

Di-muon simulation at SIS100

Update & Future steps

Sayak Chatterjee

Bose Institute, Kolkata

Acknowledgment

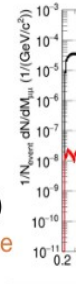
Partha Pratim Bhaduri (VECC)

Anna Senger (FAIR)

PWG-Dileptons Status and Plans (38th CBM collaboration meeting)

PT1: Low- and intermediate mass lepton pairs

- Performance studies with most up-to-date CBM setup (Adrian Meyer-Ahrens, Sayak Chatterjee)
 - detection capability (acceptance x efficiency) is <1%!
 - signal-to-background ratio to be improved
 - CbmDielectron analysis package restructured (Cornelius Riesen, Semen Lebedev)
 - employ ML for lepton ID (first results for both μ and e : factor of 2-5 better S/B, same signal efficiency)
 - $\mu^+\mu^-$ production and analysis of CBM BES (together with PWG-COM)
 - systematic study of CB with same-event & event-mixing techniques
 - develop "fast MC" analysis (filtering of generated events, including proper detector resolution)
 - $\mu^+\mu^-$ & e^+e^- eff. and acc. corr. spectra
 - estimate required statistics for each collision energy to see an effect of 1st order transition (factor of 2 more dileptons in LMR predicted)
 - influence of geometry / material budget changes (target, MVD, STS, RICH shielding box, MuCH shielding, beam-pipe, ect) ()
 - Capabilities of CBM to detect very low- p_T & low mass pairs
- Influence of transport engine on dimuon performance
 - additional production of secondaries inside the absorbers and MuCH tracks χ^2 effected significantly $\rightarrow$ CB grows
 - usage of GEANT4 is guided by data and simulation comparison of mPSD analysis for mCBM July21 beamtime (Lukas Chlad)
- Performance studies with reduced magnetic field
 - $\mu^+\mu^-$, Au+Au at 4A GeV: NO ω peak visible when going for 30% $B_{\max}$ (Anna Senger)
 - to be concluded: momentum/mass resolution vs. acceptance

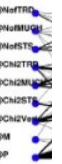


count/event

count/event x 10^4

PT2: J/ψ

- μ ID employing ANN algorithms (Sumit Kundu)
- $\mu^+\mu^-$ & e^+e^- produce and analyse Au+Au $E_{\text{beam}}=11A$ GeV and p+Au $E_{\text{beam}}=30$ GeV (together with PWG-COM)
- move to PYTHIA event generator for J/ψ production (particular pA)
- trigger concept! also for IMR dileptons

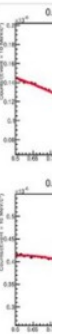


PT3: Direct photons

- analysis update

PT4: Freeze-out meson reconstruction (i.e. π , η , ω , ϕ) and Drell-Yan

- $\mu^+\mu^-$ Ajit Kumar, Anna Senger finalize multi-differential analysis
- e^+e^- Pavish Subramani (update results from photon conversion method with up-to-date detector setup)
- $\mu^+\mu^-$ & e^+e^- extract fully efficiency and acceptance corrected (in p_T -y), extrapolated to the full phase space multiplicities and compare to world data
- include Drell-Yan to the simulations, event generator?



El Andary Julio (GU Frankfurt), Dr. Maksym Teklishyn (GSI), Dr. Ritu Agarwal (Pune University)
WELCOME to the team!

Abstract submitted for QM2022 (Oral presentation)

Prospects of dilepton and charmonium measurements with CBM experiment

S. Chatterjee
(On behalf of CBM collaboration)

Department of Physics and Centre for Astroparticle Physics and Space
Science (CAPSS), Bose Institute, Kolkata-700091, India

The Compressed Baryonic Matter (CBM), currently under construction at the Facility for Anti-proton and Ion Research (FAIR) accelerator complex in Darmstadt, Germany aims to explore the QCD phase diagram at high baryon densities. Till date, no dilepton data have been collected in heavy-ion collisions at beam energies between 2A and 40A GeV. CBM aims to perform pioneering measurements of lepton pairs in nuclear collisions, employing both electron (e^+e^-) and muon ($\mu^+\mu^-$) channels, in the energy domain $\sqrt{s_{NN}} \sim 2.7 - 4.9$ GeV, using unprecedented reaction rates of up to 10 MHz. The expected performance in the two channels are compared in terms of signal significances and background components. In particular the dimuon system will allow to employ charm as a probe of compressed baryonic matter via J/ψ detection in p+A and A+A collisions.

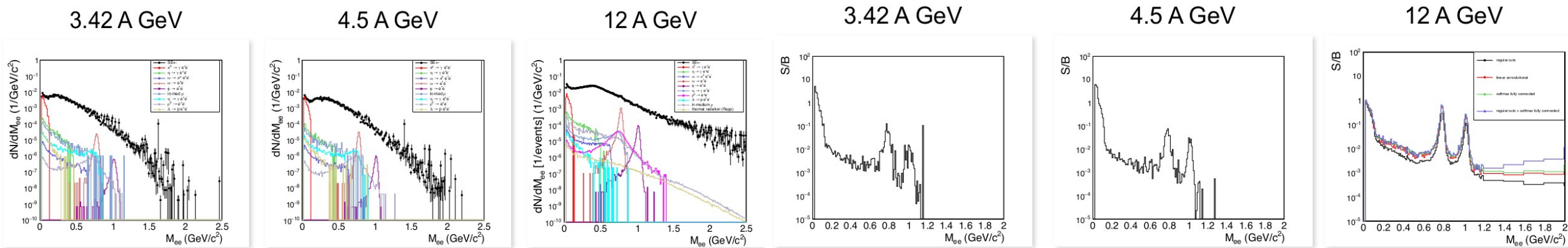
- LMVM cocktail (efficiency*acceptance corrected) at SIS100 energies (3.3, 4.4, 7.95, 12 AGeV/c) with GEANT4 transport engine
 - Lower energy setup of MuCh for 3.3 AGeV/c with reduced magnetic field
 - Reconstruction efficiencies, S/B and significance
 - Investigation on combinatorial background (Event-by-Event, Mixed event, Like-sign method, Super event technique)
- **Feasibility of J/ψ detection in A+A and p+A**
 - Results with GEANT3 for Au+Au (10 AGeV/c), Ni+Ni (15 AGeV/c) and p+Au (30 GeV/c) collisions
 - Input from PYTHIA! (Talk by Dr. R. Aggarwal)

Beam Energy Scan (BES) (e^+e^-)

Invariant mass - Signals



Signal-to-background



The resulting invariant mass spectra show the expected behavior and seem to be reconstructable with good efficiencies

The signal-to-background ratios are quite comparable

The analysis at 12 A GeV was done with stricter PID cuts as was the most optimized

Similar plots will be made for the $\mu^+\mu^-$ channel

Beam Energy Scan (BES)

SIS100 energy scan				
Pbeam (A GeV/c)	Ebeam (A GeV)	Ekin (A GeV)	sqrt(sNN) GeV	description
3.3	3.43	2.49	2.86	lowest possible for heavy-ions at SIS100
4.4	4.5	3.56	3.19	HADES@SIS100 reference energy
7.95	8	7.06	4.09	intermediate energy of the scan
12	12.04	11.1	4.93	highest possible for heavy-ions at SIS100

