Incoherent Events with BeAGLE

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Exclusive diffractive and tagging meeting
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Outline

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1. Motivation and Good-Walker paradigm
2. Details BeAGLE dataset
3. Incoherent event tagging efficiency study

    How well can we tag incoherent events at ePIC?

4. Comparisons between Pb and Au

Good-Walker paradigm

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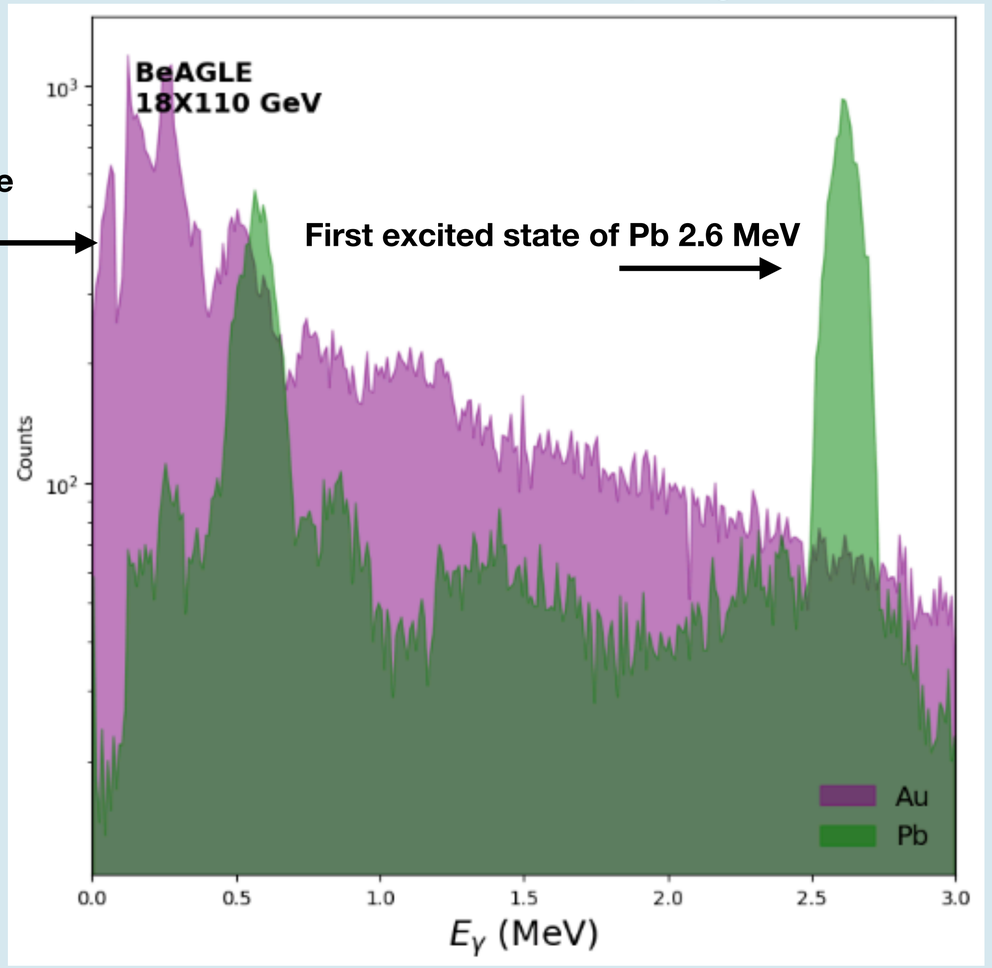
- Coherent exclusive vector meson production events are sensitive to the transverse gluon distribution within the nucleus
- Incoherent events are sensitive to event-by-event fluctuations
- Even nuclear excitations are incoherent, and the Good-Walker paradigm breaks down
- Measuring these photons coming from nuclear de-excitations can serve as a means of tagging incoherent events

Event Generation

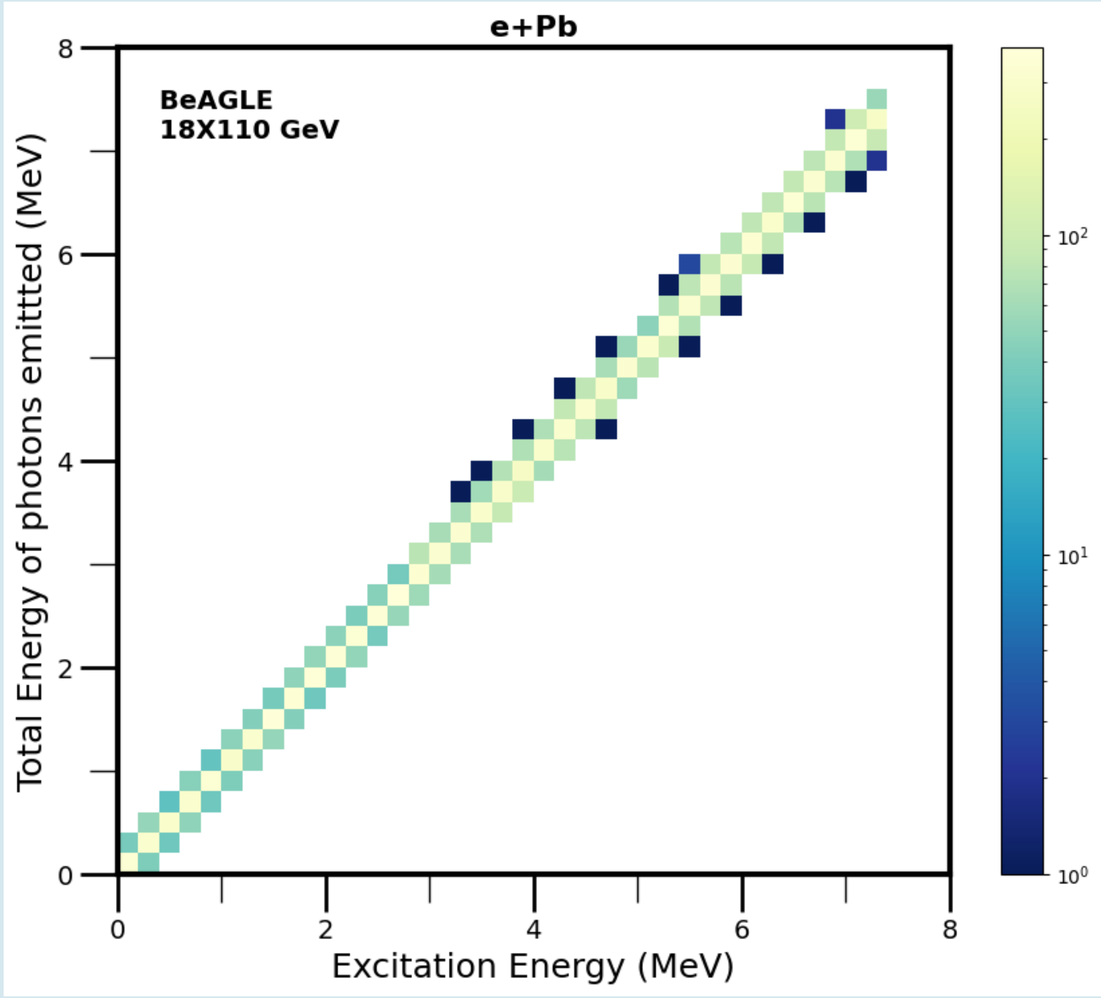
- Use BeAGLe to generate ~ 20 000 events with J/Ψ production
  - e+Pb 18x110 GeV
  - e+Au 18x110 GeV
- Force the nucleus to remain intact (ARemn = 208, 197)
- Select only photons whose parent ID is a nucleus
- Is there a target species that is preferred for VM production?

