Status of the LMD Slow Control

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$\overline{\text{P}}$ANDA DCS and EPICS

Experimental Physics and Industrial Control System (EPICS) is used for the $\overline{\text{P}}$ANDA DCS

- Set of open source software tools, libraries and applications
- Network-based client/server model
- Decentralized architecture
- Freely scalable
- Supports many platforms (Linux, Unix, Windows, RTEMS, vxWorks, ...)
- Supports many architectures (x86, x64, ARM, ...)

High Voltage Power Supply of the HV-MAPS

- HV-MAPS need high voltage power supply ($\sim 60\,\mathrm{V}$)
- High resolution in current measurement needed

$\Rightarrow$ Using ISEG EHS F2 05p-F

  - 16 channel, 500 V, 10 mA, single channel floating-GND
  - 50 pA resolution in current measurement for $I_O \leq 20\,\mu\mathrm{A}$
  - Accuracy: $\pm(0.01\% V_O + 0.02\% V_{O,nom})$
    $I_O \leq 20\,\mu\mathrm{A}$: $\pm(0.01\% I_O + 4\,\mathrm{nA})$
  - Potentiometer to set hardware limits for V_{max} and I_{max} per module

- Controlled with EPICS via CAN bus
- For prototype 80 channels arrived
  - Prototype: each sensor will be powered individually
  - Final detector: Grouping sensors with same radius on each side of one module
    $\Rightarrow$ 6 HV channels per module
    $\Rightarrow$ 240 HV channels overall

HV-MAPS

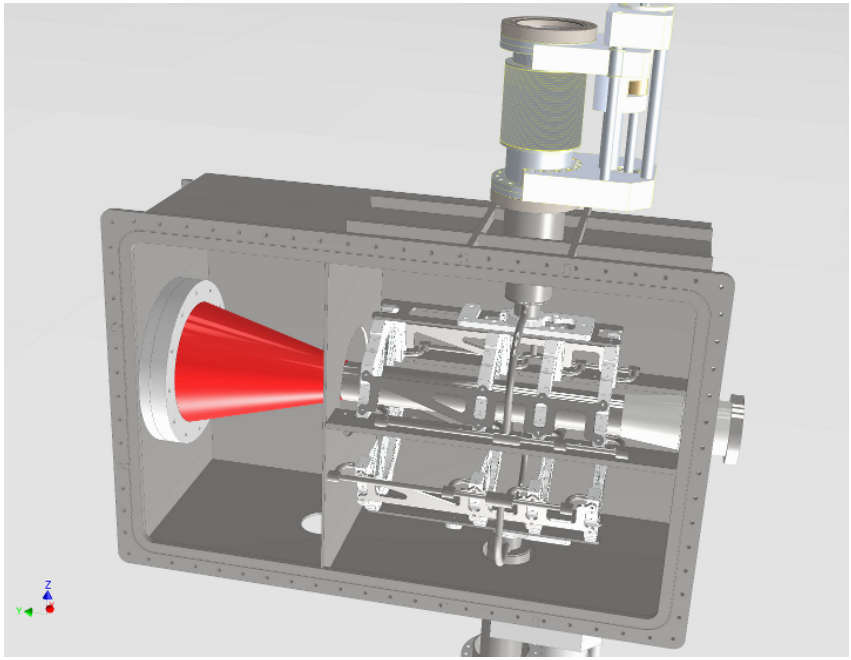
Low Voltage Power Supply of the HV-MAPS

- HV-MAPS need low voltage power supply (1.8 V, ∼1.2 A)
- Using DC/DC converters with sense pin next to sensors
- Primary LV power supply: Wiener MPOD (?)
  Can be controlled with EPICS via SNMP

Slow Control on HV-MAPS

- JTAG used to set thresholds of HV-MAPS
- To reduce feed-throughs using JTAG multiplexers
- Multiplexer controlled via microcontroller with CAN bus interface

