Update on IP-8 Simulation: Vetoing Efficiency

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Short Updates

- Kong created Github repository for EIC 2nd detector named **D2EIC**
  - Implemented IP-8 forward hadron lattice
  - Implemented forward roman pot at 2nd focus
    - Detector acceptance tested after implementation – seems to make sense
  - (Work in progress) other forward detector implementations
    - B0, OMD, and ZDC
- Randy sent IP-8 lattice study for proton 275 GeV configuration

18 GeV on 275 GeV		Momentum Dispersion ($D^{\text{secondary focus}}$)	Emittance X (ϵ_x*) [mm]	Emittance Y(ϵ_y*) [mm]	Beta function X ($\beta_x^{\text{secondary focus}}$) [mm]	Beta function Y ($\beta_y^{\text{secondary focus}}$) [mm]	Momentum spread ($\Delta p/p$)*
IP8 ep High Divergence	Old	0.382	18.e-6	1.6e-6	2289.454596	4538.713168	6.8e-4
	New	**0.465446661**	**18.e-6**	**1.6e-6**	**498.024969**	**3443.354186**	**6.8e-4**

Based on **ep** high divergence **10 GeV on 275 GeV**

Summary 10σ Safe Distance Cut

- For IP8, used IP6 beam conditions except for **momentum dispersion (D) and Beta function @ secondary focus from Randy's**

	σ_{1x}	σ_{1y}
ep β @ IP8* (= IP6*)	0.121077	0.0193225
ep β @ IP8 RPSF	**0.203642**	**0.0867277**
eAu β @ IP8* (= IP6*)	0.198869	0.0216527
eAu β @ IP8 RPSF (Old)	**0.314867**	**0.1629770**
Wan's IP8 Study	0.328283	0.085217
eAu β @ IP8 RPSF (New)	**0.147659**	**0.142338**

Above 10σ values based on **ep** high divergence **even for eAu vetoing efficiency study**
IP8 eAu lattice study will be available soon (Randy is currently working on it)

Beam Parameters for IP-8 Study

- Randy provided momentum dispersion (D) and Beta function @ secondary focus

18 GeV on 110 GeV	Momentum Dispersion ($D^{secondary\ focus}$)	Emittance X (ϵ_x*) [mm]	Emittance Y(ϵ_y*) [mm]	Beta function X (β_x) [mm]	Beta function Y (β_y) [mm]	Momentum spread ($\Delta p/p$)*
IP8 eAu	0.382	43.2e-6	5.8e-6	$\beta_x^{*(z=0)}$ = 910	$\beta_y^{*(z=0)}$ = 40	6.2e-4
	0.382	43.2e-6	5.8e-6	β_x Secondary focus 2289.454596	β_y Secondary focus 4538.713168	6.2e-4
	0.465446661	43.2e-6	5.8e-6	β_x Secondary focus **498.024969**	β_y Secondary focus **3443.354186**	6.2e-4

Based on **ep** high divergence **10 GeV on 275 GeV**

Approach – Incoherent Vetoing Efficiency

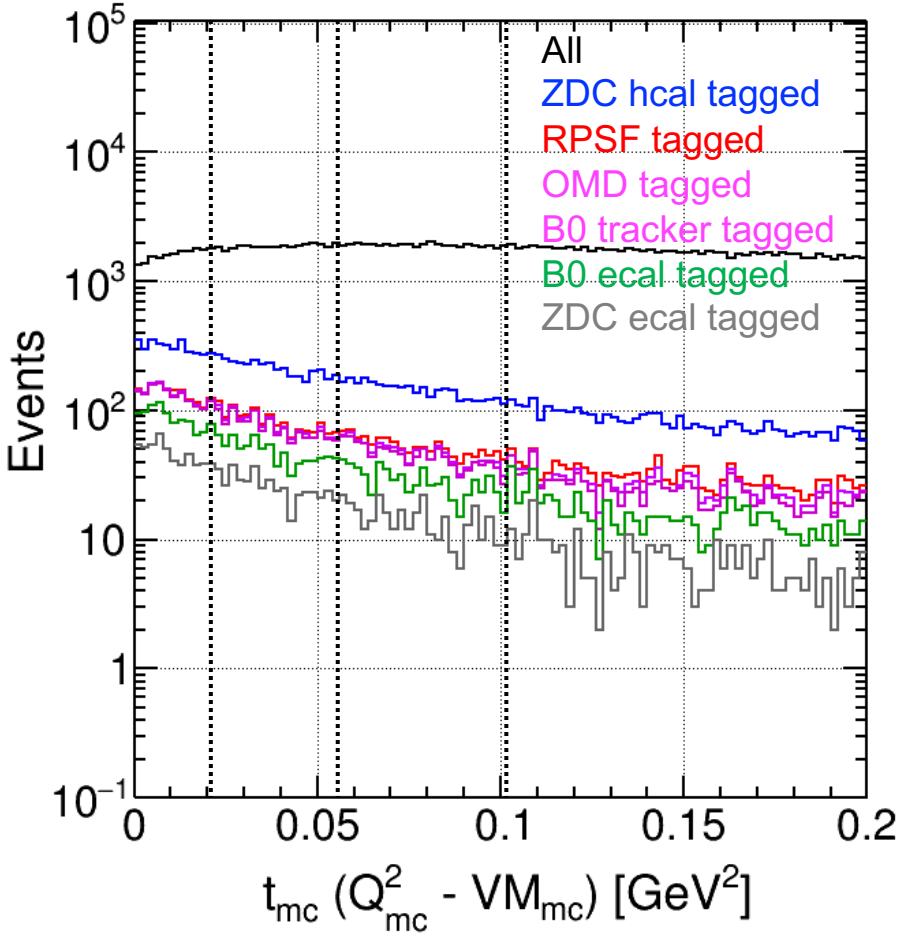
- Used simulated **BeAGLE** 801k events with **$1 < Q^2 < 10$**
  - **ePb 18×110 GeV incoherent $J/\psi(\mu\mu)$ events** $ePb \rightarrow e' + J/\psi(\mu\mu) + X$ (S3/eictest/EPIC/EVGEN/EXCLUSIVE/DIFFRACTIVE_JPSI_ABCONV/BeAGLE/ePb_18x108.41_tau10_B1.1_Jpsi_highstats/ePb_18x108.41_tune3_tau10_B1.1_extracted_Jmu_1.hepmc)
- Passed through **afterburner IP8 eAu** configuration
  - IP8 crossing angle (35 mrad) and **w/ and w/o IP6 eAu beam effects** based on **EIC CDR table 3.5**
- Discarded events having **more than one electron in final state with $\eta < -1$**
- Calculated **10σ safe distance cut** based on **old/new eAu β IP8 RPSF and Wan's**
- **Tagged events for nuclear breakups <u>*tagging purpose*</u>**
  - ZDC Hcal: **any registered RAW hits**
  - RPSF: **one layer (closet to 2nd focus)** has registered RAW hits outside **10σ** safe distance
  - OMD: **two layers** (actual four layers as redundancy) have registered RAW hits
  - B0 Tracker: **at least two out of four layers** have registered RAW hits
  - B0 Ecal: **energy** of all hits greater than **100 MeV**
  - ZDC Ecal**: energy** of all hits greater than **100 MeV**