CBM PWG-COM Productions: summary

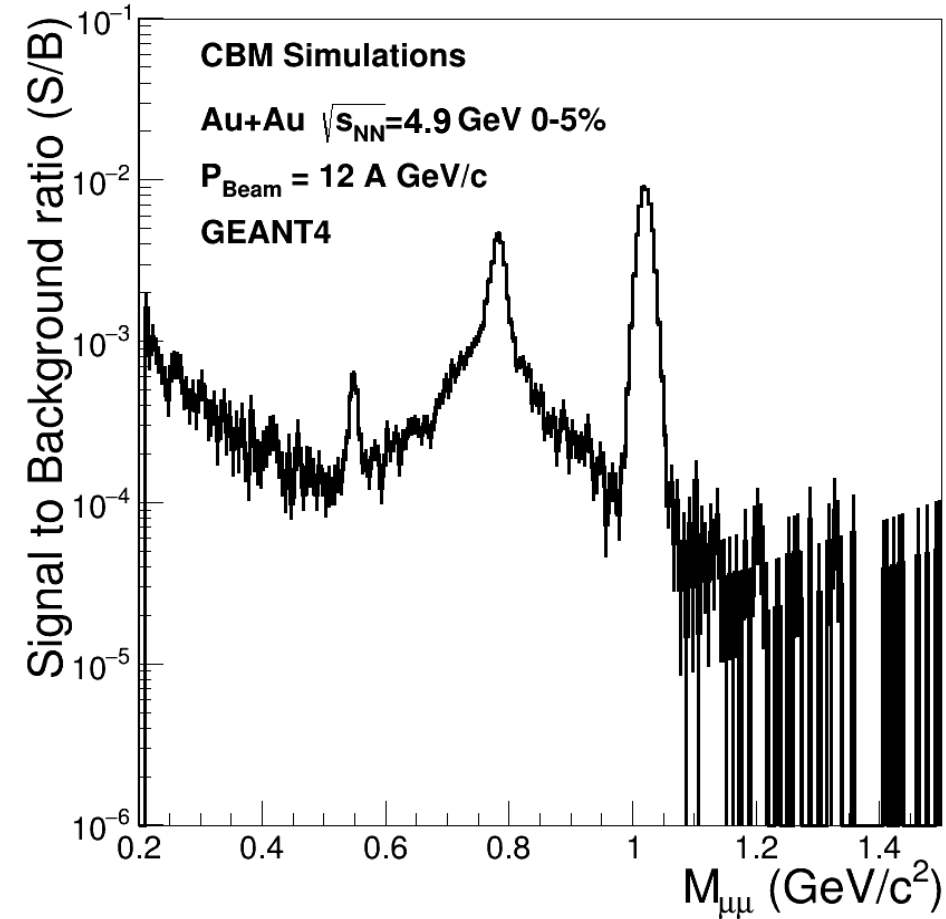
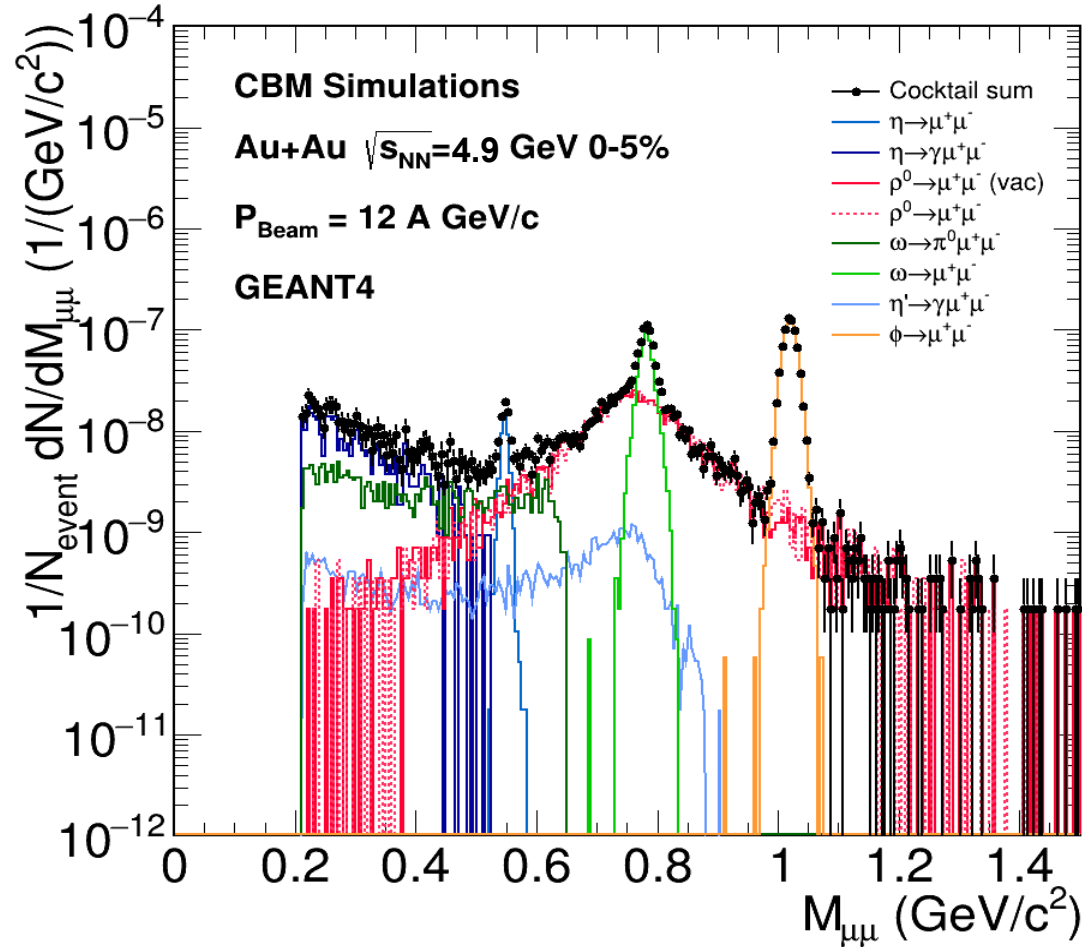
File Edit View Insert Format Data Tools Extensions Help

100% View only

A1:A2	Generator ID	A	B	C	D	E	F	G	H	I
1	Generator ID	generator		system	pbeam (AGeV/c)	centrality selection	events (millions)	disk space (Gb)	status	
2		model	config							
3	GEN001	DCM-QGSM-SMM		Au-Au	12	mibias	7	46	done	
4	GEN002	DCM-QGSM-SMM		Au-Au	12	0-10%	0.1	1.9	to do	
5	GEN013	DCM-QGSM-SMM		Au-Au	8	mibias	0.1	0.6	to do	
6	GEN014	DCM-QGSM-SMM		Au-Au	8	0-10%	0	?	to do	
7	GEN009	DCM-QGSM-SMM		Au-Au	5.36	mibias	10	47	done	
8	GEN010	DCM-QGSM-SMM		Au-Au	5.36	0-10%	0	?	to do	
9	GEN005	DCM-QGSM-SMM		Au-Au	3.3	mibias	5	19	done	
10	GEN006	DCM-QGSM-SMM		Au-Au	3.3	0-10%	0	?	to do	
11	GEN003	UrQMD	v3.4 eos0	Au-Au	12	mibias	30	474	done	
12	GEN004	UrQMD	v3.4 eos0	Au-Au	12	0-10%	10	276	done	
13	GEN015	UrQMD	v3.4 eos0	Au-Au	8	mibias	20	222	done	
14	GEN016	UrQMD	v3.4 eos0	Au-Au	8	0-10%	0	?	to do	
15	GEN034	UrQMD	v3.4 eos0	Au-Au	4.4	mibias	50	?	done	
16	GEN035	UrQMD	v3.4 eos0	Au-Au	4.4	0-10%	0	?	in progress	
17	GEN011	UrQMD	v3.4 eos0	Au-Au	5.36	mibias	10	1304	done	
18	GEN012	UrQMD	v3.4 eos0	Au-Au	5.36	0-10%	0.2	?	in progress	
19	GEN007	UrQMD	v3.4 eos0	Au-Au	3.3	mibias	50	?	done	
20	GEN008	UrQMD	v3.4 eos0	Au-Au	3.3	0-10%	0.4	?	in progress	
21	GEN021	PHSD	v4.0, csr qgp_w	Au-Au	10.9	mibias	5	?	done	
22	GEN022	PHSD	v4.0, csr qgp_w	Au-Au	10.9	b=0	5	?	done	
23	GEN023	PHSD	v4.0, csr_new	Au-Au	10.9	b=0	5	?	done	
24	GEN020	PHSD	v4.0, csr qgp_w	Au-Au	8.9	mibias	5	?	done	
25	GEN019	PHSD	v4.0, csr qgp_w	Au-Au	6.9	mibias	5	?	done	
26	GEN018	PHSD	v4.0, csr qgp_w	Au-Au	4.8	mibias	5	?	done	
27	GEN017	PHSD	v4.0, csr qgp_w	Au-Au	2.8	mibias	5	?	done	
28	EMB001	PLUTO	omega	Au-Au	12	N/A	1	0.19	done	
29	EMB002	PLUTO	omega Dalitz	Au-Au	12	N/A	1	0.264	done	
30	EMB003	PLUTO	phi	Au-Au	12	N/A	1	0.19	done	
31	EMB004	PLUTO	etaPrime	Au-Au	12	N/A	1	?	done	
32	EMB005	PLUTO	rho	Au-Au	12	N/A	1	?	done	
33	FMB006	PLUTO	in-med rad	Au-Au	12	N/A	2.5	?	done	

Summary Generators Energy scan Centrality preselction Centrality preselction (old)

Beam Energy Scan (BES) ($\mu^+\mu^-$)



- The UrQMD files (background) are available for 0-10% centrality but the PLUTO files (signal) are available for 0-5% centrality. **Scaling of background!!!**
- **To Do List:** To add Thermal sources in the simulation chain

PLUTO Input



Jump

Search

English

PWG

You are here: CBM Wiki > PWG Web > Dileptons > CbmDileptonInfo > CbmDileptonInfoFiles (03 Nov 2021, TetyanaGalatyuk)

