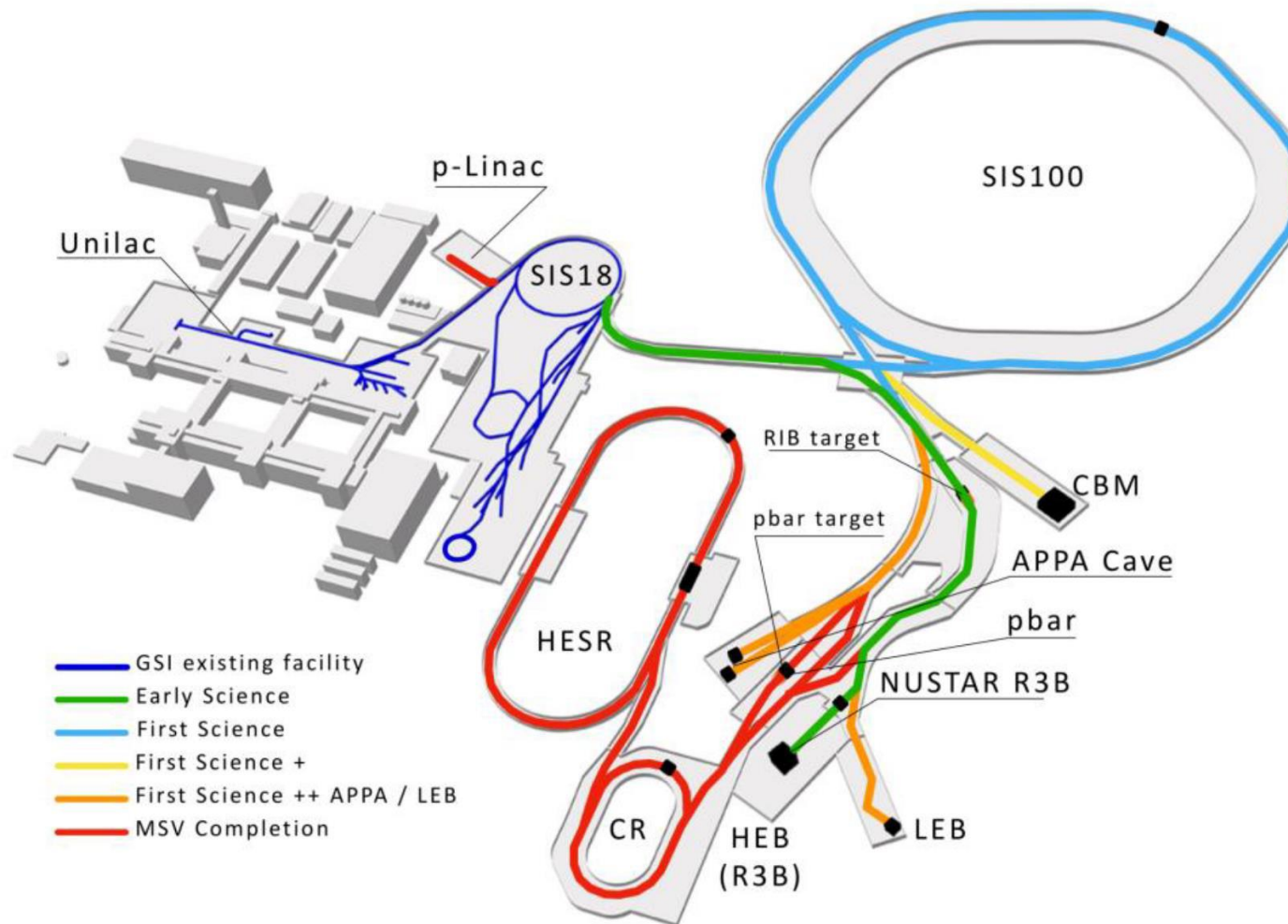
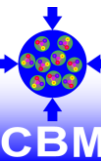


Status of experiments (CBM & HADES)



N. Herrmann, Heidelberg University

Recent developments of FAIR and CBM



Substantial cost increase
surfaced in 2021,
Russian attack on Ukraine

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

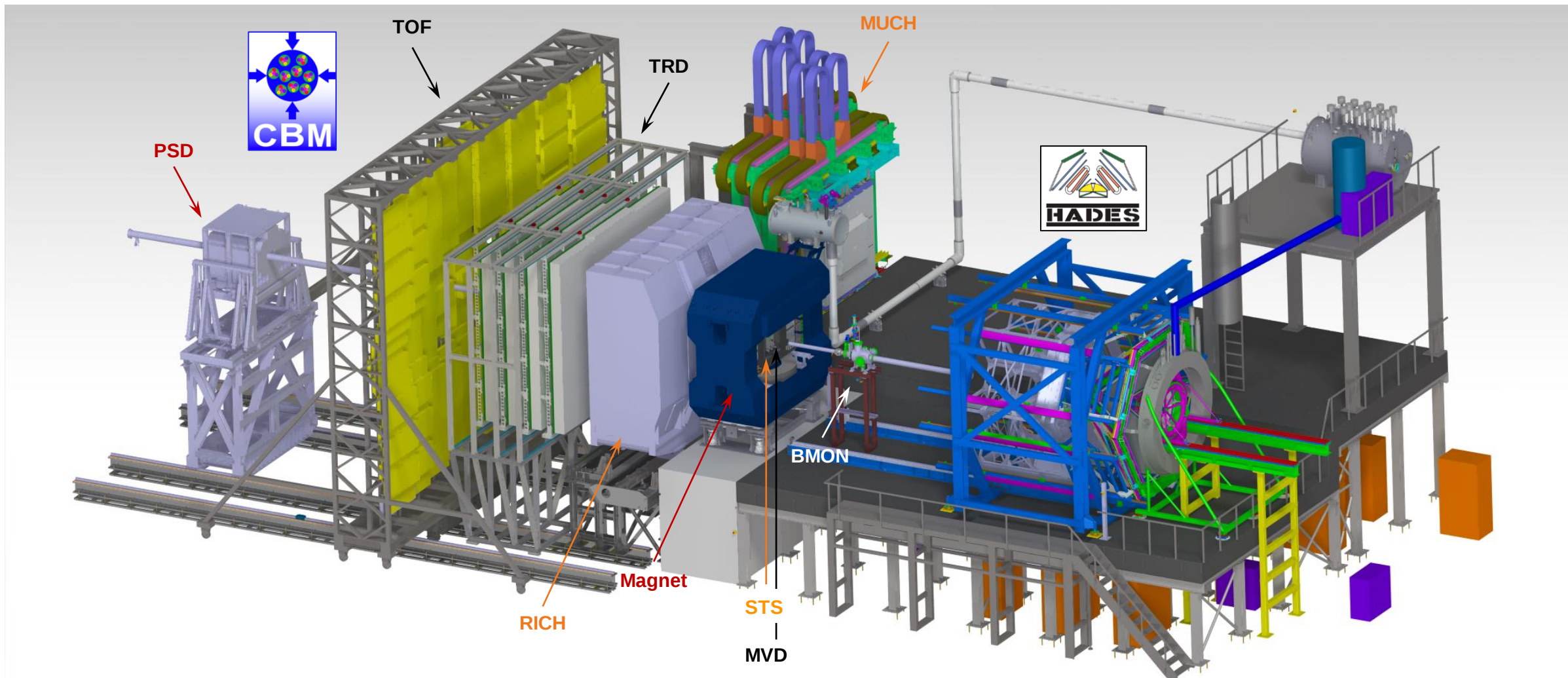
Recommendation:
downscope FAIR project with cost cap

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

Additional funds provided by BMBF
Planned scenario: FS

Start of FS operation: 2028/29

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 FSD

HADES: continue physics program at SIS18

Future measurements with SIS100 beams not part of FS+, will be done once SIS18 program is finished

Au+Au BES < 1 A GeV

EM transition form factors of hyperons

Cold matter effects including line shapes and SRC

Baryon resonances, meson baryon coupling in the 3rd resonance region

Iso-spin effects in dilepton production

SEARCHING FOR CRITICAL BEHAVIOR AND LIMITATIONS OF THE UNIVERSAL FREEZE-OUT LINE

Au+Au collisions at 0.2A-0.8A GeV

The HADES Collaboration



Spokespersons: J. Stroth (j.stroth@gsi.de), P. Thüsty (thusty@ujf.cas.cz)
GSI contact: J. Pietraszko (j.pietraszko@gsi.de)

Infrastructure: SIS18 and HADES cave

Beam: slow extraction
Au at 0.8A-0.6A-0.4A-0.2A GeV, 1.2×10^9 ions/s (flat top)
C at 0.8A-0.6A GeV, 3×10^9 ions/s (flat top)

Abstract

We will extend our exploration of the QCD phase diagram towards the location of the nuclear liquid-gas phase transition. Two longer Au+Au runs (30 shifts each) are dedicated to low-mass dilepton and strangeon production while two shorter Au+Au runs (9 shifts each) will focus on the most abundant (non-strange) particles only, suitable for event-by-event analysis of particle correlations and fluctuations as well as to extract temperature of the system at freeze-out. We aim at high statistics to enable (i) laboratory studies of the master properties (Equation-of-State) in compact stellar objects and (ii) detection of measurable consequences of phase transition and critical point in the QCD phase diagram. Moreover, C+Cu collisions (6 shifts each) will be investigated to provide reference data. In the following we elucidate the proposed studies using the HADES spectrometer.

This is a proposal for a new experiment

In total we request 94 shifts

PRODUCTION AND DECAY OF HYPERONS, AND INCLUSIVE HADRON AND DILEPTON PRODUCTION

in p+p Reactions at 4.5 GeV

The HADES and HADES-PANDA Collaborations



Spokespersons: J. Stroth (j.stroth@gsi.de), P. Thüsty (thusty@ujf.cas.cz)
GSI contact: J. Pietraszko (j.pietraszko@gsi.de)

Infrastructure: SIS18, LH2 target, HADES cave

Beam: protons at 4.5 GeV, beam intensity 7.5×10^7 p/s, slow extraction

Abstract

In this FAIR Phase-0 proposal, we request proton beam to perform a group of experiments mostly involving hyperons or hidden strangeons. This run group will make very effective and efficient use of the available beamtime since four investigations require the same beam/trigger conditions and improved detector set-up, thus they will be measured concurrently. This proposal addresses the following main physics topics: (1) Hyperon electromagnetic decays $\Lambda \rightarrow \Lambda^* \gamma$ and $\Sigma \rightarrow \Sigma^* \gamma$; (2) Hyperon hadronic decays; (3) Production of double strangeons ($\Xi^- (1321)$, $\Lambda\Lambda$) and hidden strangeons (ϕ); (4) Inclusive hadron and dilepton production as a reference for p+p and heavy-ion data. These measurements will provide first results in this energy region and an important benchmark for the future physics program at FAIR. The measurements of hyperon production and electromagnetic decays during Phase-0 are complementary to the Phase-1 studies at PANDA with antiproton-proton interactions, and will enable some PANDA detector systems to be setup and commissioned already now.

Below is a description of the proposed study with proton beam using the HADES spectrometer combined with the new forward detection system.

This is a new experiment proposal.

We request 84 shifts plus 4 shifts as a separate study

Successfully conducted in Feb./March 2022

STUDYING MEDIUM EFFECTS IN PROTON INDUCED REACTIONS

p+Ag reactions at 4.5 GeV

The HADES Collaboration



Spokespersons: J. Stroth (j.stroth@gsi.de), P. Thüsty (thusty@ujf.cas.cz)
GSI contact: J. Pietraszko (j.pietraszko@gsi.de)
SRC part: T. Aumann (T.Aumann@gsi.de), O. Hen, E. Piasetzki

Infrastructure: SIS18, HADES cave, and part of the NeuLAND detector to measure the recoil neutron

Beam: p at 4.5 GeV, beam intensity 4×10^6 protons/s, slow extraction

Abstract

We propose to investigate p+Ag reactions with an improved experimental set-up which enables measurements of charged particles emitted into the very forward hemisphere. Main physics topics are addressed: (i) dilepton production in the low and intermediate mass region; (ii) ω disappearance in "cold" nuclear matter; (iii) strangeon production and propagation in "cold" nuclear matter (comparison and constraints for thermal and transport models) (iv) $\Lambda \rightarrow p$ scattering parameters and phase shifts; (v) understanding short-range correlations in nuclei; (vi) search for a dark photon in the dilepton channel. These results will provide an important reference for the future program at FAIR. Below is an executive summary of the proposed study with proton beam using the HADES spectrometer combined with the new forward detection system.