W/O Beam effects

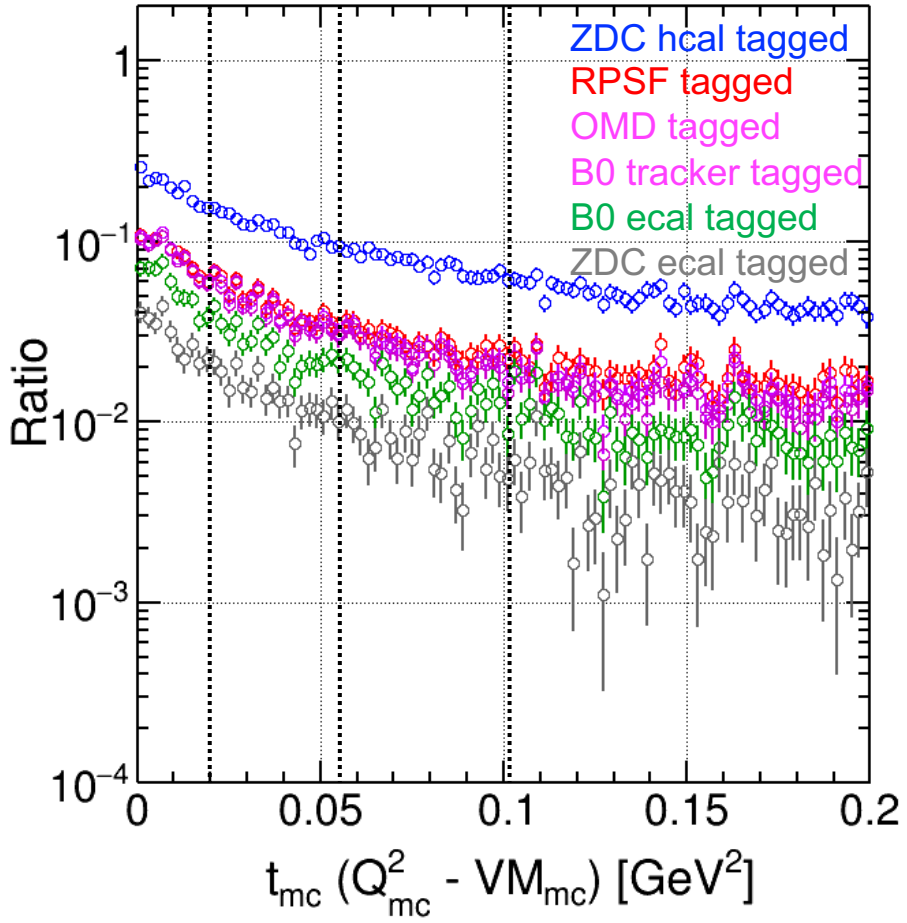
t distribution – Wan's 10σ Cut

BeAGLE 18x110 GeV^2
Incoherent events
$ePb \rightarrow e' + J/\psi(\mu\mu) + X$

Veto inefficiency for incoherent events



Coherent diffractive minima



With 10σ safe distance cut based on ***exact Wan's values***

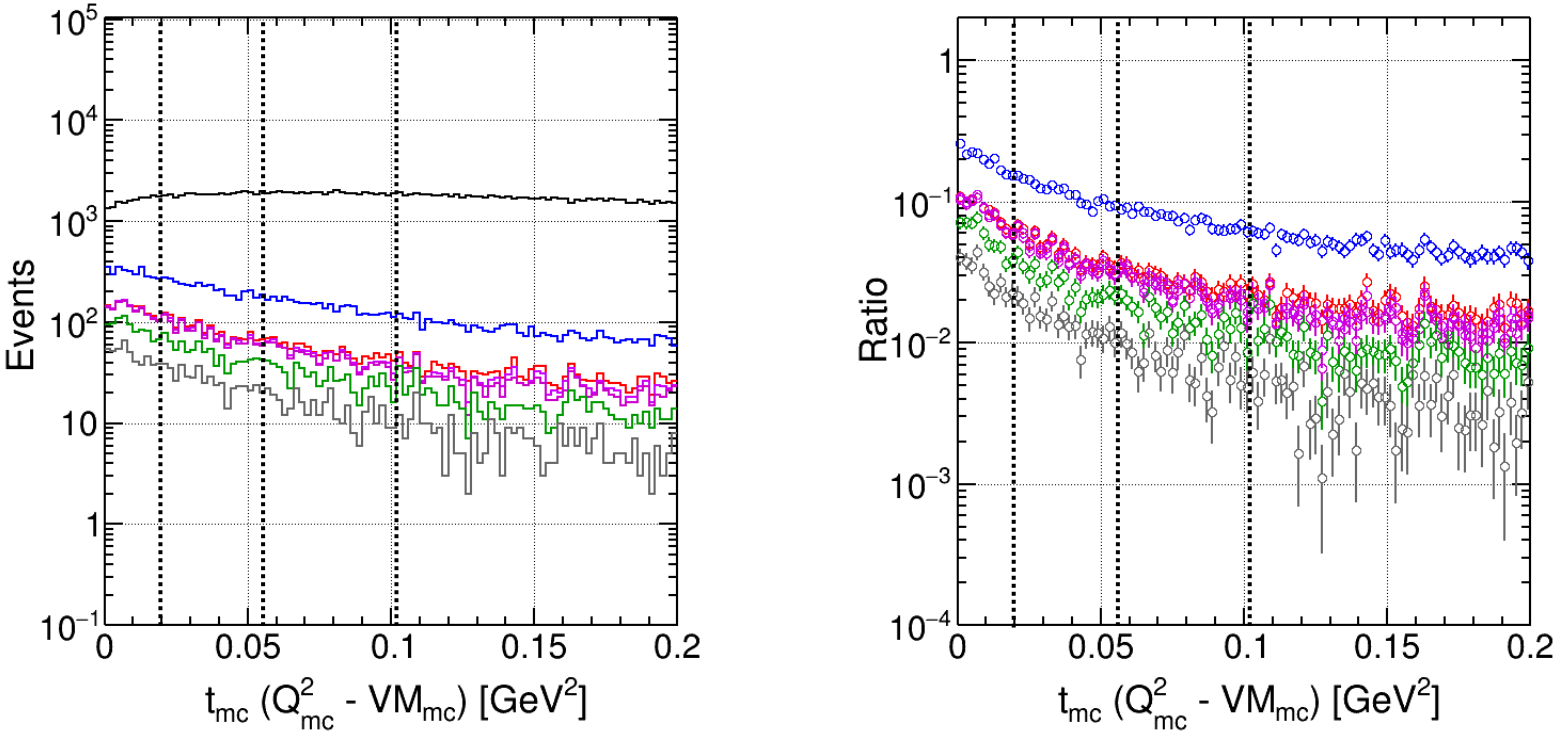
