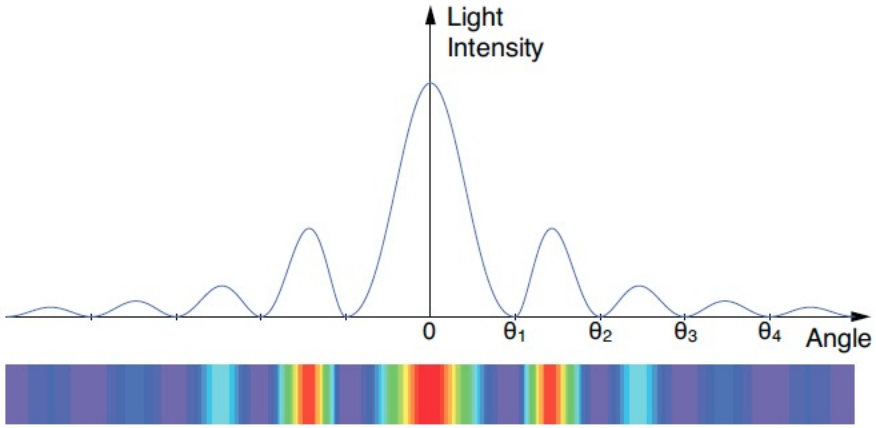
VM program in *eA* at the EIC – ATHENA



Series of study

I. Baselines and setups
II. PHP, ***t*** reco, and mass
III. Preliminary proposal of ϕ

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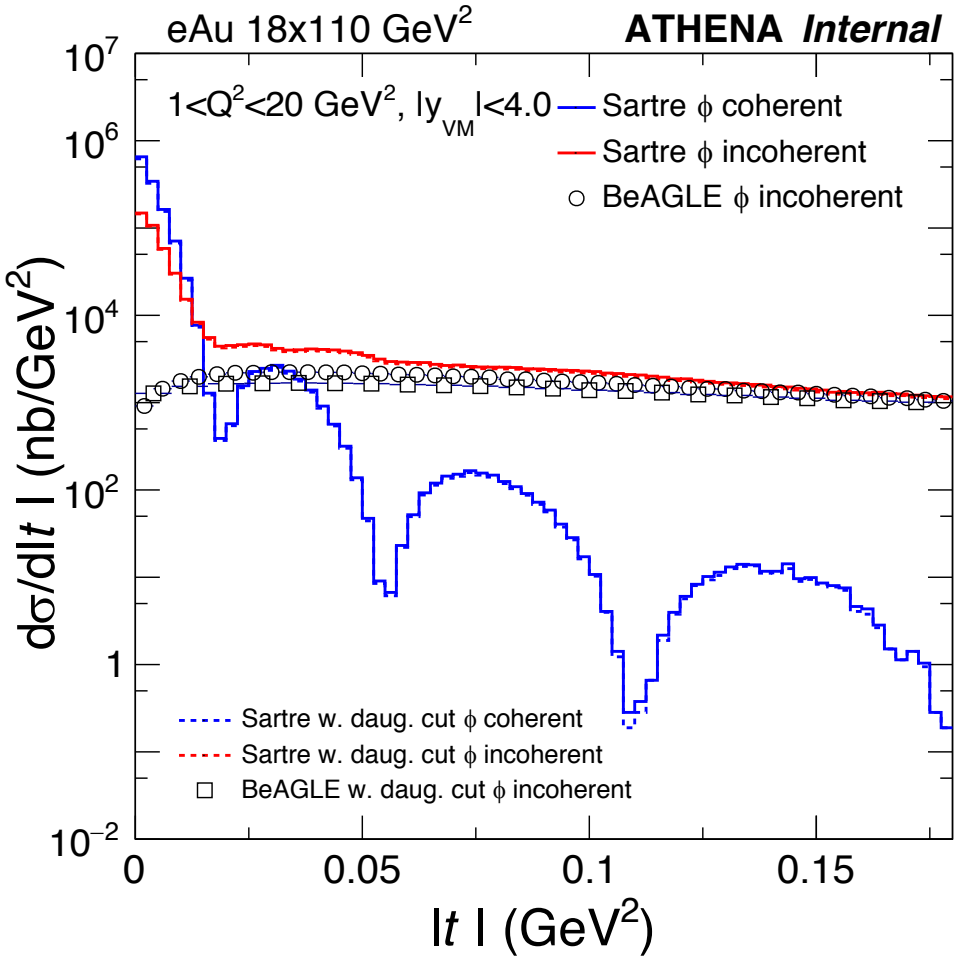
Corrections to [2021-08.20]

