



Far-Forward Detectors at the Electron-Ion Collider

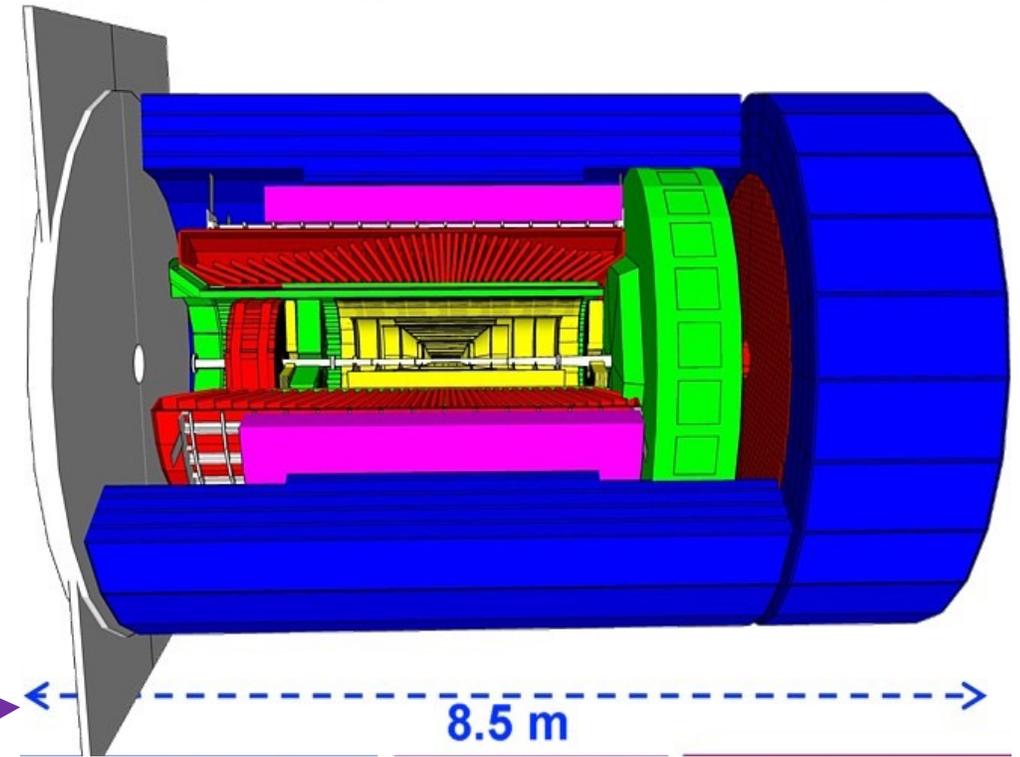
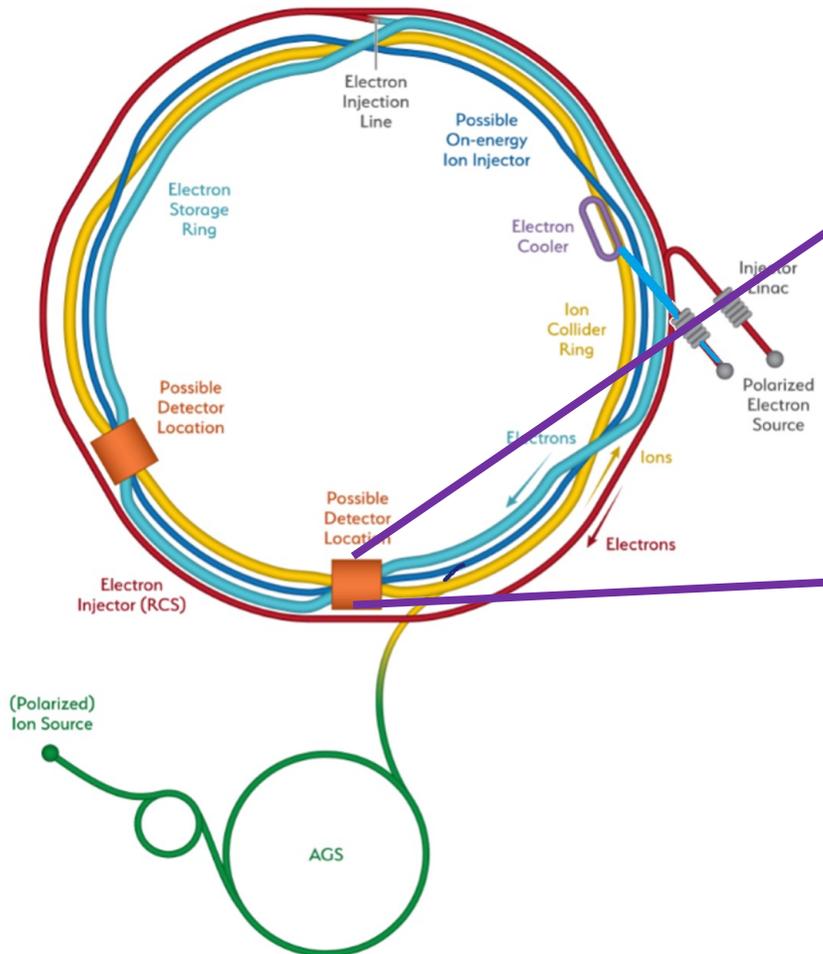
Alex Jentsch (BNL)

DIS 2022, Santiago de Compostela, Spain

May 2nd- 6th, 2022

The Electron-Ion Collider (EIC)

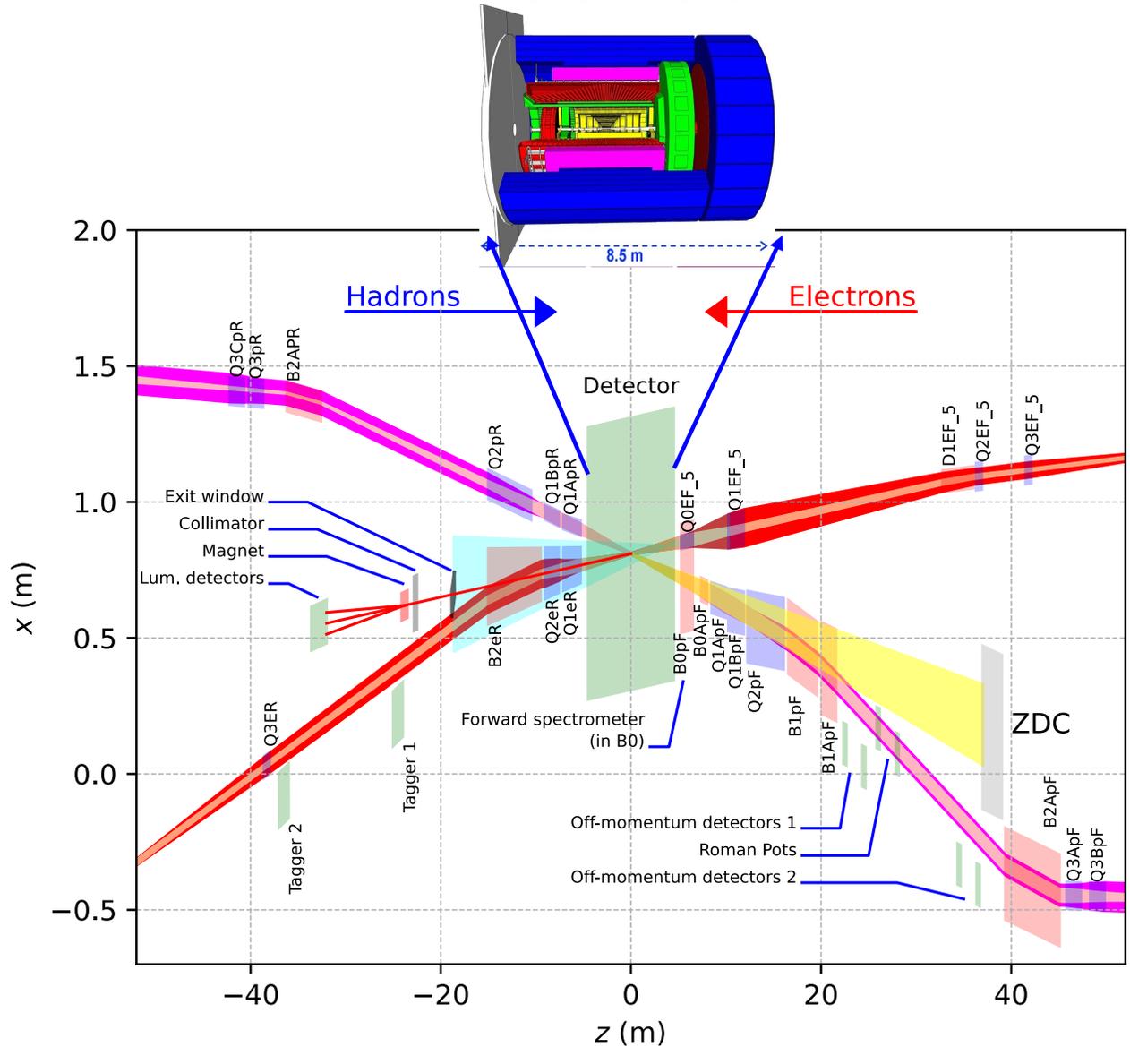
- Two interaction regions (IRs) for possible detector locations.
 - Only one IR (IP6) part of the project scope.



- Reference detector based on the 1.5T BaBar solenoid and ECCE reference design.
- Contains detectors for tracking, PID, and calorimetry.

C. Van Hulse
Tue. 10:00
WG6

The Electron-Ion Collider (EIC)

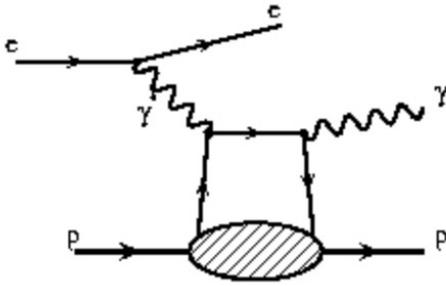


- In addition to the central detector → detectors integrated into the beamline on both the hadron-going (**far-forward**) and electron-going (**far-backward**) direction.

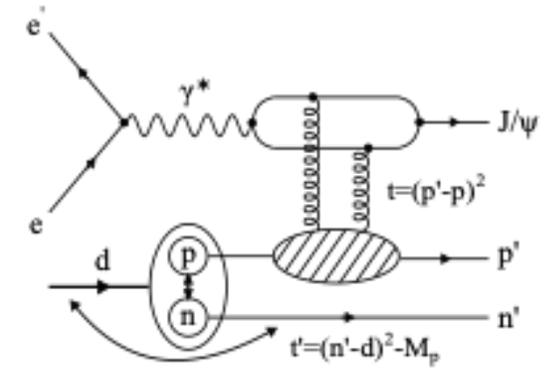
The far-forward system functions almost like an independent spectrometer experiment at the EIC!

Far-Forward Physics at the EIC

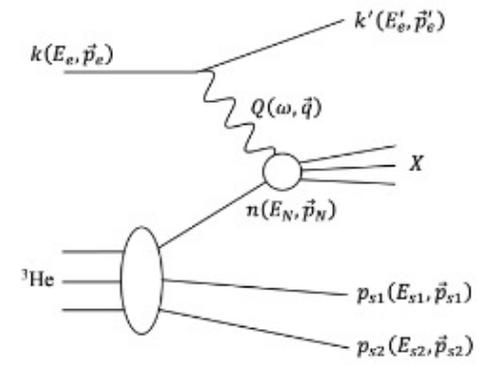
e+p DVCS



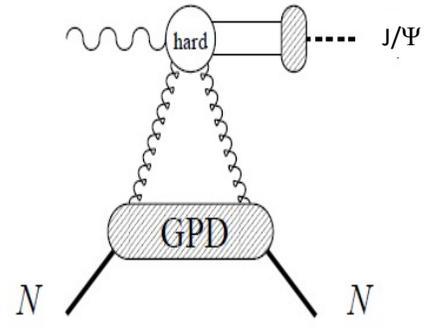
e+d exclusive J/Psi with p/n tagging



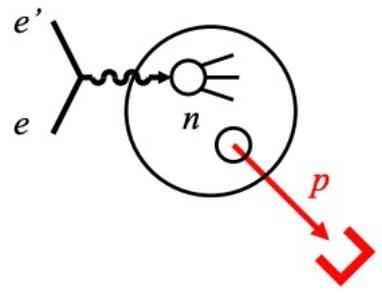
e+He3 spectator tagging



coherent/incoherent J/psi production in e+A

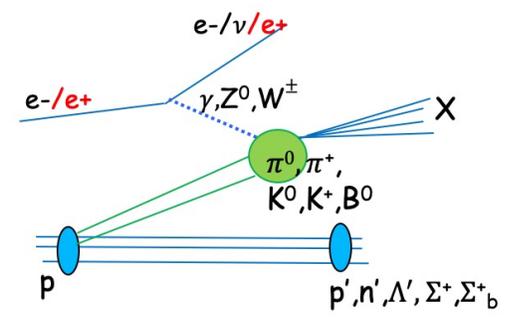


e+d DIS spectator tagging

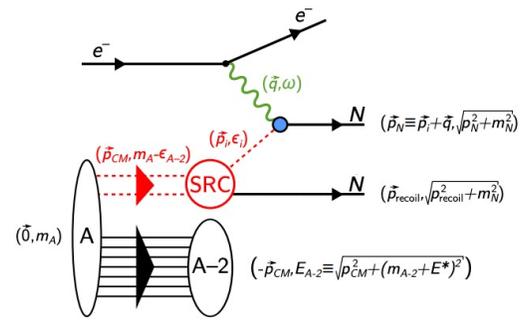


Meson structure:

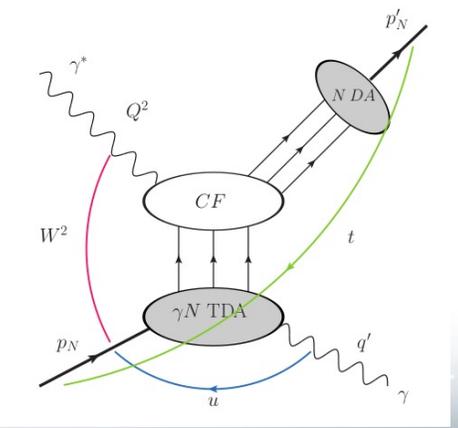
- $ep \rightarrow (\pi) \rightarrow e' n X$
- $\Lambda \rightarrow p\pi^-$ and $\Lambda \rightarrow n\pi^0$



Quasi-elastic electron scattering



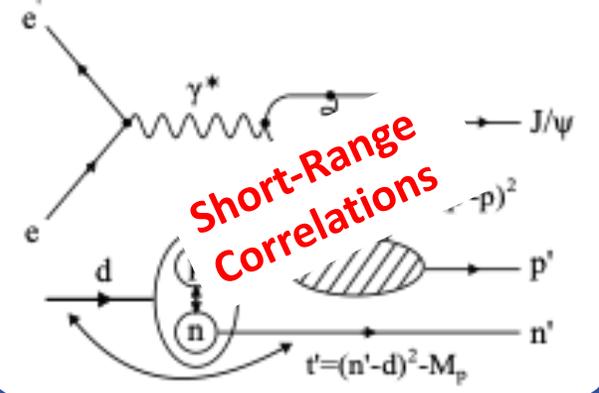
u-channel backward exclusive electroproduction



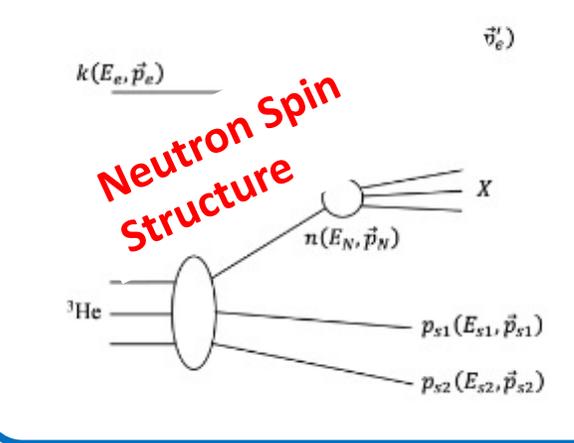
...and MANY more!

Far-Forward Physics at the EIC

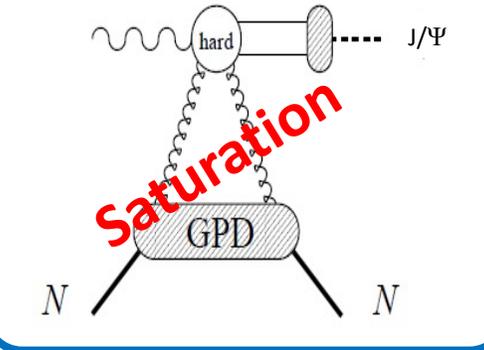
e+d exclusive J/Psi with proton or neutron tagging¹



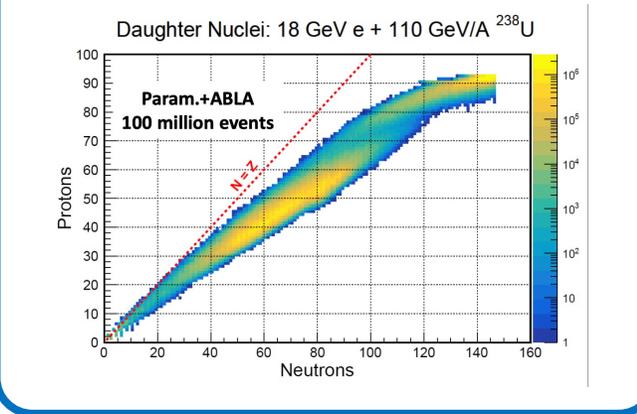
e+He3 spectator tagging²



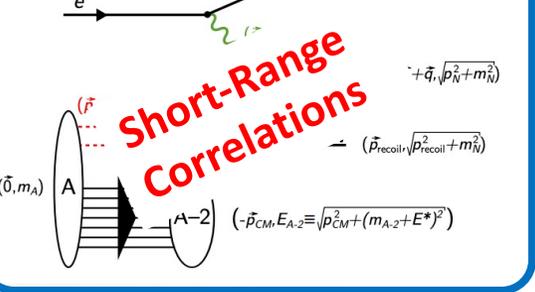
coherent/incoherent J/psi production in e+A³



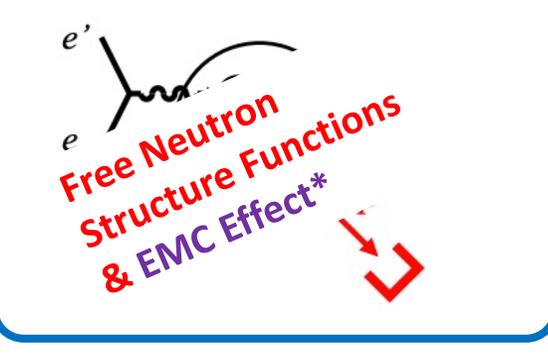
Rare isotopes**



Quasi-elastic electron scattering⁴

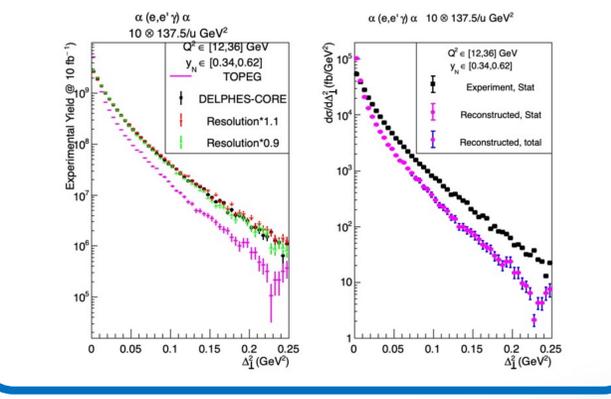


e+d DIS spectator tagging⁵



[1] Z. Tu, AJ, et al., Phys. Lett. B **811**, 135877 (2020)
 [2] I. Friscic, D. Nguyen, J. R. Pybus, AJ, et al., Phys. Lett. B, **823**, 136726 (2021)
 [3] W. Chang, E.C. Aschenauer, M. D. Baker, AJ, J.H. Lee, Z. Tu, Z. Yin, and L. Zheng, Phys. Rev. D **104**, 114030 (2021)
 [4] F. Hauenstein, AJ, J. R. Pybus, A. Kiral, M. D. Baker, Y. Furletova, O. Hen, D. W. Higinbotham, C. Hyde, V. Morozov, D. Romanov, and L. B. Weinstein, Phys. Rev. C **105**, 034001 (2022)
 [5] AJ, Z. Tu, and C. Weiss, Phys. Rev. C **104**, 065205 (2021) (Editor's Suggestion)

e+He4 DVCS***



Many examples of detailed impact studies with full detector simulations! (non-exhaustive)

*Z. Tu
Thurs. 10:00
WG6

**B. Moran
Wed. 9:00
WG6

***C. Hyde
Wed. 10:40
WG6

Far-Forward Physics at the EIC

e+d exclusive J/Psi with proton or neutron tagging¹



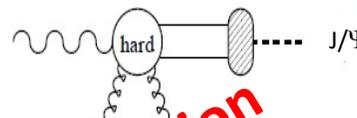
e+He3 spectator tagging²

$$k(E_e, \vec{p}_e)$$

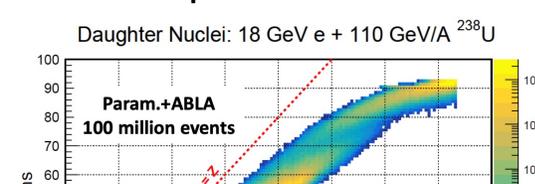
neutron spin

\vec{v}_e

coherent/incoherent J/ ψ production in e+A³



Rare isotopes**



There are numerous crucial final-states for EIC physics which require far-forward detectors!!

C 103, 054001 (2022)

[5] AJ, Z. Tu, and C. Weiss, Phys. Rev. C **104**, 065205 (2021) (Editor's Suggestion)

Many examples of detailed impact studies with full detector simulations! (non-exhaustive)

*Z. Tu
Thurs. 10:00
WG6

**B. Moran
Wed. 9:00
WG6

***C. Hyde
Wed. 10:40
WG6

Far-Forward Physics at the EIC

- Physics channels require tagging of **charged hadrons** (protons, pions) or **neutral particles** (neutrons, photons) at **very-forward rapidities** ($\eta > 4.5$).
- Different final states \rightarrow tailored detector subsystems.
- Various collision systems and energies (h: 41, 100-275 GeV, e: 5-18 GeV; e+p, e+d, e+Au, etc.).
- Placing of far-forward detectors uniquely challenging due to integration with accelerator.
- Details studied in EIC Yellow Report and Conceptual Design Report, and in the ATHENA, ECCE, and CORE EIC detector proposals.

*Z. Tu
Thurs. 10:00
WG6

**B. Moran
Wed. 9:00
WG6

***C. Hyde
Wed. 10:40
WG6

Far-Forward Physics at the EIC

- Physics channels require tagging of **charged hadrons** (protons, pions) or **neutral particles** (neutrons, photons) at **very-forward rapidities** ($\eta > 4.5$).
- Different final states → tailored detector subsystems.
- Various collision systems and energies (h: 41, 100-275 GeV, e: 5-18 GeV; e+p, e+d, e+Au, etc.).
- Placing of far-forward detectors uniquely challenging due to integration with accelerator.
- Details studied in EIC Yellow Report and Conceptual Design Report, and in the ATHENA, ECCE, and CORE EIC detector proposals.