3,830 of 711,368 events were NOT vetoed (0.538%)

W/O Beam effects

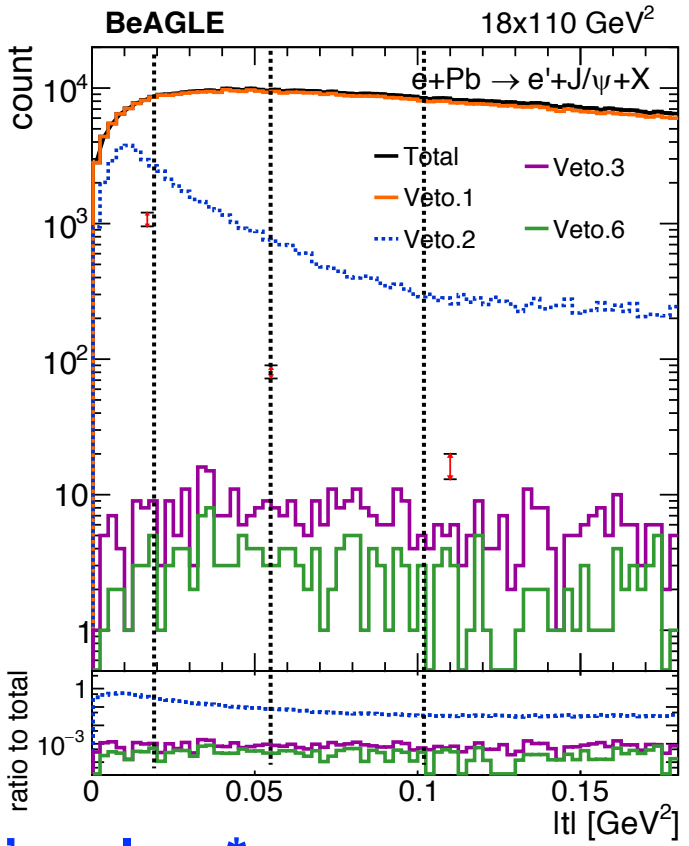
t distribution – Wan's 10σ Cut

BeAGLE 18x110 GeV^2
Incoherent events
$ePb \rightarrow e' + J/\psi(\mu\mu) + X$

IP-8 DD4hep (J. KIM)



IP-8 EicRoot (W. Chang)



With 10σ safe distance cut based on ***exact Wan's values***

IP-8 DD4hep: 3,830 of 711,368 events were NOT vetoed (0.538%)