- A few issues were found.
  1. Q^2 limits in Sartre and BeAGLE were not consistent for photoproduction.
  2. Sartre tables for photoproduction are still under investigation.
  3. BeAGLE photoproduction veto had a bug. Veto on photoproduction has been found to be slightly better, but not significantly better.

- One validation was performed against UPC data on J/psi photoproduction off Au nucleus. A good agreement has been found! [not talk about it today.]

- Today, only focusing on electroproduction of phi.

ϕ meson

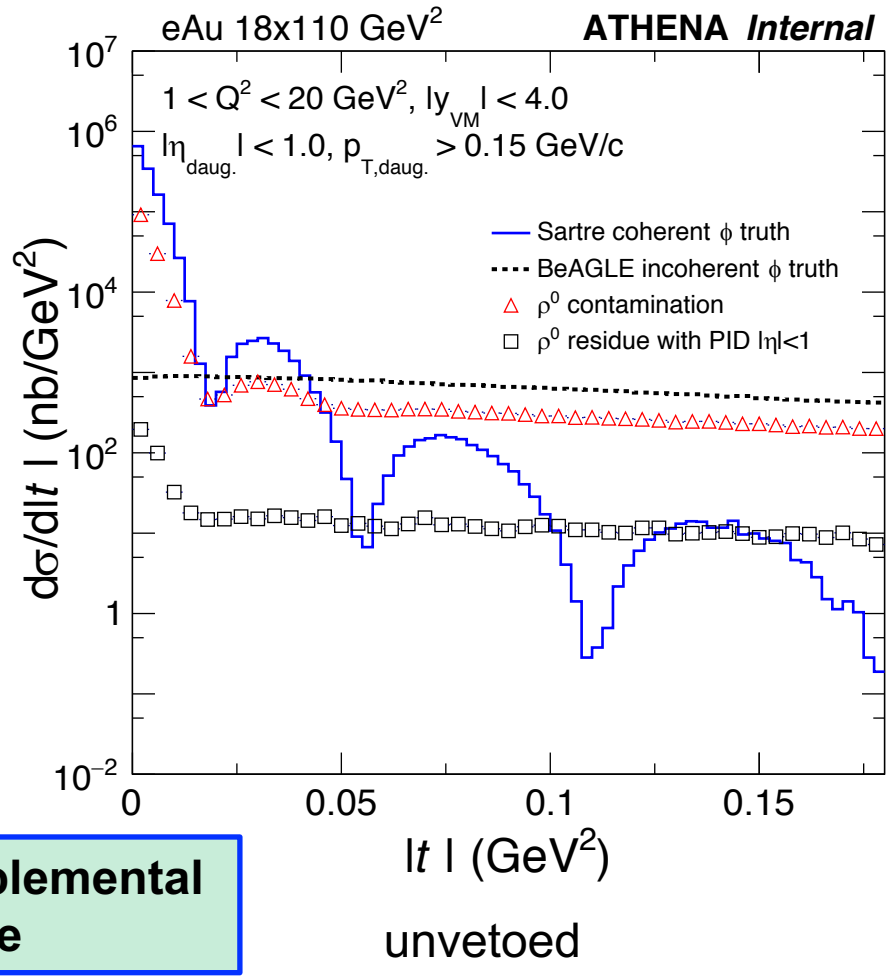


What we want to study/show:

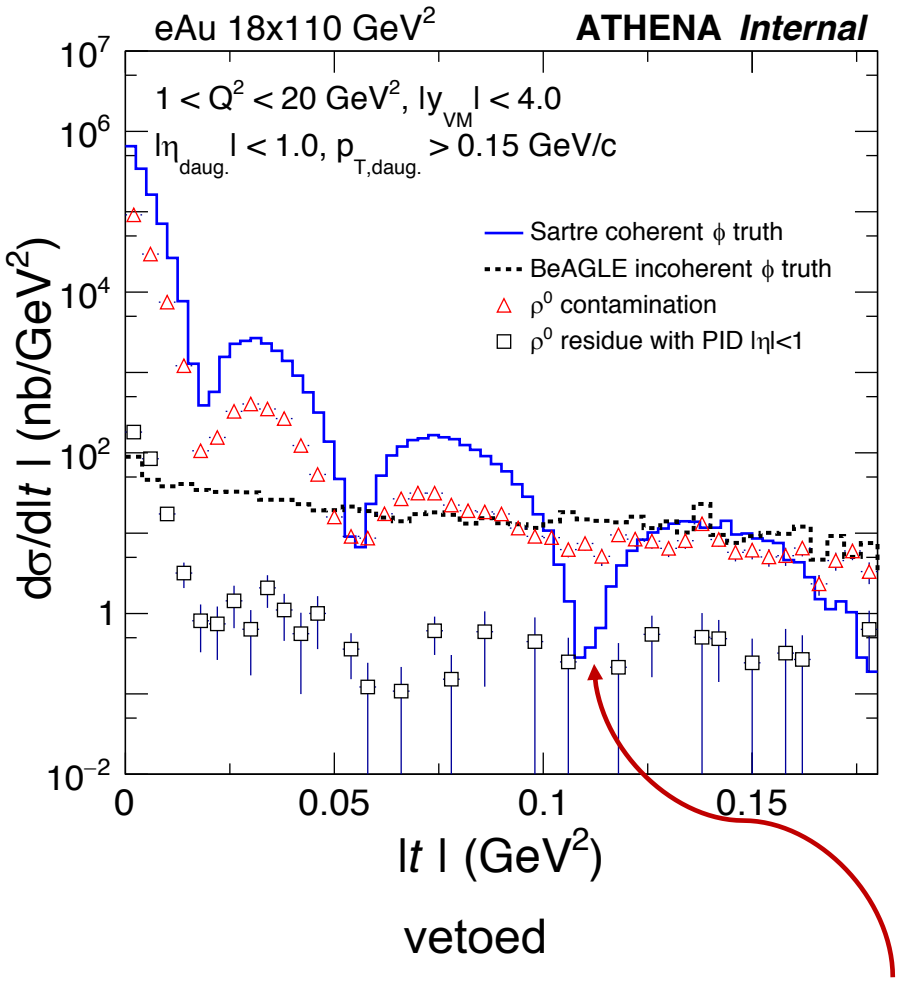
- Effects from PID within |eta| < 1.0, to suppress rho contributions;
- Effects from incoherent productions and their vetoing. How to deal with residue?
- Smearing from beam and detector effects, reconstruction of ***t*** and mass, and combine everything to the final measurement.