Pressure Measurement

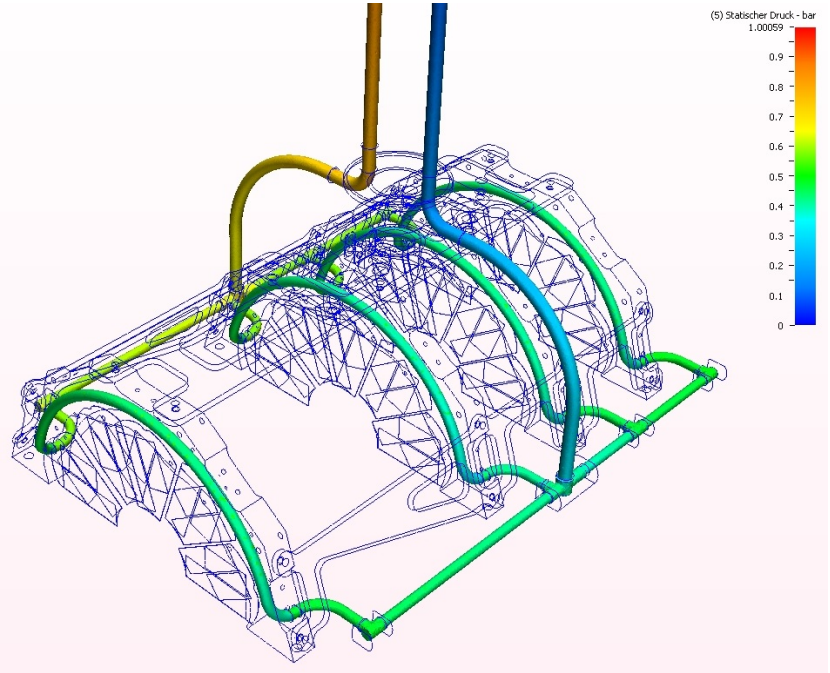


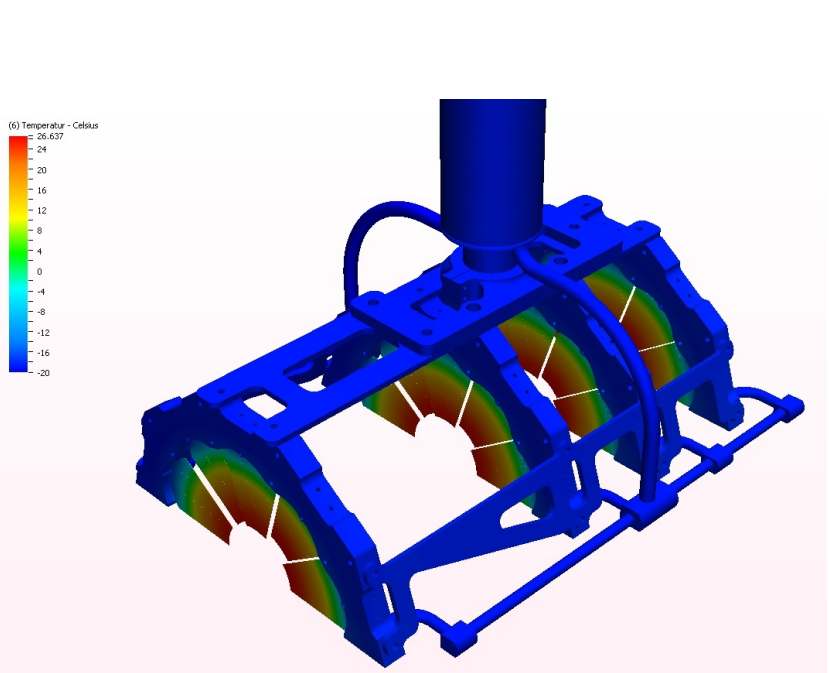
- Luminosity detector operates inside vacuum
- Aluminized Kapton foil as cone for inner beam pipe (marked in red)
- Need coupling with vacuum inside beam pipe

$\Rightarrow$ Control of vacuum pumps and pressure measurement needed

- Details have to be discussed with engineers from HESR!

Cooling

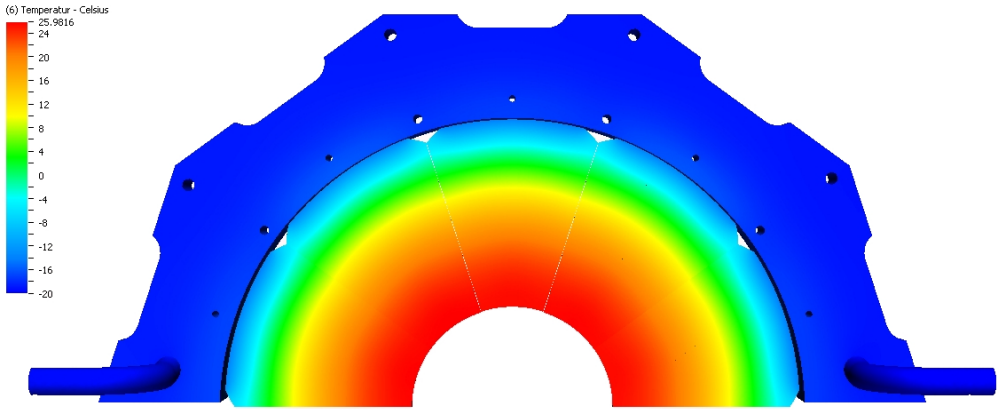




- Pumping cooling liquid with 1 bar overpressure
- Simulations with Glycol as cooling liquid
- Stainless steel pipe molded in aluminium structure
- Pressure of cooling liquid measured at inlet and outlet of the detector