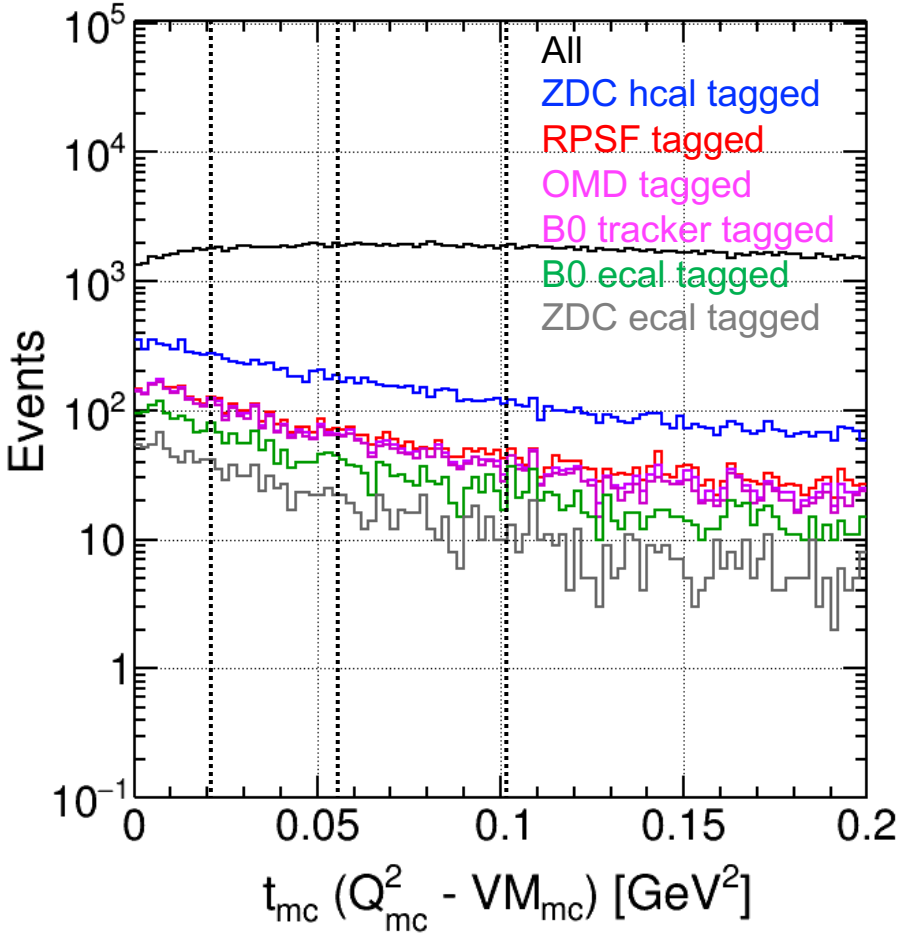
IP-8 EicRoot: 685 of 1322778 events were NOT vetoed (0.05%)

W/O Beam effects

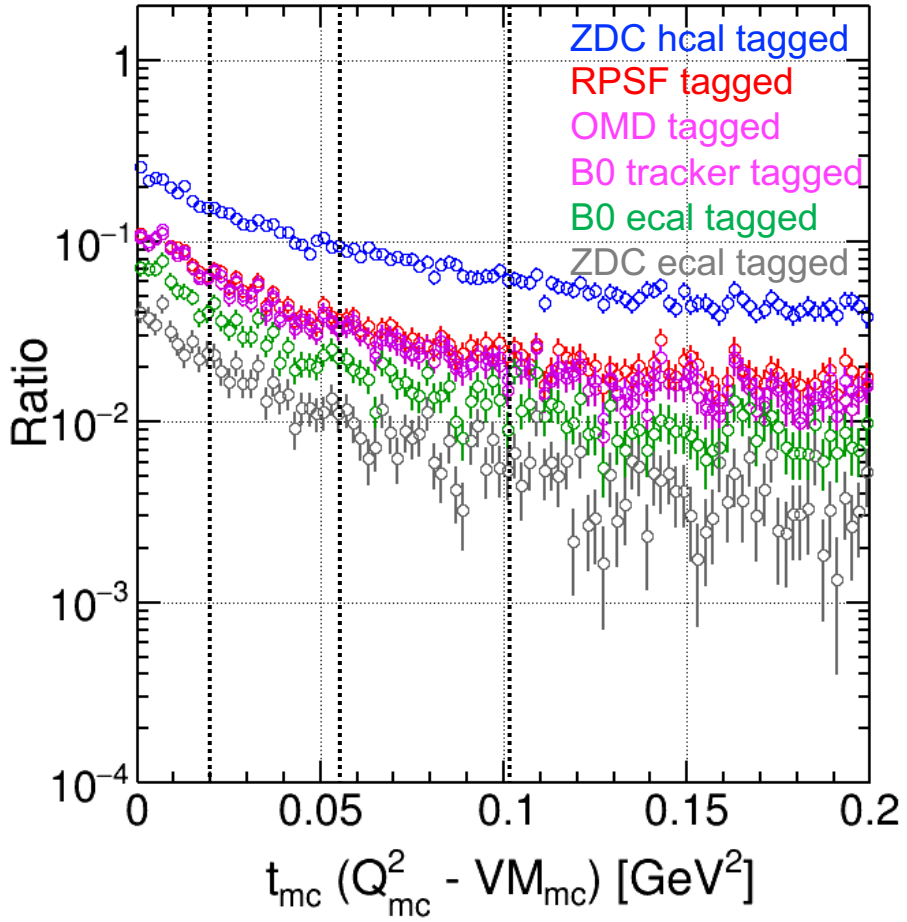
t distribution – IP-8 Old 10σ Cut

BeAGLE 18x110 GeV^2
Incoherent events
$ePb \rightarrow e' + J/\psi(\mu\mu) + X$

Veto inefficiency for incoherent events



Coherent diffractive minima



With 10σ safe distance cut based on ***old eAu @ IP-8 RPSF***

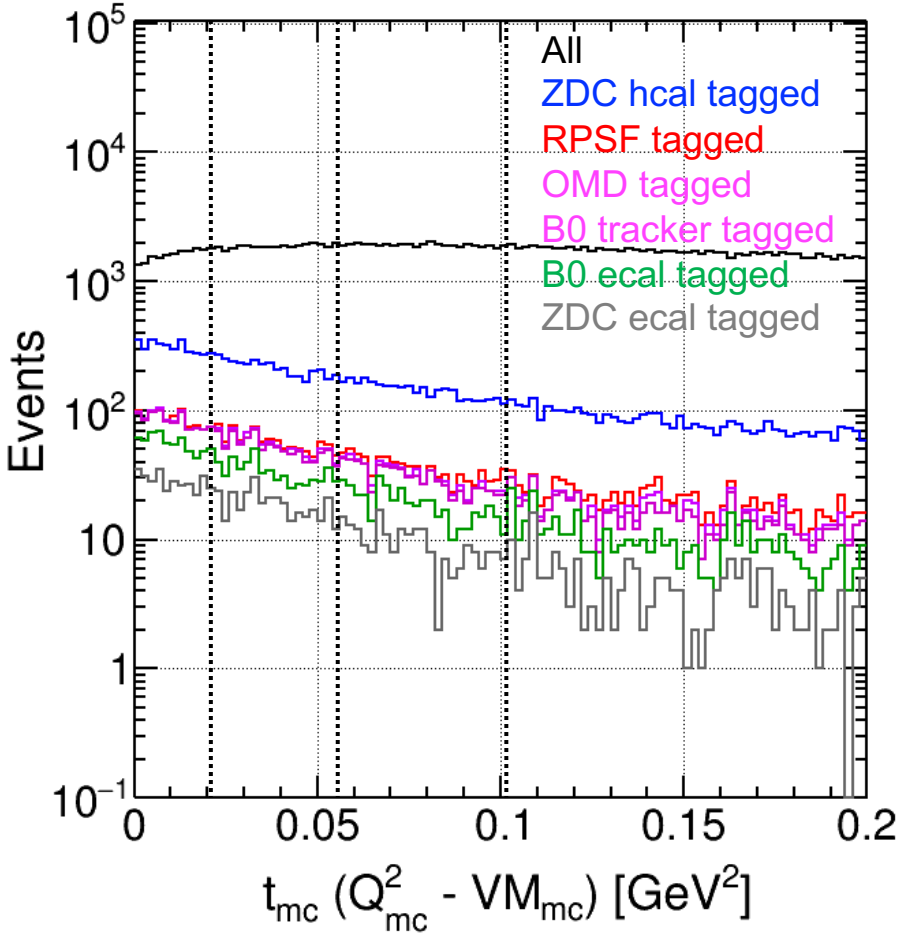
4,014 of 711,368 events were NOT vetoed (0.564%)