(In target rest frame)



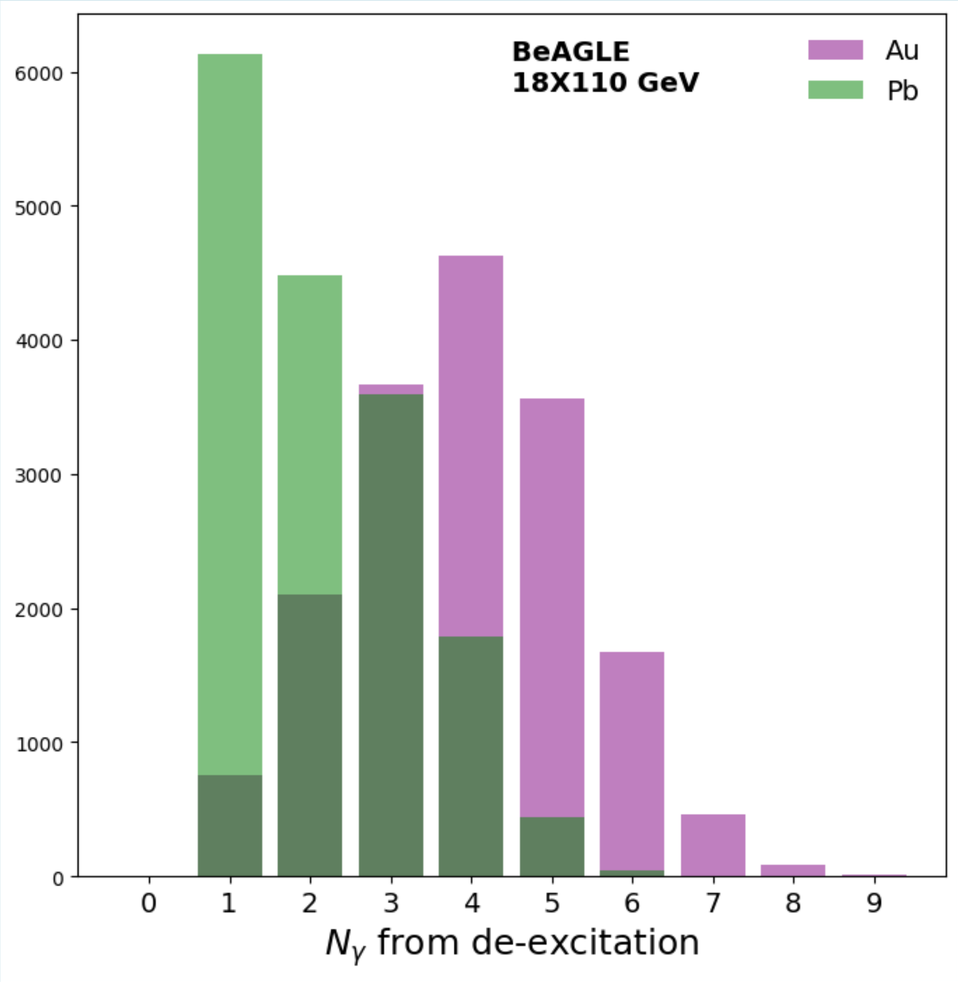
Excitation energy

- We can then plot the excitation energy against the total energy of diffractive photons in the event
- Very well correlated
- Can conclude we are properly selecting photons coming from nuclear excitations



