The Micro Vertex Detector of the CBM-Experiment

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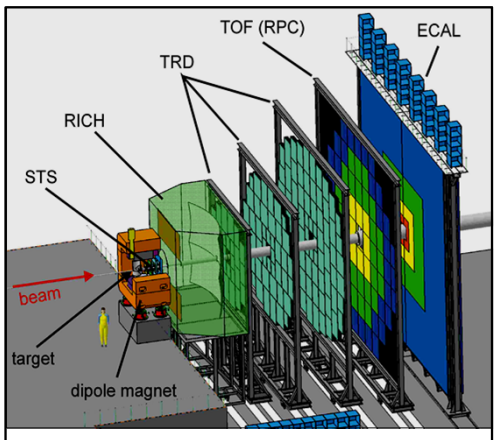
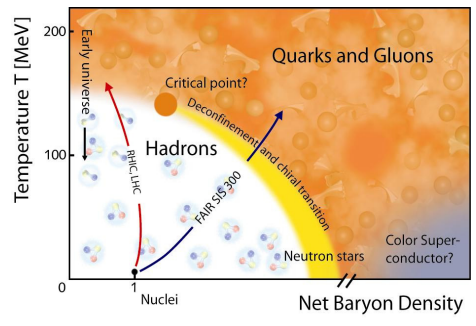
GOETHE UNIVERSITÄT FRANKFURT AM MAIN



The CBM-Experiment is one of the core experiments of the future FAIR facility. The SIS100 and SIS300 accelerators of FAIR will provide it with up to 10^9 heavy ions/s with an energy of up to 35 AGeV.

The CBM-Experiment aims to study the phase diagram of nuclear matter by probing it with open charm particles. Those particles are reconstructed by separating their decay vertex from the primary vertex of the initial heavy ion collision. A next generation vertex detector is needed for this task.



Theory predicts a first order phase transition from hadronic matter to Quark Gluon Plasma in the region of highest net baryon densities.
CBM aims to put this phase transition and its predicted critical point into evidence.

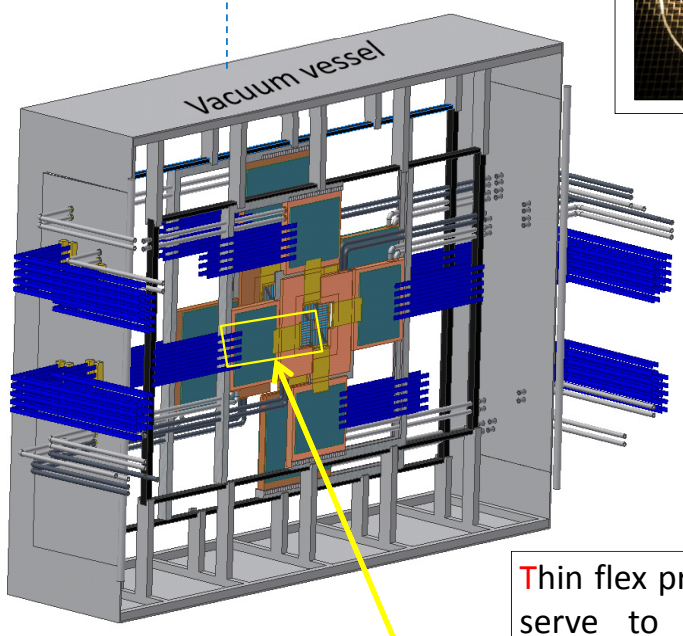
Particle	Decay channel	Branch. ratio	Life time (ct)
D^+	$K^-+\pi^++\pi^+$	9%	315µm
D^0	$K^-+\pi^+$	4%	124µm
λ_c	$p+K^-+\pi^+$	5%	62µm

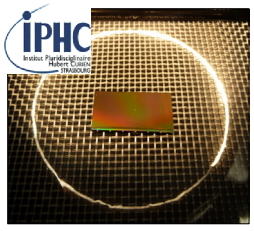
Open charm particles probe the properties of the nuclear matter in the early phase of the heavy ion collision. Measuring them provides important information for understanding the complex multi-body processes during the collision.

Concept of the Micro Vertex Detector

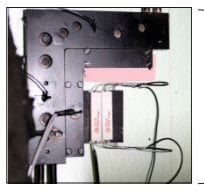
Design goals	
Number of stations	2-4
Inner acceptance	3°
Outer acceptance	25°
x/X_0 (first station)	~0.3%
x/X_0 (other stations)	~0.5%
Sec. vtx. resolution	50µm
Spatial resolution	<5µm
Time resolution	50µs
Vacuum operation	10^{-5} mbar
Cooling power	1 W/cm²
Rad tolerance (Io)	> 3MRad
Rad. tol. (non-io)	$10^{13} n_{eq}$

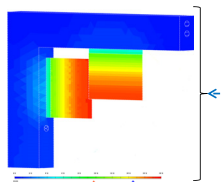
The MVD will operate in the target vacuum to obtain the best possible vertex resolution.