W/O Beam effects

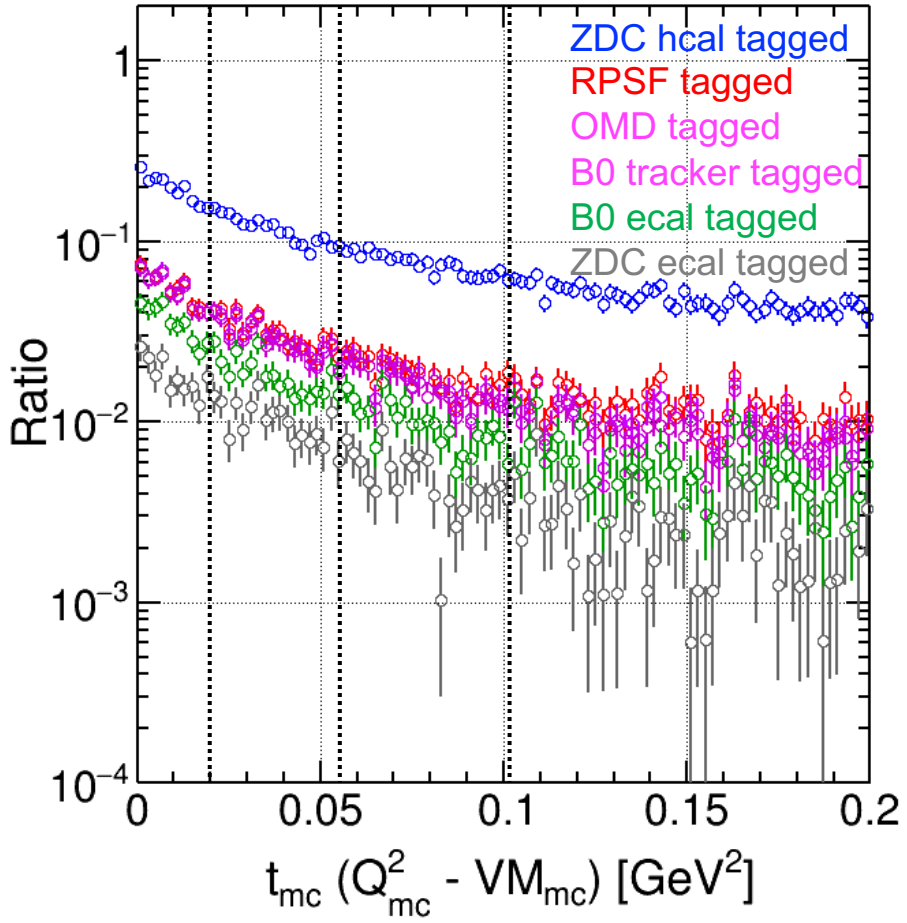
t distribution – IP-8 New 10σ Cut

BeAGLE 18x110 GeV^2
Incoherent events
$ePb \rightarrow e' + J/\psi(\mu\mu) + X$

Veto inefficiency for incoherent events



Coherent diffractive minima



With 10σ safe distance cut based on ***new eAu @ IP-8 RPSF***

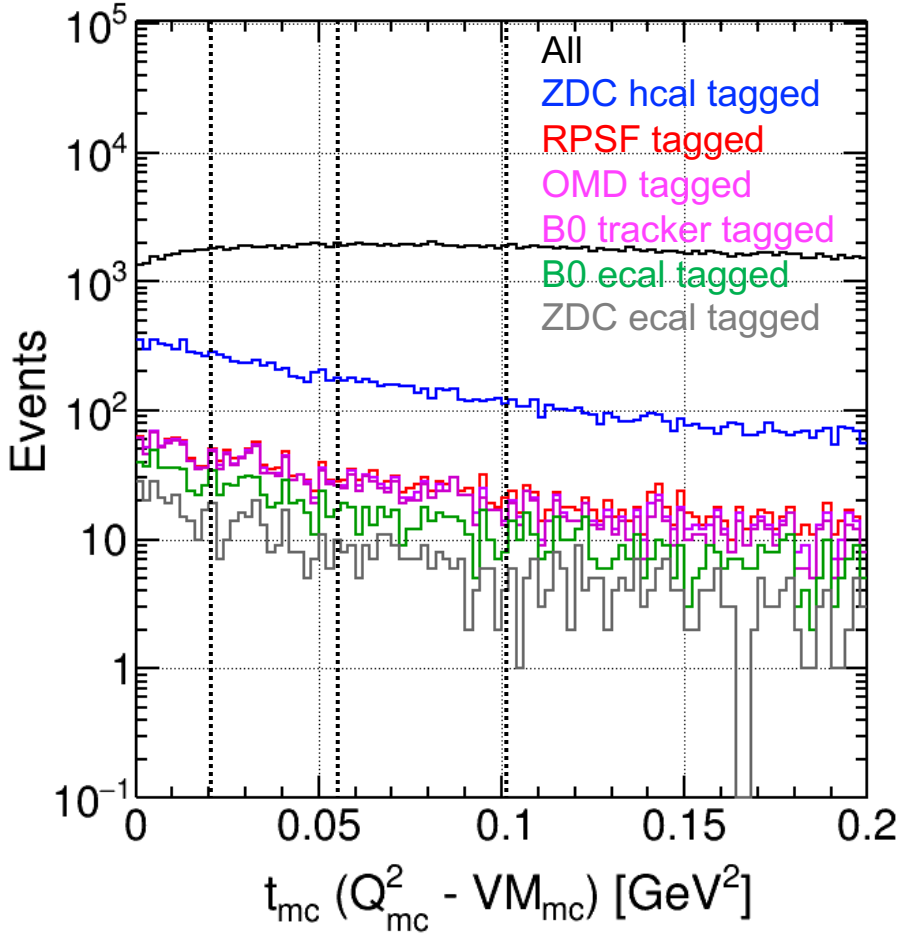
2,540 of 711,368 events were NOT vetoed (0.357%)