This is a new experiment proposal.

We request 88 shifts.

BARYON COUPLINGS TO MESONS AND VIRTUAL PHOTONS IN THE THIRD RESONANCE REGION: VACUUM AND COLD MATTER STUDIES

Pion induced reactions on CH₂ and C, Ag targets

The HADES Collaboration



Spokespersons: J. Stroth (j.stroth@gsi.de), P. Thüsty (thusty@ujf.cas.cz)
GSI contact: J. Pietraszko (j.pietraszko@gsi.de)

Infrastructure: SIS18, pion production target and HADES cave
Beam: Nitrogen at 2A GeV, maximum intensity, slow extraction

Abstract

We propose to use the GSI pion beam to provide information on baryon resonances in the third resonance region which is crucial for the understanding of the emissivity of dense and hot hadronic matter. This includes their couplings to mesons and virtual photons and their behavior in cold matter. First, differential cross sections for hadronic final states will be included in Partial Wave Analyses to extract various baryon-meson couplings, among which are ρN and ωN , with unprecedented precision. Second, the measurement of e^+e^- production off the nucleus, which is sensitive to the electromagnetic transition form factors of baryons in the time-like region, will probe the role of vector mesons (ρ , ω) therein. Finally, pion-nucleus data allow to investigate medium effects on vector mesons in cold nuclear matter. The whole data set constitutes an important input to understanding of the emissivity of dense and hot hadronic matter.

In 2017, we submitted a request for 93 shifts pion beam and got approved 40 A⁺ shifts, which could not be scheduled. This proposal is an update, and extension, of the 2017 proposal motivated by the results of the data analysis of previous experiments.

We request 143 shifts.

SCRUTINIZING ISO-SPIN EFFECTS IN N+N BREMSSTRAHLUNG AND DIBARYON D*(2380) FORMATION IN N+P COLLISIONS

A Beam Energy Scan for proton and neutron induced reactions on protons

The HADES Collaboration



Spokespersons: J. Stroth (j.stroth@gsi.de), P. Thüsty (thusty@ujf.cas.cz)
GSI contact: J. Pietraszko (j.pietraszko@gsi.de)

Beam: d with kinetic energy of $T_k = 1.0, 1.13, 1.25, 1.75$ A GeV, beam intensity 2×10^7 deuterons/s, slow extraction

Abstract

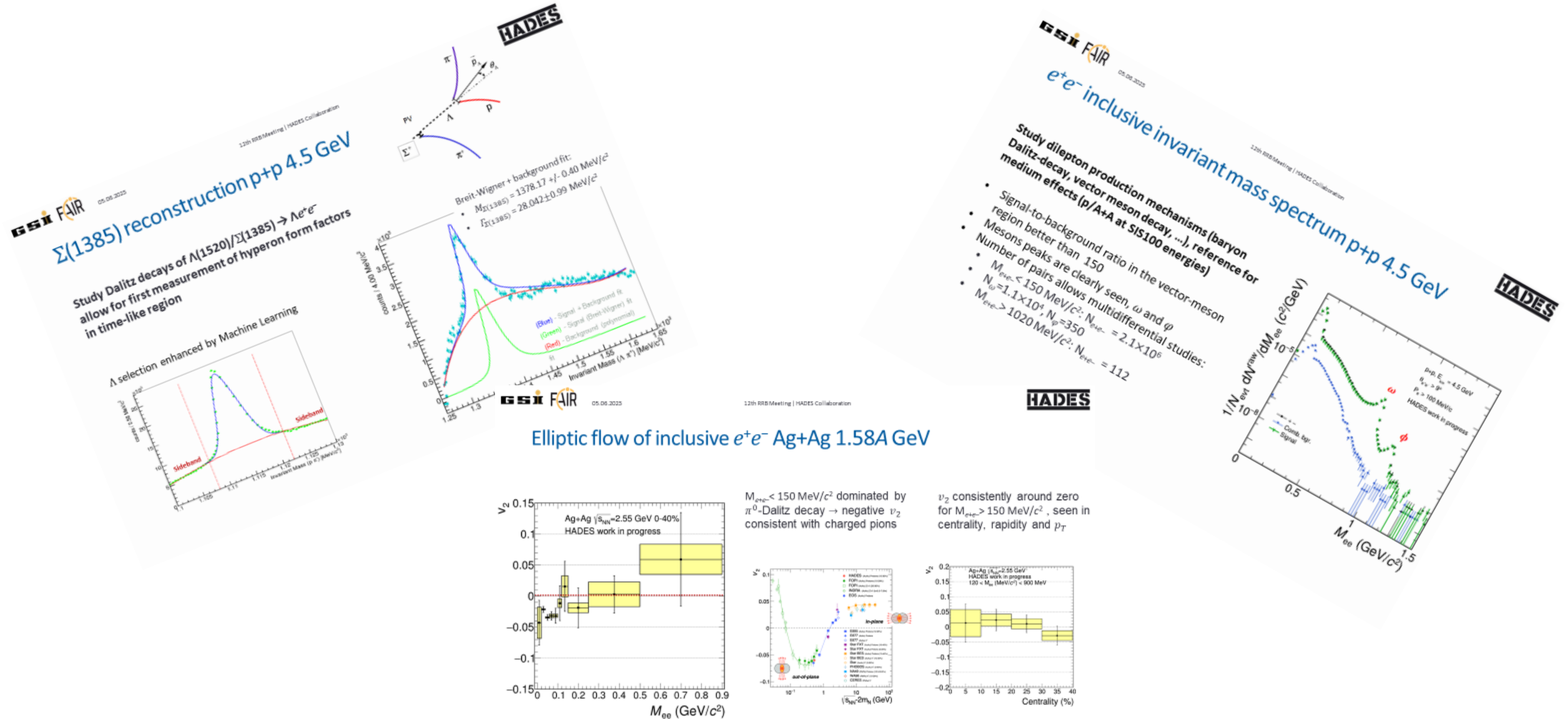
We propose to investigate p+p and quasi-free n+p reactions with deuteron beams on a LH2 target with an improved experimental set-up which enables measurements of charged particles emitted into the very forward hemisphere. Quasi-free p+p and n+p reactions will be disentangled by tagging the proton spectrometer from deuteron break-up in the new Forward Detector which covers almost complete ($\sim 98\%$) phase space for the spectator emission. The main goals of proposal are: (1) measurement of NN reference spectra for interpretation of medium effects in heavy-ion collisions in 1-2 AGeV energy range; (2) characterisation of dilepton production from baryonic sources in exclusive reaction channels (3) studies of isospin dependence of $\Lambda(1520)$ production close to the threshold and (4) Δ -baryon $M_{\Delta} = 2380$ MeV ($J = 0, J^P = 3/2$) production in quasi-free n+p reactions. The results will also provide an important reference for the future heavy-ion program at FAIR.

Below is an executive summary of the proposed study with proton beam using the HADES spectrometer combined with the new forward detection system.

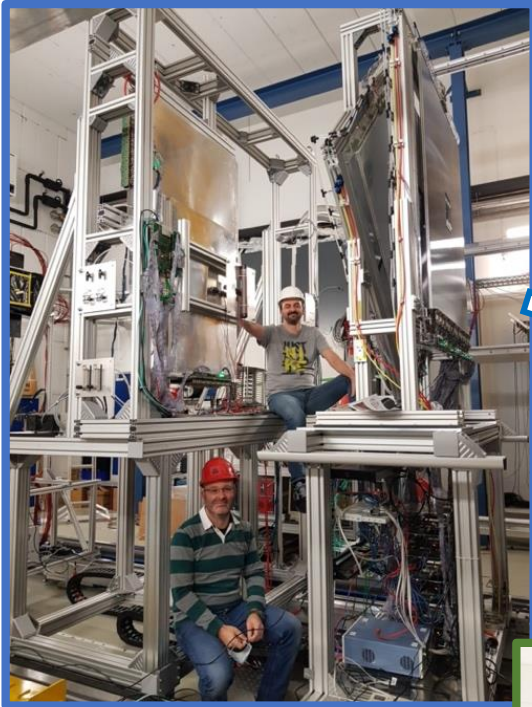
This is a new experiment proposal.
We request 106 shifts.

15 Billion events Ag+Ag taken already in 2019.

Recent HADES achievements



The upgraded HADES detector (five new detector systems)



Forward RPC

LIP Coimbra

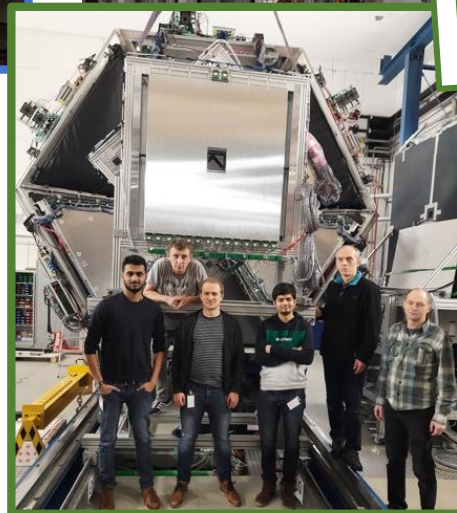
- Based on R&D for neuLAND
- TRB3 read-out

STS2

Jagiellonian Univ.

- PANDA straw technology
- PANDA PASTTREC FEE chip

- Improved physics performance through instrumentation of the very forward hemisphere using FAIR technology.
- In particular important for the Hyperon Program.



STS1

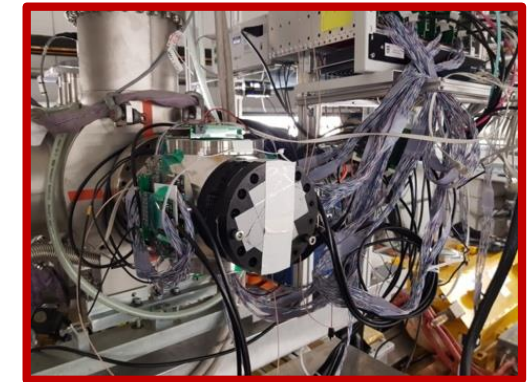
TransFAIR, Jülich

- PANDA straw technology
- PANDA PASTTREC FEE chip

iTOF

TransFAIR, Jülich

- APD read-out
- Enhances trigger purity

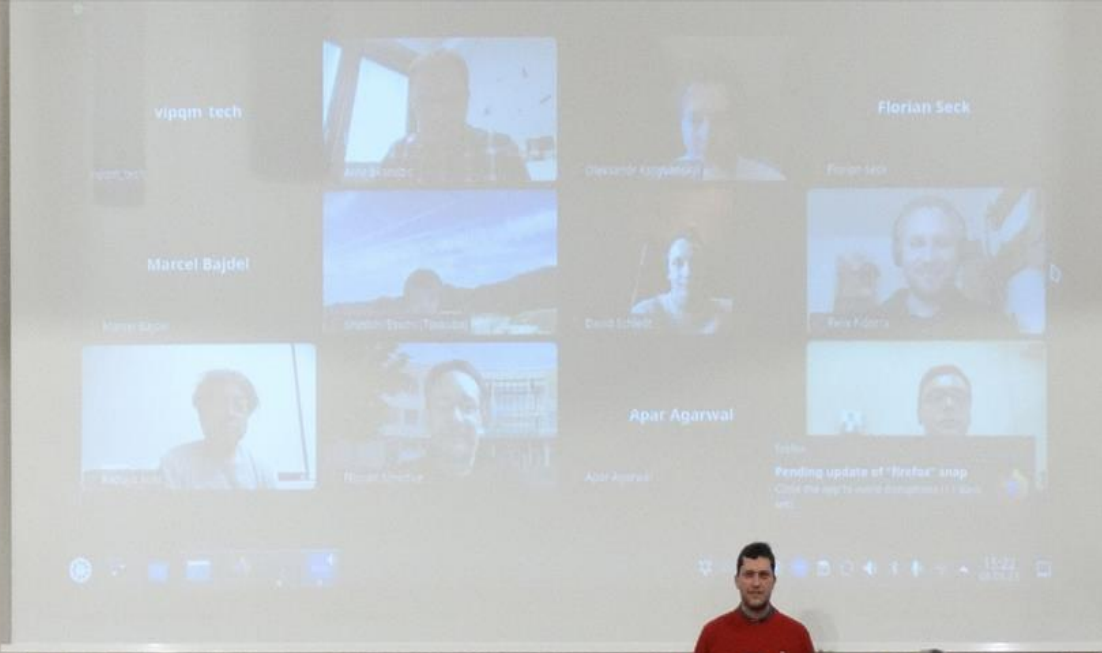
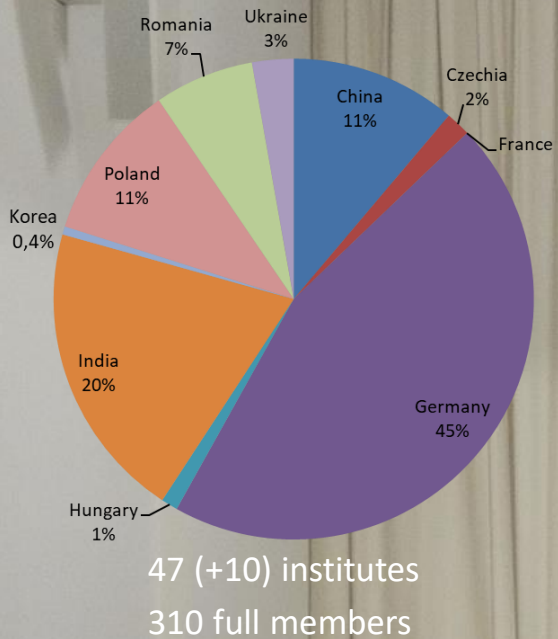
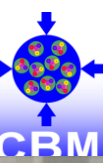