Proposal of ϕ meson. without Machine/Detector/Beam effects

“Proposal figure candidates” - PID



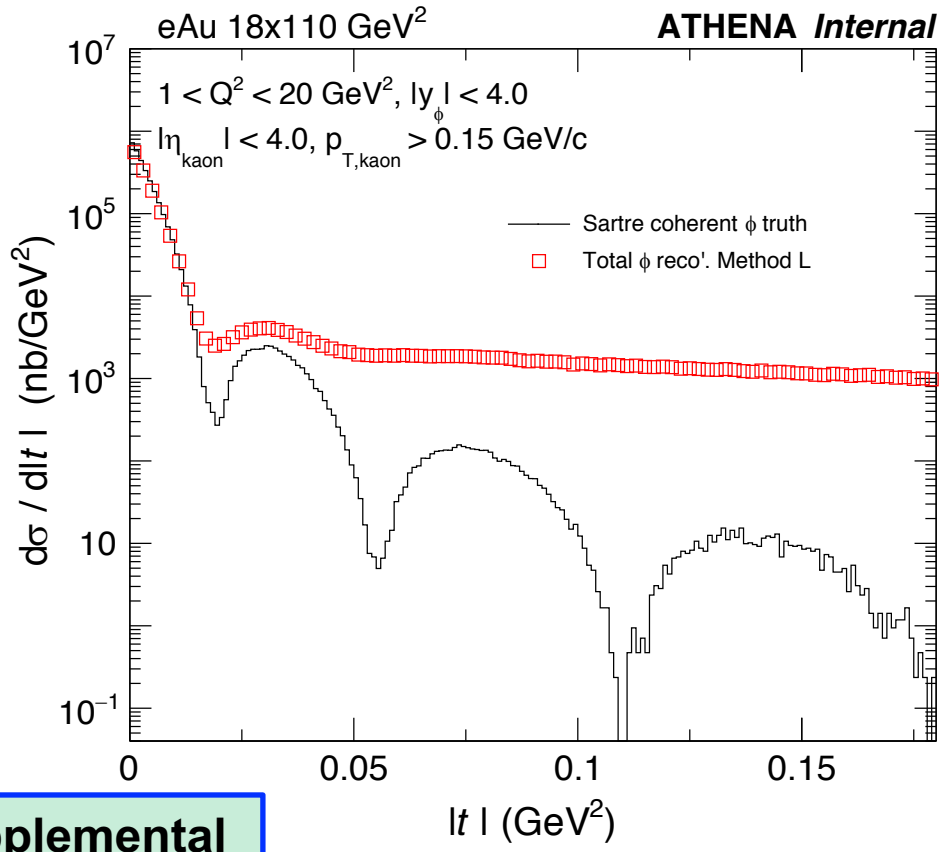
Supplemental figure



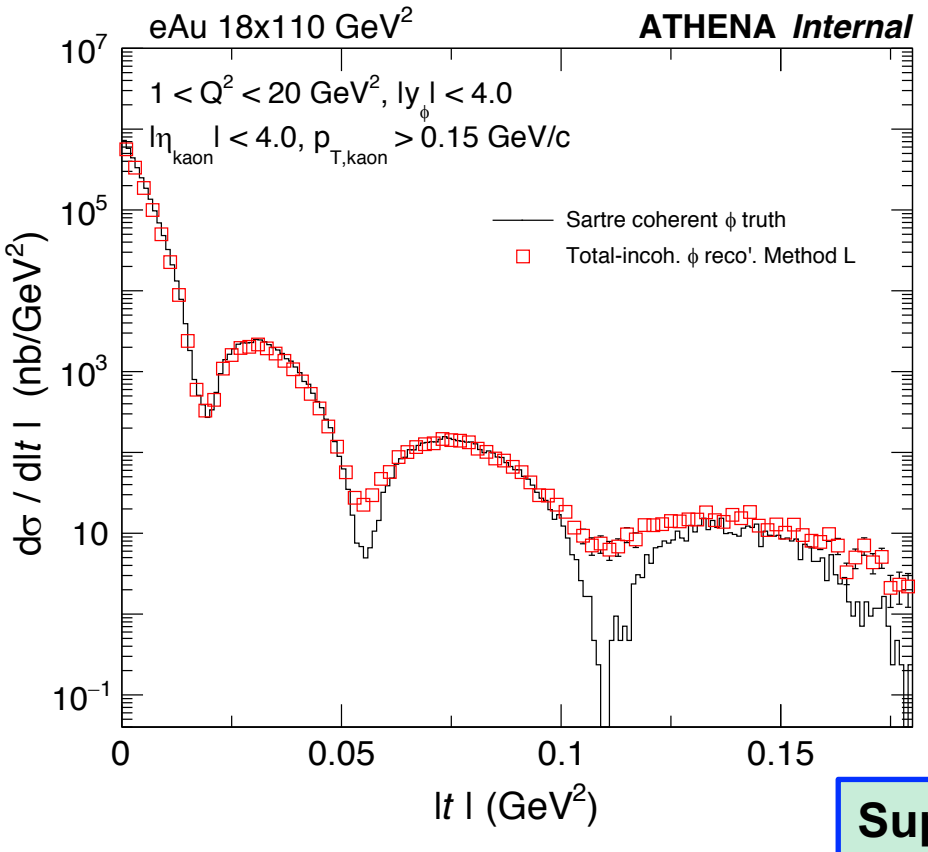
Proposed figure

This is to show by having PID, the uncertainty arising from rho VM (incoherent dominant) is eliminated.
[Note, all daughters |eta|<1.0]