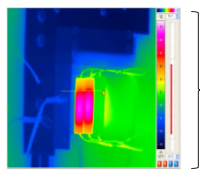




The MVD will rely on CMOS Monolithic Active Pixel Sensors (MAPS) which provide the necessary radiation tolerance, a spatial resolution of 3.5µm, 50µm thickness, and advanced on-chip data processing

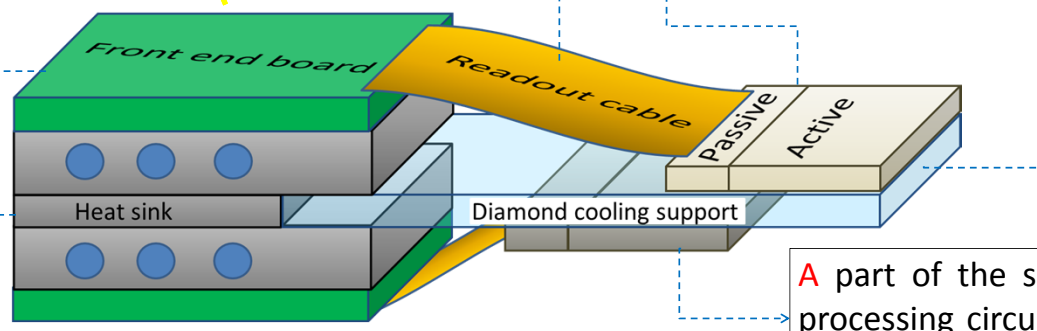






A mechanical support made from CVD diamond hosts the sensors and evacuates their dissipated power to a heat sink.
The validity of the cooling concept was tested with thermal simulations and FLIR-measurements.

Thin flex print cables serve to bias and readout the sensors.

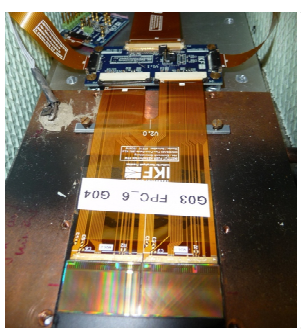


The data of the sensors will be received by a radiation tolerant, passive front end board. It sends the data (800 Mbps/sensor) to a DAQ-system based on the HADES-TRB3 standard.

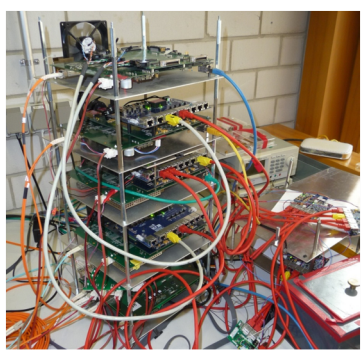
A liquid cooled heat sink located outside the detector acceptance hosts front end boards and absorbs the dissipated power of the system.

A part of the sensor chip hosts data processing circuits. The second sensor covers this surface.

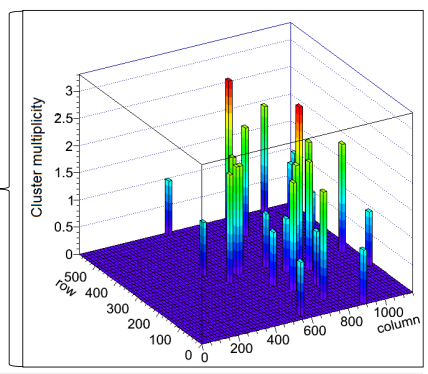
Status of the MVD Prototype



A combination of a readout cable (0.09% X_0 with Cu-traces) and two MIMOSA-26 sensors (1152x576 pixels with a pitch of 18.4x18.4 µm², 2cm² surface, 10kFrame/s, on-chip zero suppression), was built and is being tested.



Data analysis is done with a DAQ prototype based on the HADES TRB3. This prototype is scalable to the requirements of the final MVD. It demonstrated to handle several sensors, first hits from a ^{55}Fe-source were detected.



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Learn more:

CBM: http://www.gsi.de/forschung/fair_experiments/CBM/index_e.html

MVD: M. Deveaux et al. "Design considerations for the Micro Vertex Detector of the Compressed Baryonic Matter experiment". PoS(VERTEX 2008)

MIMOSA-26: M. Deveaux et al . "Radiation tolerance of a column parallel CMOS sensor with high resistivity epitaxial layer", 2011 JINST 6 C02004, doi:10.1088/1748-0221/6/02/C02004