Temperature Measurement

- Temperature varies along modules: $-20\ °\mathrm{C} \leq T \leq +26\ °\mathrm{C}$



$\Rightarrow$ Temperature measurement near pixel sensors needed

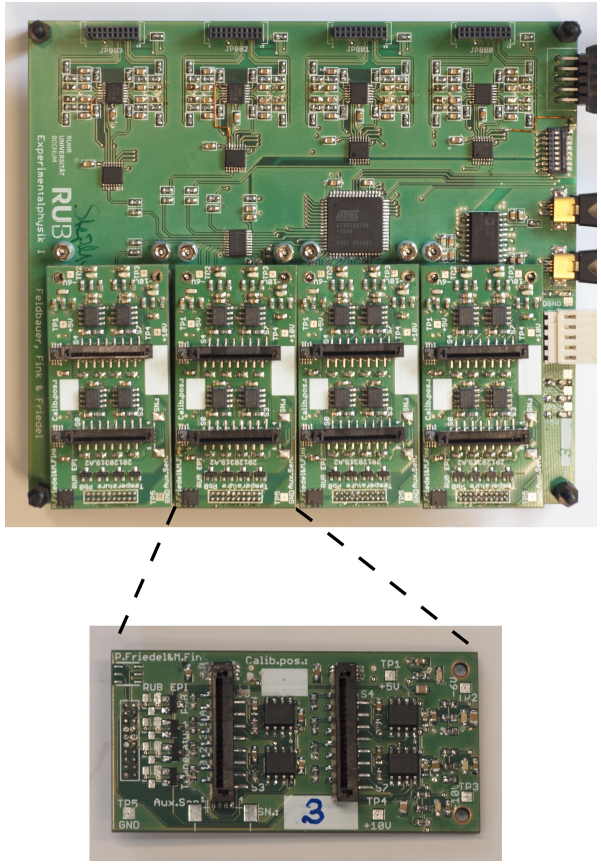
$\Rightarrow$ Gluing PT100 sensors on CVD diamond

- Need to keep material budget as low as possible

$\Rightarrow$ Sensor placed near holding structure
(maybe additional sensor on most inner part of module on last plane)

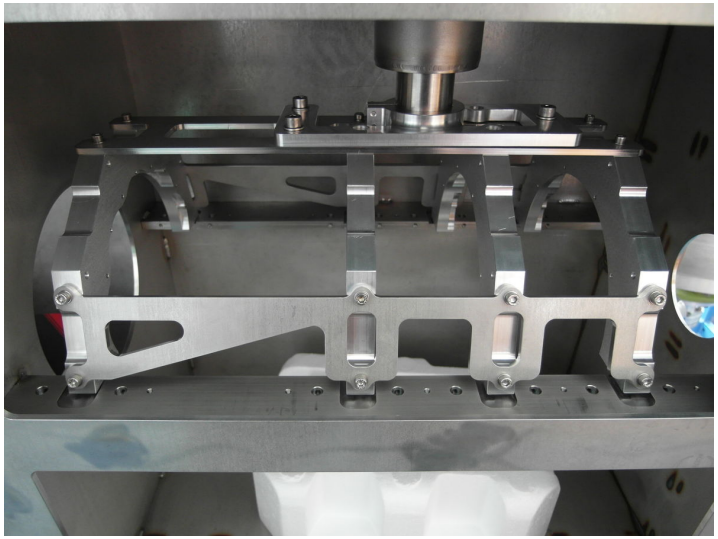
Temperature and Humidity Monitoring Board for $\overline{\text{P}}$ANDA

