CBM Report

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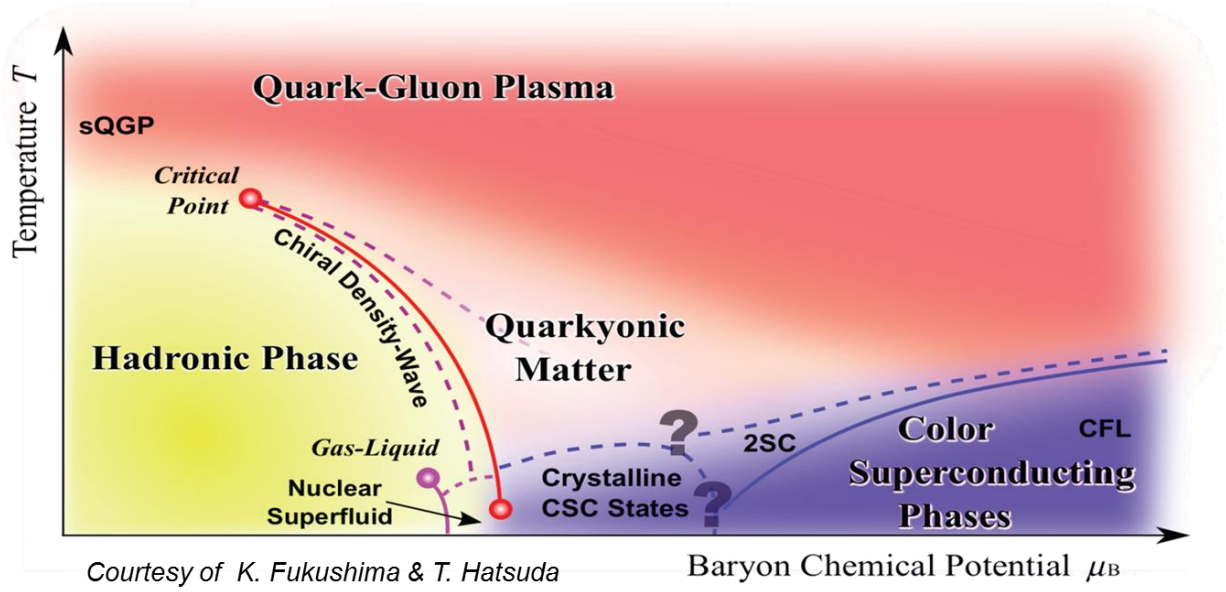
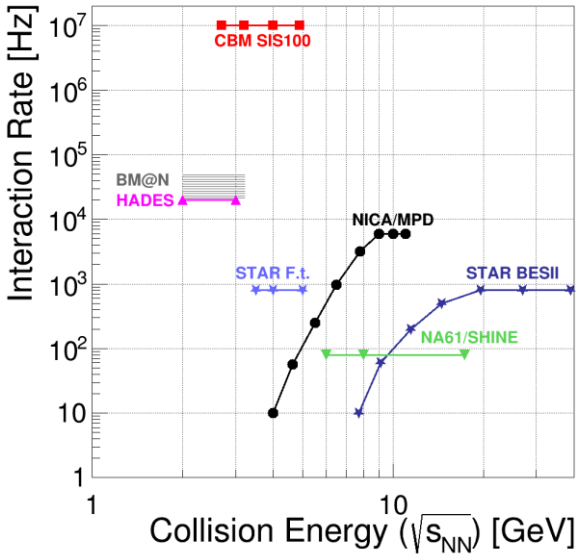
CBM – Goals



Courtesy of K. Fukushima & T. Hatsuda



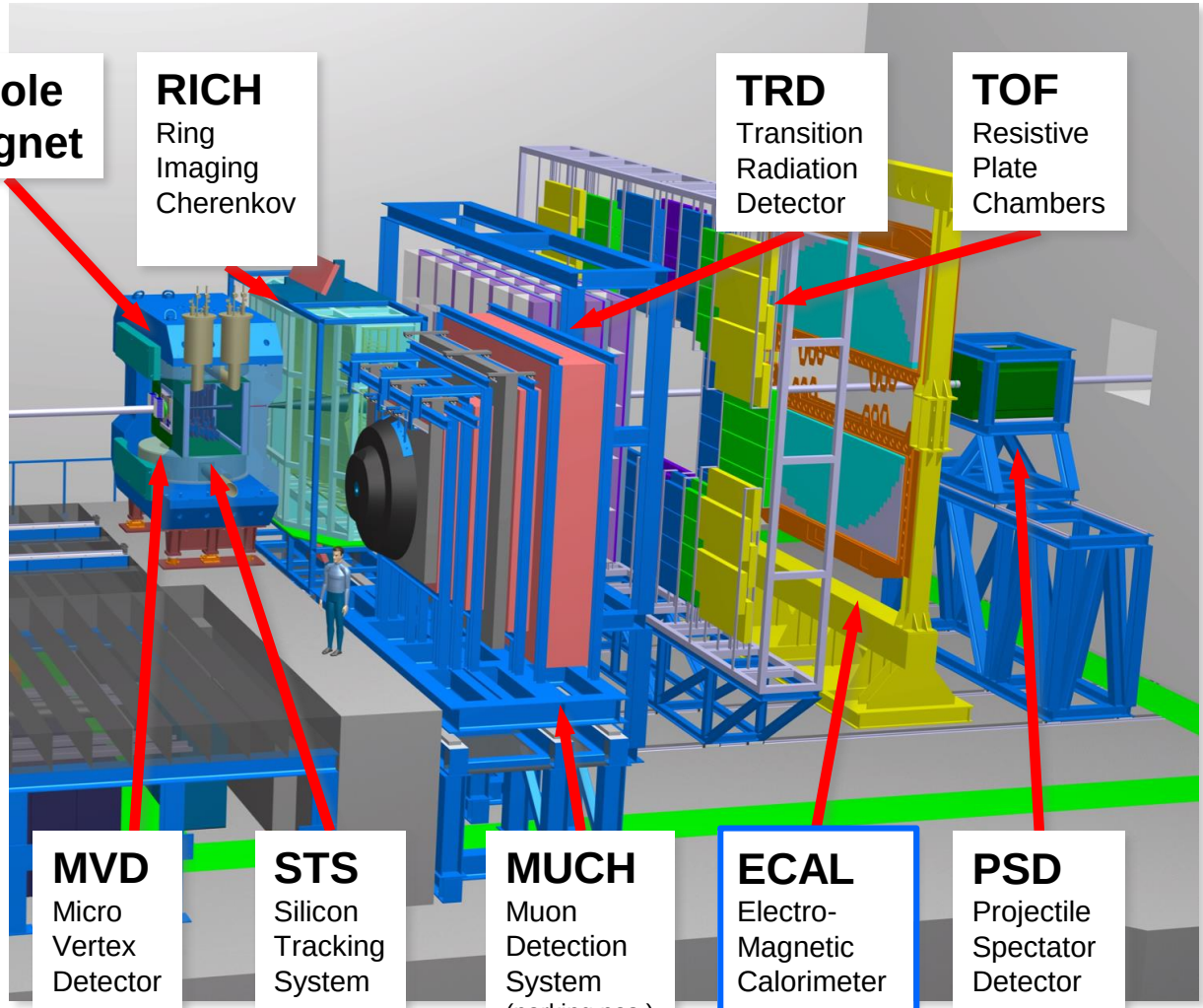
Mission:

