

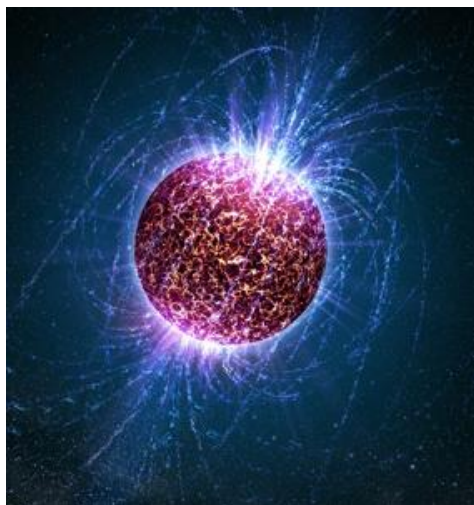
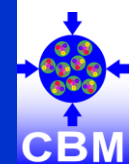
The CBM experiment at FAIR: Prospects and Status

N. Herrmann, Heidelberg University

CBM building



Dense Baryonic Matter



Neutron stars

Temperature
 $T < 10 \text{ MeV}$

Density
 $\rho < 10 \rho_0$

Lifetime
 $T \sim \text{infinity}$



Neutron star merger

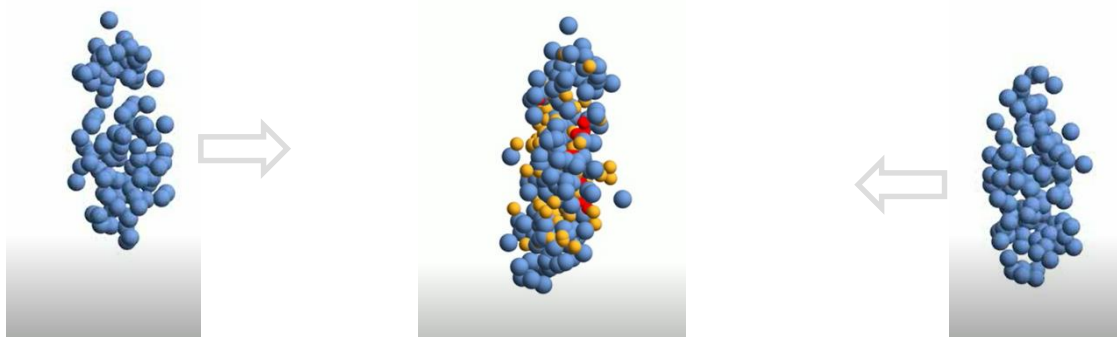
(GW070817)

Temperature
 $T < 50 \text{ MeV}$

Density
 $\rho < 2 - 6 \rho_0$

Reaction time
 $T \sim 10 \text{ ms}$

Heavy ion collisions at SIS100



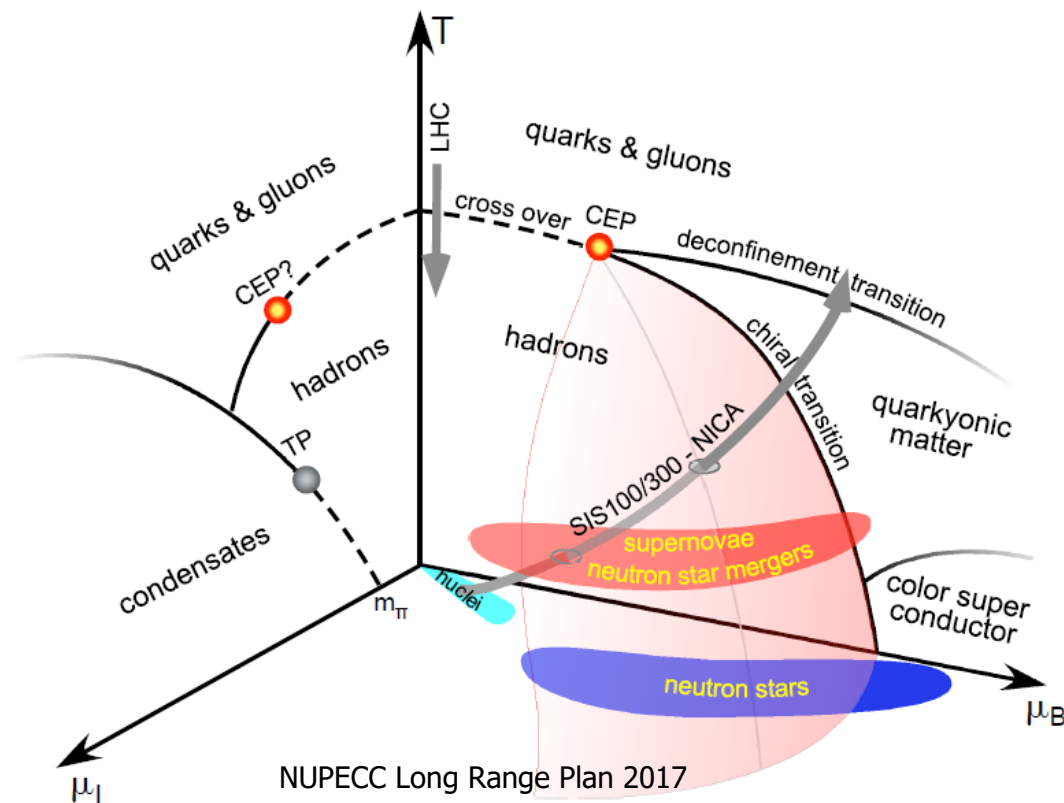
Compressed Baryonic Matter

Temperature
 $T < 120 \text{ MeV}$

Density
 $\rho < 8\rho_0$

Reaction time
 $t \sim 10^{-23} \text{ s}$

Isospin symmetric matter



Fundamental questions:

Equation of State of QCD matter at neutron star core densities
Phase structure of QCD matter
Chiral symmetry restoration at large densities
Bound states with strangeness
Charm in dense baryonic matter

Phase structure of QCD

Key features of CBM

Main observables

Equation-Of-State (EOS)
Critical-End-Point (CEP)
Global polarisation / alignment
Hypernuclei
Exotic baryonic QCD states
Electromagnetic radiation
Chiral symmetry restoration

CBM extension

proton beam options

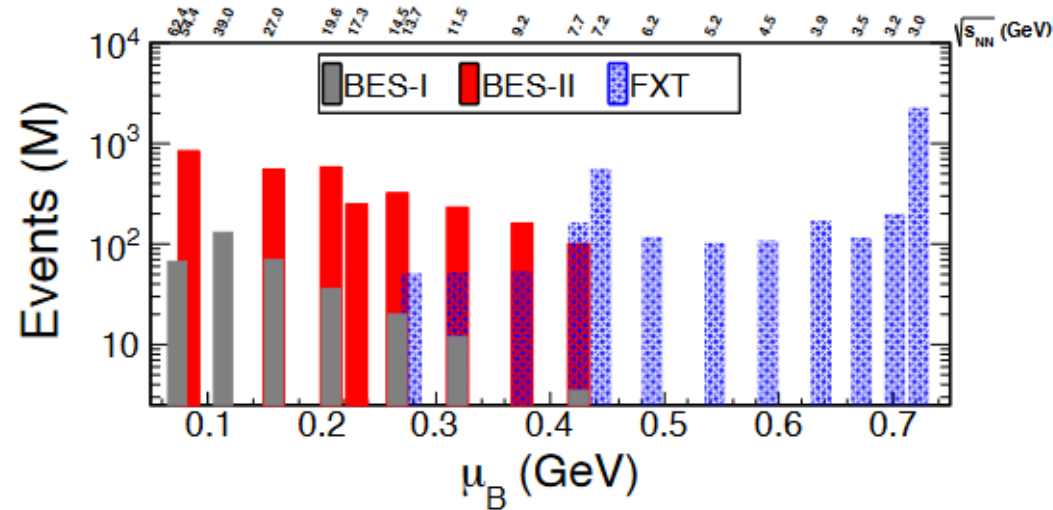
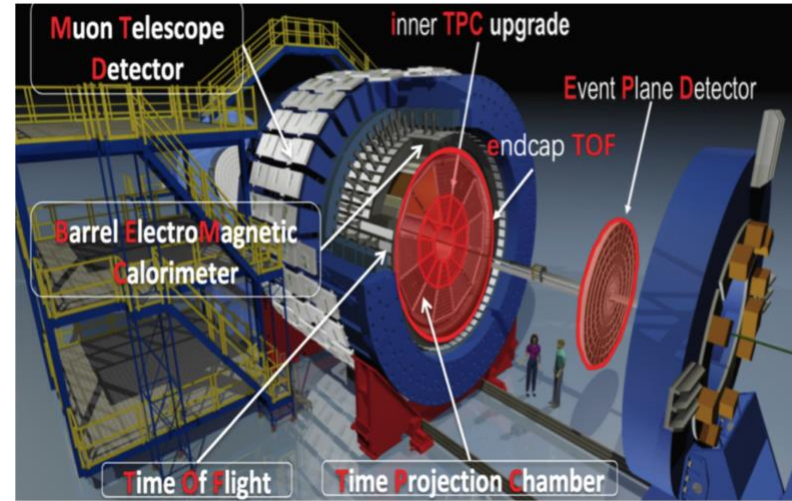
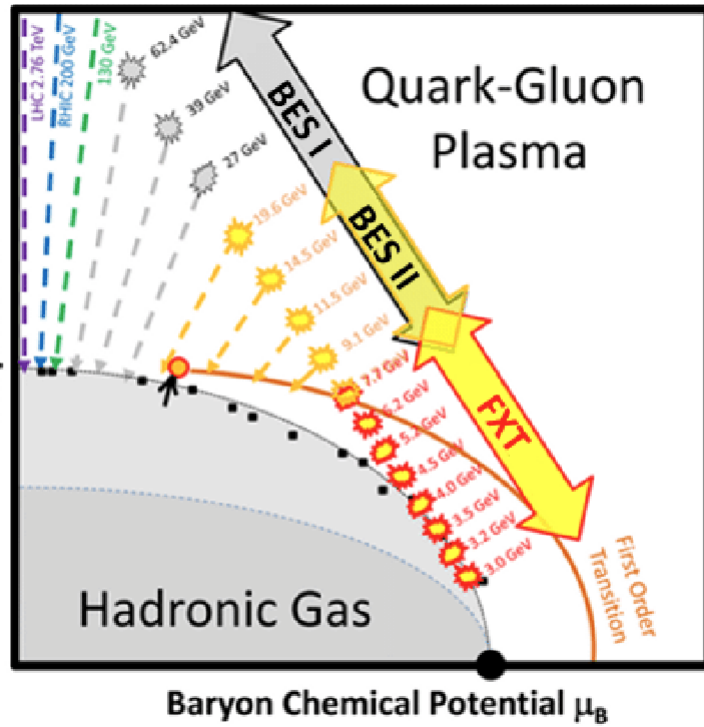
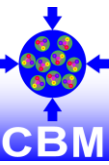
CBM demonstrator: mCBM

Performance of subsystems

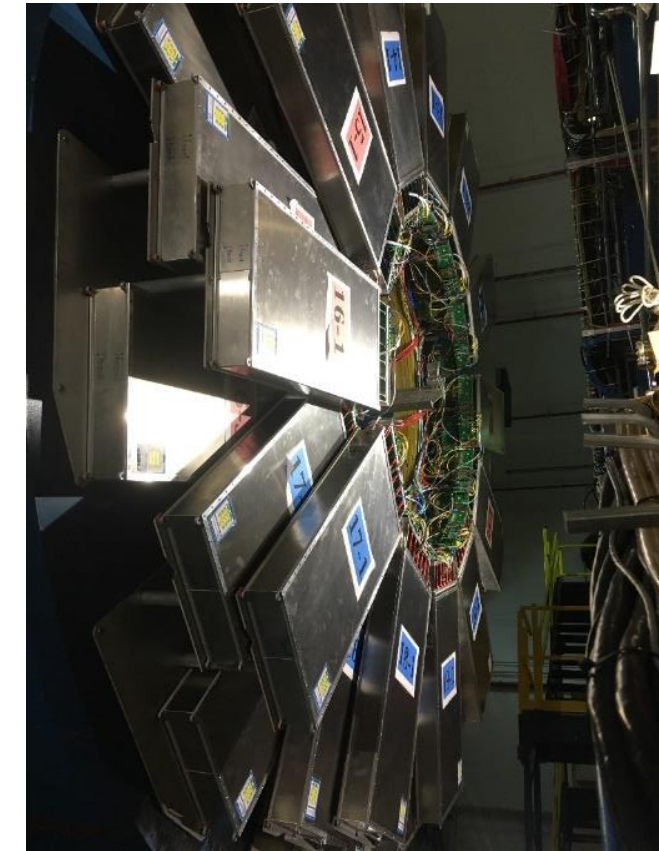
CBM status

Conclusion

Experimental method: Beam energy scan

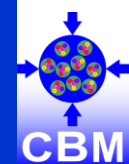


eTOF as CBM FAIR – phase 0



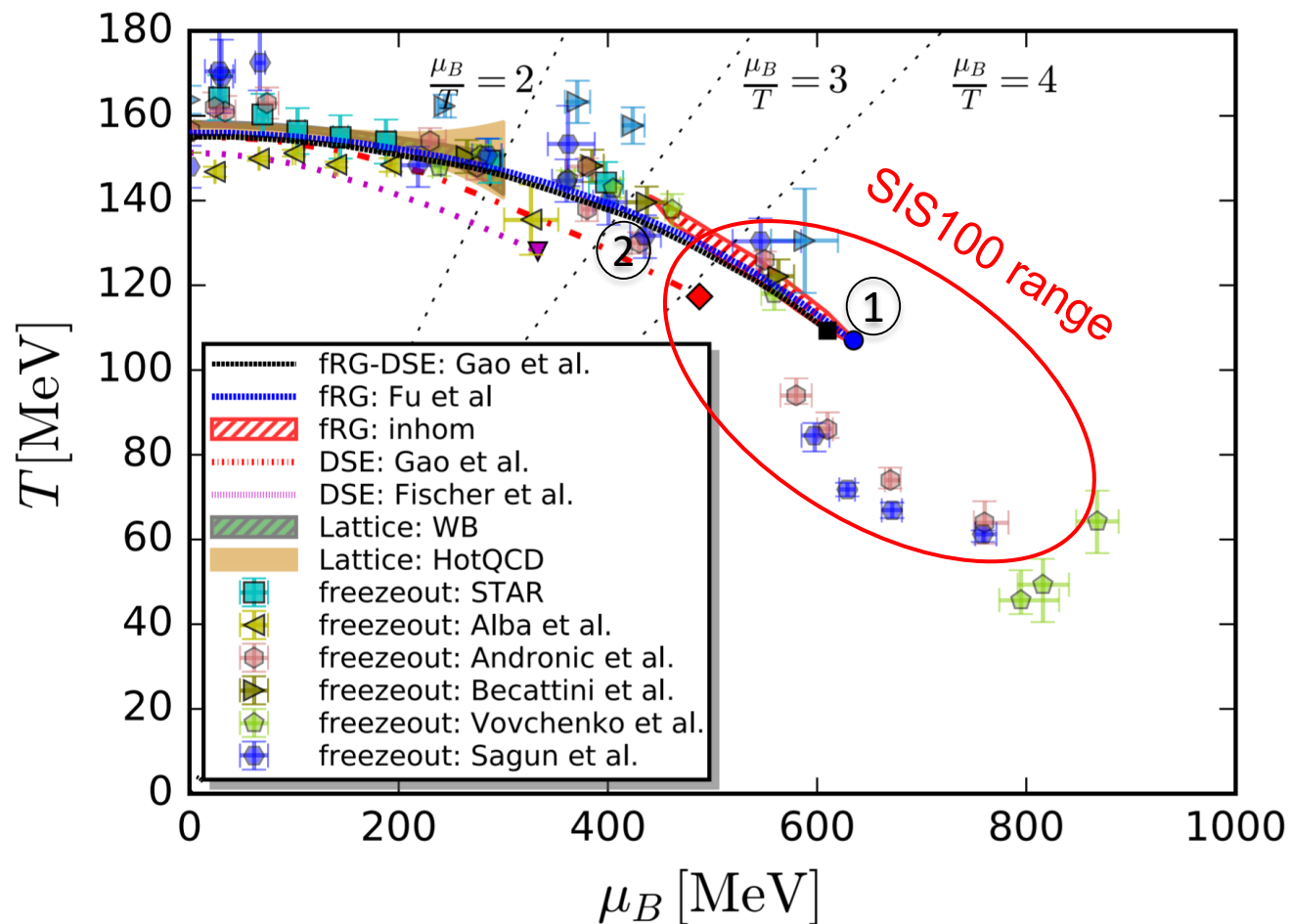
Data taking for BES II was completed in 2021, Calibration and analysis ongoing.

Phase structure of QCD

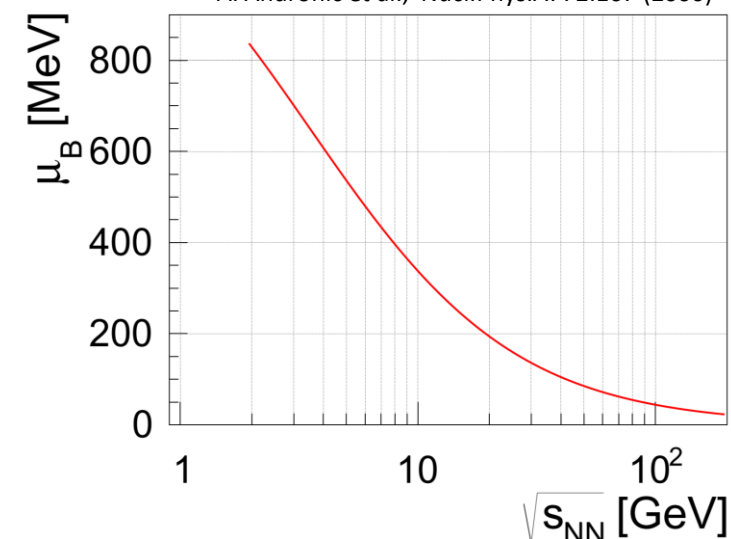


Location of chiral cross over

W. Fu, J. Pawłowski, F. Rennecke, *Phys.Rev.D* 101 (2020) 5, 054032, arXiv:1909.02991



A. Andronic et al., *Nucl.Phys.A*772:167 (2006)



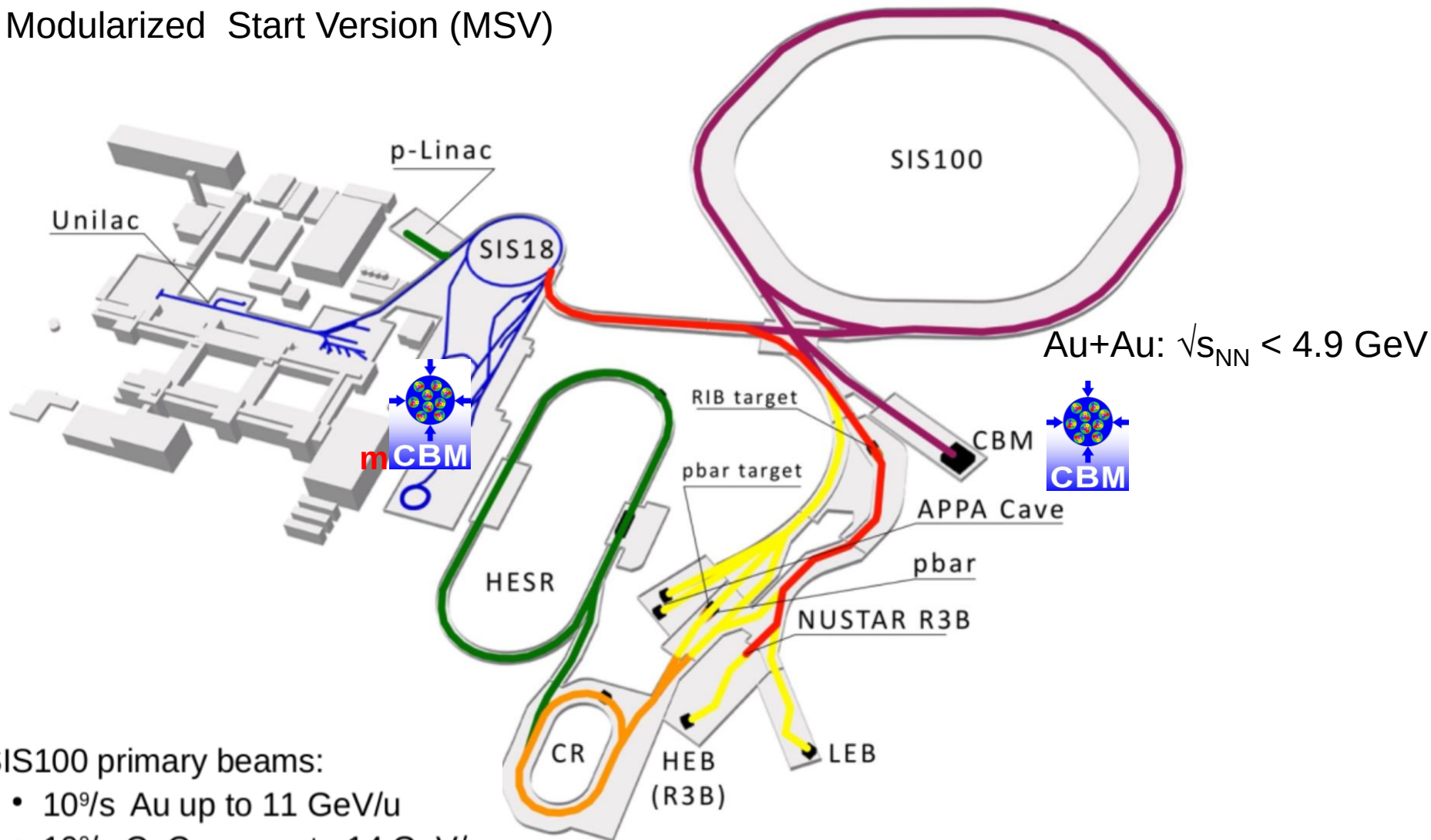
	μ_B (MeV)	$\sqrt{s_{NN}}$ (GeV)	T_{lab} (A GeV)
1	622	3.8	6.0
	500	5.2	15.0
2	400	7.8	31.5

Challenges:

Phase transition not at freeze-out line,
need probes with memory,
reaction dynamics needs to be controlled.