W/ Beam effects

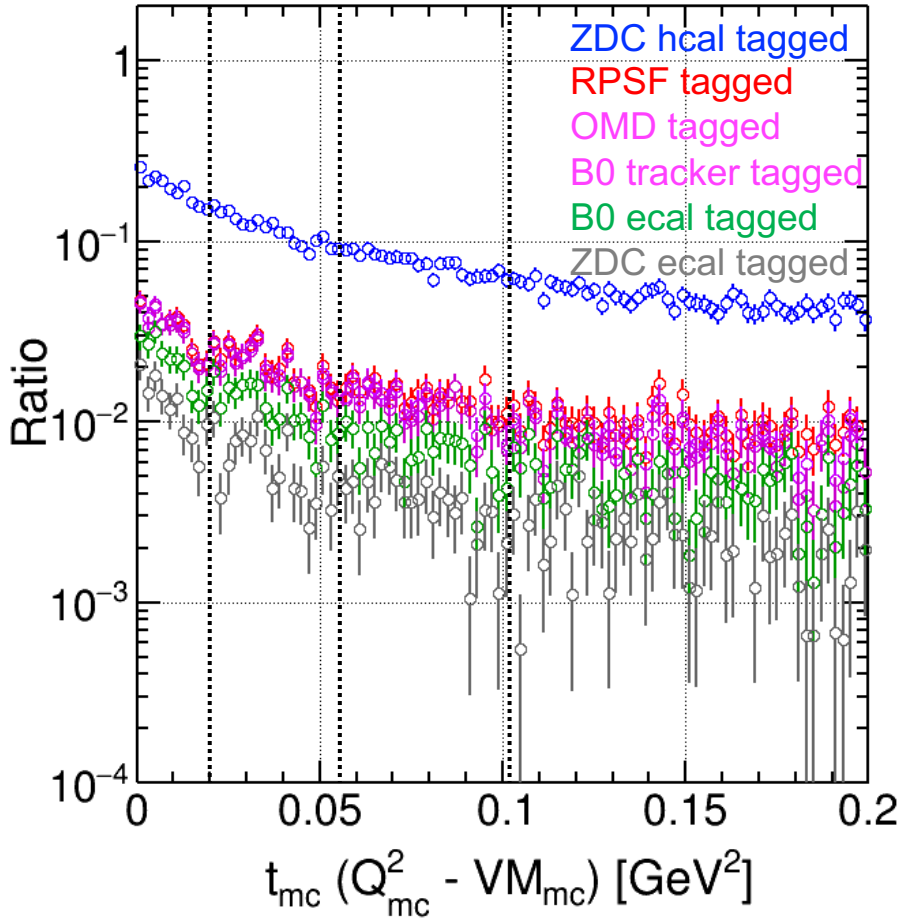
t distribution – IP-8 Old 10σ Cut

BeAGLE 18x110 GeV^2
Incoherent events
$ePb \rightarrow e' + J/\psi(\mu\mu) + X$

Veto inefficiency for incoherent events



Coherent diffractive minima



With 10σ safe distance cut based on ***old eAu @ IP-8 RPSF***

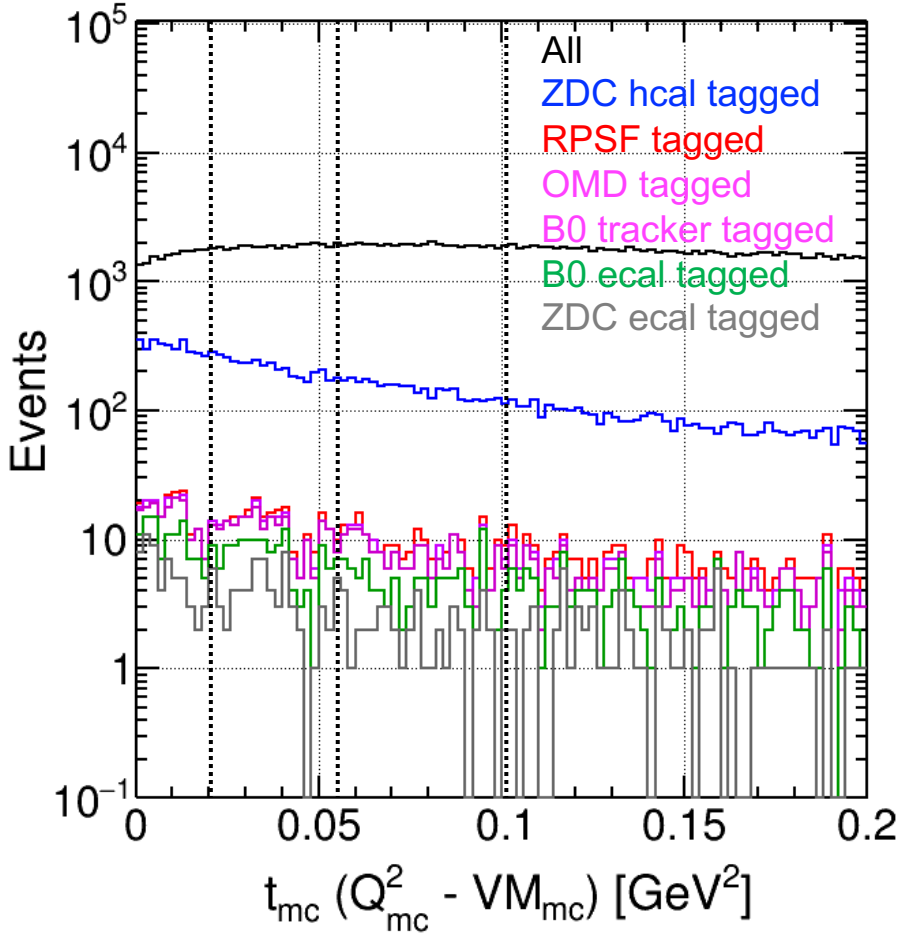
1,794 of 711,795 events were NOT vetoed (0.252%)