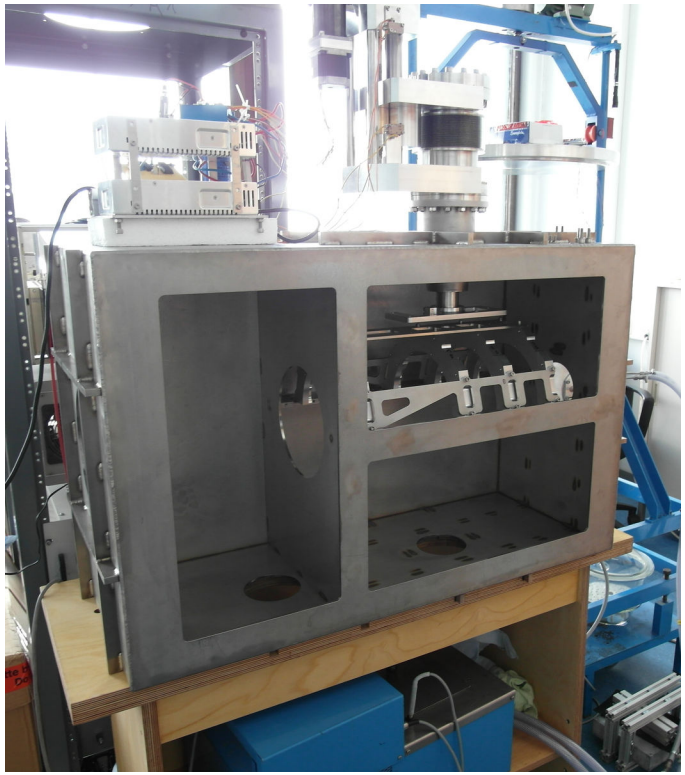
- Developed for $\overline{\text{P}}$ANDA EMC by
  F. Feldbauer and P. Friedel (Bochum)
- Modular read out system for temperature, humidity, pressure, ...
- Mainboard with 8 piggyback boards
- 8 channels per piggyback board
  $\Rightarrow$ 64 channels per THM$\overline{\text{P}}$
- 14 bit, 8 channel ADC
- Temperature measurement:
  - Working range: $-50\,^{\circ}\text{C} - +50\,^{\circ}\text{C}$
  - Resolution: $< 0.05\,^{\circ}\text{C}$
- Trying to operate THMP inside vacuum



Motor Driver

- During injection procedure of HESR luminosity detector has to be moved aside
- Using stepper motor to move half planes away from beampipe
- Precise position measurement needed

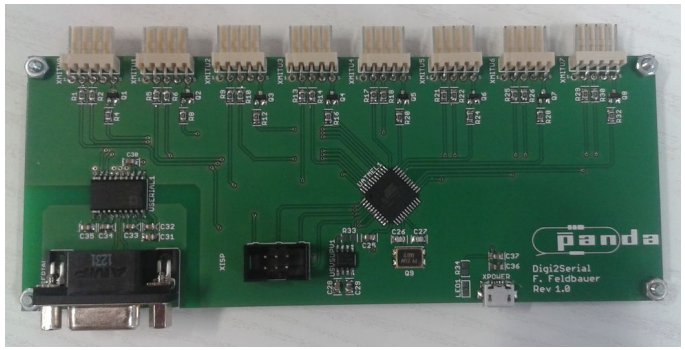




Motor Driver

- Mitutoyo digital gauge with digimatic interface for testing resolution of stepper motor
- Accurary of gauges 1 μm
- Microcontroller as digimatic-to-serial converter
- Up to eight individual channels are readable
- Data send to PC via RS232 (galvanic isolated)

$\Rightarrow$ Motor resolution: $\sim$200 nm per step (c.f. talk by Fabian Heidelberg tomorrow in lumi session)



Position Measurement

Ideas for precise position measurement:

- Using IBS CPL190 Capacitive Measurement System
- ± 10 V output
- Selectable bandwidth: 100 Hz, 1 kHz, 10 kHz, 15 kHz
- Position measurement $\leq 1\,\mu$m
- Positioning $< 200\,\mu$m


8-slot enclosure

Conclusion and Outlook

What we have

- Precise high voltage power supply from ISEG used for HV-MAPS
- THM$\overline{\text{P}}$: PT100 sensors for temperature monitoring, industrial pressure transducers for pressure measurement of cooling liquid
- Using stepper motor to move half planes away from beam during injection
- First mechanical prototypes with digital micrometer gauge ready for tests