T0

GSI, TU Darmstadt

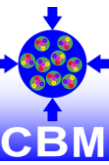
- LGAD technology
- In-beam detector

CBM collaboration

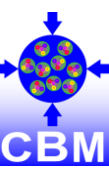


41st CBM collaboration meeting, Mar. 2023, TUD, Darmstadt

CBM experimental hall



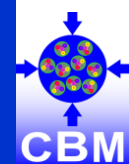
CBM installation in experimental hall



Upstream platform

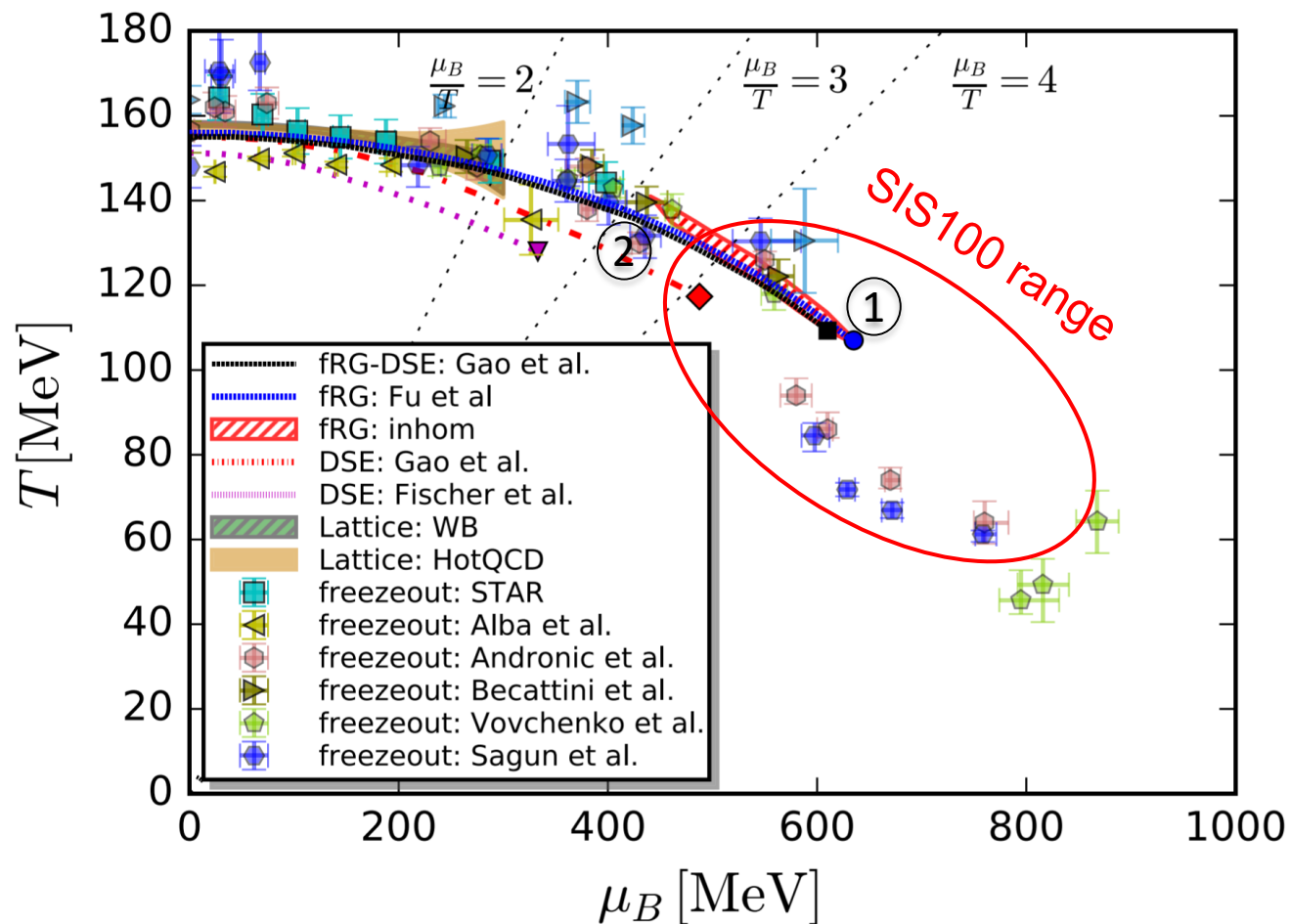
Czech contribution to CBM

Phase structure of QCD

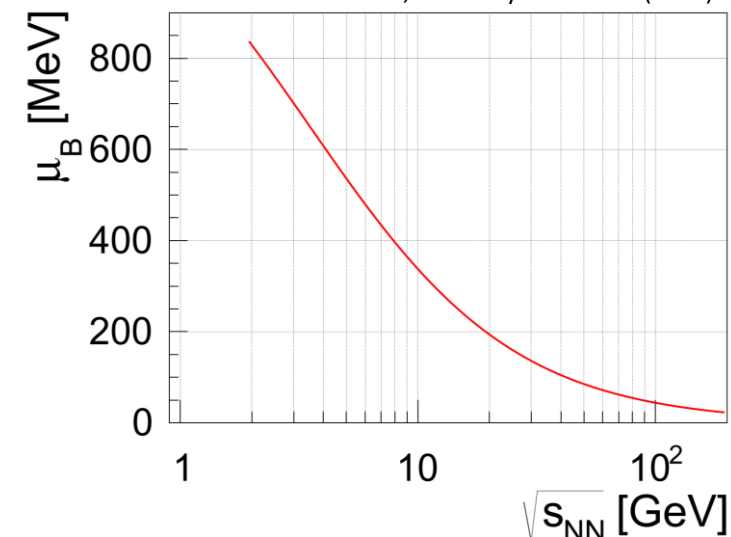


Location of chiral cross over

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)

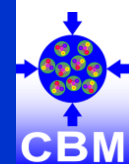


	μ_B (MeV)	$\sqrt{s_{NN}}$ (GeV)	T_{lab} (A GeV)
1	622	3.8	6.0
	500	5.2	15.0
2	400	7.8	31.5

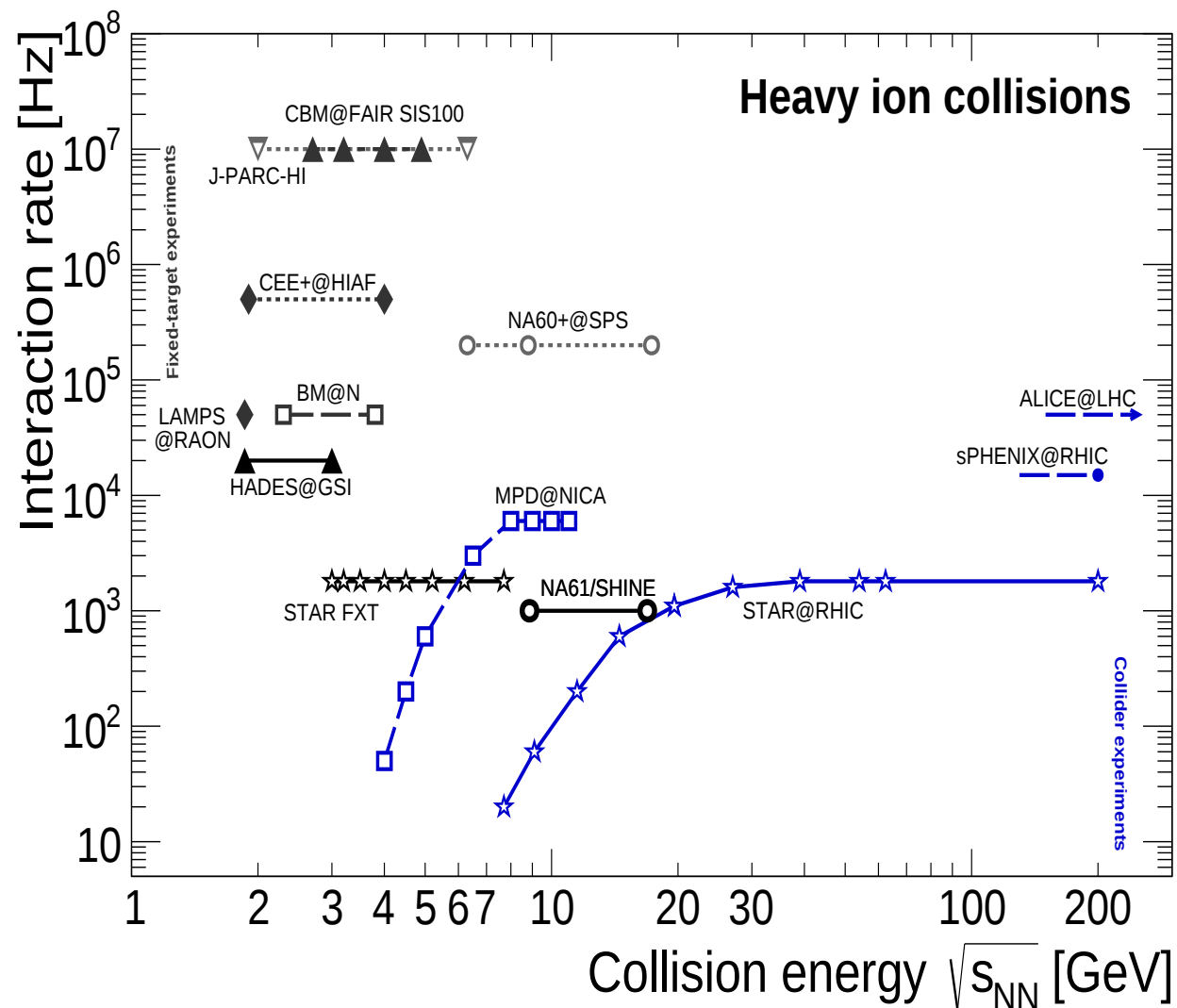
Challenges:

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

CBM – Technological Goal



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



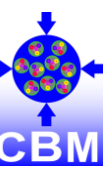
Mission:

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

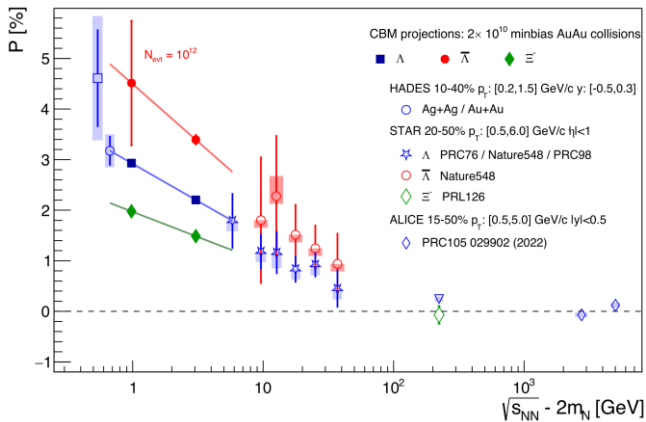
Disclaimer:

not all measurements benefit from the highest possible rates.

