Vacuum-Compatible, Ultra-Low Material Budget Micro Vertex Detector of the Compressed Baryonic Matter Experiment at FAIR

14 th Vienna Conference on Instrumentation, Vienna 2016.

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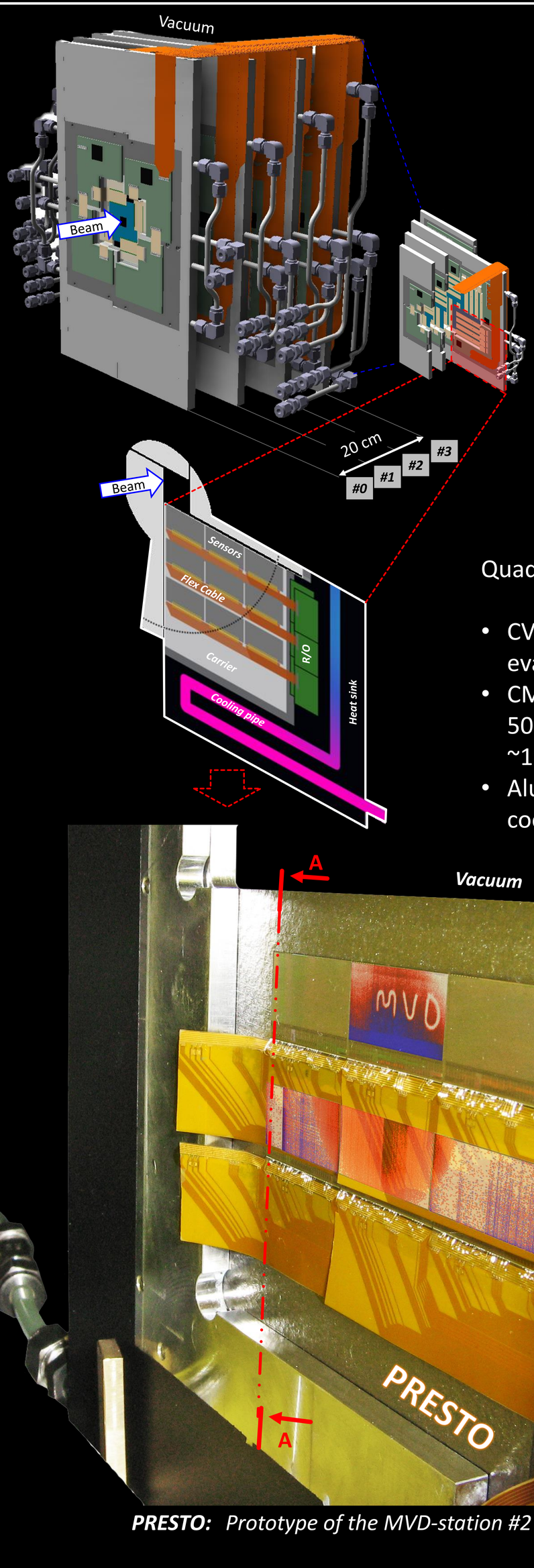
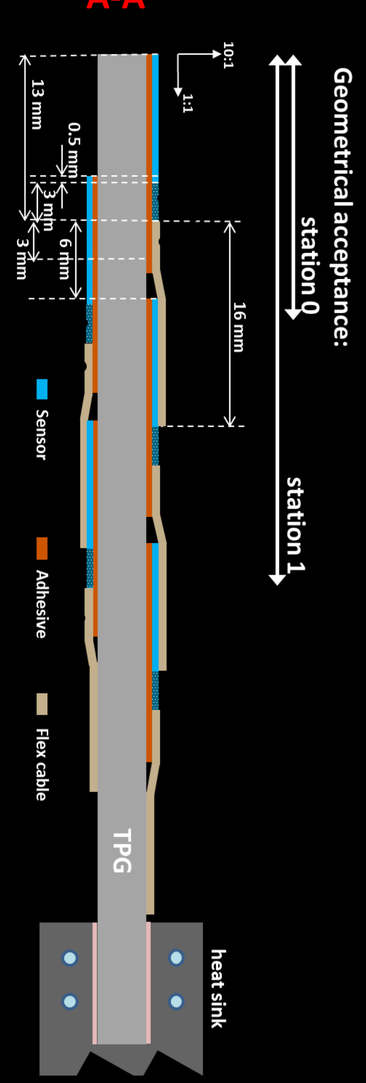


