CBM project for the study of compressed baryon matter

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X Cherenkov reading, FIAN, Moscow, 18 April 2017 г.

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Установка для исследования сжатой барионной материи (CBM)

- А.Б.Курепин (ИЯИ РАН)

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- **2. Версия регистрации электронов**
- **1) RICH, ИФВЭ – ПИЯФ - ИТЭФ**
- **2) ECALO, ИТЭФ – ИФВЭ**
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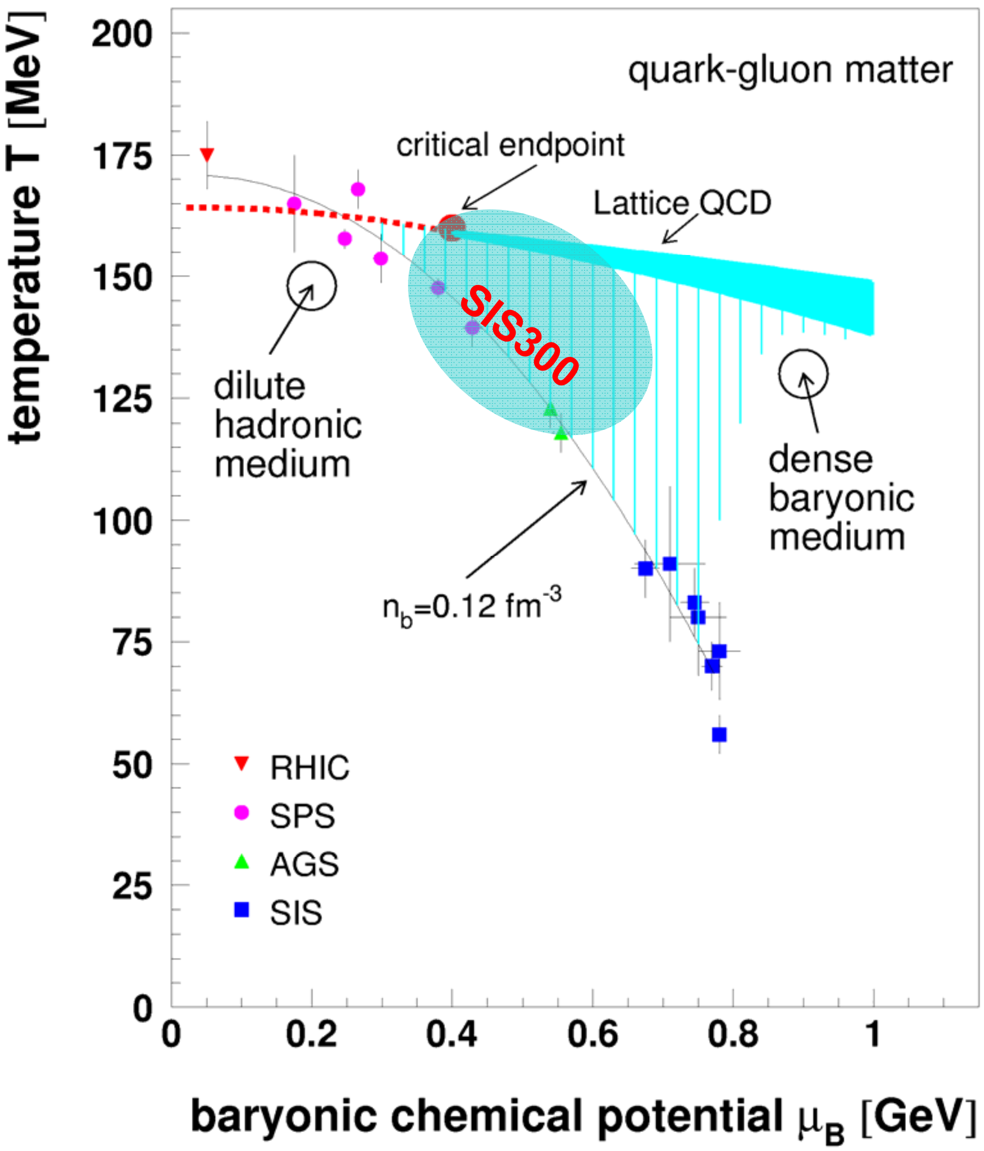
- **6. HADES - 8**
- **НТС3 Росатом 17 апреля 2007**



Lattice QCD calculations:
Fedor & Katz,
Ejiri et al.

net baryon density:

$\rho B \approx 4\,(mT/2\pi\hbar^2 c^2)^{3/2} \times$

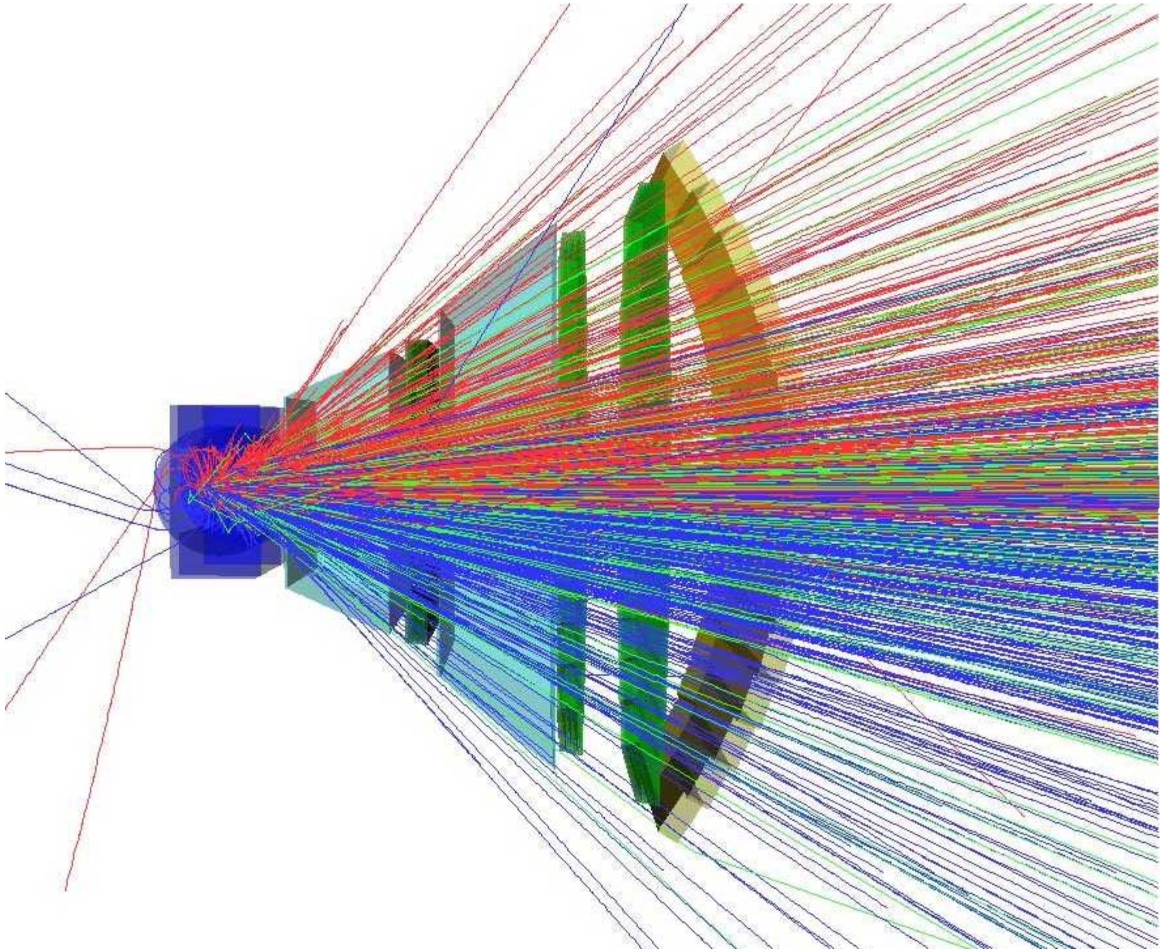
$[\exp((\mu B - m)/T) - \exp((-\mu B - m)/T)]$

baryons - antibaryons

Experimental challenges 17 April 2007

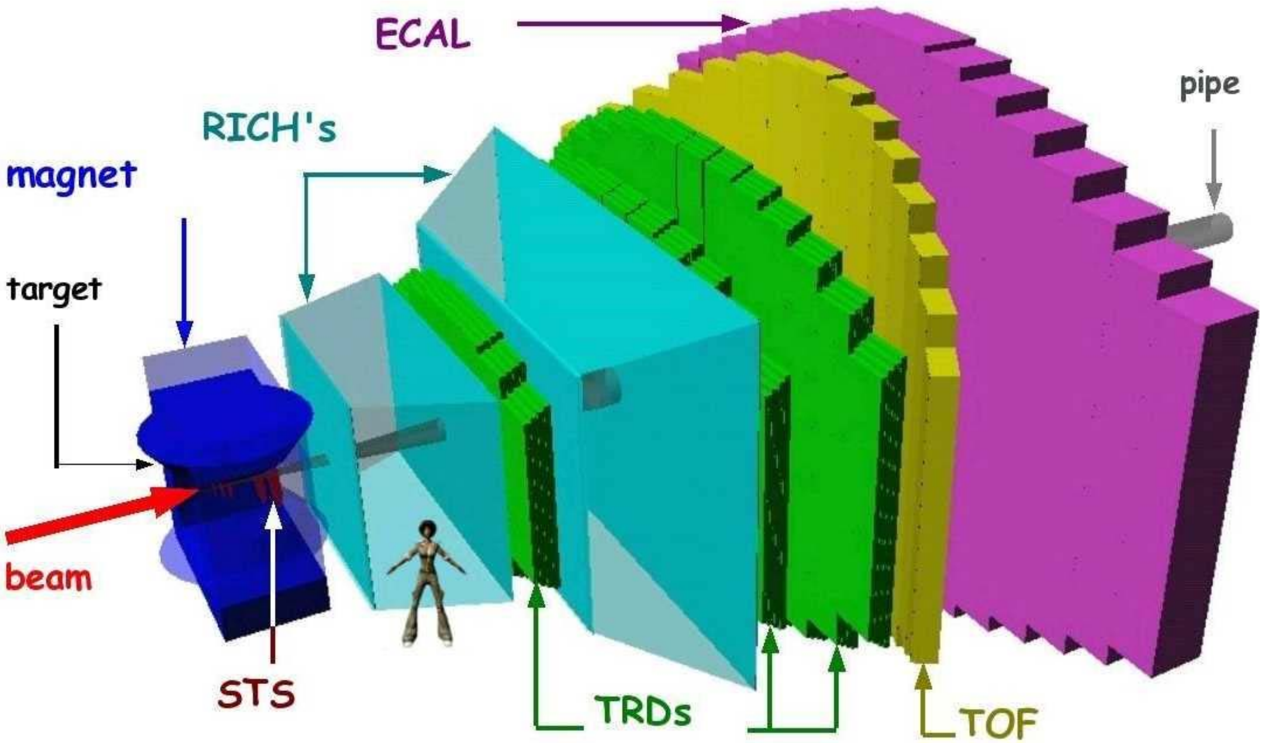
Central Au+Au collision at 25 AGeV:
URQMD + GEANT4

160 p_-
400 π_+
400 π_+
44 K_-
13 K



- 10^7 Au+Au reactions/sec
  (beam intensities up to 10^9 ions/sec, 1 % interaction target)
- determination of (displaced) vertices with high resolution (≈ 30 μm)
- identification of electrons and hadrons

Event generators: URQMD, PLUTO
Transport: GEANT3,4 via VMC



- Radiation hard Silicon pixel/strip detectors in a magnetic dipole field
- Electron detectors: RICH & TRD & ECAL: pion suppression up to 10^5
- Hadron identification: RPC, RICH
- Measurement of photons, π^0, η, and muons: electromagn. calorimeter (ECAL)

CBM R&D working packages 17 April 2007

Feasibility studies Simulations

Framework
GSI

Tracking
KIP Univ. Heidelberg
Univ. Mannheim
JINR-LHE Dubna
JINR-LIT Dubna

Ring finder
JINR-LIT, Dubna

π, K, p ID
Heidelberg Univ,
Warsaw Univ.
Kiev Univ.
NIPNE Bucharest
INR Moscow

$\rho, \omega, \varphi \to e^+ e^-$
Univ. Krakow
JINR-LHE Dubna

$J/\psi \to e^+ e^-$
INR Moscow
GSI

$J/\psi \to \mu^+ \mu^-$
PNPi St. Petersburg
SPU St. Petersburg

$D \to K\pi(\pi)$
GSI Darmstadt,
Czech Acad. Sci., Rez
Techn. Univ. Prague

Λ, Ξ, Ω
PNPi St. Petersburg
SPU St. Petersburg

Design & construction of detectors

Silicon Pixel
IReS Strasbourg
Frankfurt Univ.,
GSI Darmstadt,
RBI Zagreb,
Univ. Krakow