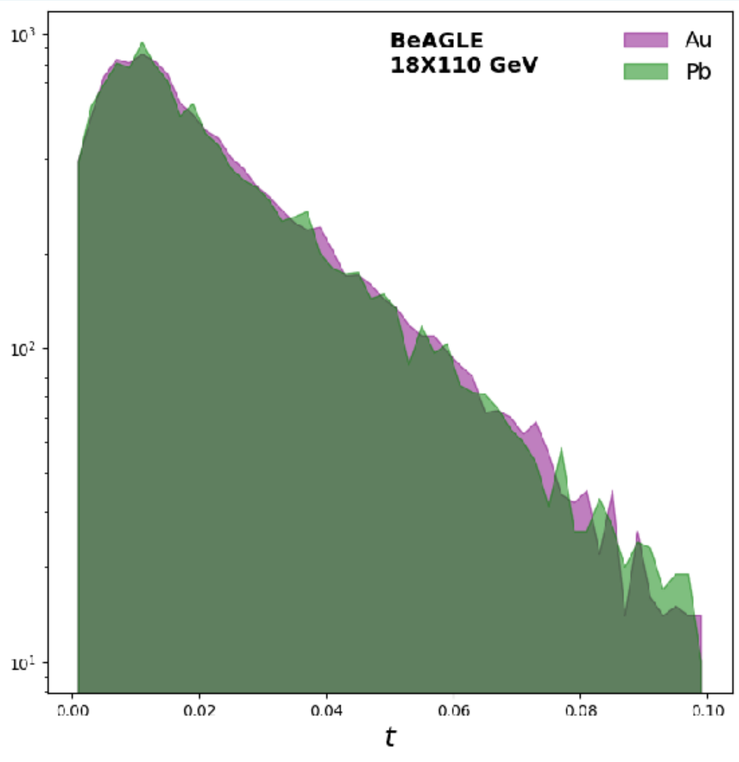
Number of photons in each event

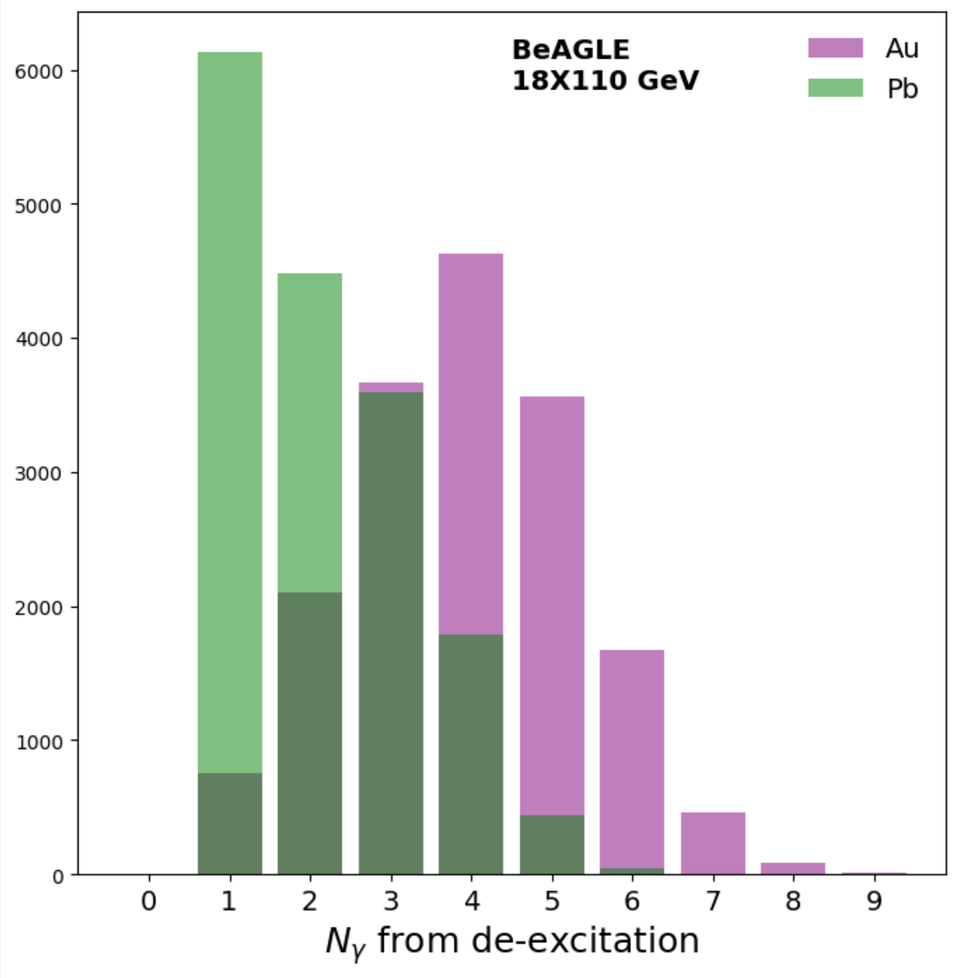
- We see Pb typically emits 1 photon, Au around 5 or 6



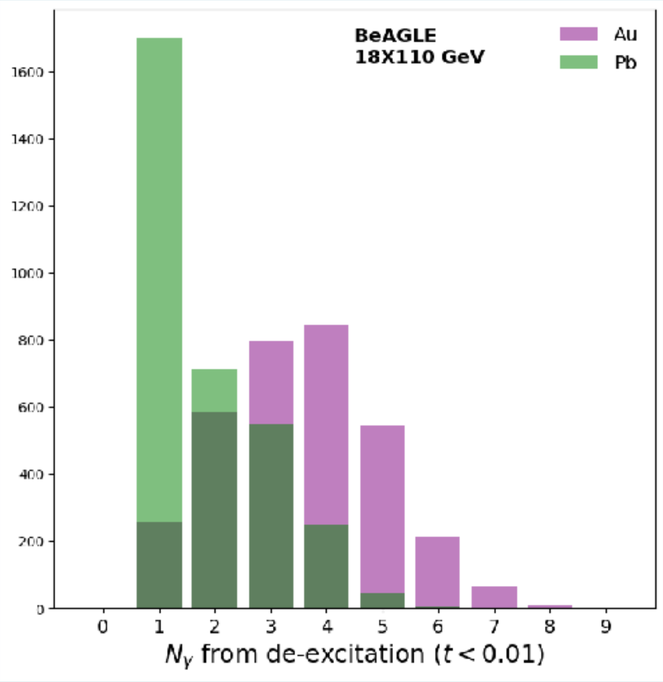
Number of photons in each event

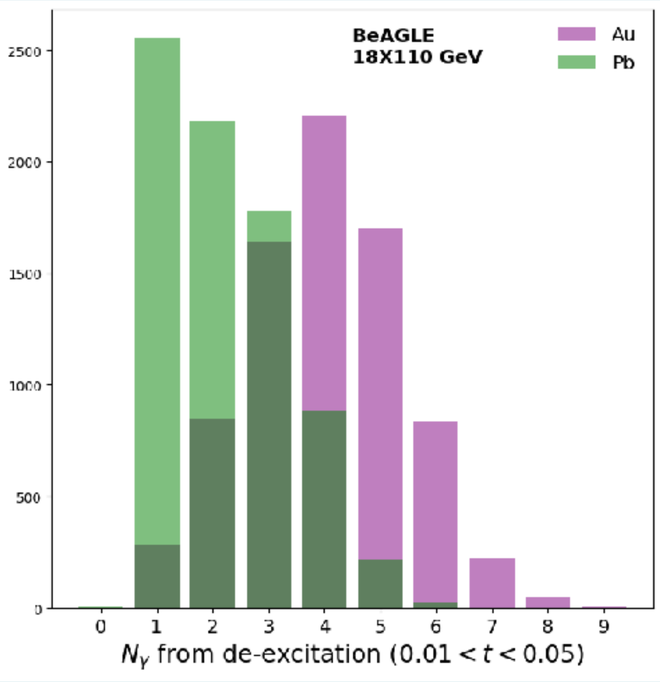
- We see Pb typically emits 1 photon, Au around 5 or 6
- How does this plot behave as a function of *t*?