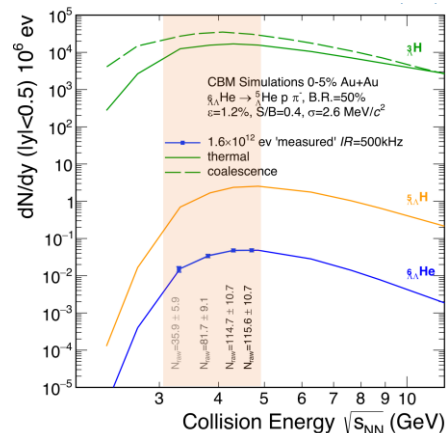
CBM observables



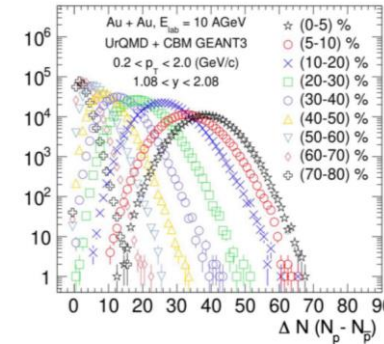
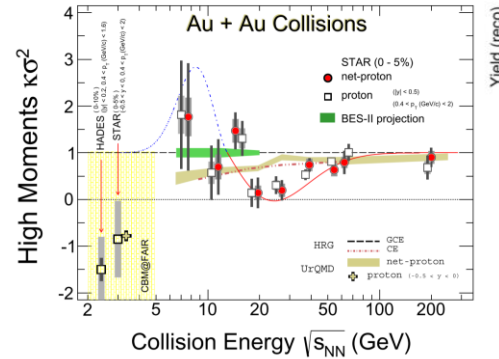
Vorticity



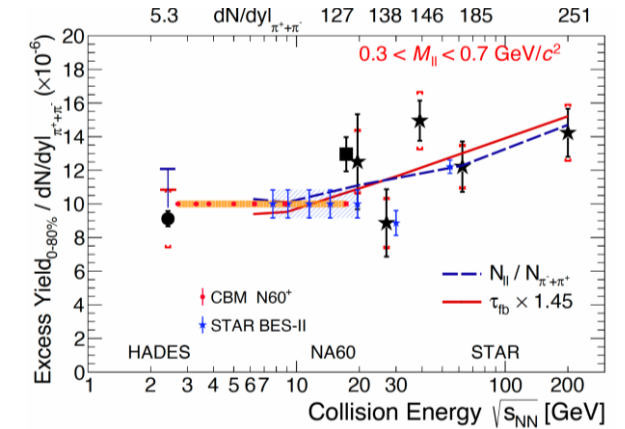
Hypernuclei



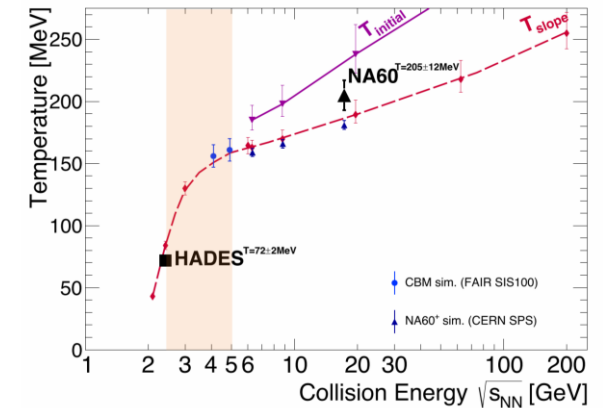
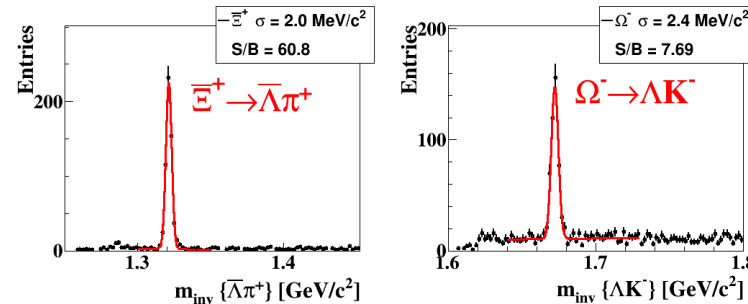
Criticality



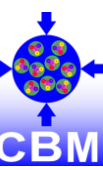
Emissivity



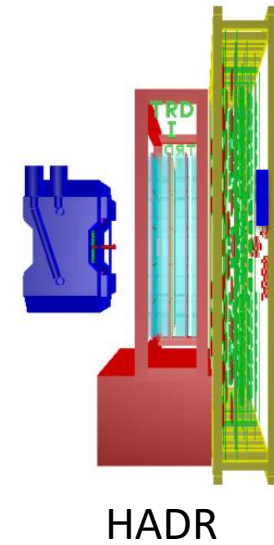
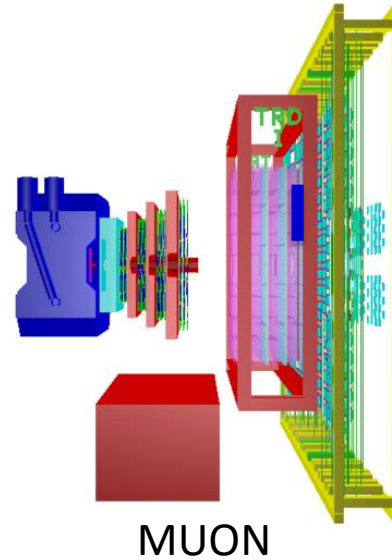
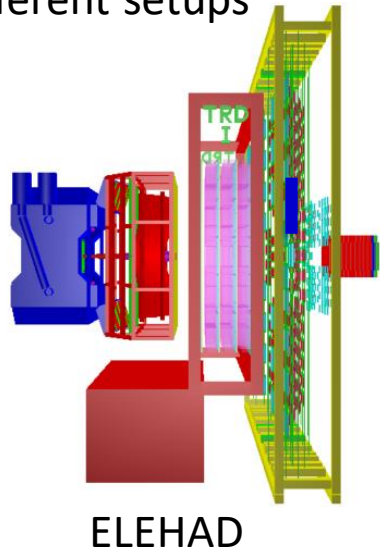
Equation-of-State



CBM setups

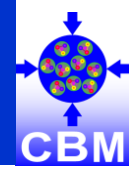


Sideview of different setups



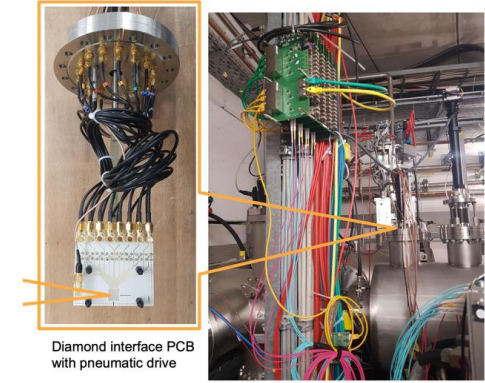
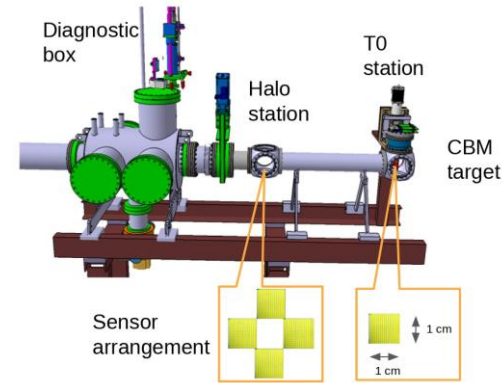
Setup	Included subsystems	Average day-1 interaction rate	Average MSV - interaction rate	Average event size in Au+Au collisions
ELEHAD	MVD,STS,RICH,TRD,TOF,FSD	0.1 MHz	0.1 MHz	75 kB
MUON	STS,MUCH,TRD,TOF,FSD	1 MHz	5 MHz	30 kB
HADR	STS,TRD,TOF,FSD	0.5 MHz	5 MHz	50 kB

Status of CBM detector systems



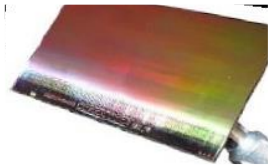
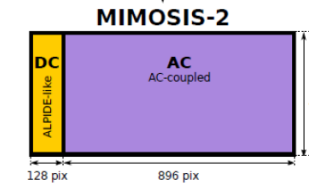
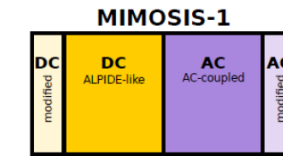
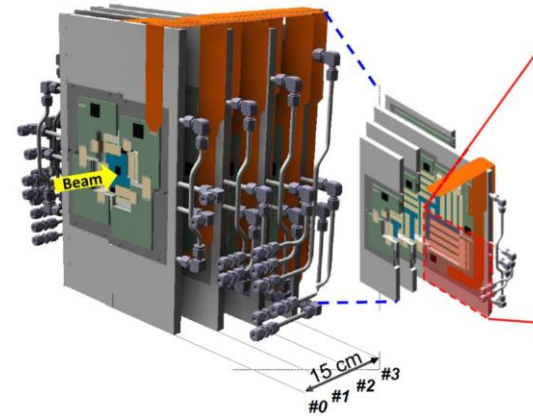
Beam Monitor (BMON)

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



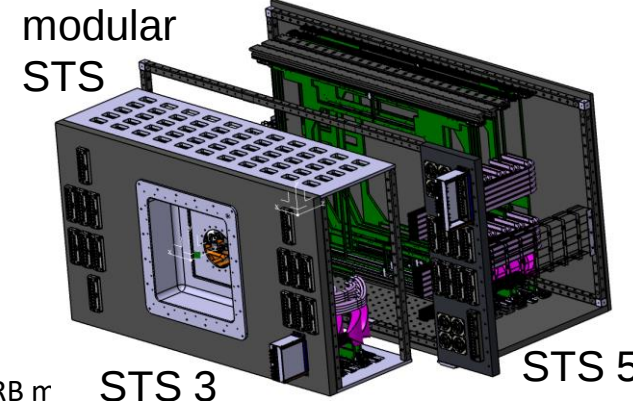
Micro Vertex Detector (MVD)

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

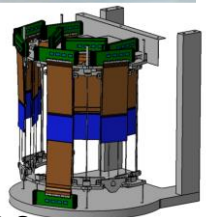


Silicon Tracking System (STS)

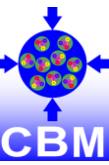
- Revised modular design with 3+5 stations
- Ladder preproduction will be deployed in J-PARC E16
- Re-design of FEB8-2 and FEB8-5



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

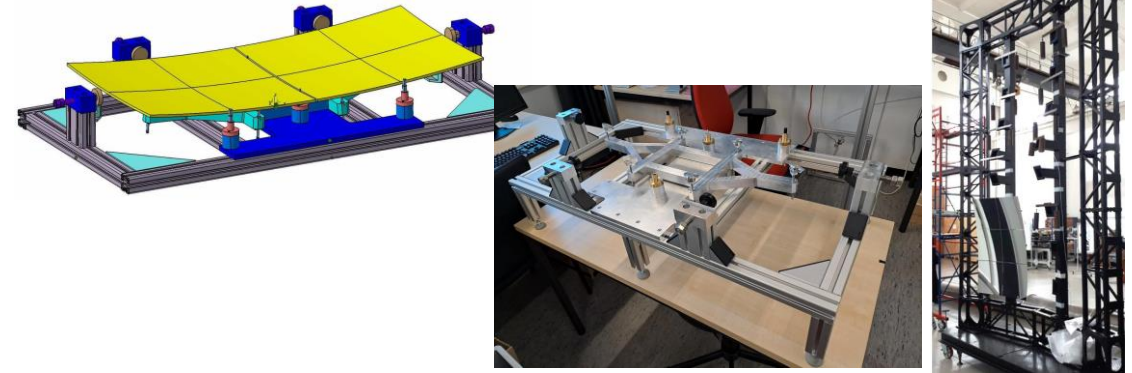


Status of CBM detector systems



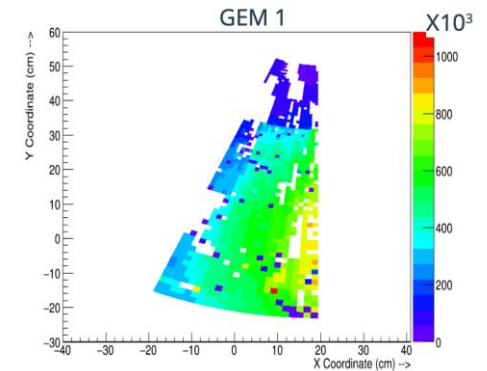
Ring Imaging CHerenkov detector (RICH)