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

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

CBM experimental setup (day-1)



- Tracking acceptance: $2^o < \theta_{lab} < 25^o$
- Free streaming DAQ
- R_{int} = 10 MHz (Au+Au)

  $R_{int} \approx 0.5$ MHz
  full bandwith:
  Det. – Entry nodes
  reduced bandwidth
  Entry nodes – Comp. farm

  with
  R_{int} (MVD)=0.1 MHz
- Software based event selection

Day-1 setup = MSV setup – Compute Performance - ECAL

Day-1 funding:
~ 90% secured

Country funding (in 2018 prices [M€]) CBM day 1 setup 8th RRB 26.11.2018

and CBM phase 1 setup (CBM start version)

CBM day 1 setup detector / system	Costs	Common fund	Germany			Russia	India	Poland	Romania	China	Czech Republic	Hungary	France	Korea	Ukraine	to be assigned
			GSI and FAIR project funds	University funding (VF)	Universities											
MVD	1,31			0,53	0,23								0,45	0,10		
STS	13,65		6,65	0,87	0,37	3,04		2,59							0,13	
TRD	3,65			1,02	0,60				1,77			0,21 + 0,05				
RICH	5,31		**1,78**	1,16	0,29	0,36 + 1,72										
TOF	8,41		1,06	0,74	0,47	0,67			1,07	4,10						0,29
Online Systems (DAQ+FLES) day-1 setup	2,72		**1,27**	1,17				0,29								
Magnet	5,40					5,40										
MuCh	8,81					0,70 + 2,62	5,49									
PSD	1,36					1,12					0,24					
Infrastructure	3,26	**3,26**														
ECAL (not part of day 1 setup)																
Sum in 2018 M€	**53,89**	**3,26**	**10,76**	**5,49**	**1,97**	**1,06 + 14,56**	**5,49**	**2,87**	**2,85**	**4,10**	**0,24**	**0,21 + 0,05**	**0,45**	**0,10**	**0,13**	**0,29**
Sum in 2005 M€	37,53	2,27	7,49	3,82	1,37	0,74 + 10,14	3,83	2,00	1,98	2,86	0,17	0,14 + 0,04	0,31	0,07	0,09	0,20
escalation factor (1./1.436)																

This calculation uses an escalation factor of 1.436 between 2005 prices and 2018 prices

1,436

amounts in green are considered as secured / **87,0 % secured / with Common Fund 93,0%**

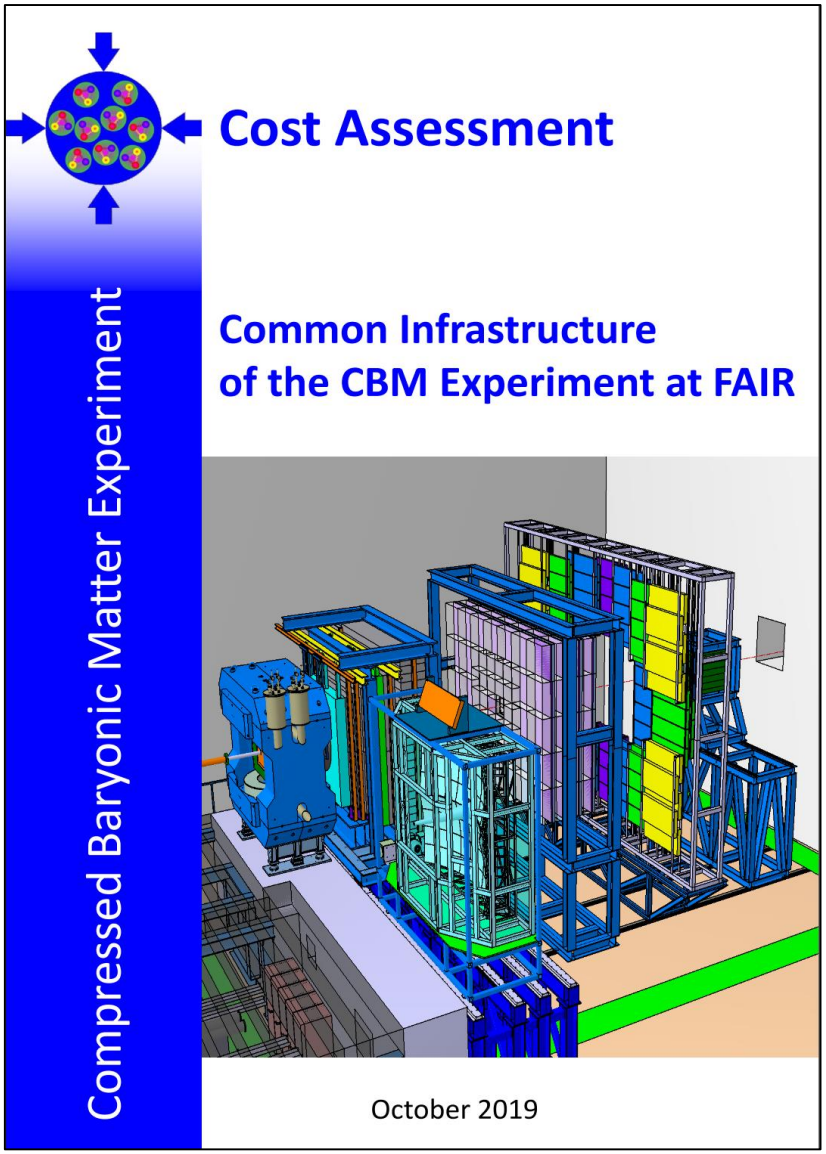
amounts in blue - Expression of Interest (EoI)

amounts in red - to be assigned

CBM phase 1 setup																
CBM day 1 setup	53,89	3,26	10,76	5,49	1,97	1,06 + 14,56	5,49	2,87	2,85	4,10	0,24	0,21 + 0,05	0,45	0,10	0,13	0,29
full bandwidth (DAQ/FLES)	0,52				0,52											
plus ECAL	4,03					4,03										
Sum in 2018 M€	**58,44**	**3,26**	**10,76**	**5,49**	**2,49**	**5,09 14,56**	**5,49**	**2,87**	**2,85**	**4,10**	**0,24**	**0,21 0,05**	**0,45**	**0,10**	**0,13**	**0,29**
Sum in 2005 M€	40,69	2,27	7,49	3,82	1,73	3,55 + 10,14	3,83	2,00	1,98	2,86	0,17	0,14 + 0,04	0,31	0,07	0,09	0,20