Facility for Antiproton and Ion Research (FAIR)

Modularized Start Version (MSV)

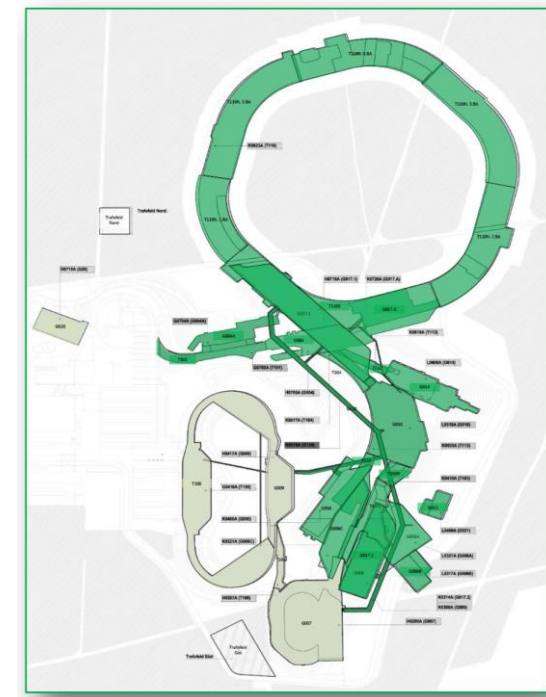


SIS100 primary beams:

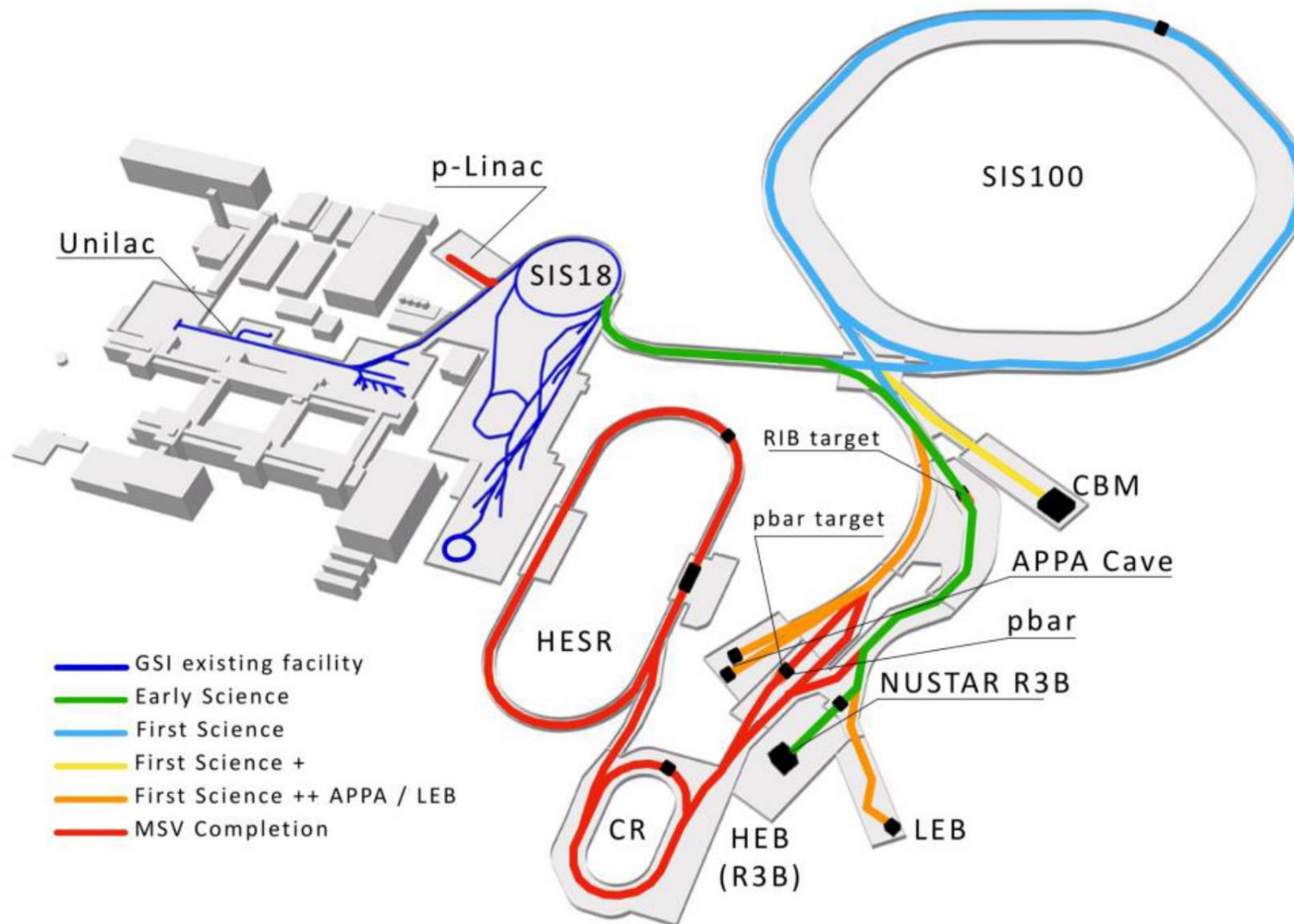
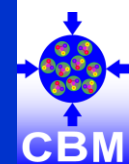
- $10^9/\text{s}$ Au up to 11 GeV/u
- $10^9/\text{s}$ C, Ca, ... up to 14 GeV/u
- $10^{11}/\text{s}$ p up to 29 GeV



FAIR Intermediate Objective



Recent developments at FAIR and CBM



Substantial cost increase surfaced in 2021,
Russian attack on Ukraine

Science evaluation in 2022
(chairs: R. Heuer, R. Tribble)

Recommendation:
downscope FAIR project with cost cap

Suggested scenario:
FS+: SIS100 & SFRS/R3B & CBM

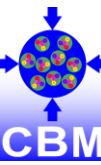
Additional funds provided by BMBF
Planned scenario: FS

Decision by FAIR council on CBM magnet
expected in July 2023

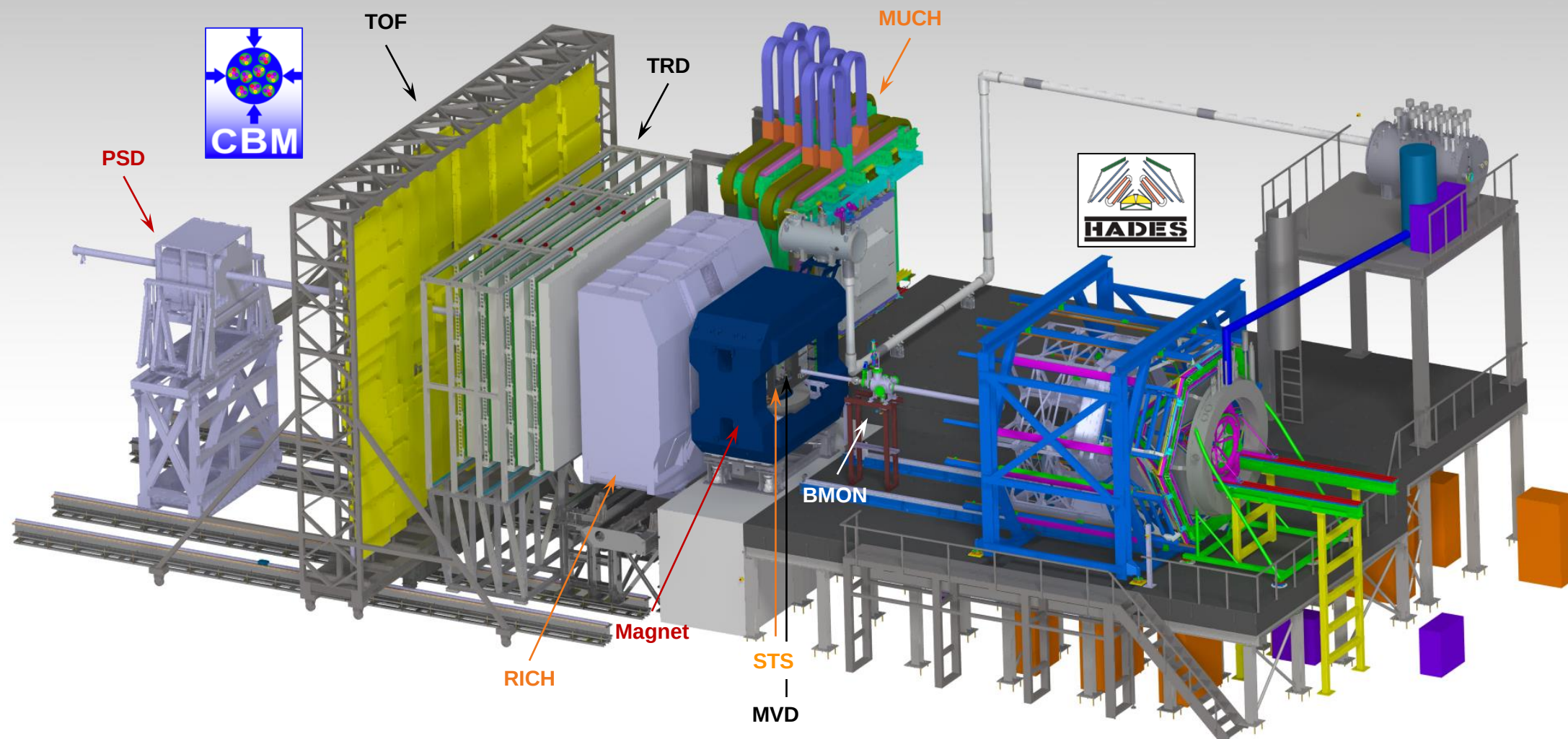
Start of operation: 2028/29

https://www.gsi.de/fileadmin/oeffentlichkeitsarbeit/fair/FAIR-report_221025.pdf

CBM experimental hall

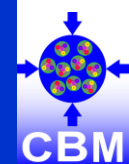


C.B.M. experiments

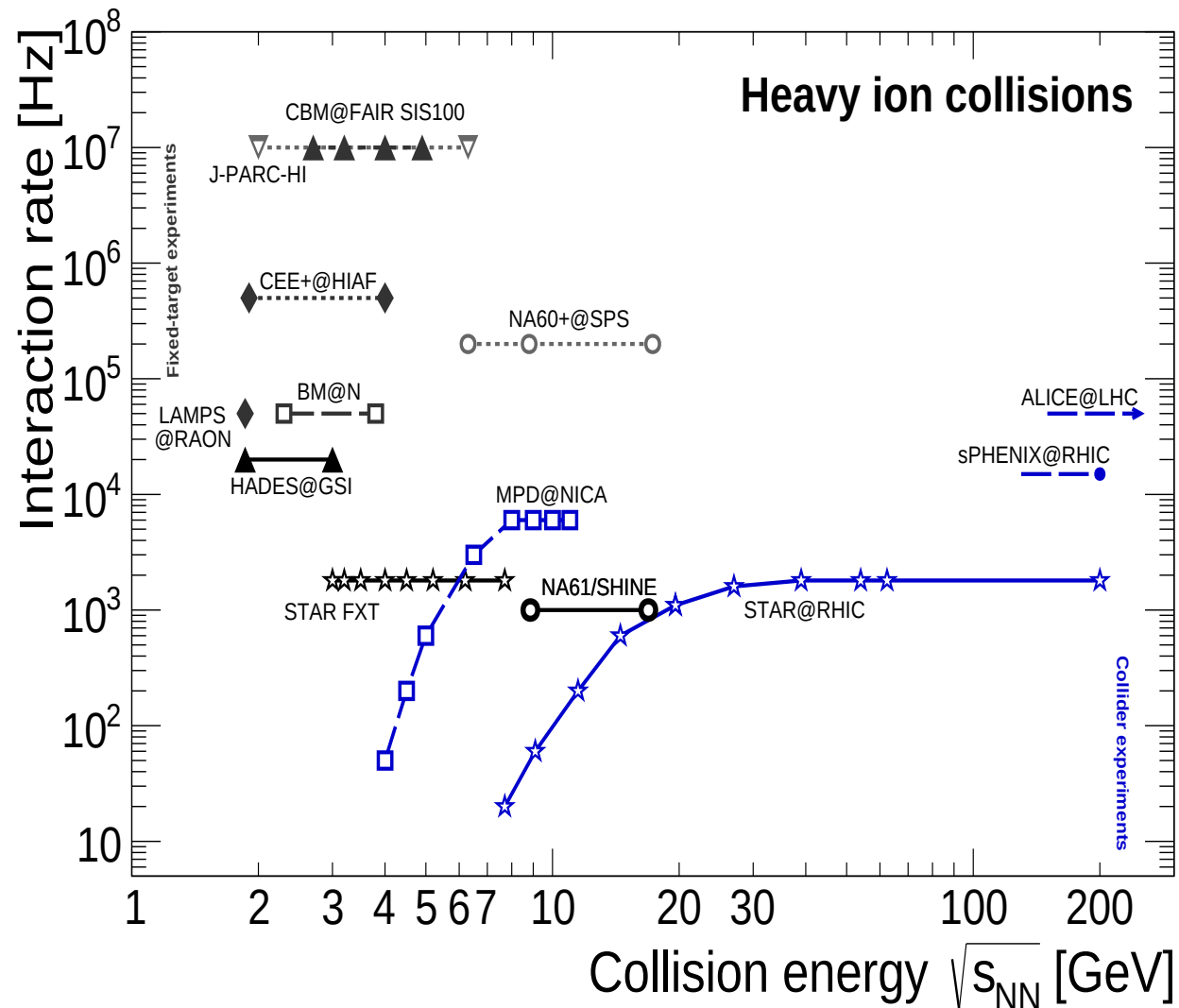


CBM Day-1 configuration (2028) : rate capability 100 kHz Au+Au reactions with streaming (triggerless) readout of MVD, STS, RICH, MUCH, TRD, TOF and PSD

CBM – Technological Goal



T. Galatyuk, https://github.com/tgalatyuk/interaction_rate_facilities, 2022



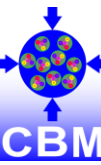
Mission:

Systematically explore QCD matter at large baryon densities with high accuracy and rare probes.

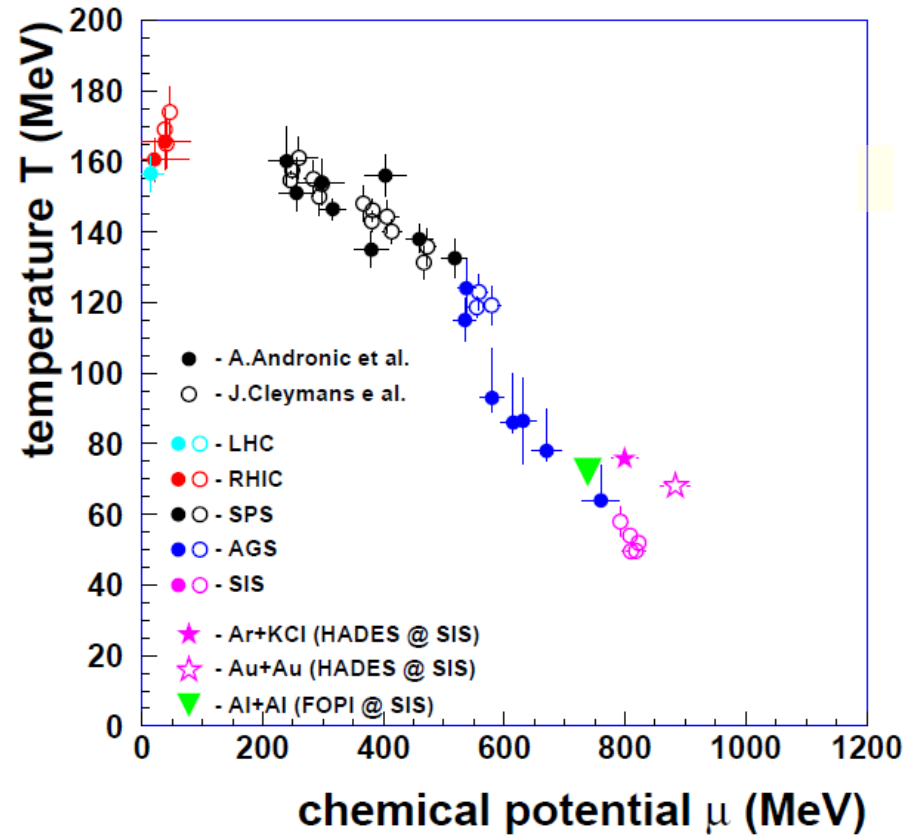
Disclaimer:

not all measurements benefit from the highest possible rates.

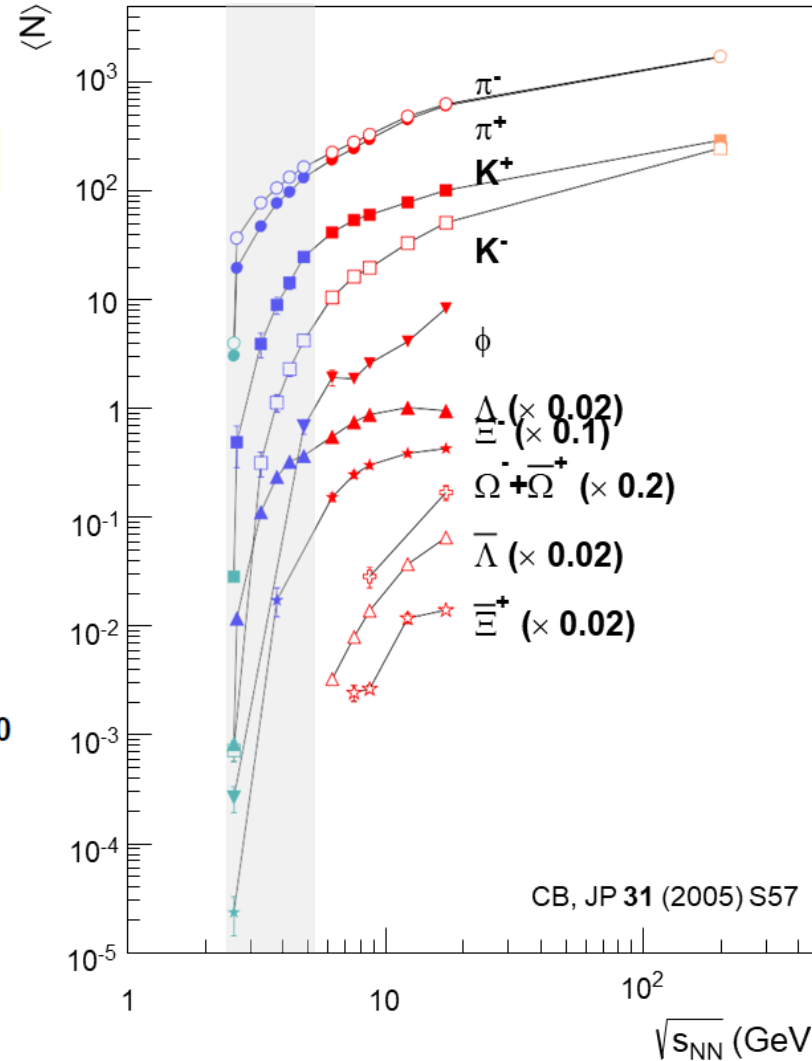
Heavy Ion Physics at SIS100



World data, central Au + Au collisions



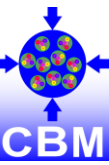
Freeze-out data are well described by
Statistical Hadronization Model



Strange and charmed particle
production thresholds in pp - collisions

reaction	$\sqrt{s}$ (GeV)	T_{lab} (GeV)
$pp \rightarrow K^+ \Lambda p$	2.548	1.6
$pp \rightarrow K^+ K^- pp$	2.864	2.5
$pp \rightarrow K^+ K^+ \Xi^- p$	3.247	3.7
$pp \rightarrow K^+ K^+ K^+ \Omega^- n$	4.092	7.0
$pp \rightarrow \Lambda \bar{\Lambda} pp$	4.108	7.1
$pp \rightarrow \Xi^- \bar{\Xi}^+ pp$	4.520	9.0
$pp \rightarrow \Omega^- \bar{\Omega}^+ pp$	5.222	12.7
$pp \rightarrow J/\Psi pp$	4.973	12.2