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



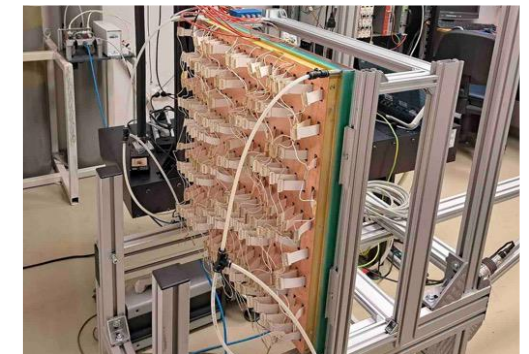
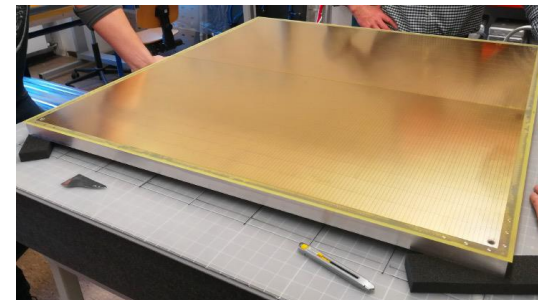
MUon CHamber system (MUCH)

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

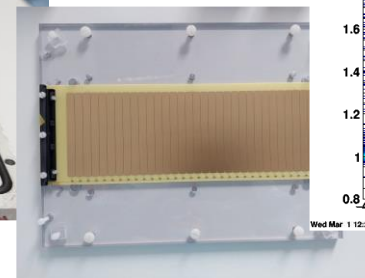


Transition Radiation Detector (TRD)

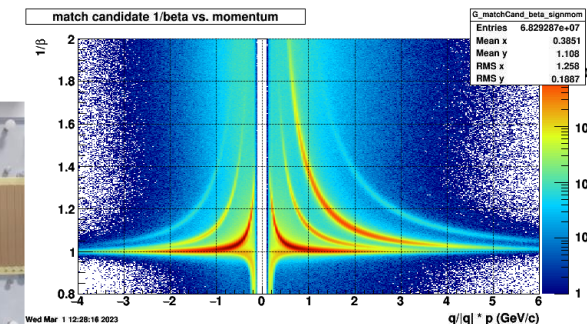
- Preproduction of 4 standard modules
- Construction of full-size TRD-2D prototype (inner part)
- New SPADIC 2.4 design, test submission planned for April 2023
- TRD as intermediate tracker, successful runs at mCBM



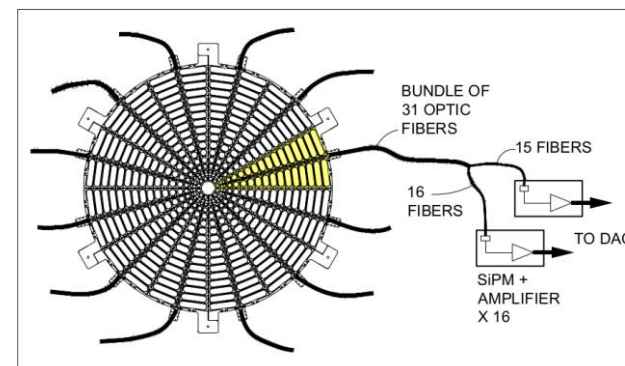
- Successful data taking at STAR and mCBM, data analysis ongoing
- Sealed RPCs to enhance rate capability
- Engineering design of main frame
- RPC preproduction



sealed RPCs

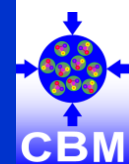


- New design, likely based on ZnS scintillators and LYSO crystals for central part
- Read-out via SiPM
- Readout electronics based on existing solutions

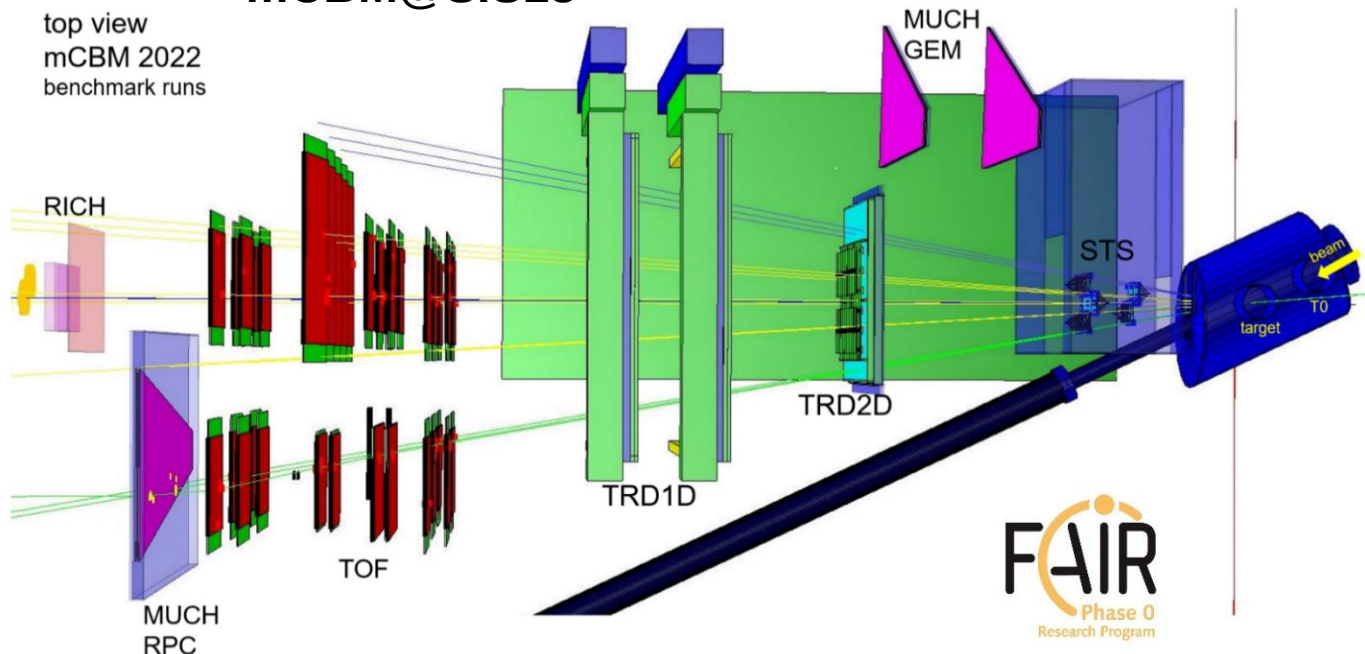


133	109	108	107	106	51	52	53	54	55						
105	104	102	102	101	48	47	48	49	50						
100	99	95	95	94	93	92	91	38	37	38	39	40	41	44	45
		90	89	86	87	86	85	30	31	32	33	34	35		
		94	83	82	79	77	75	74	73	18	19	20	21	22	23
					72	71	70	69	67	12	13	14	15	16	17
96	97				66	65	64	63	62	6	7	8	9	10	11
		81	80	79	60	59	57	56	55	1	2	3	4	5	
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		133	131	130	127	126	124	123	122	121	119	119	120	189	190
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					145	144	143	142	141	140	135	135	137	198	199
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	216	217	218	219	220					

With mCBM towards CBM



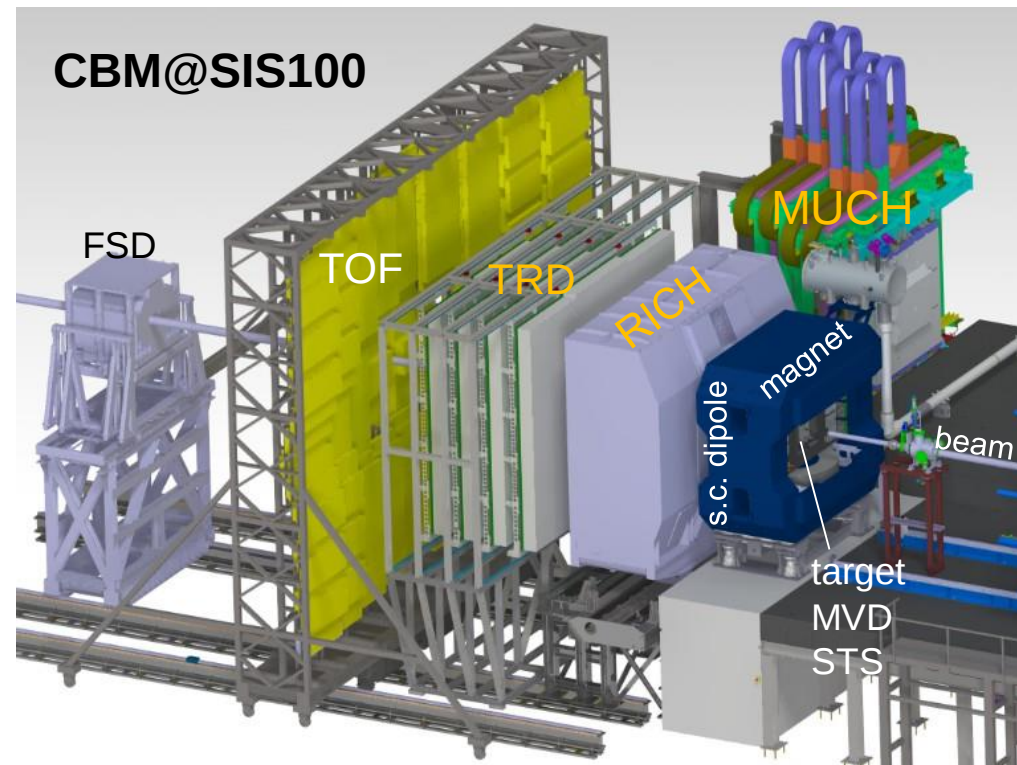
mCBM@SIS18



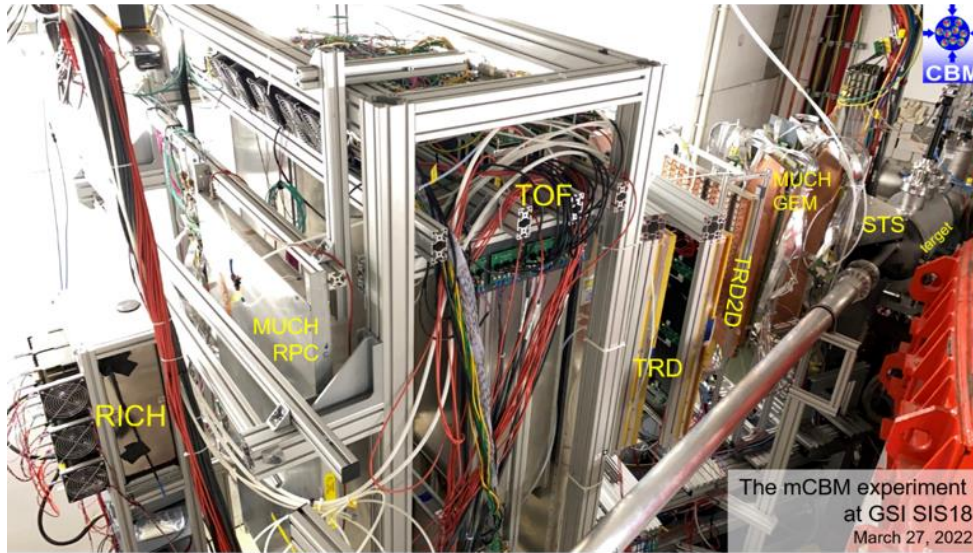
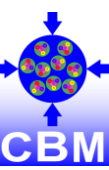
CBM full-system test setup at SIS18/GSI comprising pre-series productions of all CBM detector systems:

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	

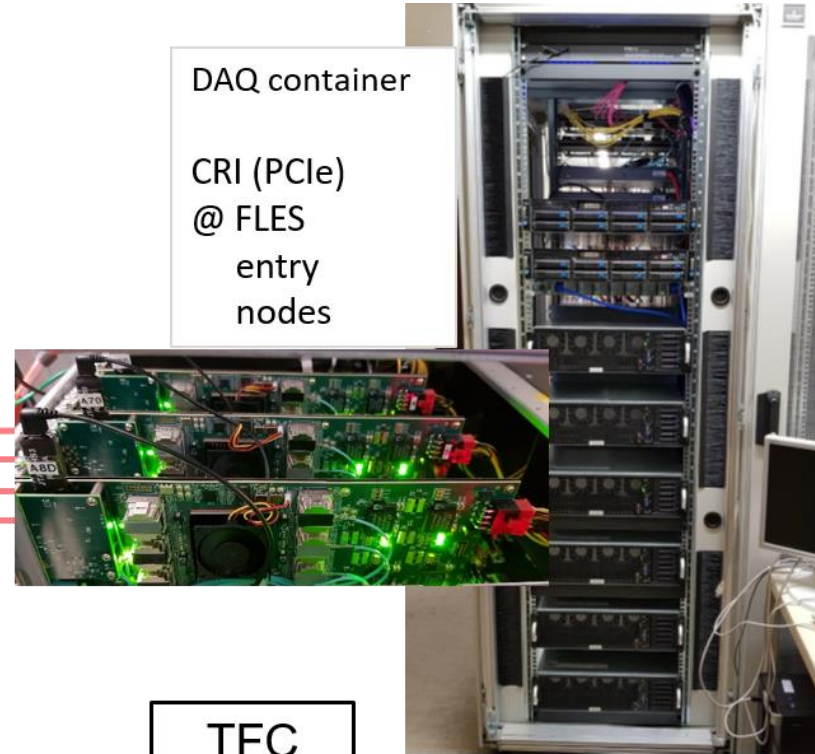
CBM@SIS100



The free-streaming CBM DAQ and data processing



The mCBM experiment
at GSI SIS18
March 27, 2022



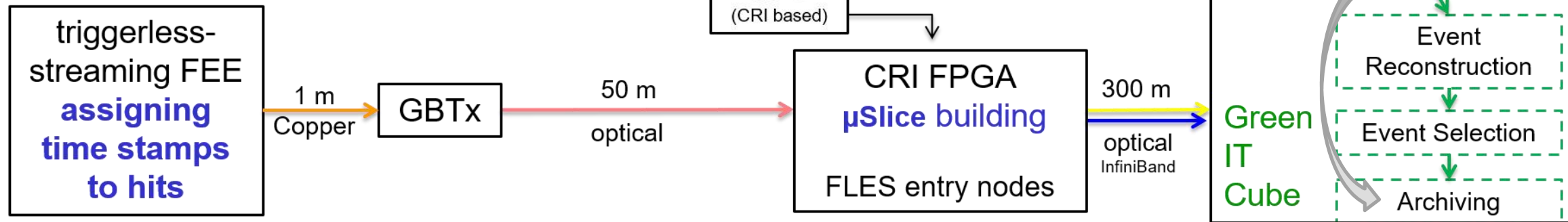
DAQ container

CRI (PCIe)
@ FLES
entry
nodes

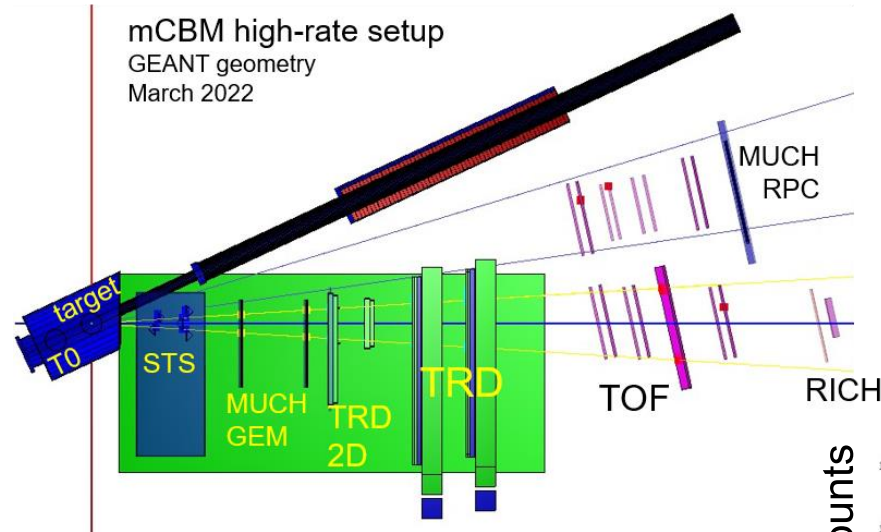
optical
fibers
300 m



FLES
processing
nodes



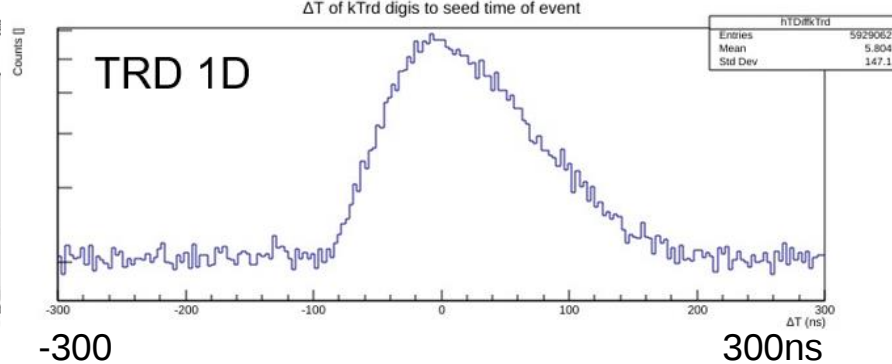
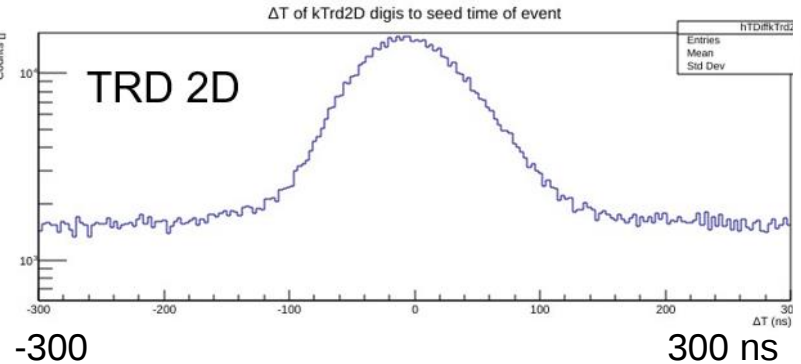
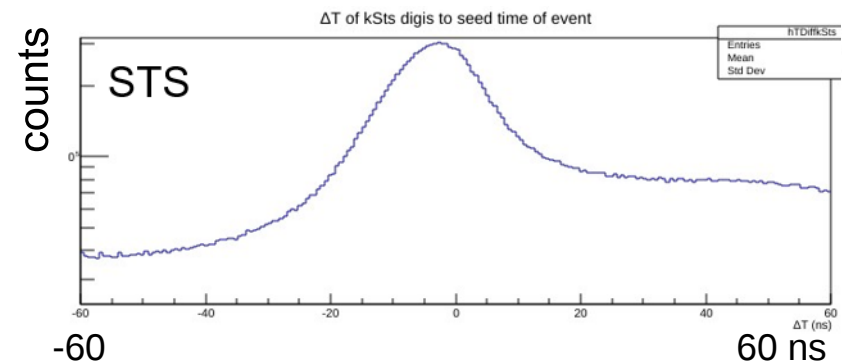
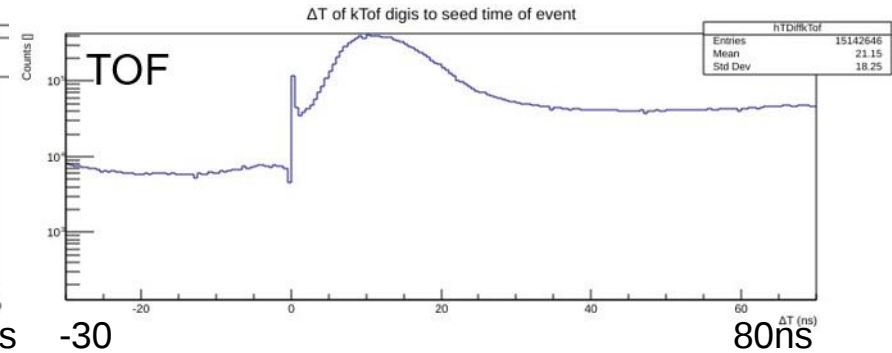
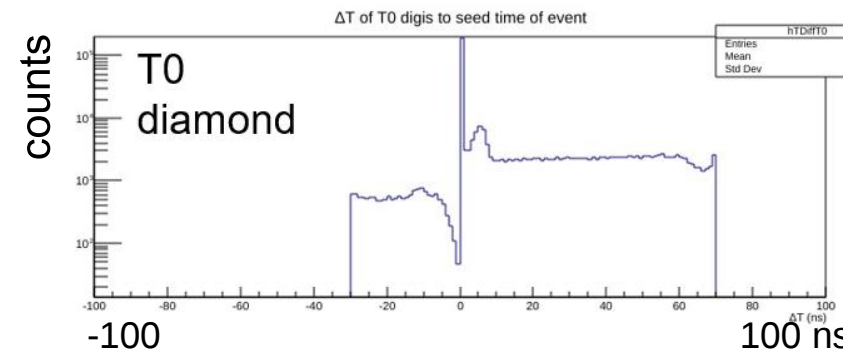
1st test version of an (FAIR MQ based) online selection



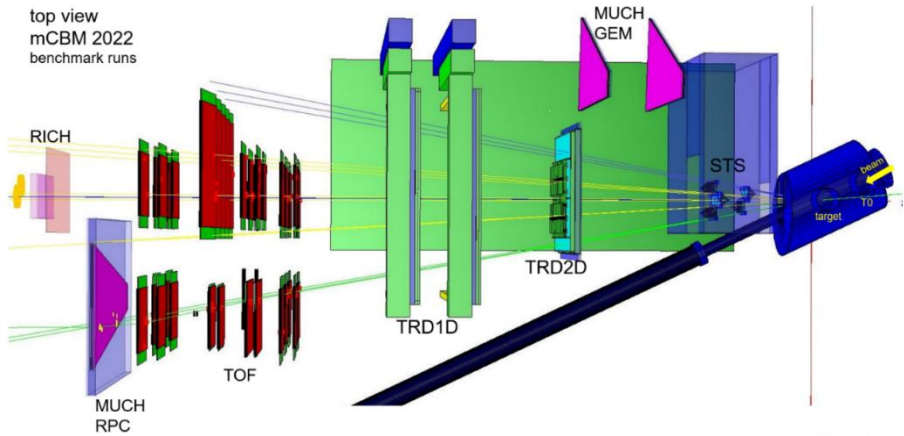
run 2188, March 31, 03:15 CET,
 10^7 U ions per spill, approx. 100 kHz averaged collision rate