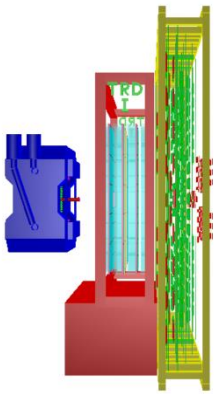
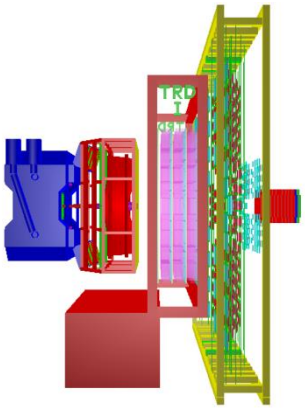
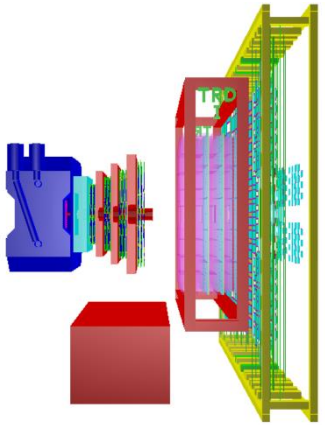
80,2 % secured / with Common Fund **85,8%**

Cost assessment of Common Fund items



-> talk by Mladen Kis

CBM MSV vs. Day-1

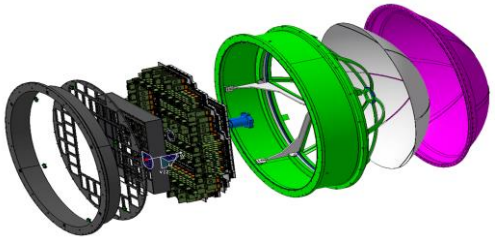




Setup	Subsystems	Average Rate (max)		Event size
		MSV	Day-1	
Hadron	STS, TRD, TOF	5 MHz	0.5 MHz	50 kB
Electron/ Hadron	MVD, STS, RICH, TRD, TOF, PSD	0.1 MHz	0.1 MHz	75 kB
Muon	STS, MUCH, TRD, TOF	5 MHz	0.5 MHz	30 kB

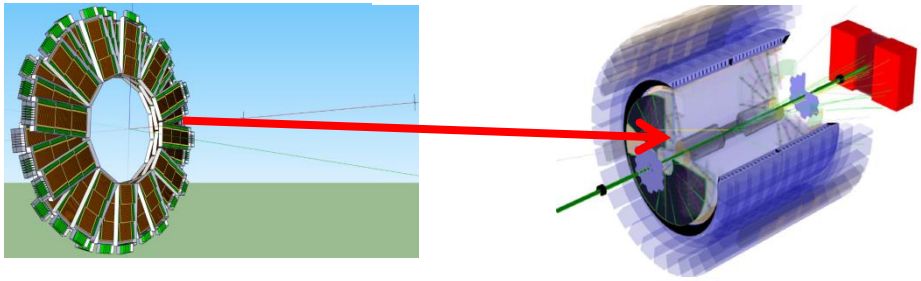
Day-1 electron setup offers final rate capability for di-electrons (due to MVD rate limitations).
No sophisticated online selection (trigger) planned for Day-1.

CBM – FAIR Phase 0 projects (2018 – 2023)

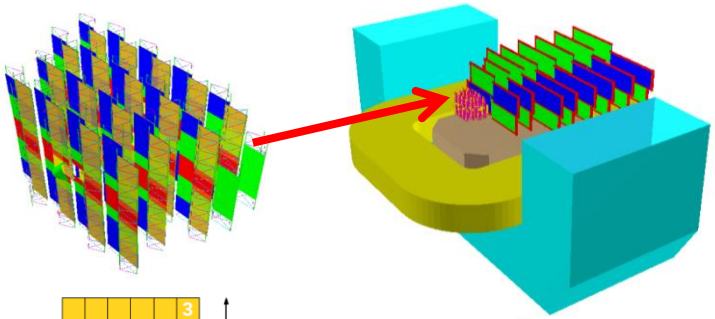
1. Install, commission and use 428 out of 1100 CBM RICH multi-anode photo-multipliers (MAPMT) including FEE in HADES RICH photon detector



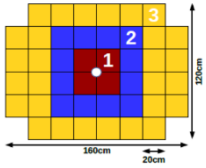
2. Install, commission and use 10% of the CBM TOF modules including read-out chain at STAR/RHIC (BES II 2019/2020)



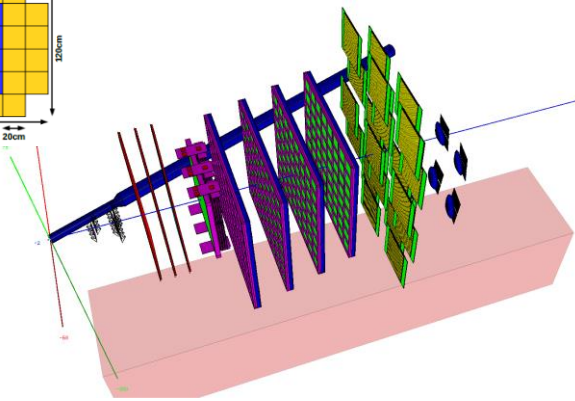
3. Upgrade BM@N experiment with 4 Silicon stations of CBM/STS design in the BM@N experiment at the Nuclotron JINR/Dubna (Au-beams in late 2022)



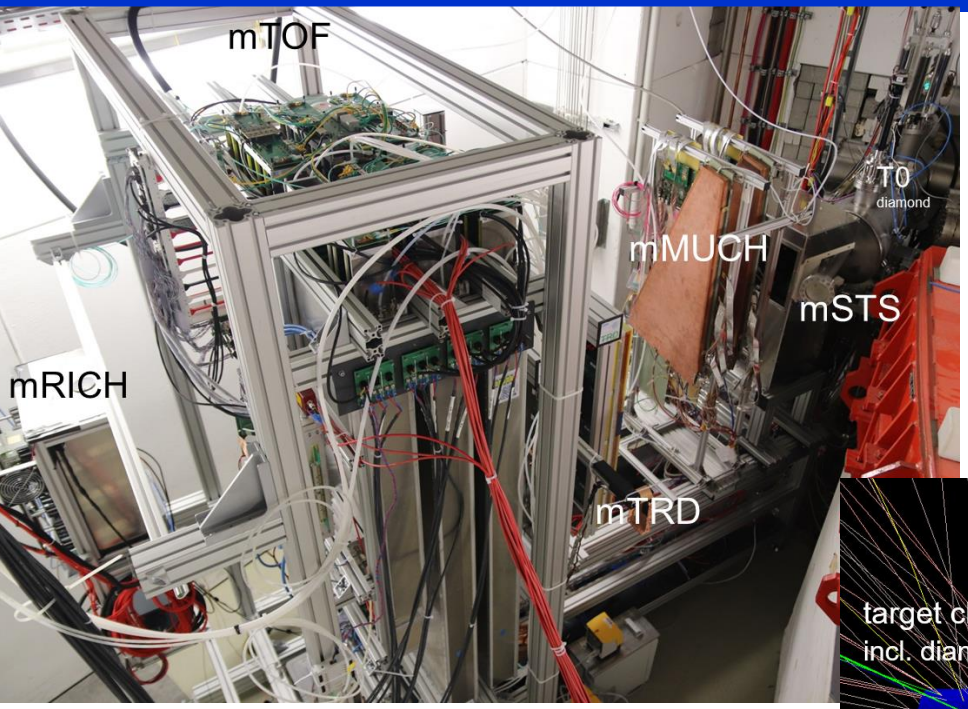
4. Install, commission and use the Project Spectator Detector at the BM@N experiment