PRESTO: *Prototype of the MVD-station #2 quadrant*



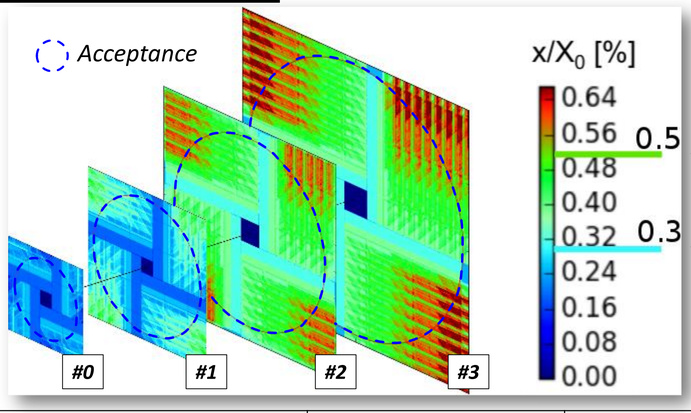
Micro Vertex Detector (MVD) for the CBM experiment at GSI/FAIR:

- Secondary vertex determination (10 µm scale), background rejection in di-electron spectroscopy, reconstruction of weak decays
- Vacuum/magnetic field operation
- 4 stations at 5, 10, 15 & 20 cm downstream the target
- ~300 CMOS sensors
- Power dissipation: 150 W
- Radiation tolerance: $>10^{13} n_{eq}/cm^2$ & >1 Mrad

Quadrant (smallest functional unit):

- CVD Diamond / TPG carrier for heat evacuation
- CMOS pixel sensors: 50 µm thin, 150 mW/cm², ~10 µs read-out
- Aluminum heat-sink (actively cooled)

Material Budget



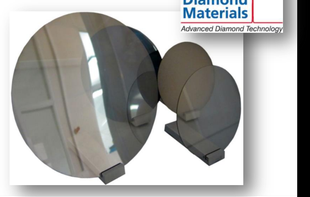
Targeted values for stations

 # 2 & 3

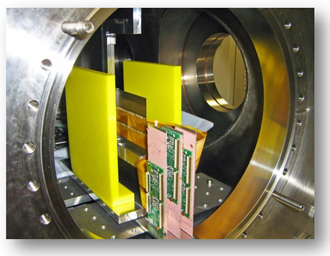
 # 0 & 1

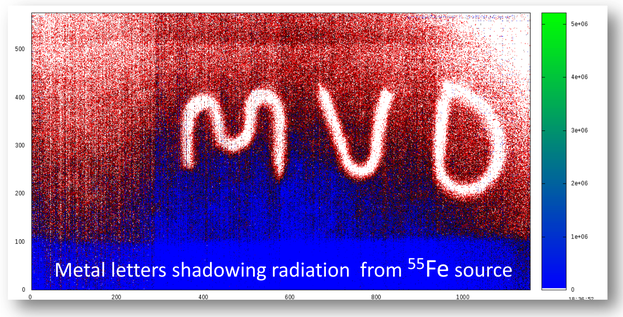
Component	*Thickness [mm]*	*x/X_0 [%]*
Sensor (MIMOSA-26)	0.05	0.053
Glue	0.03	0.009
TPG carrier (# 2&3)	0.38	0.200
CVD diamond carrier (# 0&1)	0.15	0.123
Flex cable (Cu traces)	0.063	0.051

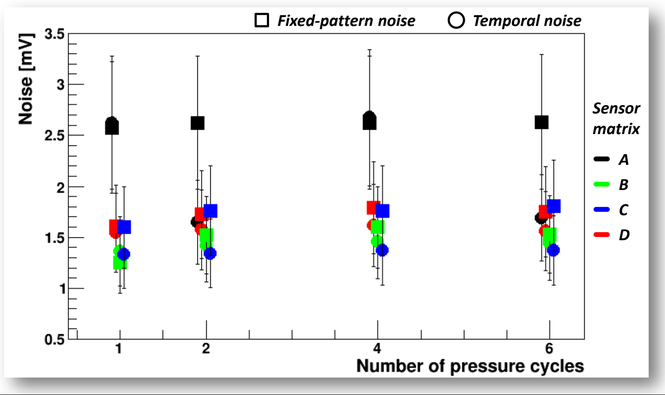
CVD diamond thickness = 150 µm
Ø = 126 mm



Vacuum Compatibility







- Pressure: 10^{-3} mbar
- Temperature: +13 °C at the heat sink
- Acquisition time: 10 min

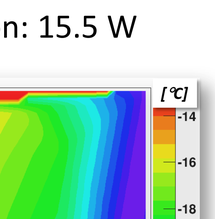
No performance loss observed after several pressure cycles