B. Surrow
S. de la Torre
Wed. 17:10
WG6

C. Van Hulse
Tue. 10:00
WG6

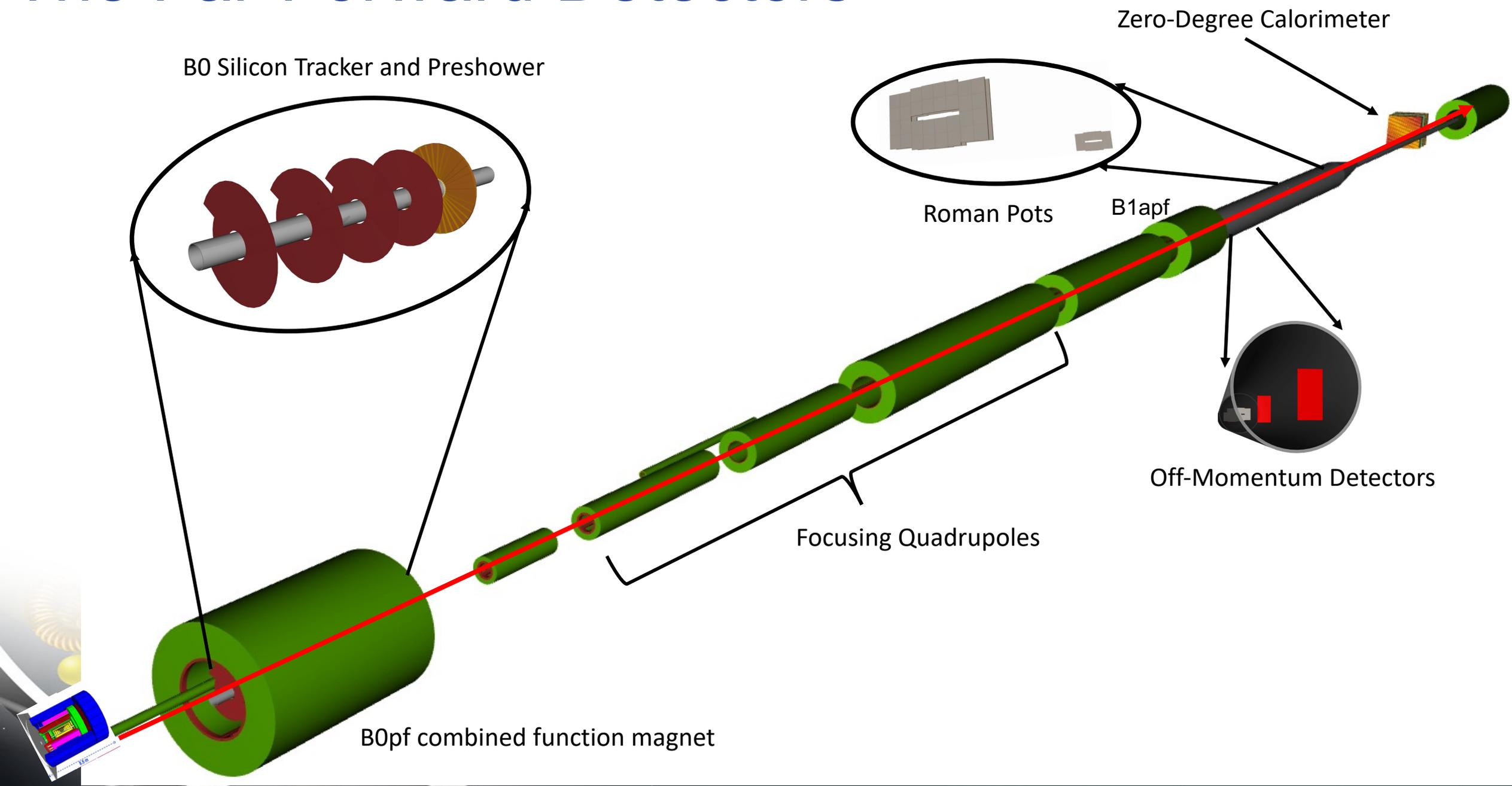
G. Schnell
Tue. 10:00
WG6

*Z. Tu
Thurs. 10:00
WG6

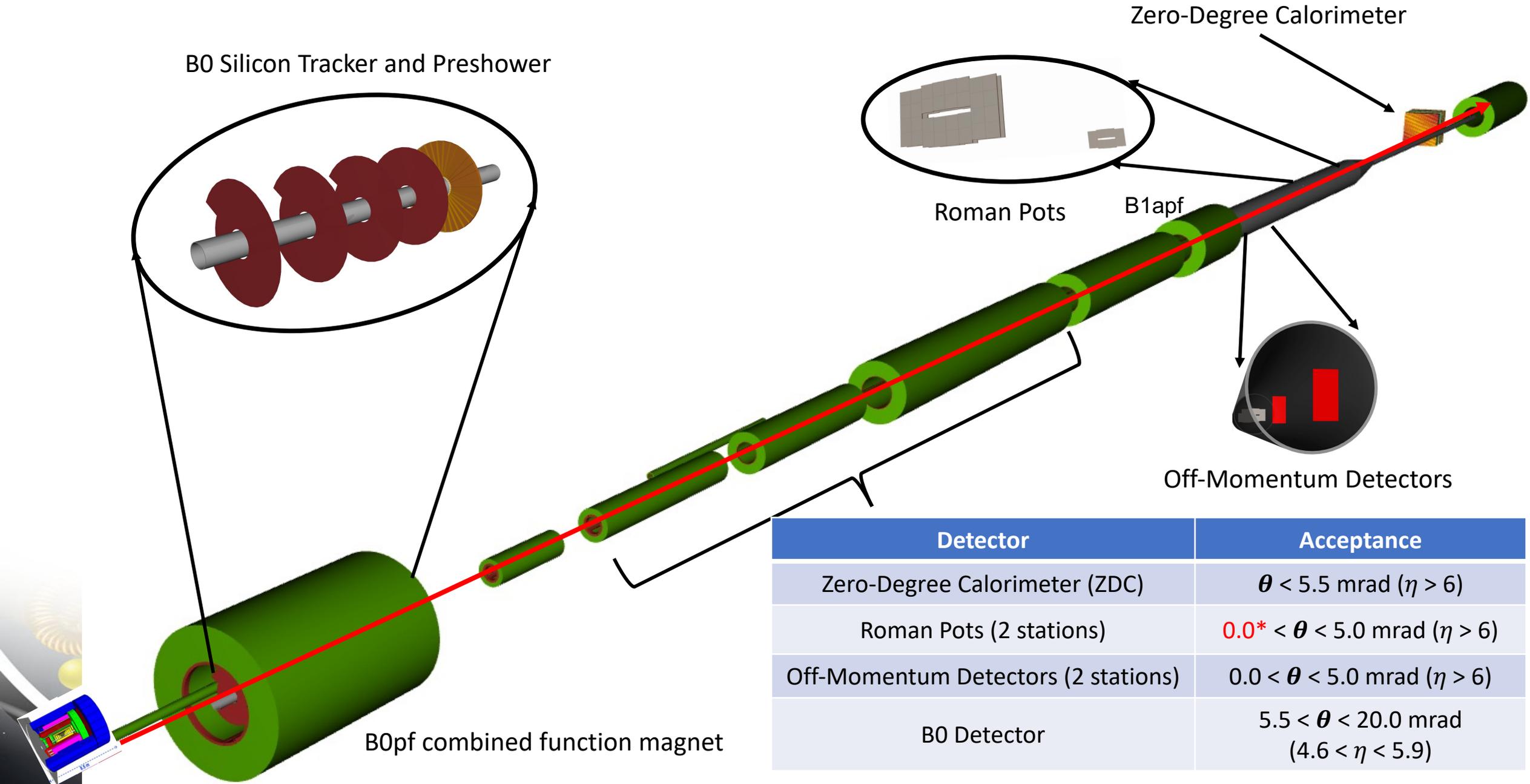
**B. Moran
Wed. 9:00
WG6

***C. Hyde
Wed. 10:40
WG6

The Far-Forward Detectors



The Far-Forward Detectors

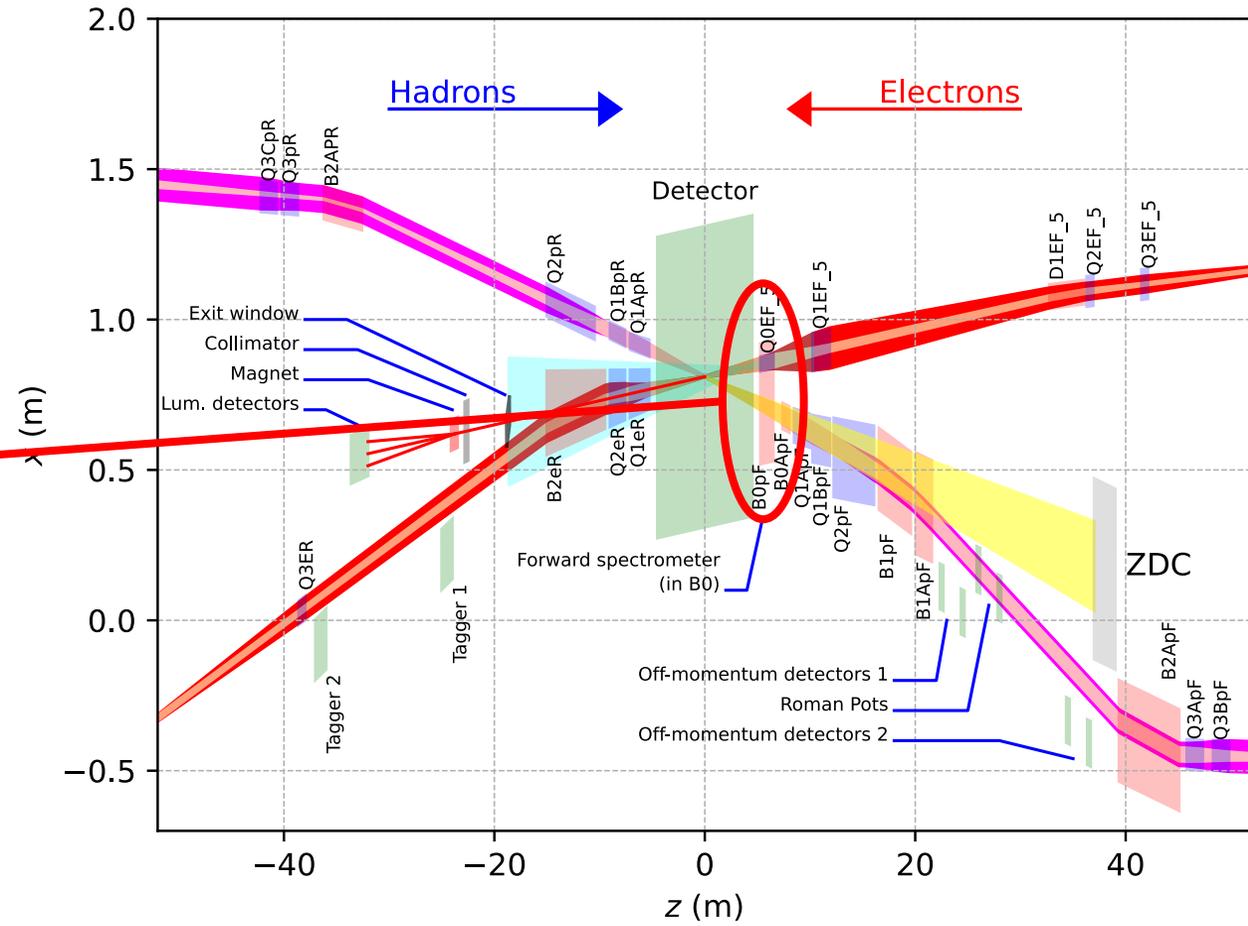
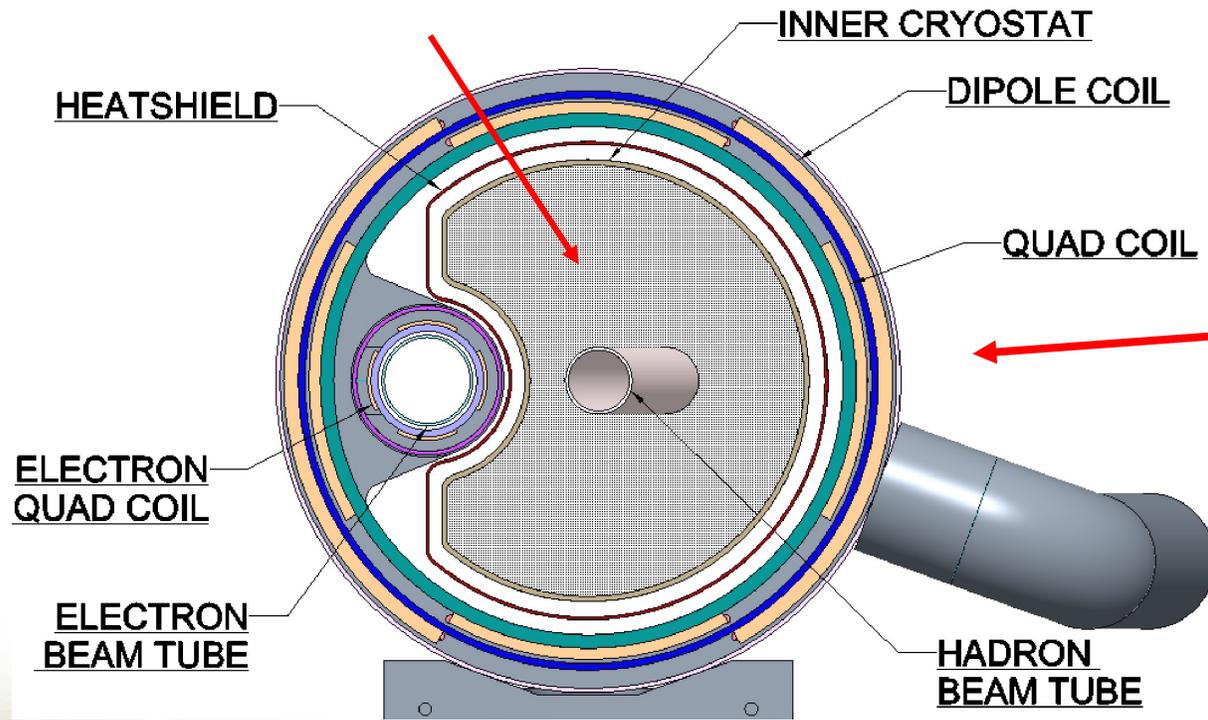




Far-Forward Detector Subsystems

B0 Detectors

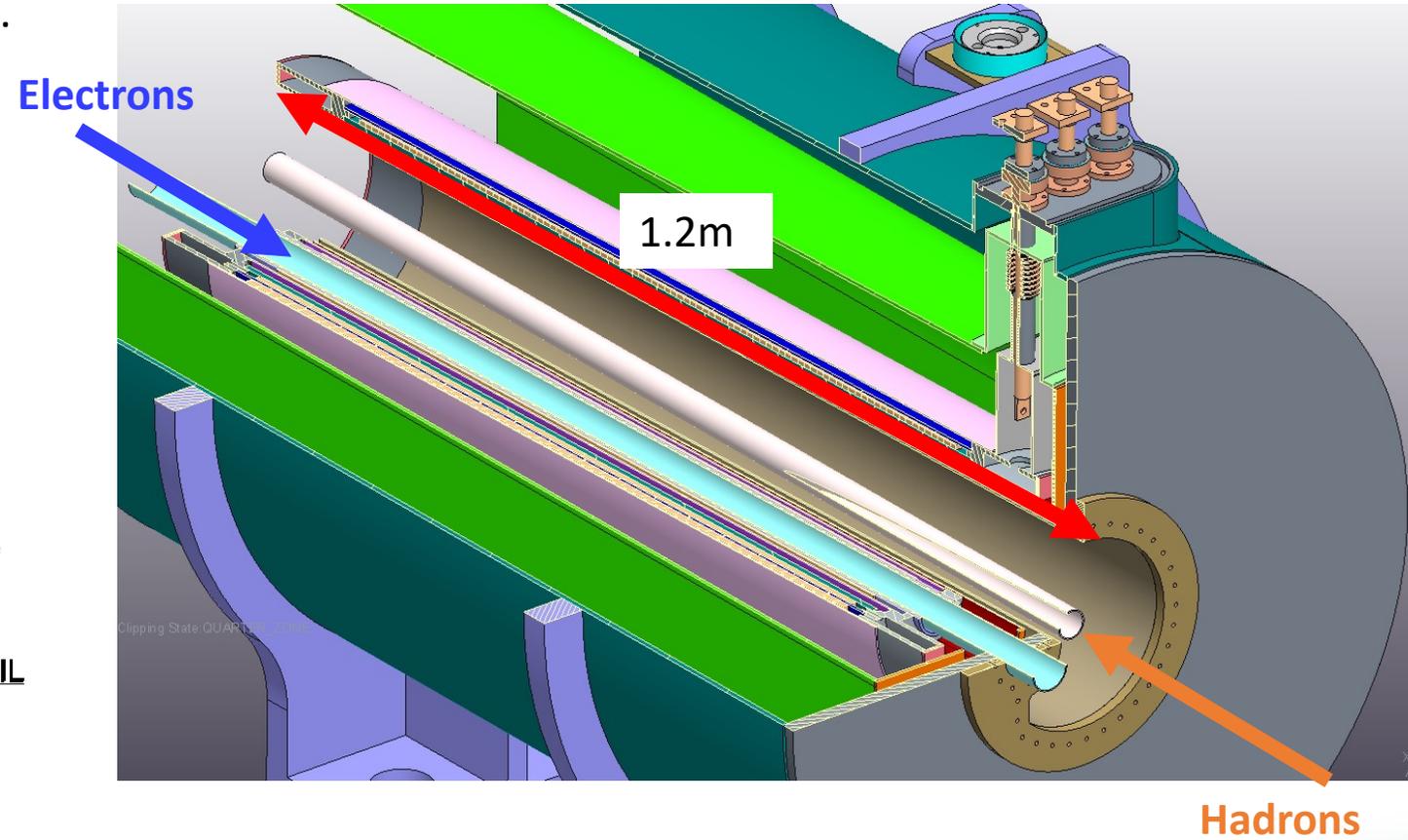
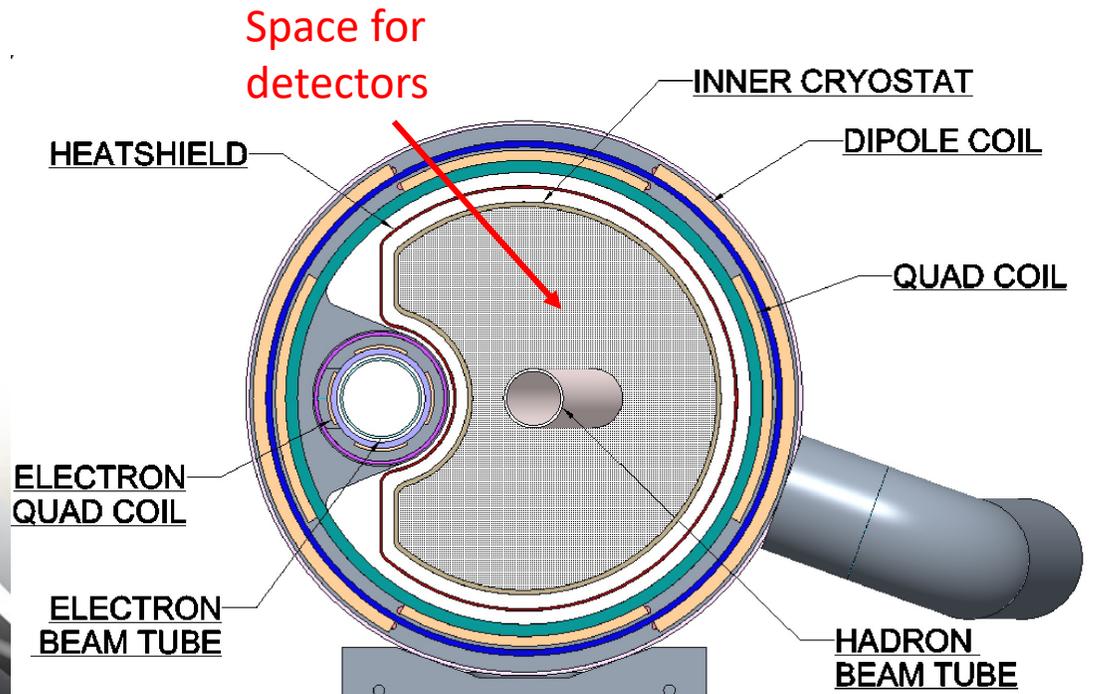
Space for detectors



B0 Detectors

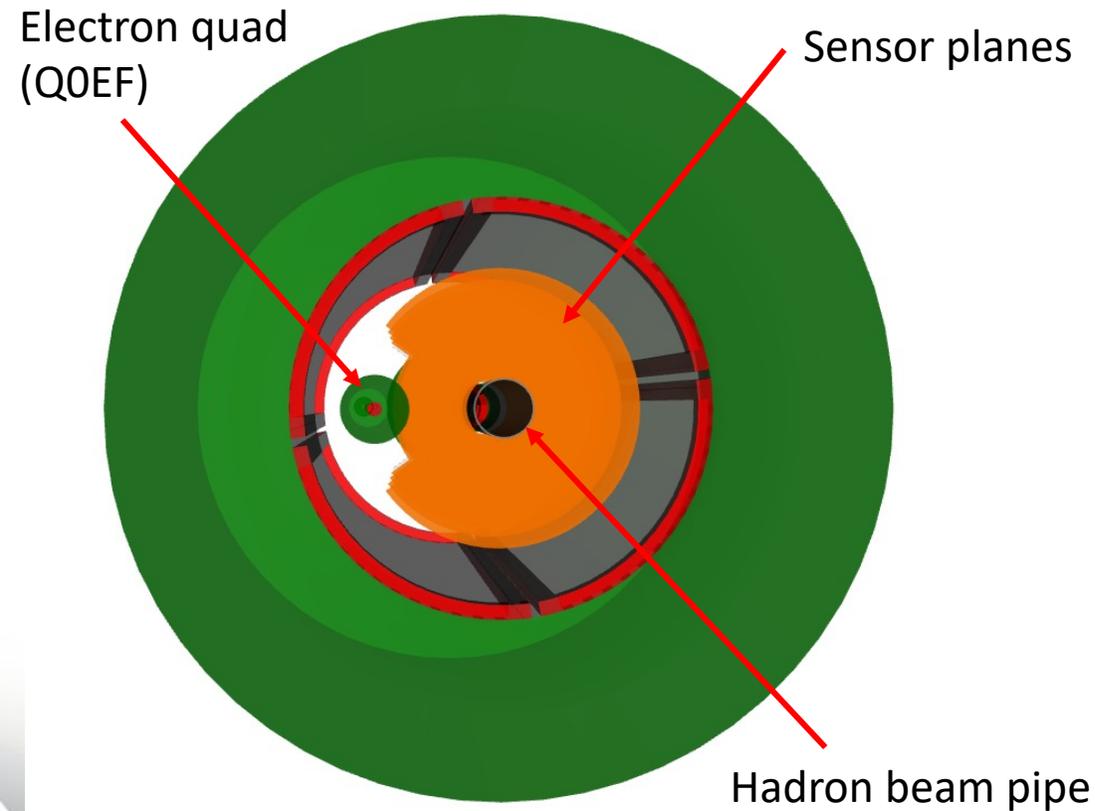
($5.5 < \theta < 20.0$ mrad)

- Charged particle reconstruction and photon tagging.
 - Precise tracking ($\sim 10\mu\text{m}$ spatial resolution).
 - Fast timing for background rejection and to remove crab smearing ($\sim 35\text{ps}$).
 - Photon detection (tagging or full reco).

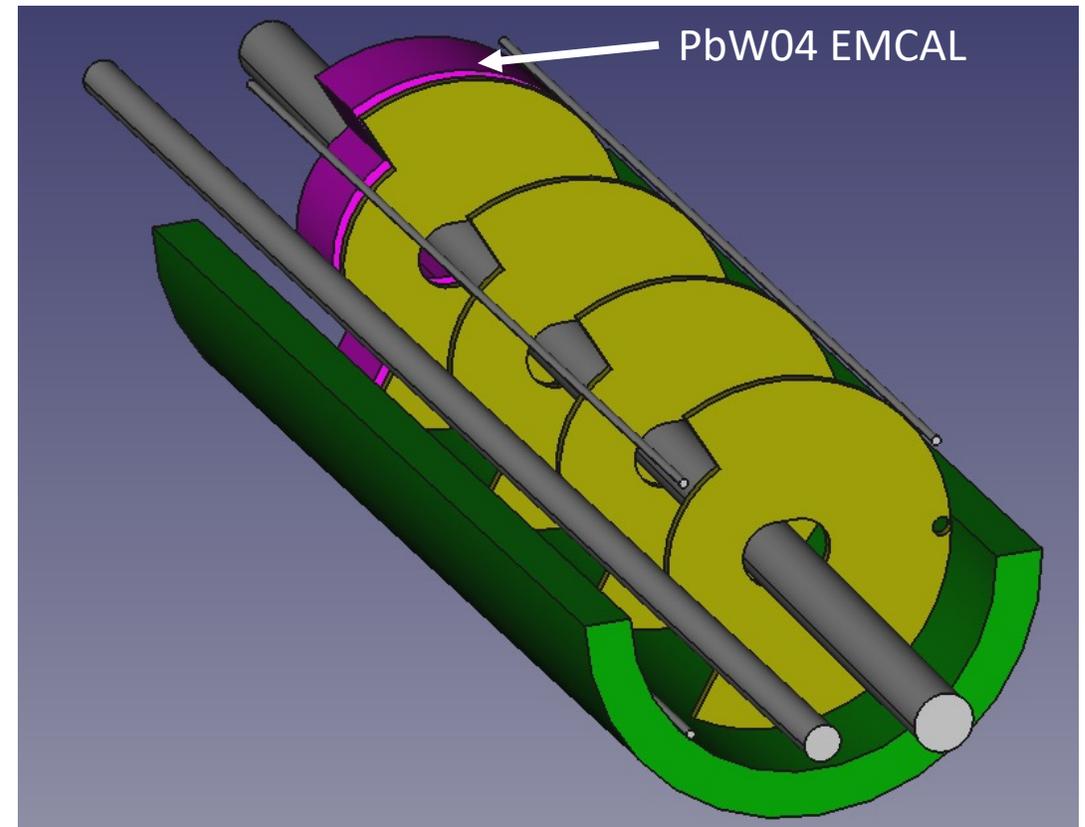


B0 Detectors

($5.5 < \theta < 20.0$ mrad)



DD4HEP Simulation

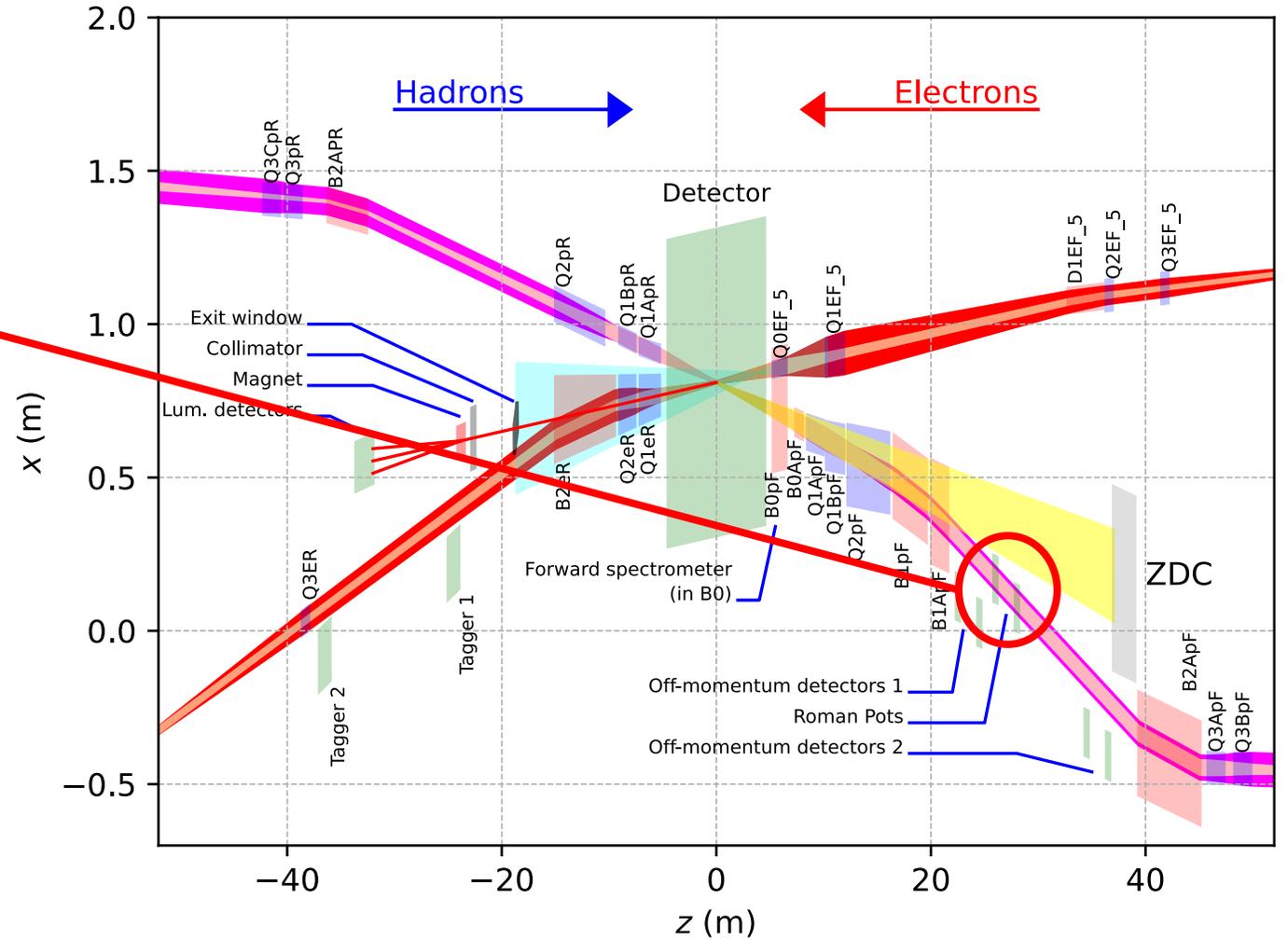
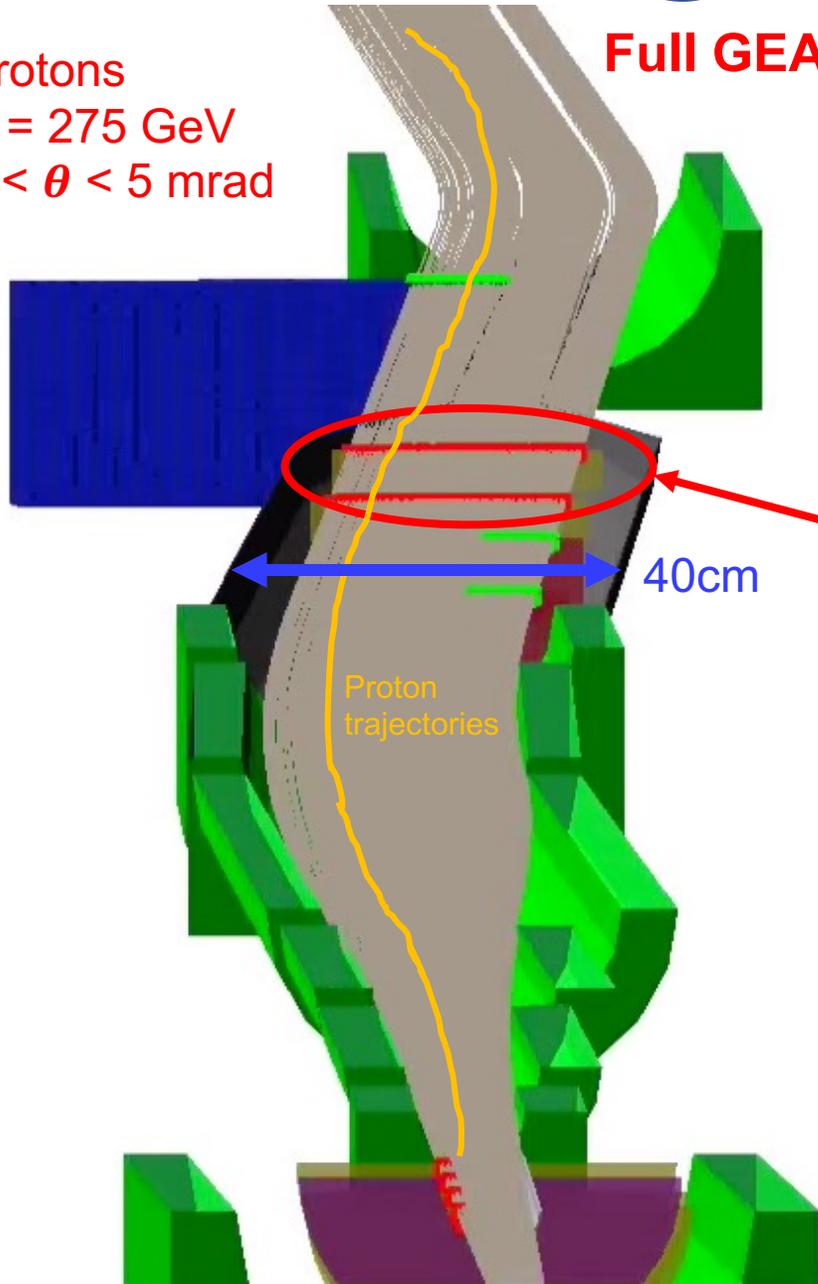


- Higher granularity silicon (e.g. MAPS) required.
- Tagging photons important in differentiating between coherent and incoherent heavy-nuclear scattering, and for reconstructing $\pi^0 \rightarrow \gamma\gamma$.
 - **Space is a major concern here – an EMCAL is highly preferred, but may only have space for a preshower.**