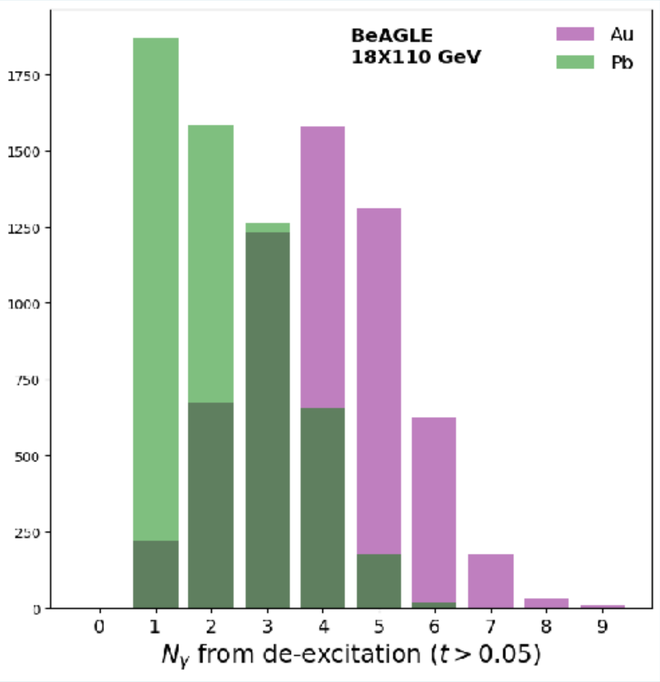




Number of photons in each event





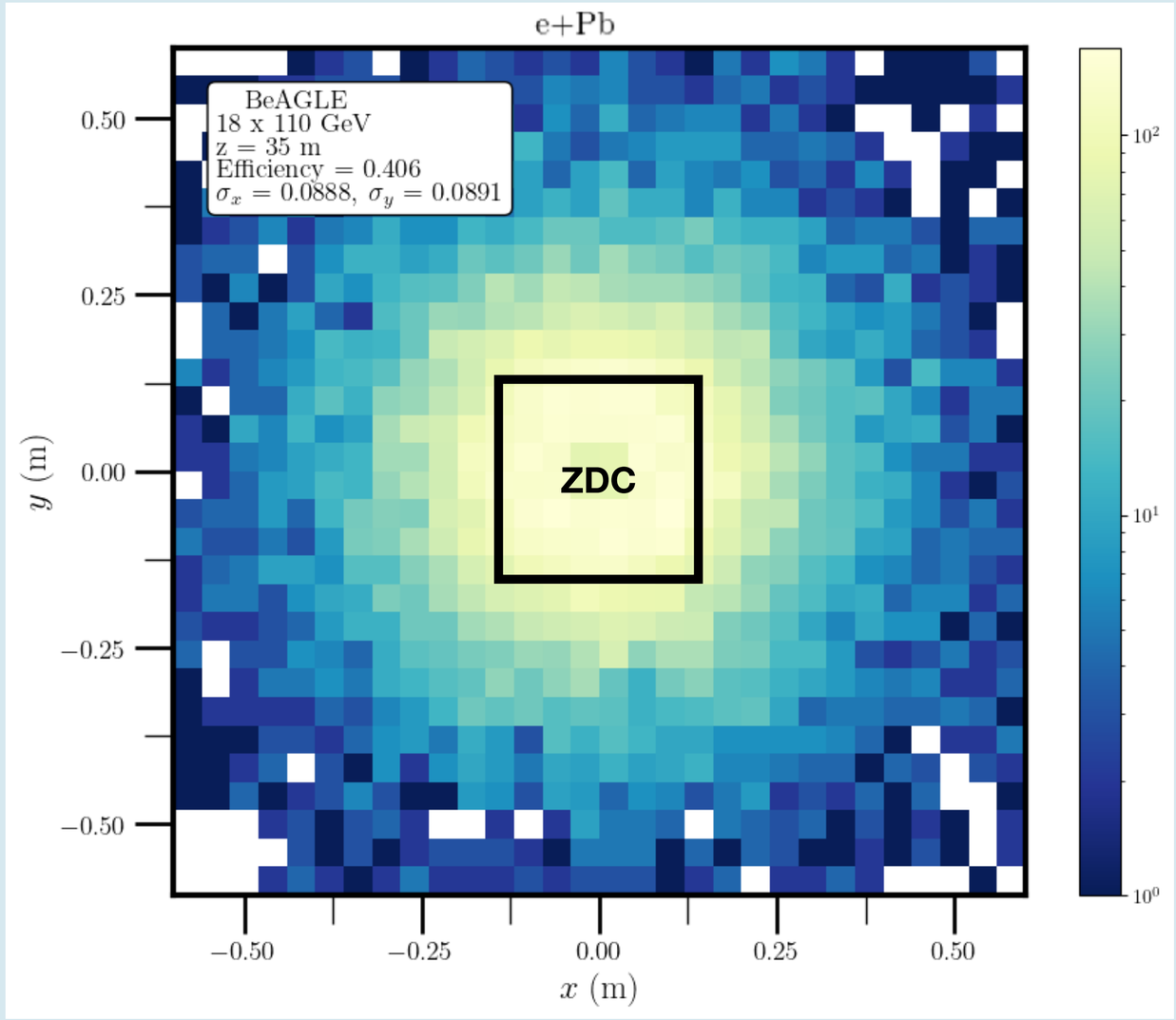


- As t increases, the collision becomes more violent and we produce more photons

How well can we tag incoherent events?

How many of photons do we see in ZDC?

- Select on the plane Z = 35 m
- Select photon with highest η in each event
- Plot the X-Y distribution of the photons
- Effective area of ZDC: 17x17 cm
- Can tag around 40% of events as incoherent in fiducial region of ZDC



How many photons do we see in B0?