“Proposal figure candidates” - vetoing



unvetoed



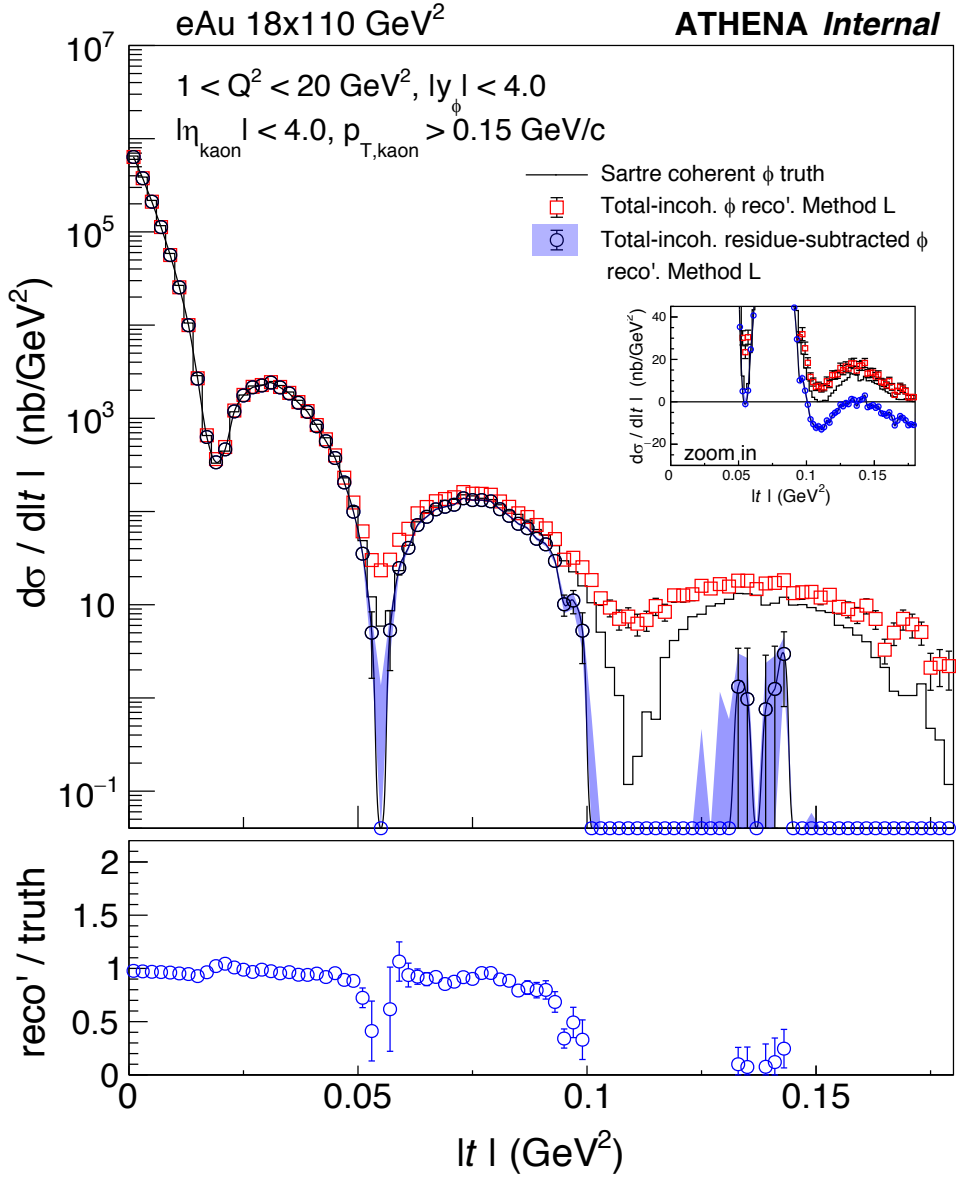
vetoed

Supplemental figure

Supplemental figure

This is the full phase space for VM daughters.

“Proposal figure candidates” - vetoing



Incoherent residue subtraction

[Conclusion]

- Works well for the second minimum
- Doesn’t work for the third.