Silicon Strip
Moscow State Univ
CKBM St. Petersburg
KRI St. Petersburg
Univ. Obninsk

RPC-TOF
LIP Coimbra,
Univ. Santiago
Univ. Heidelberg,
GSI Darmstadt,
Warsaw Univ.
NIPNE Bucharest
INR Moscow
FZ Rossendorf
IHEP Protvino
ITEP Moscow
RBI Zagreb
Univ. Marburg

Fast TRD
JINR-LHE, Dubna
GSI Darmstadt,
Univ. Münster
NIPNE Bucharest

Straw tubes
JINR-LPP, Dubna
FZ Rossendorf
FZ Jülich
Tech. Univ. Warsaw

ECAL
ITEP Moscow
Univ. Krakow

RICH
IHEP Protvino
GSI Darmstadt

Magnet
JINR-LHE, Dubna
GSI Darmstadt

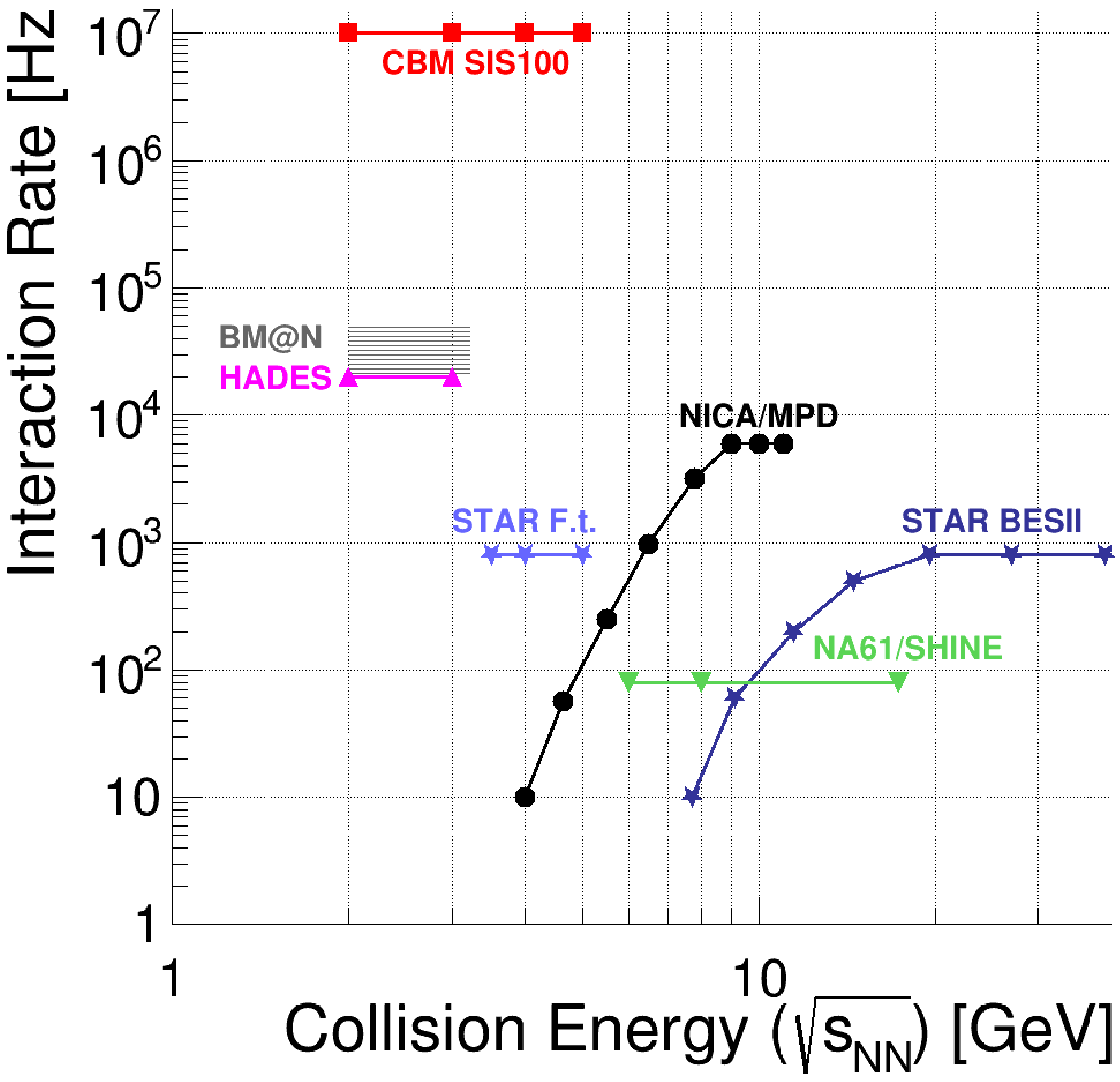
FEE, Trigger, DAQ

KIP Univ. Heidelberg
Univ. Mannheim
GSI Darmstadt
JINR-LIT, Dubna
Univ. Bergen
KFKI Budapest
Silesia Univ. Katowice
Warsaw Univ.

The Russian Federation signed the FAIR Convention on 4 October 2010 in Wiesbaden and declared its contribution to the FAIR construction to be 178.05 M Euro.
The State Atomic Energy Corporation "Rosatom", who is the Russian funding agency in FAIR, has established a legal body called Scientific and Technical Committee (STC) for FAIR to organize the Russian activities in the FAIR GmbH. The STC consists of 15 well-known Russian physicists from Russian participating institutes and chaired by Prof. A. Vasiliev from Institute for High Energy Physics, Protvino.

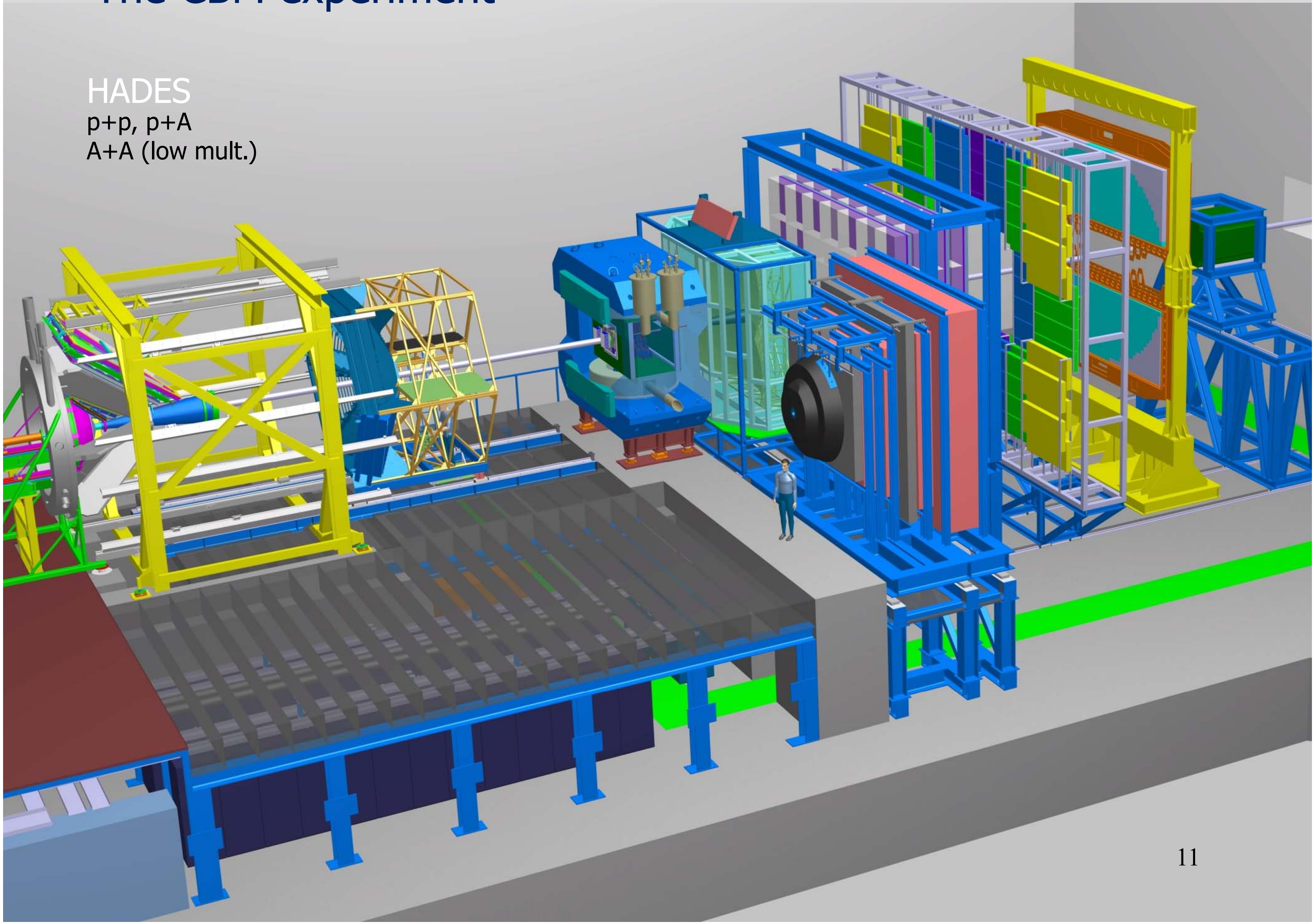
CBM Collaboration (Russian part)

1. JINR, Dubna
2. PNPI, Gatchina
3. INR, Moscow
4. ITEP, Moscow
5. MEPhI, Moscow
6. Kurchatov Institute
7. SINP-MSU, Moscow
8. IHEP, Protvino

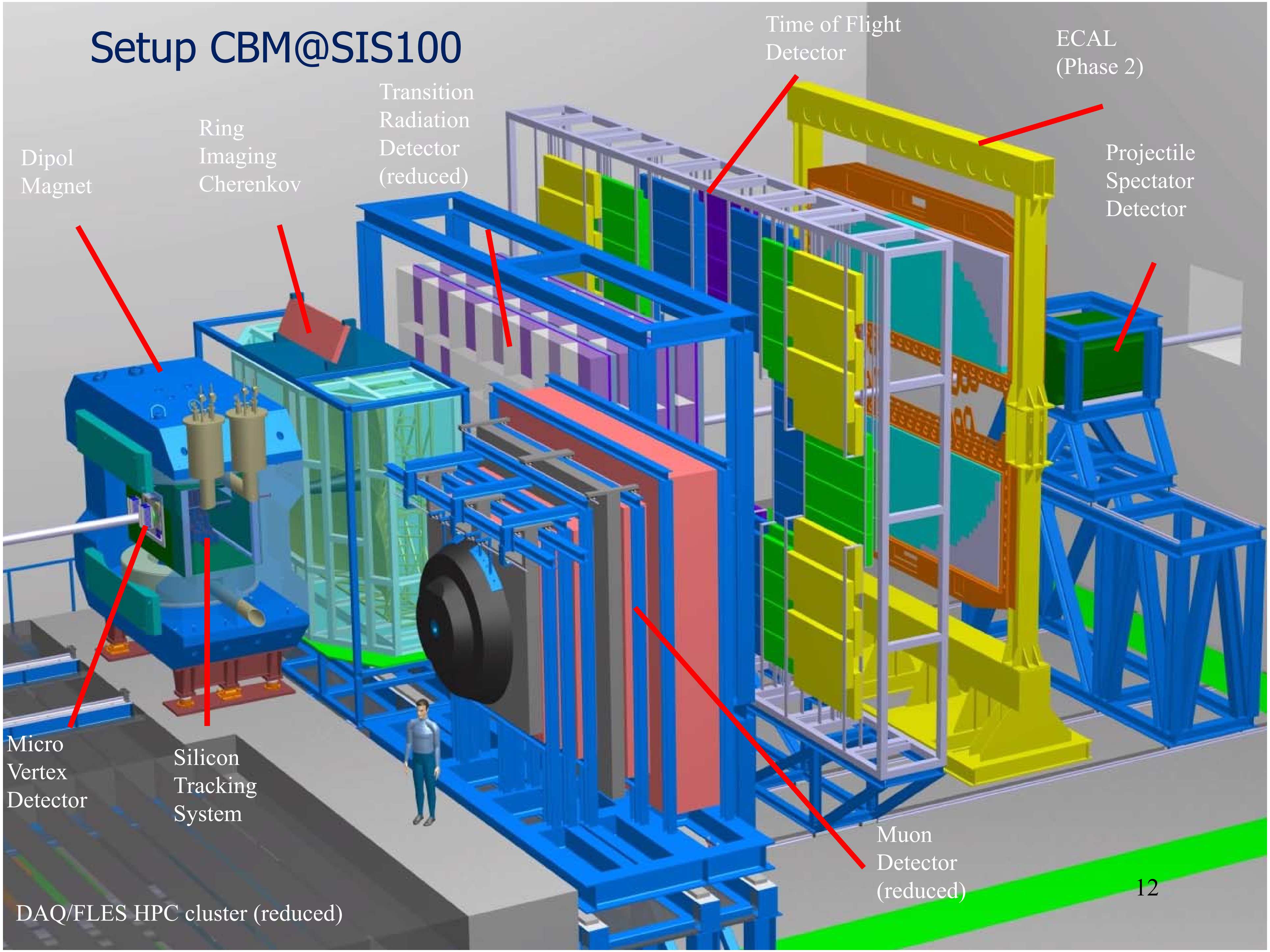


Interaction Rate [Hz]
10^7
10^6
10^5
10^4
10^3
10^2
10
1
CBM SIS100
BM@N
HADES
NICA/MPD
STAR F.t.
STAR BESII
NA61/SHINE
1
10
Collision Energy ($\sqrt{s_{NN}}$) [GeV]