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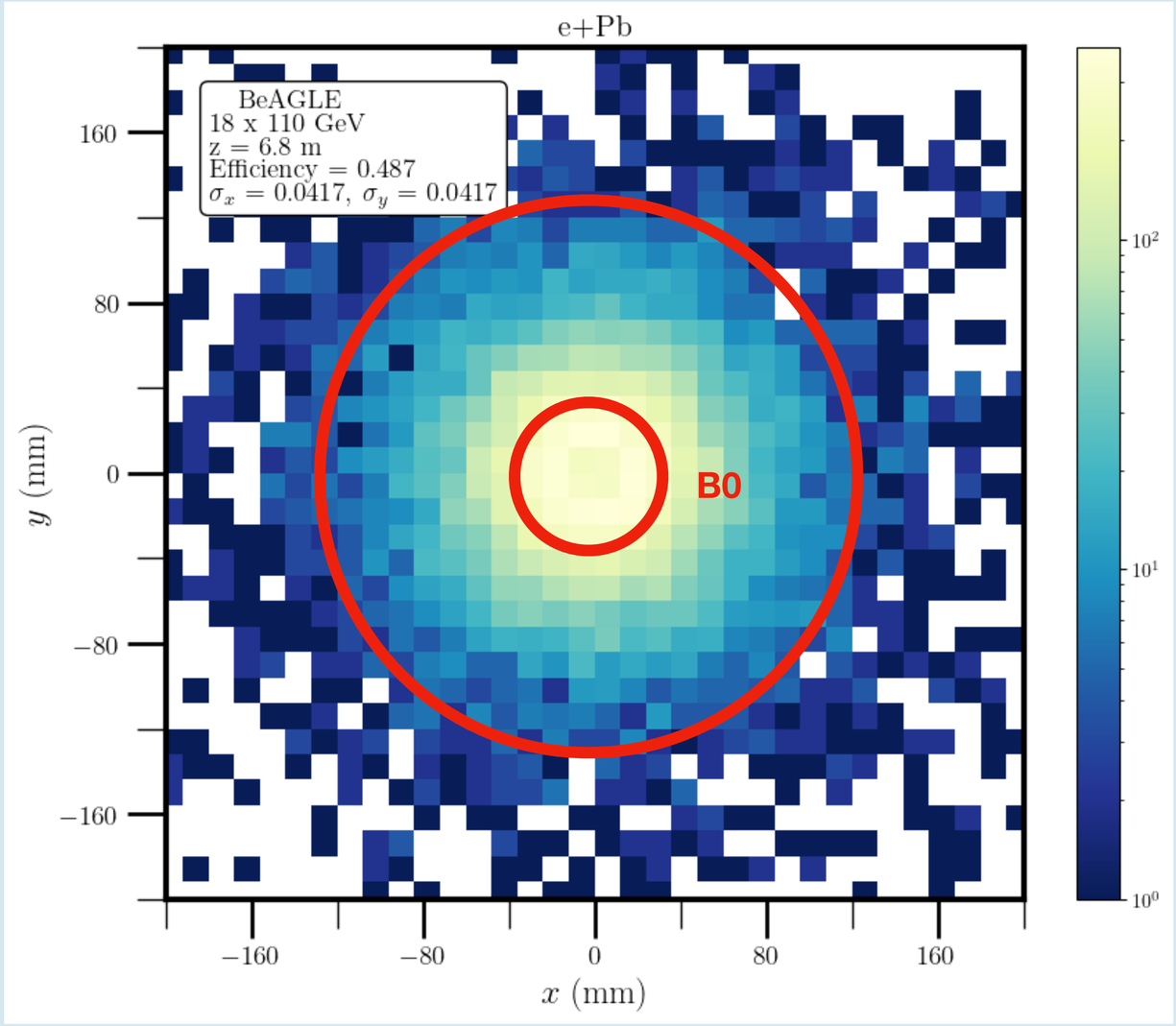
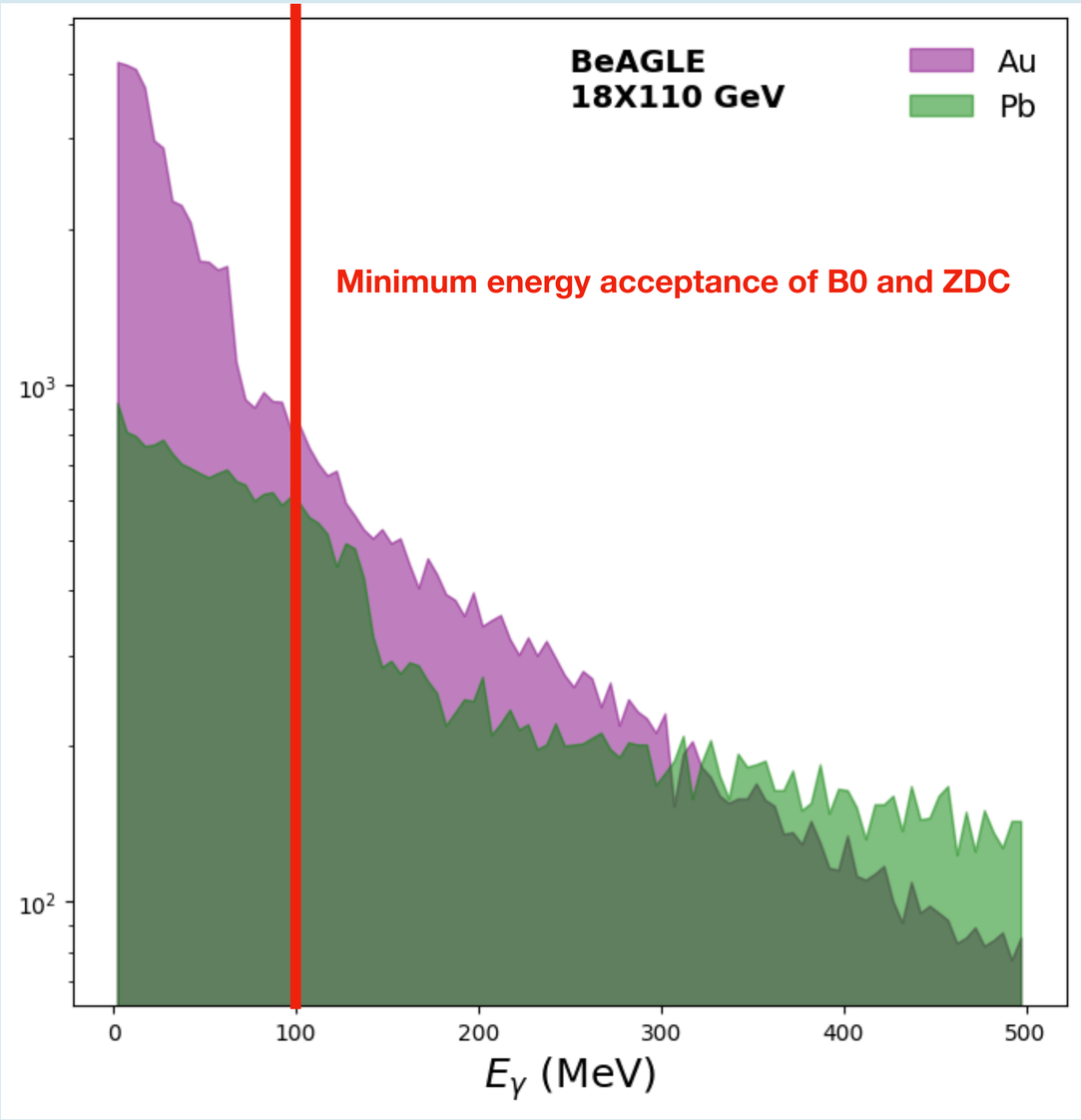
- We catch around half of the photons in the B0 at the z = 6.8 m plane
- Inner radius: 40 mm
- Outer Radius 150 mm
- Have not accounted for irregular geometry
- We see around a 50% incoherent event tagging efficiency in the B0



Accounting for minimum energy threshold

- The ZDC and B0 will be able to see photons with energies (roughly) greater than 100 MeV
- Select photon with the highest η whose energy in the lab frame is greater than 100 MeV



What about with gold?

- Gold has some excited states that are very long lived
- 77 KeV → 1.91 ns
- 409 KeV → 7.73 s
- The nucleus will travel far down the beampipe before it emits these photons
- If we want to make a similar plot, we should first cut them out