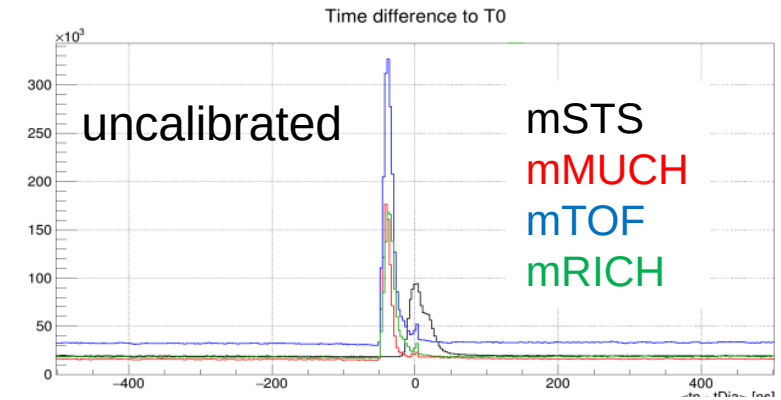
5. mini CBM (mCBM@SIS18) demonstrator for full CBM data taking and analysis chain



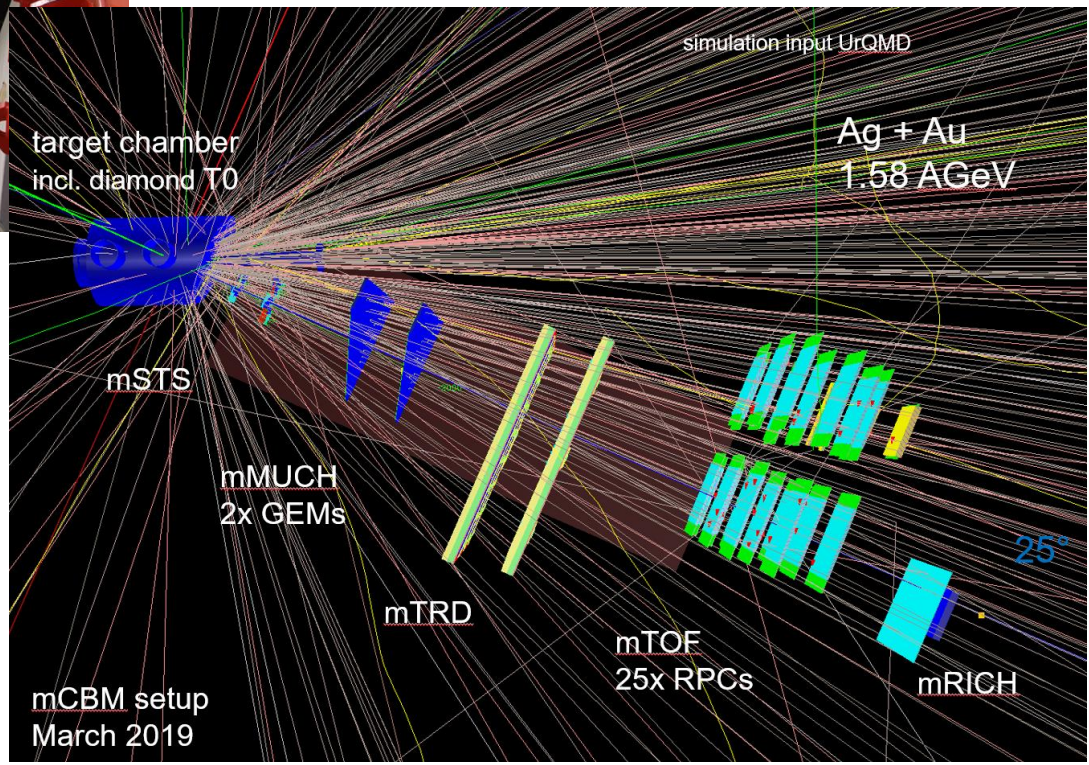
mCBM experiment



FAIR Phase 0 Research Program

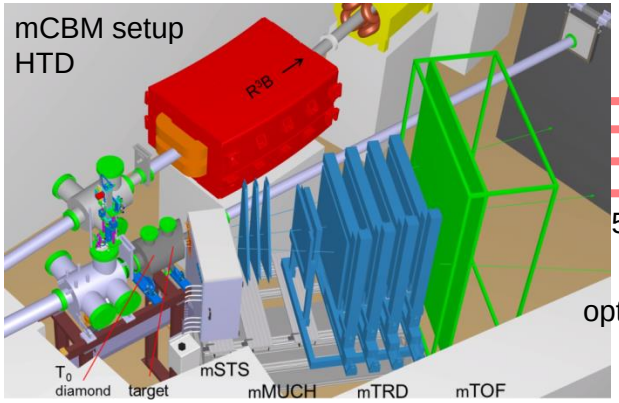


$t_{subsystem}$ – T0 [ns]

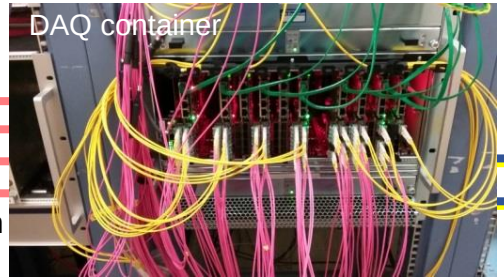


Data rate in March 2019

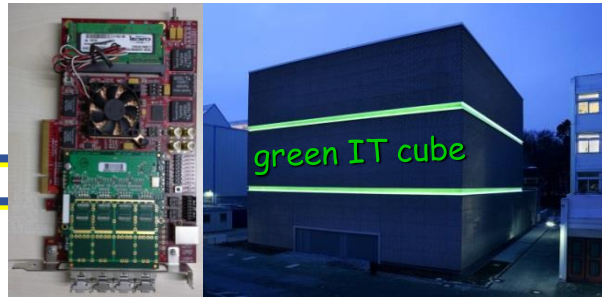
March 2019 : 10^8 Ag ions/s (1.58 AGeV) + Au (2.5mm) → 10 MHz collision rate