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- Ag+Ag 4.5A GeV min-bias
- Au+Au 3.4A GeV 0-5%
- Au+Au 4.5A GeV 0-5%
- Au+Au 8A GeV 0-5%
- Au+Au 12A GeV 0-5%
- Au+Au 25A GeV 0-10%

```
chatterj@lxbk0598: /lustre/nyx/cbm/users/chatterj/APR21_testing/cbmro...
sayak@sayak-HP-Laptop-15-d12xxx: ~
chatterj@lxbk0600: /lustre/nyx/cbm/users/galatyuk/pluto/mpmm$ pwd
/lustre/nyx/cbm/users/galatyuk/pluto
chatterj@lxbk0600: /lustre/nyx/cbm/users/galatyuk/pluto$ ls
epem input_hist_rapp mar2020 mpmm
chatterj@lxbk0600: /lustre/nyx/cbm/users/galatyuk/pluto$ cd mpmm/
chatterj@lxbk0600: /lustre/nyx/cbm/users/galatyuk/pluto/mpmm$ ls
12gev 3p42gev 4p5gev 8gev
chatterj@lxbk0600: /lustre/nyx/cbm/users/galatyuk/pluto/mpmm$ cd 12gev/
chatterj@lxbk0600: /lustre/nyx/cbm/users/galatyuk/pluto/mpmm/12gev$ ls
D+_pluto eta_pluto inmed_had_mpmm_12gev_pluto qgp_mpmm_12gev_pluto rho0_pluto w_pluto
etadirect_pluto etaP_pluto phi_pluto rho0_pipi_pluto wdalitz_pluto
chatterj@lxbk0600: /lustre/nyx/cbm/users/galatyuk/pluto/mpmm/12gev$ cd ../8gev/
chatterj@lxbk0600: /lustre/nyx/cbm/users/galatyuk/pluto/mpmm/8gev$ ls
D+_pluto eta_pluto inmed_had_mpmm_8gev_pluto qgp_mpmm_8gev_pluto rho0_pluto w_pluto
etadirect_pluto etaP_pluto phi_pluto rho0_pipi_pluto wdalitz_pluto
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D+_pluto etadirect_pluto etaP_pluto inmed_had_mpmm_4p5gev_pluto phi_pluto rho0_pipi_pluto rho0_pluto wdalitz_pluto w_pluto
chatterj@lxbk0600: /lustre/nyx/cbm/users/galatyuk/pluto/mpmm/8gev$ ls ../3p42gev/
D+_pluto gen.pluto.3p42gev.etadirect.mpmm.root gen.pluto.3p42gev.rho0.mpmm.root phi_pluto
etadirect_pluto gen.pluto.3p42gev.eta.gmpmm.root gen.pluto.3p42gev.rho0_pipi.mpmm.root rho0_pipi_pluto
eta_pluto gen.pluto.3p42gev.etap.gmpmm.root gen.pluto.3p42gev.w.mpmm.root rho0_pluto
etap_pluto gen.pluto.3p42gev.inmed_had.mpmm.root gen.pluto.3p42gev.w.pi0mpmm.root wdalitz_pluto
gen.pluto.3p42gev.D+.pmpmm.root gen.pluto.3p42gev.phi.mpmm.root inmed_had_mpmm_3p42gev_pluto w_pluto
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```

PLUTO Input

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chatterj@lxbk0600: /lustre/nyx/cbm/users/galatyuk/pluto/mpmm/8gev$ cd ../..
chatterj@lxbk0600: /lustre/nyx/cbm/users/galatyuk/pluto$ ls
epem input_hist_rapp mar2020 mpmm
chatterj@lxbk0600: /lustre/nyx/cbm/users/galatyuk/pluto$ ls mar2020/
epem/ mpmm/
chatterj@lxbk0600: /lustre/nyx/cbm/users/galatyuk/pluto$ ls mar2020/mpmm/
12gev/ 4p5gev/ 8gev/
chatterj@lxbk0600: /lustre/nyx/cbm/users/galatyuk/pluto$ ls mar2020/mpmm/12gev/
D+_pluto/ gen.pluto.12gev.rho0.mpmm.root
etadirect_pluto/ gen.pluto.12gev.rho0_pipi.mpmm.root
eta_pluto/ gen.pluto.12gev.w.mpmm.root
etaP_pluto/ gen.pluto.12gev.w.pi0mpmm.root
gen.pluto.12gev.Delta.pmpmm.root inmed_had_mpmm_12gev_pluto/
gen.pluto.12gev.eta.gmpmm.root phi_pluto/
gen.pluto.12gev.eta.mpmm.root qgp_mpmm_12gev_pluto/
gen.pluto.12gev.etap.gmpmm.root rho0_pipi_pluto/
gen.pluto.12gev.inmed_had_mpmm_12gev.mpmm.root rho0_pluto/
gen.pluto.12gev.phi.mpmm.root wdalitz_pluto/
gen.pluto.12gev.qgp_mpmm_12gev.mpmm.root w_pluto/
chatterj@lxbk0600: /lustre/nyx/cbm/users/galatyuk/pluto$ ls mar2020/mpmm/4p5gev/
D+_pluto/ gen.pluto.4p5gev.rho0.mpmm.root
etadirect_pluto/ gen.pluto.4p5gev.rho0_pipi.mpmm.root
eta_pluto/ gen.pluto.4p5gev.w.mpmm.root
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gen.pluto.4p5gev.phi.mpmm.root w_pluto/
chatterj@lxbk0600: /lustre/nyx/cbm/users/galatyuk/pluto$ ls mar2020/mpmm/8gev/
D+_pluto/ gen.pluto.8gev.inmed_had_mpmm_8gev.mpmm.root phi_pluto/
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```

PLUTO Input

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chatterj@lxbk0600:/lustre/nyx/cbm/users/galatyuk/pluto$ ls input_hist_rapp/
auau11_pluto/          pluto.auau.11gev.rapp.inmed.epem.5M.root    pluto.auau.11gev.rapp.qgp.mpmm.5M.root
auau3.5_pluto/        pluto.auau.11gev.rapp.inmed.mpmm.5M.root    qgp/
inmed-had/            pluto.auau.11gev.rapp.qgp.epem.25M.root
pluto.auau.11gev.rapp.inmed.epem.25M.root    pluto.auau.11gev.rapp.qgp.epem.5M.root
chatterj@lxbk0600:/lustre/nyx/cbm/users/galatyuk/pluto$ ls input_hist_rapp/inmed-had/
epem/ mpmm/
chatterj@lxbk0600:/lustre/nyx/cbm/users/galatyuk/pluto$ ls input_hist_rapp/inmed-had/mpmm/pluto.auau.11gev.rapp.inmed.mpmm.^C
chatterj@lxbk0600:/lustre/nyx/cbm/users/galatyuk/pluto$ ls input_hist_rapp/qgp/mpmm/pluto.auau.11gev.rapp.qgp.mpmm.□
```

PLUTO Input

chatterj@lxbk0598: /lustre/

chatterj@lxbk0600
auau11_pluto/
auau3.5_pluto/
inmed-had/
pluto.auau.11gev.
chatterj@lxbk0600
epem/ mpmm/
chatterj@lxbk0600
chatterj@lxbk0600

FW FOSWIKI
The Free and Open Source Wiki

PWG

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Webs

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CBMXYTER
CbmRoot
Computing
DAQ
DCS
Ecal
FLES
Homepages
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Integration
Juniors
MVD
Main
Meetings
MiniCBM
MuonSystem
NXYTER
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C2F
Charm
Dileptons
Hadron
Public
Radiationstudies
Rich

cbm-wiki.gsi.de/foswiki/bin/view/PWG/CbmDileptonInfoFilesAuAu11000

You are here: CBM Wiki > PWG Web > Dileptons > CbmDileptonInfo > CbmDileptonInfoFiles > CbmDileptonInfoFilesAuAu11000 (25 Nov 2021, TetyanaGalatyuk)

Au+Au 12A GeV $\sqrt{s_{NN}} = 4.9$ GeV $y_{CM} = 1.66$

Date: June 2020
Results presented:

Setup

Geometry:
Source code:
Macro:

The complete source code can be found at:

Input transport model files

The UrQMD files:

The DCM-QGSM files:

The Pluto files:

```
PFireball *source = new PFireball("rho0",Eb,T1,T2,fractionT1,blast,anisoA2,anisoA4,flowV1,flowV2);  
Float_t Eb      = 12.0;    // beam energy in GeV/u  
Float_t T1      = 0.13;    // temperature in GeV  
Float_t T2      = 0.;      // temperature in GeV  
Float_t fractionT1 = 1;  
Float_t blast   = 0.;  
Float_t anisoA2  = 0.;  
Float_t anisoA4  = 0.;  
Float_t flowV1   = 0.;  
Float_t flowV2   = 0.;
```