Excited Nuclear States for Au-197 (

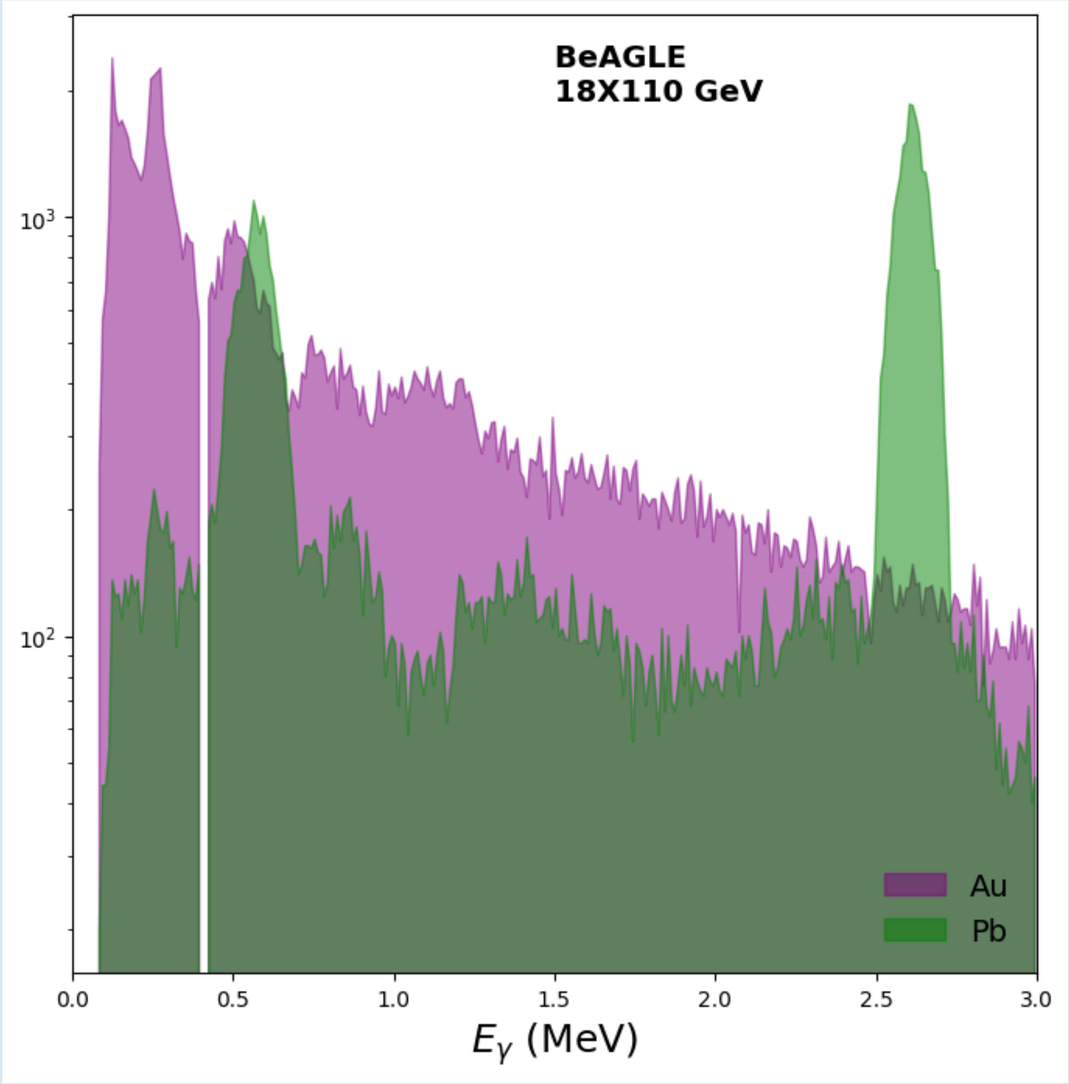
Energy levels

E^* [keV]	$2J^\pi$	μ	Q	$T_{1/2}$ or Γ_{cm}
0.0[a]	3+	+1.145746(9)	+0.547(16)	Stable
77.351(2)	1^+	+0.420(3)		1.91(1) ns
268.788(10)	3^+			15.4(13) ps
279.00(5)[A]	5^+	+0.53(5)		18.6(15) ps
409.15(8)[B]	11^-	⟨+⟩5.98(9)	+1.68(5)	7.73(6) s
502.52(13)	5^+	+3.0(5)	+3.0(5)	1.77(+19-12) ps
547.5(2)[a]	7^+	+0.53(7)		4.61(+19-13) ps
583.86(17)[C]	$\langle 7^- \rangle$			
736.84(15)	7^+	+1.7(5)	+1.7(5)	1.09(+13-9) ps
767.09(23)[B]	$\langle 15^- \rangle$			
855.6(2)[A]	9^+	+1.5(5)	+1.5(6)	2.67(+25-15) ps
882(5)				
888.11(20)	1^+			
935.96(14)	$\langle 5^+ \rangle$			
947.86(20)[C]	$\langle 9^- \rangle$			
1003.56(21)*	$\langle 13^- \rangle$			
1045.05(16)	$\langle 7^+ \rangle$			
1059.67(21)*	$\langle 9^+ \rangle$			
1118.80(19)*				
1150.54(16)	$3^+,5^+$			
1217.28(22)	$\langle 3^+ \rangle$			
1220(10)				
1231.7(3)[a]	11^+	+2.0(10)		0.91(1) ps
1242.02(22)	$\langle 1^+ \rangle$			

What about with gold?

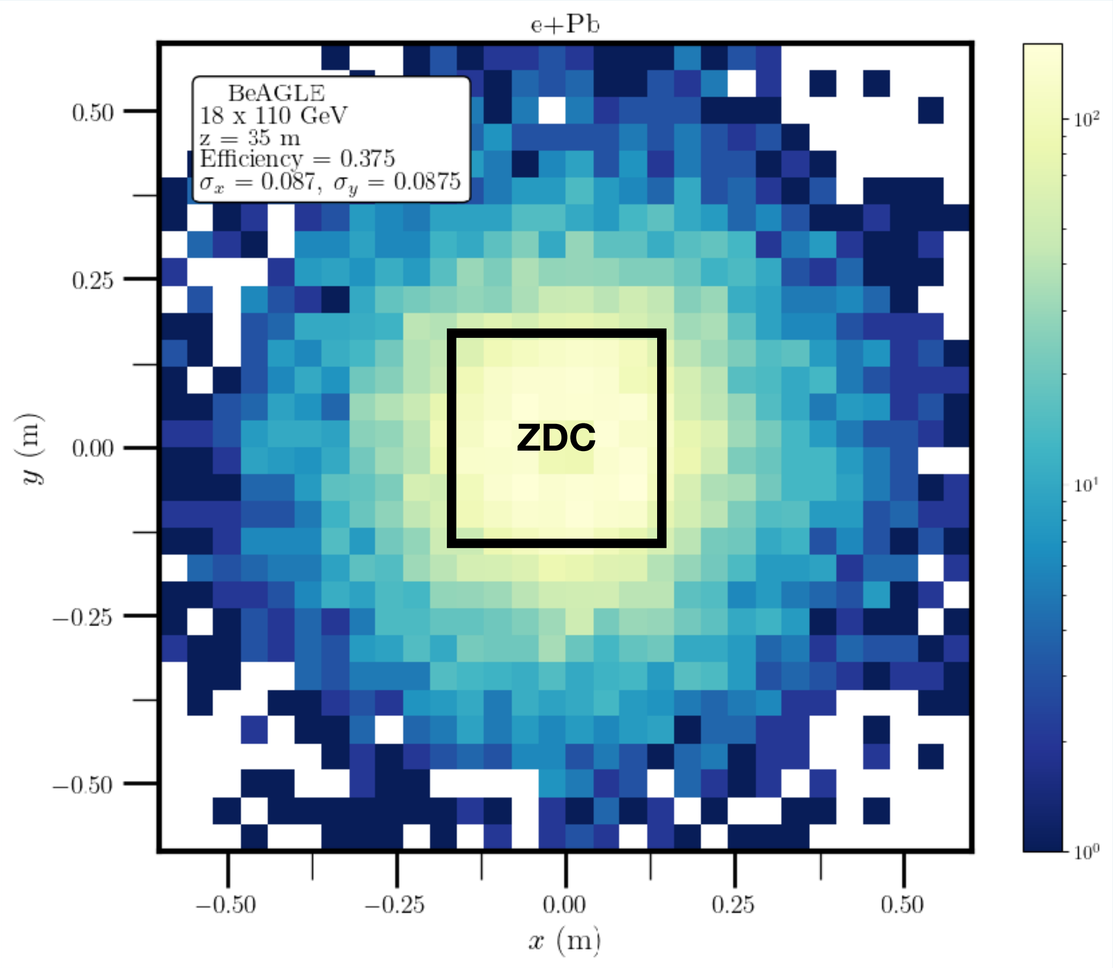
- Gold has some excited states that are very long lived
- 77 KeV → 1.91 ns
- 409 KeV → 7.73 s
- The nucleus will travel far down the beampipe before it emits these photons
- If we want to make a similar plot, we should first cut them out
- For 409 KeV peak, have not accounted for decays to higher energy levels