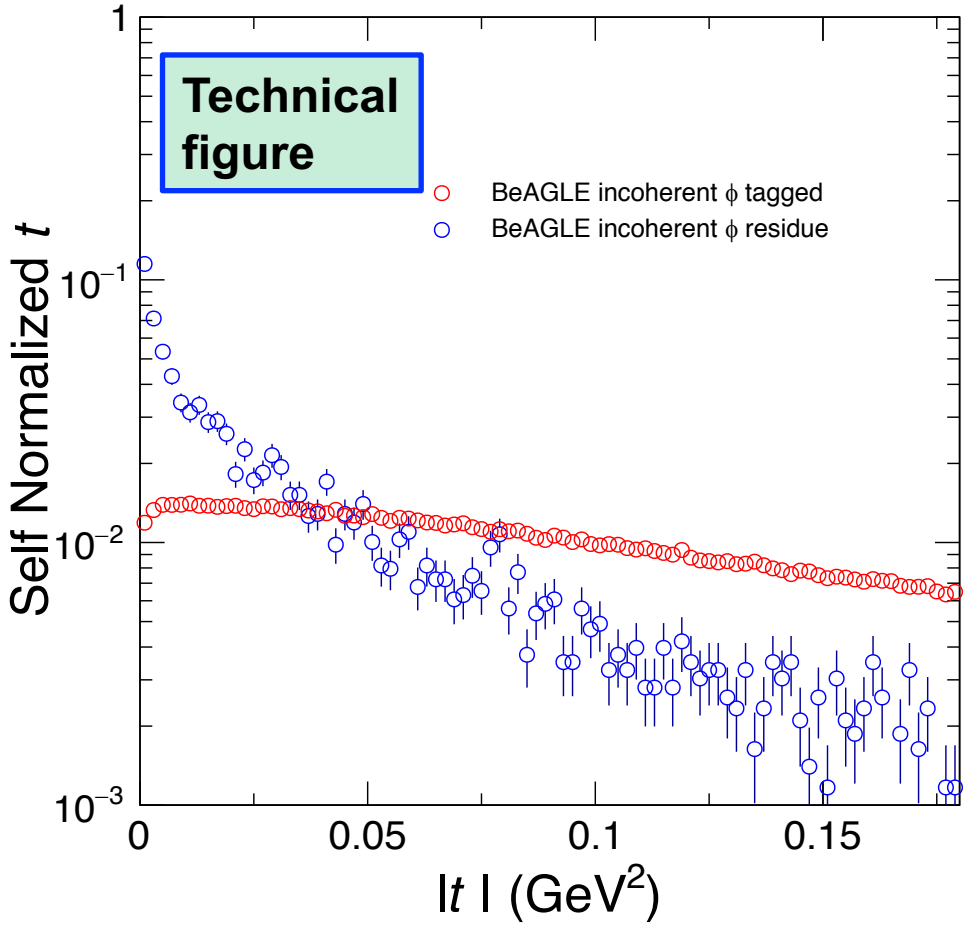
[Method]

- Only the tagged incoherent distribution is known,
  → Incoherent = residue + tagged.
- Use theory/model to estimate the total cross section (?) → estimate the residue cross section.
-
- Further subtract *tagged (distribution) scaled by residue cross section (theory/model)*

- Color band is for +/-10% uncertainty on total cross section.

Supplemental figure

Residue subtraction



- The reason it works for the 2nd minimum is because the two distributions cross around –t = 0.05 – BeAGLE model dependent
- We use the residue cross section to scale up the “tagged” distribution, which is wrong to start with.
- (alternatively, one can use theory/model input on the *shape* as well for incoherent, then it might work better)

Proposal of ϕ meson. with Machine/Detector/Beam effects

Beam effects:

1. Angular divergence e, Au
2. Momentum spread e, Au

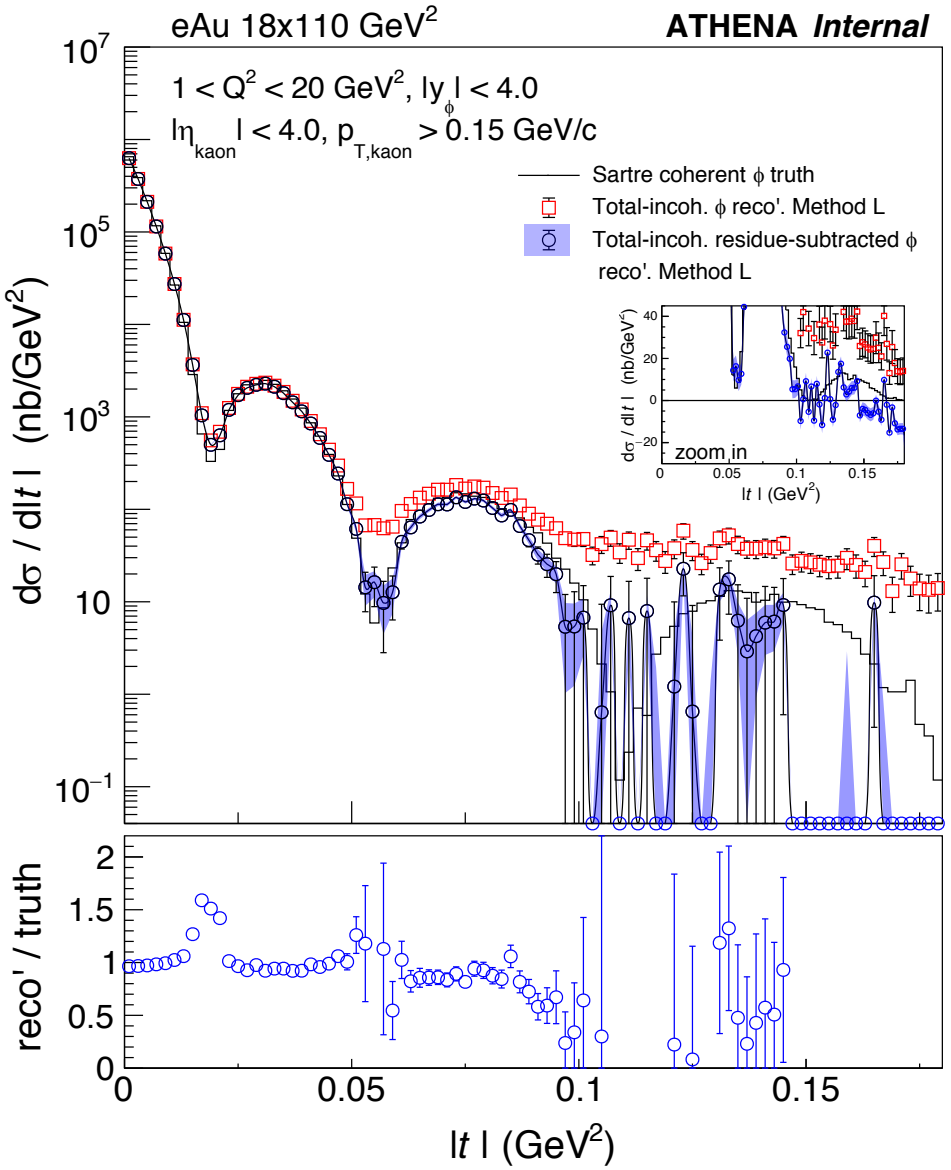
(CDR numbers)

**Crossing angle (Not yet implemented)*

Detector effects:

1. Tracking pt resolution on VM daughters
    1. 0.05%pt+0.5% |eta|<1,
    2. 0.1%pt+0.5% 1<|eta|<4
2. *Efficiency (Not yet implemented)*
3. Beam pipe for the far-forward region
    (Use ratio from arXiv:2108.01694 **)**

“Proposal figure candidates” – final (1)