W/ Beam effects

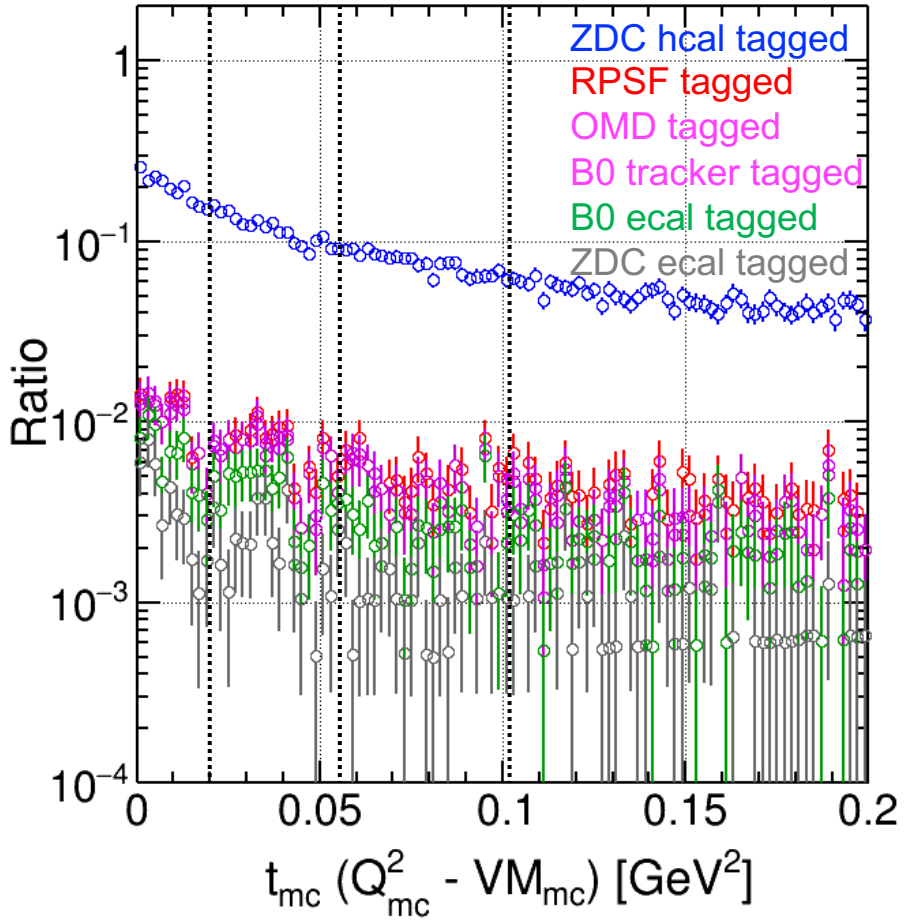
t distribution – IP-8 New 10σ Cut

BeAGLE 18x110 GeV^2
Incoherent events
$ePb \rightarrow e' + J/\psi(\mu\mu) + X$

Veto inefficiency for incoherent events



Coherent diffractive minima



With 10σ safe distance cut based on ***new eAu @ IP-8 RPSF***

605 of 711,795 events were NOT vetoed (0.085%)