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

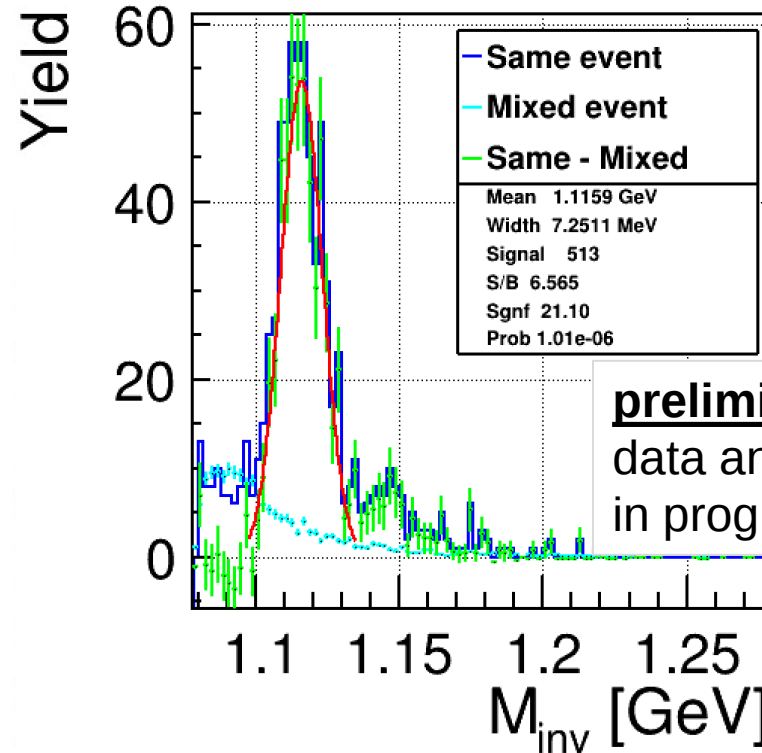
coincidence with T0



mCBM: Λ reconstruction in Ni+Ni collisions at 1.93 AGeV

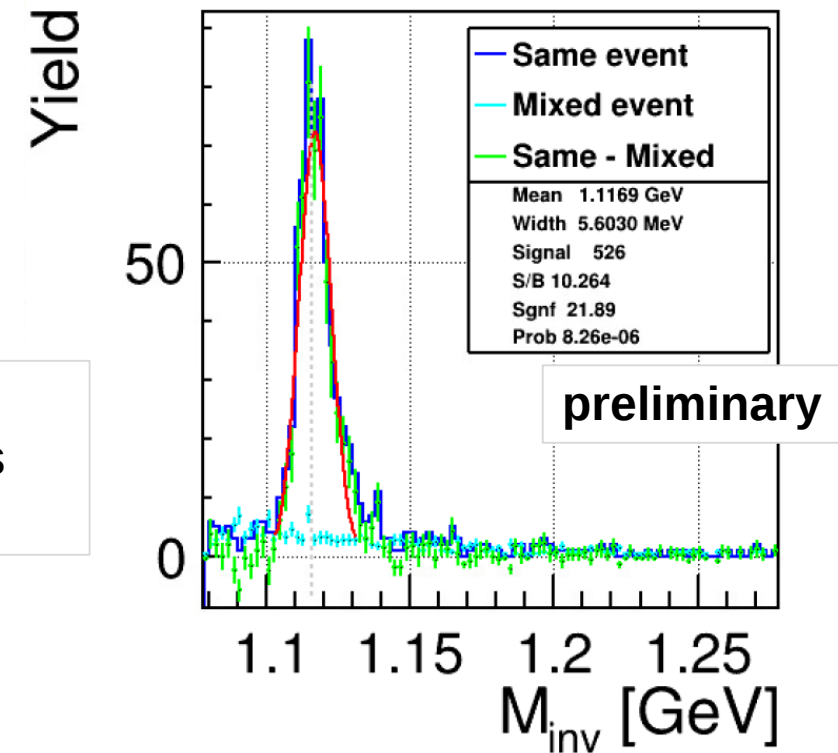


Data, run 2391, total run duration **1:57h**
4x to 5x10⁷ ions per spill, 10s spill
400 - 500 kHz average collision rate

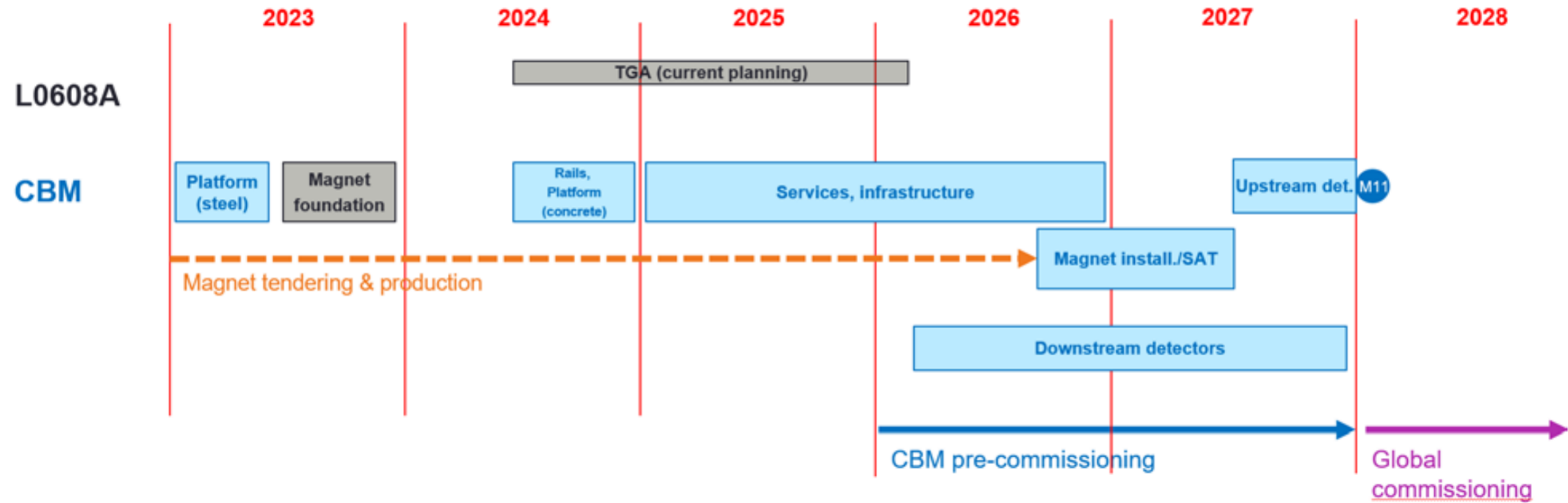
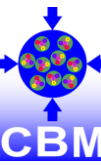


rare signal reconstructed,
- milestone reached !

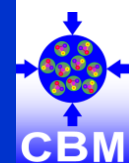
MC, identical reconstruction chain
100 M generated events
10⁵ events / s
63.7 M triggered events



Timeline



Revised CBM day-1 funding (Jun. 2023)



Estimated re-procurement costs [2023 EUROS]

- Magnet:	6,14 M€
- Forward Detector (former PSD):	0,72 M€
- RICH mechanics, gassystem:	1,28 M€
- MUCH absorbers, mechanics:	2,56 M€

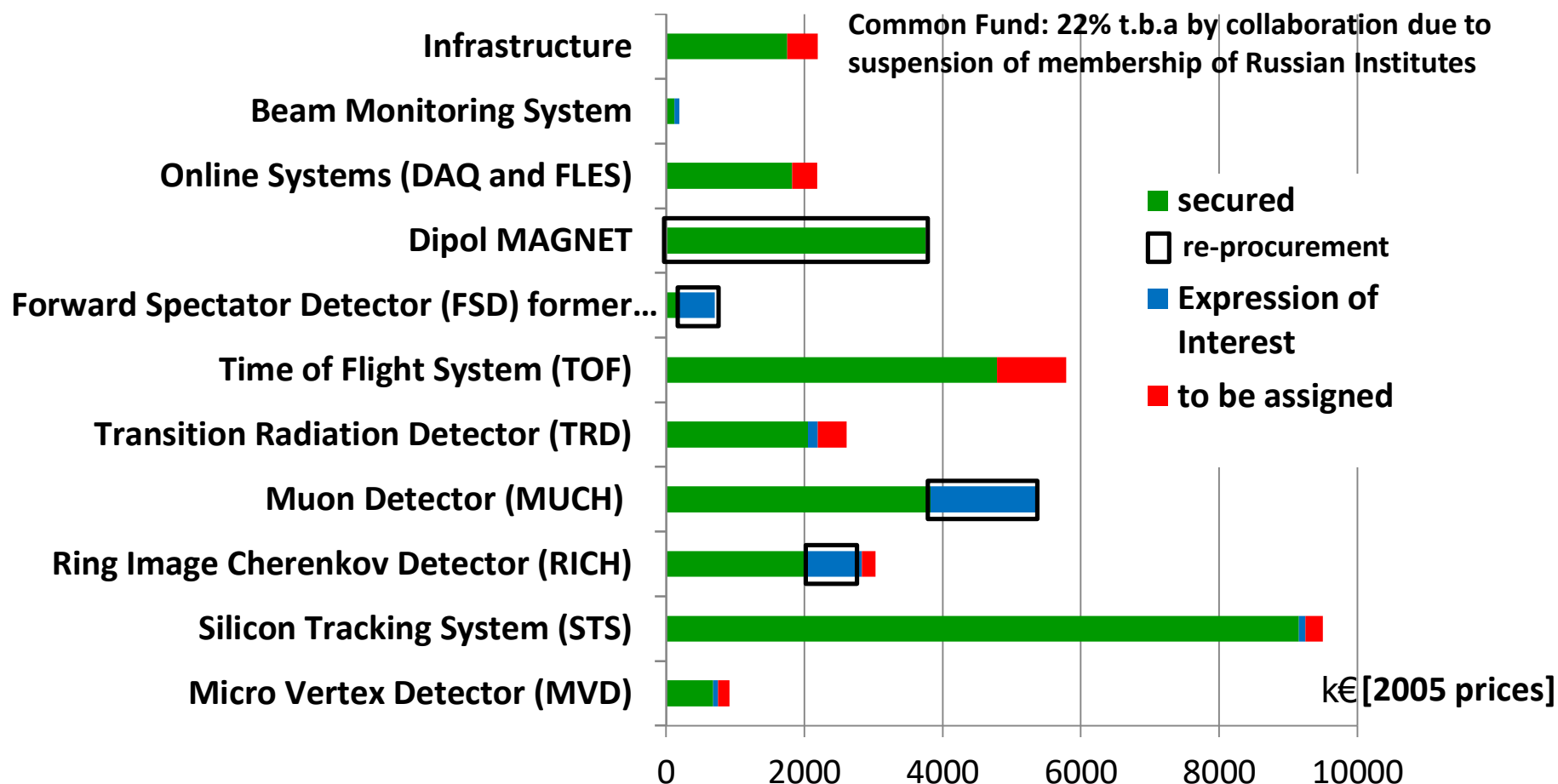
total cost: 35,97 M€ (2005 EURO)

secured: 30,17 M€

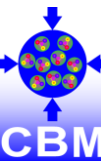
Eol: 3,32 M€

t.b.a. 2,48 M€

83,9 % secured funding



Consequences of FS / FS+



- Council decision: **(6) The additional non-German commitments will in principle be used to secure First Science. Exceptions from this principle with regard to a possibility to go beyond First Science require a Council decision, in particular the CBM magnets, expected for Summer 2023.**

- FAIR management plan: **Table 1: Components/services to be procured for the completion of the CBM science programme, their estimated costs (current price level) and their latest date for procurement/expense to keep the timeline.**

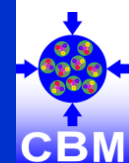
1	EXP	CBM SC Dipole magnet	4-5 Mio. €	July 2023
2	EXP	CBM Silicon Tracker System	0,9 Mio. €	Q3 2024
3	EXP	CBM PSD	0,5 Mio. €	Q4 2024
4	EXP	CBM RICH	1,0 Mio. €	Q2 2025
5	EXP	CBM MUCH	2,0 Mio. €	Q3 2025
6	ACC	CBM beamline magnets	4,2 Mio. €	Q4 2024
7	ACC	CBM beamline vacuum comp.	2,3 Mio. €	Q4 2024
8	S&B	TGA CBM cave	14,3 Mio. €	Q2 2024
9	S&B	TGA CBM cave risks	7 Mio. €	2024/2025
		Sum	ca. 37 Mio. €	

The collaboration is actively seeking alternative funding sources for detector components (items 2-5), thus, possibly mitigating the financial needs. In case of several years of delay, a significant increase of costs of at least 20% would be expected.