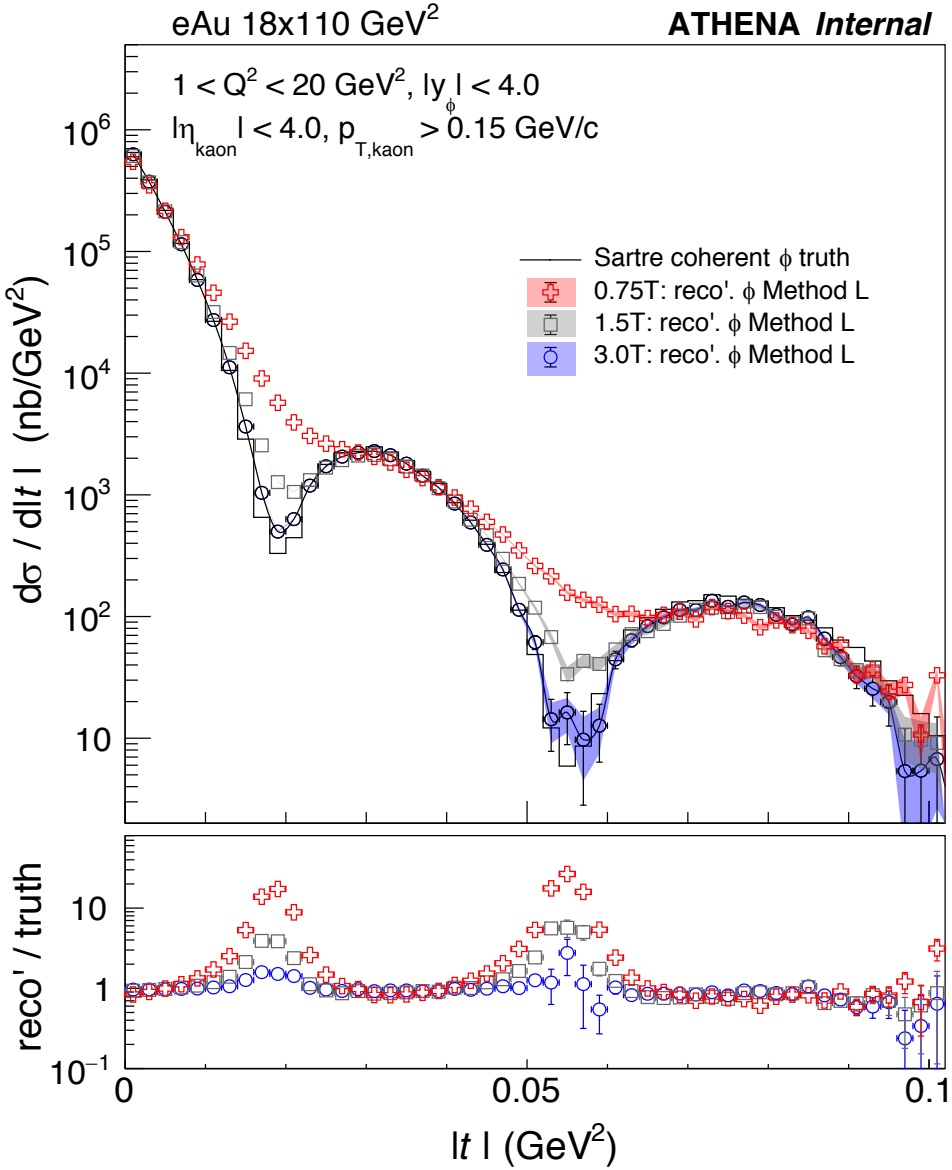
Message:

ATHENA detector can achieve the coherent ϕ meson measurement in eAu at the EIC top energy with strengths in:

- High momentum resolution (3T magnet) ensures high precision, or less “corrections/unfolding”.

Supplemental figure

“Proposal figure candidates” – final (2)



Proposed figure

Message:

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- High momentum resolution (3T magnet) ensures high precision, or less “correction/unfolding”.

Comparisons to (1.5T, 0.75T) field configuration. (e.g., all pt resolution (x2, x4) w.r.t to slide 9)

Summary

- Diffractive ϕ meson in eAu electroproduction can be (better) achieved with ATHENA.
  - With theory/model input, 2 minima can be seen.
  - 3T field is optimal and/or even necessary.

- All effects are studied in a “Toy” detector except:
  - Tracking efficiency (detectors);
  - Crossing angle (machine).

- Next step: ATHENA simulations.

(Do we really need ”real” simulations, if the dominant beam effects, crossing angles, etc. are studied by after-burner anyway?)