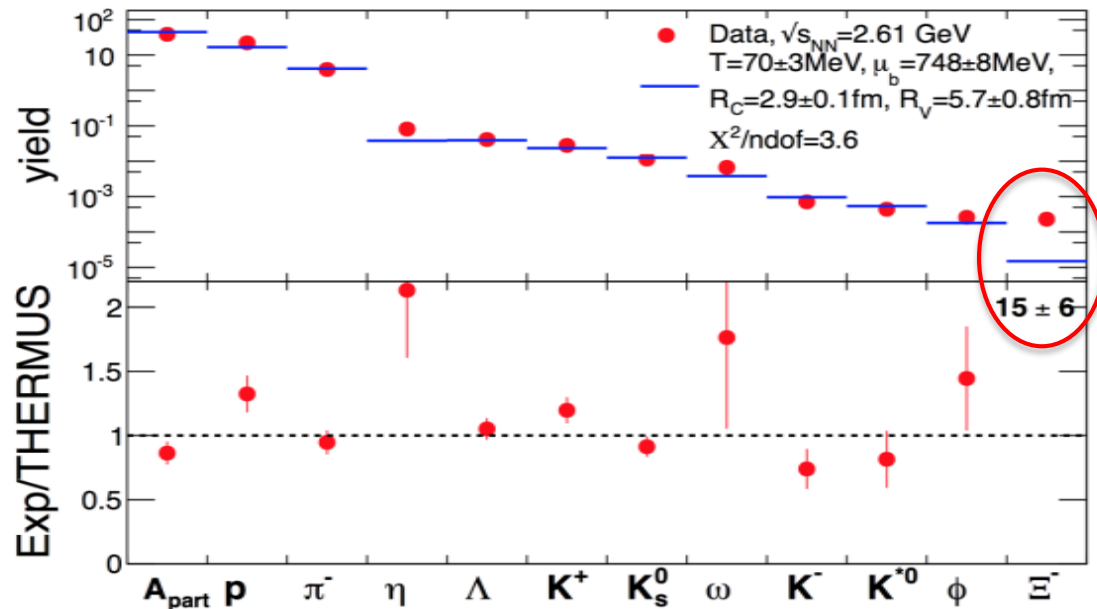
Deviations from Statistical Model



HADES data

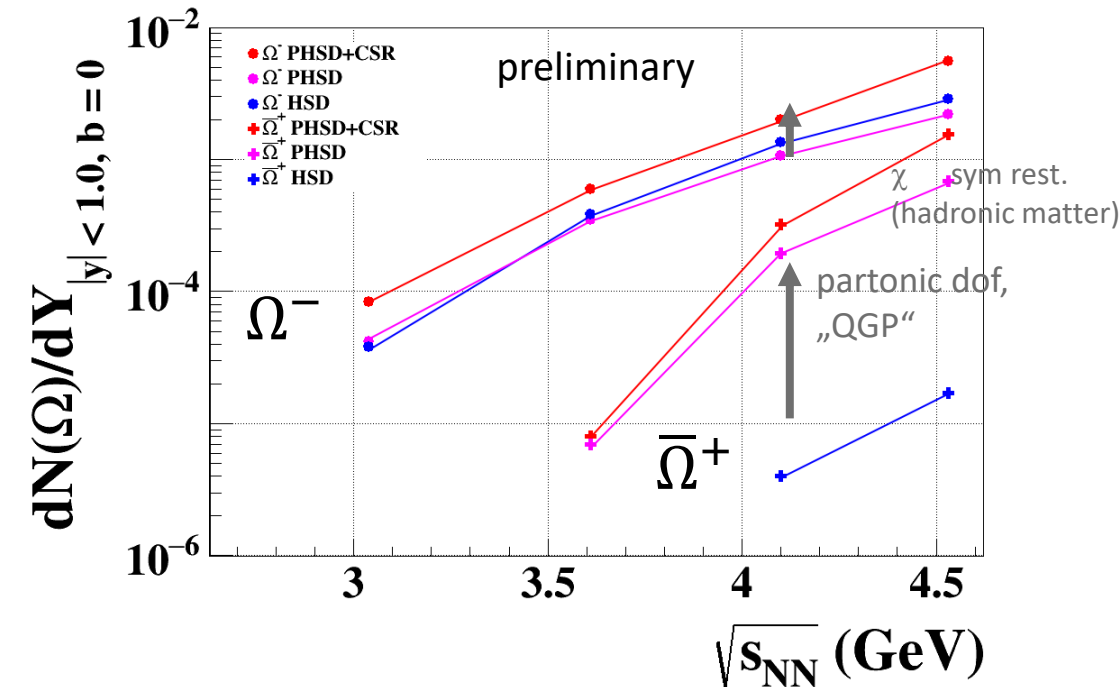
Ar + KCl 1.76 A GeV

G. Agakishiev et al., EPJA 52 (2016) 6, 178



Transport Model Predictions

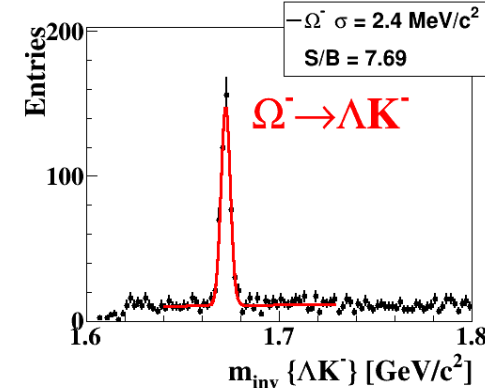
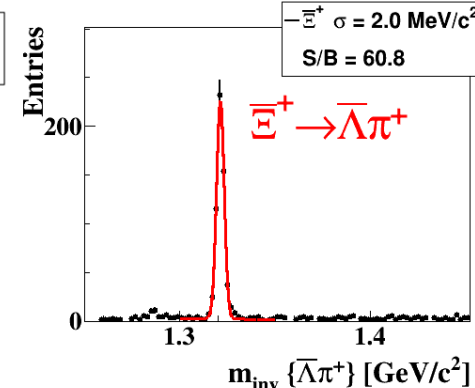
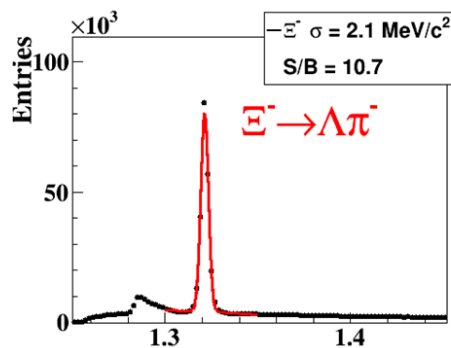
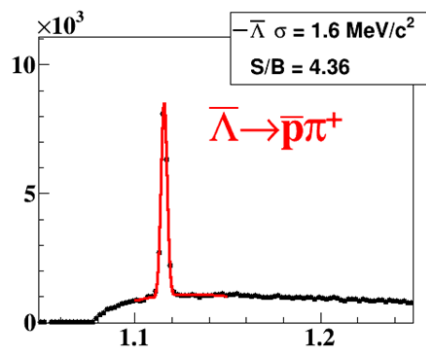
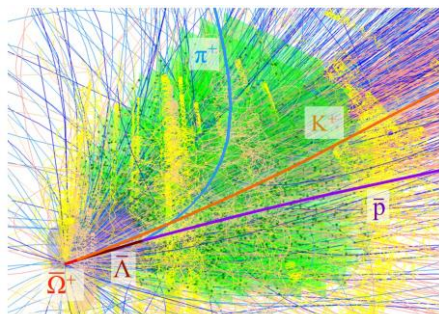
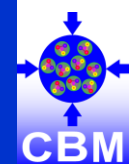
PHSD W. Cassing, E. Bratkovskaya et al., Phys.Rev. C93 (2016), 014902



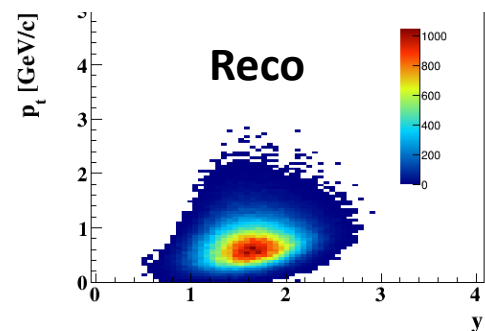
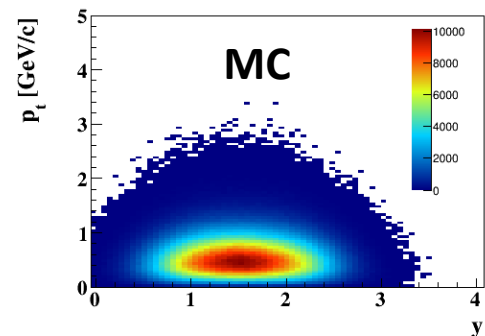
Sensitivities of subthreshold particle production

- Equation-of-state (multi step production)
- In-medium properties of hadrons
- Contributions from partonic degrees of freedom („QGP“)

Production yields of strange hadrons



Au + Au, central, 10 AGeV, Ξ^-



Eventwise reconstruction by KFPARTICLE package

Particle (mass MeV/c ²)	Multi- plicity 6 AGeV	Multi- plicity 10 AGeV	decay mode	BR	ϵ (%)
$\bar{\Lambda}$ (1115)	$4.6 \cdot 10^{-4}$	0.034	$\bar{p}\pi^+$	0.64	11
Ξ^- (1321)	0.054	0.222	$\Lambda\pi^-$	1	6
Ξ^+ (1321)	$3.0 \cdot 10^{-5}$	$5.4 \cdot 10^{-4}$	$\Lambda\pi^+$	1	3.3
Ω^- (1672)	$5.8 \cdot 10^{-4}$	$5.6 \cdot 10^{-3}$	ΛK^-	0.68	5
Ω^+ (1672)	-	$7 \cdot 10^{-5}$	ΛK^+	0.68	3

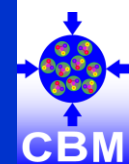
Statistics estimation at $R_{\text{int}}=0.1$ MHz
for Ω^- at T=10 AGeV

Signal counts per week:

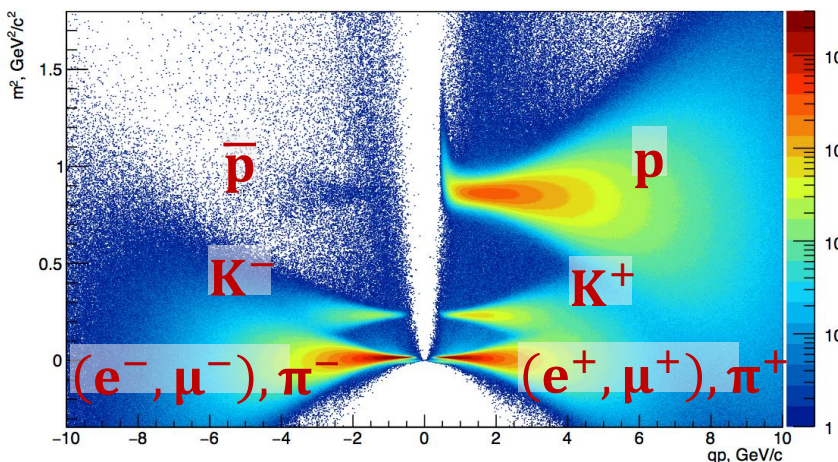
$$\begin{aligned}
 S_w &= R_{\text{av}} * \epsilon_{\text{duty}} * P_{\text{prod}} * f_{\text{mb/cen}} * \text{BR} * \epsilon_{\text{reco}} * \Delta T \\
 &= 1 \cdot 10^5 * 0.7 * 5 \cdot 10^{-3} * 0.25 * 0.68 * 0.05 * 6 \cdot 10^5 \\
 &= 1.800.000
 \end{aligned}$$

Improvements by Machine Learning under investigation.

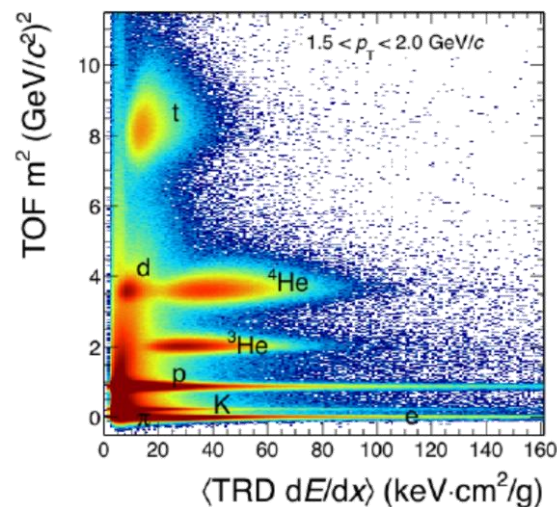
Measurement of Collective Flow



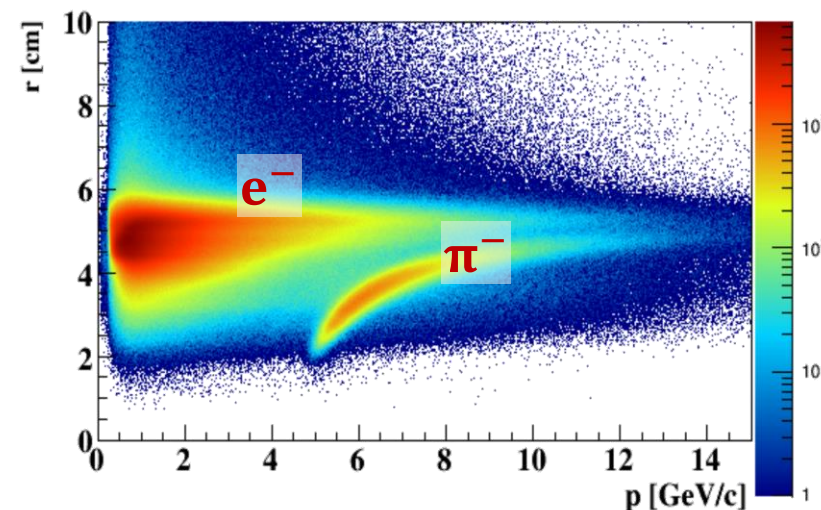
ToF - Hadron Identification



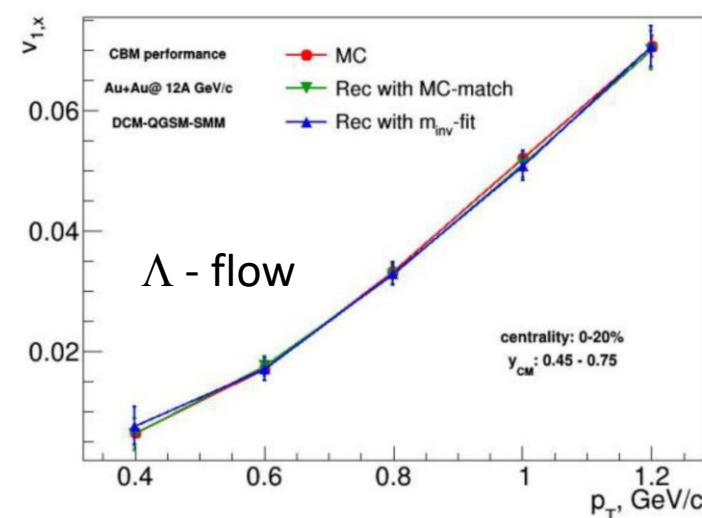
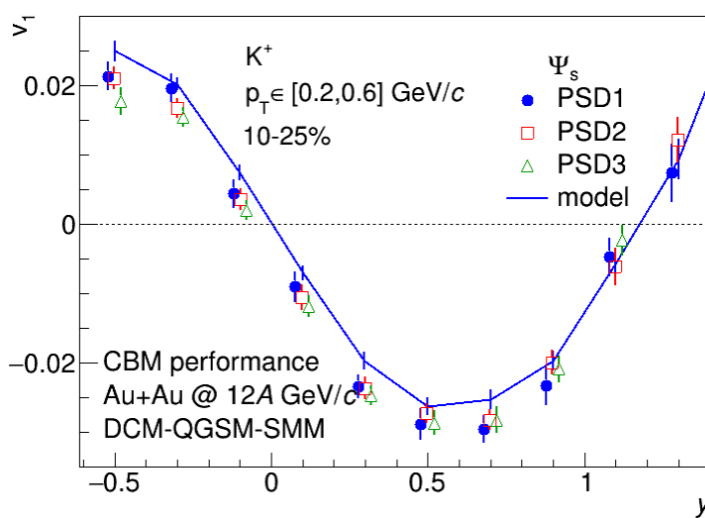
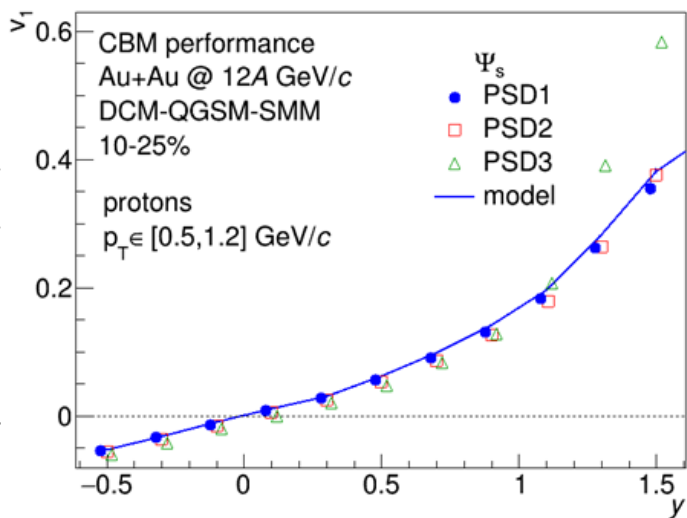
TRD + ToF – Electron, Charge Id



RICH - Electron ID



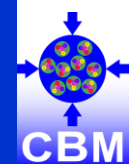
O. Golosov et al., CBM Progress Report 2020
J.Phys.Conf.Ser. 1690 (2020) 1, 012104



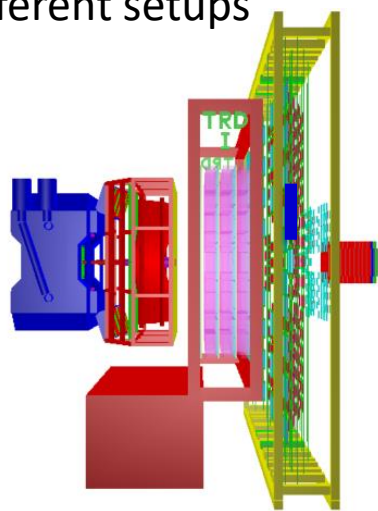
O. Golosov, CPD 2021

CBM well prepared for PID, spectra and multi-differential flow analysis.

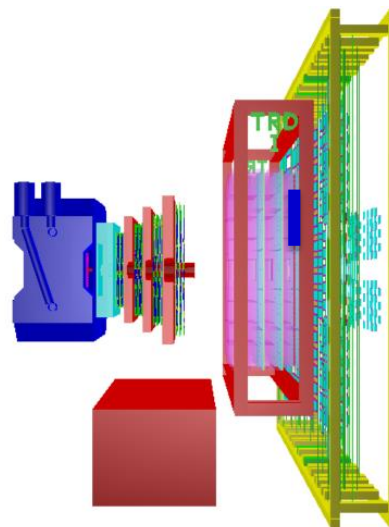
CBM setups



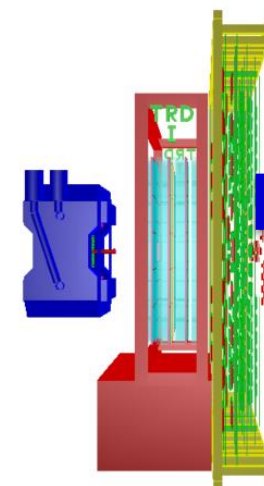
Sideview of different setups



ELEHAD



MUON



HADR

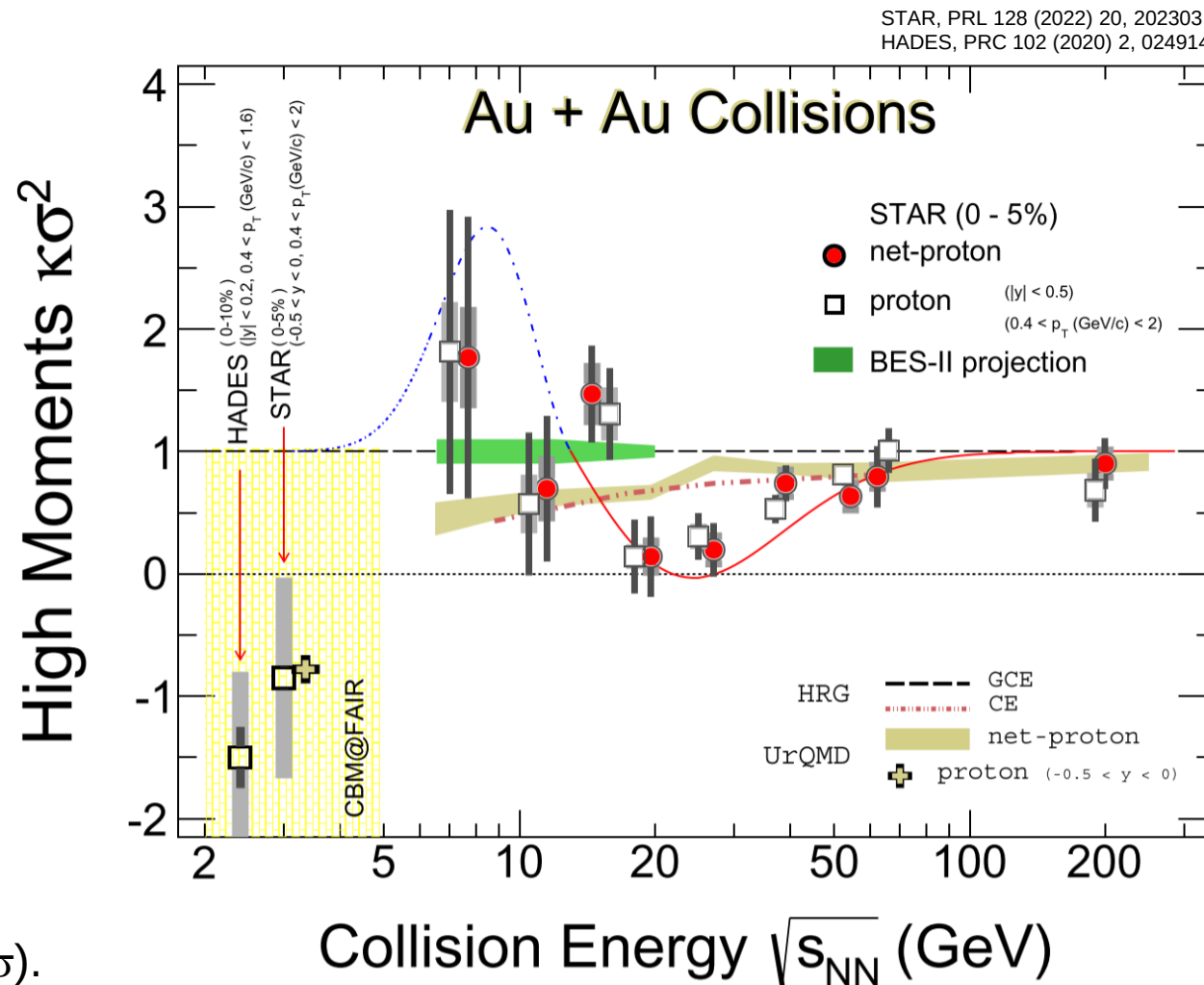
Setup	Included subsystems	Average day-1 interaction rate	Average MSV - interaction rate	Average event size in Au+Au collisions
ELEHAD	MVD,STS,RICH,TRD,TOF,FSD	0.1 MHz	0.1 MHz	75 kB
MUON	STS,MUCH,TRD,TOF,FSD	1 MHz	5 MHz	30 kB
HADR	STS,TRD,TOF,FSD	0.5 MHz	5 MHz	50 kB

Fluctuations of conserved quantum number
by higher moments of multiplicity distributions

$$K\sigma^2 \approx \frac{\chi_B^4}{\chi_B^2}$$

Search for critical end point

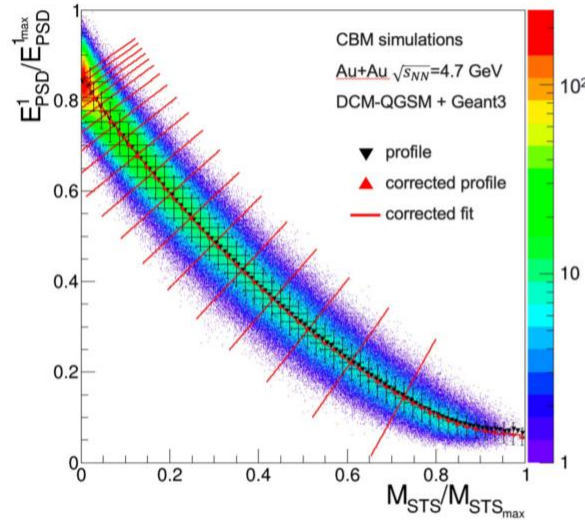
- Susceptibilities χ diverge at critical point,
- Measure ratio of 4th/2nd moment of (net)-proton multiplicity distribution,
- Non-monotonic behavior expected (observed 3.1 σ).