50 m optical fibers

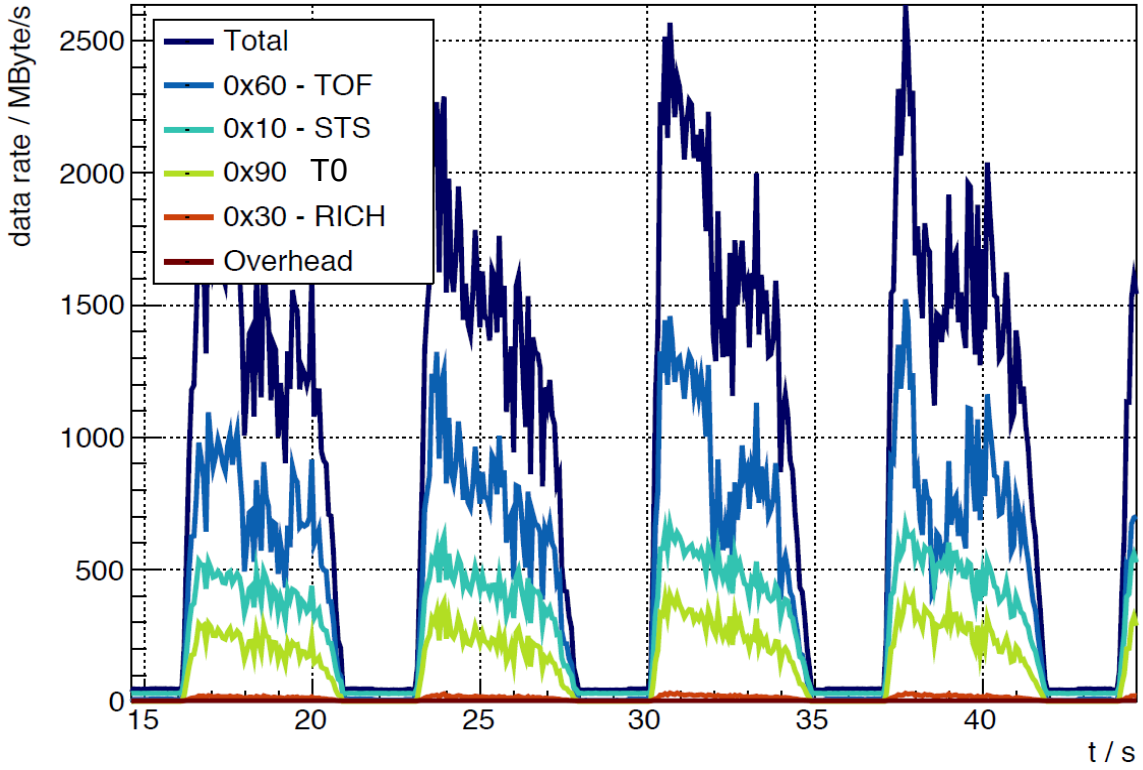


optical fibers 300 m



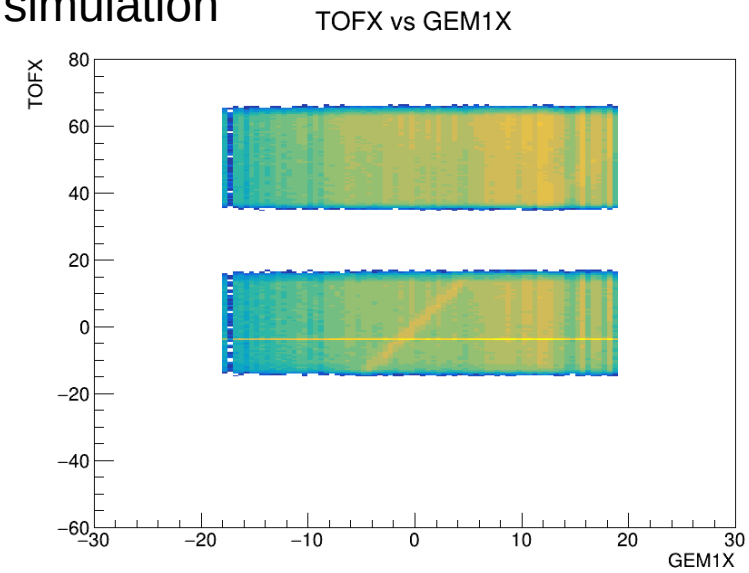
total data rate
online

2.5 GB/s (max.)

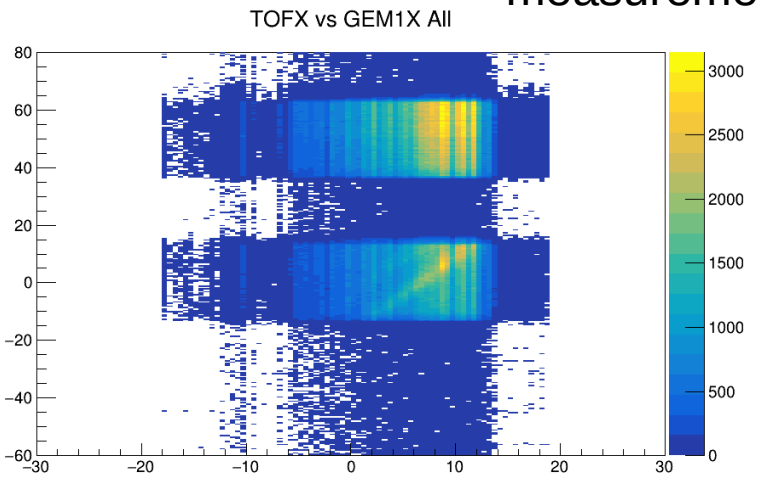


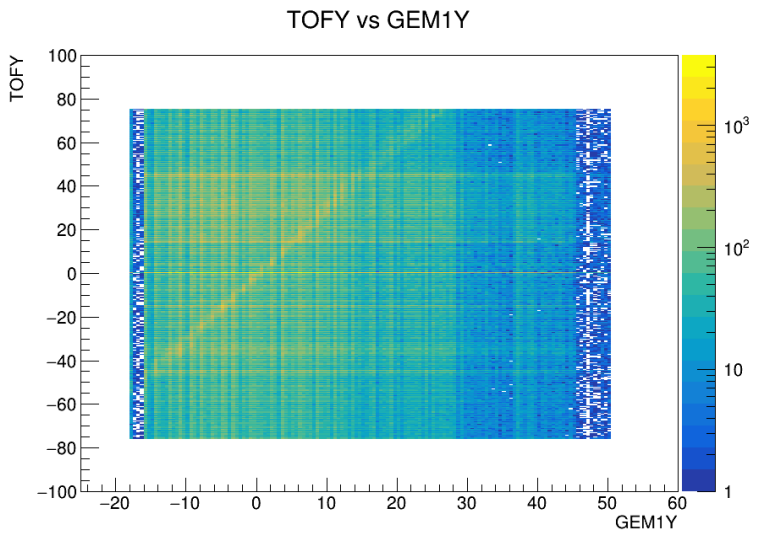
Spatial correlations: mMUCH ↔ mTOF

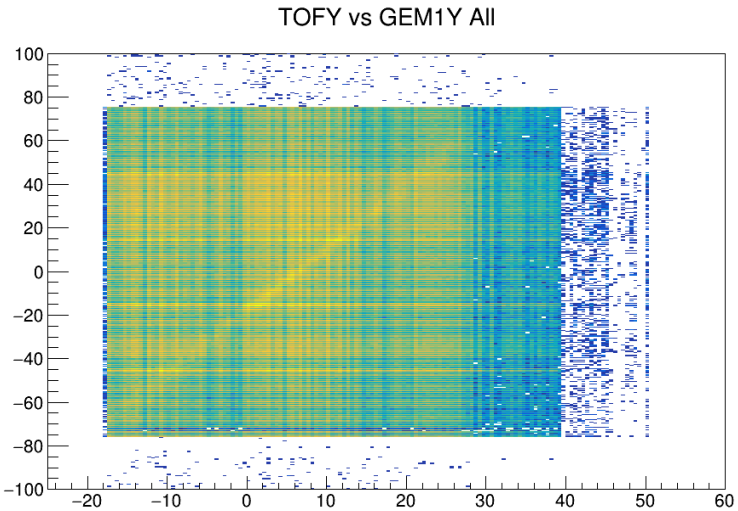
simulation



measurement





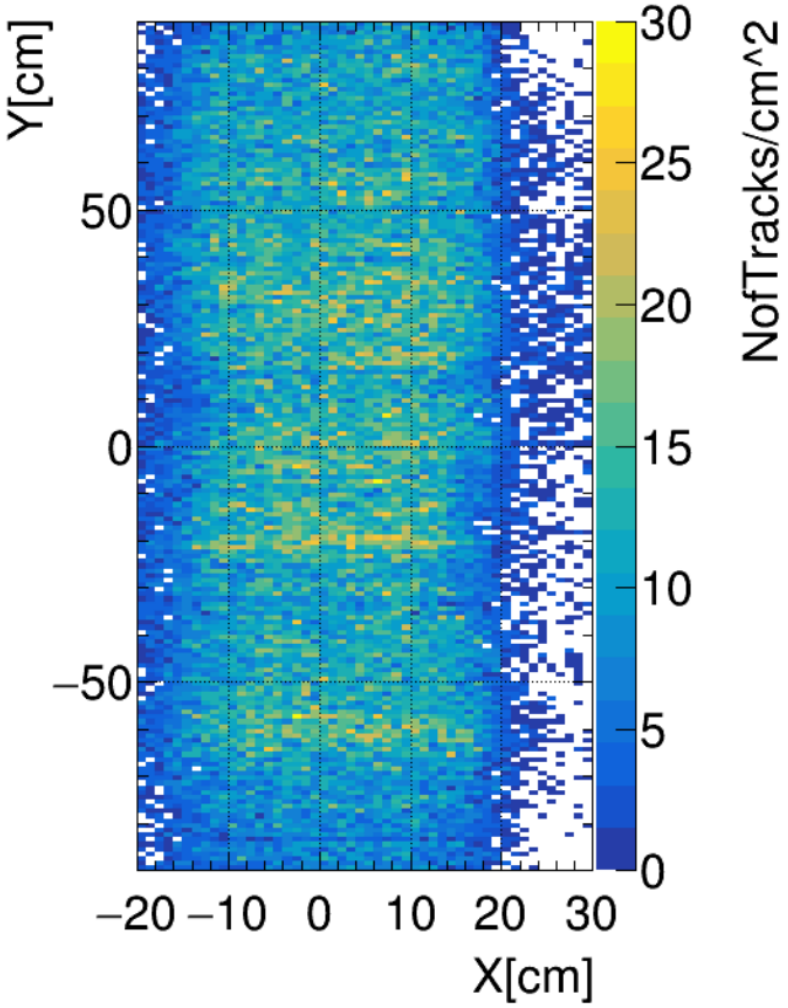


Spatial correlations mTOF ↔ mRICH

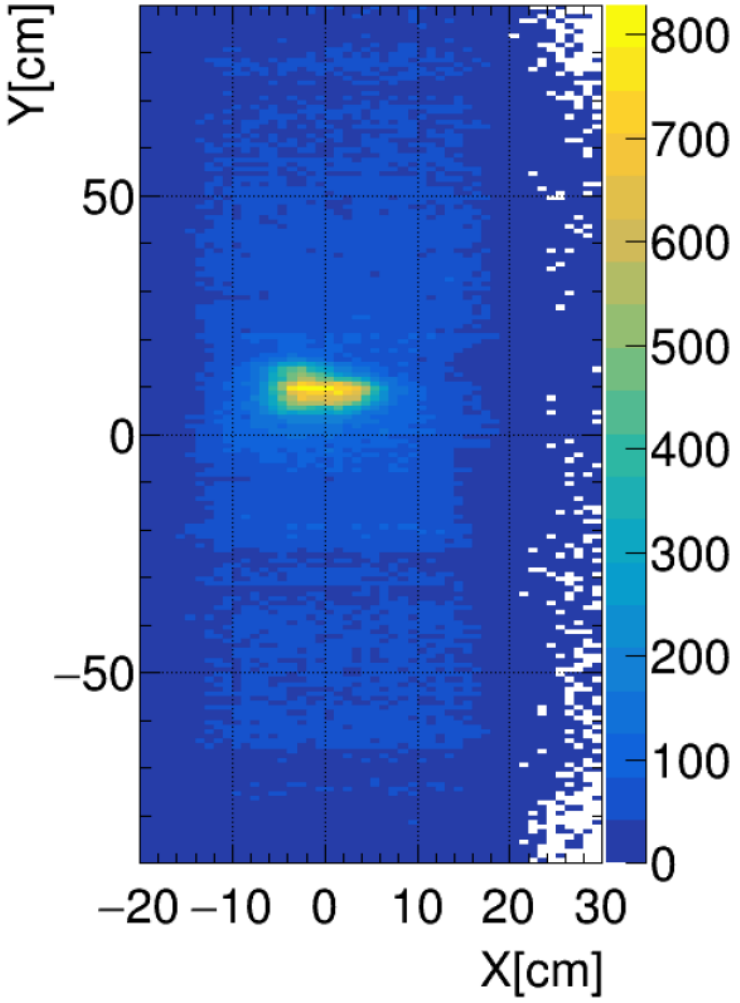
TOF Tracks extrapolated to mRICH plane

preliminary results, run 160

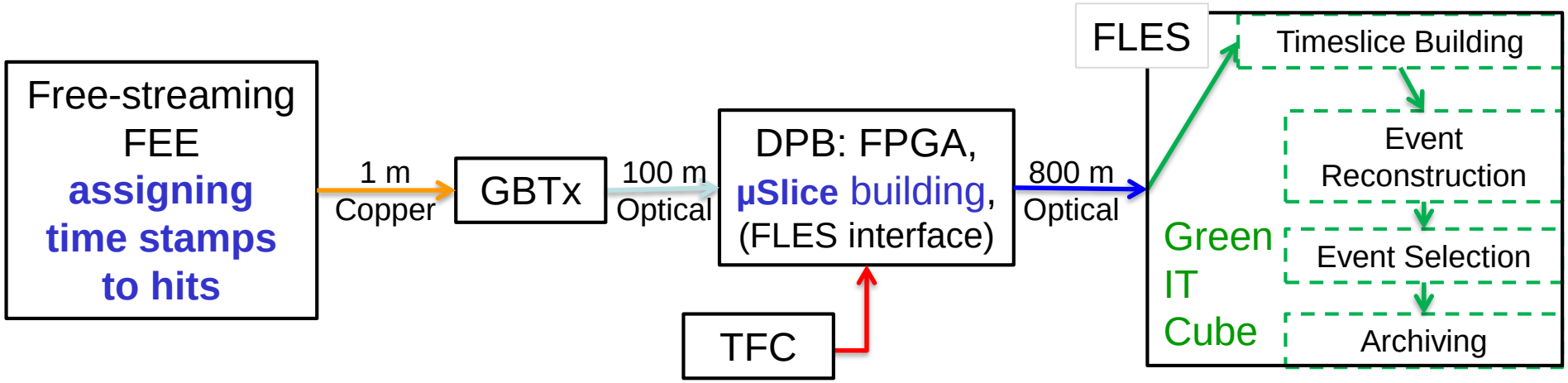
all events



events with at least 1x RichDigi



CBM data transport and processing



Acronyms

FPGA : Field Programmable Gate Array

DPB : Data Processing Board

TFC : Timing and Fast Control Syst.

FLES : First Level Event Selector

GBTx : CERN rad.-hard interface ASIC

µSlice (µS) : self contained data block for a subset of the experiment,