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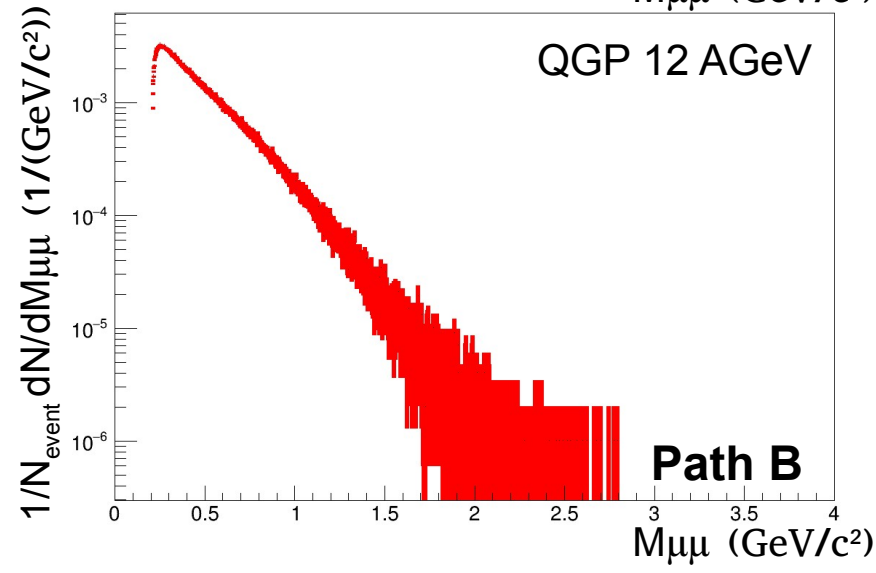
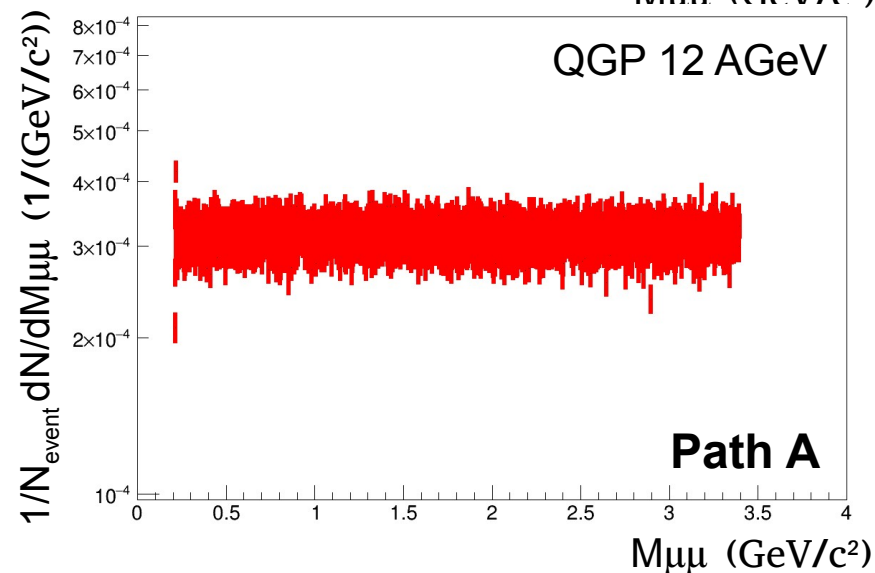
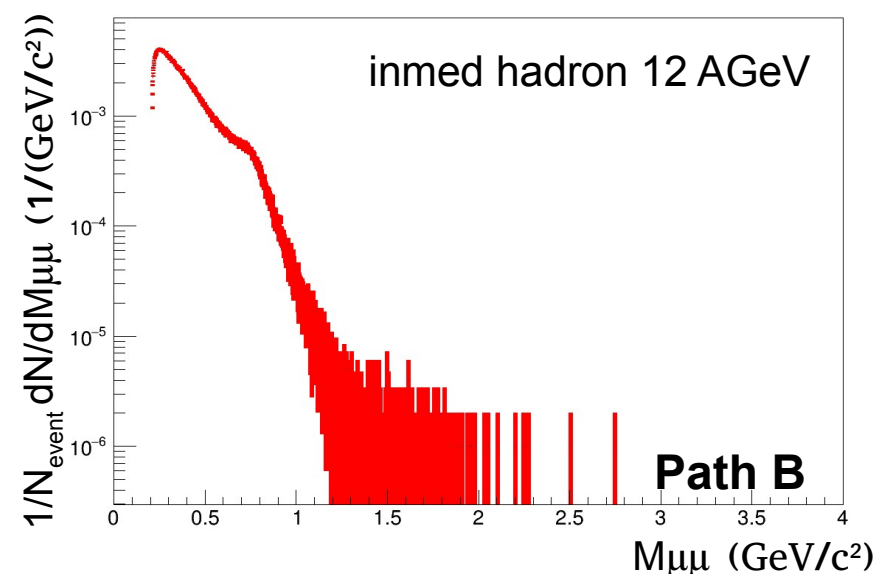
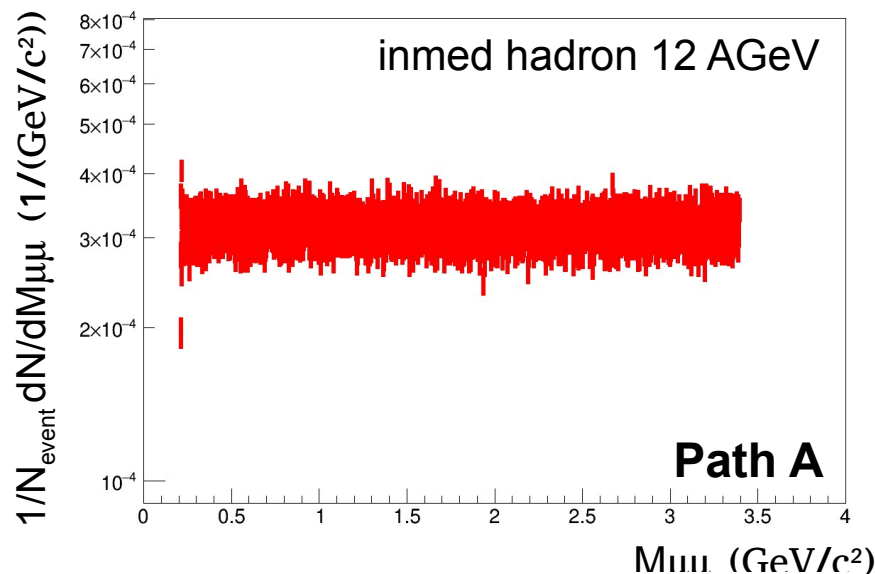
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ev.rapp.inmed.mpmm.^C
p.qgp.mpmm.