**CBM is part of FAIR2028.
Thanks to all involved
committees (ECE, JSC, AFC)
and
FAIR management!**

- Note: Project core invest is necessary but not sufficient to keep the CBM collaboration active. BMBF – funds through German „Verbundforschung“ are indispensable and needed **for funding of personnel (PhD students and postdocs)**

Residual needs beyond project C1



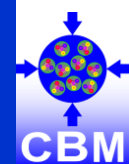
Lead institutions

Univ. Frankfurt
GSI, Univ. Tübingen
Univ. Münster, Frankfurt
Univ. Giessen, Wuppertal
Univ. Heidelberg
TU Darmstadt
Univ. Frankfurt, FIAS
GSI
VECC Kolkata
Rez, Prague -> FSD

GSI

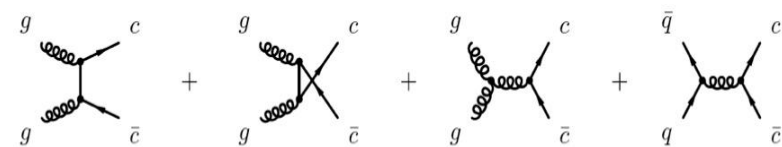
CBM day 1 setup detector / system	Costs	Common fund	Germany		FAIR (re- procurement) *IKC for STS with JINR (will be terminated)			India	Poland	Romania	China	Czech Republic			Hungary			France	Korea	Ukraine	to be assigned
			GSI and FAIR project funds	University funding (VF)																	
MVD	1,49			0,60		*	3,46		2,94								0,51	0,12		0,27	
STS	15,54		7,57	0,99		*	3,46		2,94										0,15	0,42	
TRD	4,28			1,28						2,02				0,23	+	0,06				0,68	
RICH	4,96		2,03	1,32	1,28	+														0,33	
TOF	9,46		1,21	0,72			0,00			1,22	4,67									1,63	
Beam Monitoring System	0,39			0,12								0,08								0,20	
Online Systems (DAQ+FLES) day-1 setup	2,98		1,44	1,22					0,33												
Magnet	6,14					+	6,14														
MuCh	8,82				2,57	+		6,26													
Forward Detector (former PSD)	1,15				0,72	+						0,27	+	0,16							
Infrastructure	3,58	2,87																		0,72	
ECAL (not part of day 1 setup)																					
Sum in 2023 M€	58,81	2,87	12,25	6,25	4,57	+	9,60	6,26	3,27	3,24	4,67	0,35	+	0,16	0,23	+	0,06	0,51	0,12	0,15	4,25
Sum in 2005 M€	35,97	1,75	7,49	3,82	2,79	+	5,87	3,83	2,00	1,98	2,86	0,21	+	0,10	0,14	+	0,04	0,31	0,07	0,09	2,60
escalation factor (1./1.635)																					
This calculation uses an escalation factor of 1.635 between 2005 prices and 2023 prices																					
amounts in green are considered as secured / 83,9 % secured																					
amounts in blue - Expression of Interest (Eol)																					
amounts in red - to be assigned																					
CBM phase 1 setup																					
CBM day 1 setup	58,81	2,87	12,25	6,25	4,57	+	9,60	6,26	3,27	3,24	4,67	0,35	+	0,16	0,23	+	0,06	0,51	0,12	0,15	4,25
full bandwidth (DAQ/FLES)	0,59																			0,59	
plus ECAL	4,59				4,59																
Sum in 2023 M€	63,99	2,87	12,25	6,25	9,15		9,60	6,26	3,27	3,24	4,67	0,35	+	0,16	0,23	+	0,06	0,51	0,12	0,15	4,84
Sum in 2005 M€	39,14	1,75	7,49	3,82	5,60	+	5,87	3,83	2,00	1,98	2,86	0,21	+	0,10	0,14	+	0,04	0,31	0,07	0,09	2,96
77,1 % secured																					

Extension of the CBM Physics Program

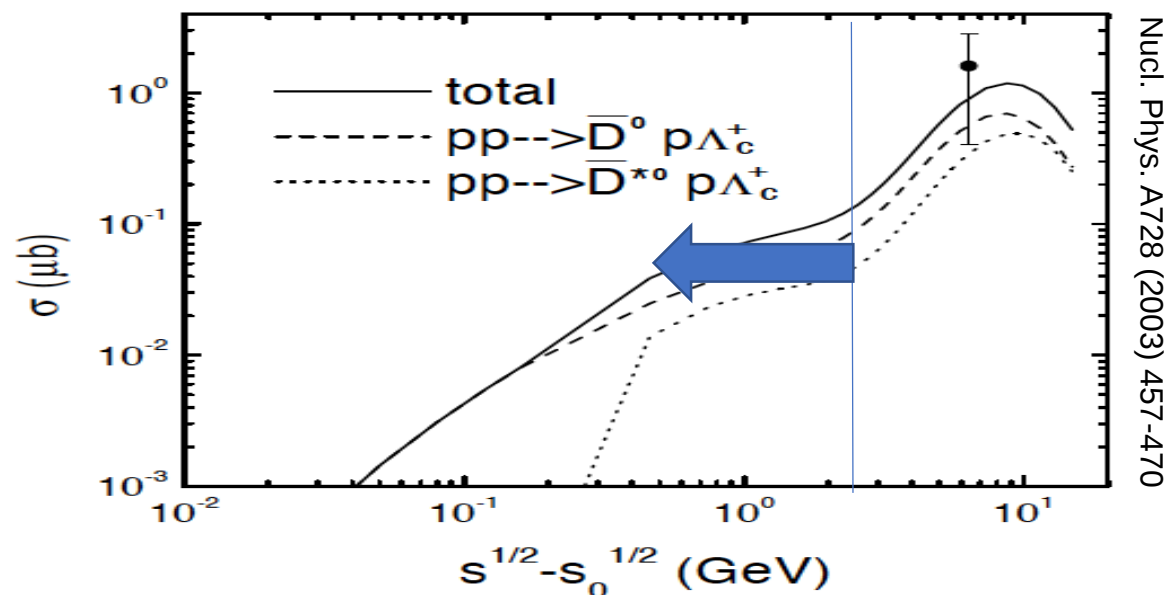
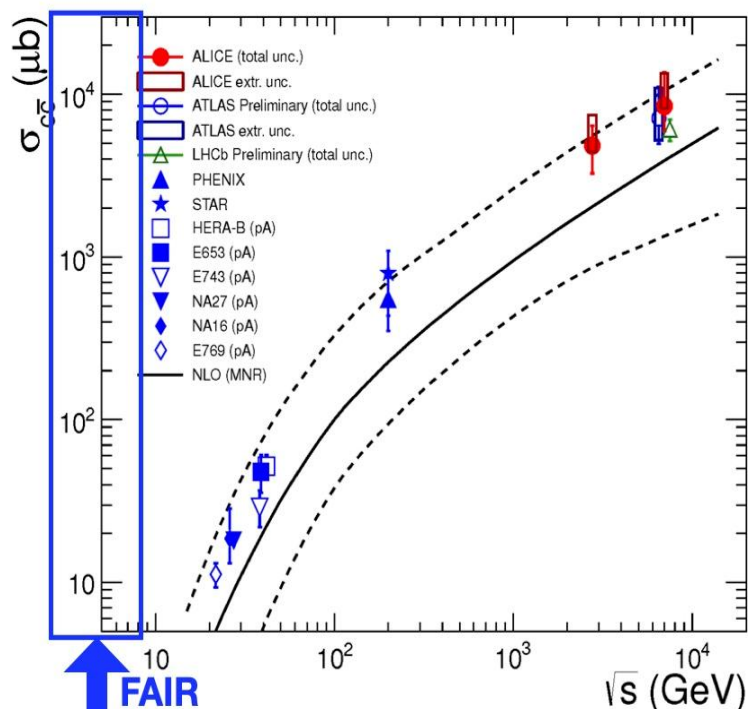


Physics potential of 29 GeV proton beams is being explored together with PANDA groups (J. Messchendorp, J. Ritman, P. Salabura)

Example for Day-1 CBM hadron setup: charm production, charm-N interaction



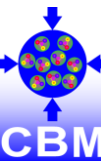
- Validity of pQCD at SIS100 energies?
- SU(4) estimates for (exclusive) charm hyperon production: 100 nb@SIS100
- Perspectives to study for the first time near-threshold charm production



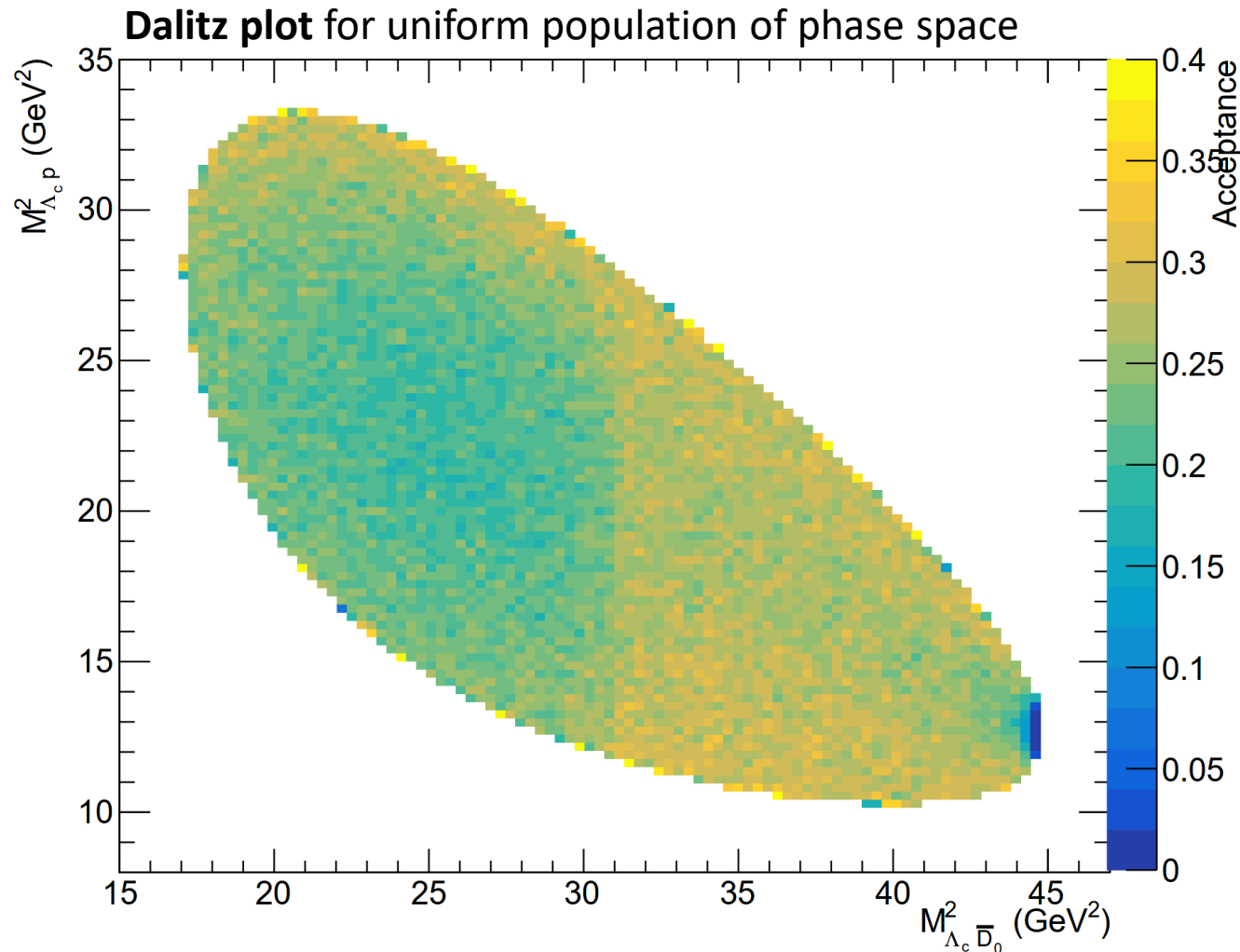
Nucl. Phys. A728 (2003) 457-470

Can intrinsic charm of nucleon enhance production cross section?
(Analogy of $s\bar{s}$ bar content in nucleon and ϕ production)

CBM projection for studying exclusive reactions



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



Rate estimate:

Cross section: 100 nb

Beam intensity: 10^{12} 1/s

Target: LH2

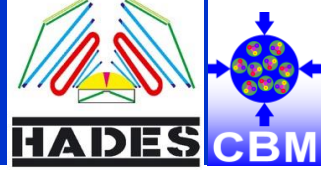
Target thickness: 5 cm

Duty cycle: 50%

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

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

Conclusion



- Hades will continue successful program with SIS18 beams (H, p, π)
- CBM pushes to be part of the official FAIR2028 program by FAIR Council decision
 - uniqueness of physics program is confirmed by Heuer/Tribble, ECE and JSC
 - CBM planning is assuming a positive decision of FAIR council and goes for first SIS100 beams in 2028
 - missing the 'urgency requirement' will be hindering the application for necessary funds for completion
 - personnel funding (PhD students, postdocs) is essential for the university groups to continue
 - CBM groups should be funded to secure alternatives in SIS100 usage in 2027/2028
- CBM is working on the possibility of including the beam line to CBM-Cave into FAIR 2018
 - CBM is in contact with PANDA groups to define a competitive hadron physics program with proton beams.
 - APPA (ESA) measurement options are being investigated.