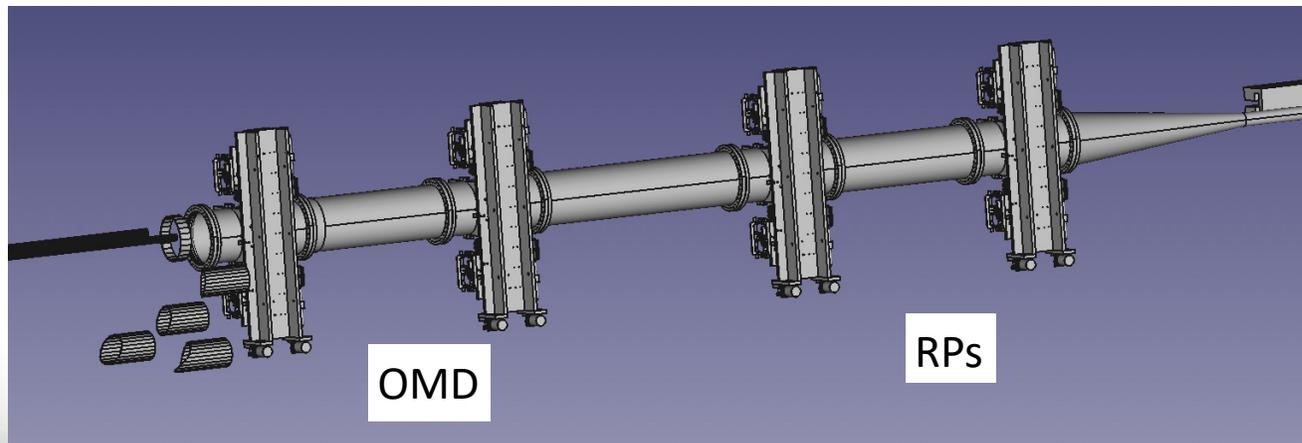
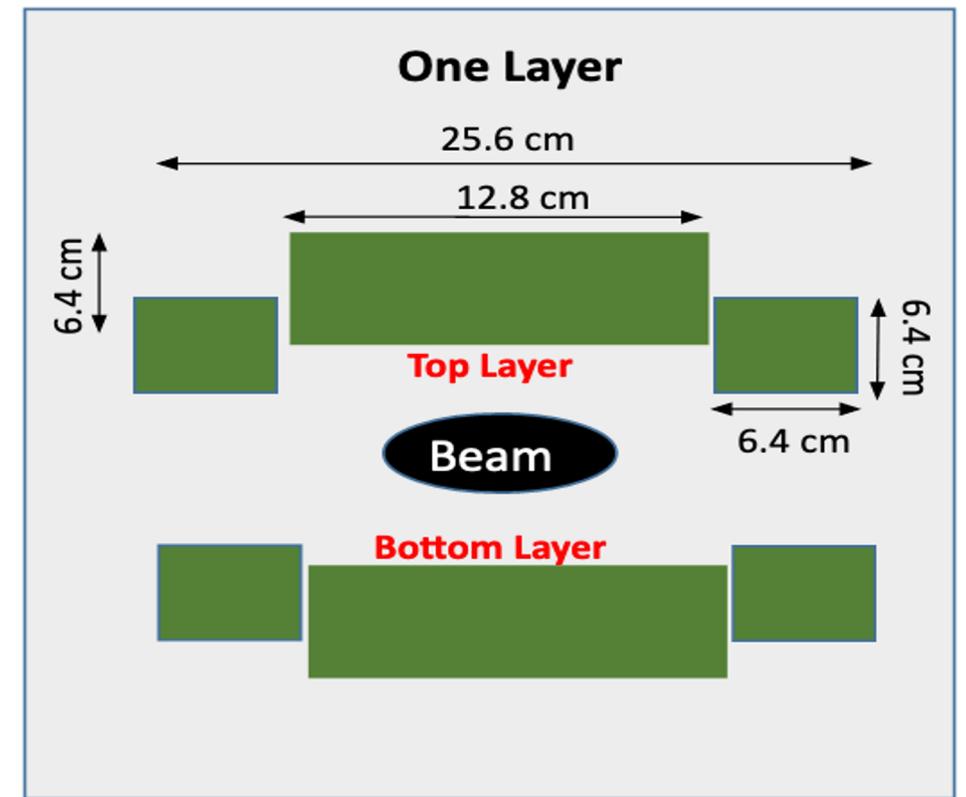
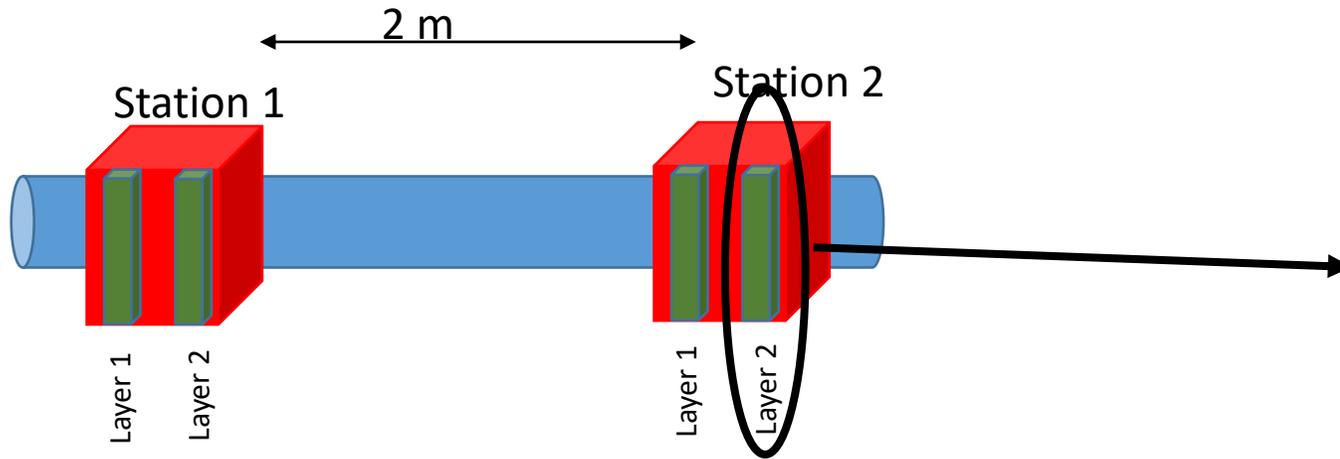
Roman Pots @ the EIC

Protons
 $E = 275 \text{ GeV}$
 $0 < \theta < 5 \text{ mrad}$

Full GEANT4 simulation.

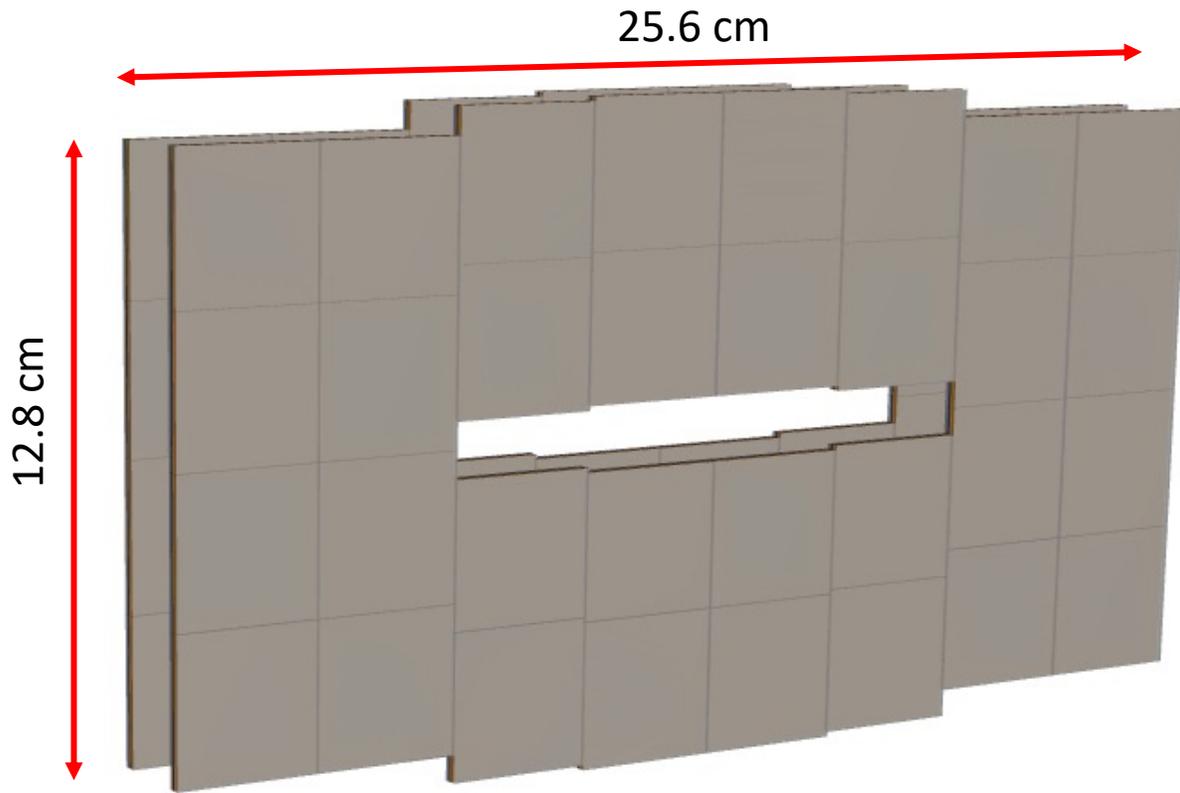


Roman "Pots" @ the EIC

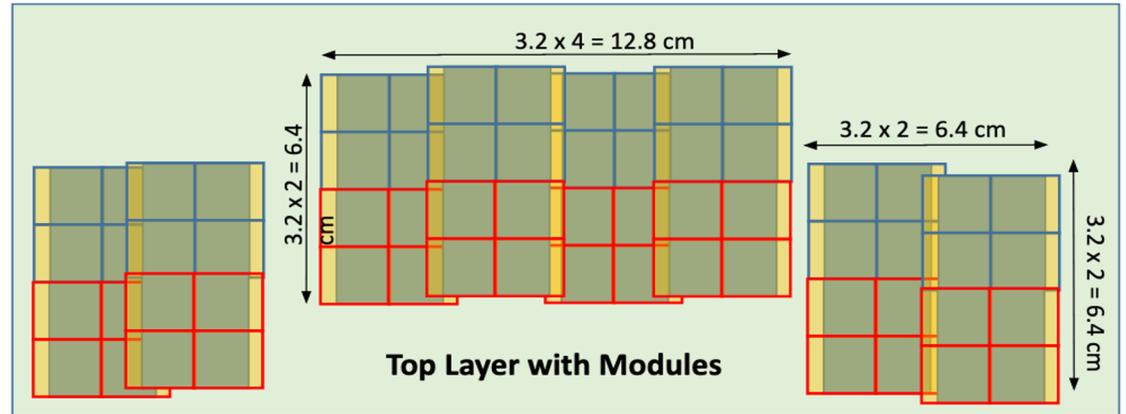


- Silicon detectors placed directly into machine vacuum!
 - Allows maximal geometric coverage!
- Need space for detector insertion tooling and support structure.

Roman “Pots” @ the EIC



DD4HEP Simulation



- **Two main options**

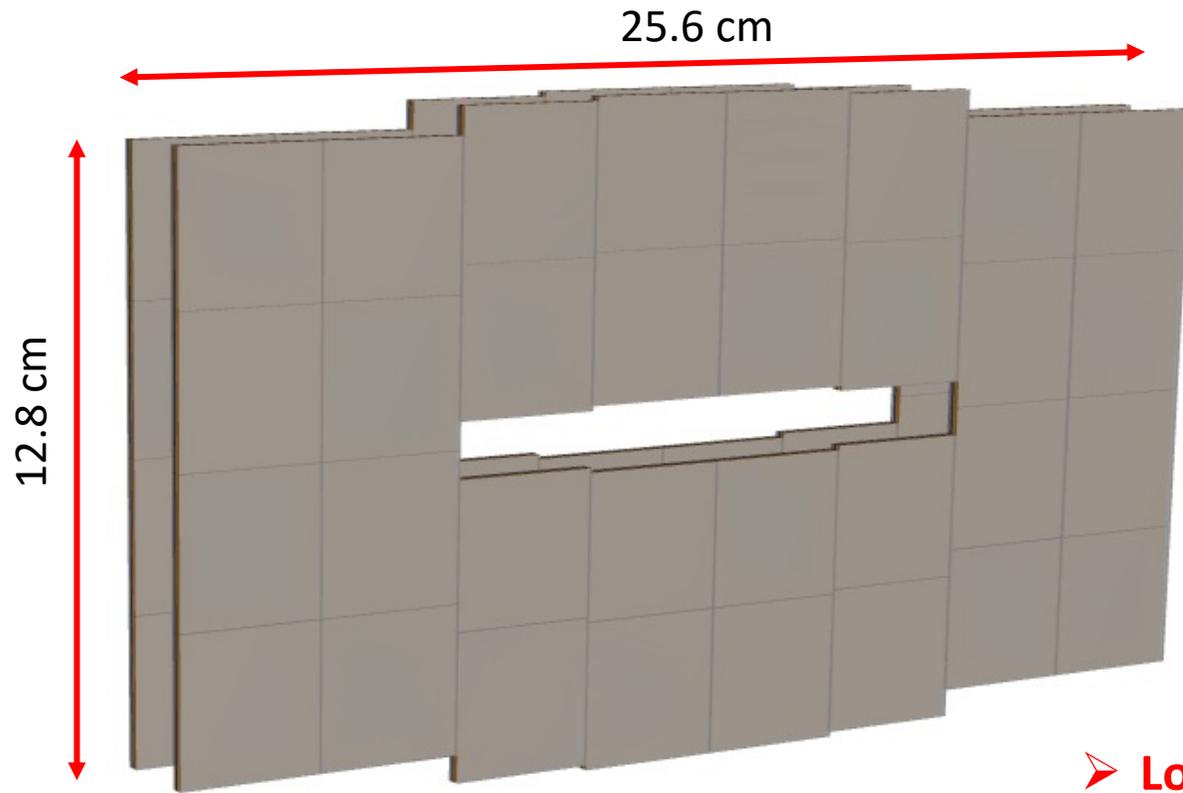
- AC-LGAD sensor provides both fine pixilation ($\sim 140\mu\text{m}$ spatial resolution), and fast timing ($\sim 35\text{ps}$).
- MAPS + LYSO timing layer.
- “Potless” design concept with thin RF foils surrounding detector components.

Roman "Pots" @ the EIC

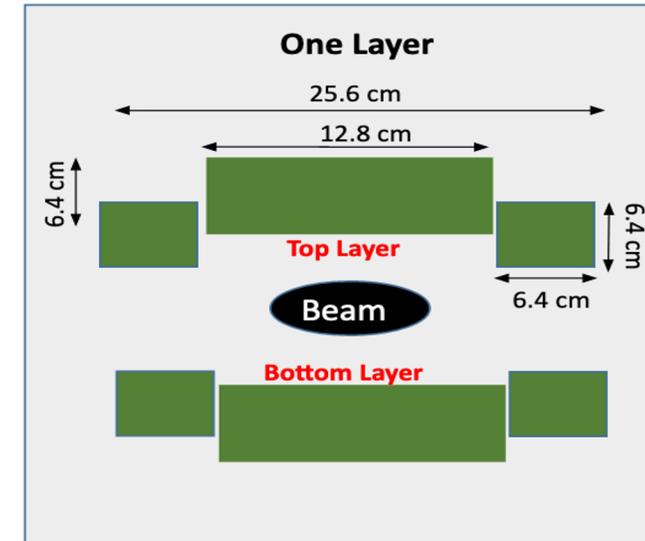
$\sigma(z)$ is the Gaussian width of the beam, $\beta(z)$ is the RMS transverse beam size.

ε is the beam emittance.

$$\sigma(z) = \sqrt{\varepsilon \cdot \beta(z)}$$

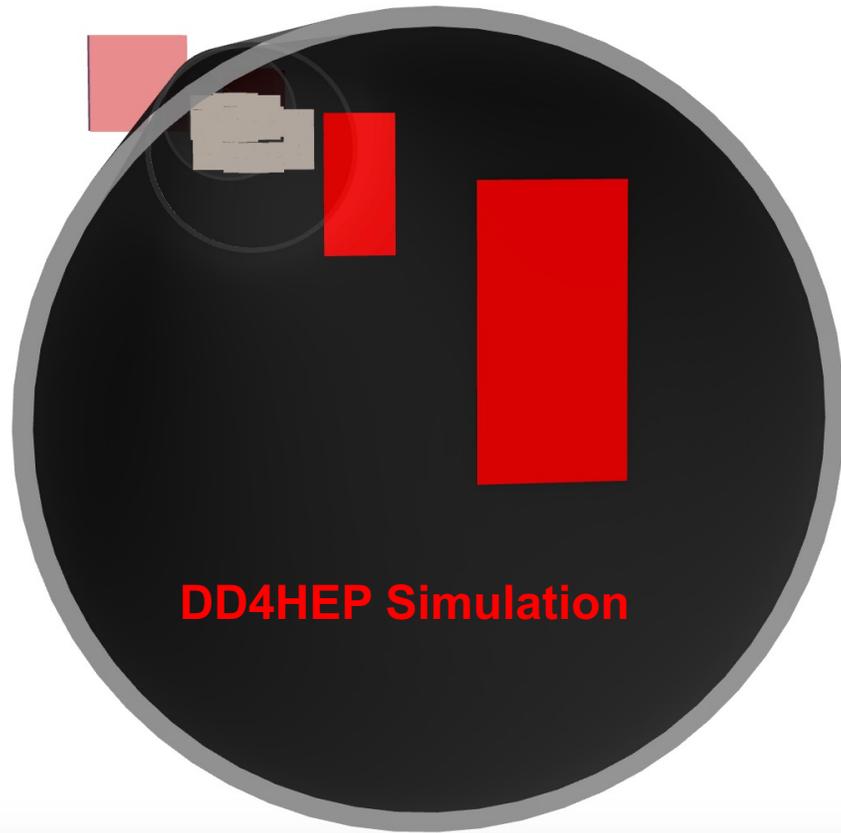


DD4HEP Simulation



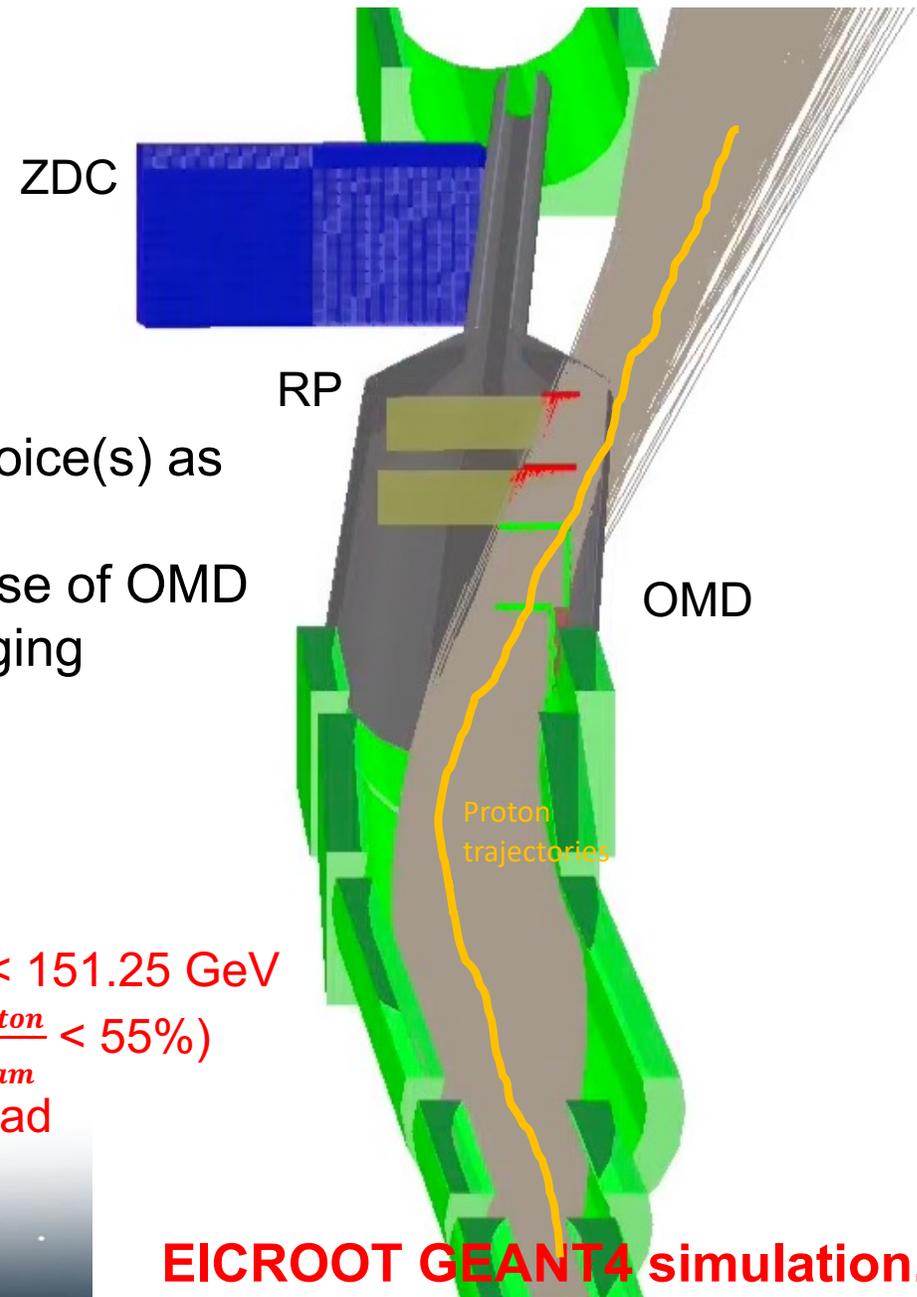
- Low-pT cutoff determined by beam optics.
 - The safe distance is $\sim 10\sigma$ from the beam center.
 - $1\sigma \sim 1\text{mm}$
- These optics choices change with energy, but can also be changed within a single energy to maximize *either acceptance at the RP, or the luminosity.*

Off-Momentum Detectors



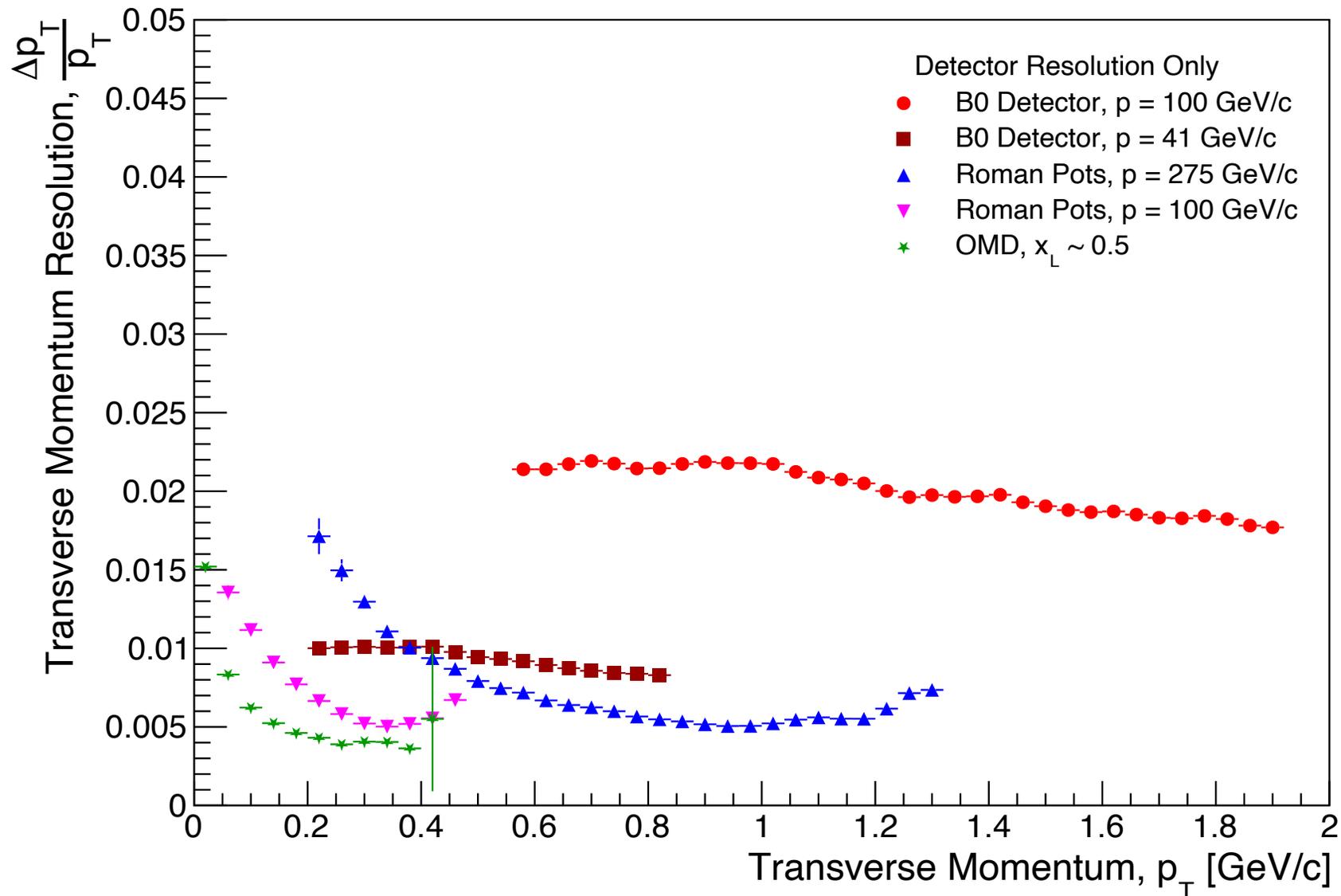
- Same technology choice(s) as for the Roman Pots.
- Need to also study use of OMD on other side for tagging negative pions.

Off-momentum detectors implemented as horizontal "Roman Pots" style sensors.



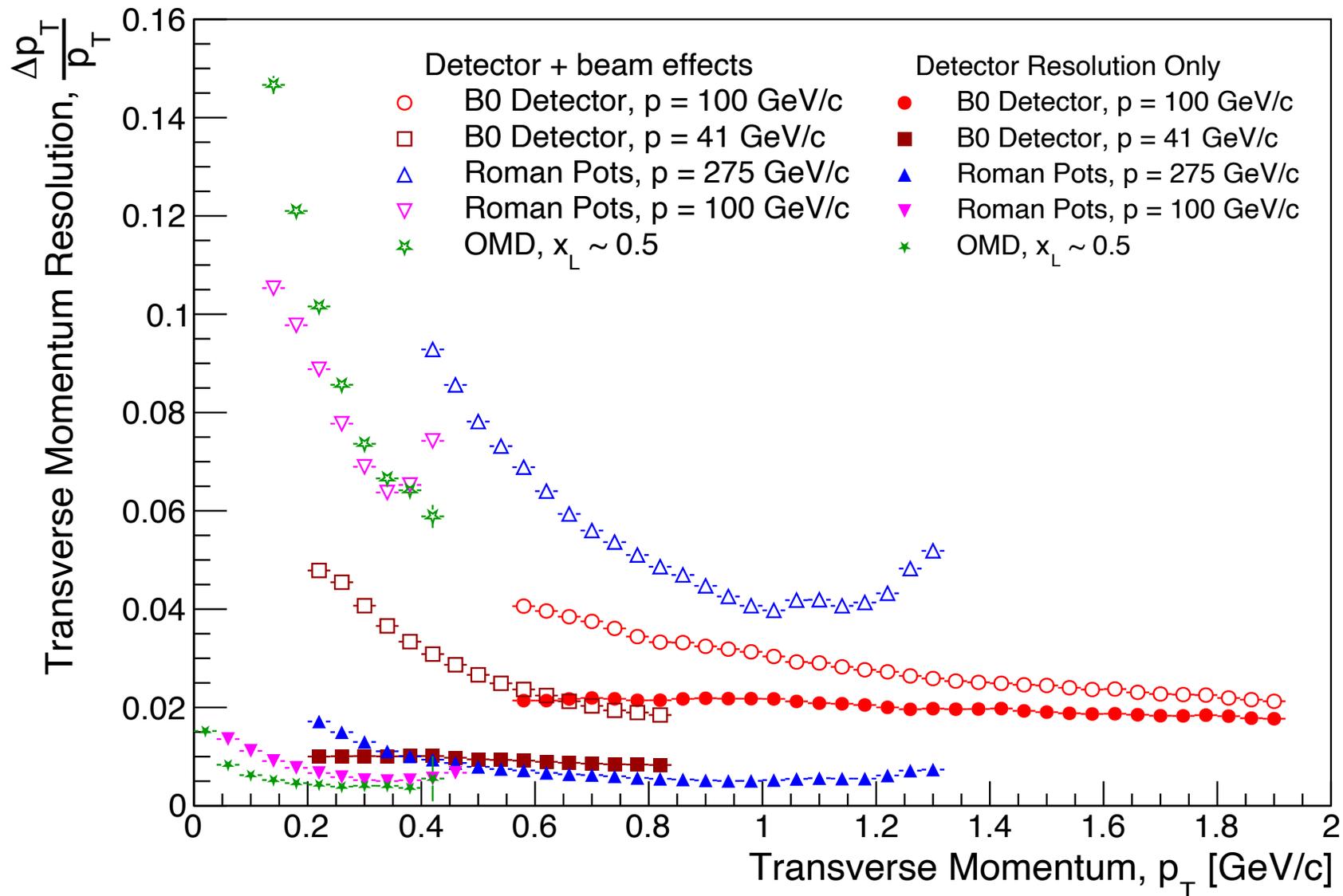
Protons
 $123.75 < E < 151.25$ GeV
 $(45\% < \frac{p_{z,proton}}{p_{z,beam}} < 55\%)$
 $0 < \theta < 5$ mrad

Summary of Detector Performance (Trackers)



- Includes realistic considerations for pixel sizes and materials
 - More work needed on support structure and associated impacts.
- Roman Pots and Off-Momentum detectors suffer from additional smearing due to improper transfer matrix reconstruction.
 - This problem is close to being solved!