9

PLUTO Input

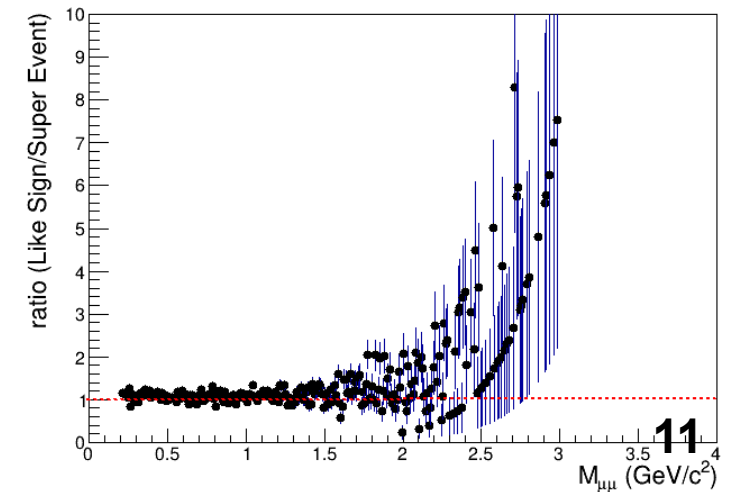
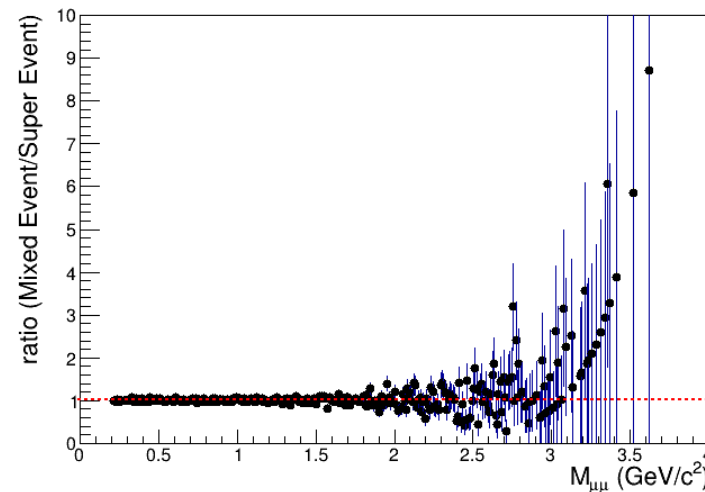
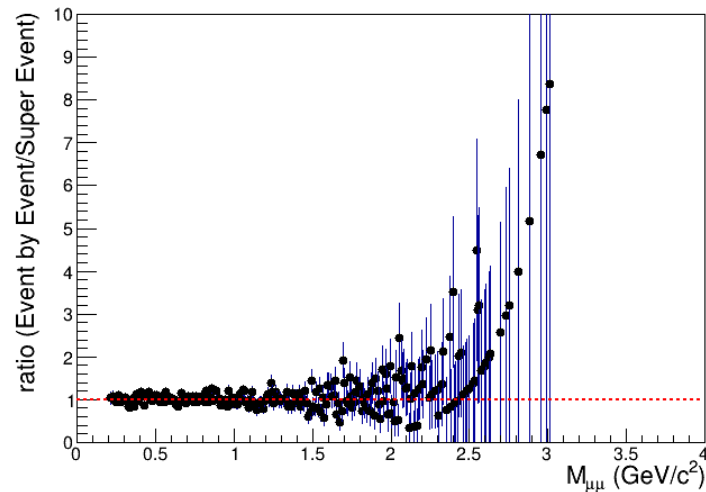
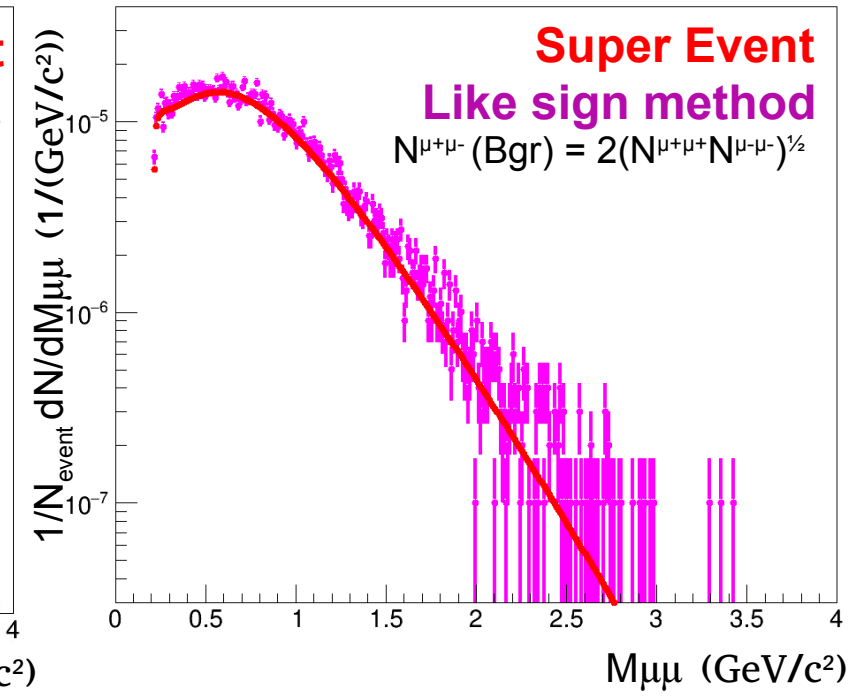
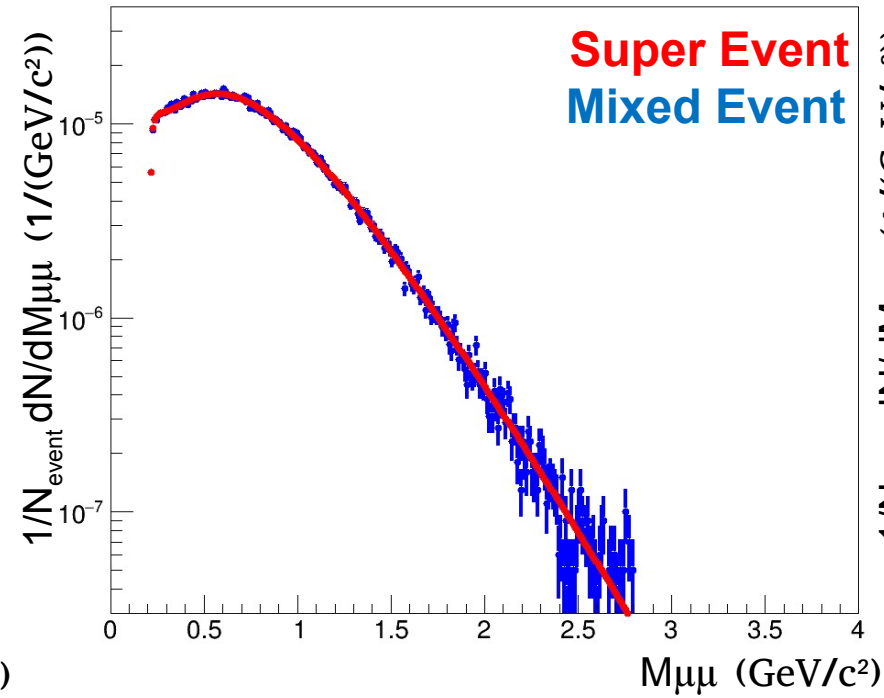
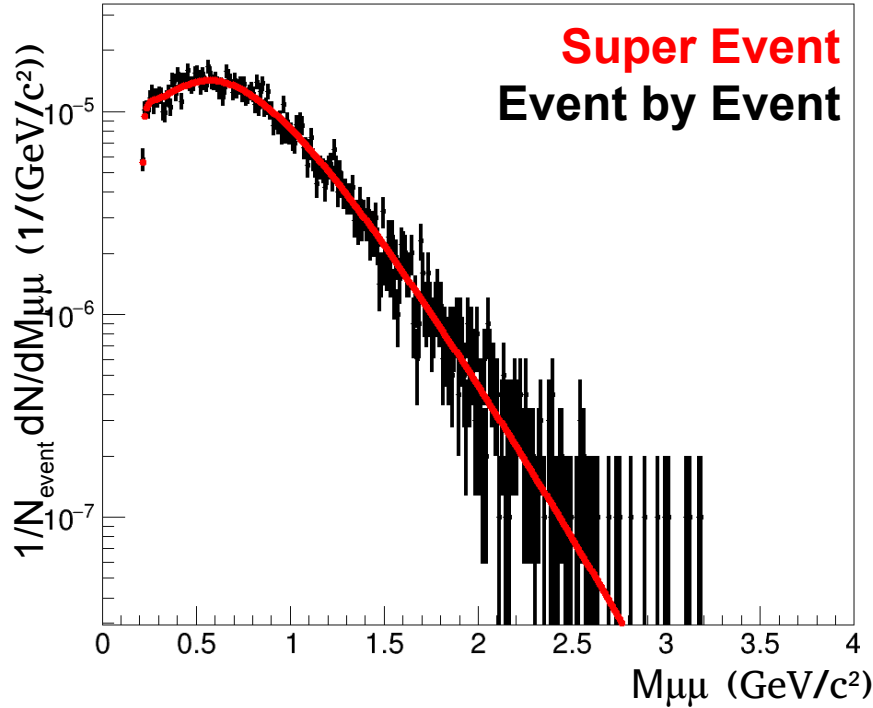
Path A : /lustre/nyx/cbm/users/galatyuk/pluto/mpmm/12gev/inmed_had_mpmm_12gev_pluto
/lustre/nyx/cbm/users/galatyuk/pluto/mpmm/12gev/qgp_mpmm_12gev_pluto
Path B: /lustre/nyx/cbm/users/galatyuk/pluto/input_hist_rapp/inmed-had/mpmm
/lustre/nyx/cbm/users/galatyuk/pluto/input_hist_rapp/qgp/mpmm