Heat Evacuation in Vacuum

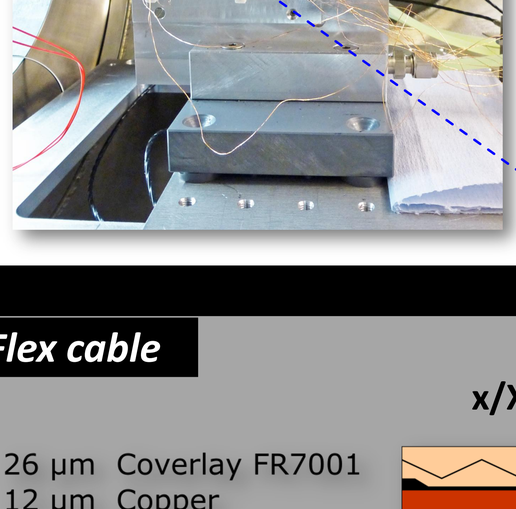
TPG support MOMENTIVE™

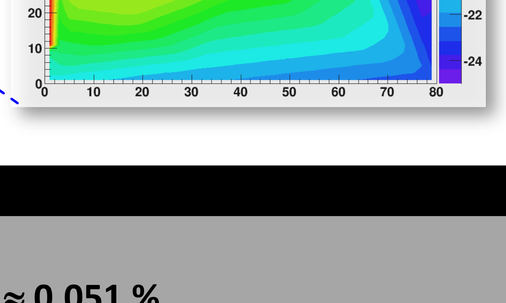
- Thickness: 500 µm
- Conductivity: 1500 W/mK
- x/X_0: 0.262 %

- Cooling liquid: -40 °C
- Heat source: Flexible Kapton heaters from OMEGA®



- Power dissipation: 15.5 W



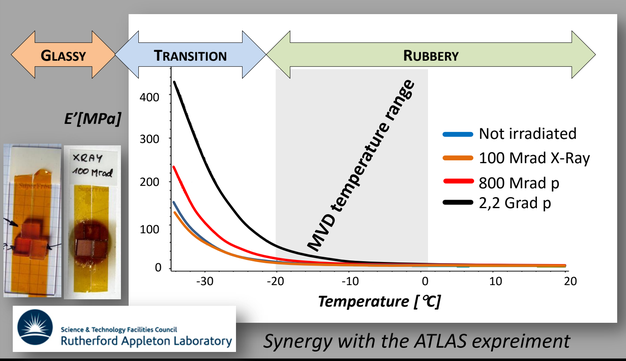


Integration Aspects

Custom-made adhesive

RAL-247 features:

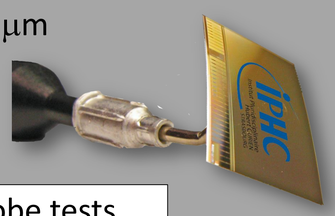
- Glass temperature (Tg) @ -45 °C
- Viscosity of below 100 mPa·s
- Curing time 48h @ +50 °C and more than a week at 20 °C



Synergy with the ATLAS expreiment

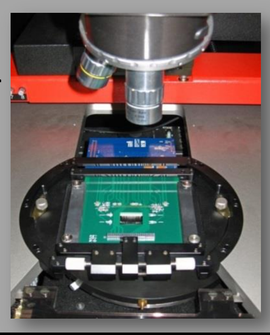
Sensor

Family: CMOS pixel sensor
Process: AMS CMOS 0.35 µm
Model: MIMOSA-26
Thickness: 50 µm



Sensor probe tests

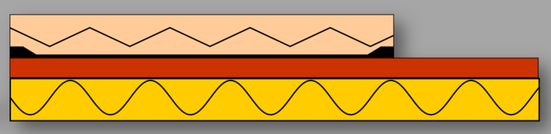
- 65 standard tungsten needles
- Dedicated chuck adapter for holding 50-µm thin sensors
- No cooling
- Sensor yield ~67 %
- QA for other applications (PLUME, NA-61)



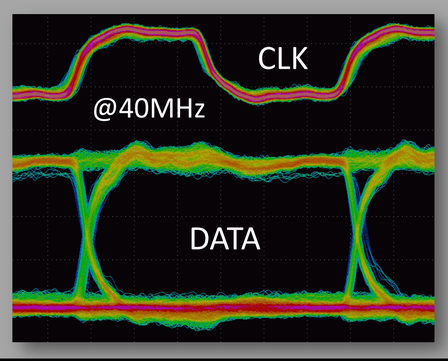
Flex cable

$x/X_0 \approx 0.051$ %

26 µm Coverlay FR7001
12 µm Copper
25 µm Polyimide AP7164E



- Industry standard
- Single layer
- Cu-based
- Material-budget oriented
- ~30 cm long



- No sensor-to-sensor influence during read-out and power cycling
- Locally, material budget of the TPG-based MVD stations is slightly above an accepted limit → improvement by changing Cu to Al traces

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