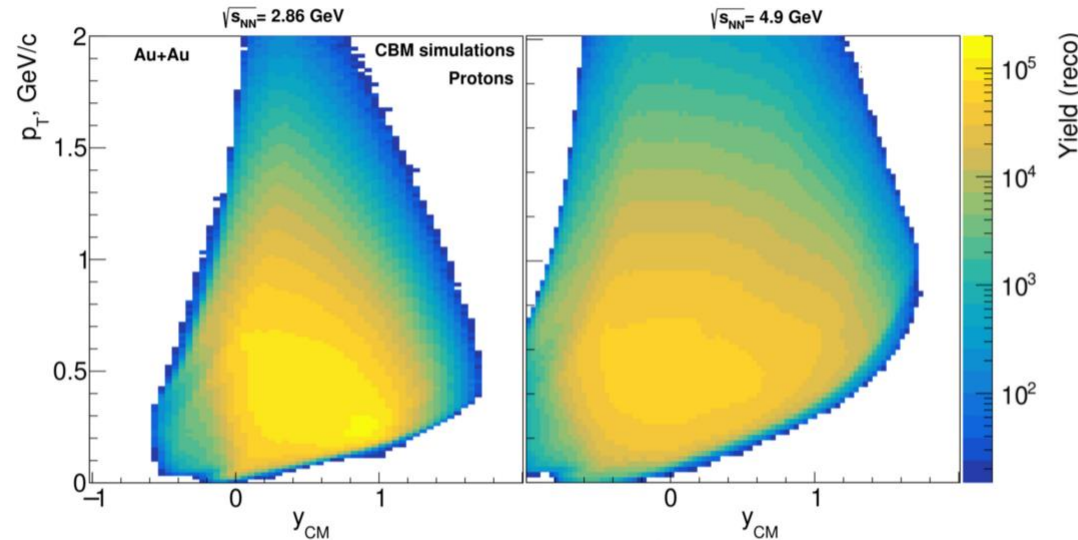
Net – proton fluctuations

- Corrections for volume fluctuations and conservation laws
- Event-by-event changes of efficiency
- Proper selection of $p_T - y$ bite
- (Net-)baryons vs. protons, neutrons, nuclei

Impact of the effects is being scrutinized

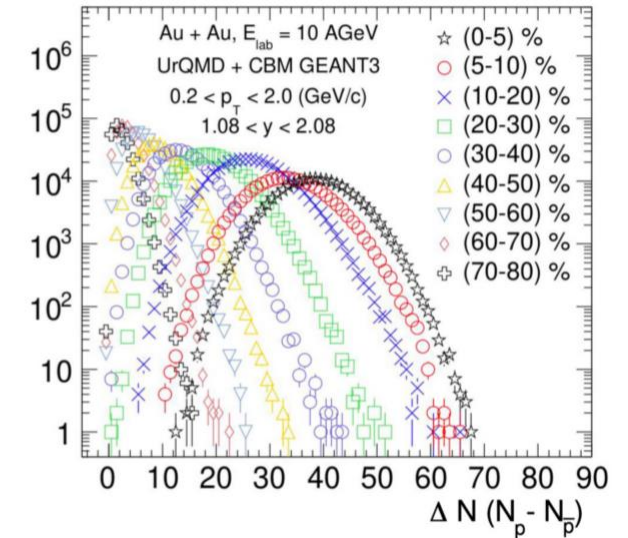


Crucial: centrality determination with independent detector → avoids bias on e-b-e fluctuation observables



Low p_T and midrapidity coverage

Reconstruction efficiency allows for precision measurement of cumulants

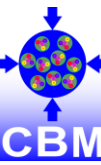


Statistics sufficient to study derivatives of order $> 0(4)$

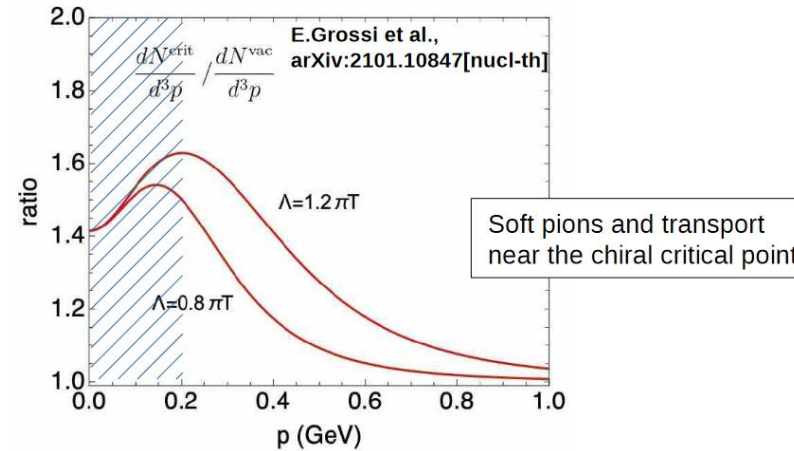
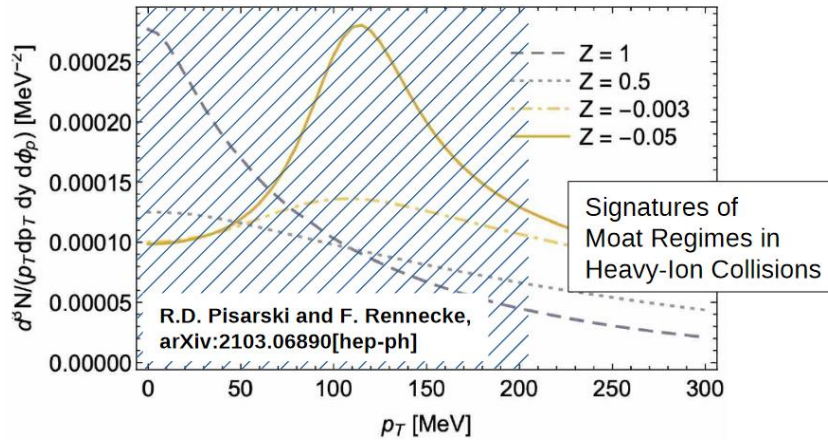
After 3 years of running:

- Completion of the excitation function for $\kappa_4(p)$
- First results on $\kappa_6(p)$
- Extension into strangeness sector $\kappa_4(\Lambda)$

Low transverse momentum acceptance at midrapidity

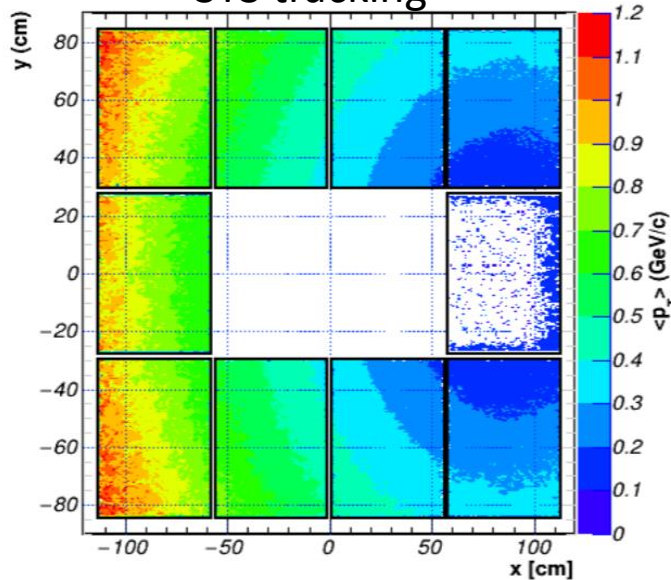


TRD2D physics case

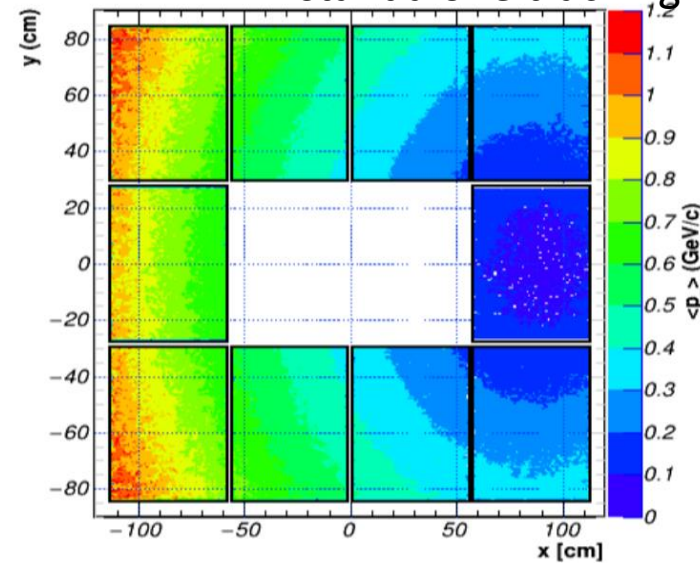


Signature of spatial constraints
-> by Fourier transform gives enhancement at low p_T

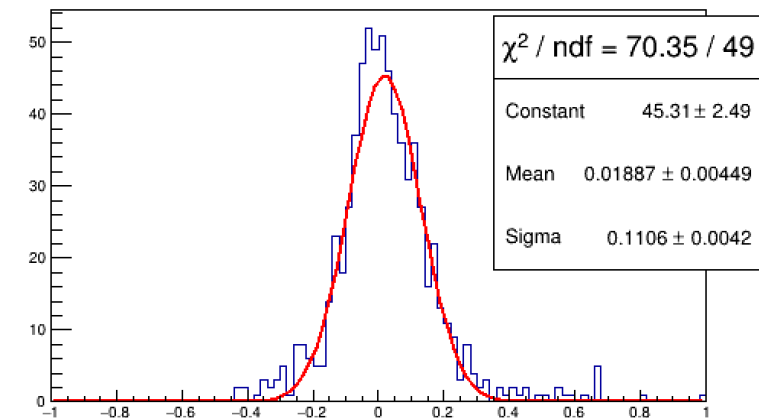
STS tracking



TRD2D standalone tracking

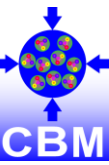


Resolution P Primaries [100%], No Sts hits

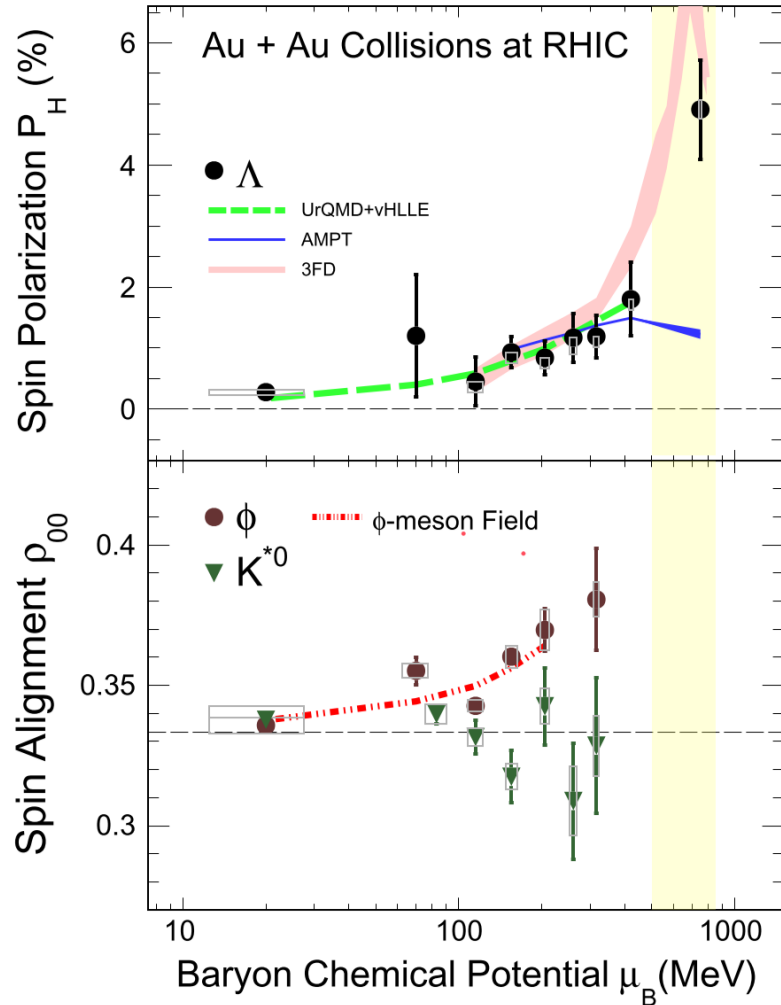


Downstream tracking enables momentum measurement

Global Spin Polarisation / Alignment / Vorticity

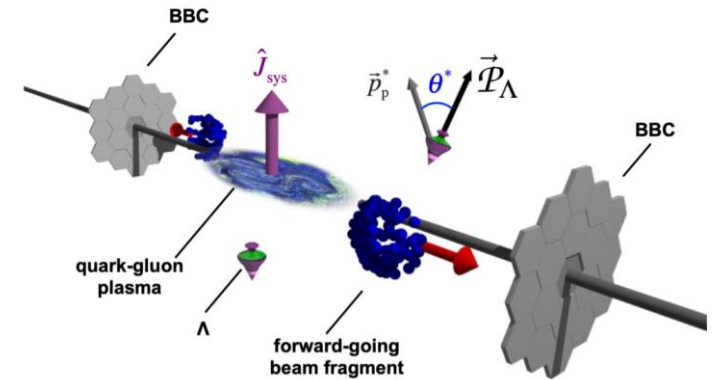


arXiv:2209.05009v2

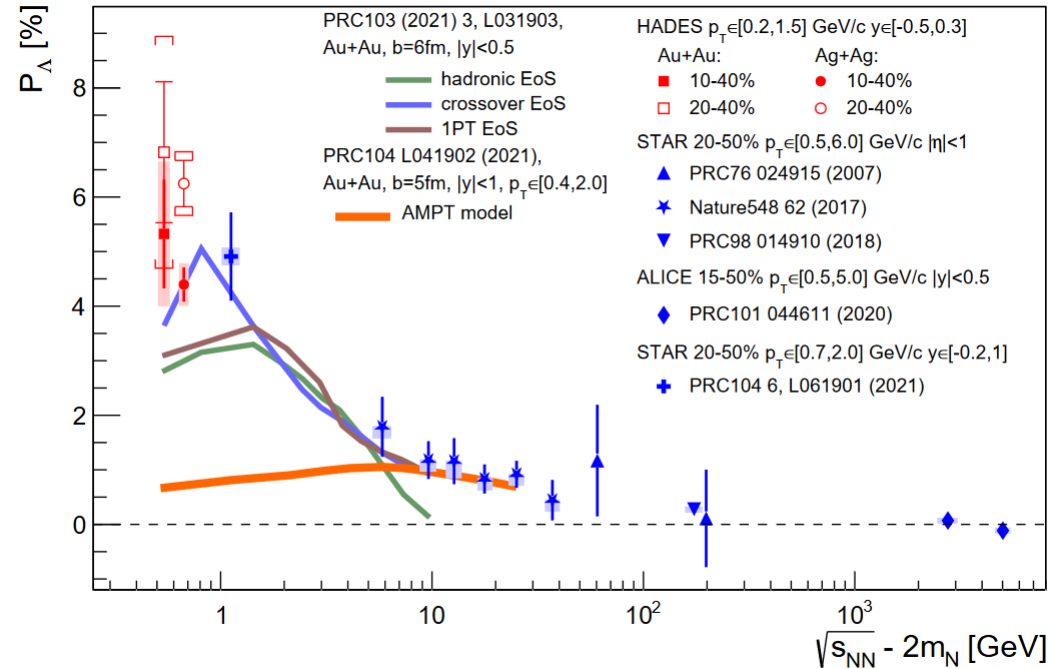


Observables pioneered by STAR

STAR, Nature 548 (2017) 62,
 PRC 104 (2021) 061901,
 arXiv: 2204.02302



HADES Phys.Lett. B 835 (2022) 137506, arXiv:2207.05160

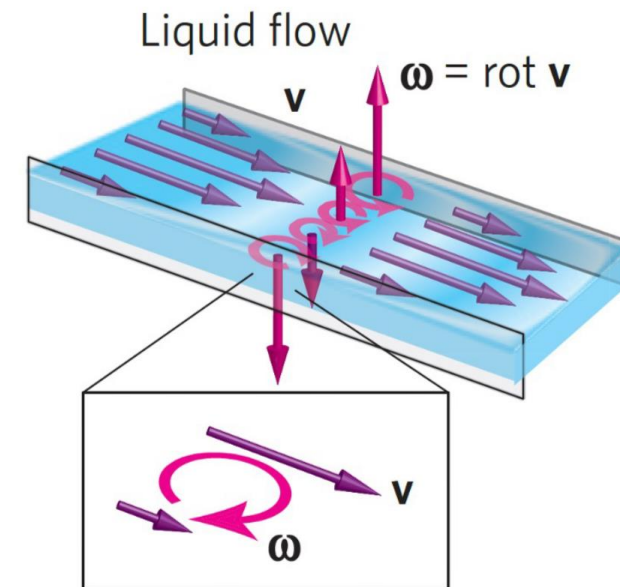
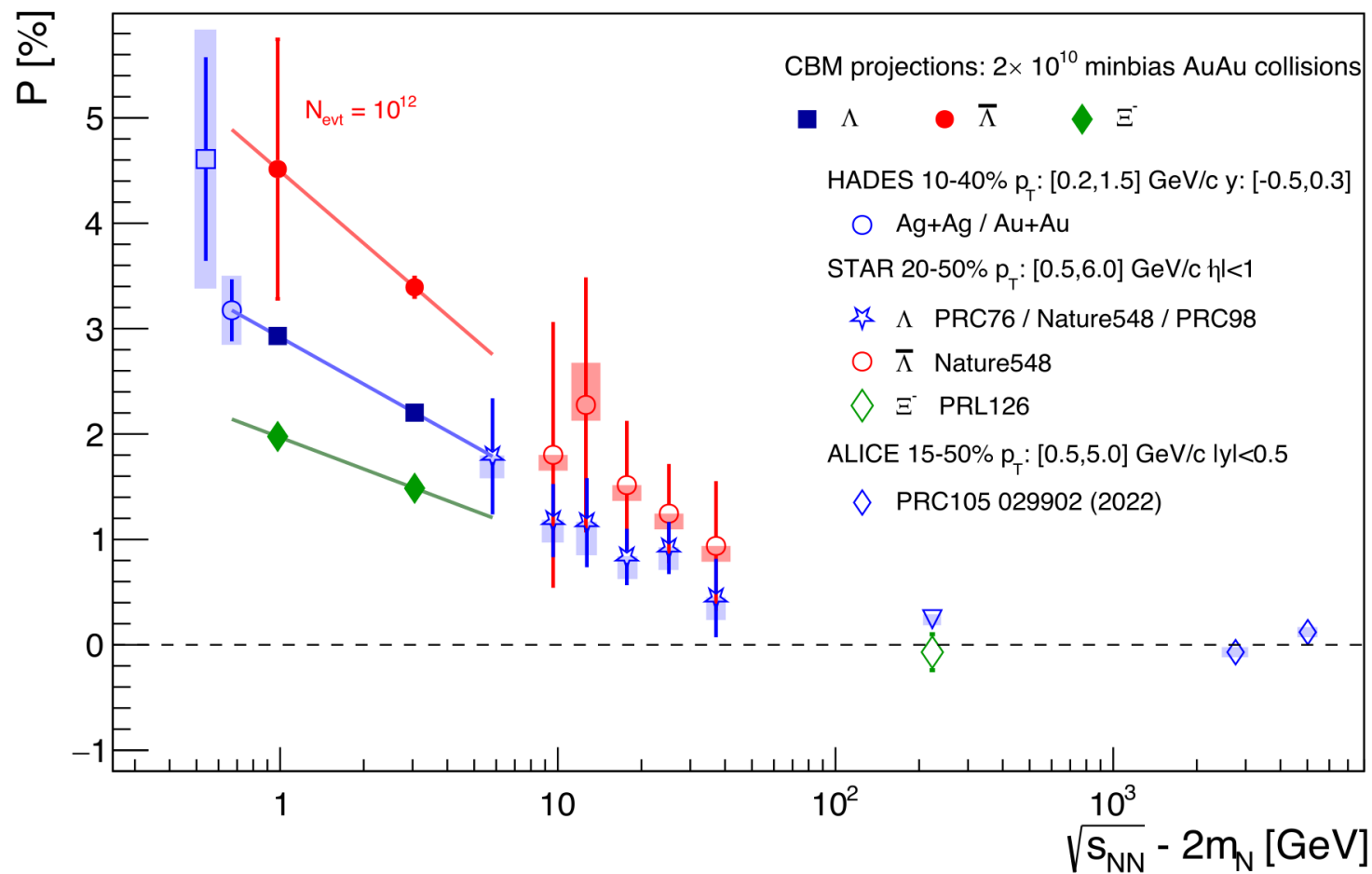


New sensitivities:

- thermal vorticity
- meson fields

Large data sets needed
 e.g. mapping of the
 excitation function for $\bar{\Lambda}$
 requires $\geq 10^{13}$ events.