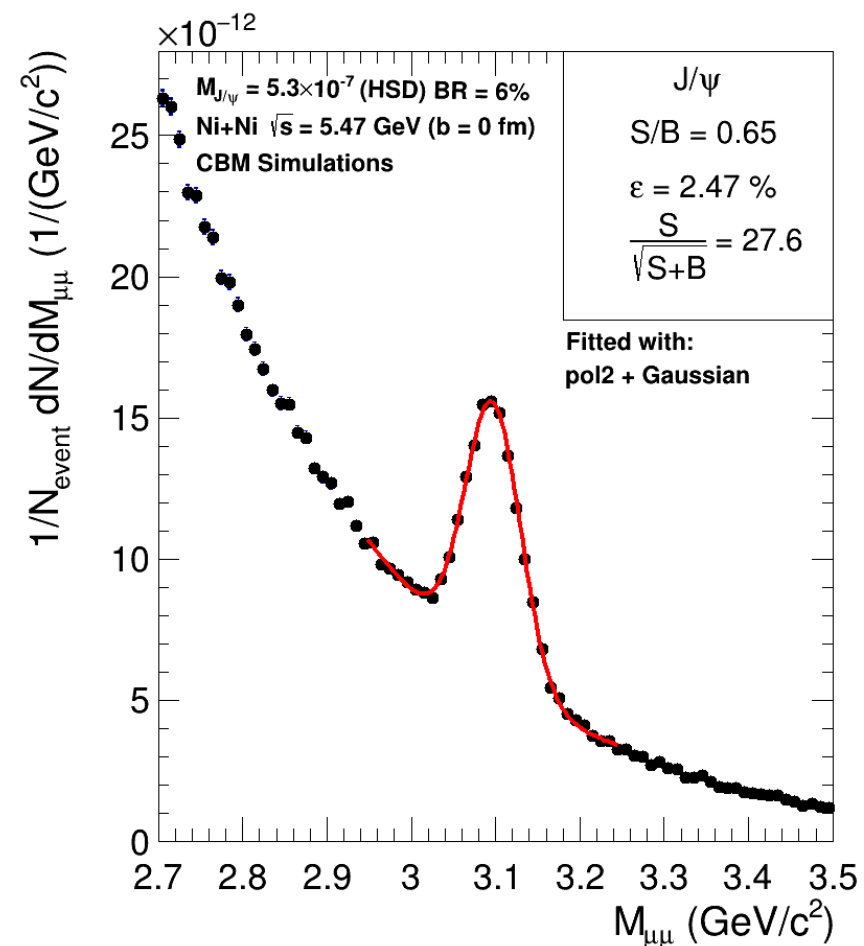
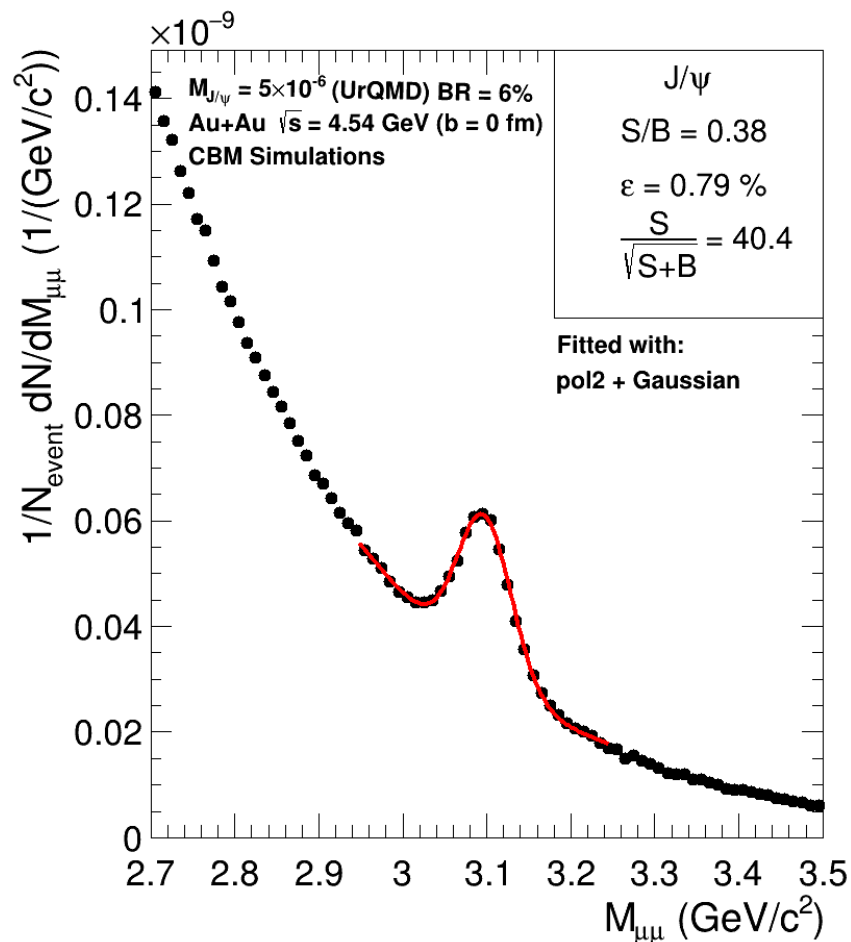
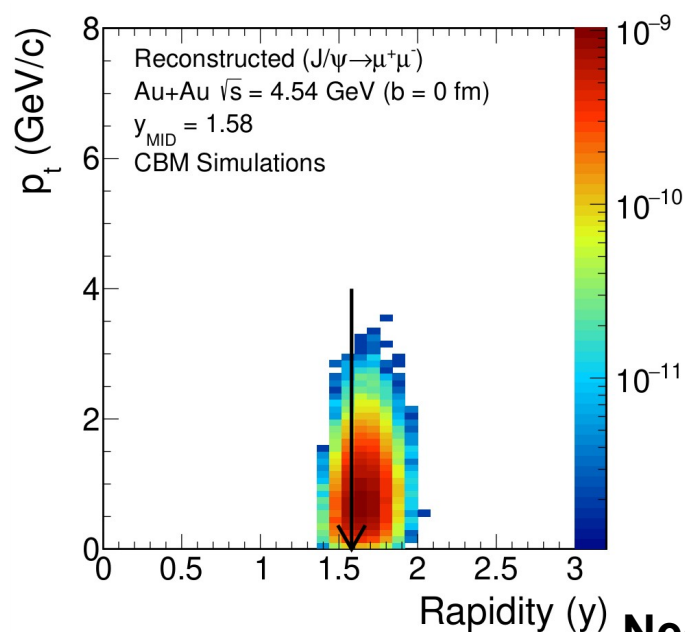
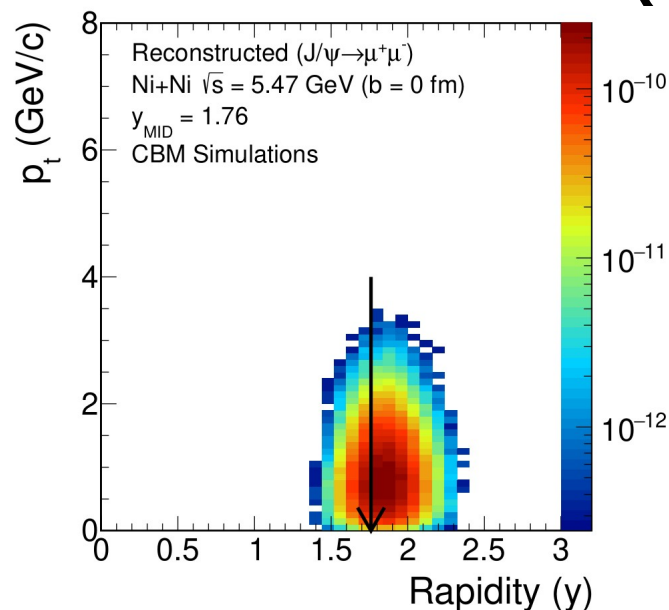
Similar discrepancies (left column plots) are also observed for 4.5 GeV, 8 GeV input files!

Combinatorial background

Au+Au (0-10%) @ 12 AGeV/c ; GEANT4 (# of events : 5×10^6)



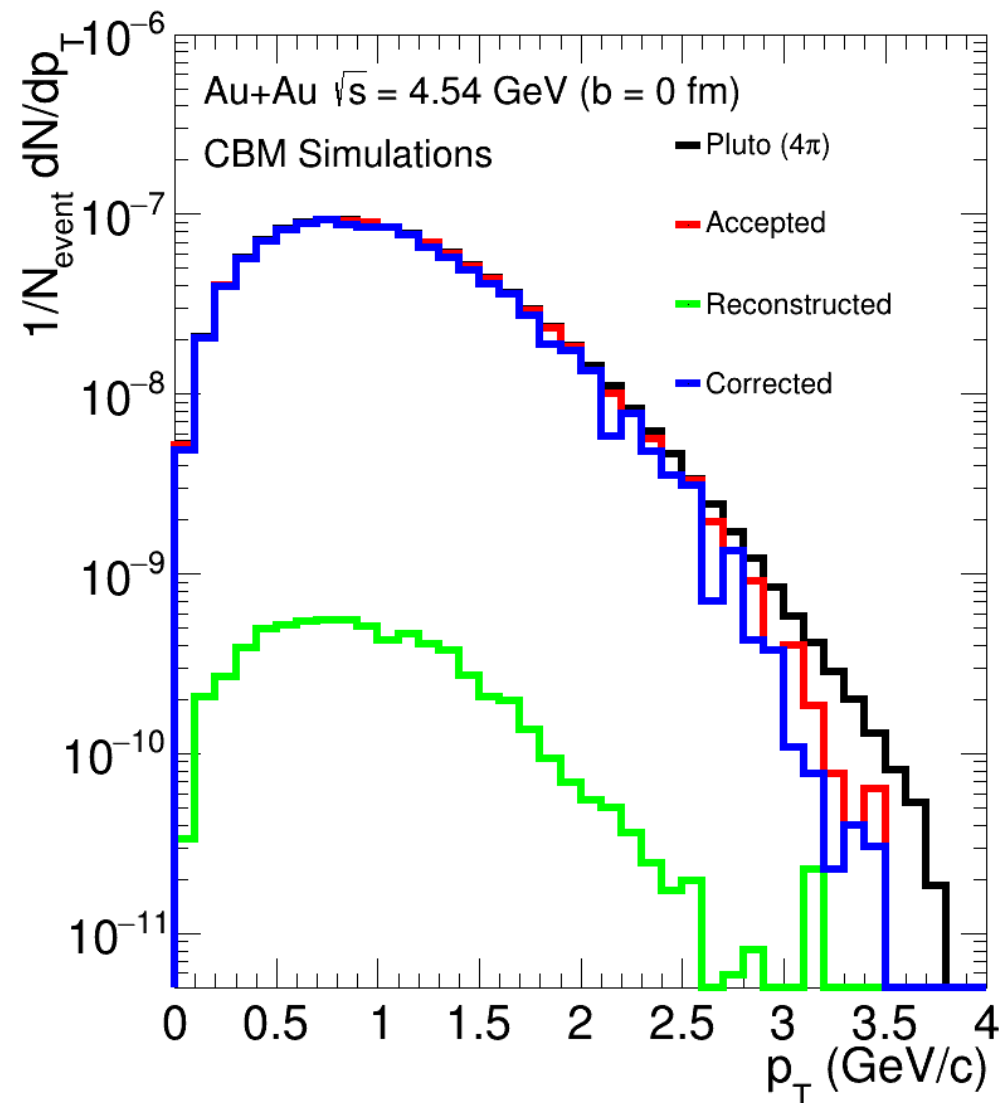
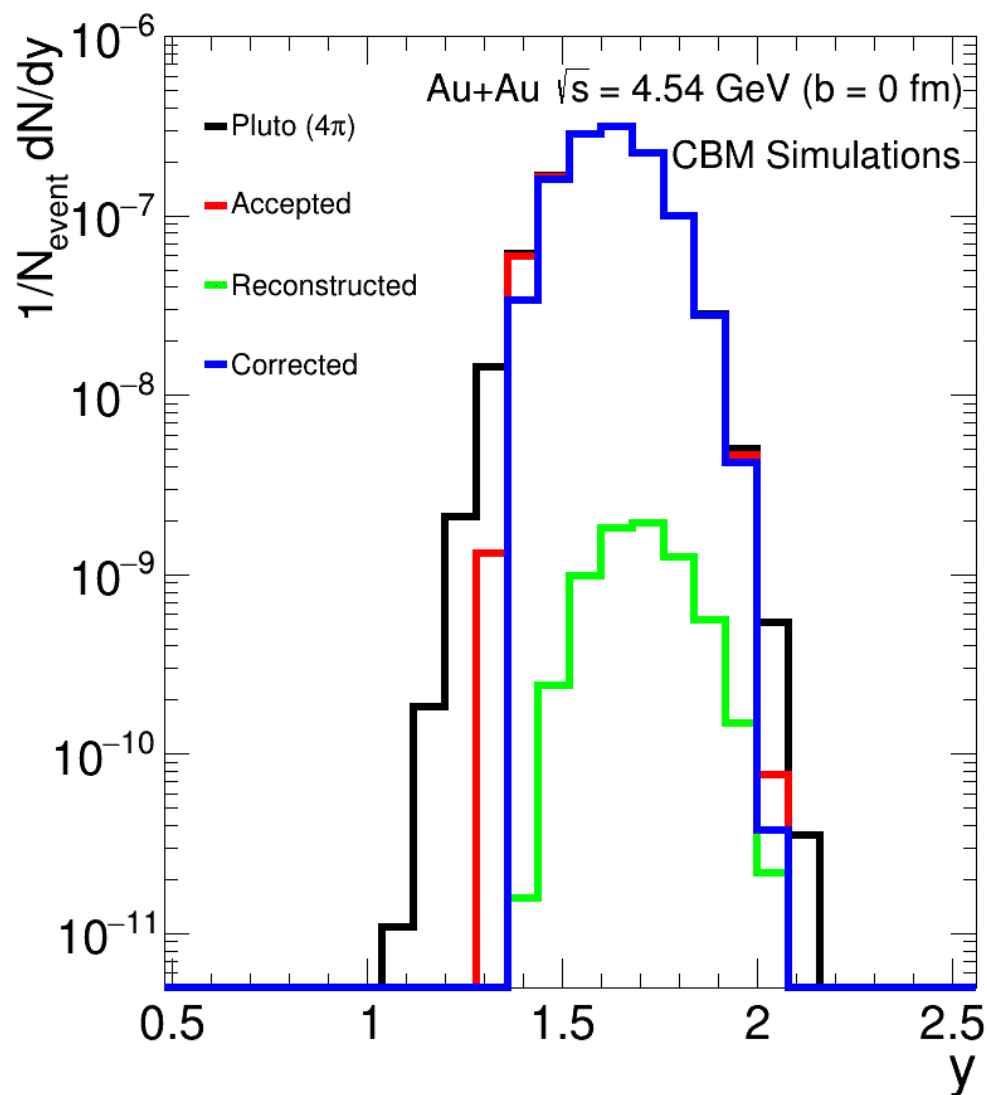
J/ψ results A+A (with APR20 and GEANT3)