Summary of Detector Performance (Trackers)

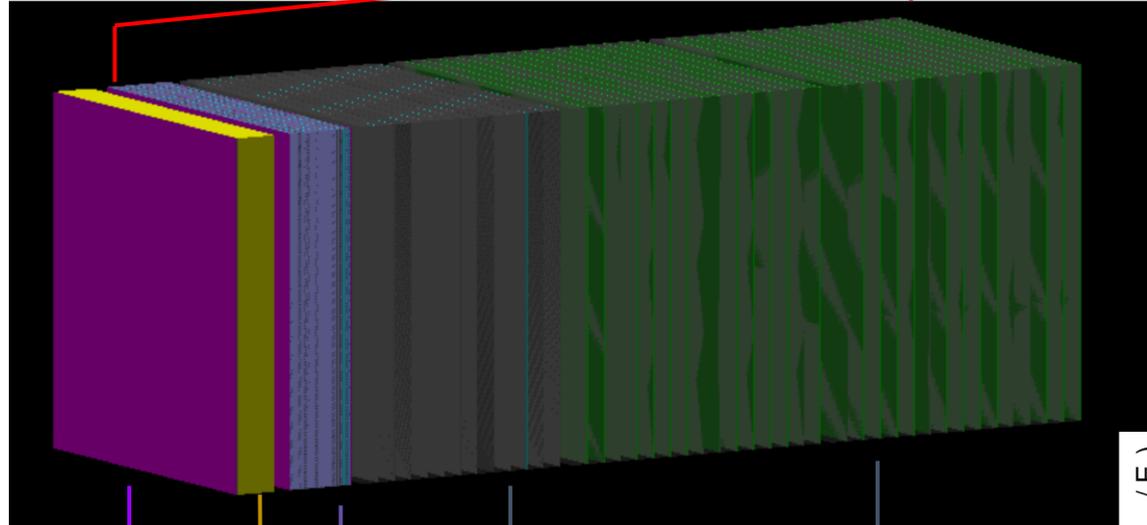


- All beam effects included!
 - Angular divergence.
 - Crossing angle.
 - Crab rotation/vertex smearing.

Beam effects the dominant source of momentum smearing!

Zero-Degree Calorimeter

64 Layers



Si Tracker

12 W/Si planes

30 Lead/Scintillator planes

7 cm PbWO4 Crystal Layer

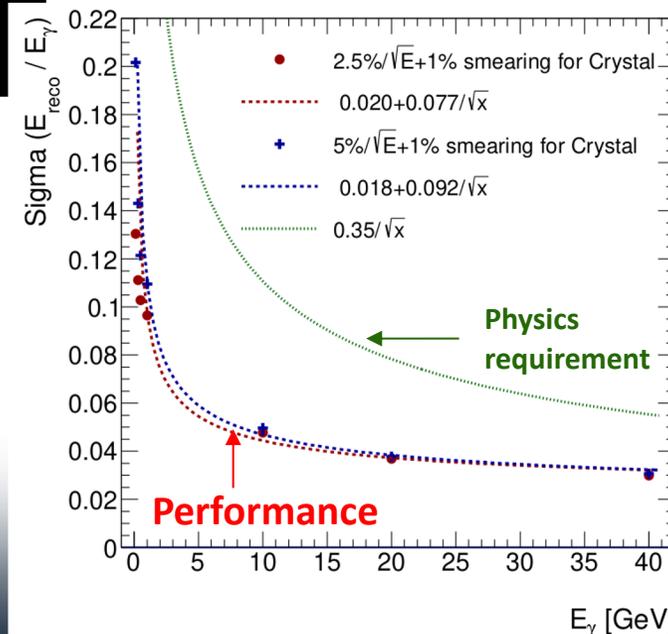
22 Pb/Si planes

Credit to Shima Shimizu (Kobe U., Japan)

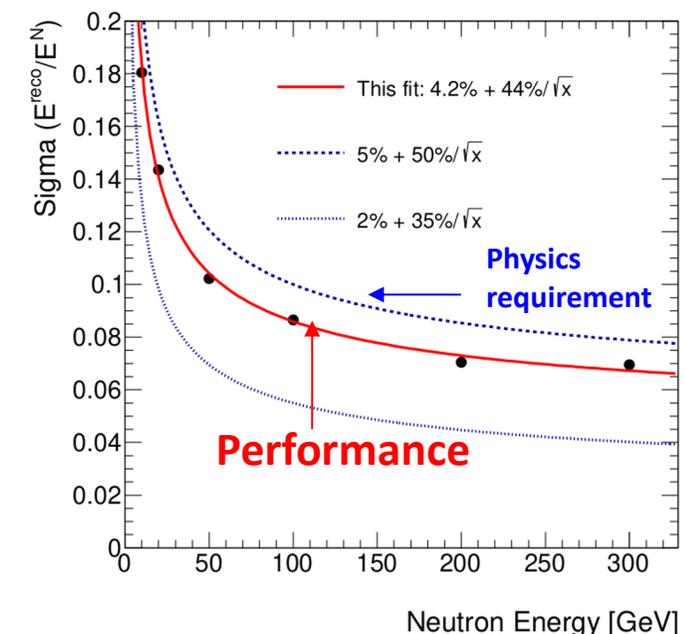
Thanks to Bill Li for providing the slide!

- Zero Degree Calorimeter (improved ALICE design):
 - Dimension: 60 cm x 60 cm x 168 cm
 - 30 m from IR
 - Detect spectator neutron
 - Acceptance: +4.5 mrad, -5.5mrad
 - Position resolution $\sim 1.3\text{mm}$ at 40 GeV
 - Full reconstruction of photons (EMCAL) and neutrons (HCAL)

Photon energy resolution

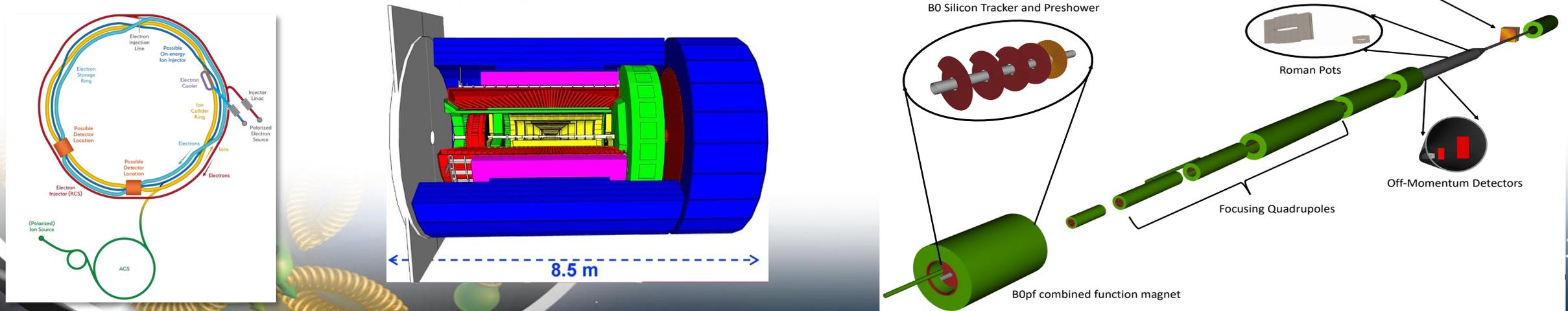


Neutron energy resolution

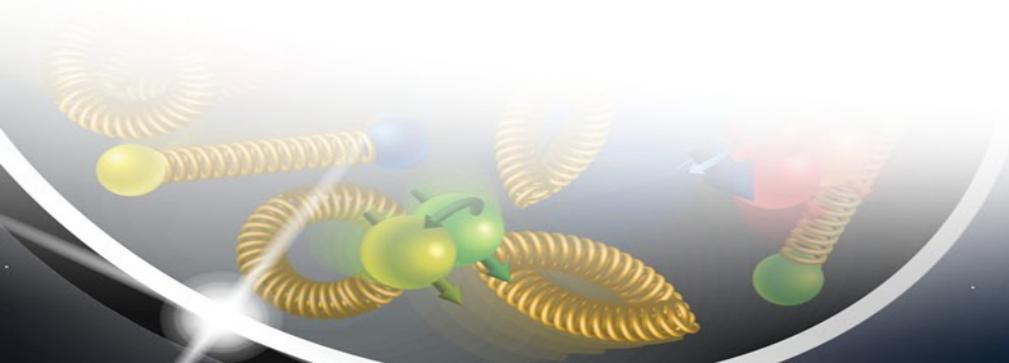


Summary and Takeaways

- All FF detector acceptances and detector performance well-understood with currently available information.
 - Numerous impact studies done!
 - Some final choices on technology underway → also important for IP8 complementarity.
 - Full effort benefitted from three (ECCE, ATHENA, CORE) proposals to identify multiple technology solutions!
- More realistic engineering considerations need to be added to simulations as design of IR vacuum system and magnets progresses toward CD-2/3a.
 - Lots of experience in performing these simulations, so this work will progress rapidly as engineering design matures.
 - Already well-established line of communication between detector and physics parties and the EIC machine/IR development group ⇒ Crucial for success!!!

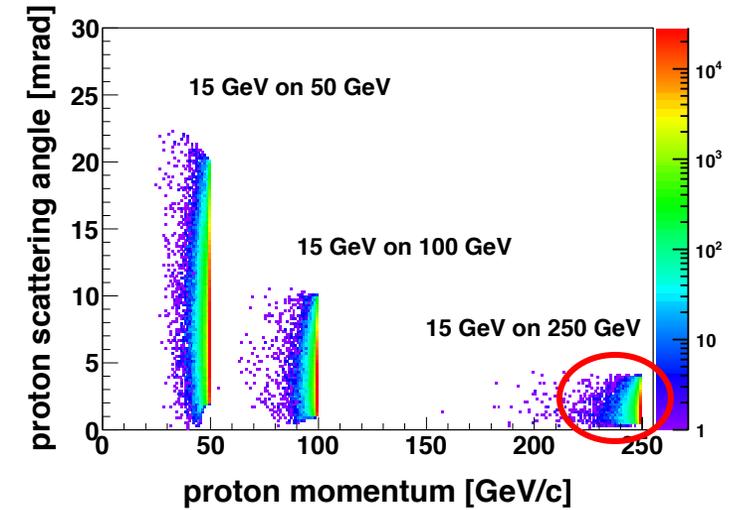
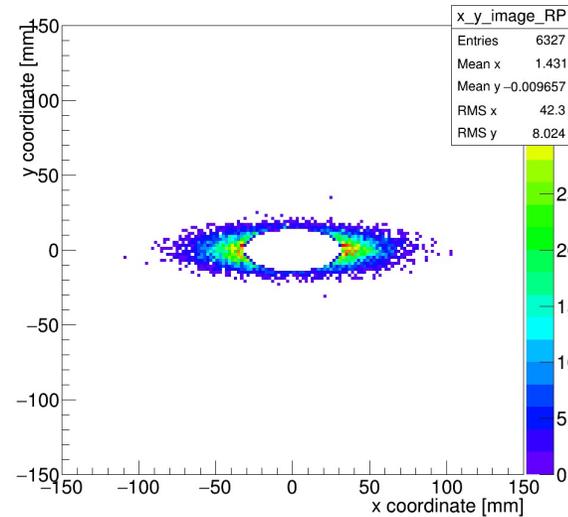
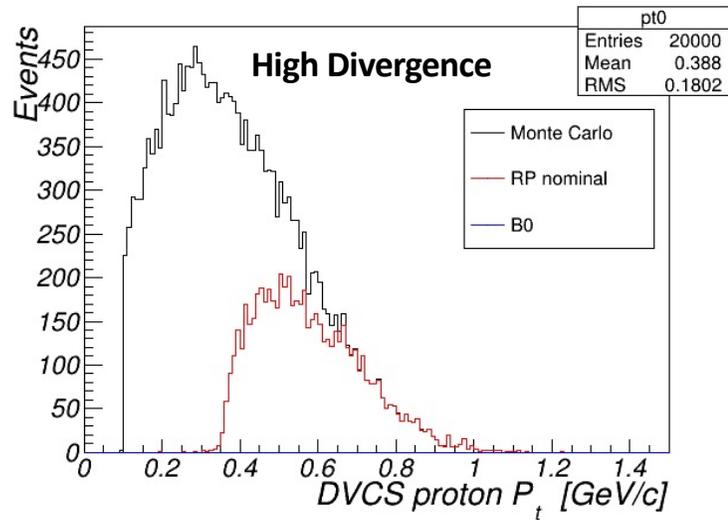


Backup



Digression: Machine Optics

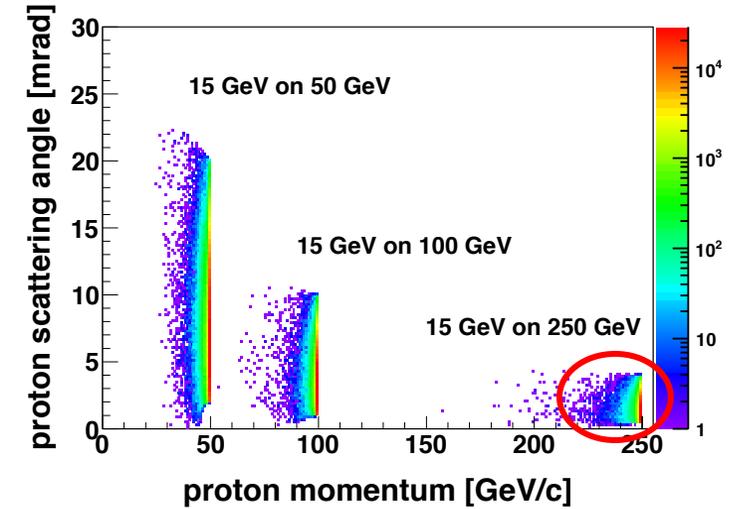
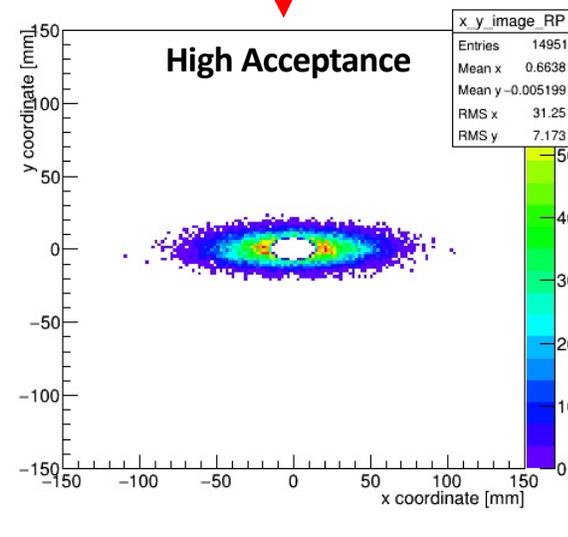
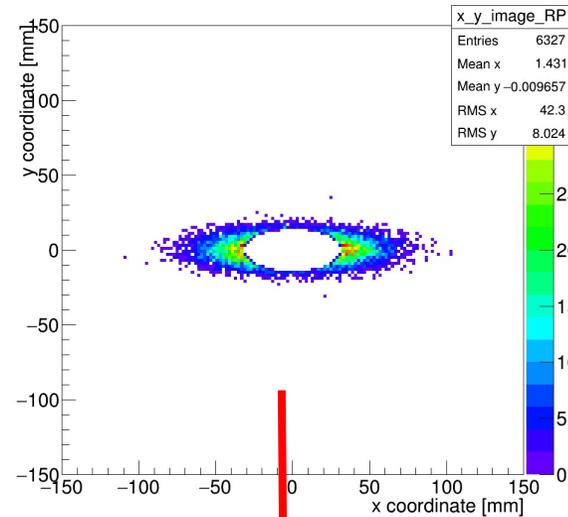
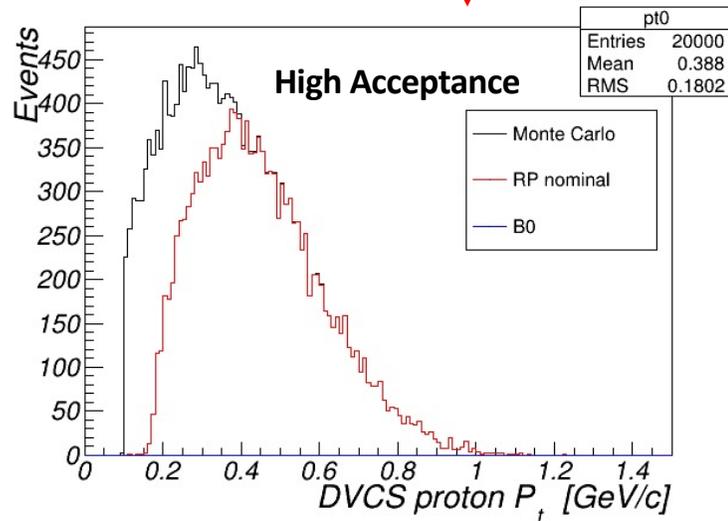
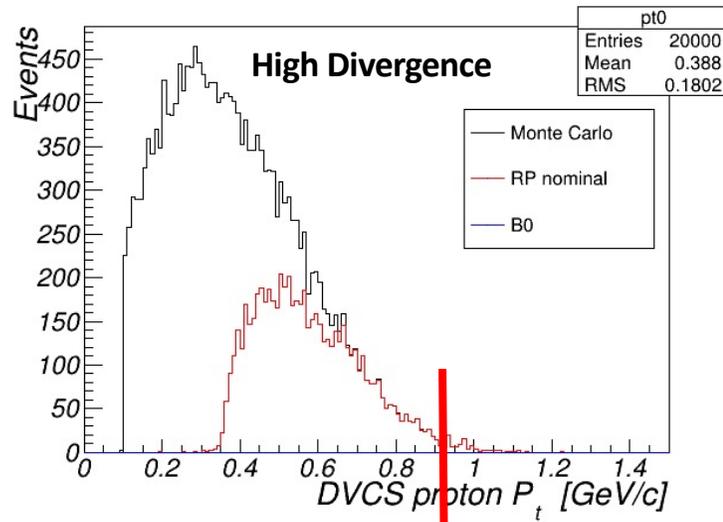
275 GeV DVCS Proton Acceptance



High Divergence: smaller β^* at IP, but bigger β ($z = 30m$) -> higher lumi., larger beam at RP

Digression: Machine Optics

275 GeV DVCS Proton Acceptance

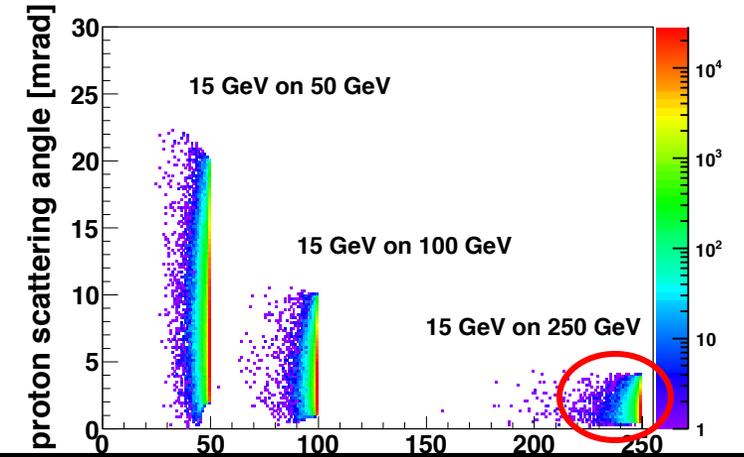
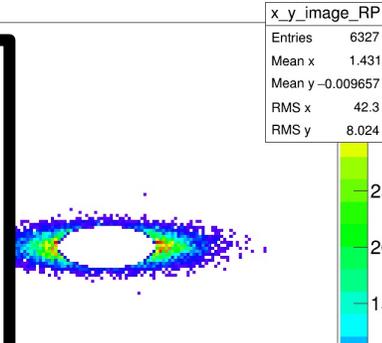
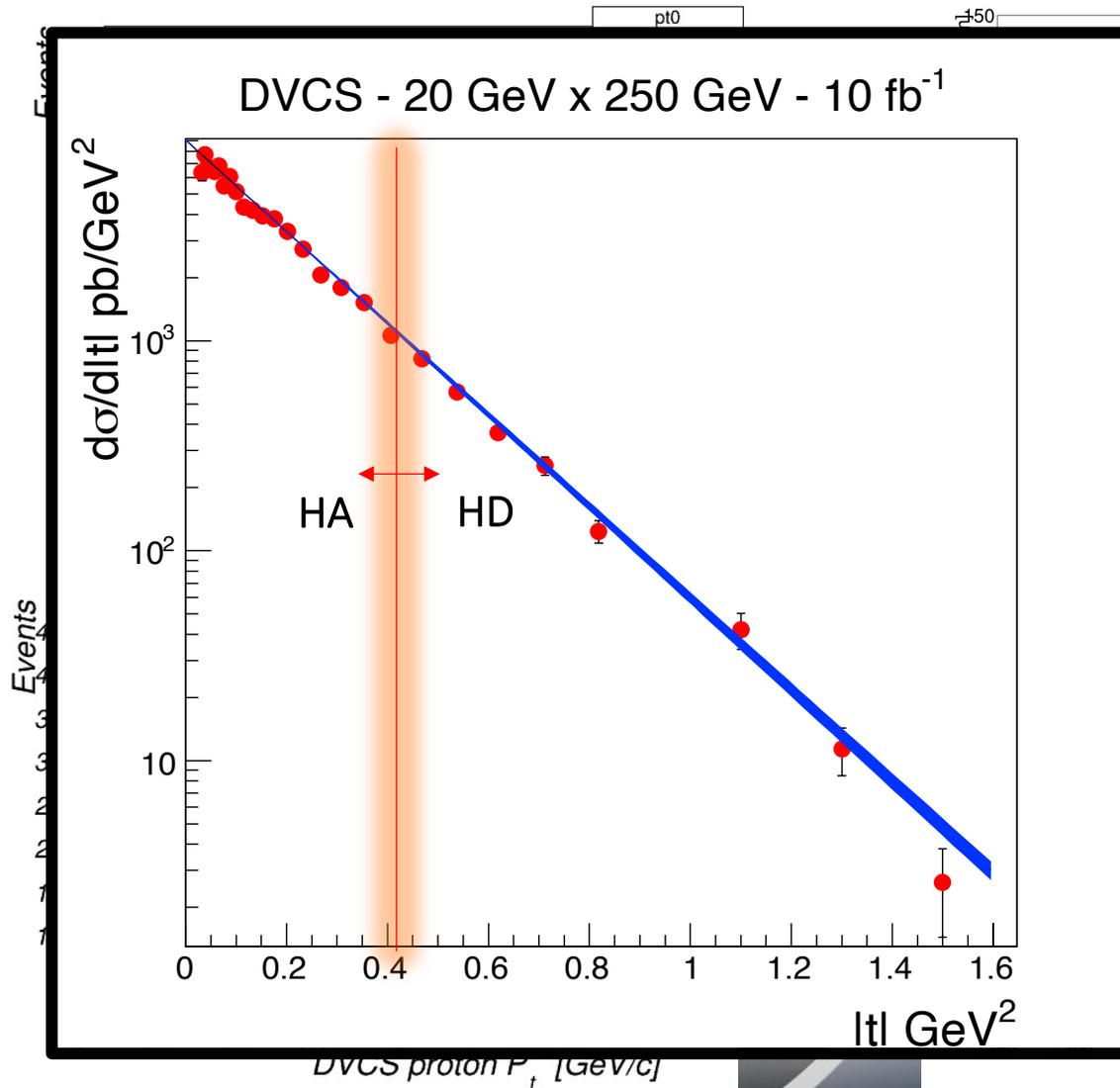


High Divergence: smaller β^* at IP, but bigger $\beta(z = 30m)$ -> higher lumi., larger beam at RP

High Acceptance: larger β^* at IP, smaller $\beta(z = 30m)$ -> lower lumi., smaller beam at RP

Digression: Machine Optics

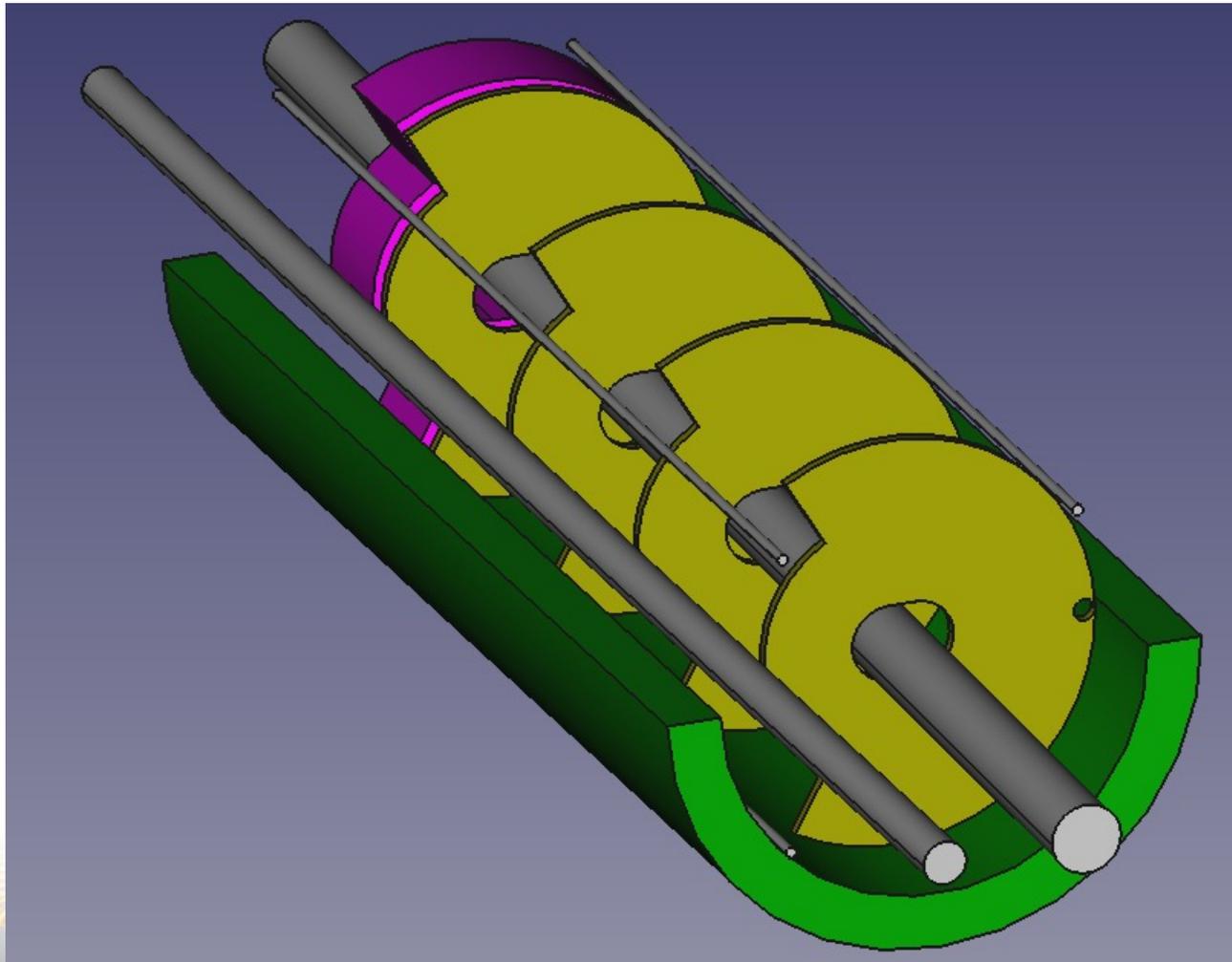
275 GeV DVCS Proton Acceptance



Using the two configurations, we are able to measure the low- t region (with better acceptance) and high- t tail (with higher luminosity).