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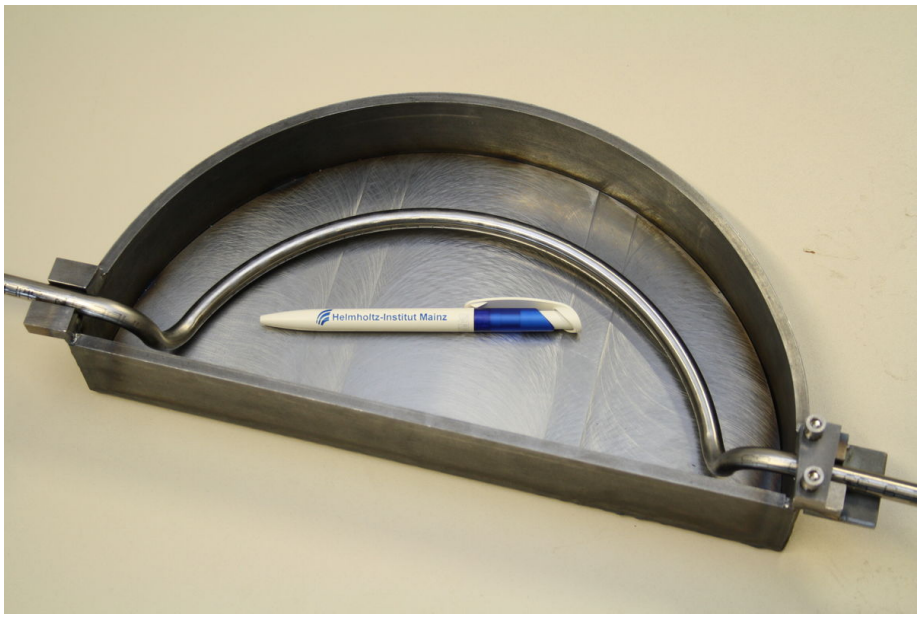
What is missing and on the way

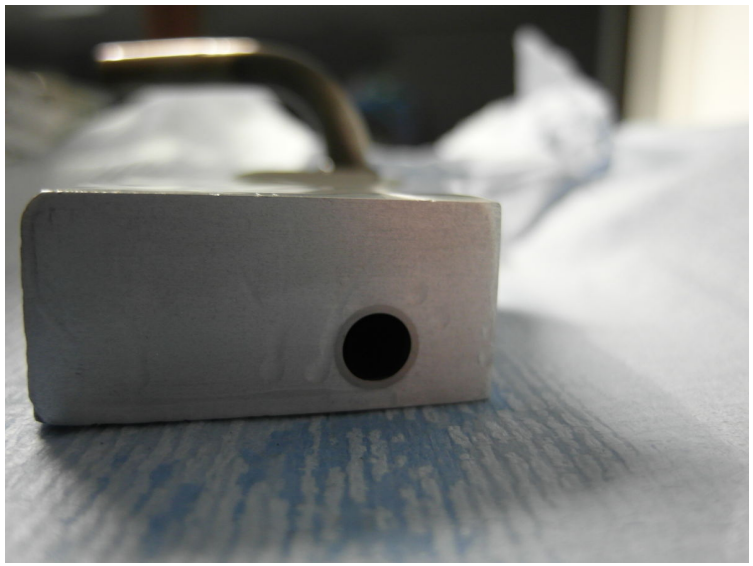
- Low voltage power supply via DC/DC converters
- Vacuum: Pumps and pressure measurement for prototype available
  For final detector details to be discussed with engineers from HESR
- Decision on cooling machine has to be made
- Precise position measurement of the half planes inside vacuum has to be implemented

Cooling

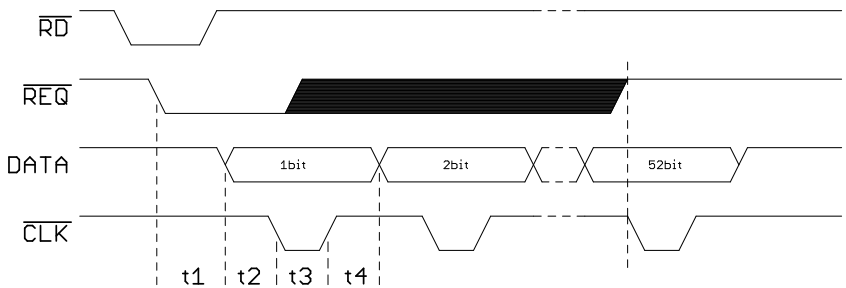
- Stainless steel pipe molded in aluminium structure
- First prototypes have been produced
  - Melting aluminium (AlMg4.5Mn) under vacuum
  - Melting aluminium (Al99.5) under argon atmosphere

  $\Rightarrow$ Similar results
  (c.f. talk by Heinrich Leithoff tomorrow in lumi session)





Digimatic



- Timing: $10\,\text{ms} \leq t_1 \leq 150\,\text{ms}$
  $0.1\,\text{ms} \leq t_{2,3,4} \leq 0.2\,\text{ms}$
- Gauge sends 13 nibbles with self generated clock pulse
- Nibbles send with LSB first
- Data send as BCD value
- Open-drain outputs