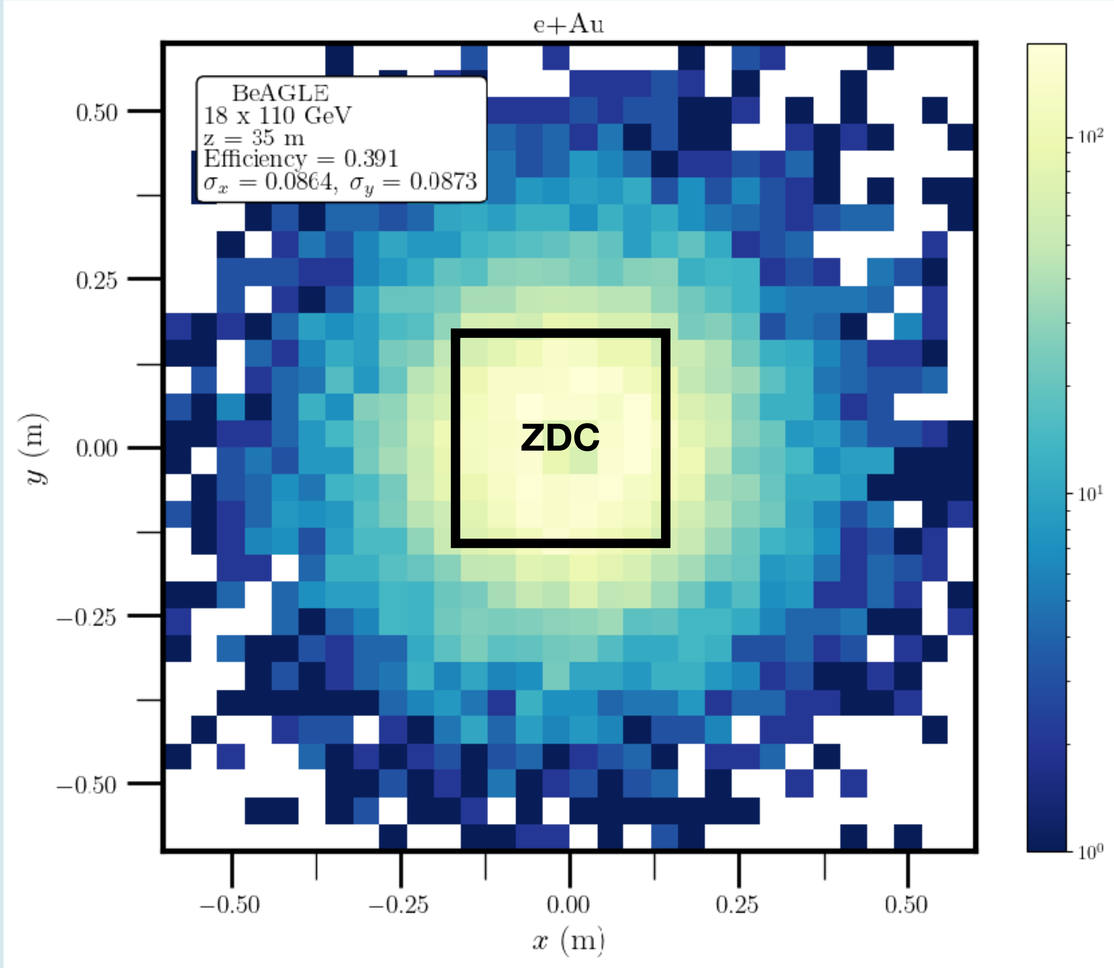
(In target rest frame)



How many of photons do we see in ZDC?

$$\text{Efficiency} = \frac{\#\text{ of events with photon in ZDC acceptance}}{\#\text{ of total events}}$$