The CBM experiment



Setup CBM@SIS100



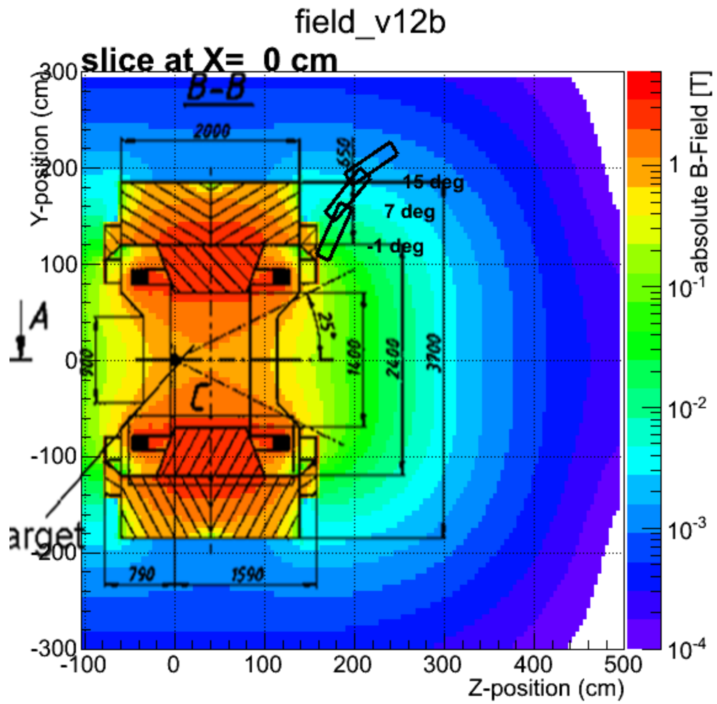
Physics goals of CBM@SIS100

Physics of compressed baryon matter	**Observables in the CBM project**
1.Collective flow	Reaction plane, multiplicity, azymuthal distribution
2. Event-by-event fluctuations and search of QCD critical point	Deviation of multiplicity distributions from Poisson expectation
3. Chiral symmetry restoration	Broadening of the in-medium spectral functions
4. Strangeness enhancement	Multistrange hyperon production

5. Hypernuclear physics	Search for double Lambda hypernuclei
6. Charmonium suppression	Open and hidden charm production
7. Bremsstrahlung of direct virtual photons	Excess yield of lepton pairs

Superconducting Dipole Magnet

SC Magnet: JINR Dubna, BINP Novosibirsk



Status:

TDR approved by FAIR in January 2014

- Financed 100% by Russian Project funds (4.69 M€ in Euros of 2016)
- Collaboration Contract with Budker Institute Novosibirsk signed Dec. 2016
- Conceptional Design Review with internatl. experts in May 22-24, 2017

Micro Vertex Detector

Univ. Frankfurt, IPHC Strasbourg

- Background suppression for di-electron measurements
- Determination of secondary vertices of open charm decays ($\tau = 10^{-12}$-10^{-13} s)
- Improved tracking for hyperon-ID

Status:

- Prototyping well advanced with PRESTO module: integration concept (vacuum operation / material budget) demonstrated
- Dedicated CBM sensor in synergy with ALICE-ITS upgrade: improved in-pixel logic and data throughput, R/O time ~ 5 µs.
- TDR to be submitted in 2017

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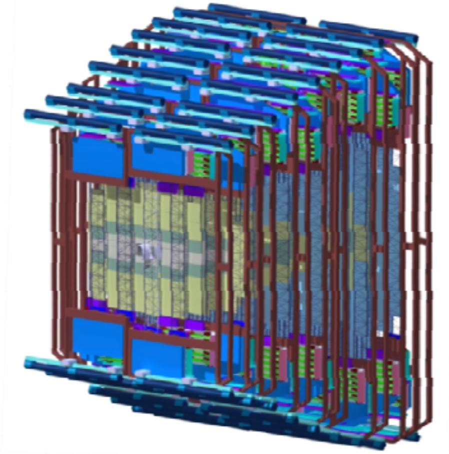
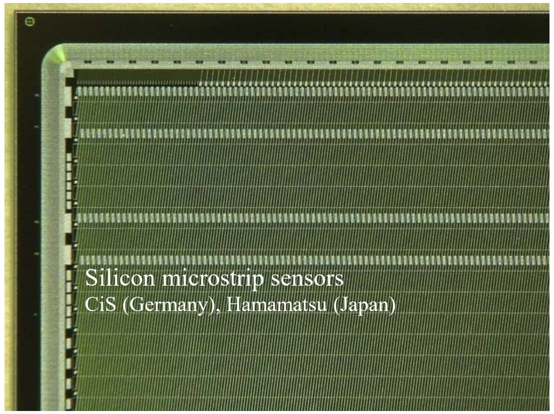
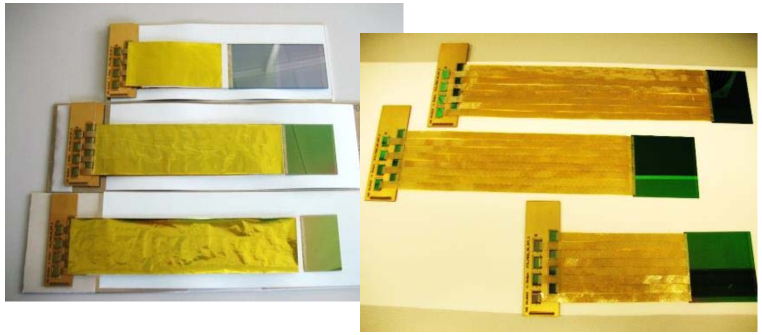
Silicon Tracking System

- Charged particle track reconstruction, momentum determination

Core teams: Darmstadt, Dubna, Karlsruhe, Krakow, Kiev, Tübingen, Warsaw







Module assembly at GSI and JINR

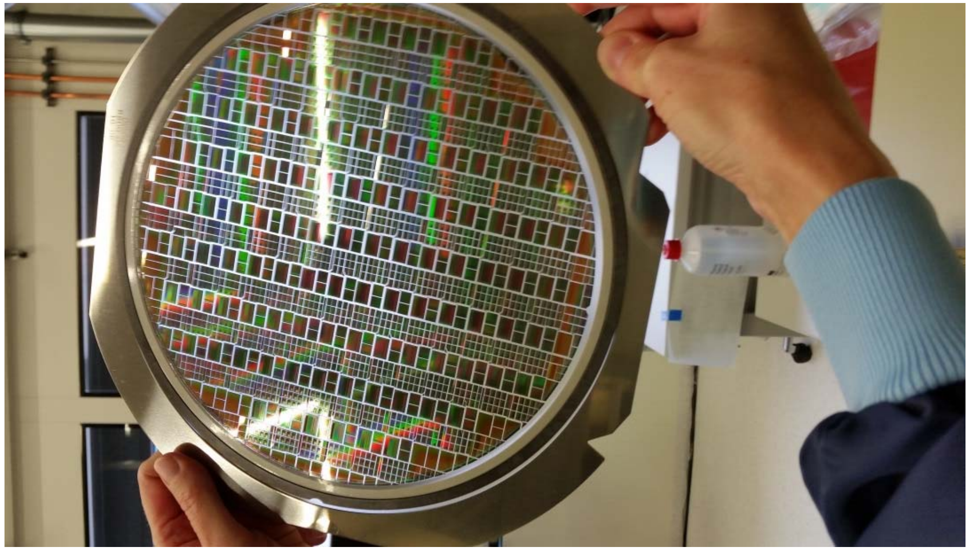
Status:
TDR approved by FAIR in July, 2013

- Progress in establishing QA processes and module assembly procedures,
- Radiation tolerance of sensors tested up to neq (1 MeV) = 2×10^{14} /cm^2,
- Second design iteration of the STS-XYTER ASIC finalized,
- Progress in engineering design and system integration.

Contracts signed with:
- JINR/Dubna on production of 50 % of detector modules,
- KIT/Karlsruhe on production of 40% of detector modules,

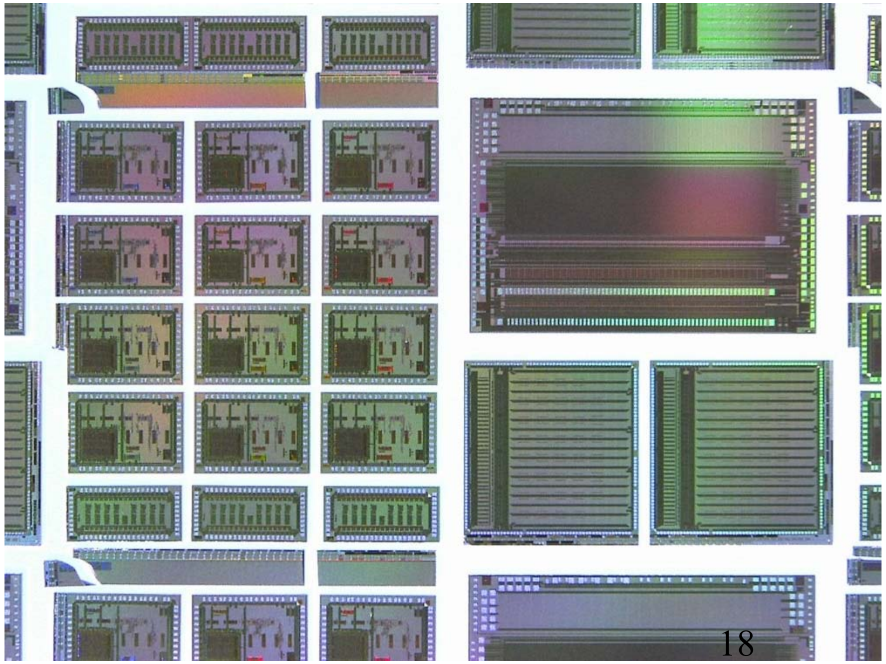
Contract ready for signature with Polish groups on the development and production of ASIC and parts of the read-out chain.

Successful Multi Project Chip Prototyping for CBI



5 final prototype chips for CBM:

- STS-XYTER and Much-XYTER
- Get4 in two versions for TOF
- PADI production for CBM@STAR
- SPADIC for CBM-TRD



- CBM-TOF goes for FAIR Phase 0 at STAR with Get4 and PADI
- CBM-STS can now do detector prototyping and for production readiness
- CBM-TRD can now do detector prototyping

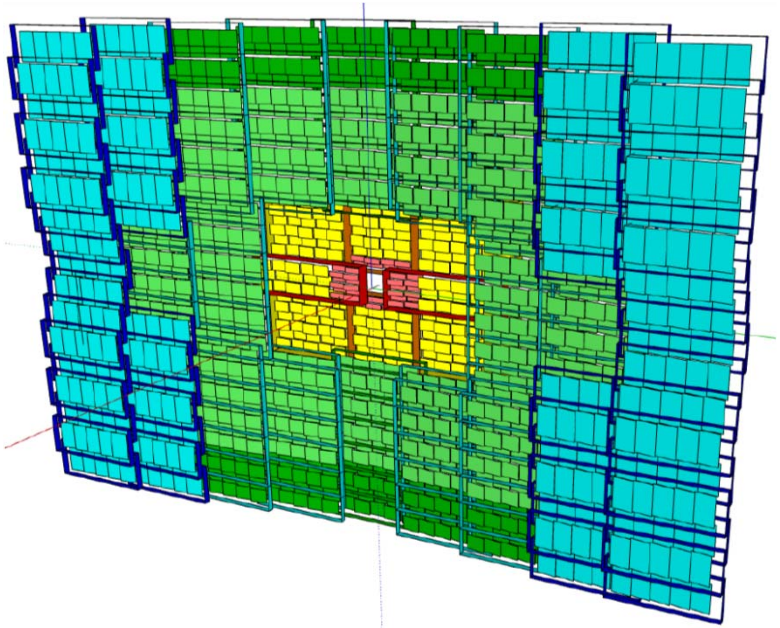
Beam energy Au + Au	4A GeV	10A GeV	25A GeV
Max. rate of all particles [kHz/cm^2]	15	25	45
Max multi-hit prob. of all part. [%]	3.4	5.8	7.4
Max rate of prim. particles [kHz/cm^2]	12	20	25
Max multi-hit prob. of prim. part [%]	1.3	2.4	3.6

The high-rate MRPC TOF wall

- Particle identification

Challenge: Time resolution 50 ps up to 25 kHz/cm^2. Total area 100 m^2

THU Beijing, NIPNE Bucharest, GSI Darmstadt, TU Darmstadt, IfI Frankfurt, USTC Hefei, Univ. Heidelberg, ITEP Moscow, HZDR Rossendorf, CCNU Wuhan.