Timeslice : collection of µS, self contained data block for the full experiment and a given time interval, includes overlap to avoid edge losses

Open issues: stability, error handling, pickup noise, data loss, online processing

Additional men power

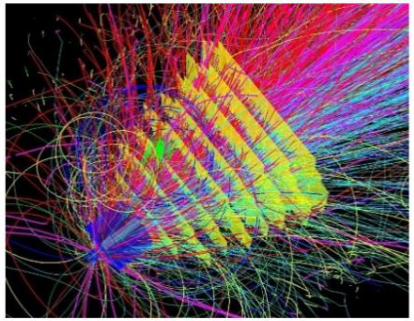
Cremlin Connecting Russian and European Measures for Large-scale Research Infrastructures

EU project CREMLINplus

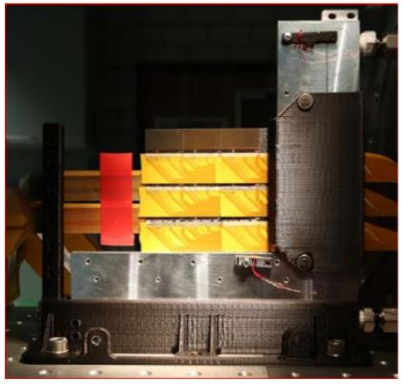
Science Cooperation between European Research Infrastructures and the Russian megascience projects (NICA, PIK, USSR, SCT and EXCELS)

Good news!

Proposal approved: 4-year-project – starting 1.2.2020, **Total Budget: 25 M€**
Consortium: 35 participants from 12 countries - 25 European laboratories 10 Russian laboratories
10 working packages (WPs), GSI/FAIR and JINR involvement in WP2 and WP7

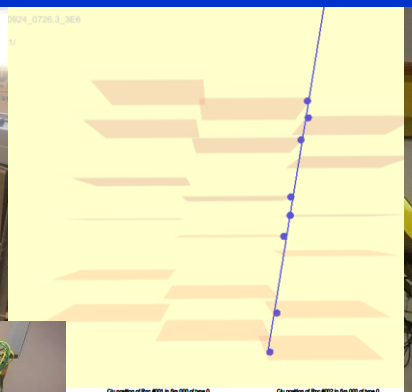


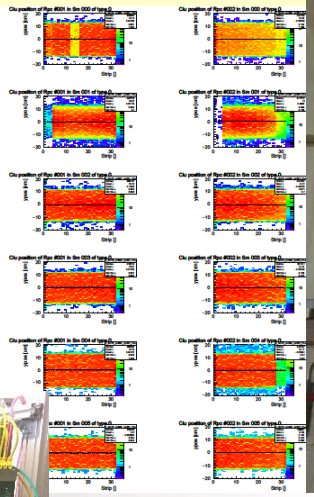
WP2: Collaboration with NICA - Development of instrumentation for NICA and FAIR/CBM