Need to repeat with GEANT4 and input from PYTHIA

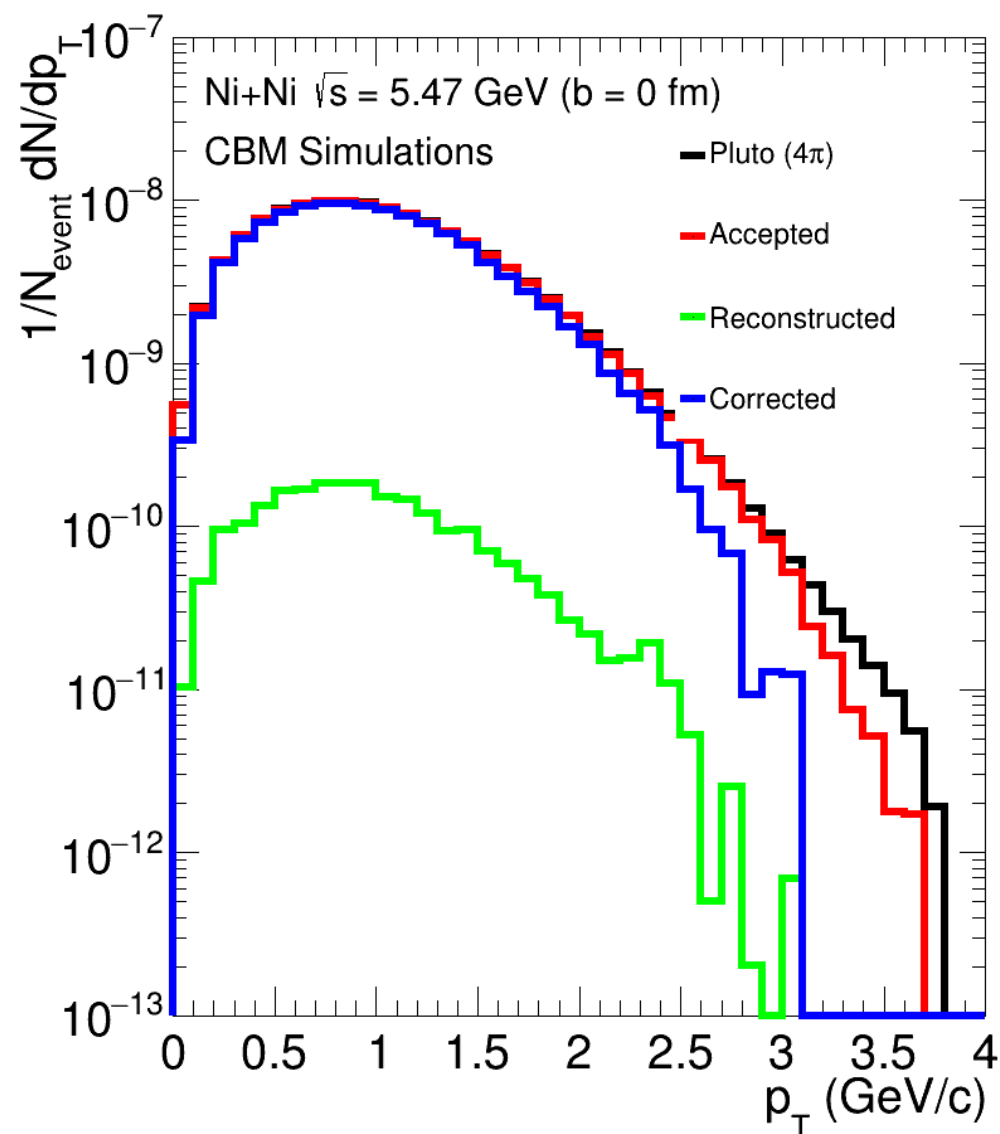
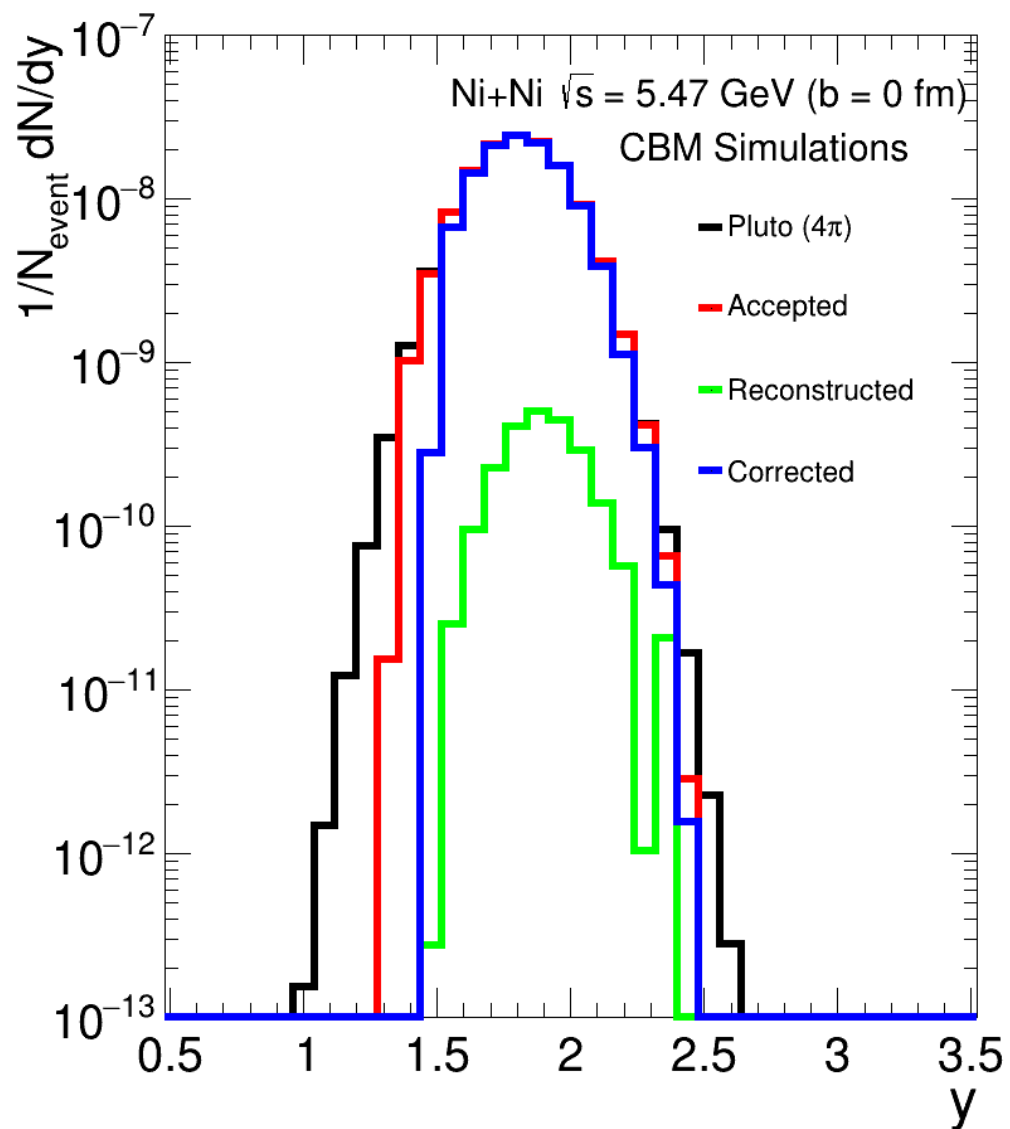
Ref: [DAE symposium 2020](#)