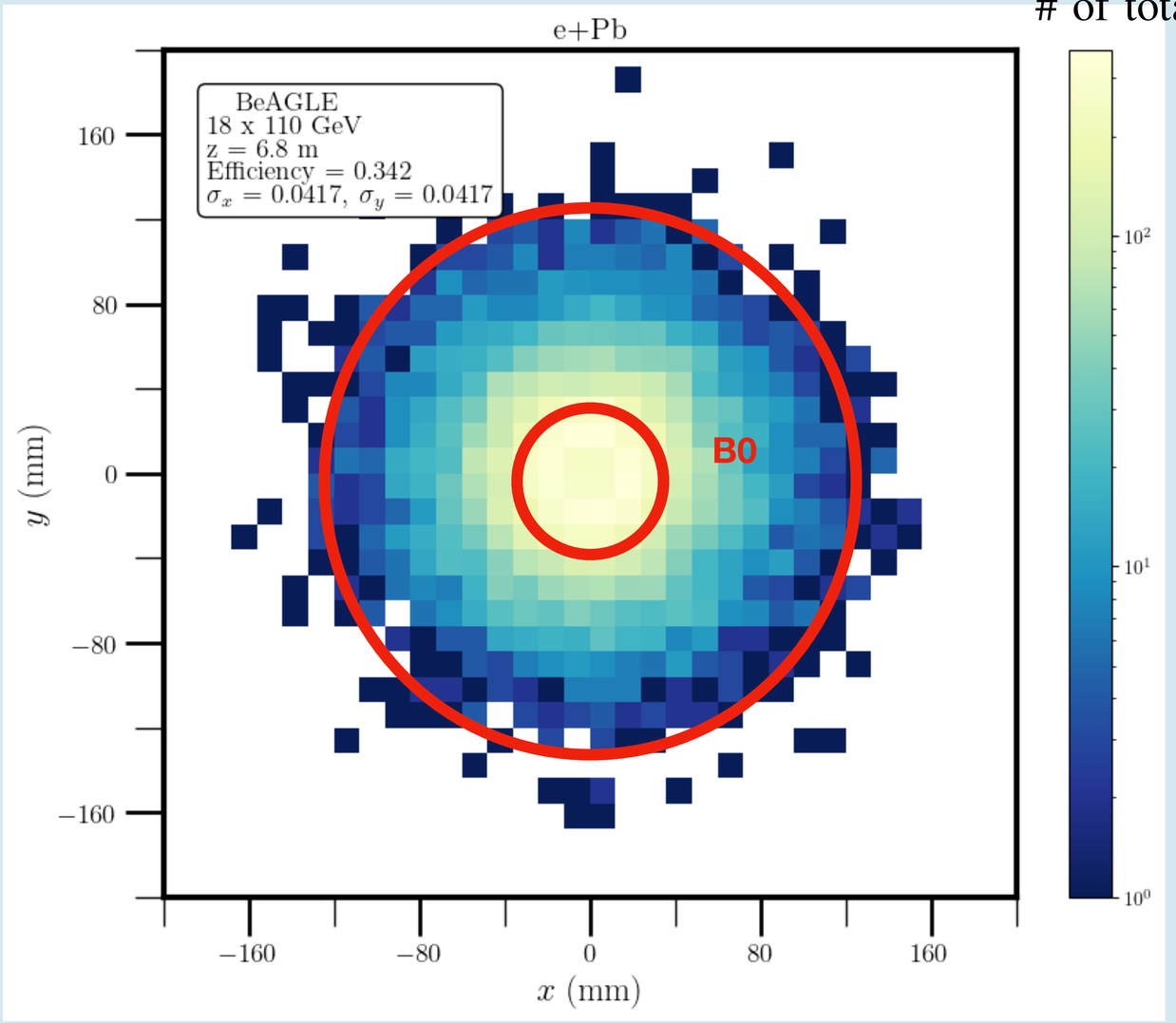


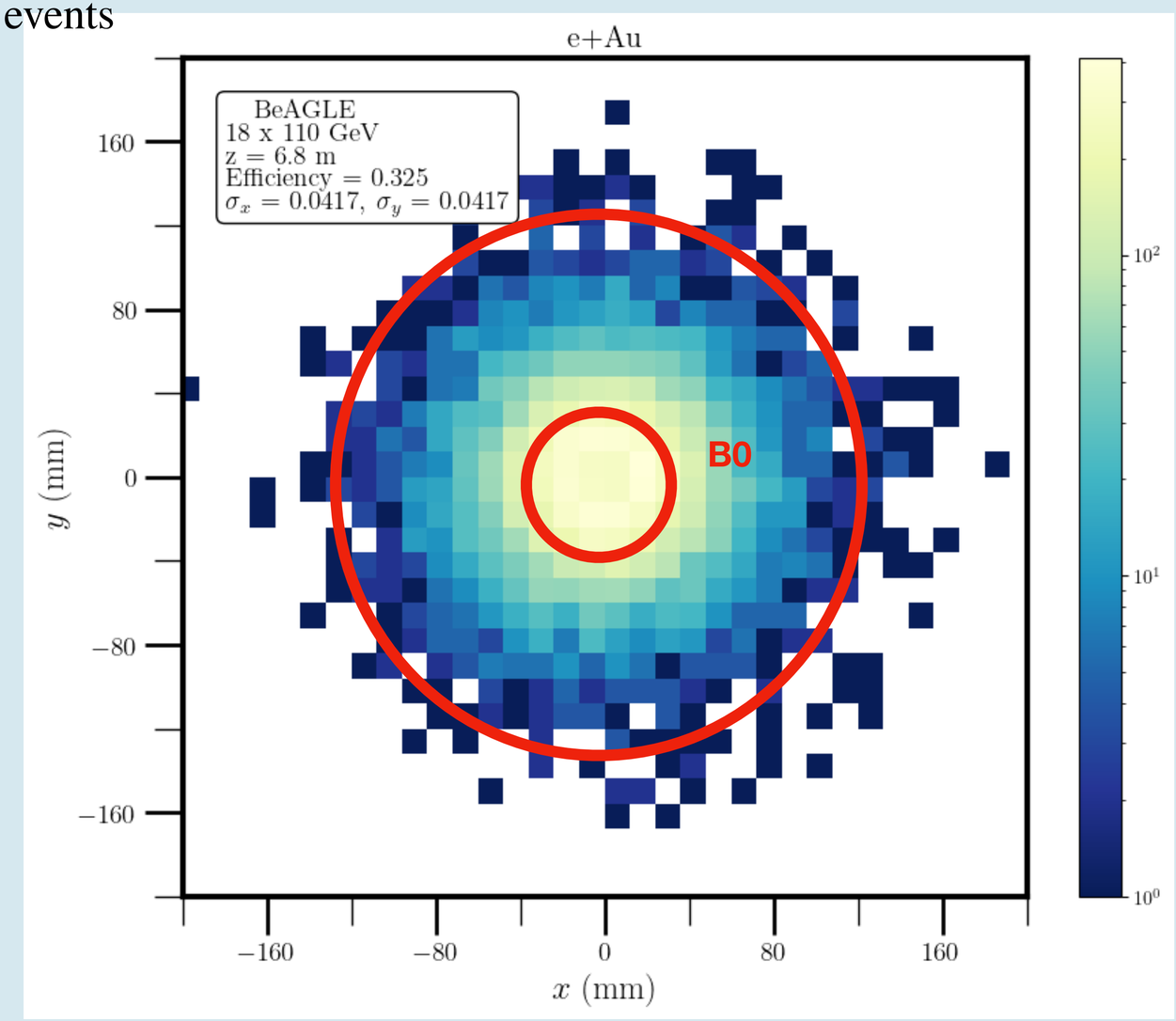


***WITH minimum energy requirement $E_\gamma > 100$ MeV

How many photons do we see in B0?

$$\text{Efficiency} = \frac{\text{\# of events with photon in B0 acceptance}}{\text{\# of total events}}$$





***WITH minimum energy requirement $E_\gamma > 100$ MeV

Conclusion

- It is critical to tag incoherent events when studying vector meson production
- We can tag incoherent events with the ZDC with a ~38% efficiency
- We can tag incoherent events with the B0 with a ~34% efficiency
- Au spectrum has some longer lived states that wont decay within ePIC acceptance
- Regardless, the tagging efficiencies are roughly the same between the two species