High Acceptance: larger β^* at IP, smaller $\beta(z = 30m)$ -> lower lumi., smaller beam at RP

B0-detectors (calorimetry)



- For studies of u -Channel (Backward-angle) exclusive electroproduction, need capability to reconstruct photons from π^0 decays.
 - Physics beyond the EIC white paper!
- Would require full EMCAL with high granularity and energy resolution.
 - PbWO4 used in ECCE studies.
- Longitudinal space in B0pf magnet limited.
 - Would be a great candidate for an upgrade or for IP8 complementarity!

Thanks to Bill Li for the figure!

Zero-Degree Calorimeter (alt. option)

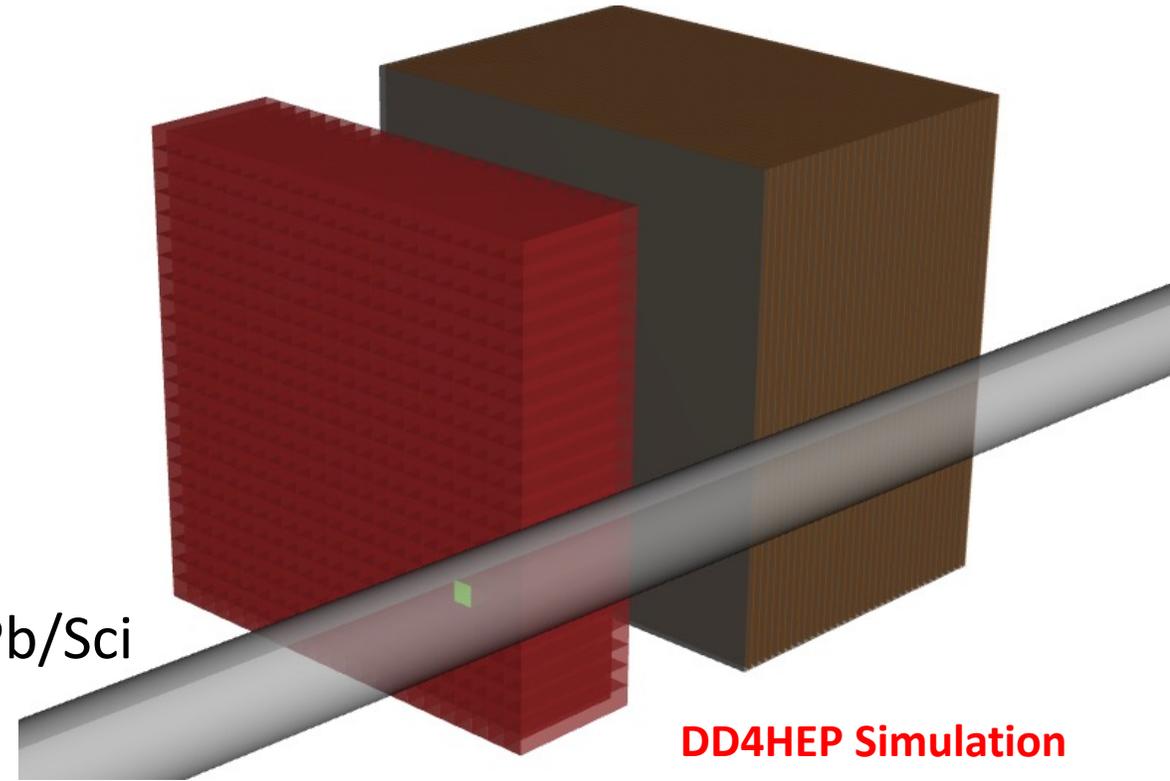
Multi-functional design including EMCAL and HCAL, with imaging layers to improve pT/angular resolution for neutrons.

EMCAL (W/SciFi):

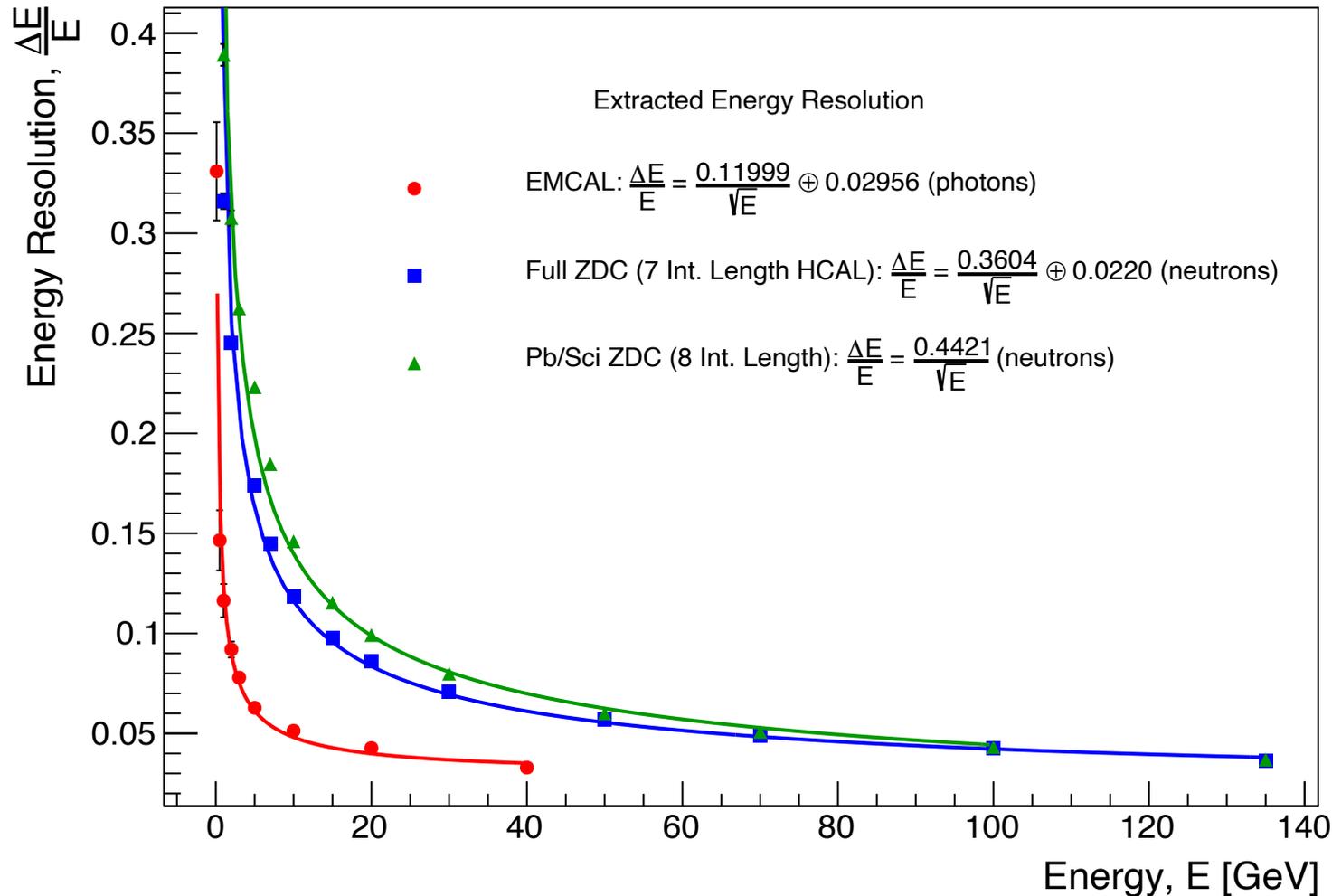
- Scintillating fibers embedded in W powder.
- Photon energy resolution $\frac{12\%}{\sqrt{E}} \oplus 3\%$.
- $23X_0$ and $1\lambda_I$

HCAL (Pb/Sci):

- Neutron energy resolution $\frac{36\%}{\sqrt{E}} \oplus 2.2\%$ - using Pb/Sci sampling HCAL with $7\lambda_I$, plus EMCAL section.
- Imaging layers could be silicon or scintillating fibers.
 - Need to better establish how many are needed and at what level of granularity to produce needed resolution.

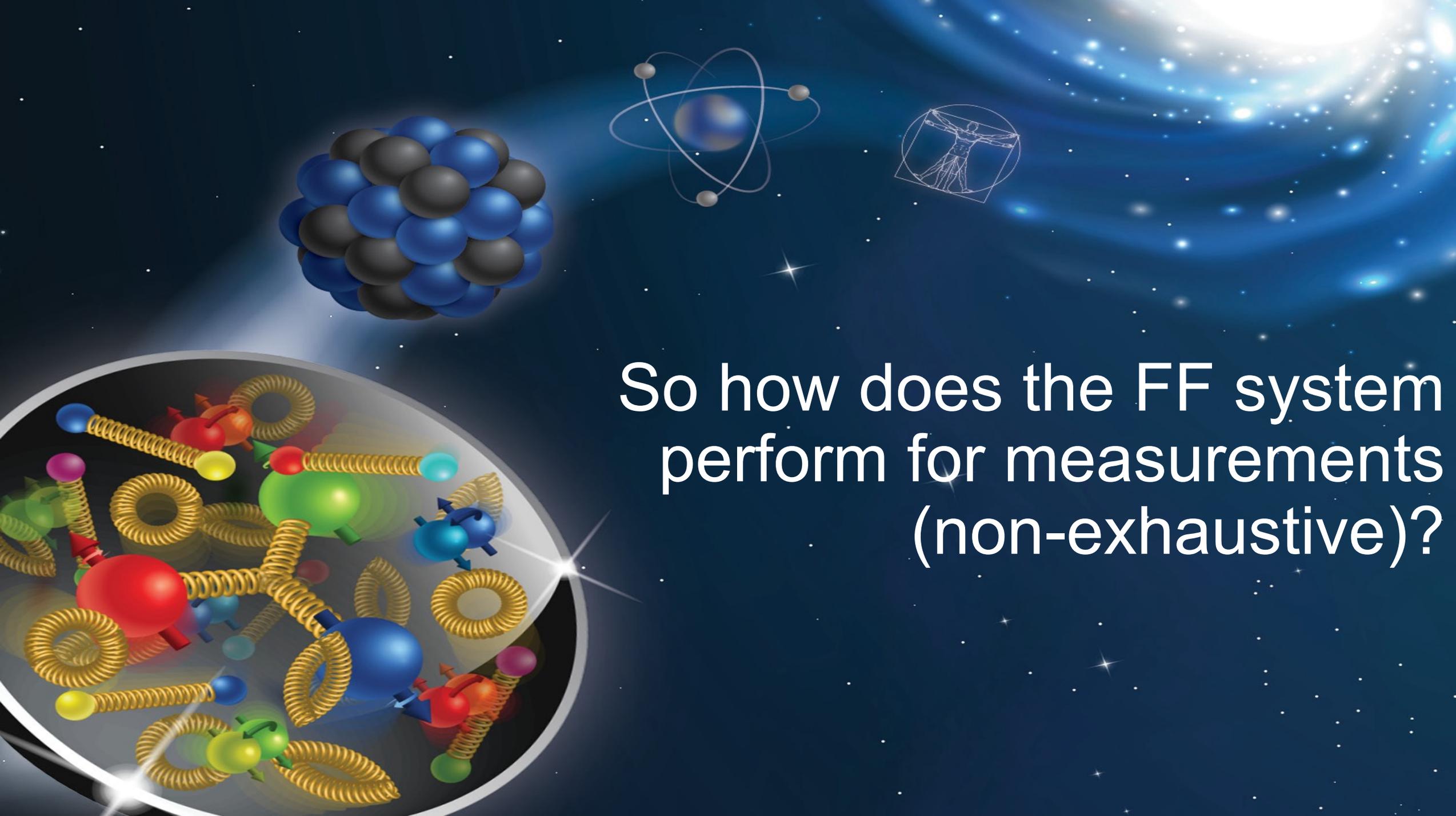


Alt. ZDC Performance (E resolution)



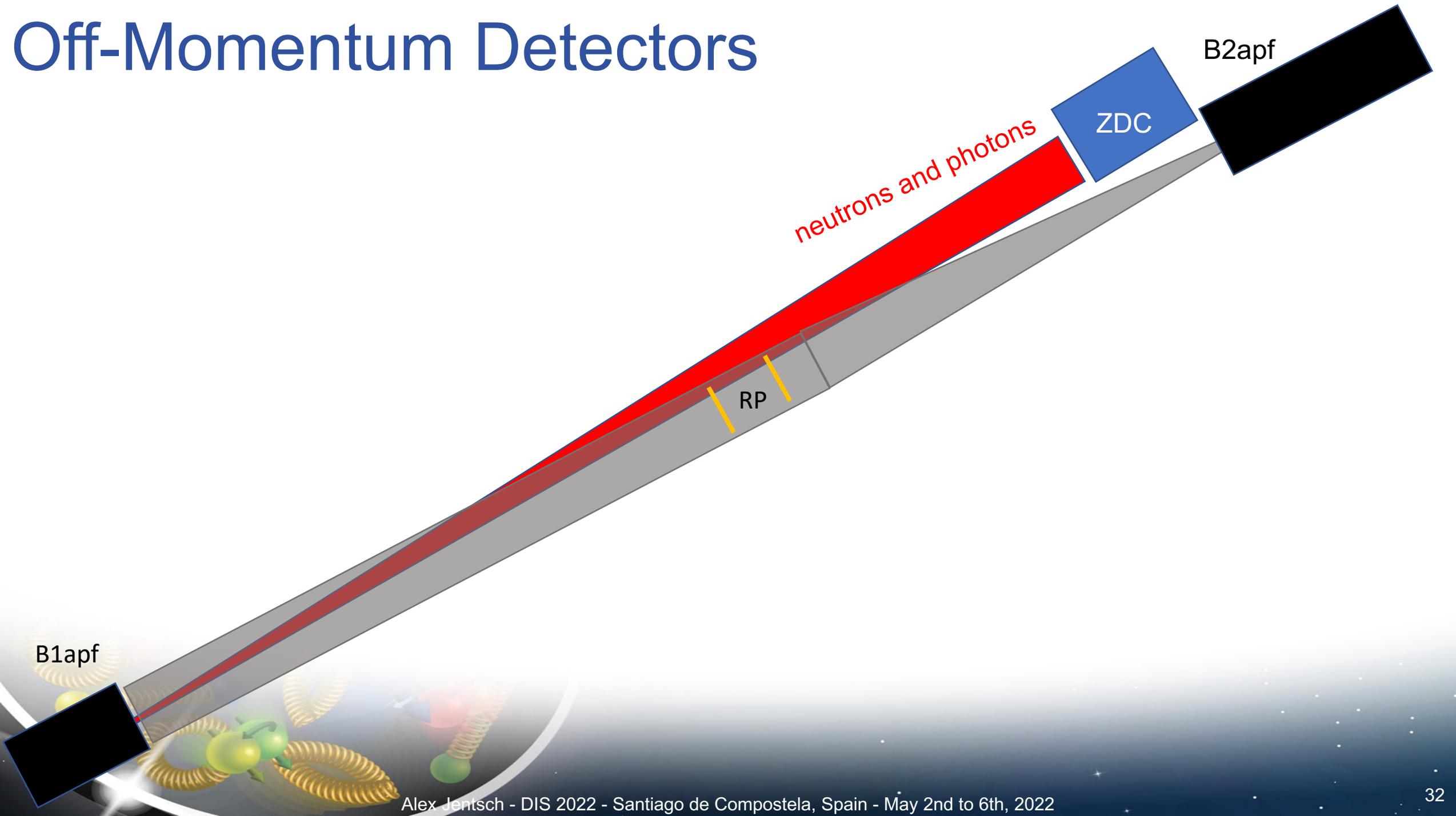
- **Alt. ZDC**

- Comparisons made with simulations for pure Pb/Sci.
 - Performance in GEANT4 simulations consistent with test beam studies for similar construction.
- Performance will worsen for particles with larger polar angles due to transverse leakage.



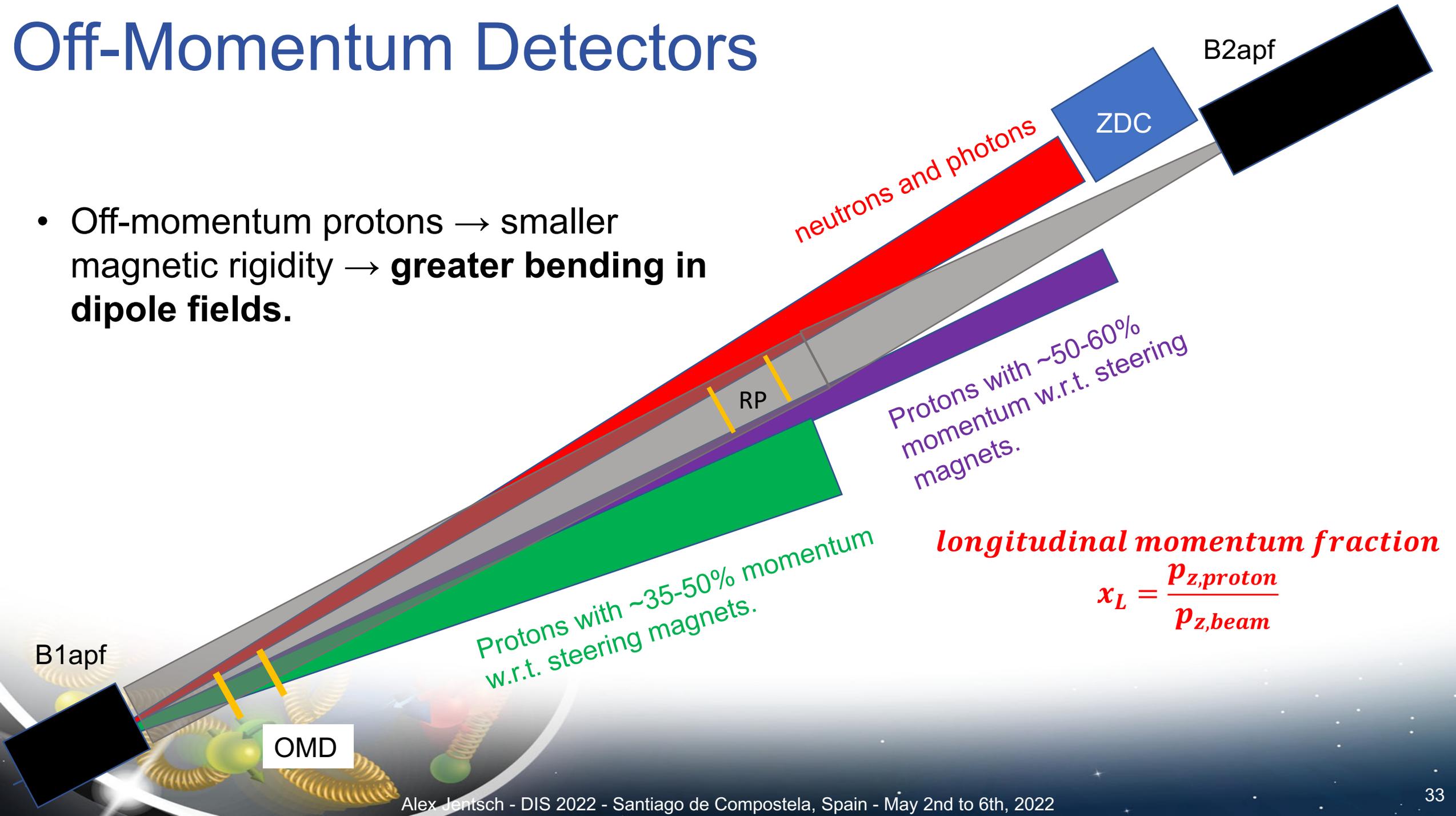
So how does the FF system perform for measurements (non-exhaustive)?

Off-Momentum Detectors



Off-Momentum Detectors

- Off-momentum protons → smaller magnetic rigidity → **greater bending in dipole fields.**



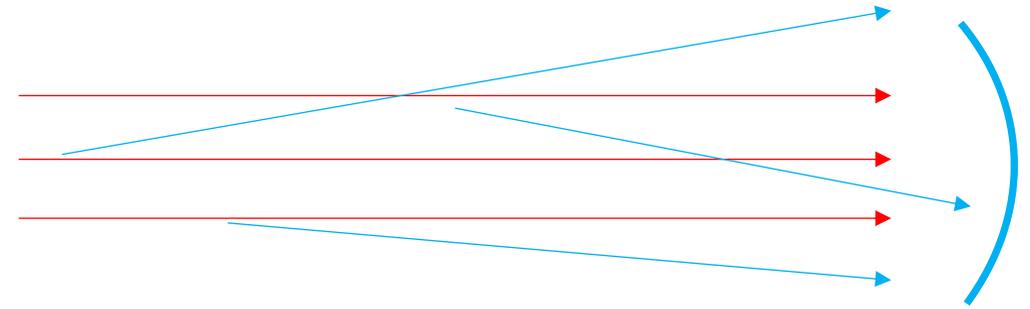
longitudinal momentum fraction

$$x_L = \frac{p_{z,\text{proton}}}{p_{z,\text{beam}}}$$

Digression: particle beams

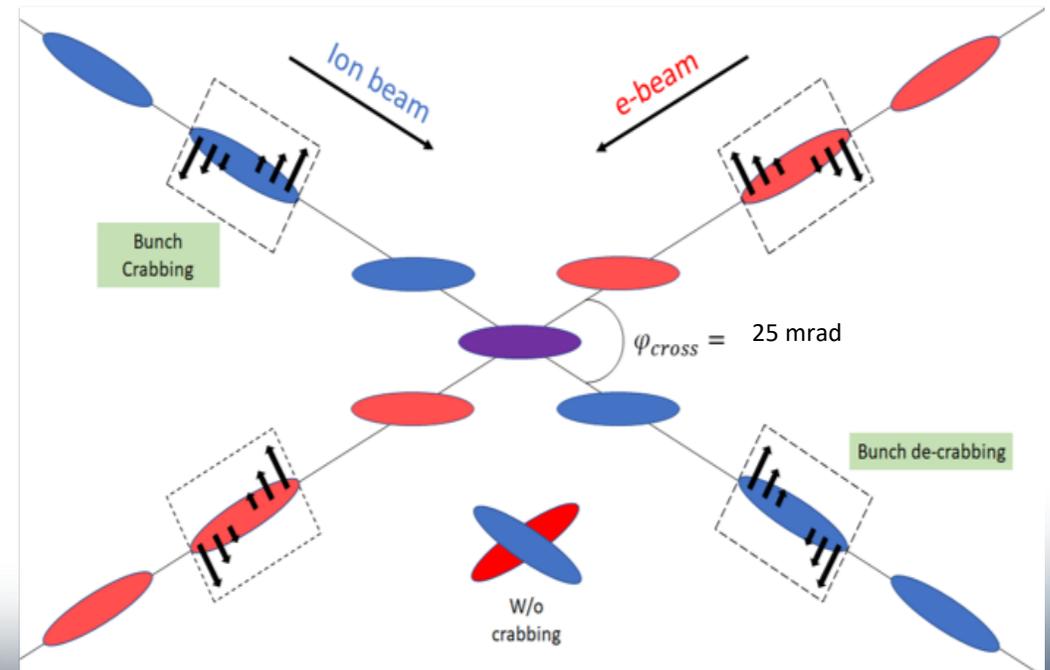
- **Angular divergence**

- Angular “spread” of the beam away from the central trajectory.
- Gives some small initial transverse momentum to the beam particles.



- **Crab cavity rotation**

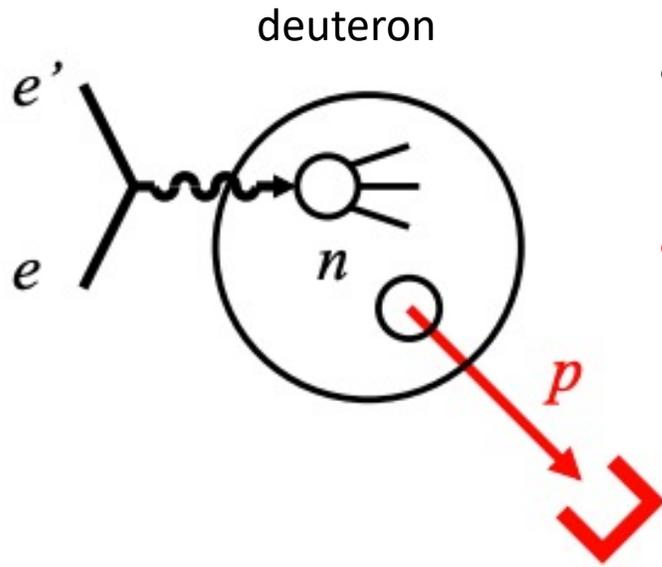
- Can perform rotations of the beam bunches in 2D.
- Used to account for the luminosity drop due to the crossing angle – allows for head-on collisions to still take place.



These effects introduce smearing in our momentum reconstruction.

Spectator Tagging in Light Nuclei

EIC enables use of deuteron beams → the next best thing to a beam of neutrons!



- Measurements on unpolarized deuterons¹ (or polarized He-3)² at the EIC.
- **Spectator** proton momentum → enables selection of nuclear (p/n) configurations.
 - Extract **free neutron** structure function³ → **Not possible elsewhere!**
 - Study nuclear modifications of both nucleons in the deuteron (**study in progress**).

[1] Z. Tu, A. Jentsch, et al., Physics Letters B, (2020)

[2] I. Friscic, D. Nguyen, J. R. Pybus, A. Jentsch, *et al.*, Phys. Lett. B, **Volume 823**, 136726 (2021)

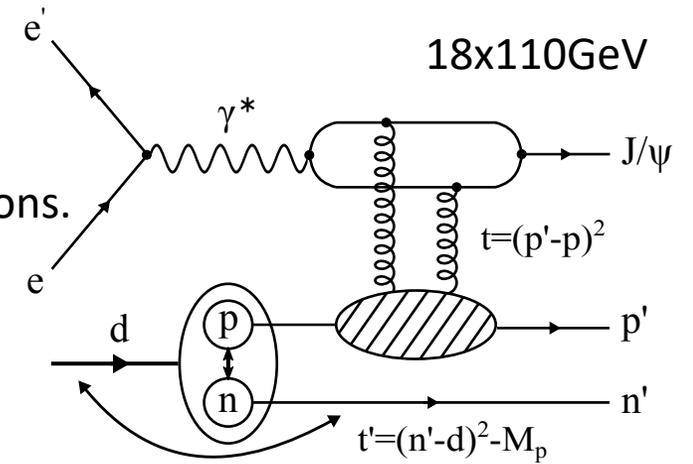
[3] A. Jentsch, Z. Tu, and C. Weiss, Phys. Rev. C **104**, 065205, (2021) (**Editor's Suggestion**)

e+d Spectator Tagging

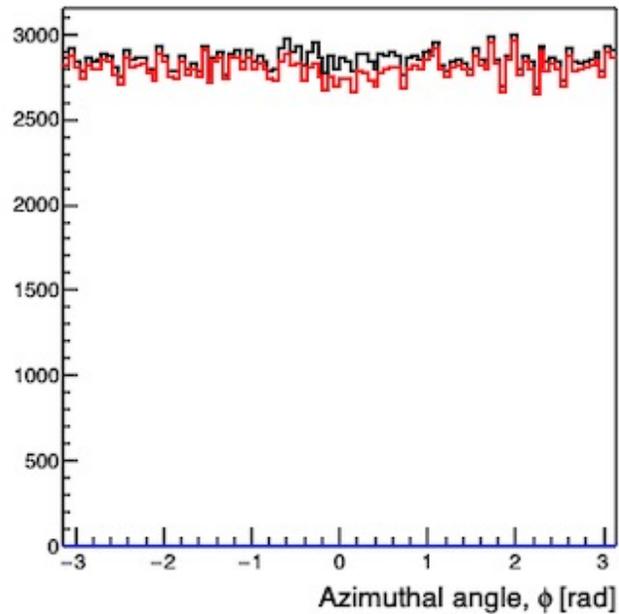
Proton spectator case.

Particular process in BeAGLE:
incoherent diffractive J/psi
production off bounded nucleons.

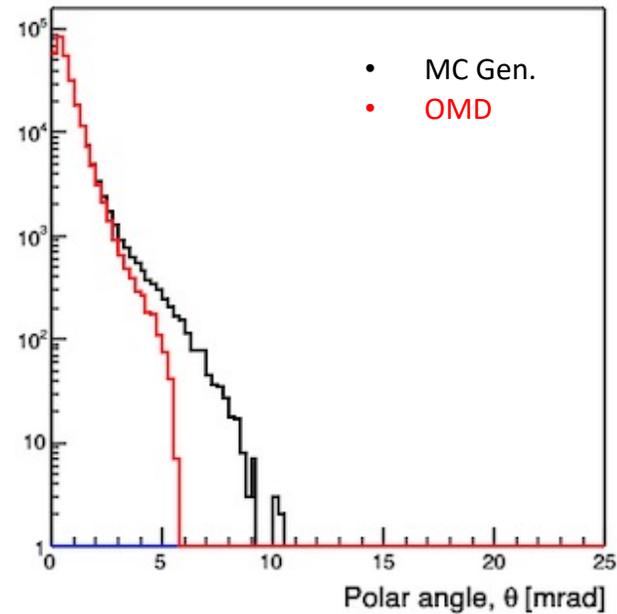
Short-range correlations!