J/ψ results A+A (with APR20 and GEANT3)



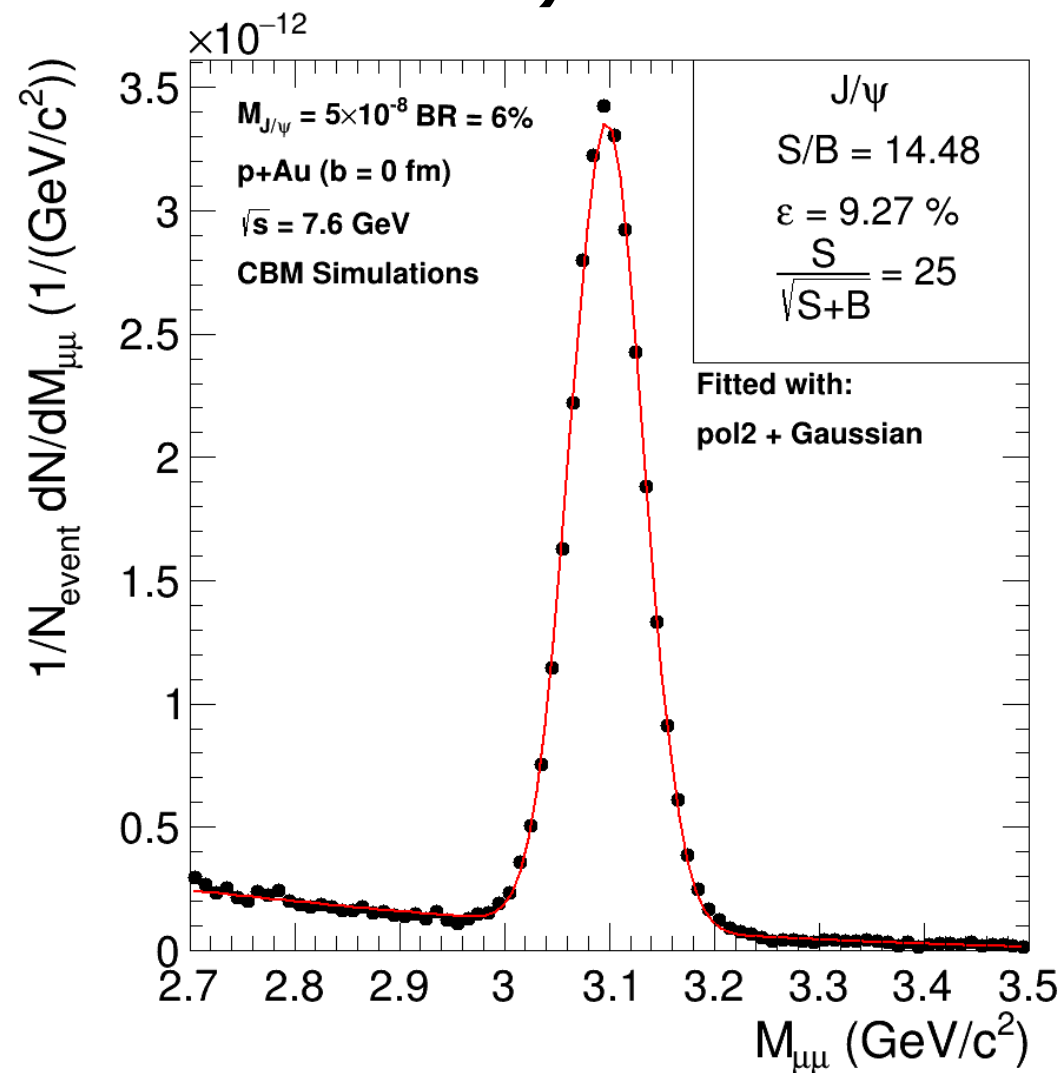
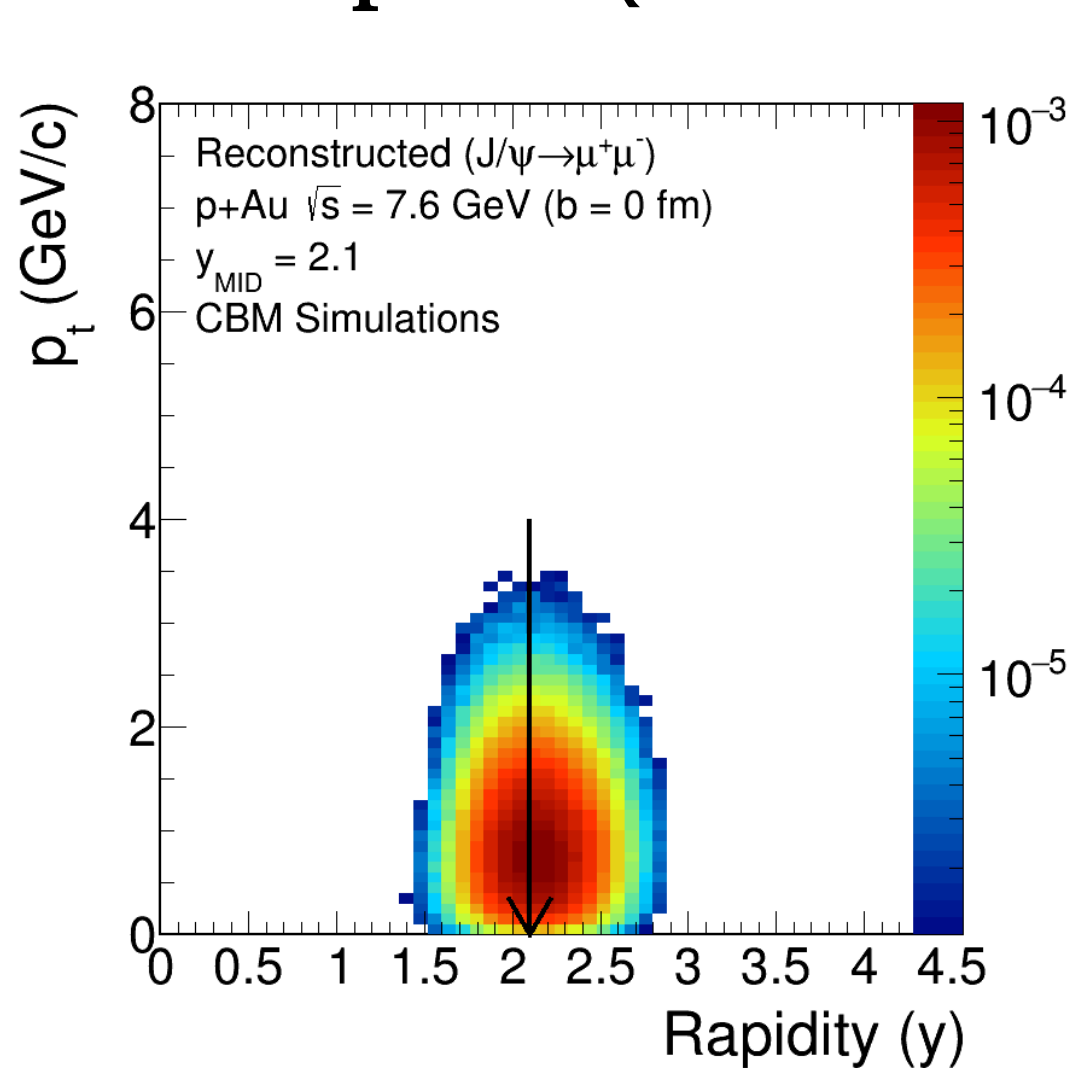
Need to repeat with GEANT4 and input from PYTHIA

J/ψ results A+A (with APR20 and GEANT3)



Need to repeat with GEANT4 and input from PYTHIA

J/ψ results p+Au (with APR20 and GEANT3)



Need to repeat with GEANT4 and input from PYTHIA

To do list

- Completion of the common production data at SIS100 energies with the muon setup for LMVM and J/Ψ (By the end of January 2022!)
- J/Ψ reconstruction with the input from PYTHIA and GEANT4 transport engine (By the end of January 2022!)
- Optimization of the space usage at the GSI cluster

Thank you...