Vorticity

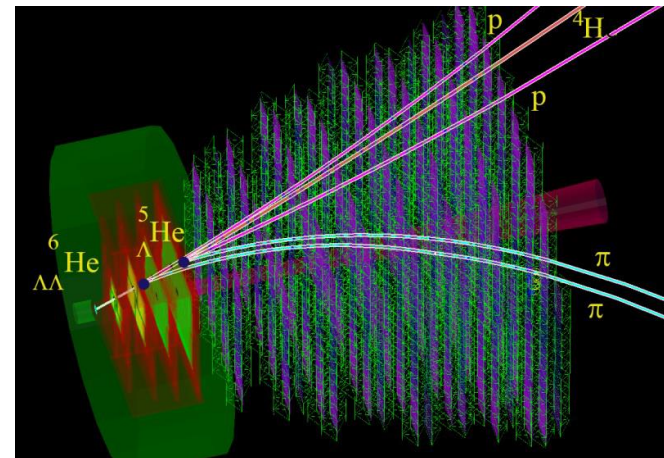
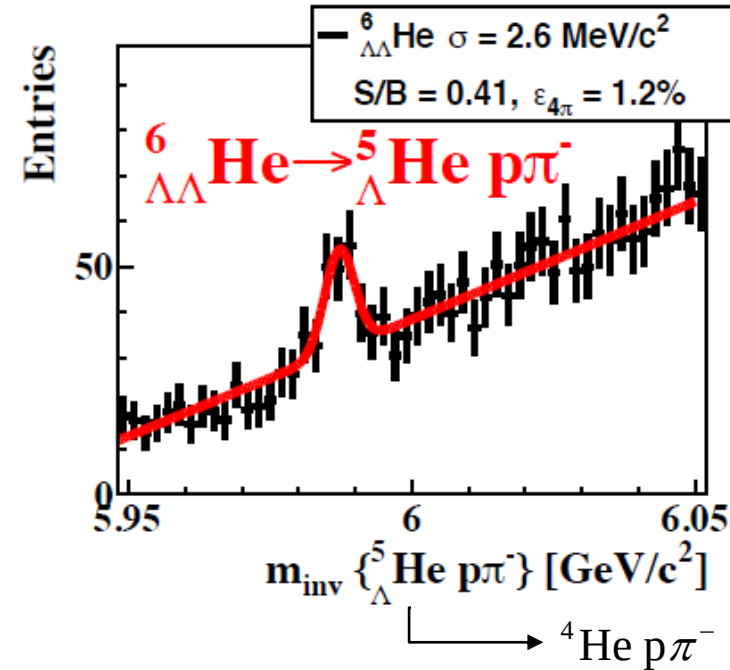
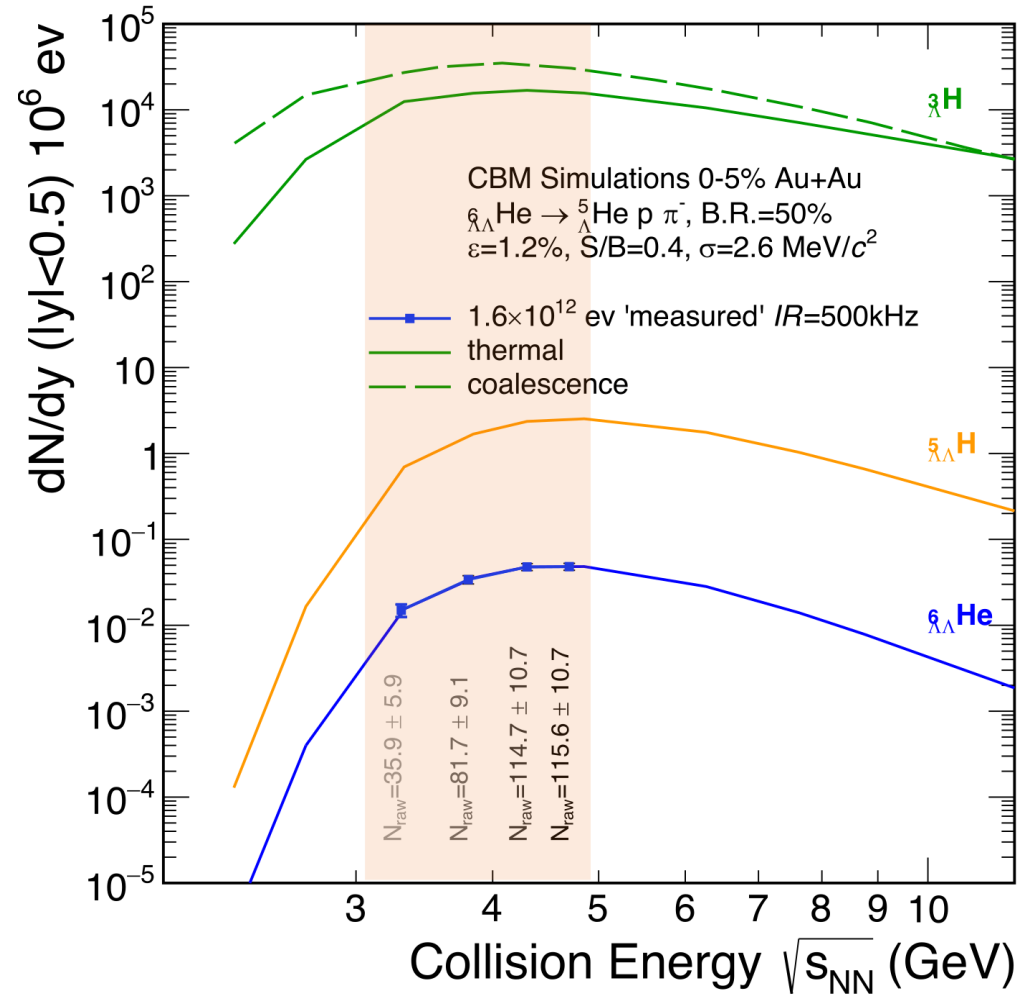


Driving mechanism for coupling orbital momentum to spin not understood yet.

Measurement of polarization of Λ and Ξ^- with precision of 5% possible.

Mapping of the excitation function for $\bar{\Lambda}$ requires $\geq 10^{13}$ events.

Hypernuclei

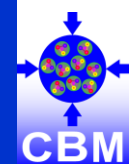


Lifetime and binding energy measurements are feasible with hadron setup.

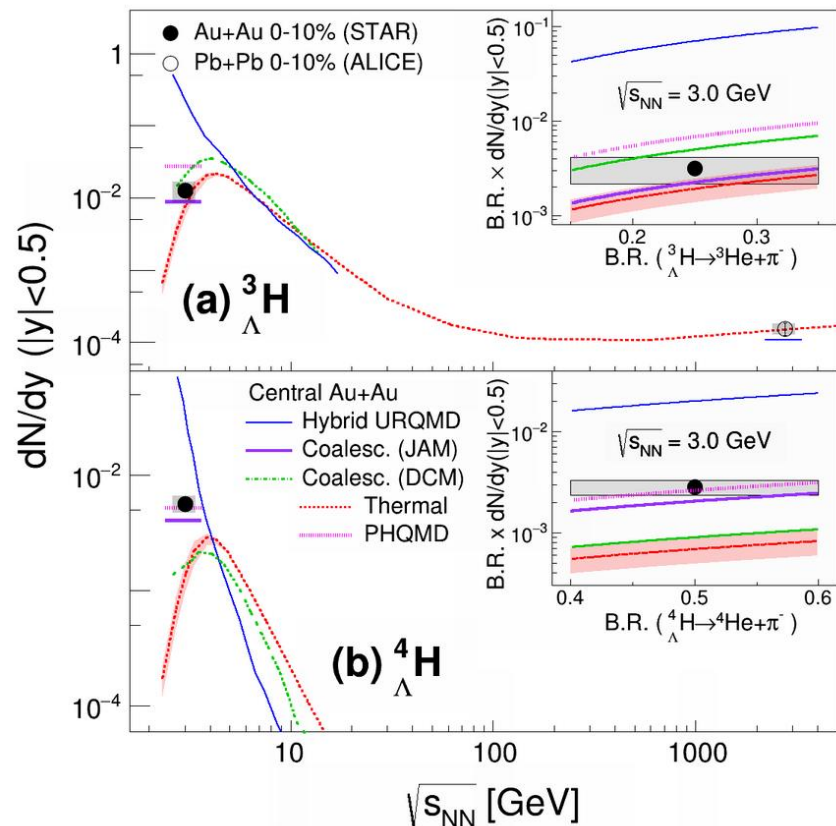
Production mechanism accessible through excitation function.

Data set will contain all the hypernuclei with larger production cross section

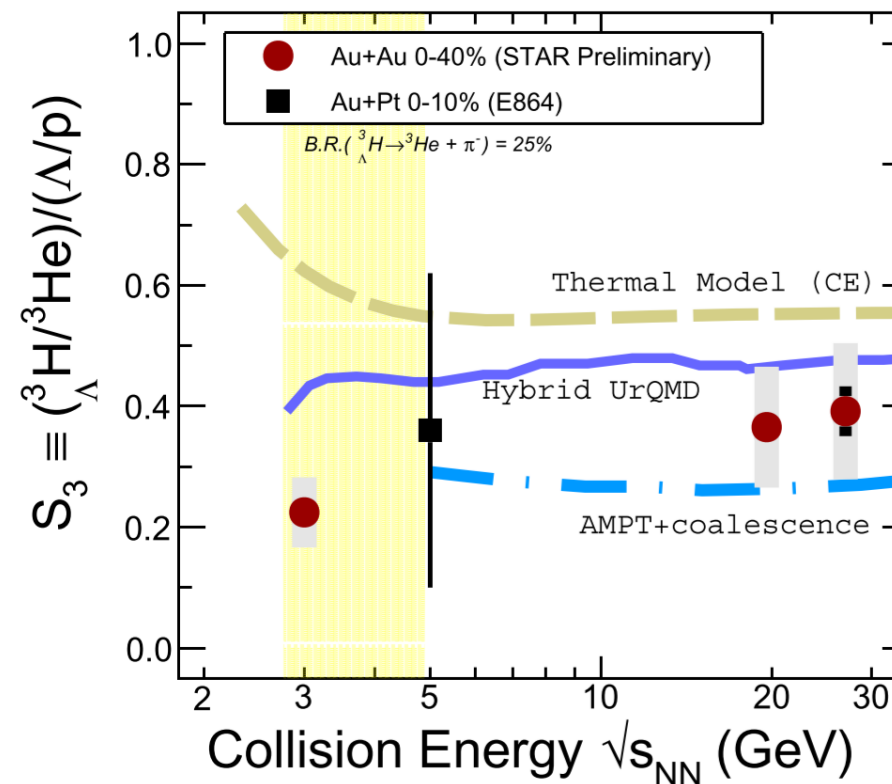
Hypernuclei as probe for dense baryonic matter



STAR, Phys. Rev. Lett. 128, 202301

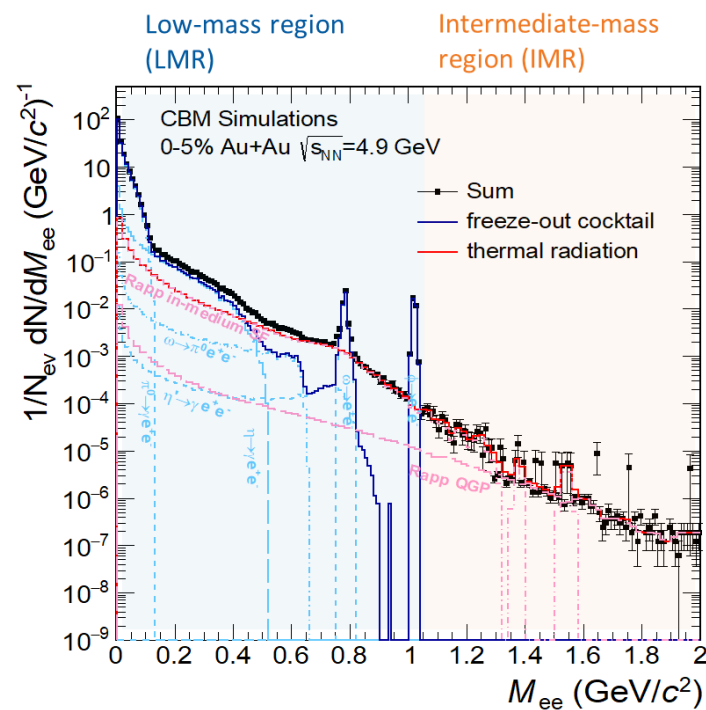
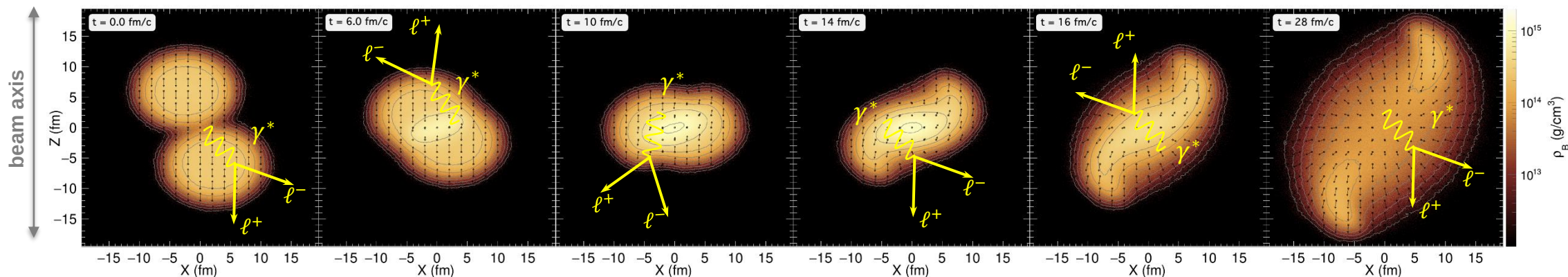
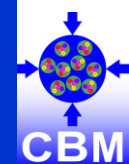


arXiv:2209.05009v2



- thermal light hypernuclei production is peaked around $\sqrt{s_{NN}} = 3 - 5$
- $\Lambda\Lambda$ – hypernuclei very rare -> require high rates / long run times
- production yields discriminate between models

Electromagnetic radiation

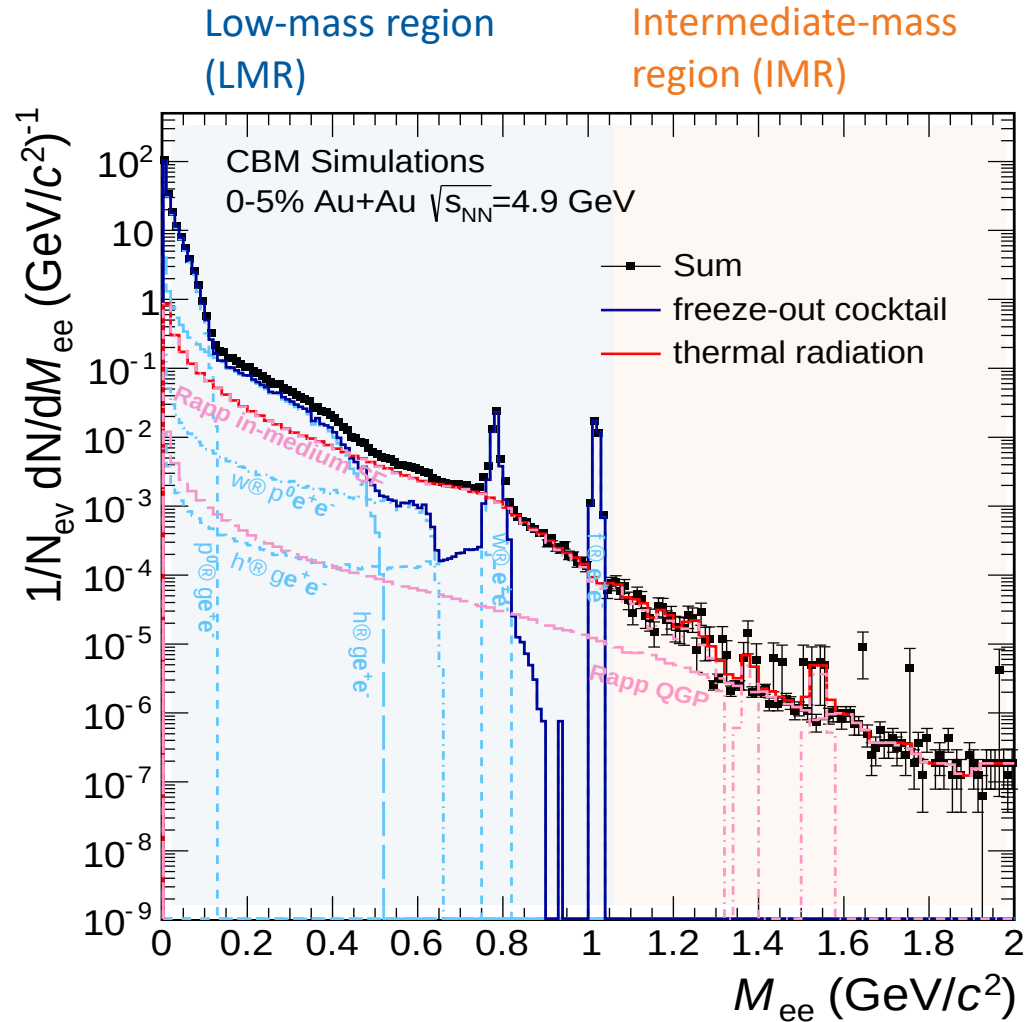
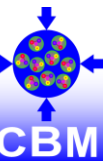


Electromagnetic radiation (γ, γ^*)

- no strong final state interaction
- integrates over whole history of collision
- sensitive to
 - degrees of freedom of the medium
 - fireball lifetime, temperature, polarization
 - transport properties
 - restoration of chiral symmetry

- LMR: total yield $\sim$ fireball lifetime
- IMR: slope $\sim$ emitting source temperature

Emissivity

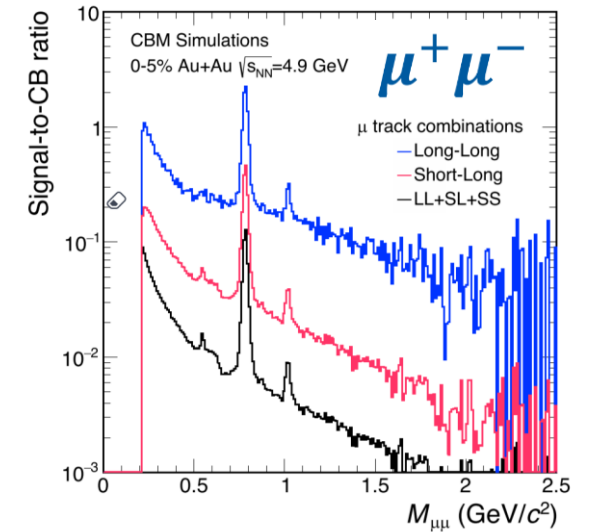
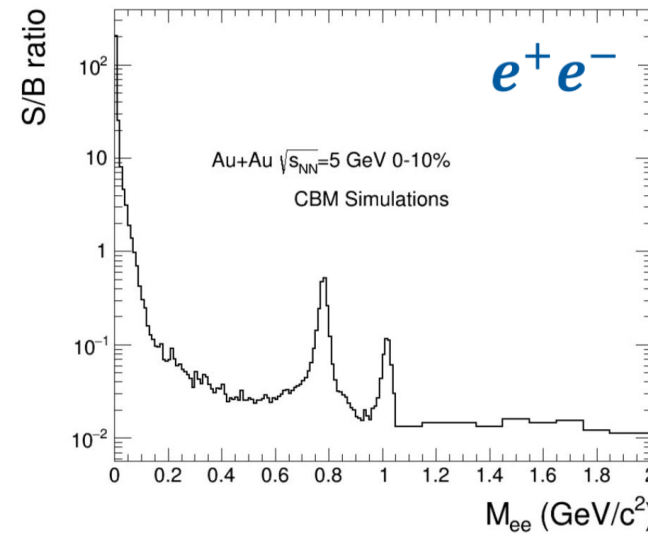


Electron-setup $R_{int} = O(0.1 \text{ MHz})$:

identification with RICH-TRD-ToF (π suppr. $\geq 10^4$);
major CB γ -conversions in target, π^0 Dalitz decays;
topological cuts used to reject CB, MVD needed $\rightarrow$ rate limitation

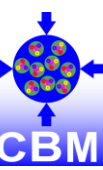
Muon-setup $R_{int} = O(1 \text{ MHz})$:

instrumented hadron absorber, low- and high energy configuration



Similar S/B and resolution

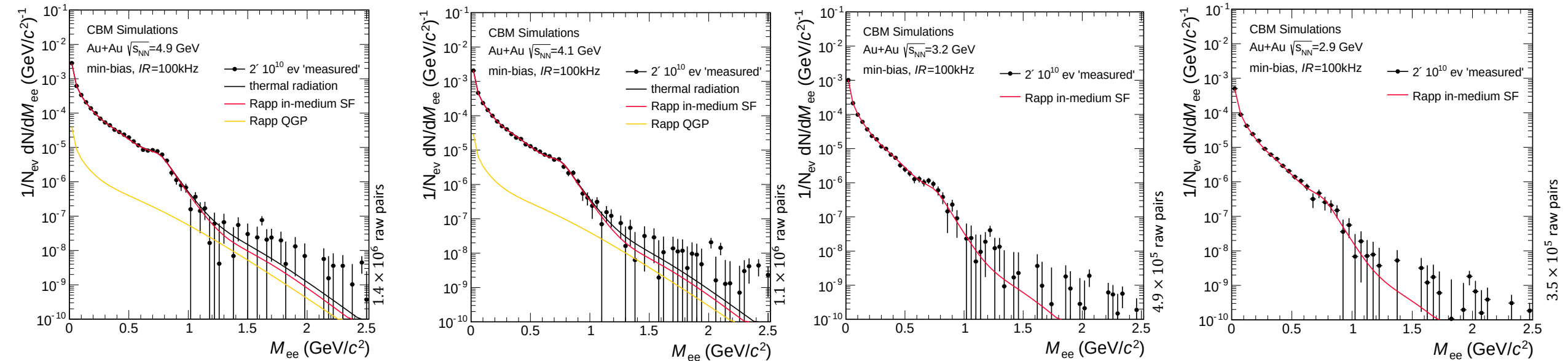
CBM dielectron performance (first 3 years, 5 days / energy)



Isolated dielectron thermal radiation yield, corrected for acceptance x efficiency:

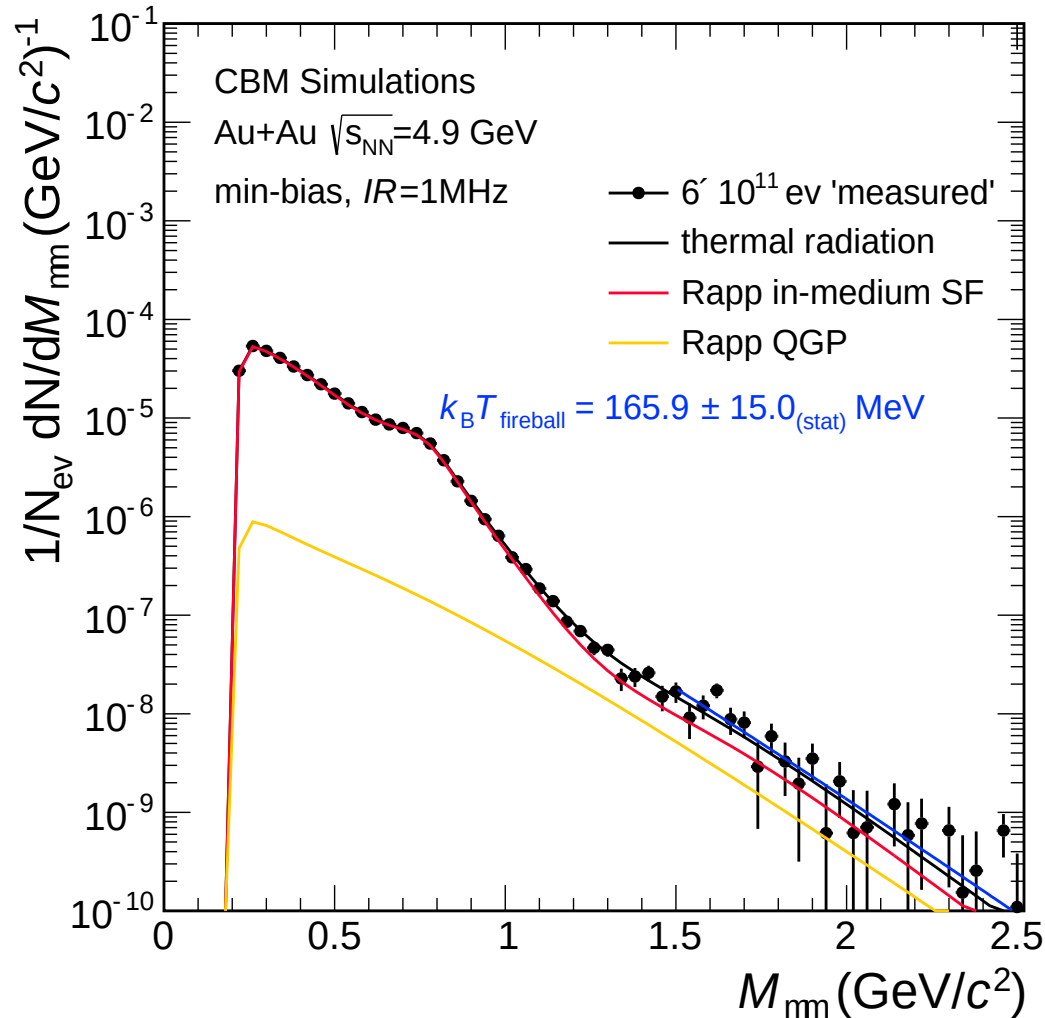
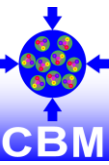
- Dominated by ρ contribution at low mass ($M_{\ell\ell} < 1 \text{ GeV}/c^2$); can be reconstructed with precision of 1.5 – 4.5%
 - allows fireball lifetime measurement
 - transport properties – electrical conductivity?
- Intermediate mass range ($M_{\ell\ell} > 1 \text{ GeV}/c^2$) accessible, statistics will not (yet) be sufficient to extract physics

$$\sigma_{el}(T) = -e^2 \lim_{q_0 \rightarrow 0} \frac{\delta}{\delta q_0} \text{Im} \Pi_{em}(q_0, q = 0; T)$$