ToF MRPC detectors tested with free-streaming read-out electronics at the CERN-SPS Nov.-Dec. 2016

Status:

- TDR approved Feb. 2015
- Successful test of a stack of 11 MRPCs and a Diamond start detector
- Series production of MRPC for participation in STAR starts soon in USTC and Tsinghua University.

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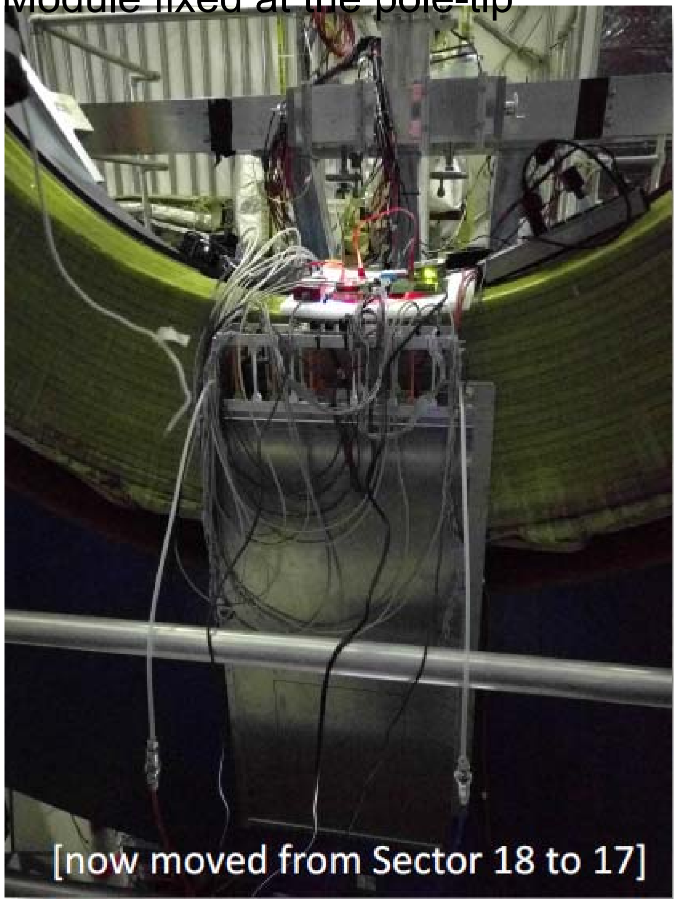
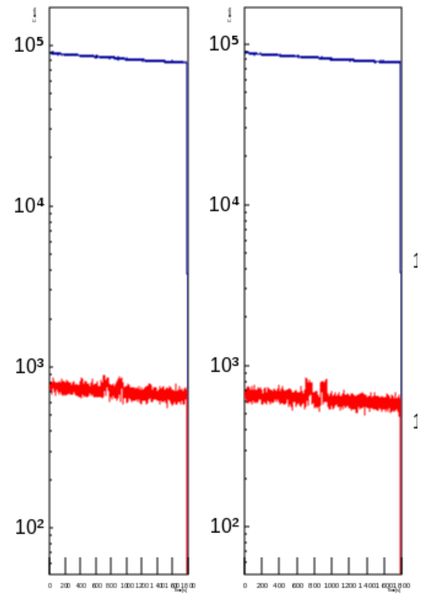
Module installation in Oct. 2016

Open module

Module fixed at the pole-tip

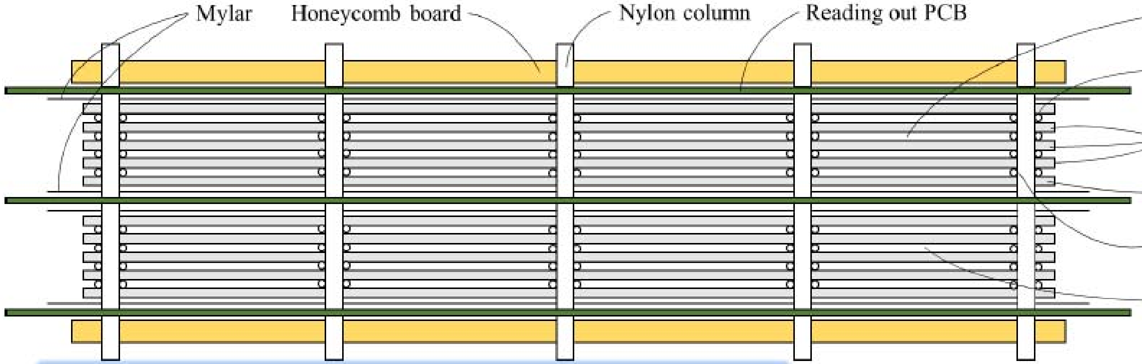


Running (Mar. 2017)



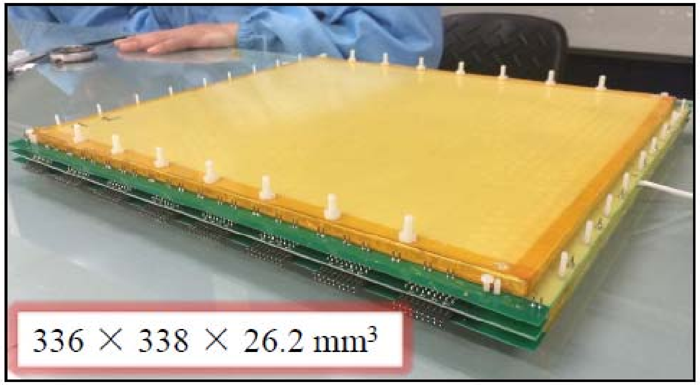
about 100 Hz/cm^2

Conceptional Design of MRPC3a



The sectional sketch of the double-stack MRPC3a.

The picture of a real-size prototype of MRPC3a.

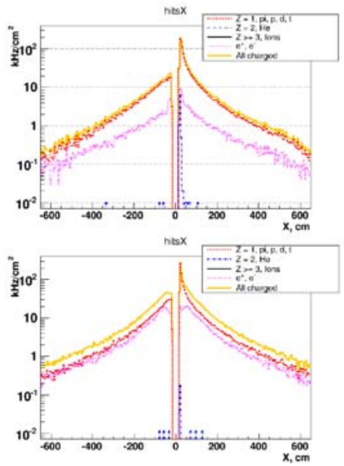


336 × 338 × 26.2 mm³

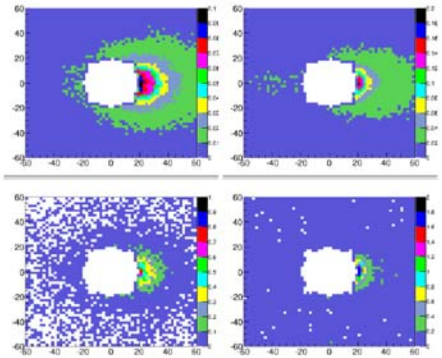
Parameter	Design value/mm
PCB dimension	360 × 338
Glass dimension	330 × 276
Gas gap number	2 × 4
Gas gap width	0.25
Strip pitch	7 + 3
Strip length	270
Strip number	32
Detection area	317 × 270
Height	26.2

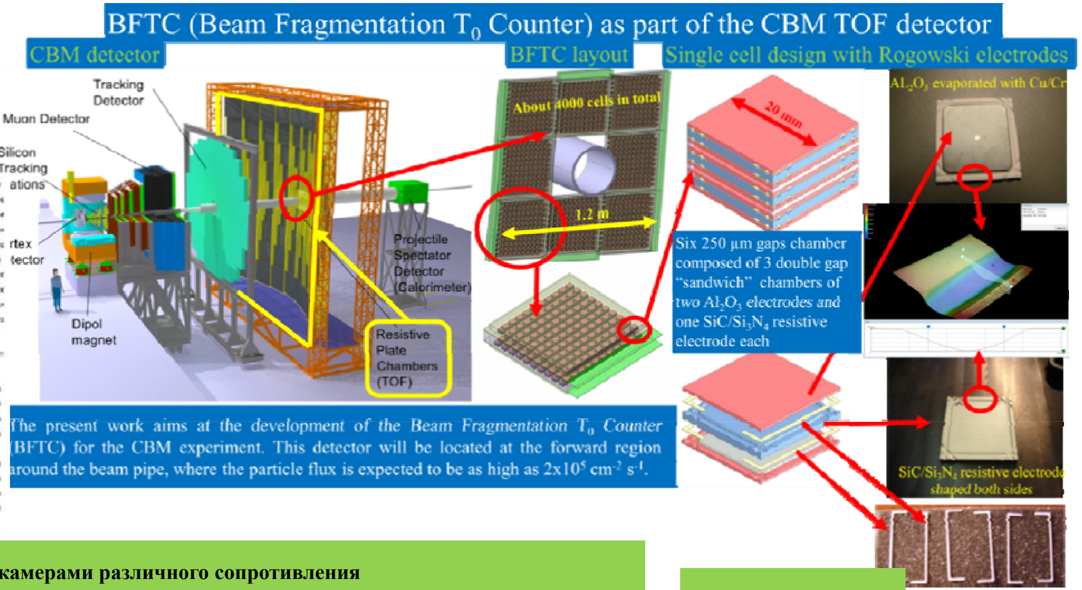
Центральная часть детектора TOF (BFTC)

Загрузки до 200 kHz/cm^2

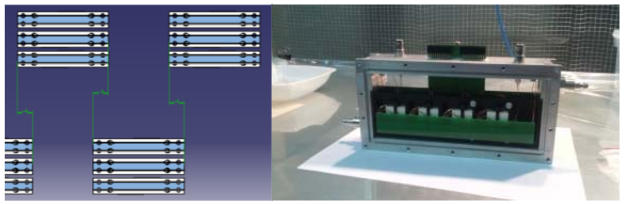


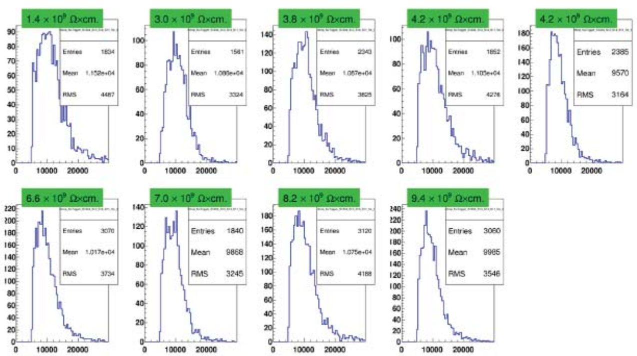
Высокая гранулярность для минимизации попадания двух частиц в одну ячейку (размер ячейки 2x2см^2)





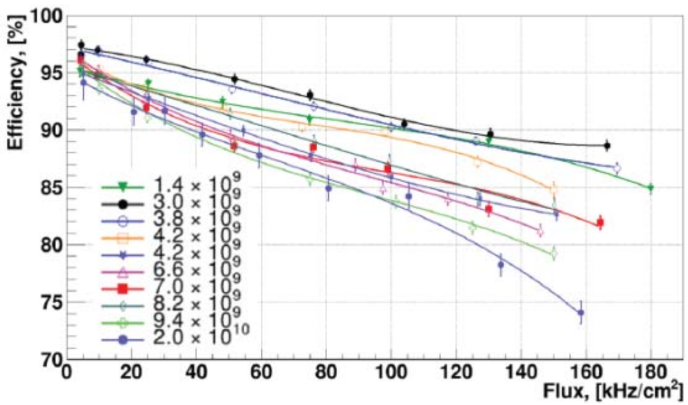
Мини-модуль с камерами различного сопротивления





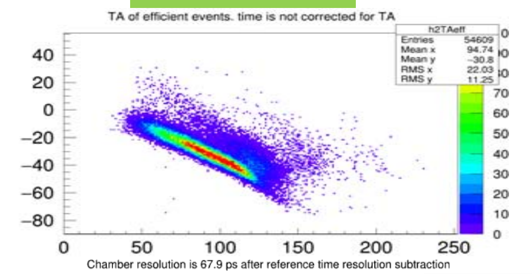
Проверка качества сборки и технологии производства (одинаковость зарядовых спектров в мини-модуле)

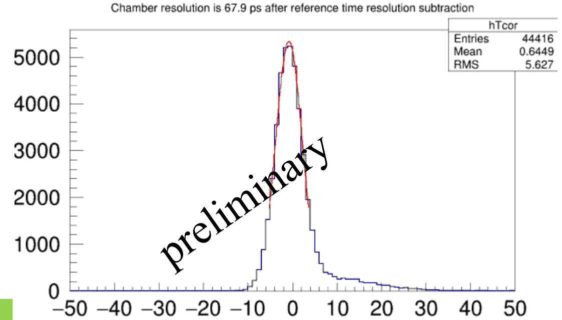
Фундаментальный результат



Определение минимальной величины сопротивления, при которой еще возможна работа в лавинной моде – 4*10^9 Ом*см. В настоящее время достигнутая предельная загрузка ~160 кГц/см^2 при эффективности выше 90%. Более двух порядков по сравнению с обычными RPC!