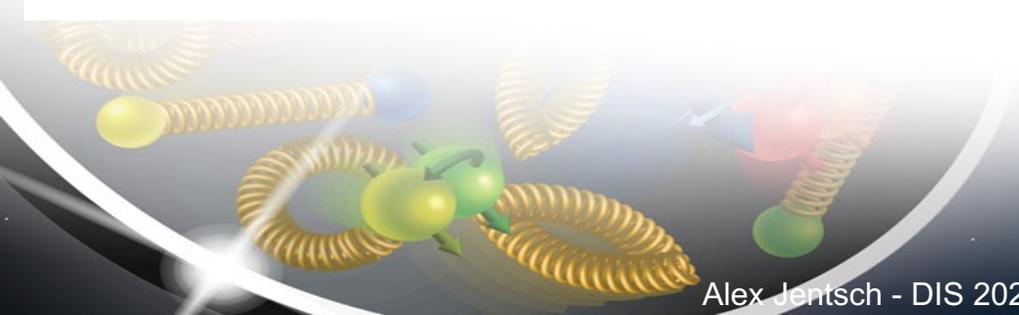
Protons



Protons

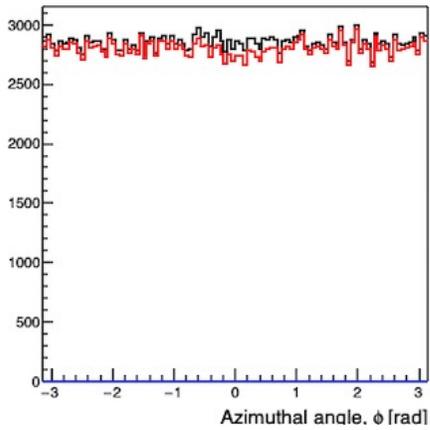


Spectator proton acceptance (in the off-momentum detectors)

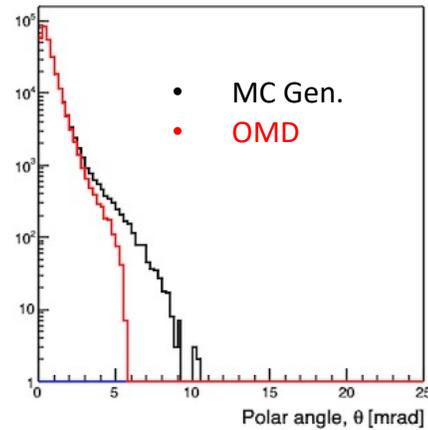


e+d Spectator Tagging

Protons



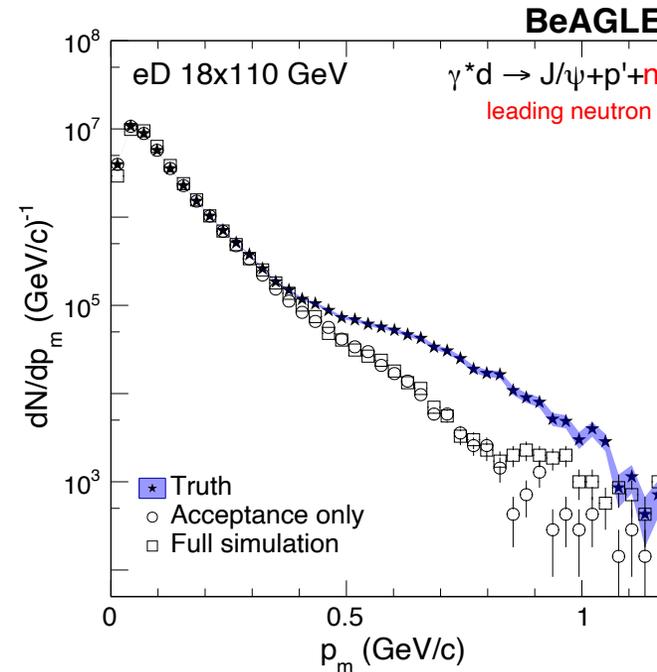
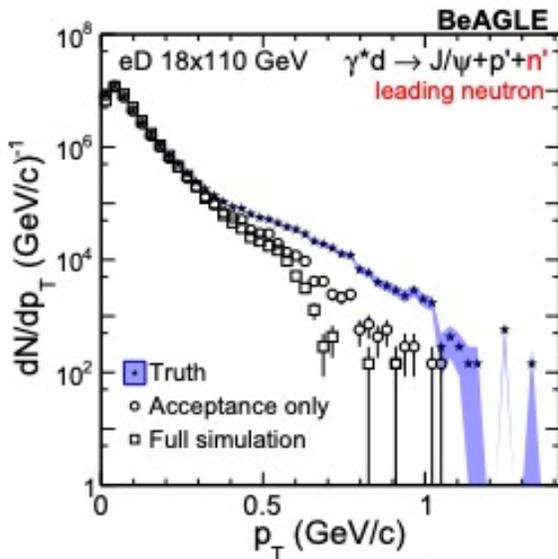
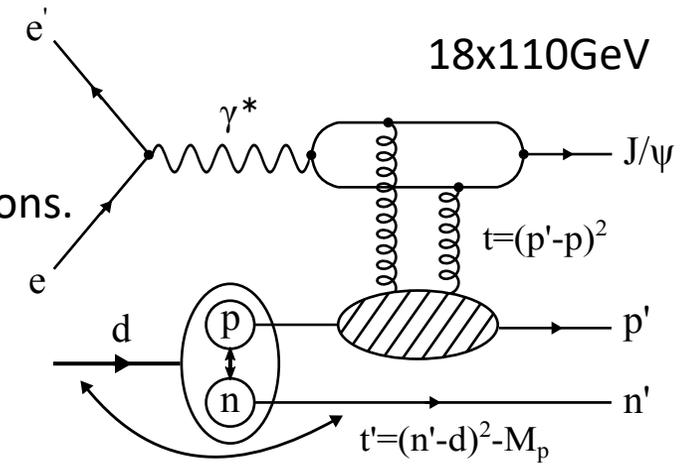
Protons



Proton spectator case.

Particular process in BeAGLE:
incoherent diffractive J/psi
production off bounded nucleons.

Short-range correlations!



- Spectator kinematic variables reconstructed over a broad range.
- All beam/detector effects included.
- Bin migration is observed due to smearing in the reconstruction.

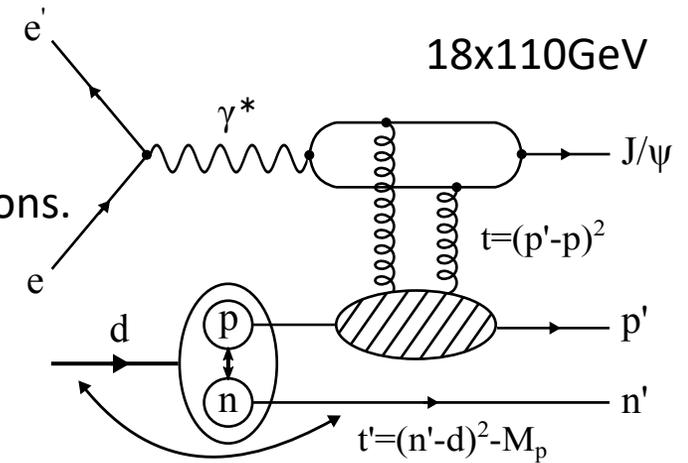
- In the proton spectator case, essentially all spectators tagged.
- Active neutrons only tagged up to 4.5 mrad.

e+d Spectator Tagging

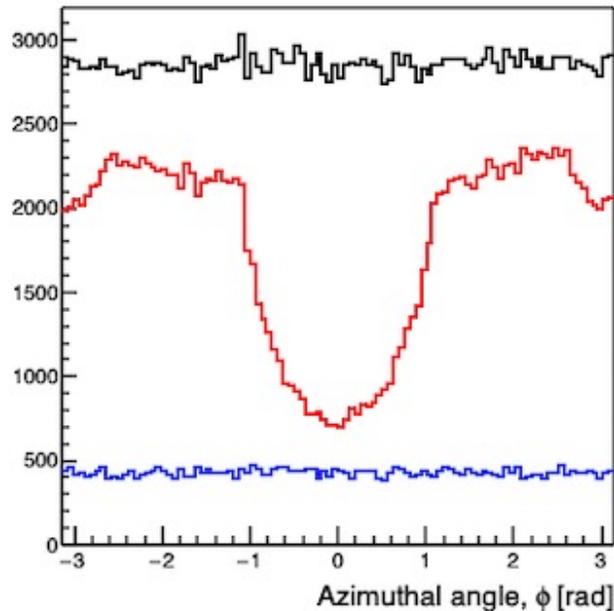
Neutron spectator case.

Particular process in BeAGLE:
incoherent diffractive J/psi
production off bounded nucleons.

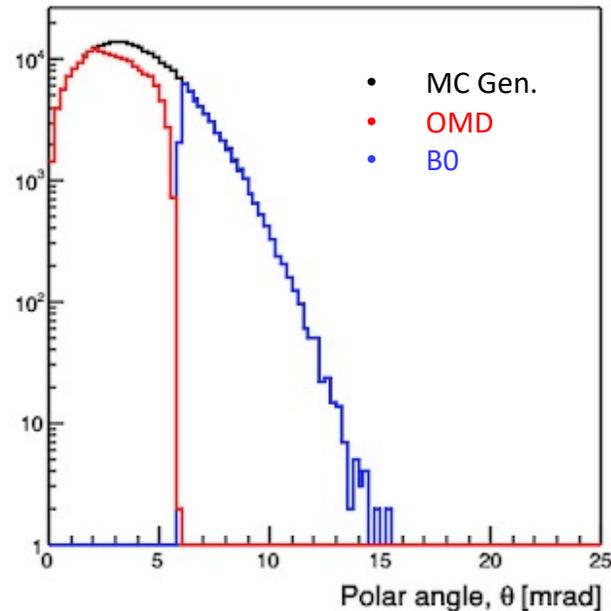
Short-range correlations!



Protons



Protons



Active proton acceptance!

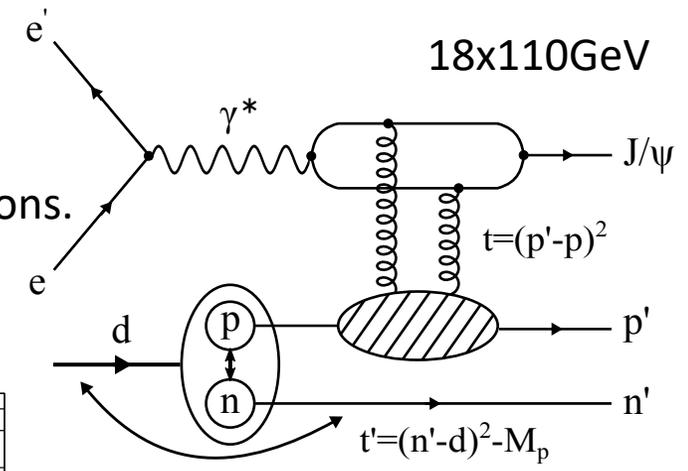
Need multiple FF subsystems!

e+d Spectator Tagging

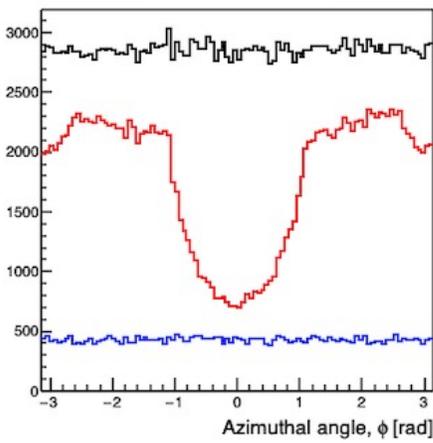
Neutron spectator case.

Particular process in BeAGLE:
incoherent diffractive J/psi
production off bounded nucleons.

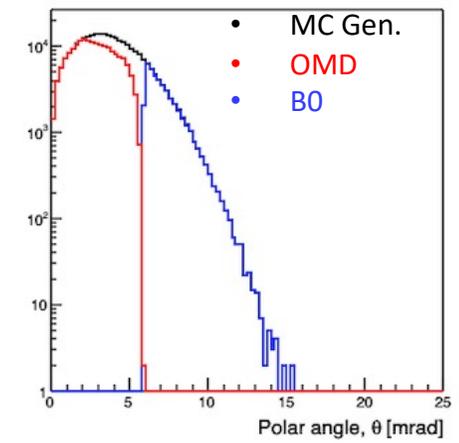
Short-range correlations!



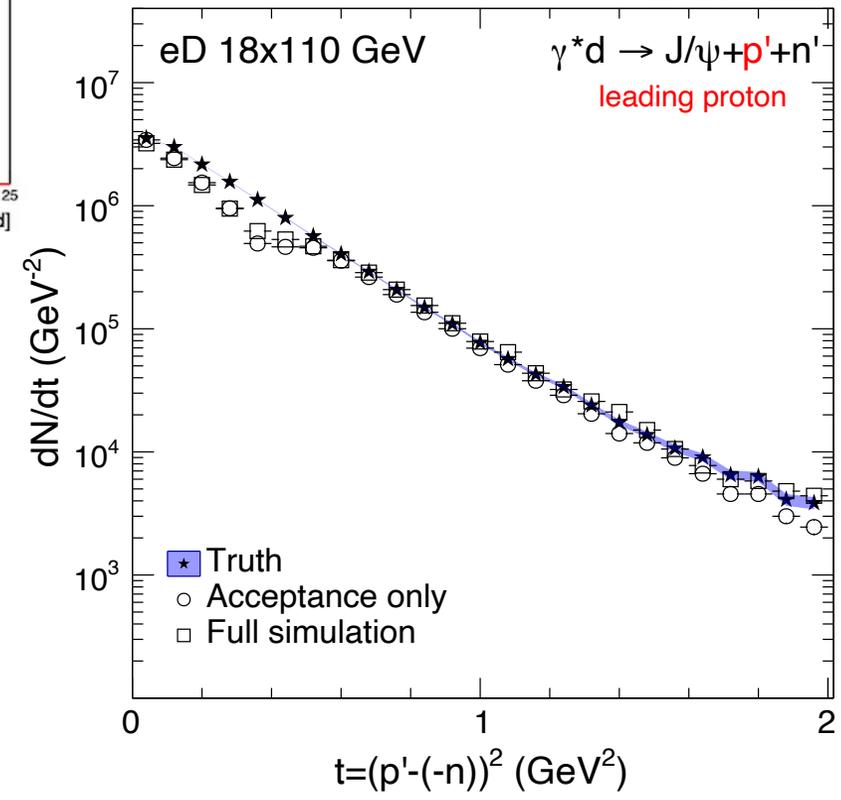
Protons



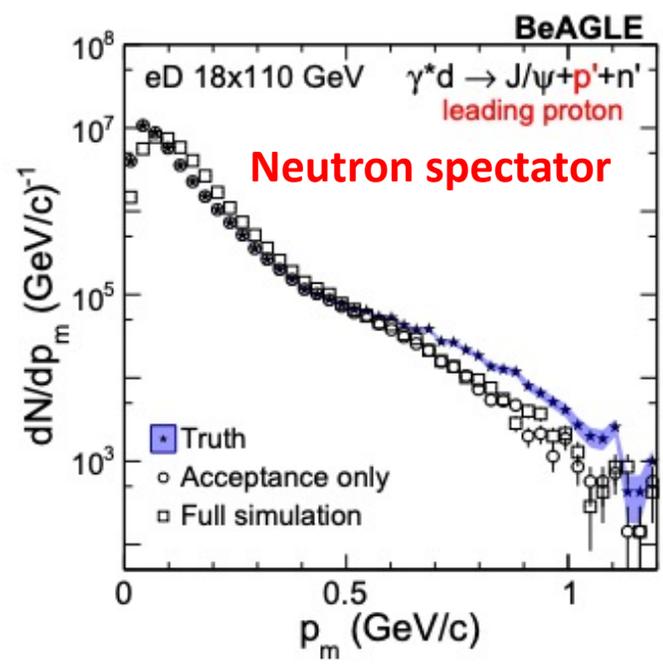
Protons



BeAGLE



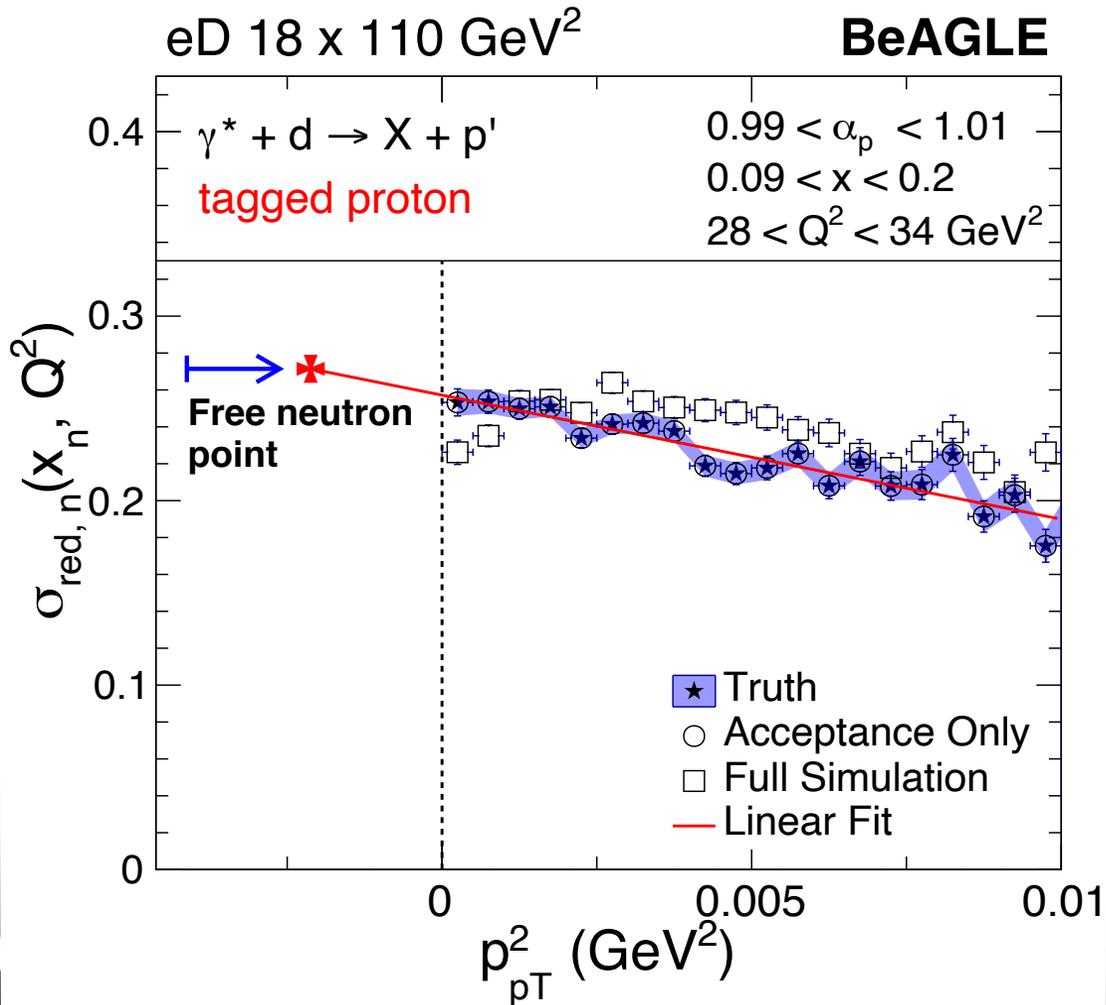
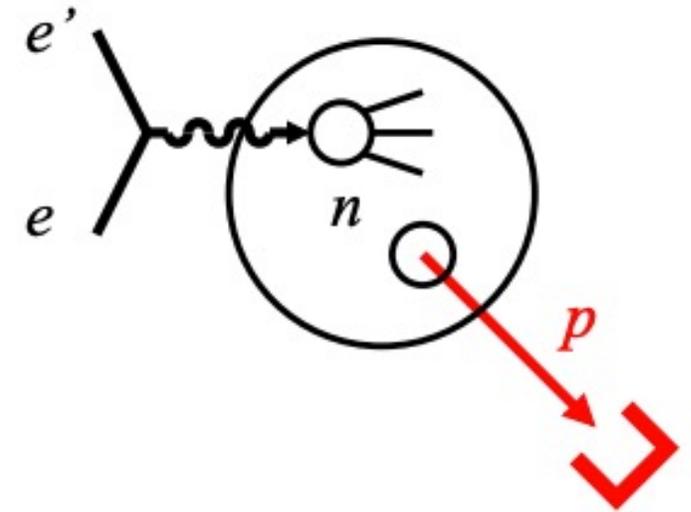
t-reconstruction using double-tagging (both proton and neutron). Takes advantage of combined B0 + off-momentum detector coverage. Better coverage in the neutron spectator case.



➤ Spectator information is the “dial” for the SRC region.

Free Neutron F_2 Extraction

(Active nucleon reduced cross section) $\sim F_2$



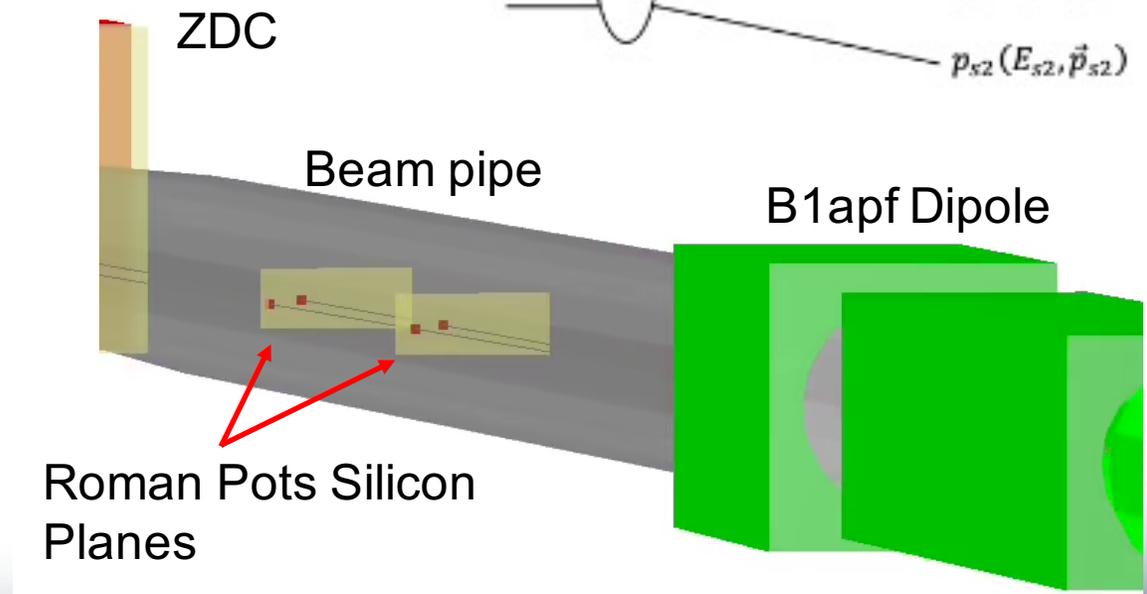
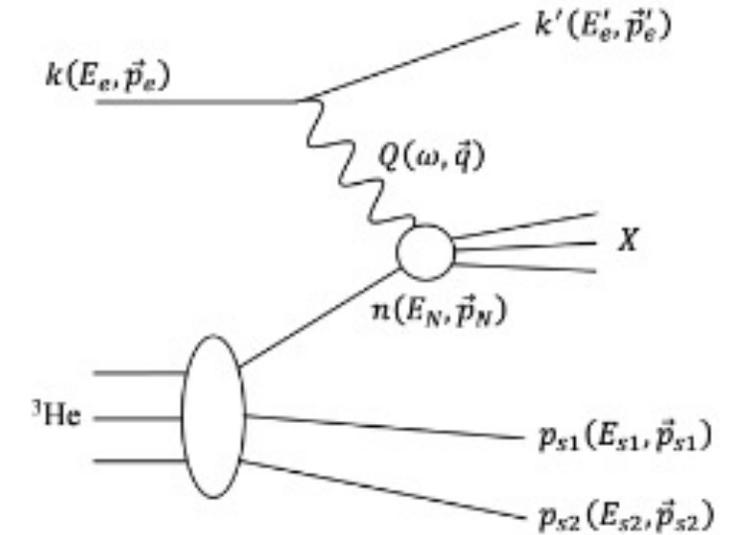
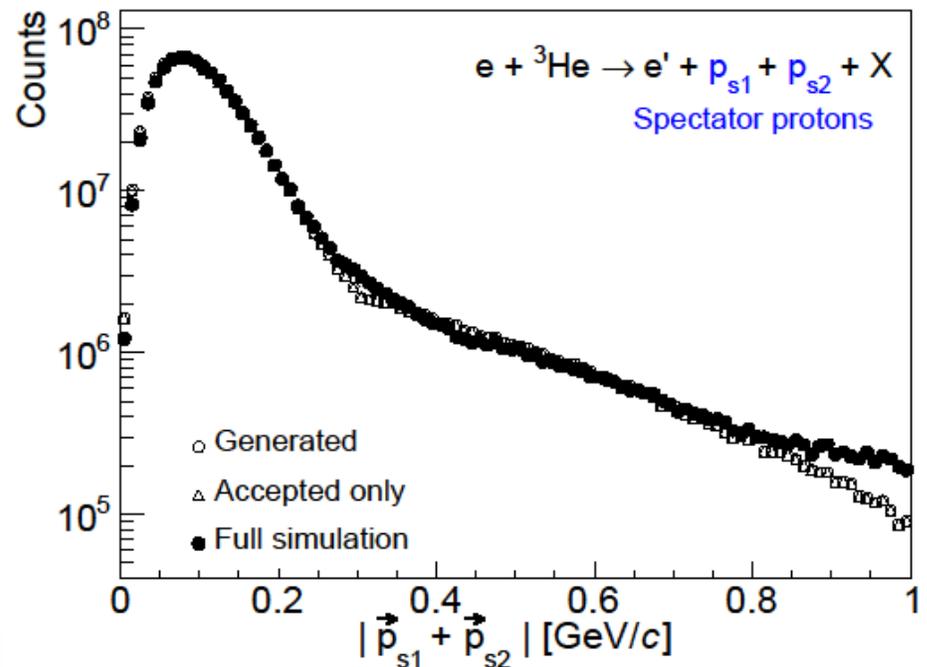
- Cross-section as a function of the **proton spectator** kinematics \rightarrow dial to select nuclear configuration \rightarrow allows **extrapolation** to “free” neutron region.
- Enables measurement of **free** neutron structure function!

$$p_{pT}^2 = p_{px}^2 + p_{py}^2$$

$$\sigma_{red,n} \sim F_{2,n} \text{ (cross section)}$$

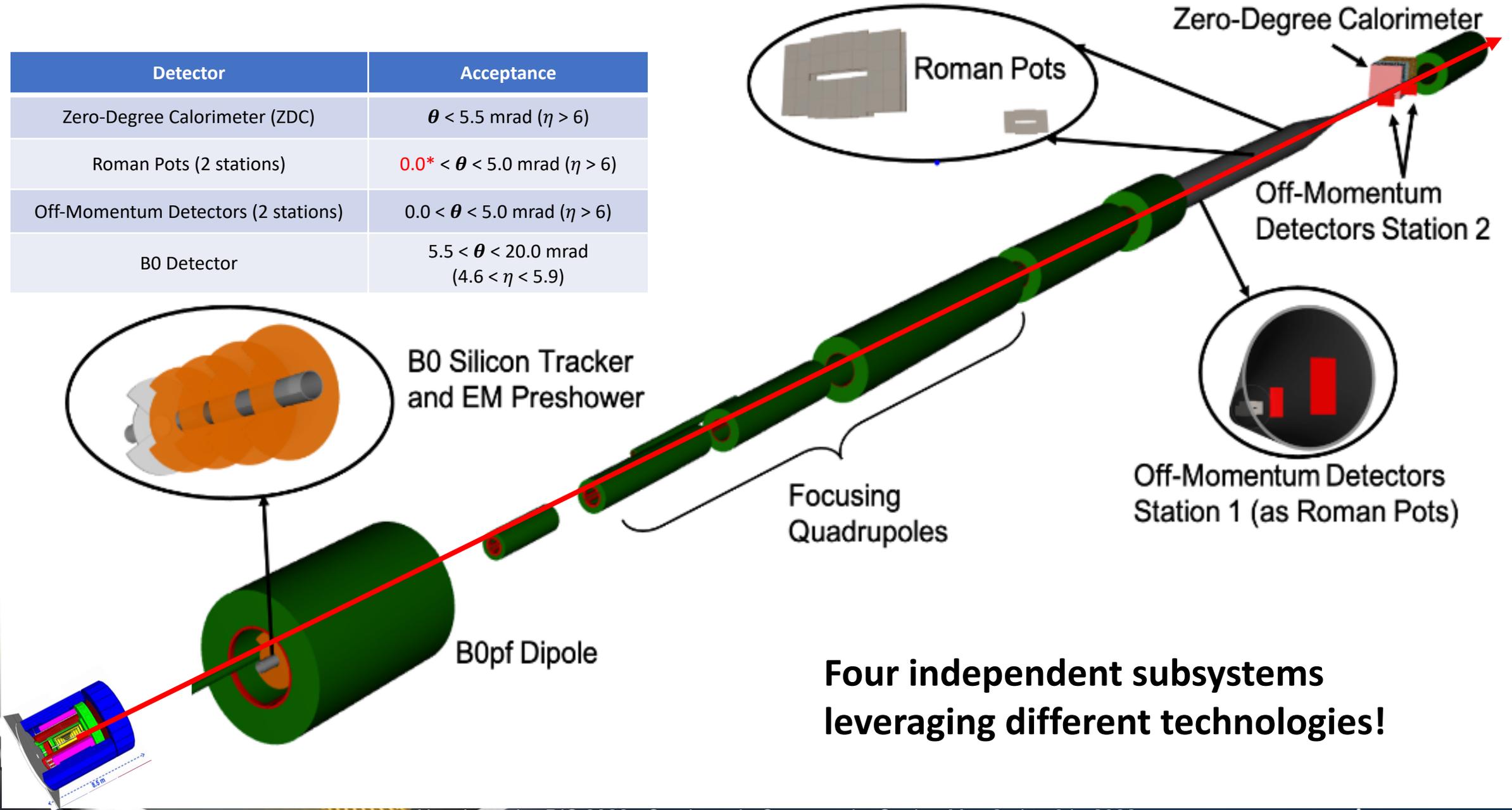
Neutron Spin Structure in He3

- Studies of neutron structure with a *polarized* neutron.
- More challenging final state tagging since *both* protons must be tagged in the FF region.
- MC events generated with CLASDIS in fixed-target frame, and then boosted to collider frame.



