Update on mechanics, cooling and vacuum of the luminosity detector

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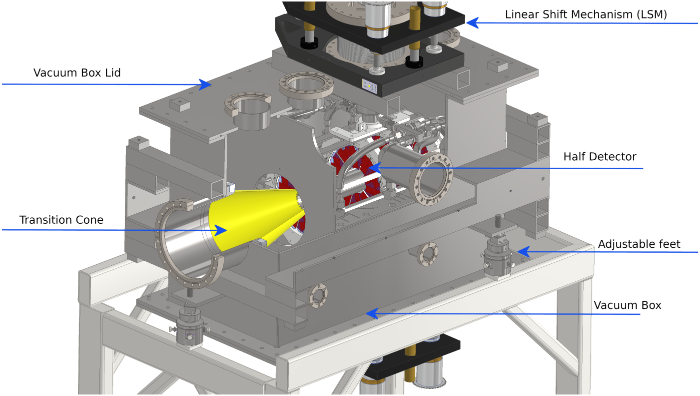
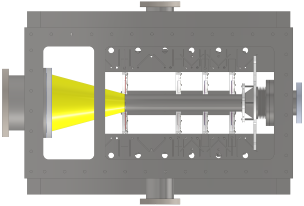
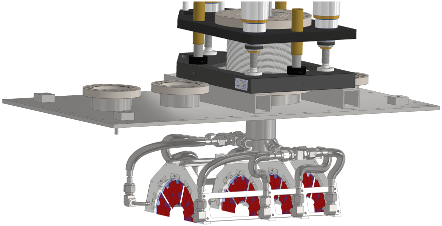
Overview of the luminosity detector



- 4 retractable layers of active sensors in secondary vacuum
- rigid vacuum box for good position information of the sensors
- active cooling necessary

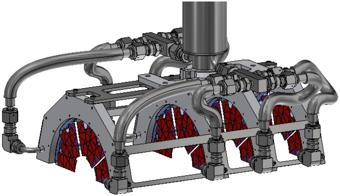
Mechanics status

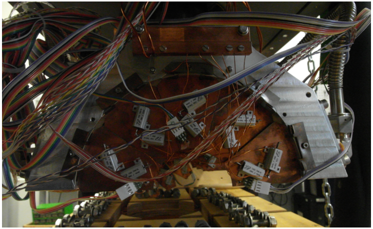




- prototype box build and tested
- vacuum box deformation under vacuum <130 μm
- half detectors mounted on lids, closing postion repeatable within 50 μm
- glueing of foil cone in the box after positioning the inner beampipe
- inner beampipe changed to 68 mm outer diameter in titanium
- final box production in preparation

Cooling system: General setup



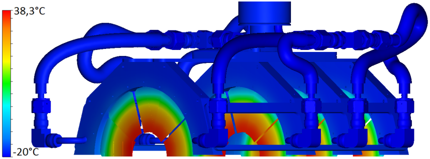


	sensors	LDO voltage regulator	resistance in flexcables	multiplexer etc.
worst case	1040 W	320 W	160 W	∼100 W
likely case	380 W	120 W	20 W	∼100 W

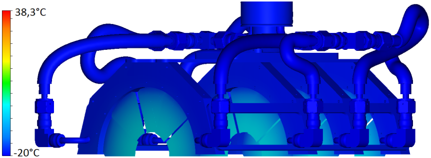
- worst case: $7\,\mathrm{mW\,mm^{-2}}$, likely case: $2.5\,\mathrm{mW\,mm^{-2}}$
- total estimated heat load per half detector: 310 W to 810 W
- for cooling test: copper dummys and high power resistors

Simulation

worst case:



expected case:



- no transition or radiative effects
- inlet temperature $-20\,^{\circ}\mathrm{C}$, pressure difference 1 bar
- diamond in nominal thickness
- maximum temperature:

worst case: $\sim 39\,^{\circ}\mathrm{C}$
expected case: $\sim 0\,^{\circ}\mathrm{C}$

Cooling cycle test

Cooling cycle:

- set bath temperature to $-20\,^{\circ}\mathrm{C}$
- when $-20\,^{\circ}\mathrm{C}$ is reached wait 10 min
- switch on power supply and wait 15 min
- switch off power supply and set bath temperature to $20\,^{\circ}\mathrm{C}$
- when $20\,^{\circ}\mathrm{C}$ is reached wait 10 min