Engineering and construction of fast detectors,
Development of high rate data acquisition chain and software packages for simulation and data analysis, PSD, beam pipe design
Budget 4.61 M€
Participants: JINR (9 FTE), FAIR (8.5 FTE), U Tübingen (1 FTE), WUT Warsaw (2 FTE), Wigner Budapest (2 FTE), MEPhI (4 FTE),
INR Moscow (1 FTE), NPI Prague (2 FTE)



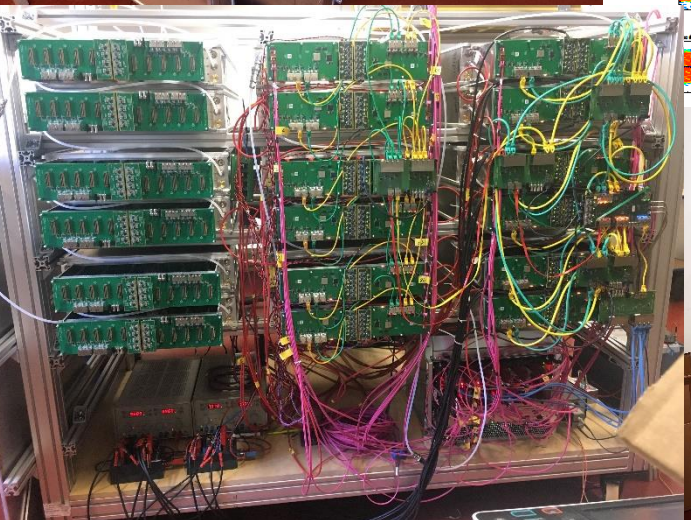
WP7: **Joint development of detector technologies**
Develop a beyond state of the art CMOS pixel sensors (MAPS) for high-rate Silicon trackers for several particle physics and heavy-ion research communities in Europe and Russia for the potential upgrade of many experimental setups
Development of neutron detectors, detector school at BINP
Budget 1.8 M€ (~1.2 M€ for MAPS)
Participants: JINR (1 FTE), FAIR (1 FTE), DESY (1 FTE), U Frankfurt (1 FTE), IPHC Strasbourg (1 FTE), KINR Kiev (1 FTE), ESS (1FTE), PNPI (1 FTE), BINP