T vs. baryon density effects
from partonic to hadronic fireballs

CBM dimuon performance (first 3 years, 15 days)

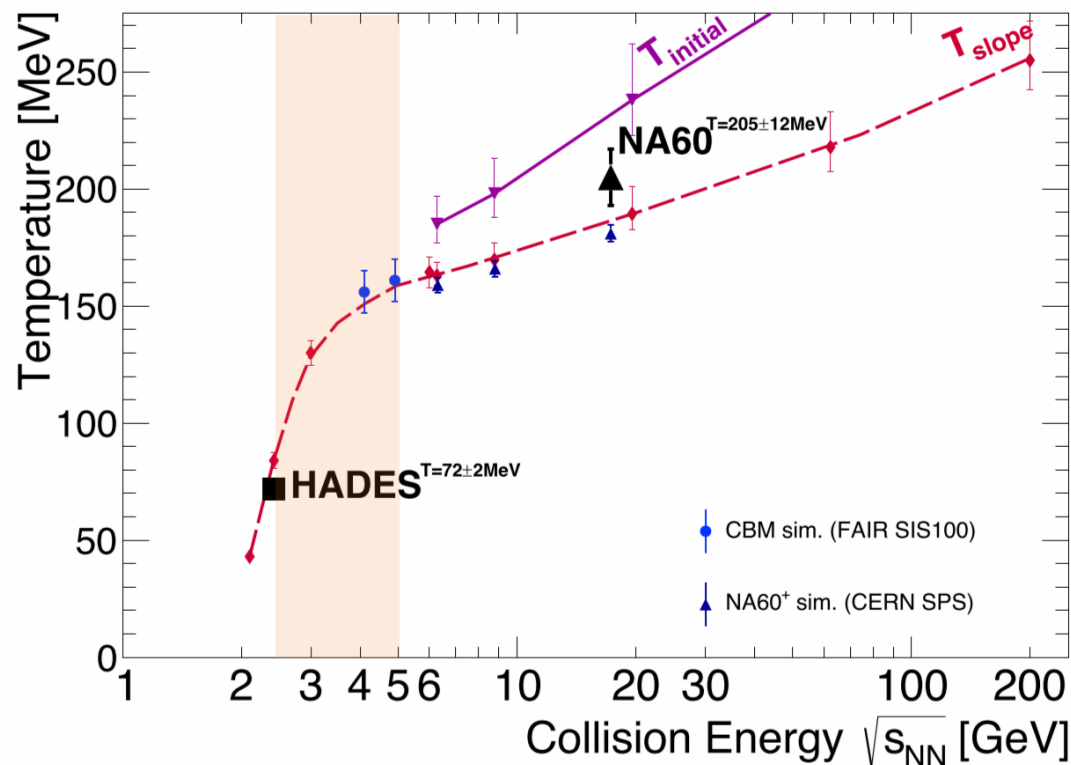
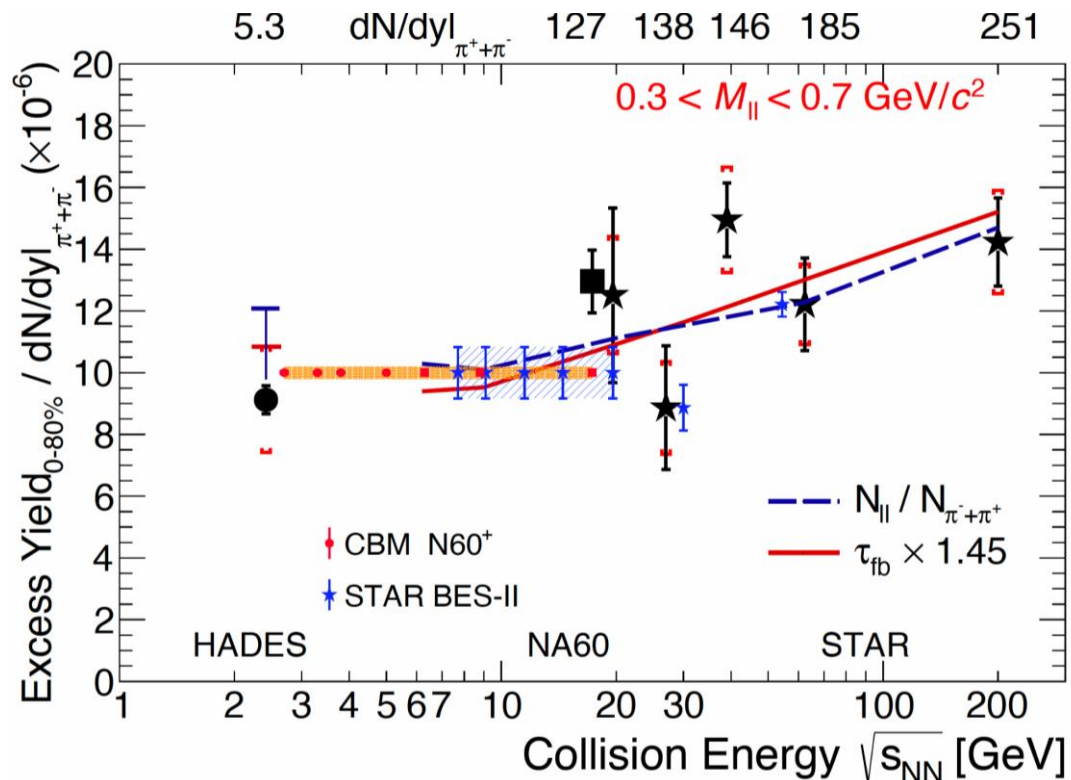
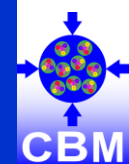


- IMR spectrum falls off exponentially
- In the IMR the dilepton rate is

$$\frac{dR_{ll}}{dM} \propto (MT)^{\frac{3}{2}} \exp\left(-\frac{M}{T}\right)$$

- Independent of flow: no blue shift!
- After first 3 years, **focus on two top SIS100 energies**
→ 9% uncertainty on the evaluation of T_{fireball}

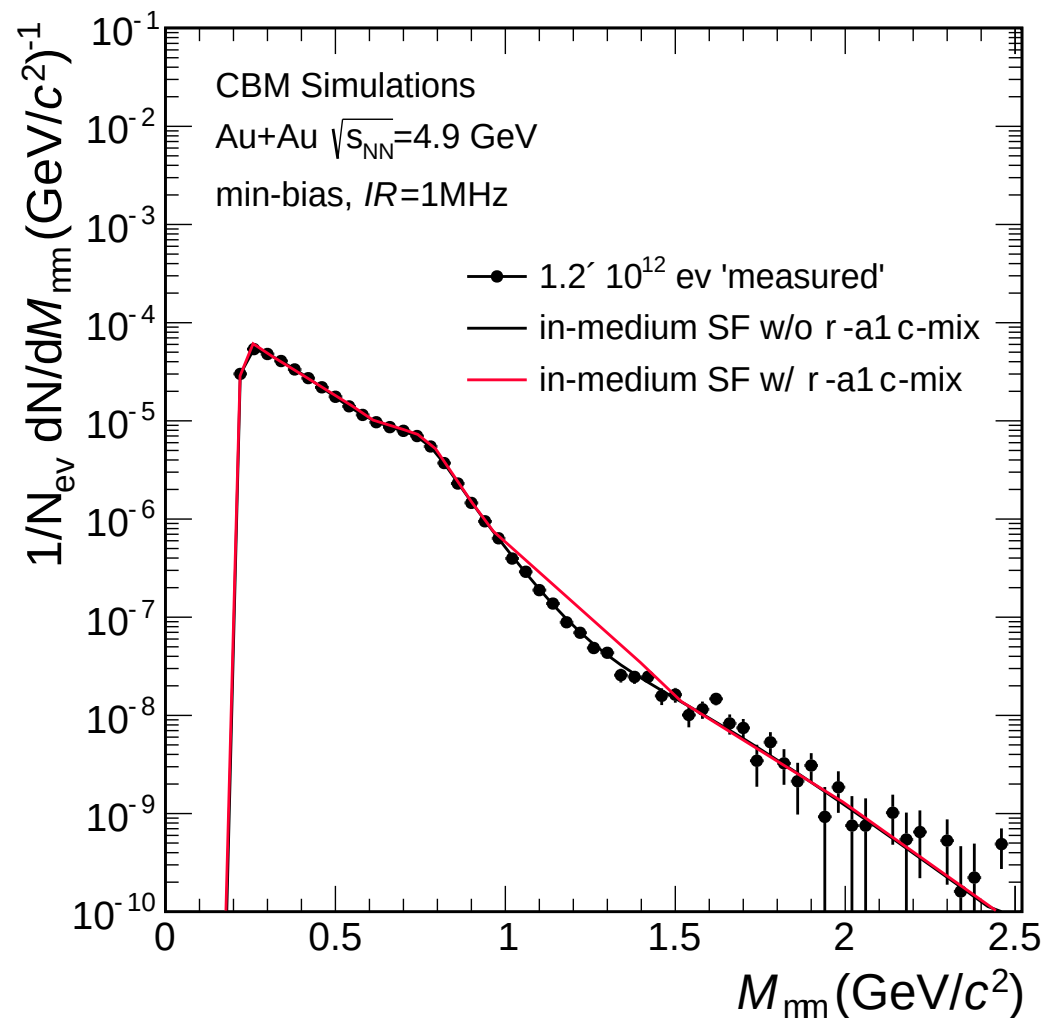
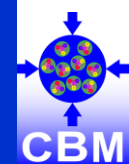
Emissivity with e^+e^- after first 3 years



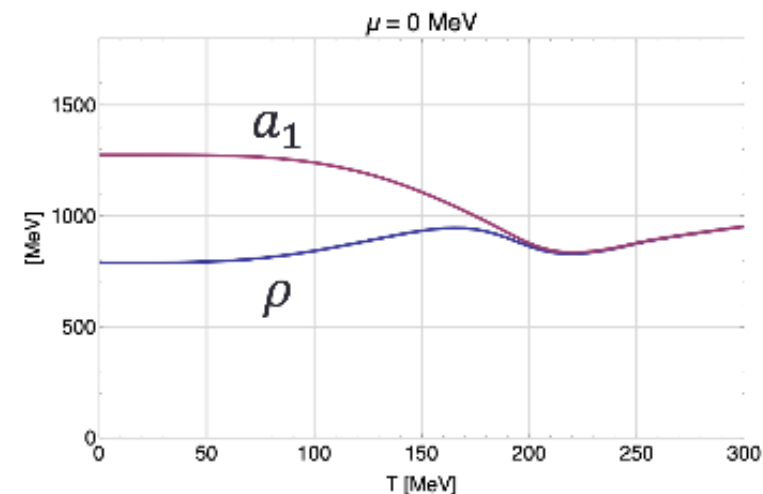
Excess yield in LMR tracks fireball lifetime
 Search for "extra radiation" due to latent heat at phase transition.
 Precision sufficient to observe 1st order phase transition, predicted to be of the order 2 – 3

Slope of invariant mass spectra in IMR measures source temperature
 Flattening of caloric curve (T vs ε) would give evidence for a phase transition.
 Statistics after 3 years not sufficient for conclusive results.

Chiral Symmetry Restoration



Jung *et al.*, PRD 95, 036020 (2017)
Hohler and Rapp, PLB 731 (2014)



Due to higher rate capability IMR accessible with $\mu^+\mu^-$.

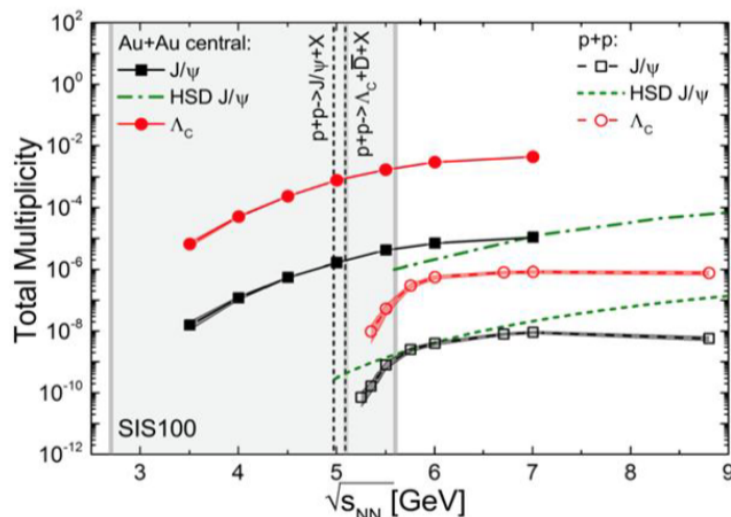
Focus on IMR with first MUCH measurements.

Chiral symmetry (degeneracy of ρ and a_1) accessible

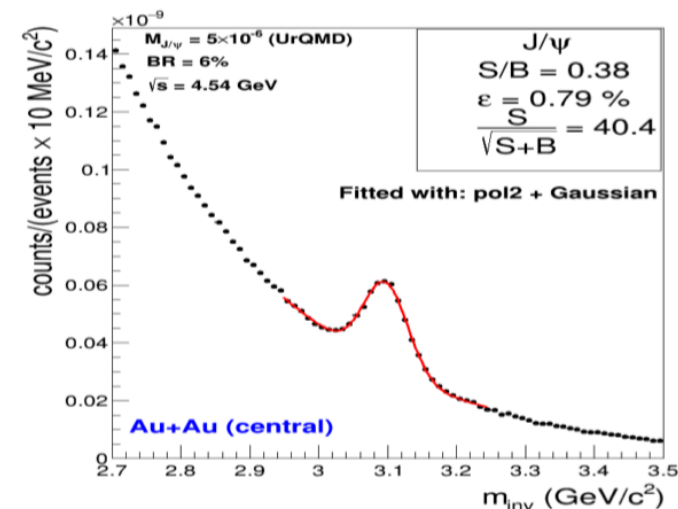
Charmonium at SIS100 in Au +Au collisions

P. Bhaduri, CPOD 2021

J. Steinheimer et al., PRC 95 (2017) 1, 014911



10 A GeV/c central Au+Au collisions



J/ψ production is rare but measurement is feasible

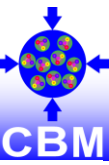
- Production below kinematic threshold
- Production via multiple collision process
- No data below collision energy 158A GeV

Reconstruction via $\mu^+\mu^-$ decay channel

- Clear signal peak $\rightarrow$ feasible detection
- Detectors: STS+MuCh+TRD
- Expected yield:
 $\sim 30K$ J/ψ in 4 weeks @ $R_{int} = 10$ MHz

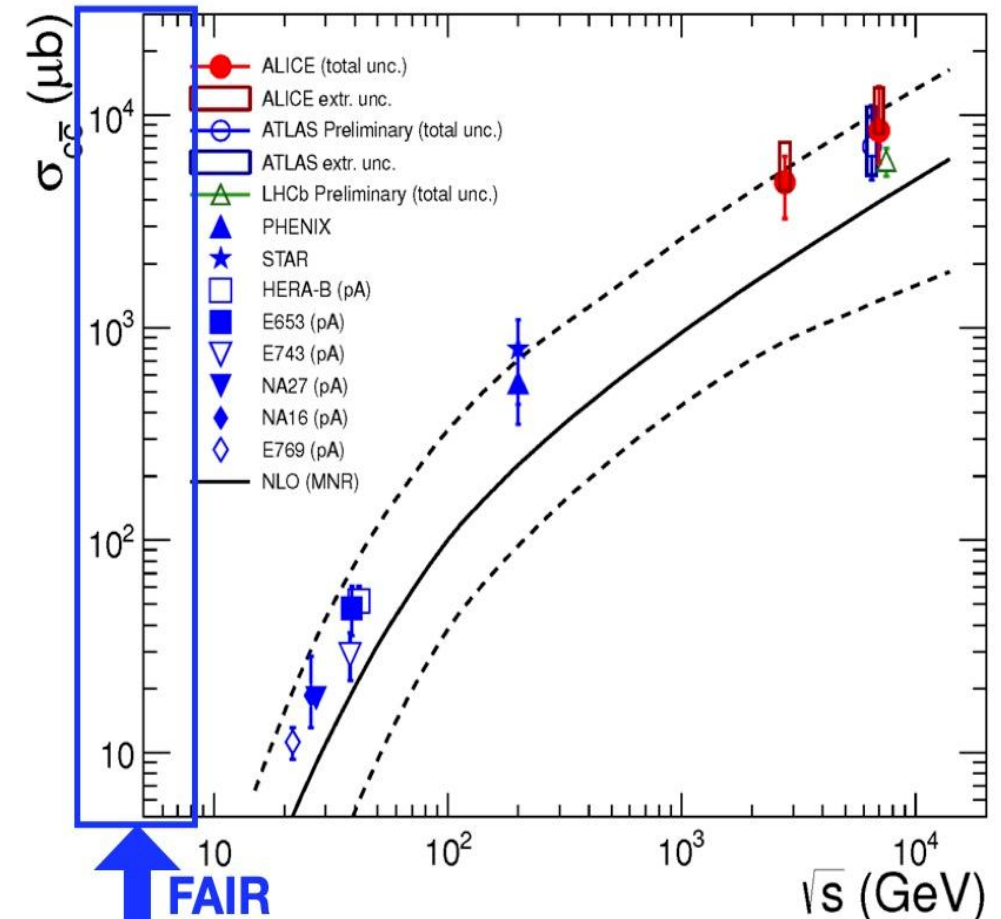
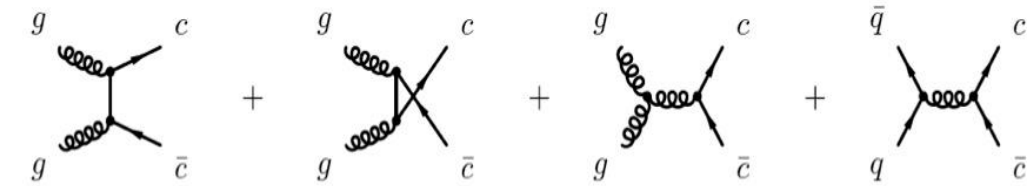
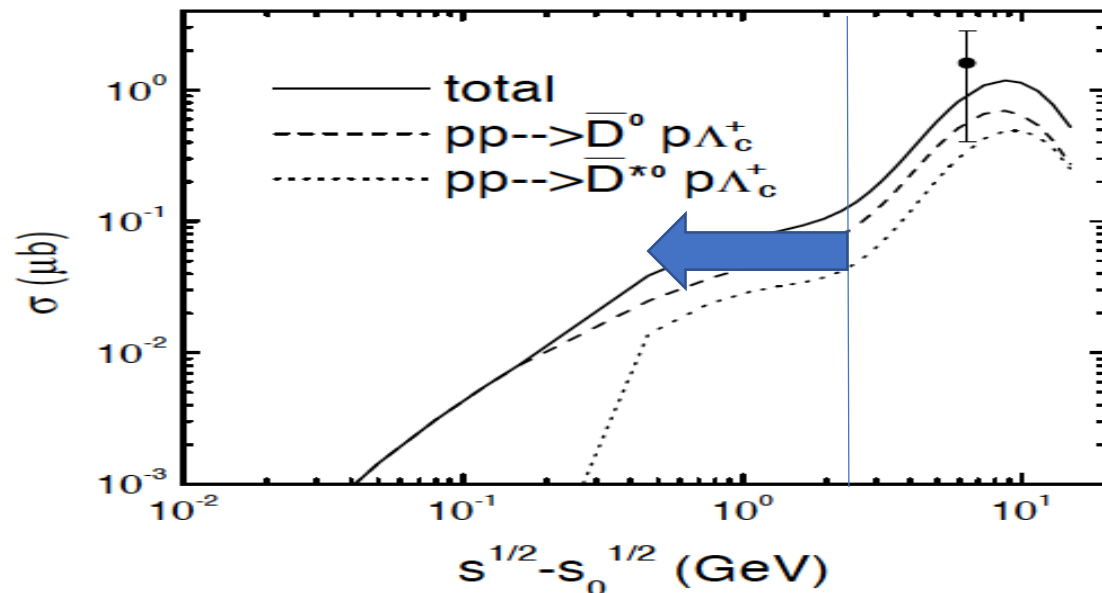
Note: Charm production threshold can be exceeded with proton and N=Z isotope beams from SIS100.

Charm production, charm-N interaction



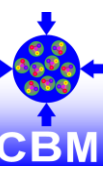
- Validity of pQCD at SIS100 energies?
- SU(4) estimates for (exclusive) charm hyperon production up to 100 nb@SIS100
- Perspectives to study for the first time near-threshold charm production at FS+ .