Next Steps

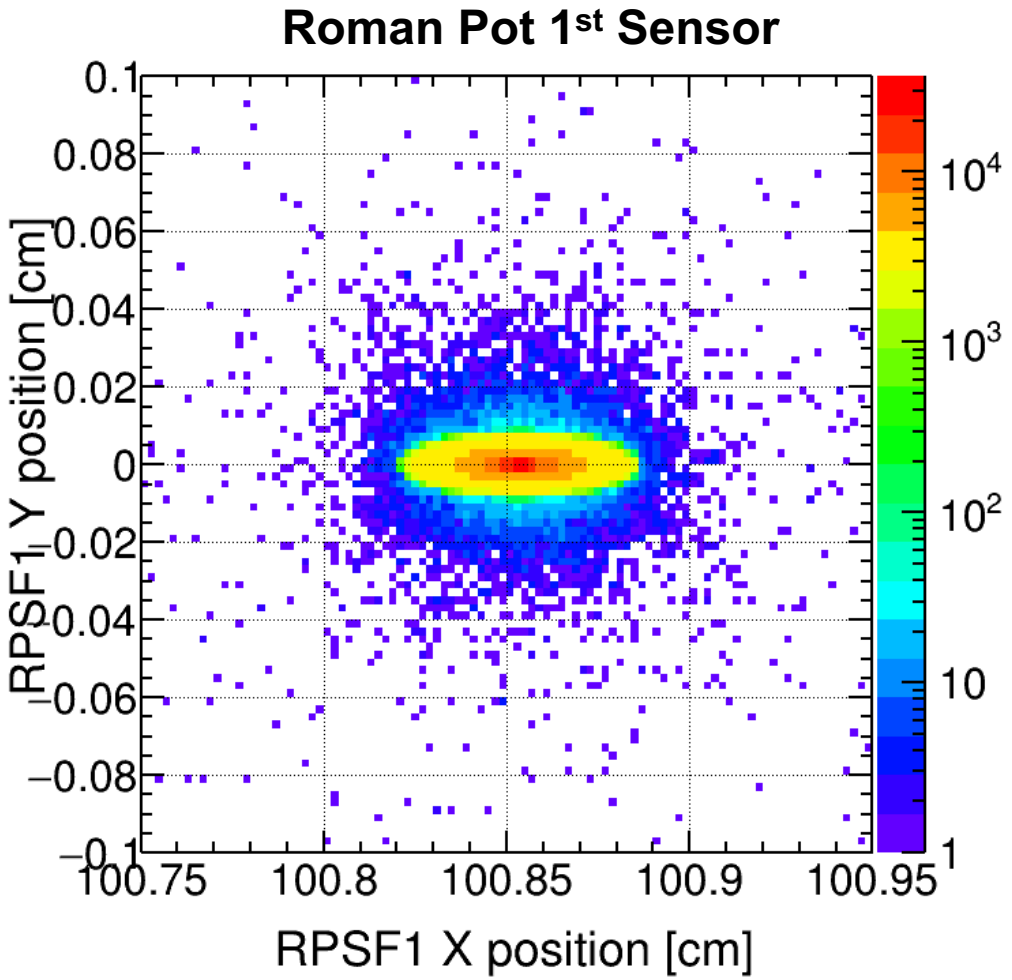
- Keep communicating with Randy
  - ep 18×275 GeV^2, 10×100 GeV^2, and 5×41 GeV^2 coming up
  - eAu lattice study coming up
  - IP8 interaction point coordinate
    (x, z) = (0.65 m, 0.057673 m) or **(0.65 m, -0.2975 m)**
    (current setting; Randy confirmed)
    - This affects all coordinates of magnets and detectors
  - Some magnet field values, for instance dipole BXDS01B
    - This will affect on particle trajectories. Will confirm each hadron lattice element and update if needed and re-evaluate vetoing efficiency

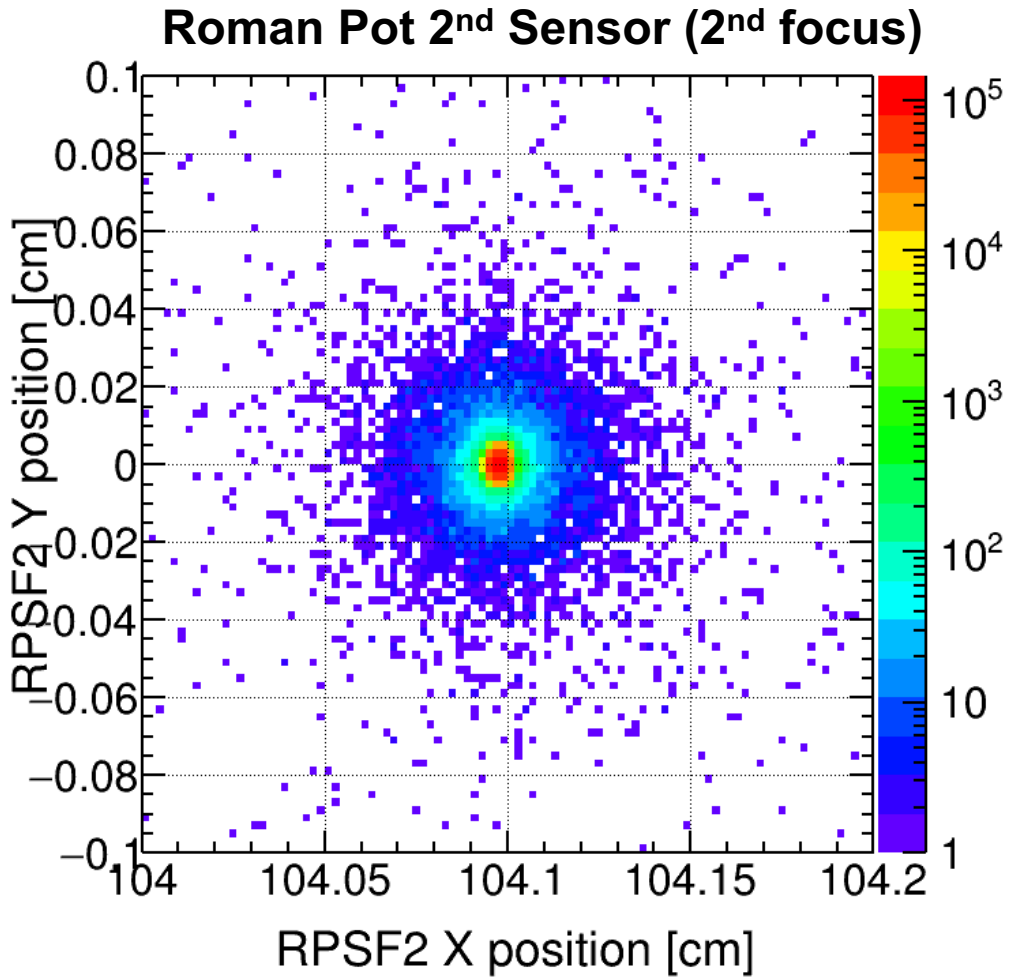
- Understand discrepancy between Wan's study and this study (w/o beam effects)
  - Direct comparison (code-wise) in vetoing process on detector response

Backup Slides

Beam Spot Study

Single Proton
E = 275 GeV
$0 < \theta_{MC} < 0.15$ mrad





Used **IP6 ep high divergence beam RMS** $\Delta\theta$ h/v [μrad] = 150/150 (EIC CDR table 3.3)
Ran single particle gun and Mimic **"1σ beam profile" to take a look**