CBM-STAR eTOF: production/installation 2018





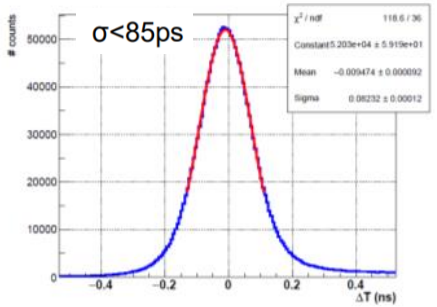
Nov.6, 2018

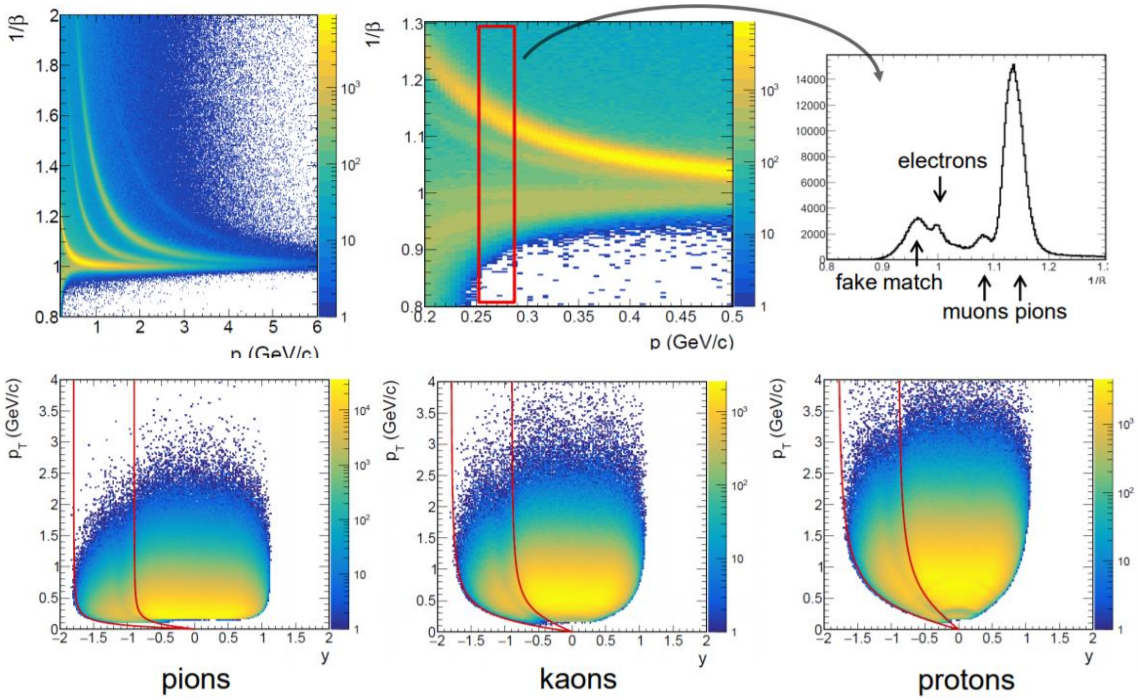


eTOF@STAR: key achievements in last 6 month

CCNU, GSI, TUD, UHD, TSU, USTC

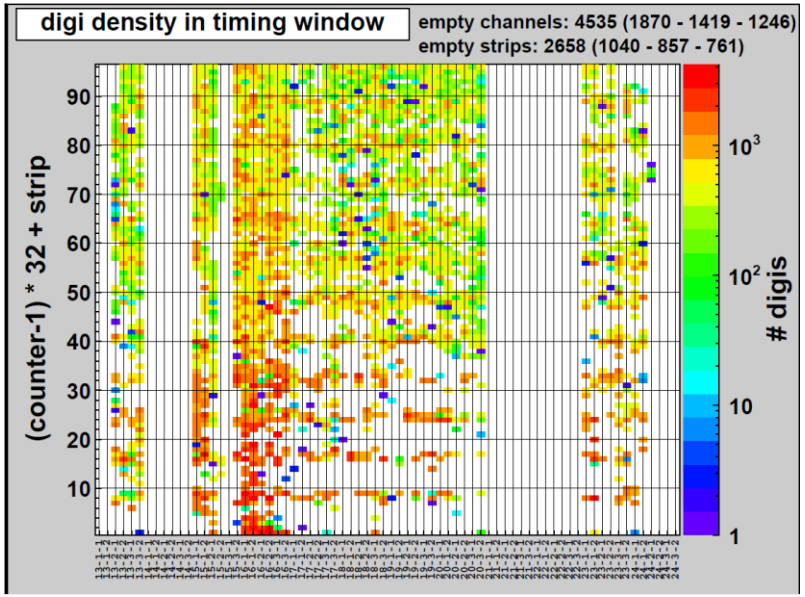
- eTOF@STAR is installed, commissioned and running
- BESII started in February 2019
- System time resolution better than 85 ps
- PID capability demonstrated





eTOF status after 6 month of operation

Status on 9th of Jul. 2019



Observed problems

- Loss of about 50% of the readout channels (PADI) due to beam related events
- Stability for long term operation insufficient:
  - Occurrence and handling of noisy channels
  - GBTx boards configure unreliably at power-up
  - GET4 synchronization mismatches
  - Clock jumps observed in pulser data
- eTOF – TPC matching probability < 70 %

Mitigation as of Oct. 2019

- Replace all PADI preamplifier boards
  - New preamplifier boards have a protection diode (ESD 113-B1)
  - Counter performance is not influenced by ESD
- Change gas mixture to include 1% SF6
- Ramp to full voltage only after both beams are declared stable
- Lower the standby voltage
- Replacing all GBTx boards (now with SCA functionality) and delayed power-up reset signal
- Firmware upgrades ongoing

Summary / Conclusion

CBM is well on track for realization of ist day-1 configuration

CBM Phase 0 activities targeted towards efficient startup

- CBM – RICH sensors & readout in HADES at SIS18
- CBM – TOF and HPC software in STAR at RHIC/BNL
- CBM – PSD and CBM - STS in BM@N at Nuclotron/JINR
- Integration of all subsystems & FLES in mCBM at SIS18

Status of CBM day1 hardware projects:

	Component/ Sub-System	TDR	Cost [k€ 2005]	Funding	Construction	Construction completed	Test/ Commissioning
Day-1	Micro Vertex Detector (MVD)		914			12/2024	
	Silicon Tracking System (STS)		9504			08/2024	
	Ring Image Cherenkov Detector (RICH)		3697			01/2024	
	Muon Detector (MUCH)		6138			03/2024	
	Transition Radiation Detector (TRD)		2544			11/2024	
	Time of Flight System (TOF)		5857			11/2024	
	Projectile Spectator Detector (PSD)		944			11/2023	
	Dipol Magnet		3758			10/2022	
	Online Systems (DAQ and FLES)		1896			12/2023	
	Infrastructure		2273			12/2023	
		86% *value weighted*	37525	87% *secured*	11% *value weighted*		
Phase-0 (SIS18) & Day-1 (SIS100)	HADES upgrade		2453			03/2023	

Thank you !