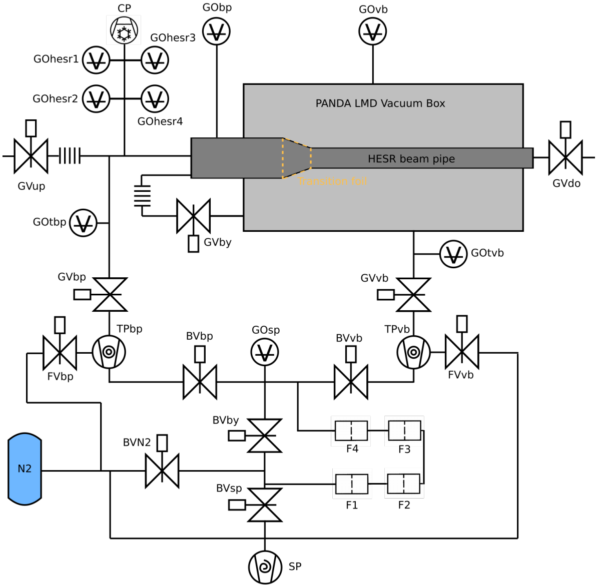
$>$500 cycles run with 340 W (14 W/module)

$>$500 cycles with 465 W (19 W/module)

expected case: 10 W/module

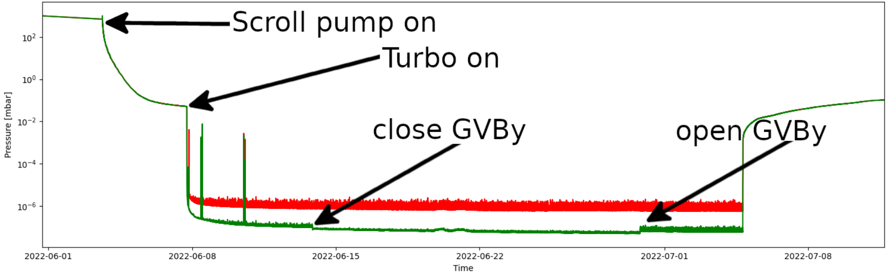
- no changes in cooling behaviour
- no leaks in the cooling circuit

Vacuum concept



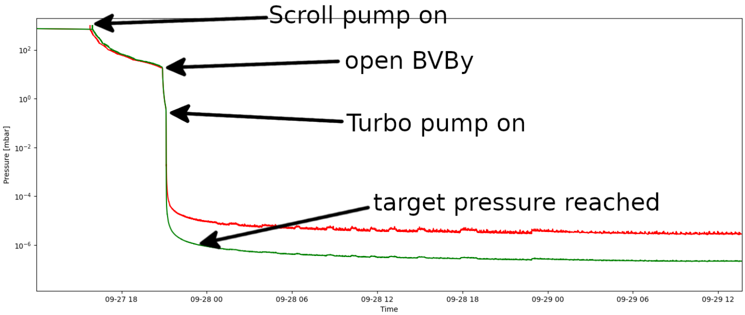
- two separate vacuum volumes (beampipe and box)
- one turbopump per volume
- common scroll pump
- initial slow pumping to reduce risk of foil damage
- pumps, valves and gauges controlled by PLC

Long term vacuum tests



- lowest pressure in beampipe: 5×10^{-8} mbar
- lowest pressure in box: 6×10^{-7} mbar
- long pumping time, further improvement needs more pumps (additional cryo pump possible)
- test without electronics in vacuum!

Vacuum tests 2



- pumping procedure with focus on shorter duration
- slow pumping in the beginning to protect the transition foil
- 1×10^{-6} mbar in beampipe reached after ∼9h of pumping
- automatisation will further shorten the time needed

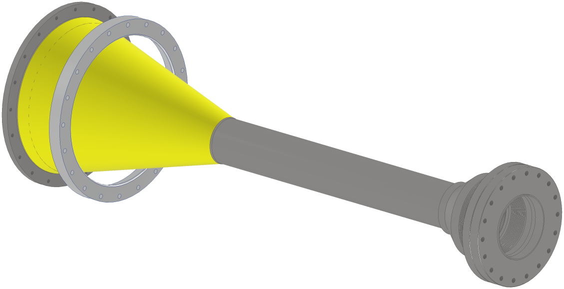
Summary and outlook

- vacuum box prototype successfully tested for mechanical stability and handling
- half detector cooling working
- vacuum system performance successfully tested

What is next:

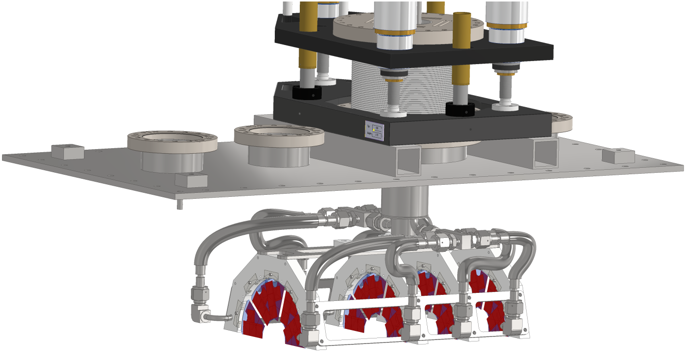
- production of half detector prototype with sensors
- production of final vacuum box
- automatisation of vacuum procedures
- production of final detector