SPS Dec.2016



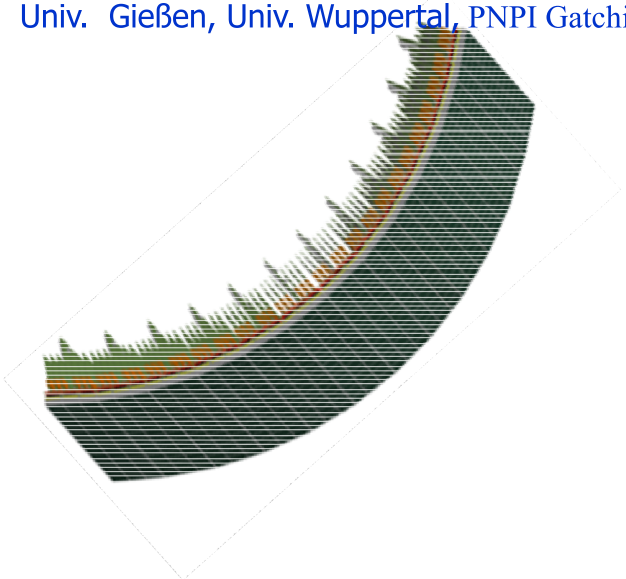
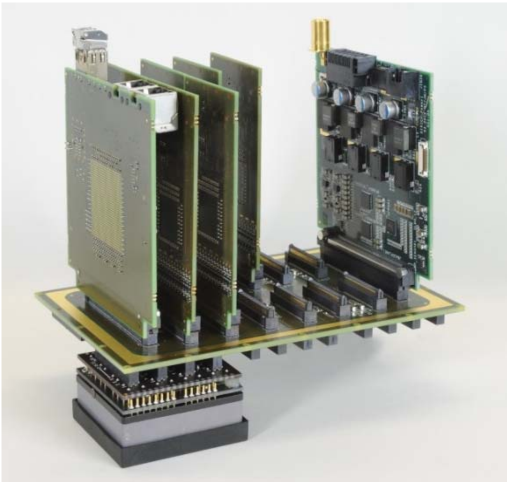
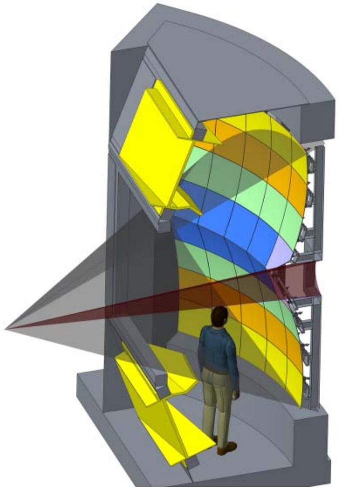


Предварительный результат в моде "free streaming" ~ 80 пс. без коррекции по скорости вторичных частиц.

Ring-Imaging Cherenkov (RICH) Detector

- Electron identification

Univ. Gießen, Univ. Wuppertal, PNPI Gatchina, GSI

Status:

- RICH geometry with bended photodetector plane for optimized ring detection in large acceptance fully implemented in simulations
- First version of RICH readout chain produced, assembled, under test in lab
- 400 out of 1100 H12700 MAPMTs delivered and tested
- Concept for new structure of mirror wall with substantially reduced material budget First software correction cycle for mirror misalignments ready

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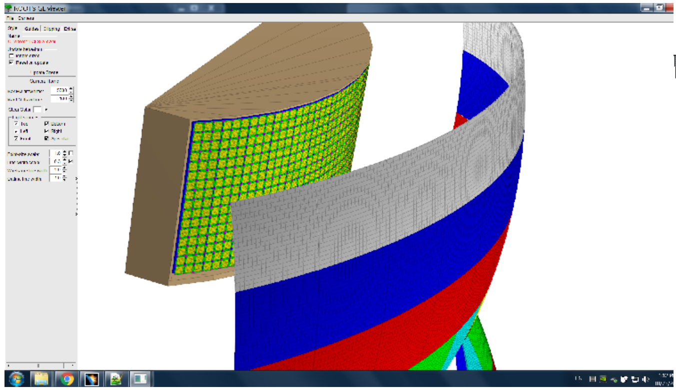
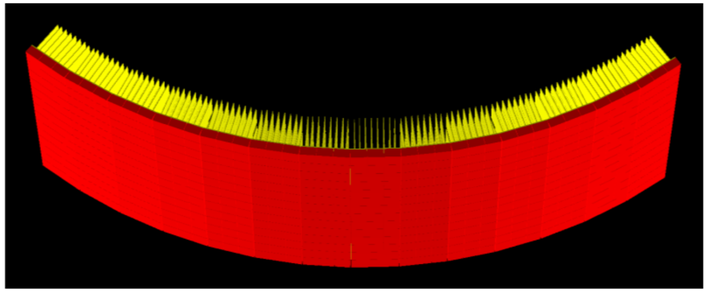
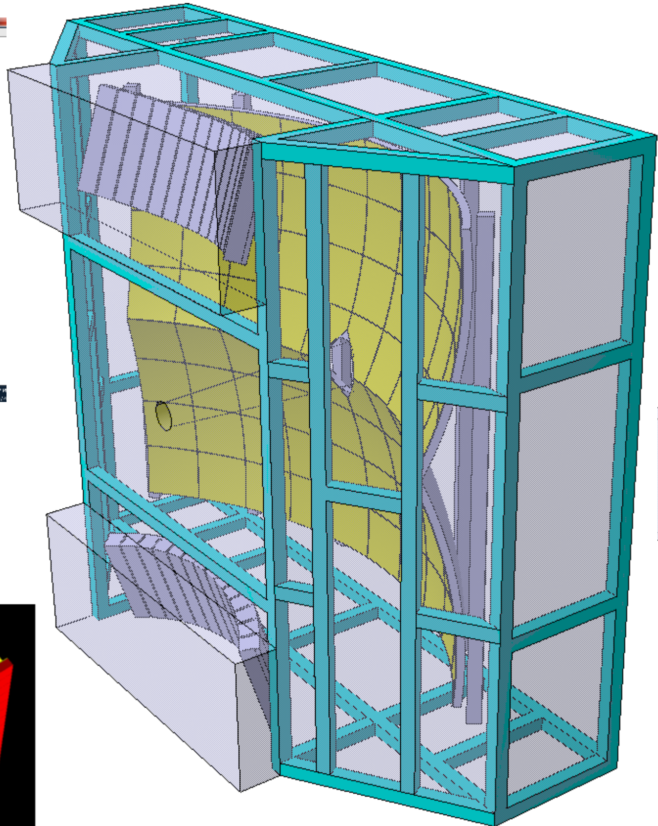
Geometry optimization

- New “cylindrical” geometry is fully implemented in CBMROOT .

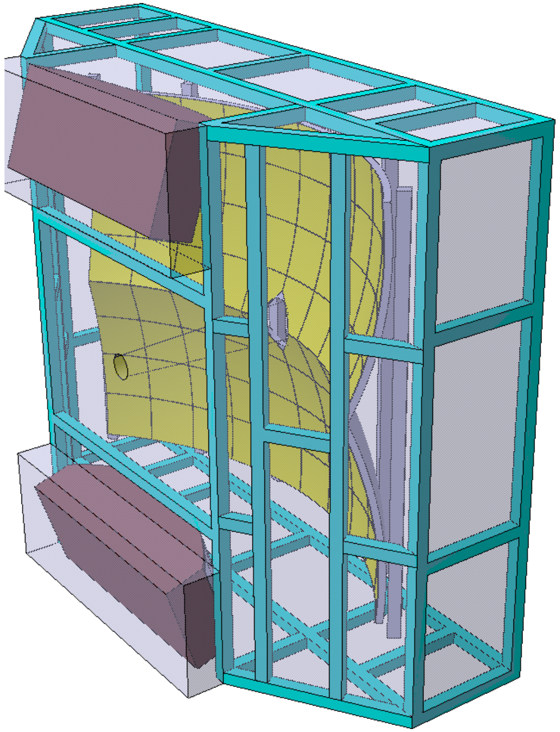






E.Ovcharenko

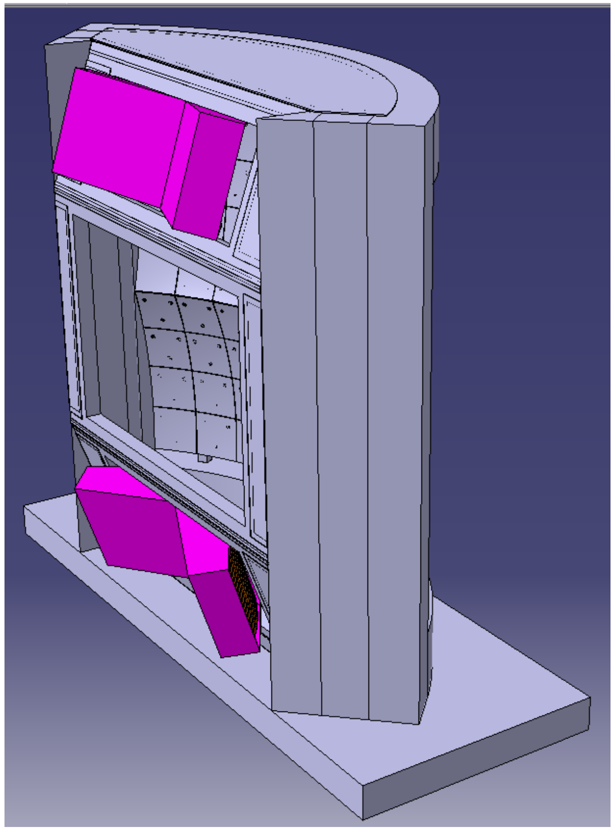
S.Lebedev

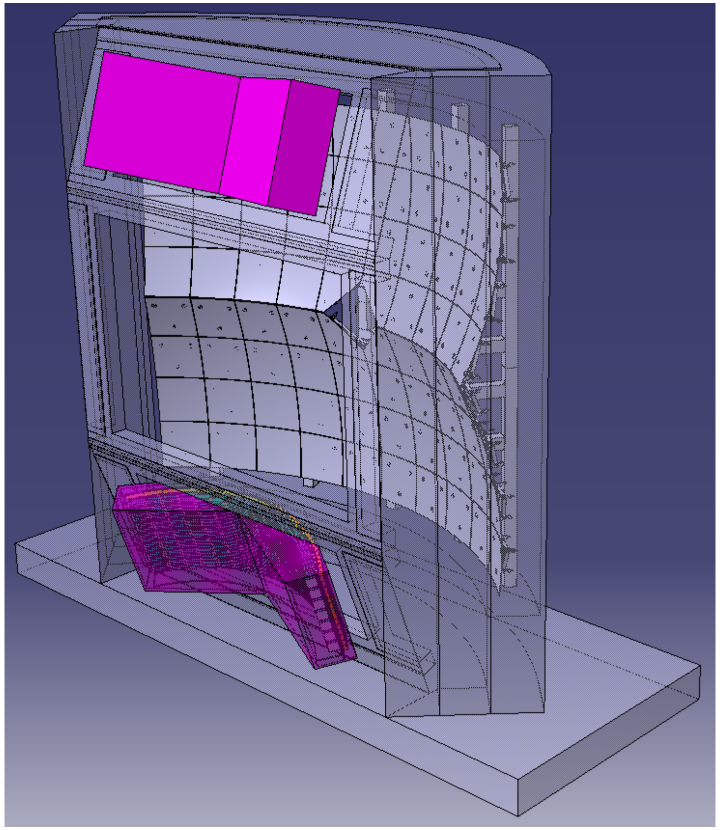


- and fully tested.