The Far-Forward Detectors

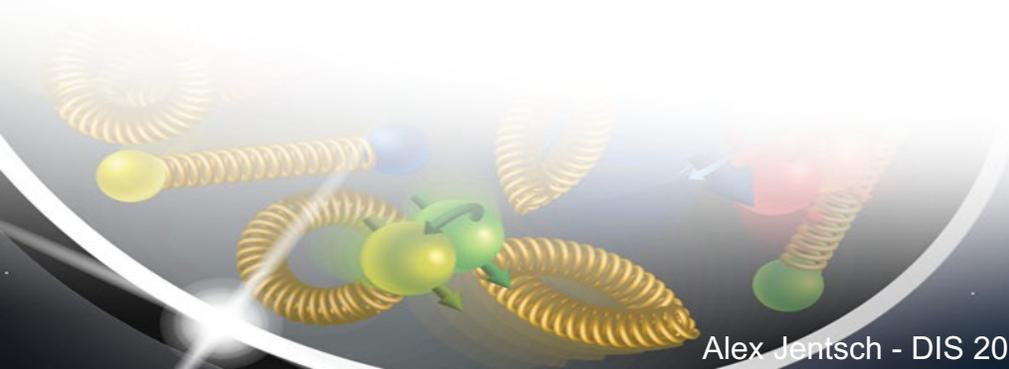
Detector	Acceptance
Zero-Degree Calorimeter (ZDC)	$\theta < 5.5 \text{ mrad}$ ($\eta > 6$)
Roman Pots (2 stations)	$0.0^* < \theta < 5.0 \text{ mrad}$ ($\eta > 6$)
Off-Momentum Detectors (2 stations)	$0.0 < \theta < 5.0 \text{ mrad}$ ($\eta > 6$)
B0 Detector	$5.5 < \theta < 20.0 \text{ mrad}$ ($4.6 < \eta < 5.9$)



**Four independent subsystems
leveraging different technologies!**

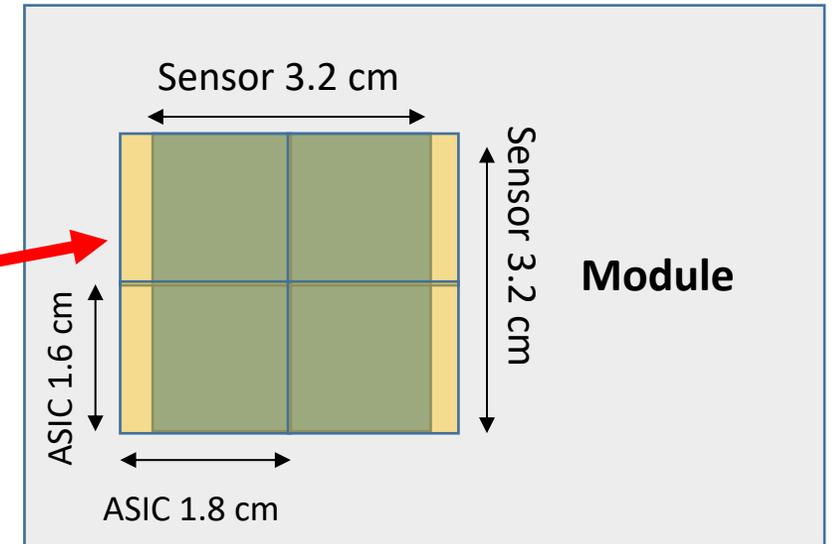
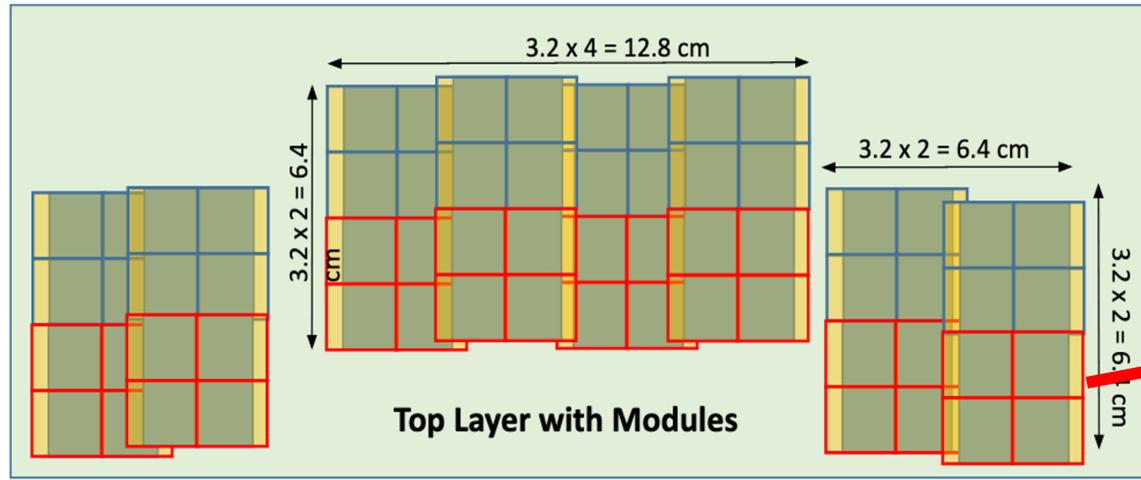
Roman Pots

- Active sensor area very large (26cm x 13cm).
- “Potless” design could make better use of space.
- With AC-LGADS + ALTIROC ASIC, current estimates of power dissipation around 400-500 watts for entire subsystem, so roughly 100 watts/layer.
 - With potless design, leveraging experience from LHCb VELO for cooling would allow for cooling of the electronics within the vacuum.
- Support structure only to be placed between hadron pipe and wall to avoid interference with the ZDC.



Roman Pots

- Updated layout with current design for AC-LGAD sensor + ASIC.

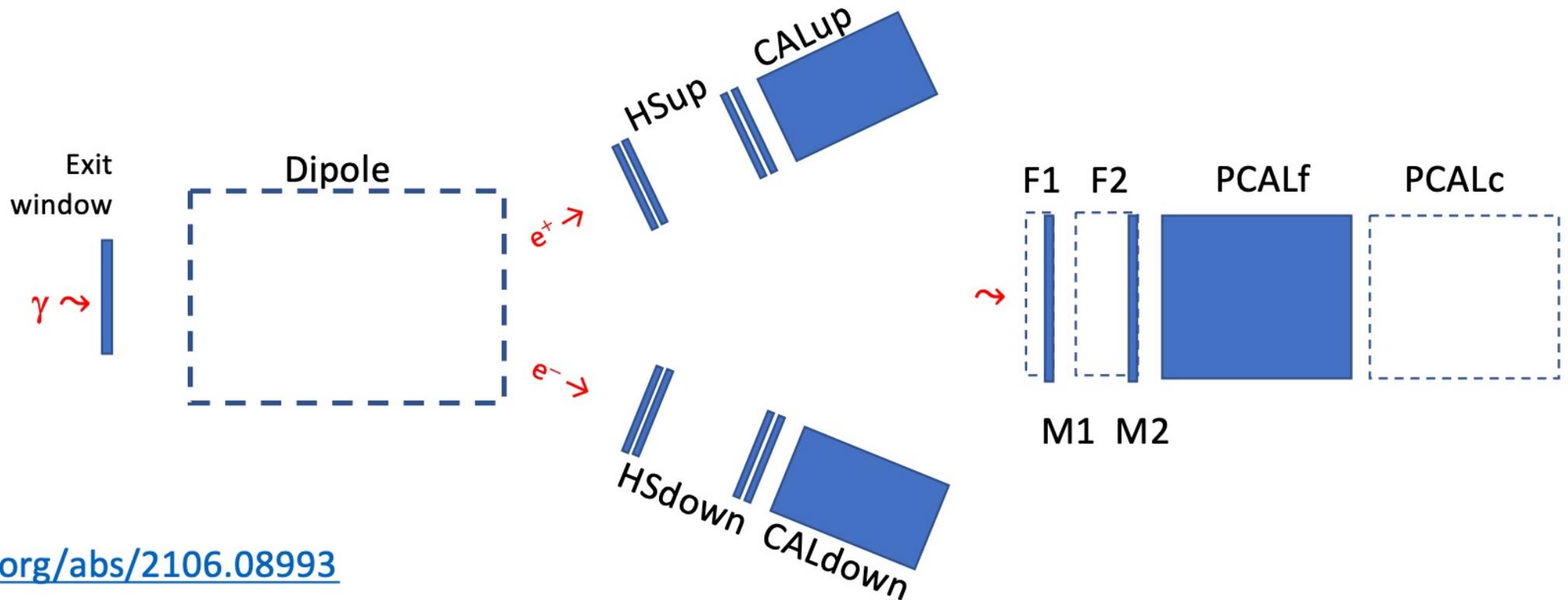


- Current R&D aimed at customizing ASIC readout chip (ALTIROC) for use with AC-LGADs.

ASIC size	ASIC Pixel pitch	# Ch. per ASIC	# ASICs per module	Sensor area	# Mod. per layer	Total # ASICs	Total # Ch.	Total Si Area
1.6x1.8 cm ²	500 μm	32x32	4	3.2x3.2 cm ²	32	512	524,288	1,311 cm ²

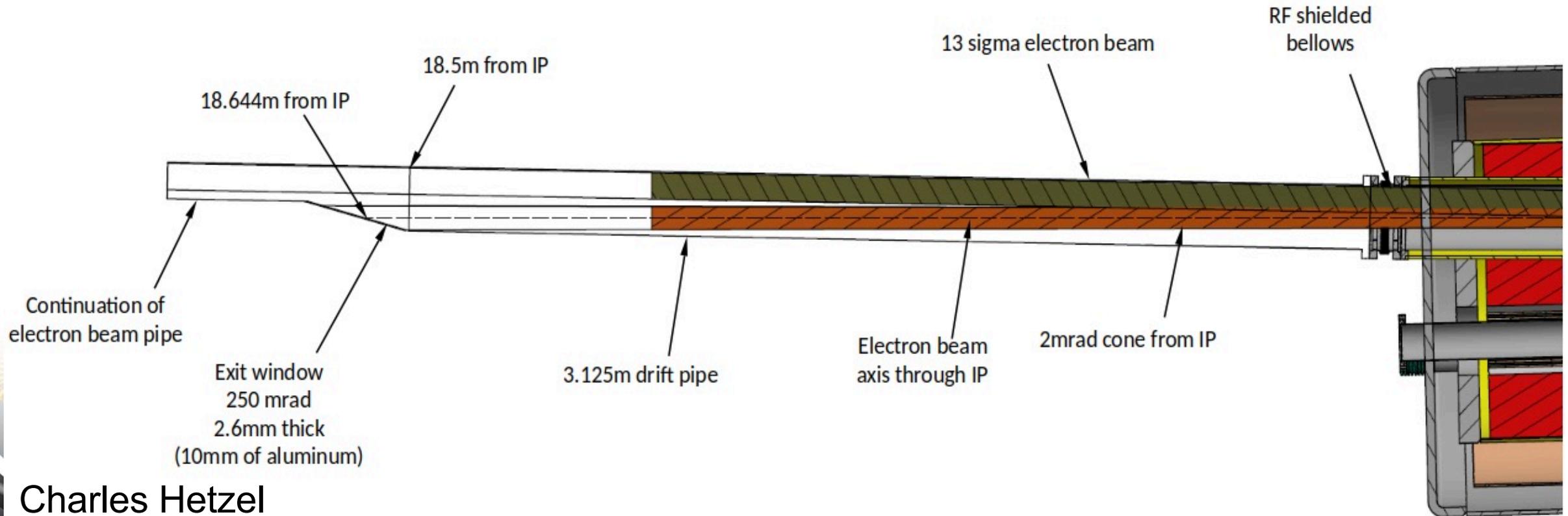
Luminosity Monitor

- Must make measurement in challenging environment.
 - High synchrotron radiation, high bremsstrahlung rates (~ 10 GHz), etc.
- Need $\sim 1\%$ for absolute luminosity measurement, $\sim 10^{-4}$ for relative luminosity measurement.
- Can make direct photon measurement, or indirect via pair conversion in exit window, where e^+e^- pair is steered toward two calorimeters opposite a dipole magnet.
- Direct photon calorimeter includes moveable SR filters/monitors (F1 and F2), and has configurations for high (PCALf) and low (PCALc) luminosity running.



Exit window for luminosity monitor

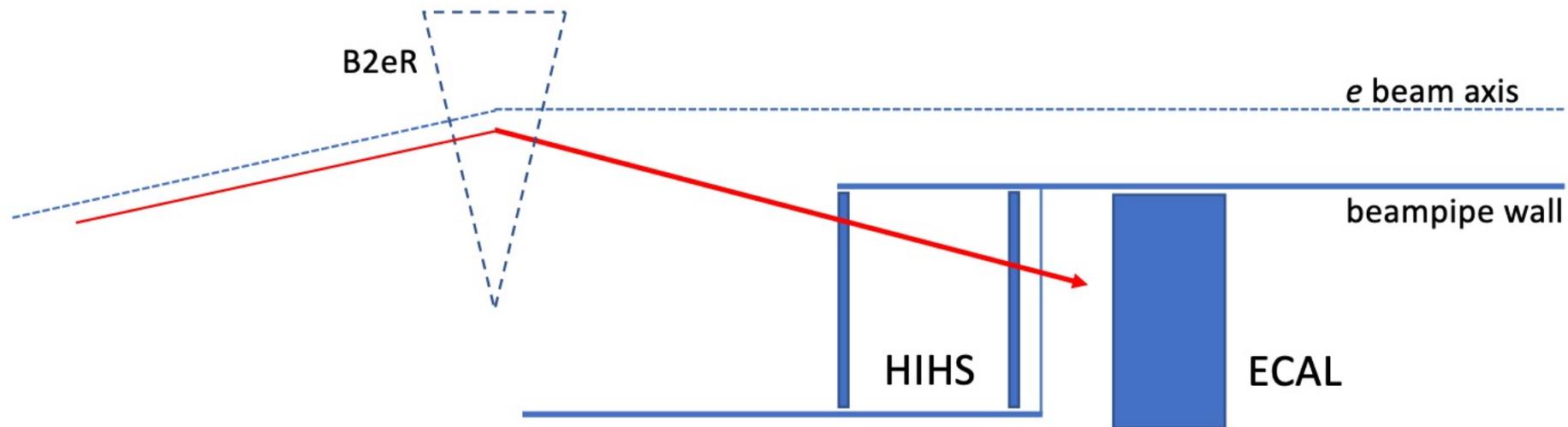
- Part of outgoing electron beam pipe
- Conversion layer for bremsstrahlung photons
- Tilt angle vs. electron (and photon) beam axis against synchrotron radiation



Charles Hetzel

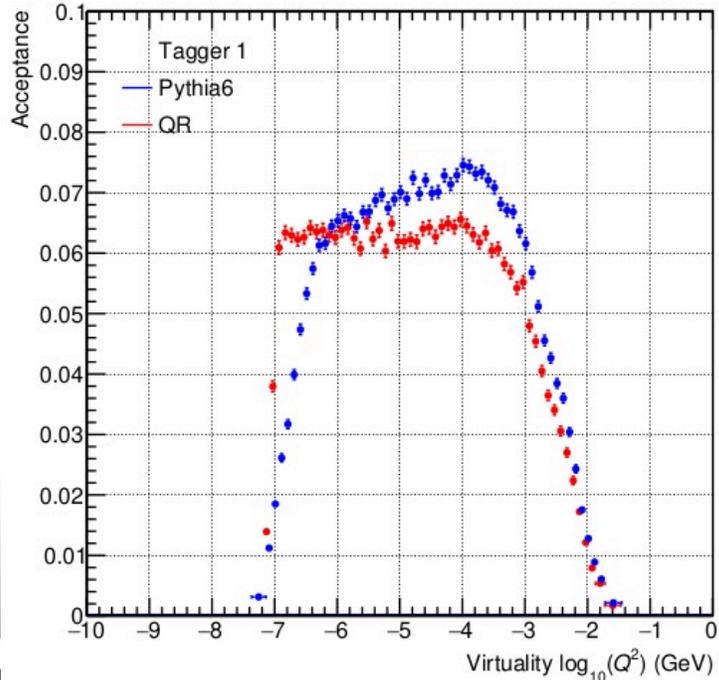
Low- Q^2 Taggers

- Two taggers for reconstructing electrons from low- Q^2 ($< 10^{-1} \text{ GeV}^2$) reactions.
- Combination of EM calorimetry for energy reconstruction, and silicon layers (High Resolution Hodoscope – HIHS) for position and angular resolution.

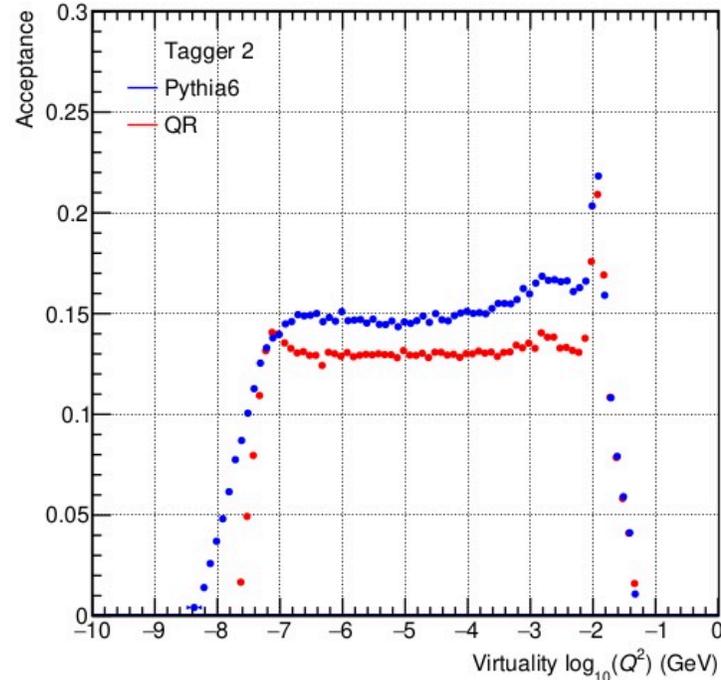


Performance for low- Q^2 tagger

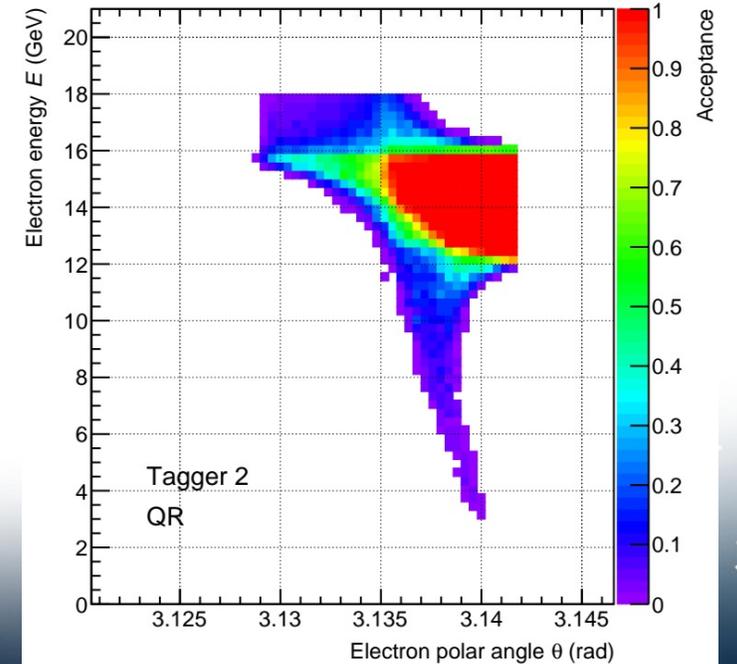
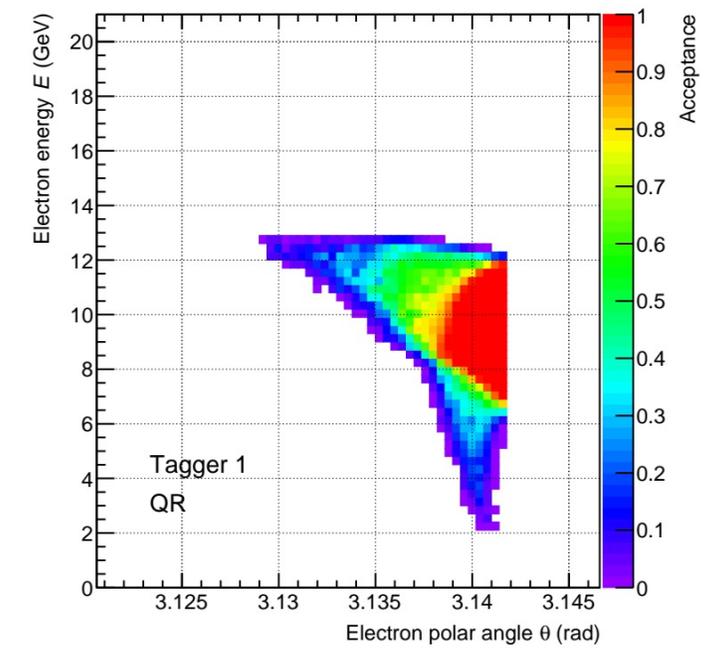
- Tagger 1 and 2 are placed closer (further) from the IP
- Overlap in Q^2 acceptance ($< 0.1 \text{ GeV}^2$)
- Complementary in electron energy (higher energies reach Tagger 2)
- Consistent for Pythia6 and quasi-real photoproduction (QR)



(a) Tagger 1

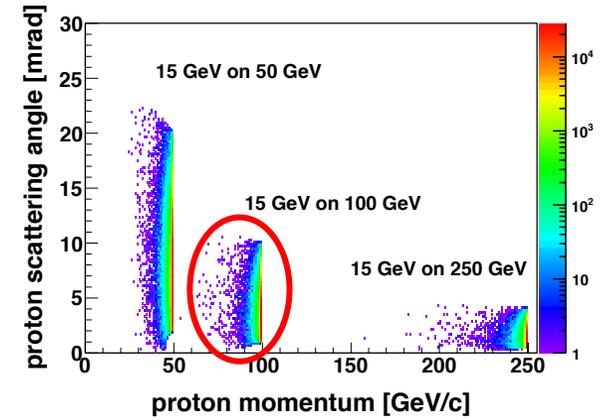
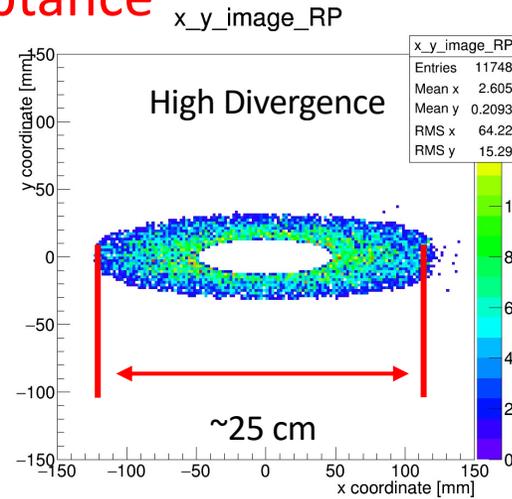
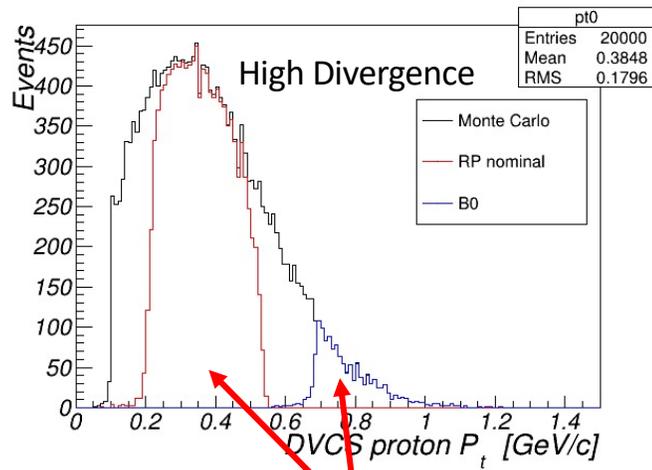


(b) Tagger 2

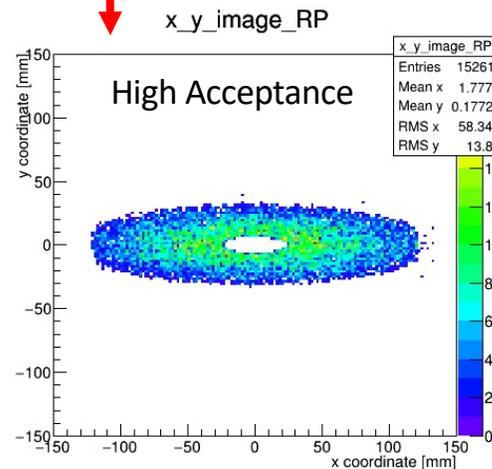
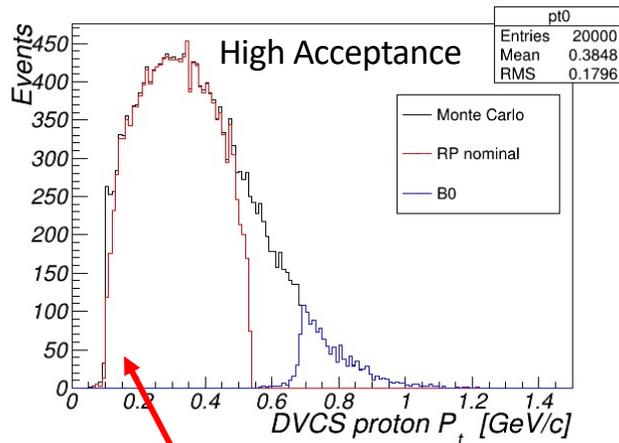


Machine Optics: Roman Pots

100 GeV DVCS Proton Acceptance



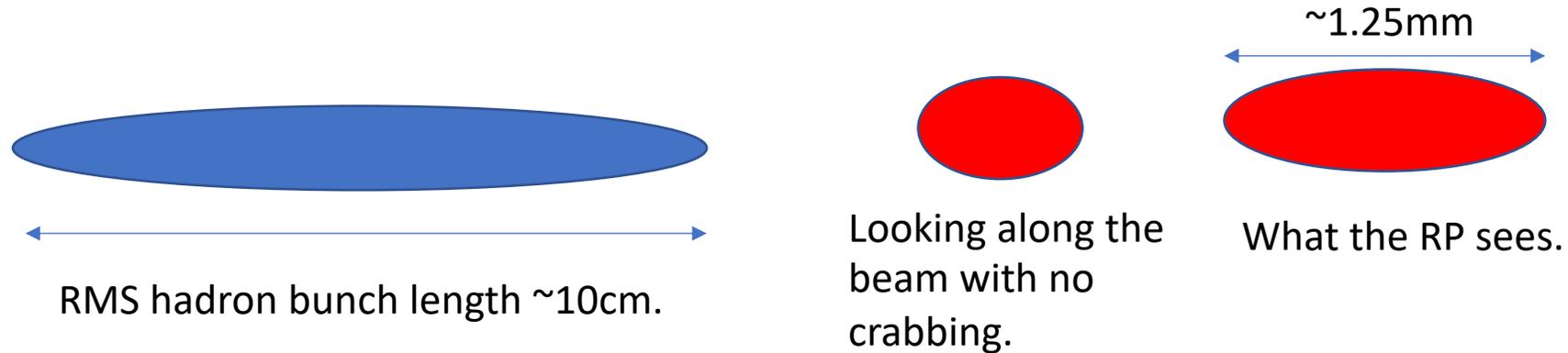
Need both detector systems together here!