Nucl. Phys. A728 (2003) 457-470



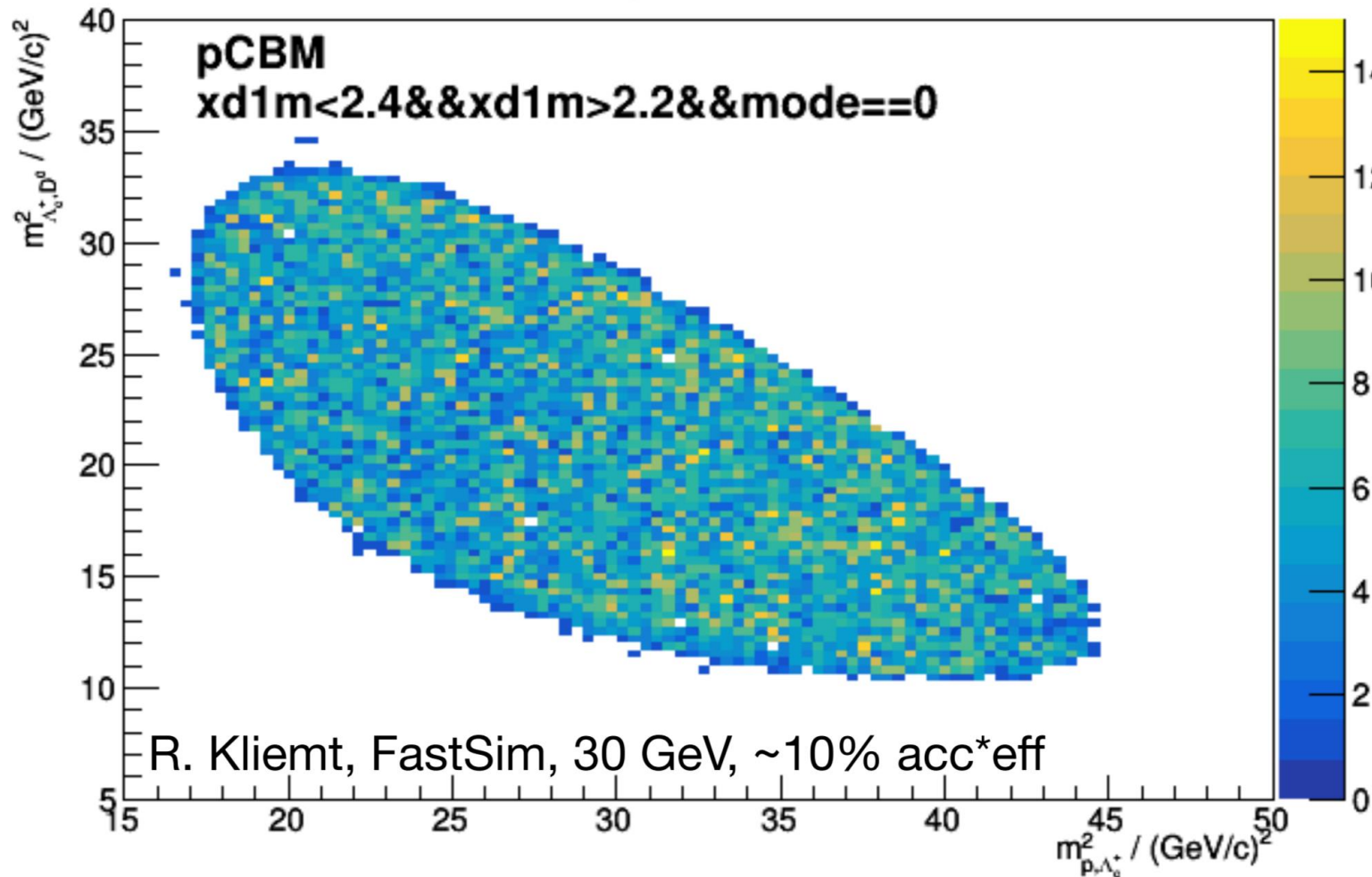
Can IC of nucleon enhance production cross section? (Analogy of ss bar content in nucleon and ϕ production)

CBM projection for studying exclusive reactions



$$pp \rightarrow p\Lambda_c(\rightarrow pK^-\pi^+)\bar{D}_0(\rightarrow K^+\pi^-)$$

Dalitz plot:



Rate estimate:

Cross section: 100 nb

Beam Intensity: 10^{12} 1/s

Target: LH2

Target thickness: 5 cm

Duty cycle: 50%

$\Rightarrow$ Detected reaction rate
(including BRs): $1 \text{ Hz} = 8.6 \cdot 10^4 / d$

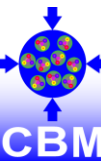
Detailed studies pD and $p\Lambda_c$ interactions
become possible (femtoscropy).

Ongoing discussions with PANDA groups: J. Messchendorp, J. Ritman, P. Salabura

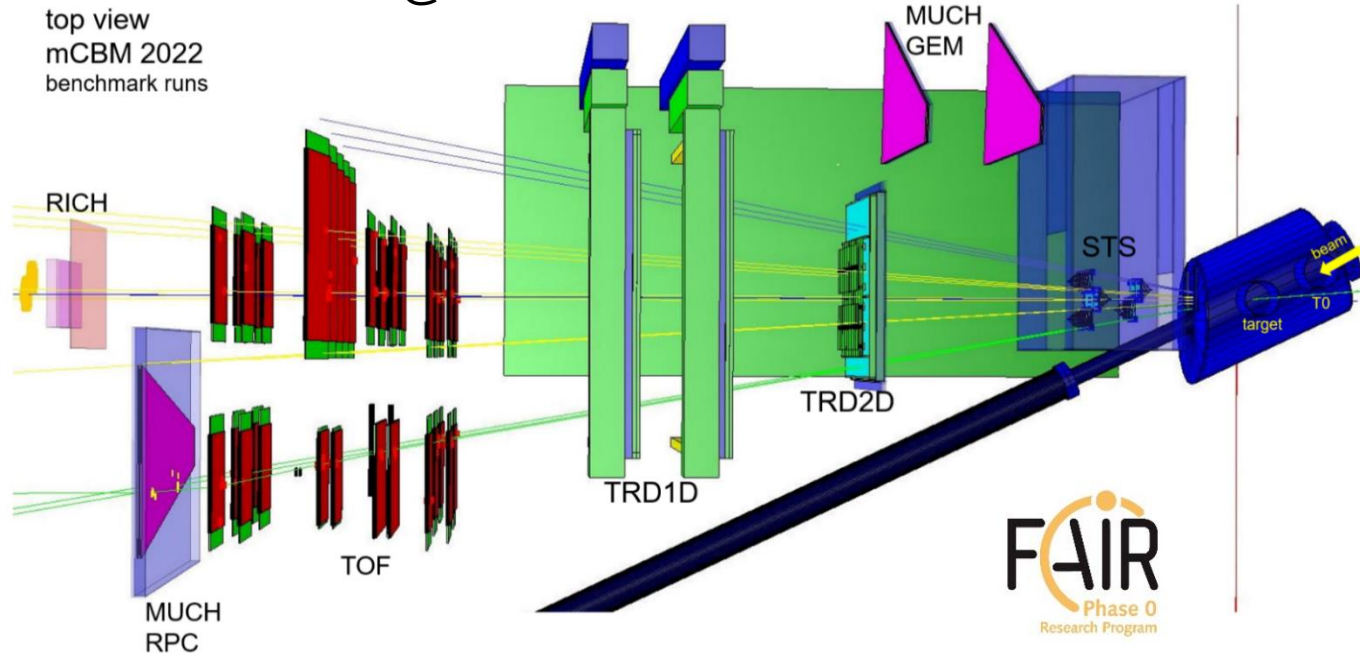
Further questions to be addressed (incomplete list):

- Input to heavy ion reactions, e.g. huge underprediction of Ξ
- Hyperon ($S=1,2,3$) and N^* (e.g. $N^* \rightarrow \Xi KK$) spectroscopy
- YN , YY interactions (like femtoscopy)
- Hyperon structure $Y^* \rightarrow Y \ell^+ \ell^-$ (eTFF studies)
- Low-energy constants in chiral $SU(3)$ via axial-vector TFF, e.g. $\Xi^* \rightarrow \Xi \pi \gamma$

With mCBM towards CBM



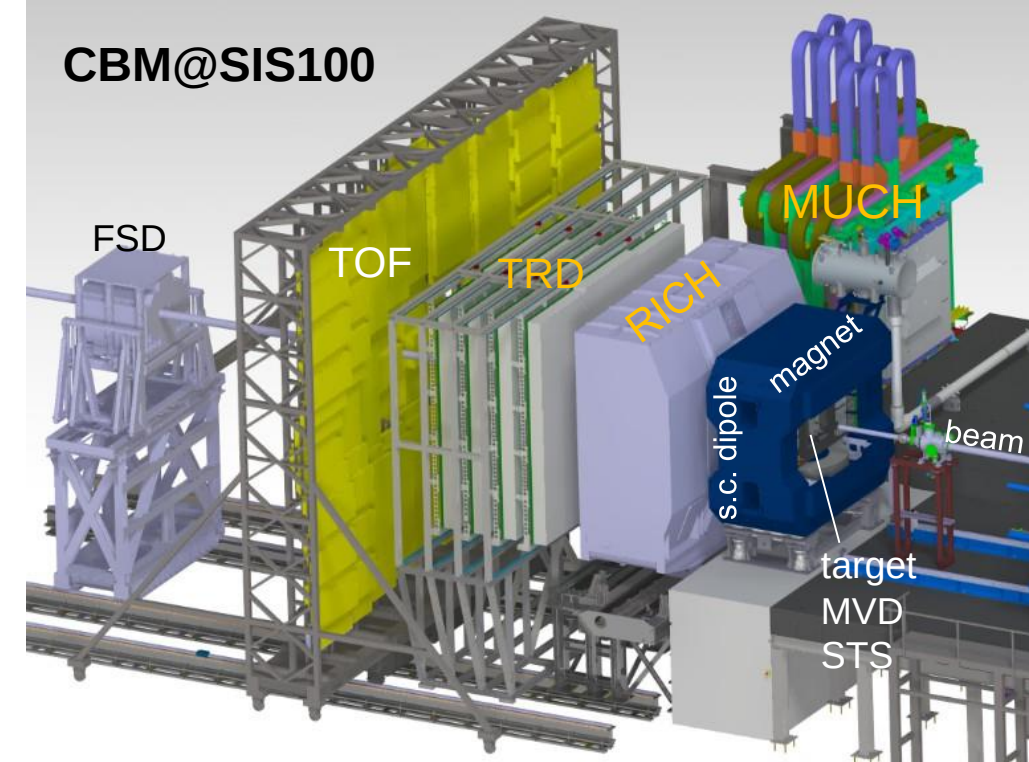
mCBM@SIS18



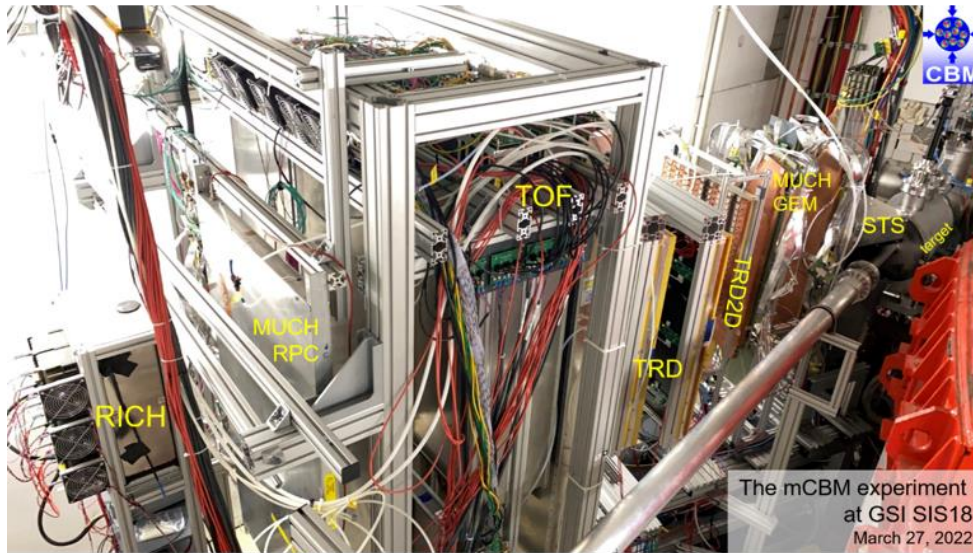
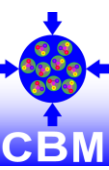
CBM full-system test setup at SIS18/GSI comprising pre-series productions of all CBM detector systems:

T0	16+16ch pcCVD diamond, 1x1cm ² , 80 μm, part of BMON
STS	11 modules, 6x6cm ² and 6x12cm ² double-sided silicon-strip sensors, 5 ladders on 2 stations
MUCH	2 GEMs M2 modules (MUCH 1+2), 1 RPC (MUCH 3+4)
TRD	2 MWPCs with rect. pad (TRD1D, outer region), 1 MWPC with triang. pads (TRD2D, inner part)
TOF	8 MRPCs modules in 2 stacks
RICH	2 aerogel radiators (2 20x20cm ²), 36 MAPMTs
FSD and MVD test systems in preparation	

CBM@SIS100



The free-streaming CBM DAQ and data processing



optical
fibers
50m



DAQ container

CRI (PCIe)
@ FLES
entry
nodes

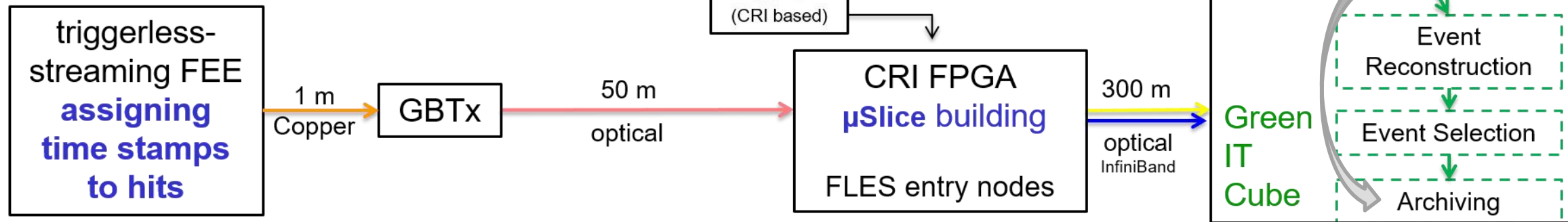


optical
fibers

300 m

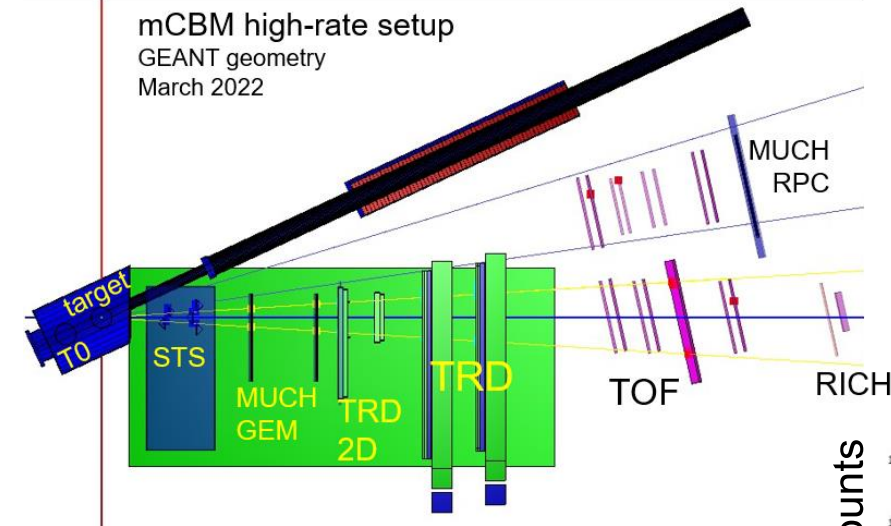


FLES
processing
nodes



1st test version of an (FAIR MQ based) online selection

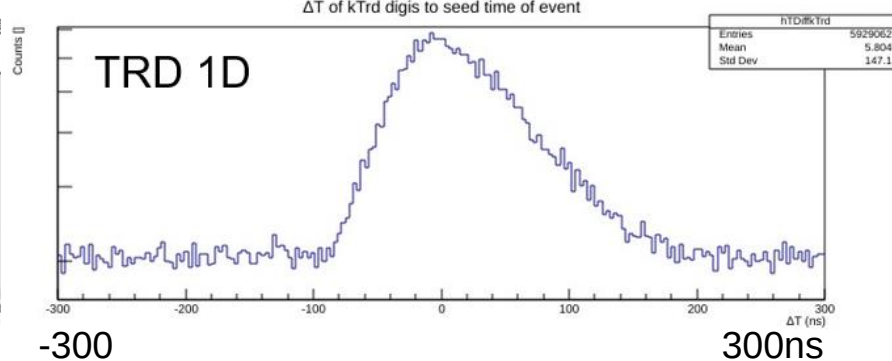
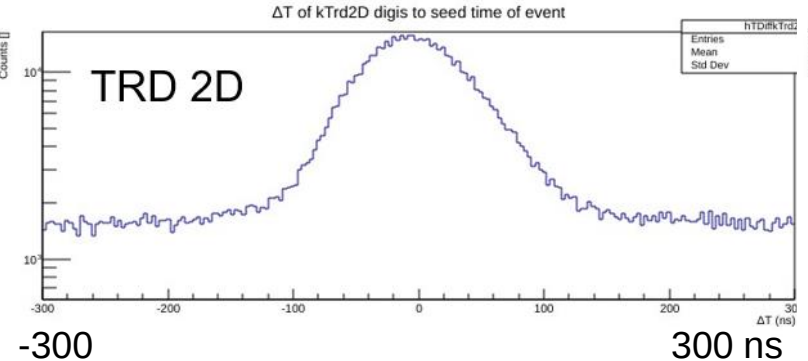
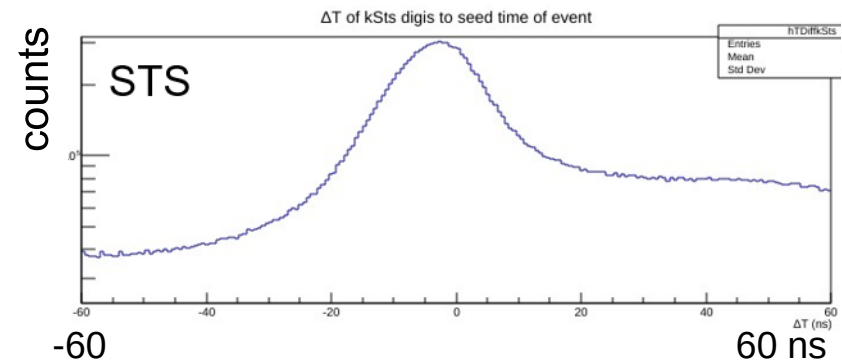
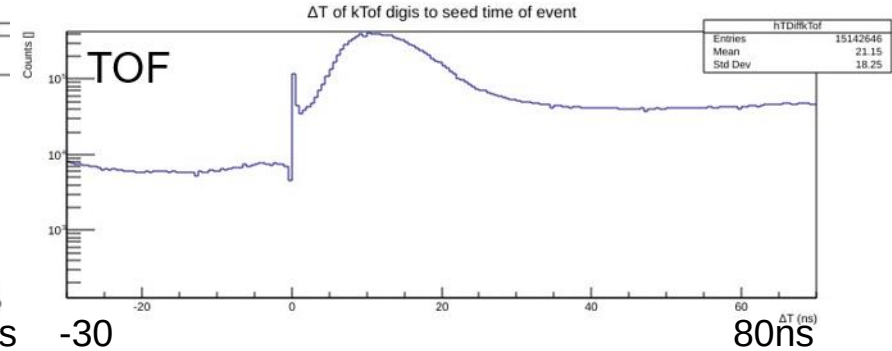
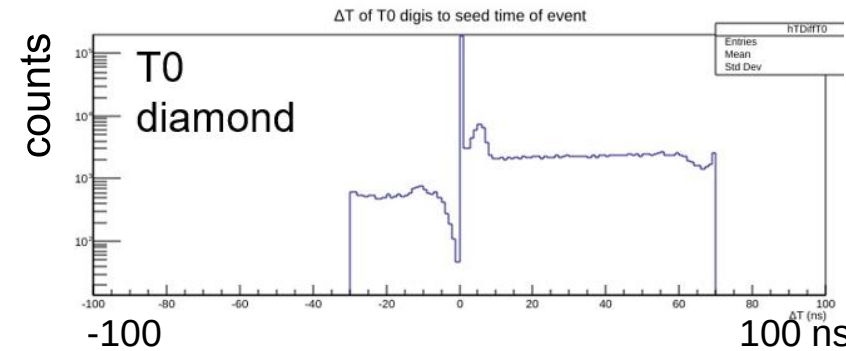
mCBM high-rate setup
GEANT geometry
March 2022



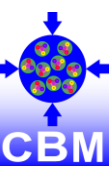
run 2188, March 31, 03:15 CET,
 10^7 U ions per spill, approx. 100 kHz averaged collision rate

