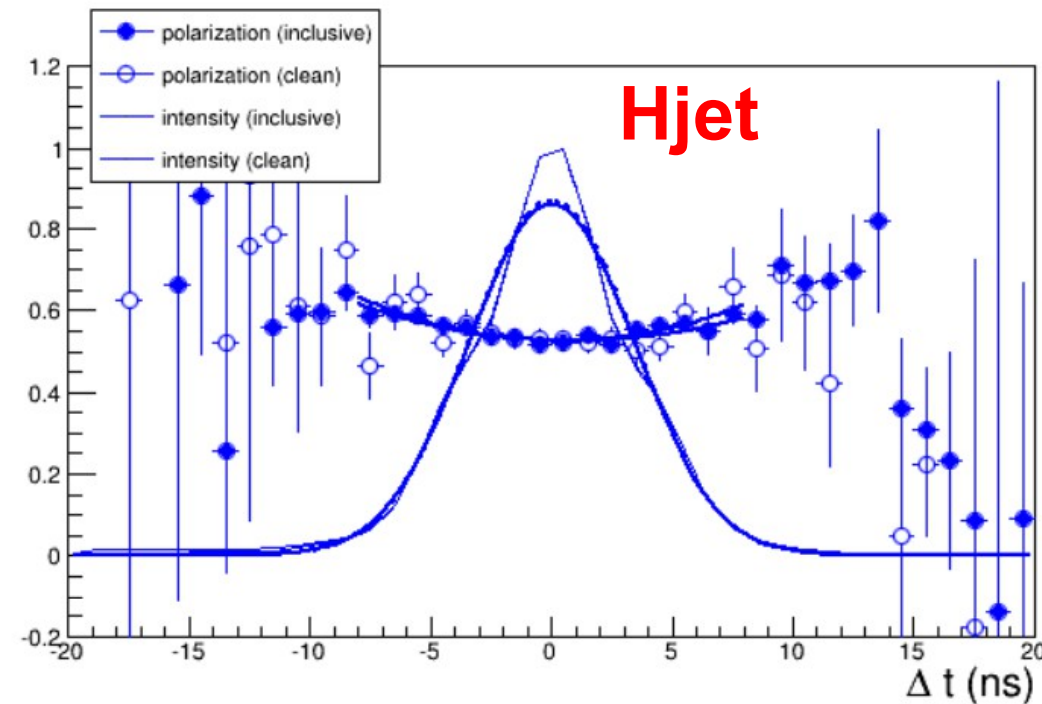
spin tilts @ store

$\phi_{pC}(^\circ)$	Blu	Yel
Run9-100	6	5
Run11-250	3	1
Run12-100	3	3
Run12-255	11	7
Run13-255	16	9
Run15-100 pp	3	2
Run15-104 pAu	0	-
Run15-104 pAl	1	-
Run17-255	12	8

→ Vincent's talk

Longitudinal polarization profile

- Well known transverse polar. profile:
polarization drops at edges of beam
- Longitudinal profile?
- Asymmetry in t bins along proton bunch:

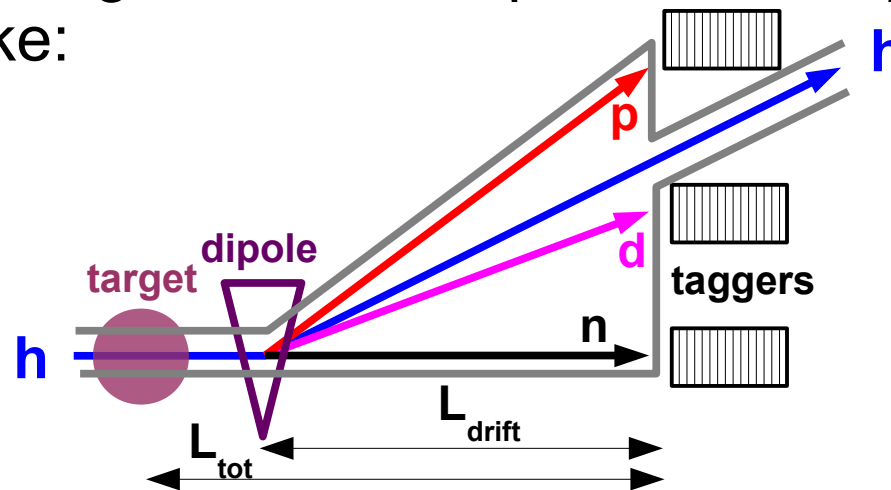


- Polarization lower center of bunch; beam-beam effect?

Extras

Tagging ${}^3\text{He}$ ($\equiv h$) breakup @ EIC

- At breakup threshold, fragments travel colinearly with beam;
fraction of beam rigidity $R_h : R_d = 4/3R_h ; R_p = 2/3R_h ; R_n = \infty$
- Dipole single bend approx., beam bent by $\theta_h : \theta_d = 3/4\theta_h ; \theta_p = 3/2\theta_h ; \theta_n = 0$
- Require: arrangement target \rightarrow some dipole \rightarrow drift space \rightarrow taggers might look like:



- Require: drift space L_{drift} long enough to get fragments out of beampipe vacuum and into taggers
- Fragments from breakup @ threshold define 0° point in taggers; breakup above threshold spread around this point
- Require: total target \rightarrow tagger distance L_{tot} as small as possible, maximize tagger angular acceptance