Inner beampipe



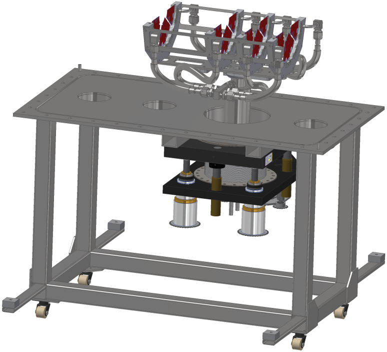
- connection to vacuum box changed to CF type flange
- seamless pipe from titanium grade 2
- outer pipe diameter 68 mm, wall thickness $\leq$ 750 µm

Vacuum box lid 1



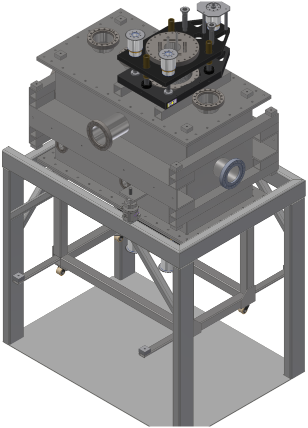
- houses half detector and LSM with all feedthroughs
- allows easier installation and testing
- next steps: LSM and prototype installation

Vacuum box lid 2



- lower lid installation procedure successfully tested
- repeatability of lid position good ($\sim$50 µm), see talk by Jannik

Vacuum box lid 2



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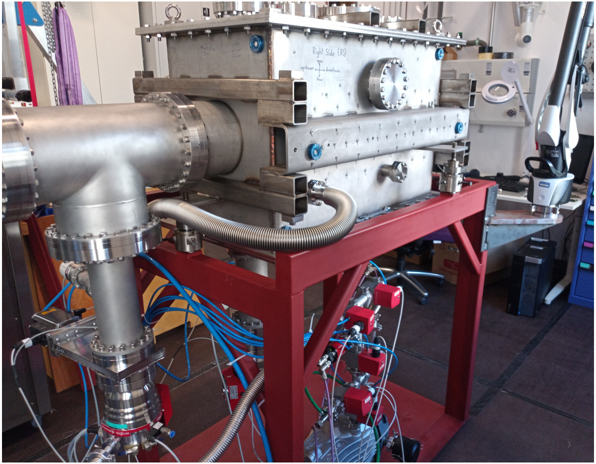
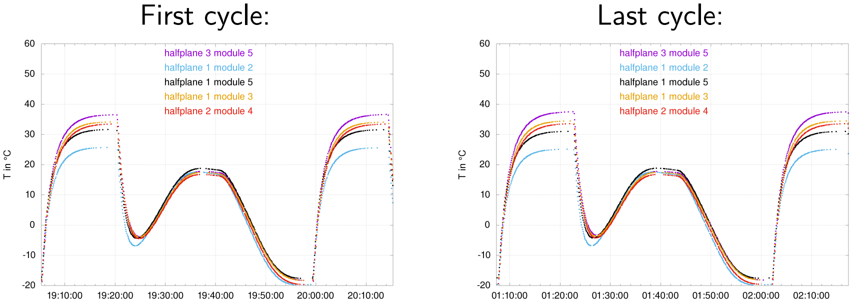
Mechanics: Vacuum box



- mechanical rigidity within expected parameters, see talk by Jannik
- vacuum tests under preparation

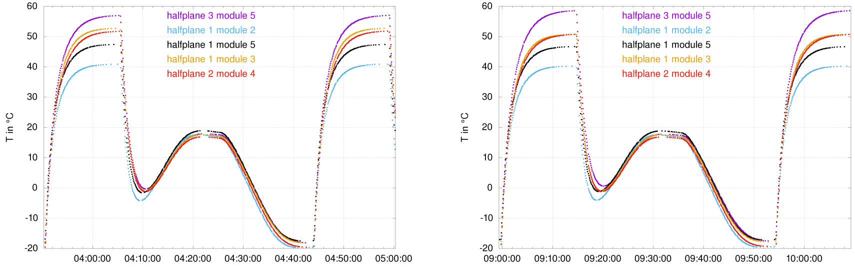
Cooling cycle result I



- No change in 500 cycles for 340 W
- Placement of modules difficult du to stiff copper cabling and heavy weight
- Well-placed modules show acceptable temperature under realistic conditions

Cooling cycle result II

First cycle: Last cycle:



- Small changes after 500 cycles for 465 W
- Three copper dummies lost contact
- Well-placed modules still ok
- Contact loss due to mechanical collision of resistors and inner beampipe aligner (not a problem with sensors)