Geometry optimization

- We also implemented a new detector plane in the CAD model.
- Even with a shifted detector, we still need shielding box (magnetic protection).
- The shielding box have to be recalculated for the new detector geometry.





E.Ovcharenko

D. Tyts

Here we used a realistic approximation in order to see how it looks all together.
Then try to implement our detector model in the general CBM CAD project.

Transition Radiation Detector (TRD)

- Electron identification, energy-loss measurements

NIPNE Bucharest,
Univ. Frankfurt,
Univ. Heidelberg,
Univ. Münster

Challenge:
$\varepsilon(e^{\pm}) = 90\%$
$\varepsilon(\pi) = 7.5\%$
at 100 kHz/cm^2

Prototype TRDs tested at the CERN-SPS in Nov.-Dec. 2016

Status:

- New simulations: measurement of intermediate mass di-electrons and on the identification of fragments via their energy loss in the TRD gas.
- Design and construction of four large detector modules (95 x 95 cm^2), tested with heavy ion beams at the CERN-SPS in Nov. - Dec. 2016. Successful test of a realistic read-out chain employing the SPADIC v1.0 ASICs and FLES-DAQ.
- Internal evaluation of TDR by external experts March 14-15, 2017 (V. Angelov, T. Kirn, C. Rembser, W. Riegler, E. Scomparin)

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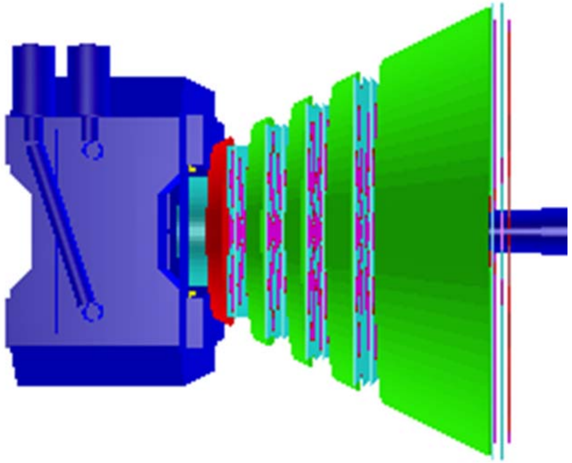
Muon Chamber (MuCh) System

- Muon identification

VECC Kolkata + 12 Indian Inst., PNPI Gatchina, JINR Dubna



MuCh at SIS100: 2 GEM triplets,
2 tracking detector tripletts,TRD

Full size GEM detectors tested with free-streaming read-out electronics at the CERN-SPS Nov.-Dec. 2016

Bakelite trigger RPCs under investigation for stations 3 and 4.
Required for high rate (kHz) operation: low resistivity Bakelite

Status:

- TDR approved in Feb. 2015
- GEM construction sites are under preparation in India.
- The GBTx emulator was implemented and tested.
- In-kind Contract with VECC Kolkata and Collaboration Contract with PNPI St. Petersburg close to signature

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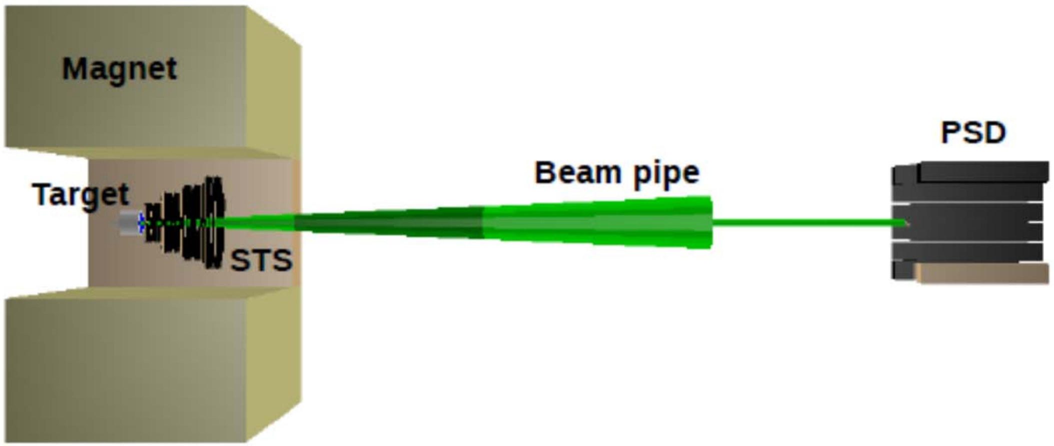
Projectile Spectator Detector

- determination of collision centrality and orientation of the reaction plane

INR Moscow, TU Darmstadt, Prague, Rez



Status:

- TDR approved Feb. 2015,
- A few versions of PSD readout electronics tested at CERN (Nov. 2015 – April 2016),
- 19 PSD modules (out of 45) have been fully assembled, and tests with cosmic rays at INR Moscow are ongoing,
- Reconstruction algorithms for the reaction plane and centrality determination were developed and used in the analysis of NA61 data for Pb-Pb at 30 AGeV. New centrality reconstruction algorithm has been proposed.

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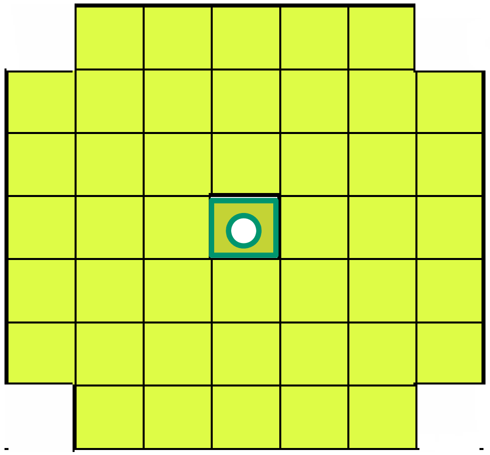
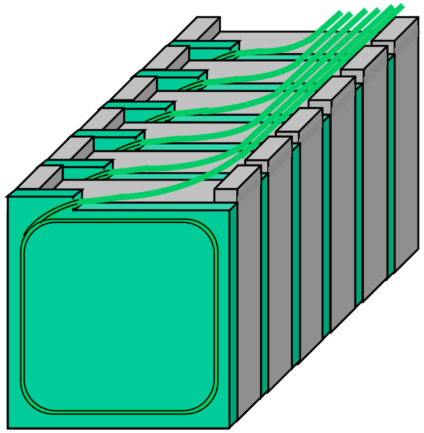
Structure of detector

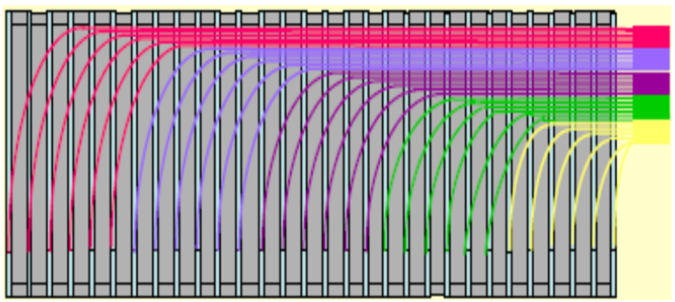


45 modules,
Each module 20x20cm^2,
Depth 5.6 λint
Weight - 22t
Central module with hole ϕ=6-10 cm

Modular Lead/Scintillator sandwich compensating calorimeter.
Sampling ratio Pb:Scint=4:1.

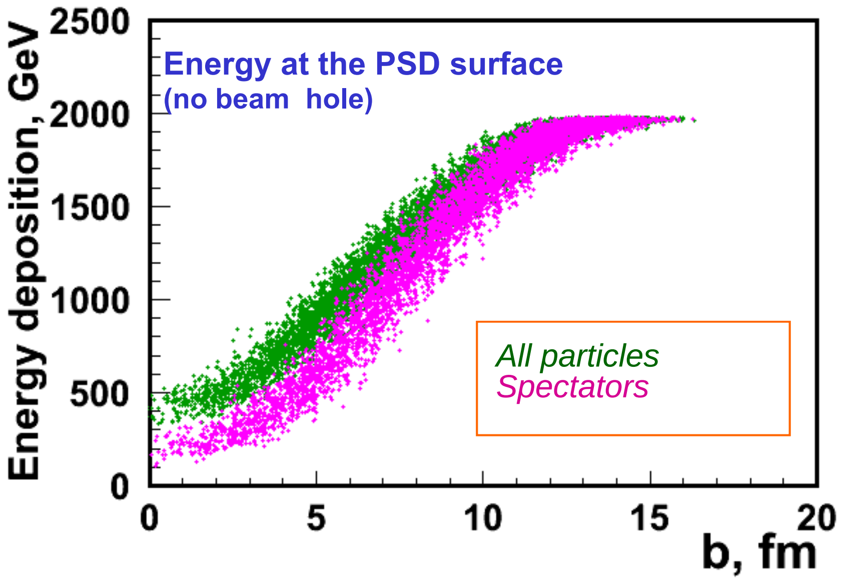


TOP View



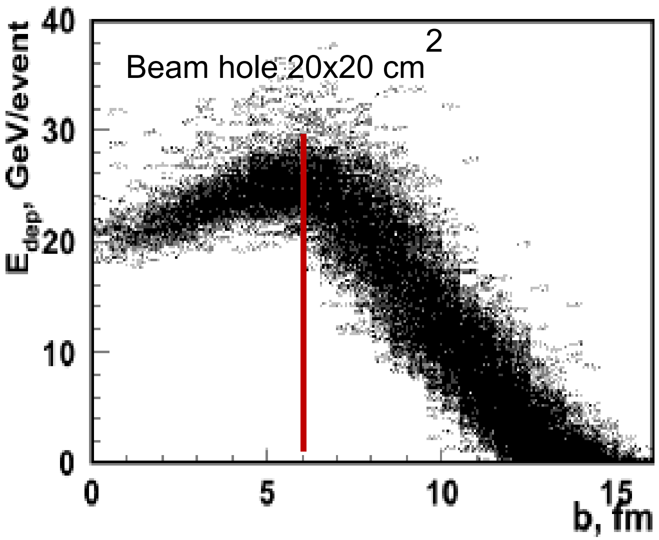
10 longitudinal sections, 10 photodetectors/module
1 section~0.5**λint**

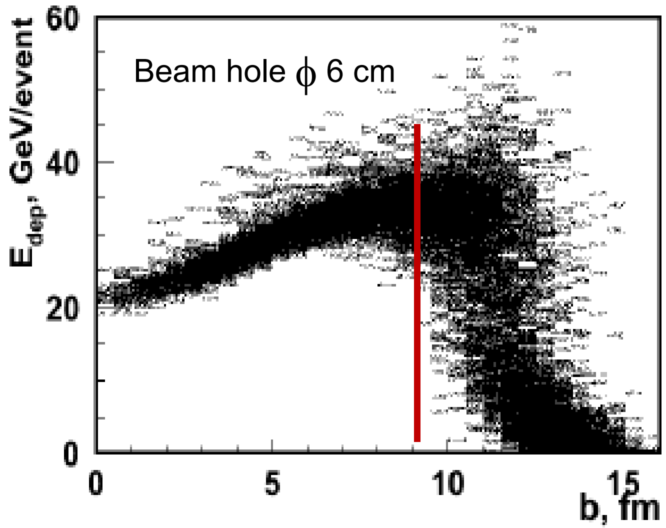
Event characterization (Centrality of collision)



Effect of beam hole (leak of heavy fragments) is very important.
GEANT4 is needed!