Improves low p_t acceptance.

Momentum Resolution – Timing

For exclusive reactions measured with the Roman Pots we need good timing to resolve the position of the interaction within the proton bunch. But what should the timing be?



- Because of the rotation, the Roman Pots see the bunch crossing smeared in x.
- **Vertex smearing = 12.5mrad (half the crossing angle) * $10\text{cm} = 1.25\text{ mm}$**
- If the effective vertex smearing was **for a 1cm bunch**, we would have **$.125\text{mm}$** vertex smearing.
- The simulations were done with these two extrema and the results compared.

- From these comparisons, reducing the effective vertex smearing to that of the 1cm bunch length reduces the momentum smearing to negligible from this contribution.
- This can be achieved with timing of $\sim 35\text{ps}$ ($1\text{cm}/\text{speed of light}$).

Momentum Resolution – Comparison

- The various contributions add in quadrature (this was checked empirically, measuring each effect independently).

$$\Delta p_{t,total} = \sqrt{(\Delta p_{t,AD})^2 + (\Delta p_{t,CC})^2 + (\Delta p_{t,pxl})^2}$$

Angular divergence
Primary vertex smearing from crab cavity rotation.
Smearing from finite pixel size.

	Ang Div. (HD)	Ang Div. (HA)	Vtx Smear	250um pxl	500um pxl	1.3mm pxl
$\Delta p_{t,total}$ [MeV/c] - 275 GeV	40	28	20	6	11	26
$\Delta p_{t,total}$ [MeV/c] - 100 GeV	22	11	9	9	11	16
$\Delta p_{t,total}$ [MeV/c] - 41 GeV	14	-	10	9	10	12

- Beam angular divergence**

- Beam property, can't correct for it – sets the lower bound of smearing.
- Subject to change (i.e. get better) – beam parameters not yet set in stone

- Vertex smearing from crab rotation**

- Correctable with good timing (~35ps)

- Finite pixel size on sensor**

- 500um seems like the best compromise between potential cost and smearing

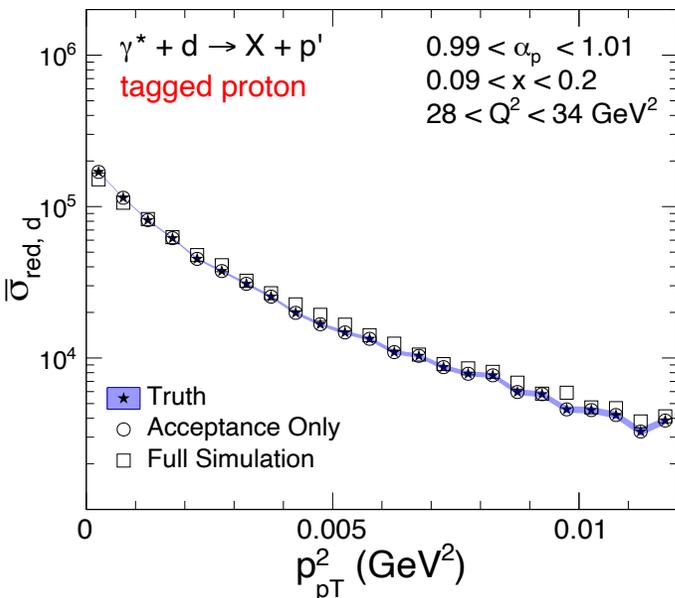
Free Neutron F_2 Extraction

$$\sigma_{red,n}(x, Q^2) = \frac{\sigma_{red,d}}{[2(2\pi)^3]S_d(p_{pT}, \alpha_p)}$$

(deuteron reduced cross section)

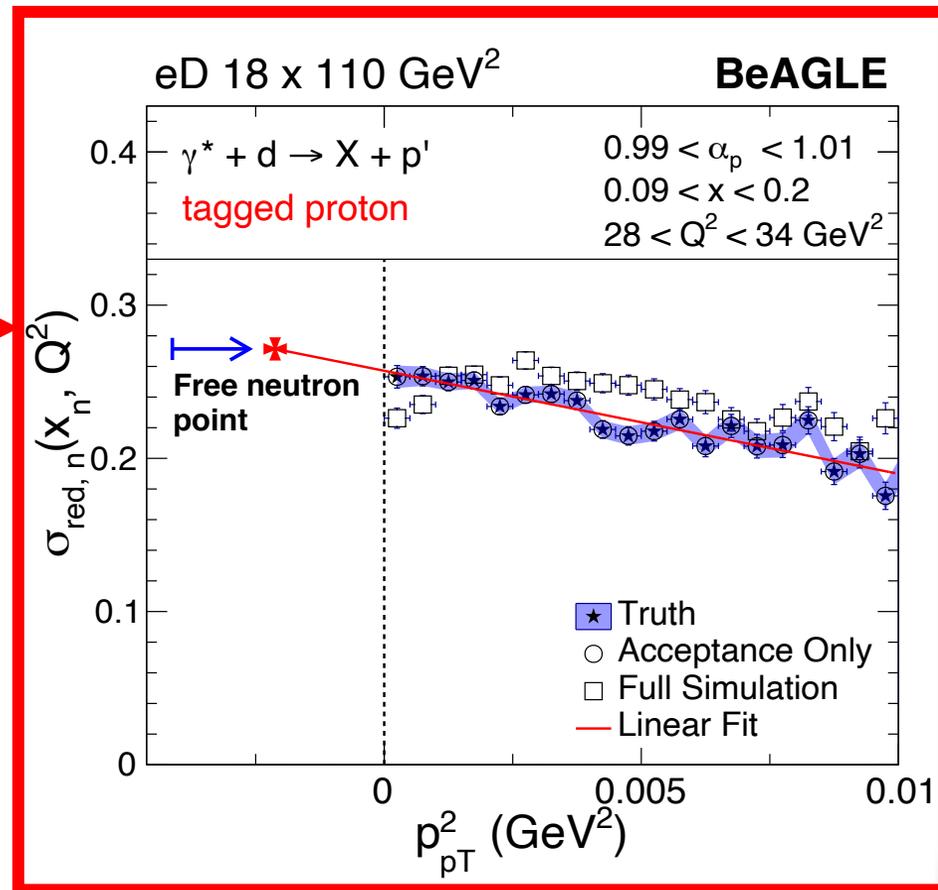
eD 18 x 110 GeV²

BeAGLE



$$\frac{1}{S_d(p_{pT}, \alpha_p)[pole]}$$

(inverse pole of deuteron spectral function)



(Active nucleon reduced cross section)

- Resulting dependence on p_{pT}^2 is very weak and the extrapolation can be performed with a 1st-degree polynomial fit.
- Extrapolation only performed for the generator-level distribution.

$$R = 2\alpha_n^2 m_N \Gamma^2 (2 - \alpha_n)$$

$$a_T^2 = m_N^2 - \alpha_p (2 - \alpha_p) \frac{M_d^2}{4}$$

$R =$ residue of spectral function

$a_T^2 =$ position of pole

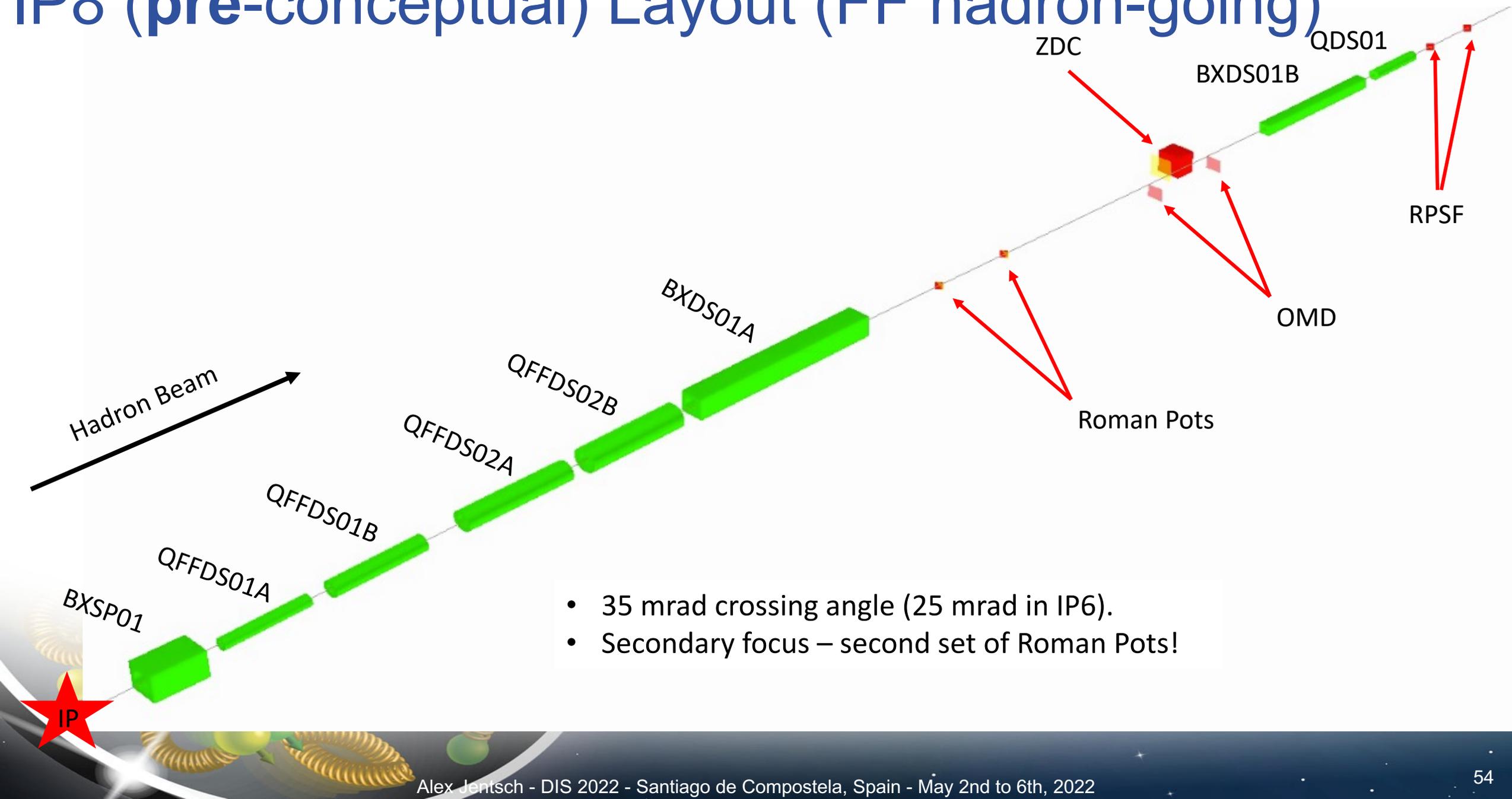
$$S_d(p_{pT}, \alpha_p)[pole] = \frac{R}{(p_{pT}^2 + a_T^2)^2}$$

<https://arxiv.org/abs/2108.08314>
Submitted to Physical Review C



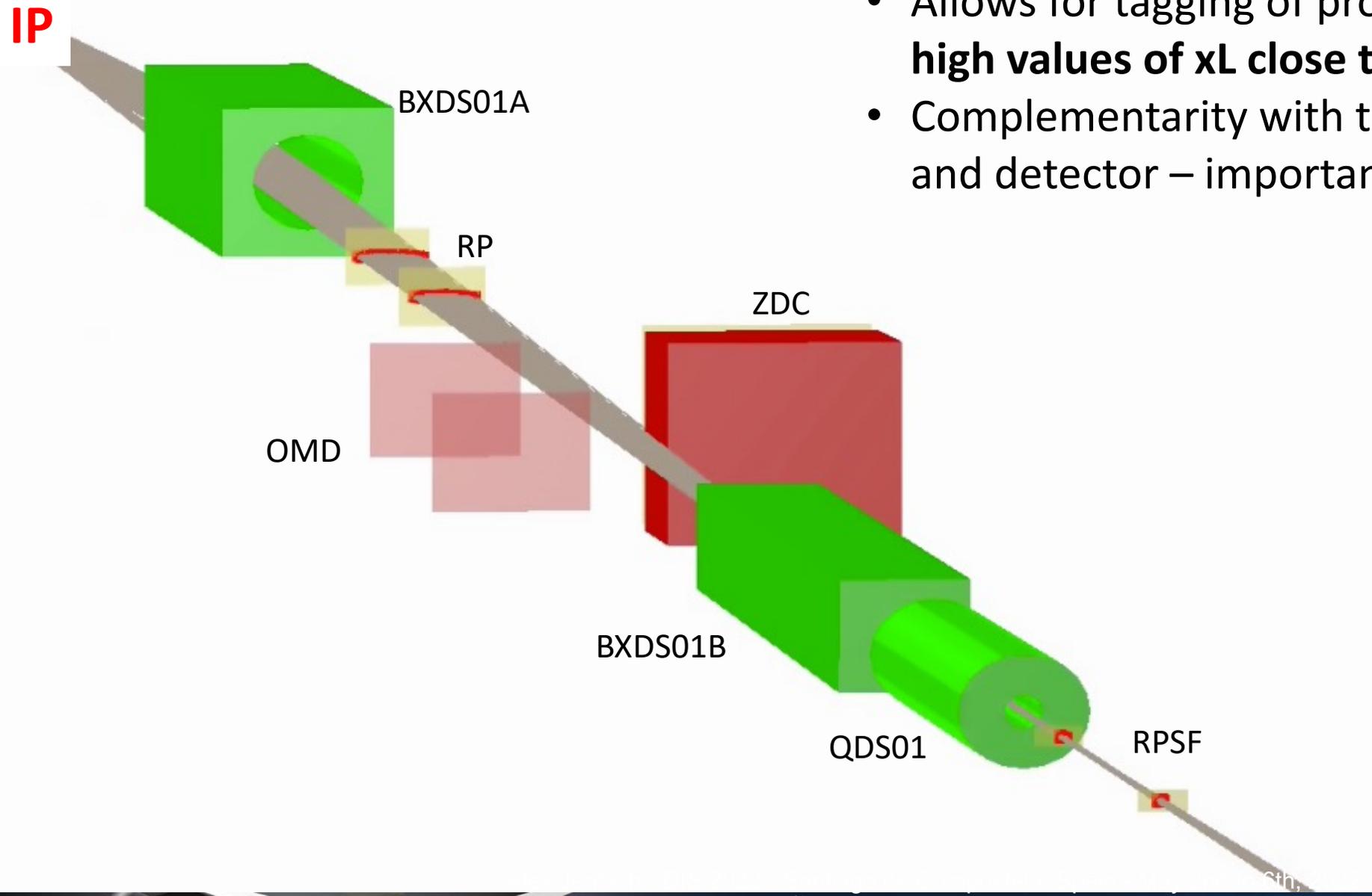
What about IP8?

IP8 (pre-conceptual) Layout (FF hadron-going)



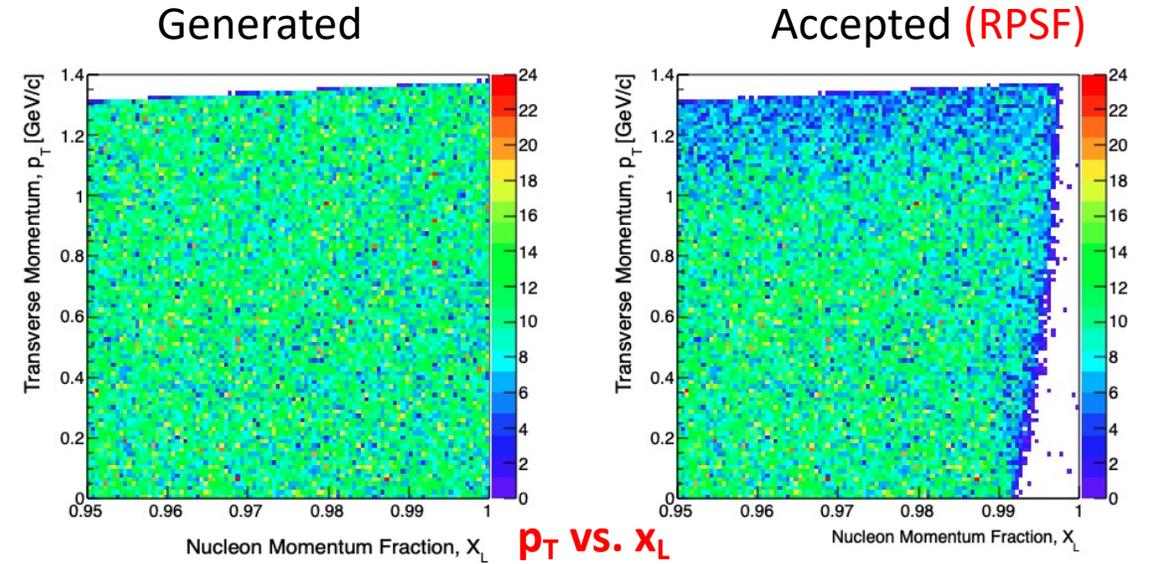
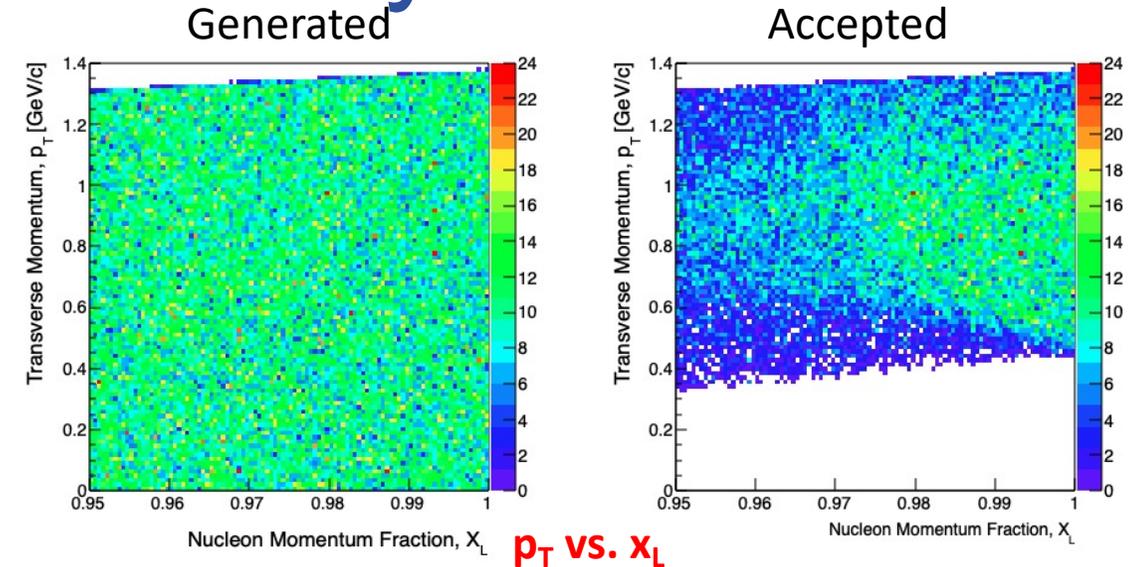
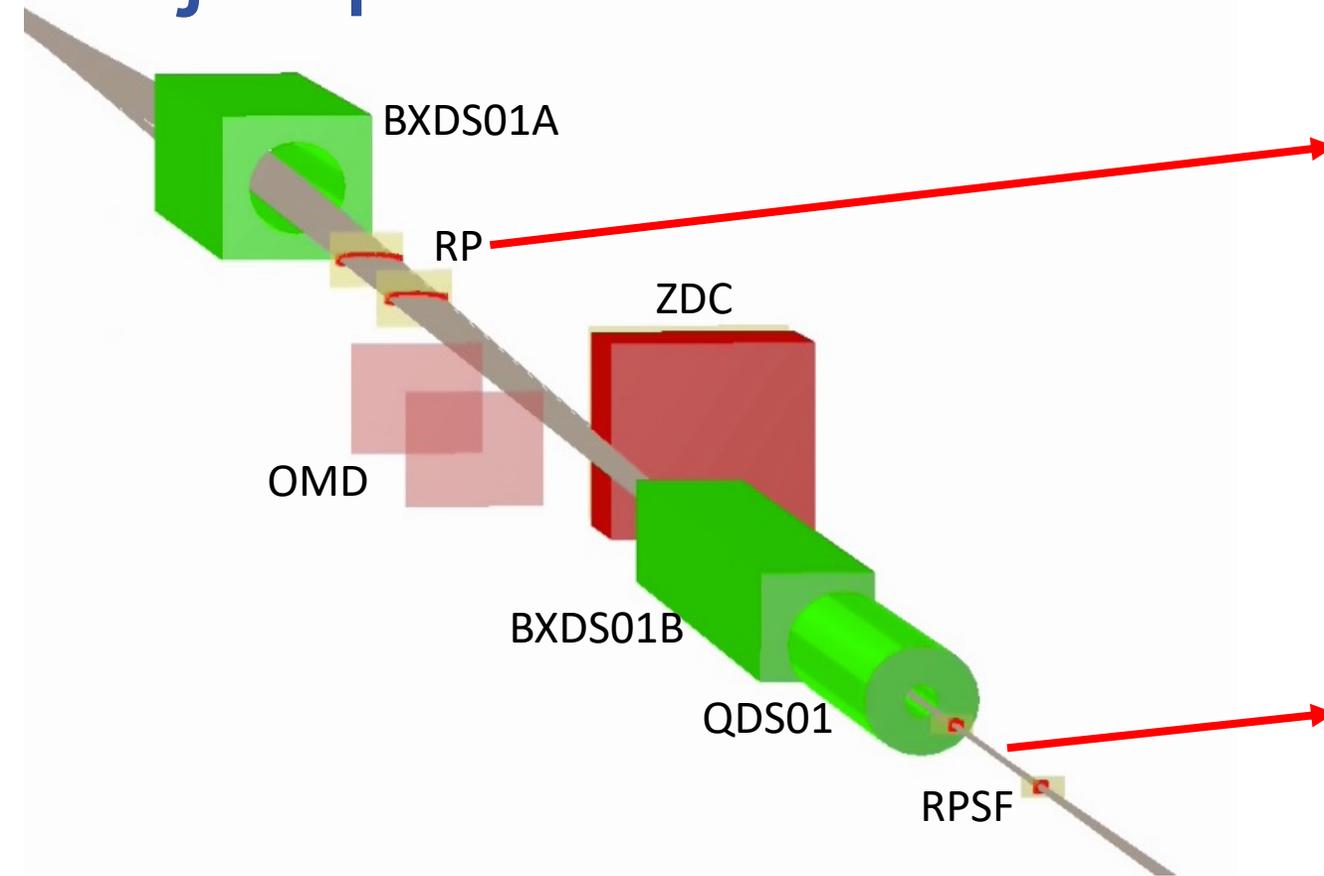
- 35 mrad crossing angle (25 mrad in IP6).
- Secondary focus – second set of Roman Pots!

Major potential benefit: Secondary Focus

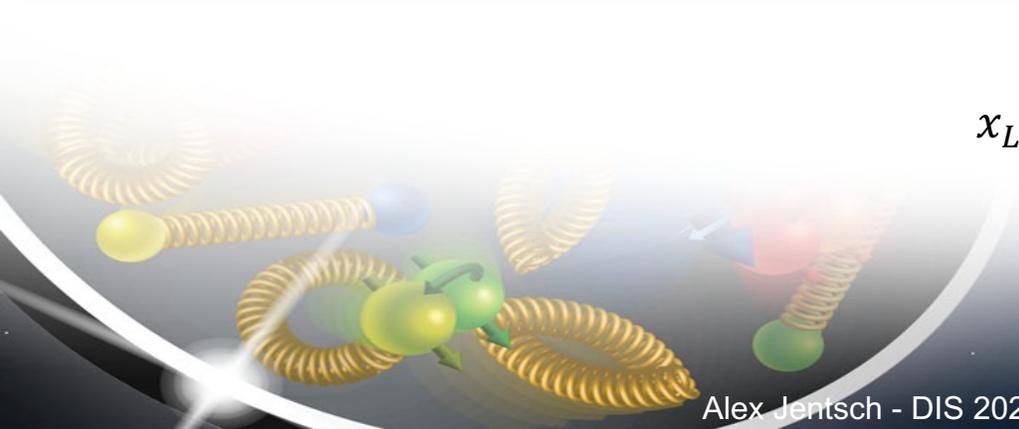


- Allows for tagging of protons and nuclei at very **high values of x_L close to one** ($p_T \sim 0$).
- Complementarity with the IP6 configuration and detector – important for the EIC!

Major potential benefit: Secondary Focus

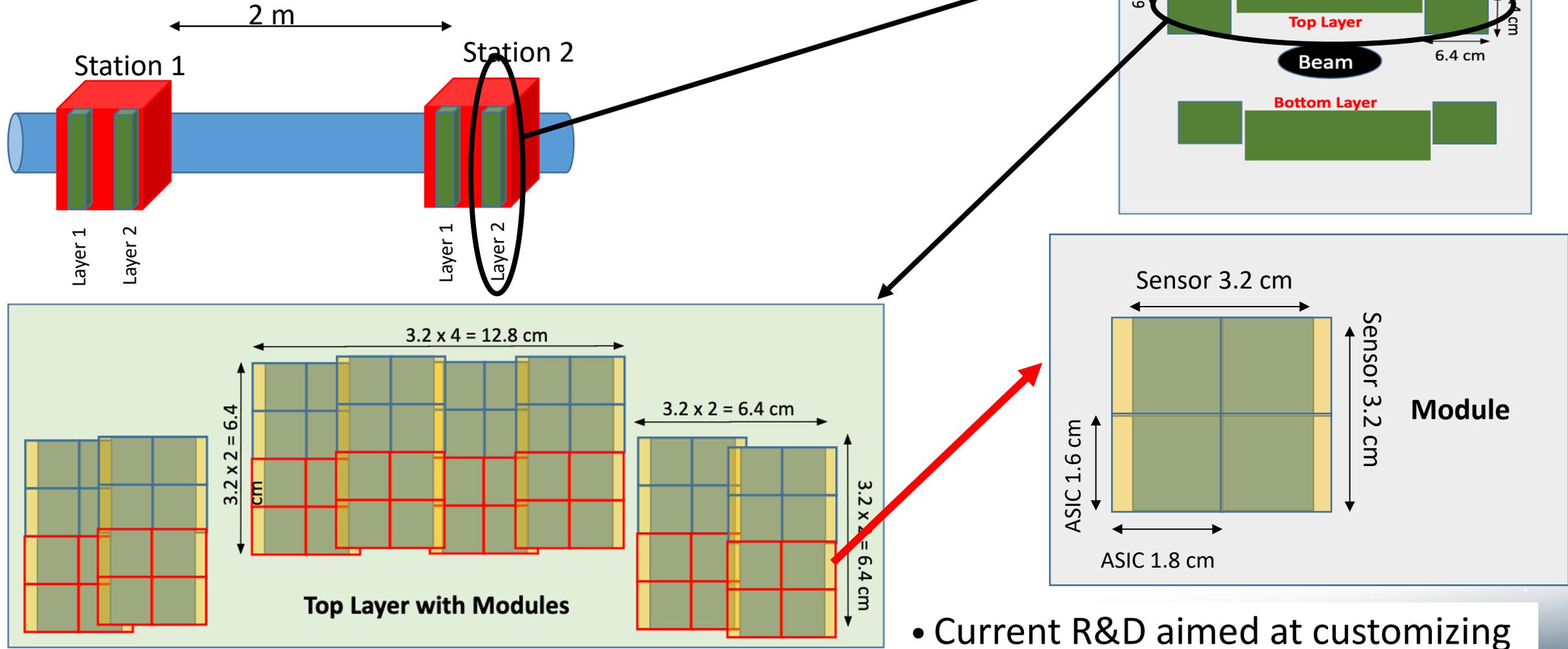


$$x_L = \frac{p_{z,particle}}{p_{beam}}$$



Roman Pots @ the EIC

- Updated layout with current design for **AC-LGAD sensor** + ASIC.



Based on eRD24 R&D work.

- Current R&D aimed at customizing ASIC readout chip (ALTIROC) for use with AC-LGADs.