Applied
filter condition: 1 T0 hit, 2 STS hits, 5 TOF hits ("Λ trigger")

coincidence with T0

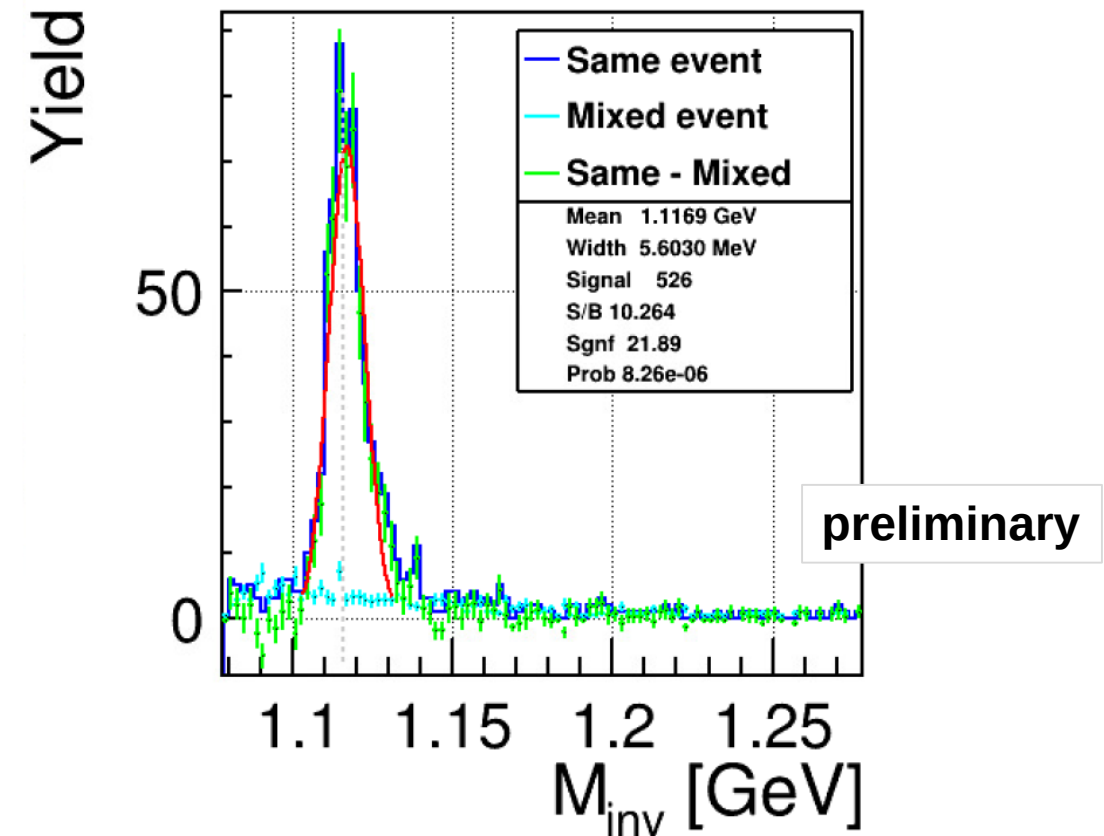
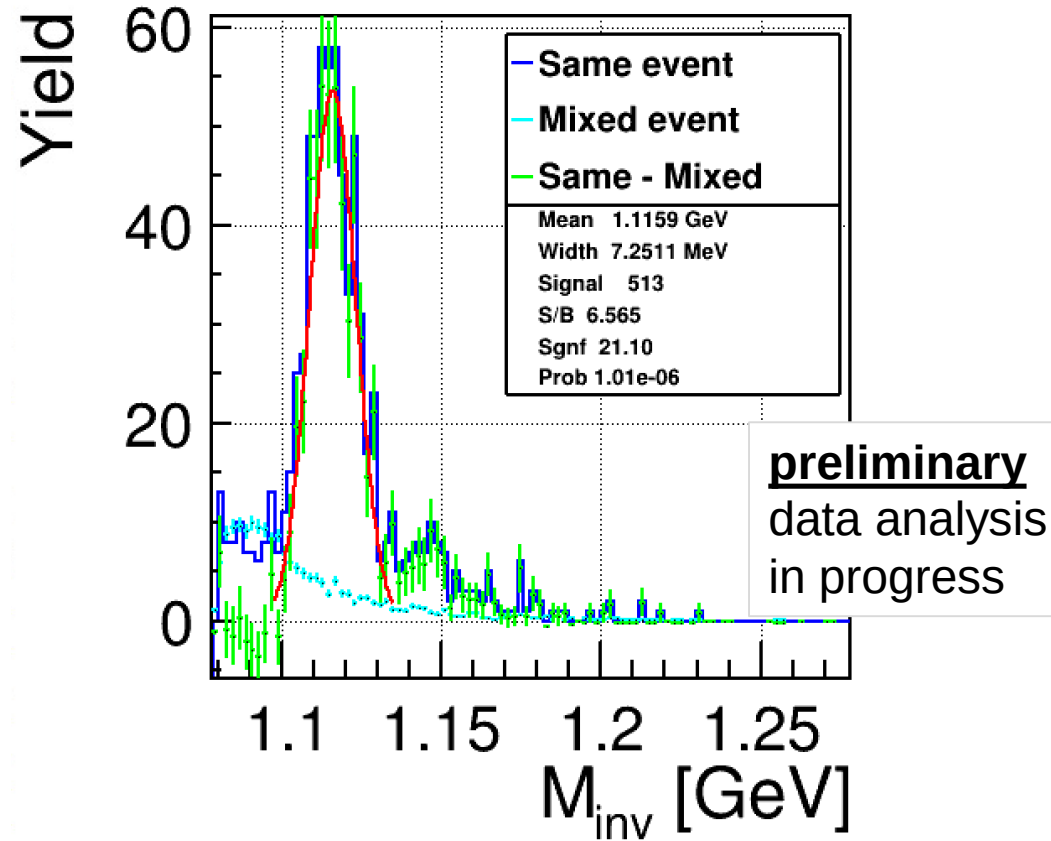


Λ reconstruction in Ni+Ni collisions at 1.93 AGeV



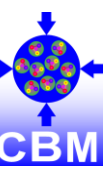
Data, run 2391, total run duration **1:57h**
4x to 5x10⁷ ions per spill, 10s spill
400 - 500 kHz average collision rate

MC , identical reconstruction chain
100 M generated events
10⁵ events / s
63.7 M triggered events



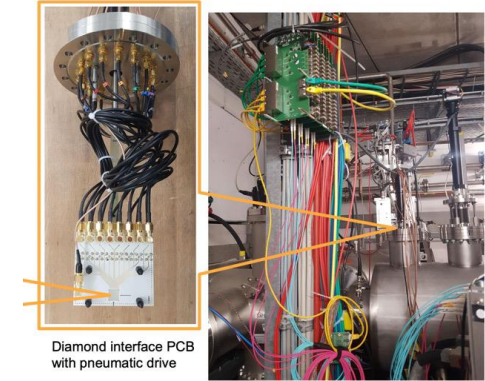
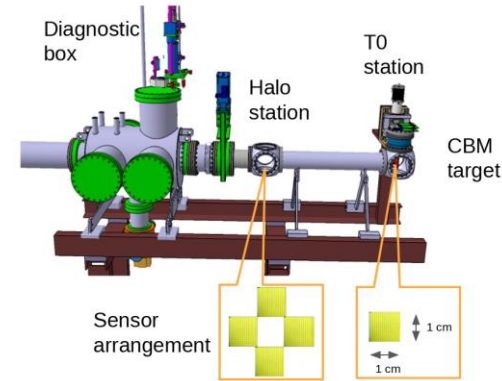
rare signal reconstructed - milestone reached !

Status of CBM detector systems



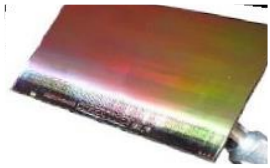
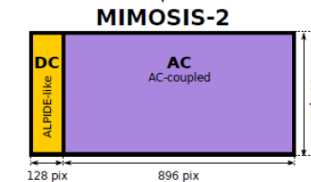
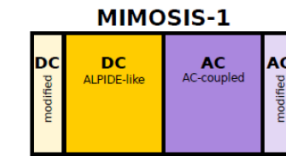
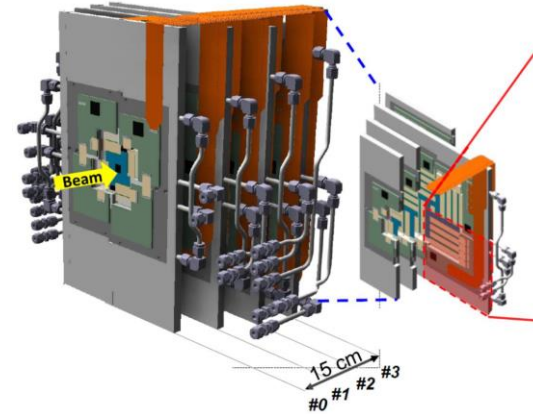
Beam Monitor (BMON)

- T0 high purity pcCVD diamond demonstrator successfully tested in mCBM 2022 runs
- novel sensor technologies (LGAD, SiC) under investigation



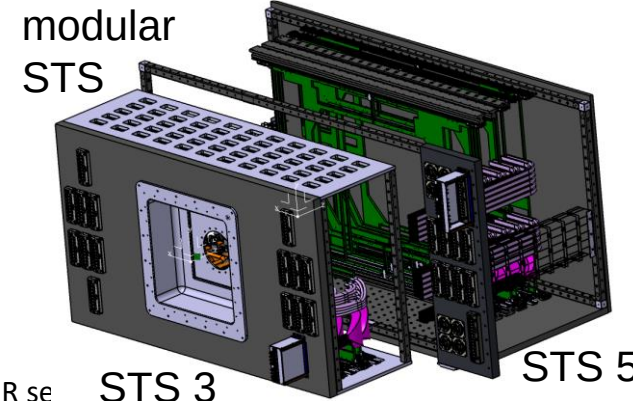
Micro Vertex Detector (MVD)

- Intensive test campaigns of full-size MAPS prototype MIMOSIS-1 → MIMOSIS-2 expected for mid of 2023
- Preproduction quadrant in preparation

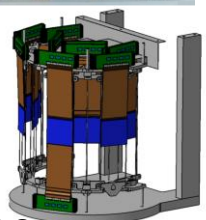


Silicon Tracking System (STS)

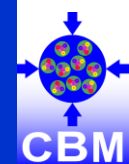
- Revised modular design with 3+5 stations
- Ladder preproduction will be deployed in J-PARC E16
- Re-design of FEB8-2 and FEB8-5



STS ladder pre-series production deployed in J-PARC E16

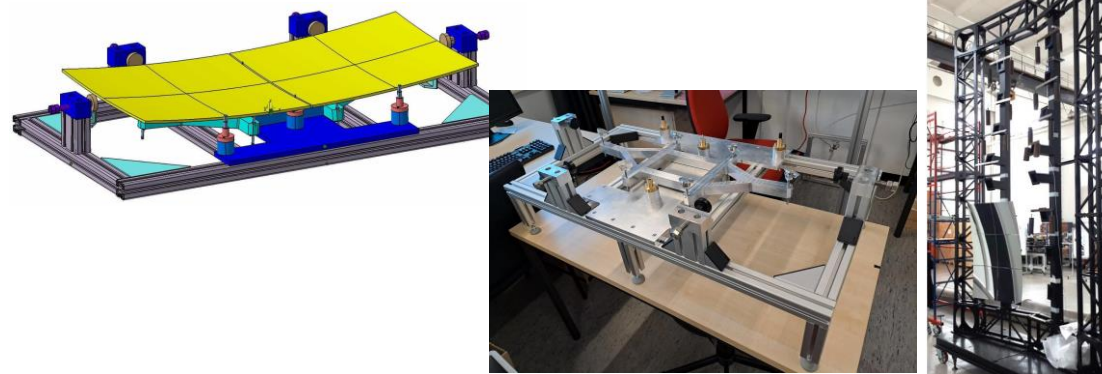


Status of CBM detector systems



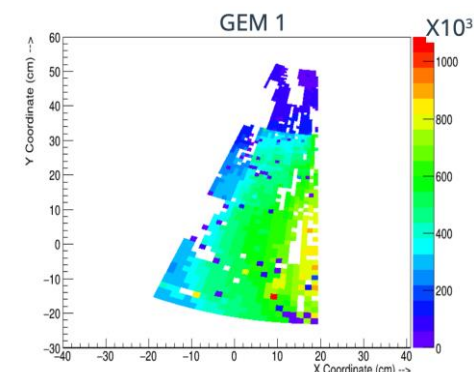
Ring Imaging CHerenkov detector (RICH)

- Towards mechanics engineering design and production readiness
- Photocamera - series production of readout electronics
- Successful runs at HADES and mCBM



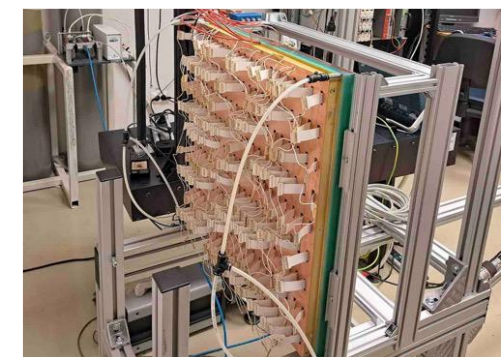
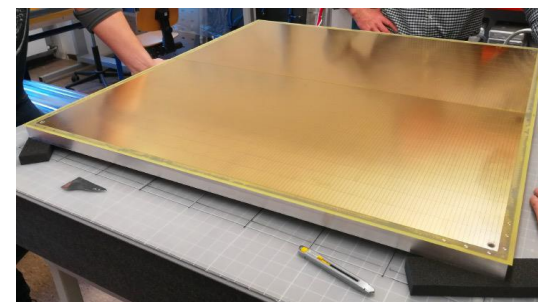
MUon CHamber system (MUCH)

- Intensive test campaigns of full-size GEM and RPC prototypes at GIF++ and mCBM, readout stability significantly improved, data analysis ongoing.

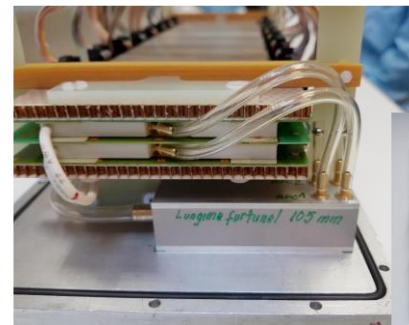


Transition Radiation Detector (TRD)

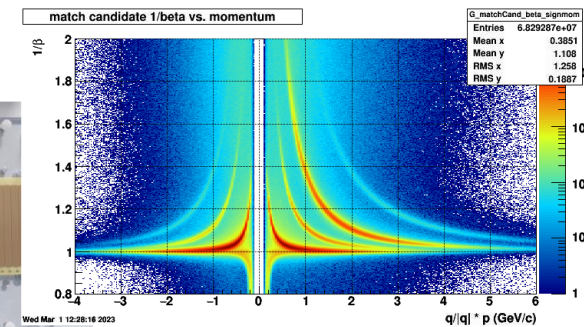
- Preproduction of 4 standard modules
- Construction of full-size TRD-2D prototype (inner part)
- New SPADIC 2.4 design, test submission planned for April 2023
- TRD as intermediate tracker, successful runs at mCBM



- Successful data taking at STAR and mCBM, data analysis ongoing
- Sealed RPCs to enhance rate capability
- Engineering design of main frame
- RPC preproduction

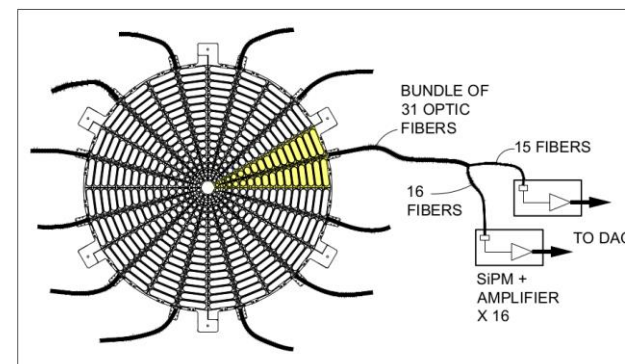


sealed RPCs



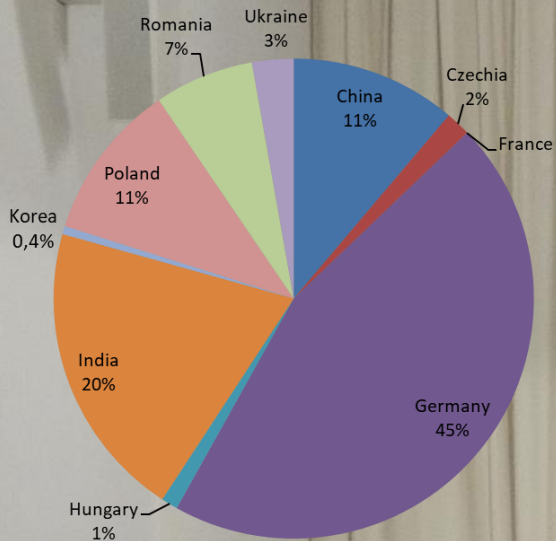
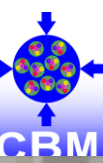
Forward Spectator Detector (FSD)

- New design, likely based on ZnS scintillators and LYSO crystals for central part
- Read-out via SiPM
- Readout electronics based on existing solutions

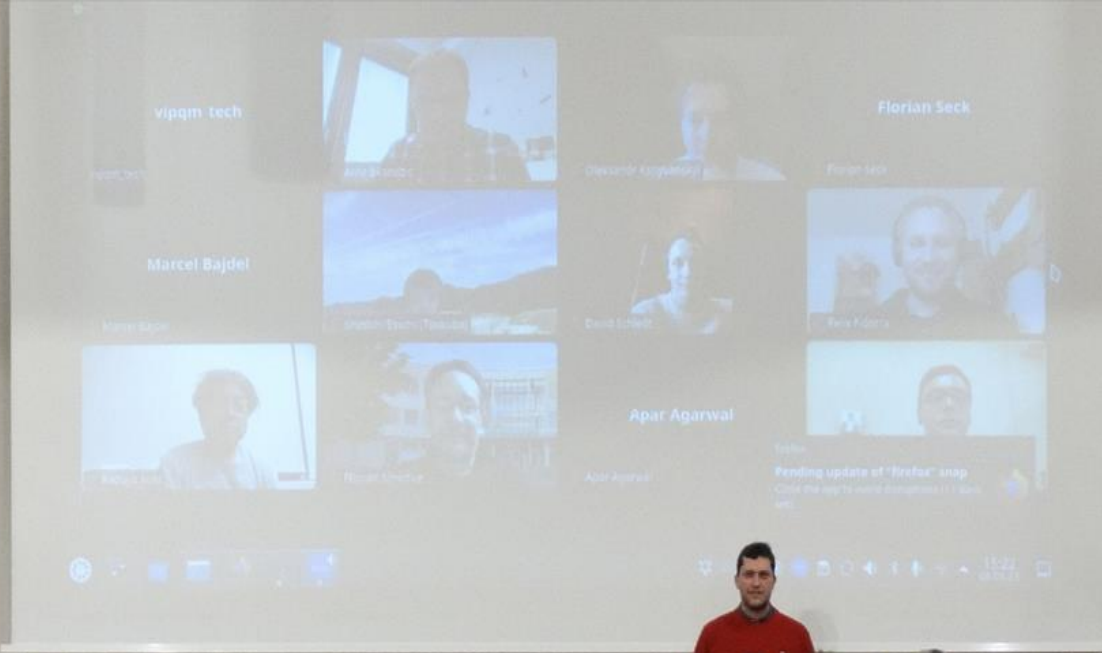


133	109	108	107	106	51	52	53	54	55						
105	104	102	102	101	48	47	48	49	50						
100	99	95	95	94	93	92	91	38	37	38	39	40	41	44	45
		90	89	86	87	86	85	30	31	32	33	34	35		
		94	83	82	79	77	75	74	73	18	19	20	21	22	23
					72	71	70	69	67	12	13	14	15	16	17
96	97				66	65	64	63	62	6	7	8	9	10	11
		81	80	79	60	59	57	56	55	1	2	3	4	5	
					125	123	113	112	111	108	107	106	105	104	103
					122	120	118	118	117	116	117	117	116	117	116
153	152	136	135	134	127	126	124	123	122	121	119	119	120	119	120
		133	132	131	127	126	124	123	122	121	119	119	120	119	120
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					145	144	143	142	141	140	135	135	137	138	139
155	154				151	150	149	148	147	146	201	202	203	204	205
											202	203	204	205	206
180	159	158	157	156						211	212	213	214	215	
185	184	183	182	181	216	217	218	219	220						

CBM collaboration



47 (+10) institutes
310 full members

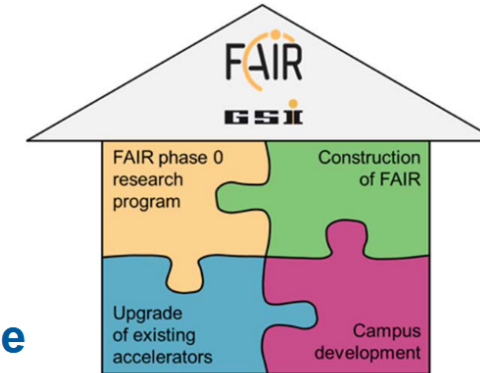


41st CBM collaboration meeting, Mar. 2023, TUD, Darmstadt

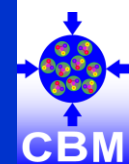
Our vision for the future: FAIR 2028



- The Management remains committed to fulfil the 4 common FAIR/GSI strategic objectives
- **FAIR 2028** is based on the assumption that the extension from FS to FS+ will be approved, so that science in the CBM cave can start without delays.
- **FAIR in 2028 will feature the most valuable science program which can be hosted in the FS+ infrastructure.**
 - The proposals are being carefully assessed by the JSC, ECE and ECSG
- The „**FAIR 2028**“ science program will include:
 - **APPA** experiments *at the low-energy rings, at SIS100*, at the *caves at SIS18 and UNILAC* with and at *PHELIX* and a limited set of experiments which could be hosted at all the *caves served by SIS100*
 - **NUSTAR** at the *Super FRS with SIS100 beams*, plus *SHE experiments at UNILAC* and *ILIMA at the low-energy rings*
 - **CBM** at the *new cave with SIS100 beams*, and *HADES at SIS18*
 - **PANDA** is developing a hadron physics program to be carried as bridge towards the program with antiprotons, when possible *using the caves and beams available at GSI/FAIR*.
- Given the limits of financial and human resources, other activities will be downscaled, delayed or even discontinued.



Conclusion



CBM scientific program at SIS100 is unique

- explore QCD matter at neutron star core densities
- employ high statistics capability
 - to achieve high-precision of multi-differential observables
 - to enable rare processes as sensitive probes

CBM day-1 setup already has significant discovery potential

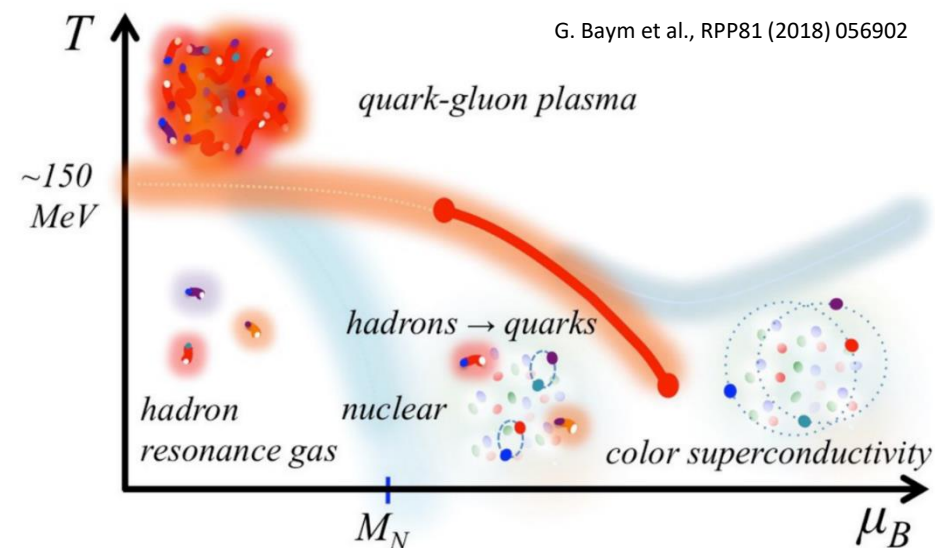
- excitation function of hyperon production
- excitation function of di-lepton production
- study of light hypernuclei
- emerging proton beam program

CBM Phase 0 activities (mCBM, HADES, STAR)

- understanding of major components
- production of physics results with CBM devices

CBM collaboration is open for new members.

CBM eagerly awaits a positive FAIR council decision concerning SC magnet production and realization of the FAIR2028 goals.



An aerial photograph of a large-scale construction project, likely a stadium or arena, captured during the "golden hour" of sunset. The sun is a bright, glowing orb in the upper right corner, casting a warm, orange and red light across the sky and the scene. The construction site is a complex of earthworks, with several large, curved concrete retaining walls or seating tiers under construction. Numerous yellow tower cranes are positioned around the site, their long jibs extending over the work areas. In the background, there are several large, modern buildings with white and blue roofs, possibly existing infrastructure or temporary site offices. The surrounding landscape includes patches of green fields and dense forests. The overall atmosphere is one of industriousness and the beauty of a day's end.

Thank you!

Photo: © Betz