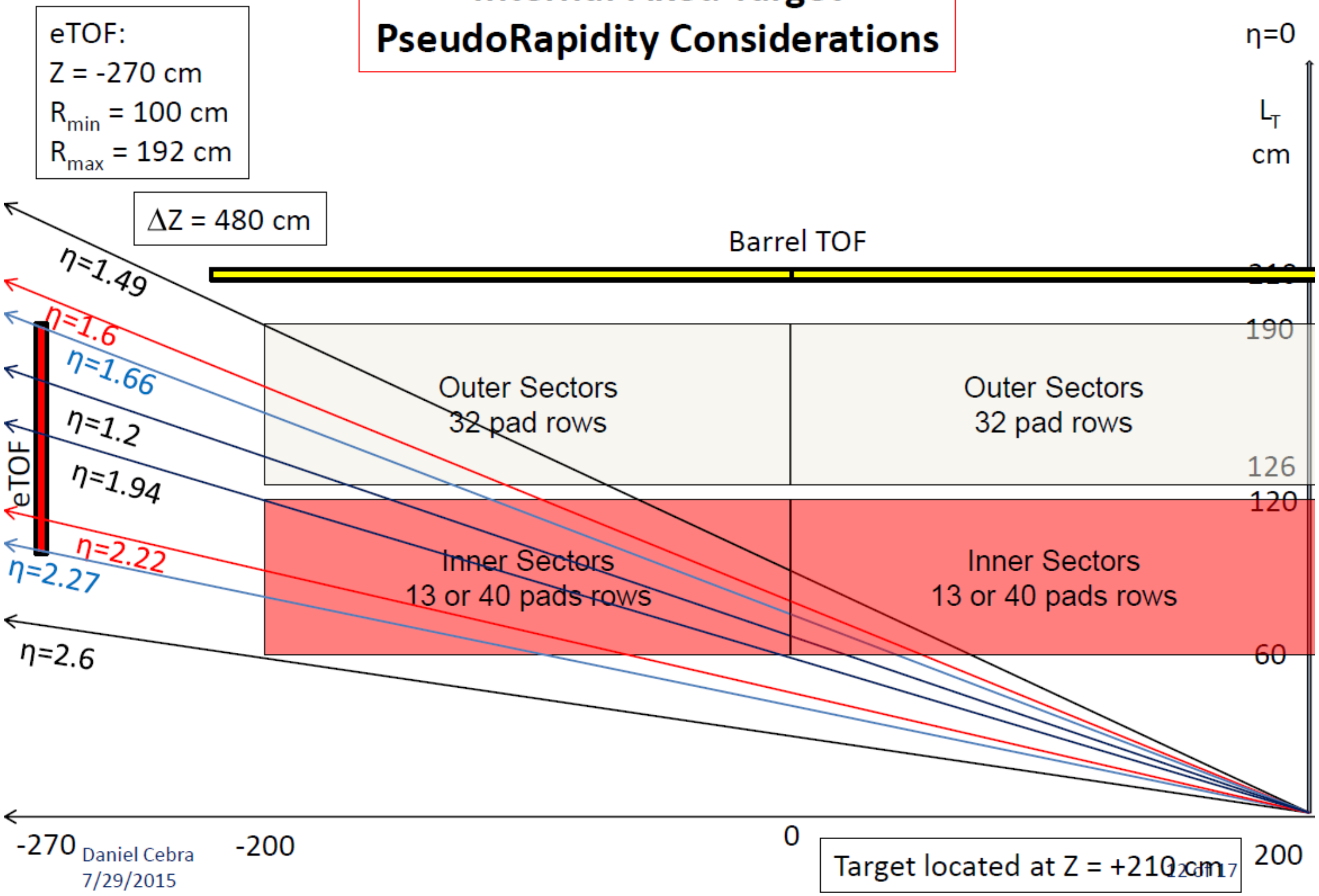
Behavior depends on hole size and Z-position. More realistic simulation is needed!





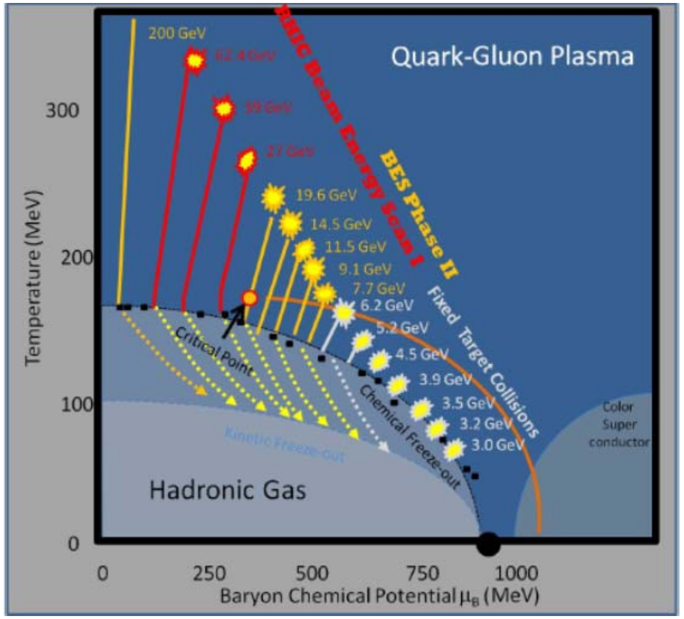
10 AGeV, Z=6 m

Internal Fixed Target
PseudoRapidity Considerations



The BES phase II program is designed to study the phase diagram of QCD matter (see Fig. 1). The program has several goals:

The general physics goals are common for STAR and CBM



- Onset of deconfinement
- Chiral symmetry restoration
- 1st order phase transition
- Critical point
- Strange states of matter

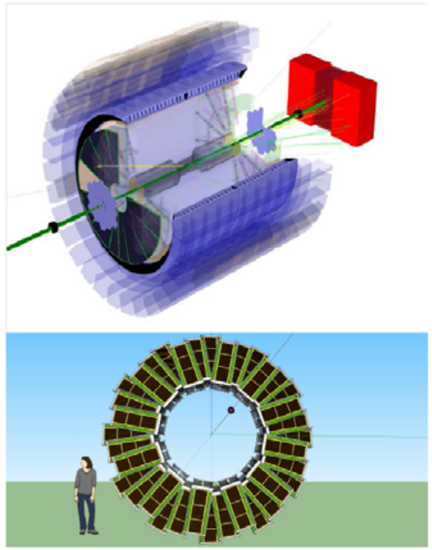
Physical observables

- Rapidity dependence
- Di-lepton
- Directed flow
- Elliptic flow
- Fluctuations
- Hypernuclei

arXiv:1609.05102v

Physics Program for the STAR/CBM eTOF Upgrade - version 2.1

The STAR/CBM eTOF Group
(Dated: March 29, 2016)



Daniel Cebra
7/29/2015

BES phase II Proposal

μ_B Step size is about 50 MeV

Collision Energies (GeV):	7.7	9.1	11.5	14.5	19.6
Chemical Potential (MeV):	420	370	315	260	205
Proposed Number of Events:	100	160	230	300	400

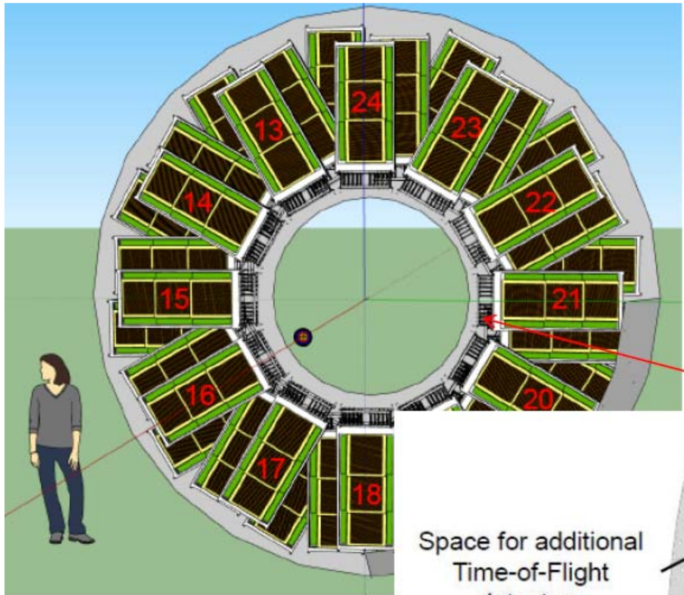
Fixed Target Program

- cms energies from 3 to 7.7 GeV
- Baryon chemical potential range from 420 MeV to 720 MeV
- Fixed target program not yet approved

Collider Energy	Fixed-Target Energy	Single beam AGeV	Center-of-mass Rapidity	μ_B (MeV)
62.4	7.7	30.3	2.10	420
39	6.2	18.6	1.87	487
27	5.2	12.6	1.68	541
19.6	4.5	8.9	1.52	589
14.5	3.9	6.3	1.37	633
11.5	3.5	4.8	1.25	666
9.1	3.2	3.6	1.13	699
7.7	3.0	2.9	1.05	721

CBM

CBM ToF



36 modules
3 layers
12 sectors
6912 channels

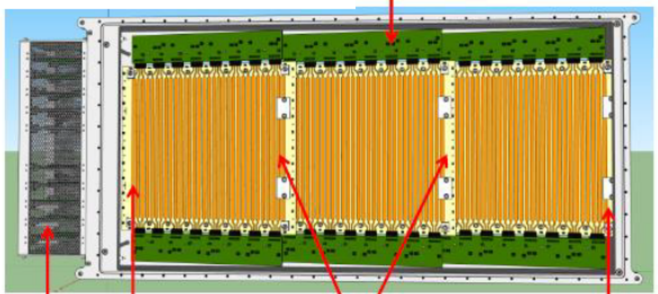
Sector counting match the TPC sectors

Total depth about 14.2" (36 cm)

GET4 Electronics Boards on inn

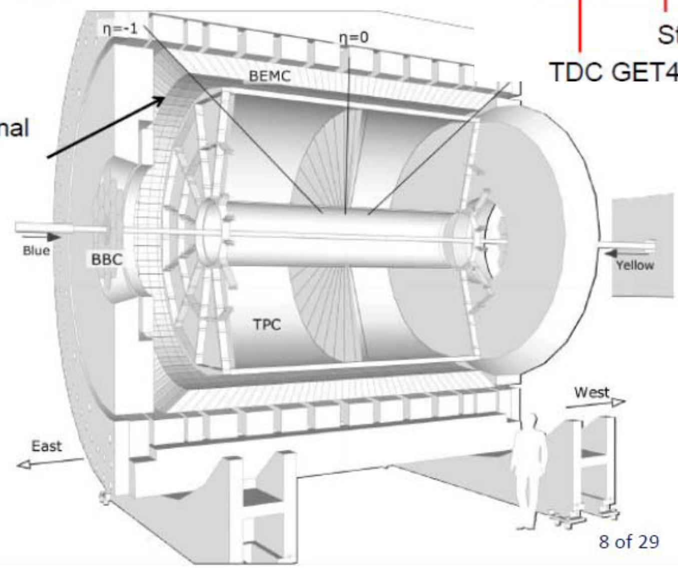
3 MRPCs
32 strips/MRPC with pitch of 1 cm
27 cm strip length
Active area ~ 92 X 27 cm
192 readout channels

Preamplifier PADI boards



Strip 1
TDC GET4 boards
overlapping strips
Strip 96

Space for additional Time-of-Flight detectors



Where to put the CBM TOF modules

Daniel Cebra
3/20/2017

8 of 29

HADES Strategy

Until 2018 (upgrade, preparation for FAIR phase 0)

- o Installation of CBM/HADES UV photo-detector and ECAL
- o Install new forward detection system, STS and fRPC

2018-202x (experiment campaign at SIS18 - FAIR phase 0)

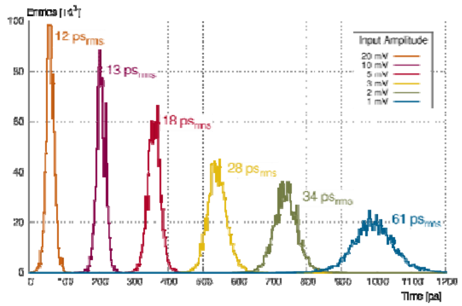
- o DAQ und MDC FEE upgrade – 200 kHz interaction rate
- o Backward neutron detector (neuLAND modules)
- o Strong physics program at SIS18, 1 run per year

202x on (HADES at SIS100)

- Transfer spectrometer to new experimental hall
- Cold matter physics (p+A)
- Exclusive measurements (p+p)
- (A+A collisions for comparison)

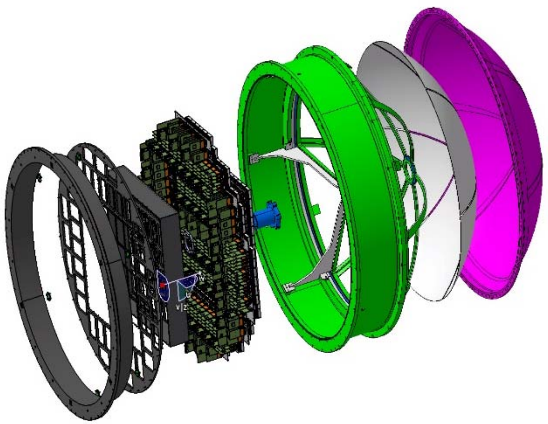
RICH MAPMT UV Detector (with CBM)

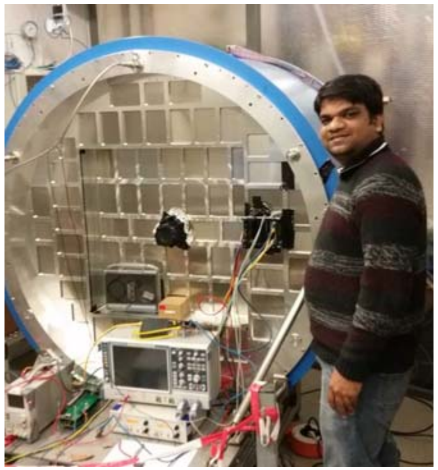
- MAPMT (Hamamatsu) based detector modules
- Joint design and realization effort
- Design compatible for use in HADES and CBM RICH

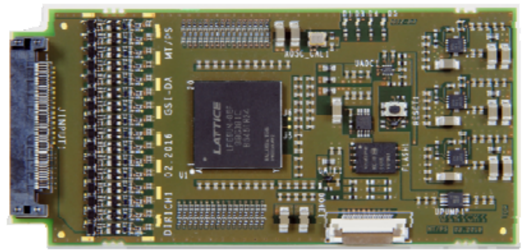


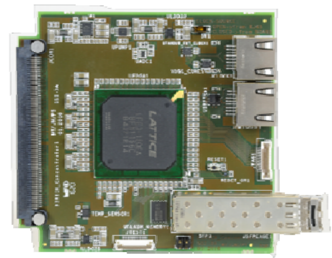
Added value

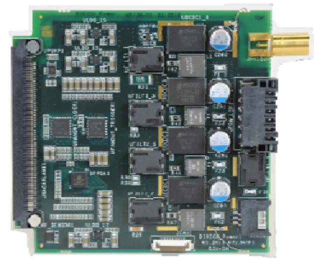
- Replaces aging CSI photo detector
- will provide substantially improved detection efficiency





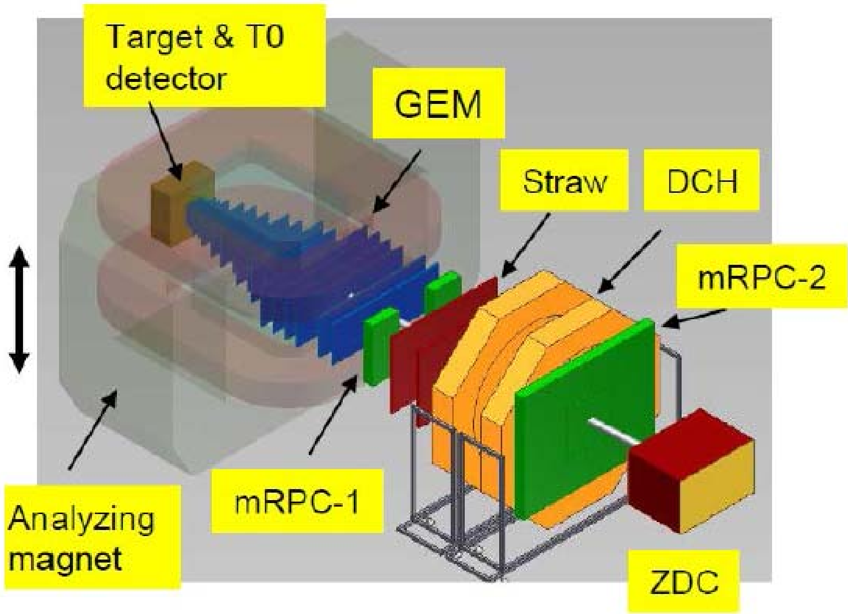


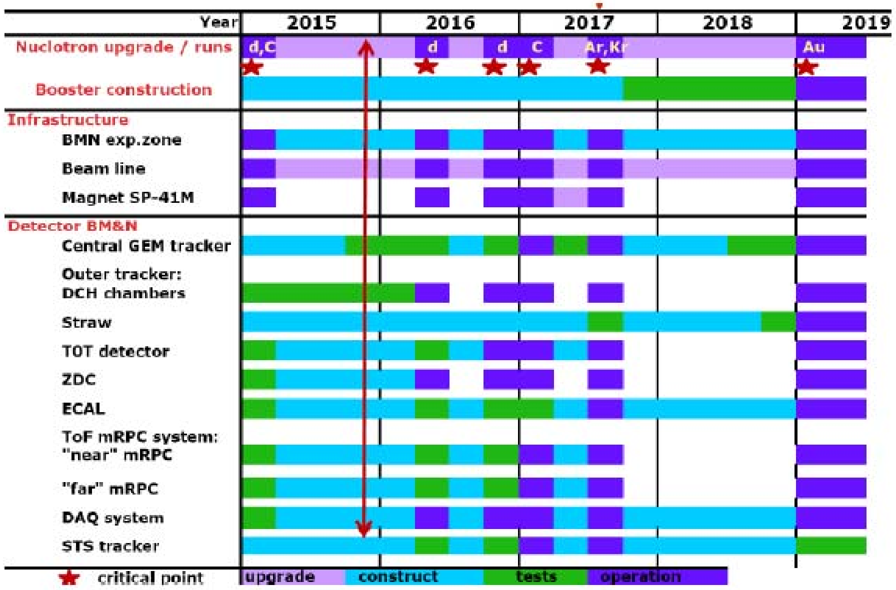




PSD at BM@N

A.Ivashkin presentation



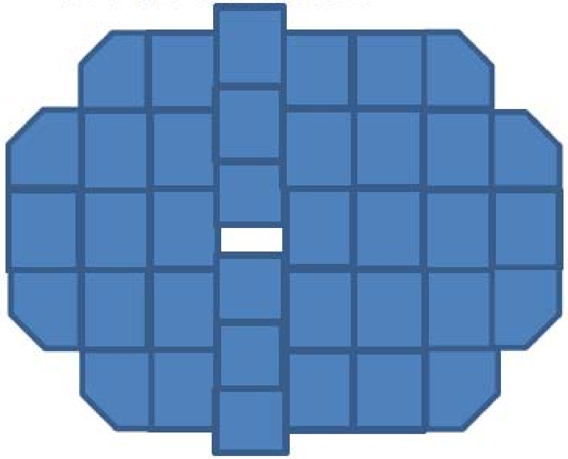


Profit of CBM at BM@N

- Participation in real experiment,
- Getting an experience in PSD operation,
- Teaching of young scientist in PSD team.

Present ZDC

Proposed new ZDC of PSD modules



Fixed target experiment at LHC proposals

1. **Fixed-target experiment at LHC for the energies between SPS and RHIC in 2009 at CERN Workshop "New opportunities at CERN" by INR RAS.**

   A.B.Kurepin, N.S.Topilskaya, M.B.Golubeva

   Charmonium production in fixed-target experiments with SPS and LHC beams at CERN.

   Phys.Atom.Nucl.74:446-452, 2011, Yad.Fiz.74:467-473, 2011.

2. **Then experiment AFTER@LHC (A Fixed Target ExpeRiment at the LHC).**

   S.J.Brodsky, F,Fleuret, C.Hadjidakis and J.P.Lansberg

   Physics Opportunities of a Fixed-Target Experiment using the LHC Beams

   Phys. Rept. 522 (2013) 239

Colliders (RHIC,LHC)

AA collisions

RHIC CuCu, AuAu $\sqrt{s}$ =39, 62, 130 GeV, 200 GeV
LHC PbPb $\sqrt{s}$ = 2.76, 5.02 TeV (max 5.5 TeV)

pA collisions

RHIC pp, dAu $\sqrt{s}$ = 130, 200 GeV
LHC pp $\sqrt{s}$ = 2.76, 7, 8, 13 TeV (max 14TeV)
pPb $\sqrt{s}$ = 5.02 TeV (plan for 8 TeV)

Fixed target experiment at LHC

AA collisions

Pb-Pb 2.75 TeV/nucleon, $\sqrt{s}$ = 0.072 TeV

pA collisions

p-A 7.0 TeV , $\sqrt{s}$ = 0.115 TeV
(5.0 TeV, $\sqrt{s}$ = 0.097 TeV)

Special issue " Advances in High Energy Physics 2015 (2015)"

Physics at a Fixed-Target Experiment Using the LHC Beams

The Gluon Sivers Distribution: Status and Future Prospects,
D.Boer et al., ID 371396

Transverse Single-Spin Asymmetries in Proton-Proton Collisions at the AFTER@LHC Experiment in a TMD Factorization Scheme,
M.Anscelmino et al., ID 475040

A Gas Target Internal to the LHC for the Study of *pp* Single-Spin Asymmetries and Heavy Ion Collisions,
C.Barschel et al., ID 463141

Quarkonium Production and Proposal of the New Experiments on Fixed target at the LHC,
A.B.Kurepin and N.S.Topilskaya, ID 760840

Feasibility Studies for Quarkonium Production at a Fixed-Target Experiment Using the LHC Proton and Lead Beams (AFTER@LHC),
I.Massacrier et al., ID 986348

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Eur. Phys. J. A (2017) **53**: 60   DOI 10.1140/epja/i2017-12248-y

Challenges in QCD matter phy[illegible]
The scientific programme of th[illegible]
Baryonic Matter experiment at [illegible]

T. Ablyazimov *et al.*

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Eur. Phys. J. A (2017) **53**: 60
DOI 10.1140/epja/i2017-12248-y

THE EUROPEAN PHYSICAL JOURNAL A

Review

Challenges in QCD matter physics —The scientific programme of the Compressed Baryonic Matter experiment at FAIR

T. Ablyazimov[1], A. Abuhoza[2,a], R.P. Adak[3], M. Adamczyk[4], K. Agarwal[5], M.M. Aggarwal[6], Z. Ahammed[7], F. Ahmad[8], N. Ahmad[9], S. Ahmad[8], A. Akindinov[10], P. Akishin[1], E. Akishina[1], T. Akishina[1], V. Akishina[13,1,2], A. Akram[12], M. Al-Turany[2], I. Alekseev[10], E. Ale[illegible]ov[1], I. Alexandrov[1], S. Amar-Youcef[13], M. Anđelić[14], O. Andreeva[15], C. Andrei[16], A. And[illegible][17], H. Appelshäuser[13], D. Argintaru[18], E. Atkin[19], S. Avdeev[17], R. Averbeck[2] [illegible]Bach[11], E. Badura[2], S. Bähr[20], T. Balog[2], M. Balzer[20], E. Bao[12], N. [illegible]shir[8], M. Baszczyk[23], O. Batenkov[24], V. Baublis[25], [illegible] D. Belyakov[1], J. Bendarouach[27], I. Berceanu[16], [illegible][29], G. Berezin[17], C. Bergmann[29], D. Bertini[2], [illegible]A. Bhasin[31], A.K. Bhati[6], B. Bhattacharjee[32], [illegible]Blank[20], D. Blau[34], V. Blinov[2], C. Blume[13], [illegible]Brzychczyk[4], A. Bubak[37], H. Büsching[13], T. Bus[13], [illegible] M. Călin[18], Ping Cao[40], G. Caragheorgheopol[16], I. Carević[14], [illegible]Chattopadhyay[7,3], A. Chaus[42], Hongfang Chen[40], LuYao Chen[35], [illegible][17], H. Cherif[13,2], A. Chernogorov[10], M.I. Ciobanu[2,b], G. Claus[44], F. Constantin[16], [illegible] N. D'Ascenzo[46], Supriya Das[3], Susovan Das[5], J. de Cuveland[11], B. Debnath[32], D. Dementiev[17], [illegible] Deng[39], Zhi Deng[43], H. Deppe[2], I. Deppner[12], O. Derenovskaya[1], C.A. Deveaux[27], M. Deveaux[13], K. Dey[32], M. Dey[7], P. Dillenseger[13], V. Dobyrn[25], D. Doering[13], Sheng Dong[39], A. Dorokhov[44], M. Dreschmann[20], A. Drozd[23], A.K. Dubey[7], S. Dubnichka[17], Z. Dubnichkova[17], M. Dürr[27], L. Dutka[4], M. Dželalija[14], V.V. Elsha[17], D. Emschermann[2], H. Engel[35], V. Eremin[47], T. Eşanu[18], J. Eschke[48,2], D. Eschweiler[11], Huanhuan Fan[40], Xingming Fan[49], M. Farooq[8], O. Fateev[17], Shengqin Feng[50], S.P.D. Figuli[20], I. Filozova[1], D. 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Perspectives and conclusions

1. First beams of FAIR are expected in 2024, protons 30 GeV, heavy ions 11 AGeV, light ions 15 AGeV
2. In the mean time the detectors of CBM will be used at HADES, STAR and BM&N