Status of Mechanical Design

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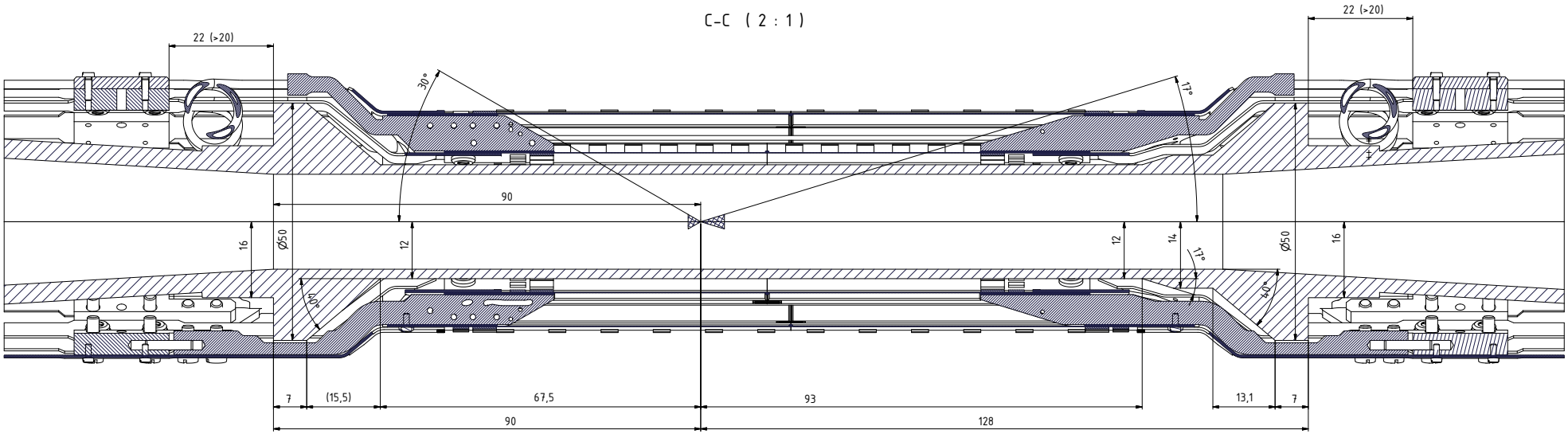
5th International Workshop on DEPFET Detectors and Applications
September 29, 2010

Mechanical Design
First Vibration Tests
Thermal stability

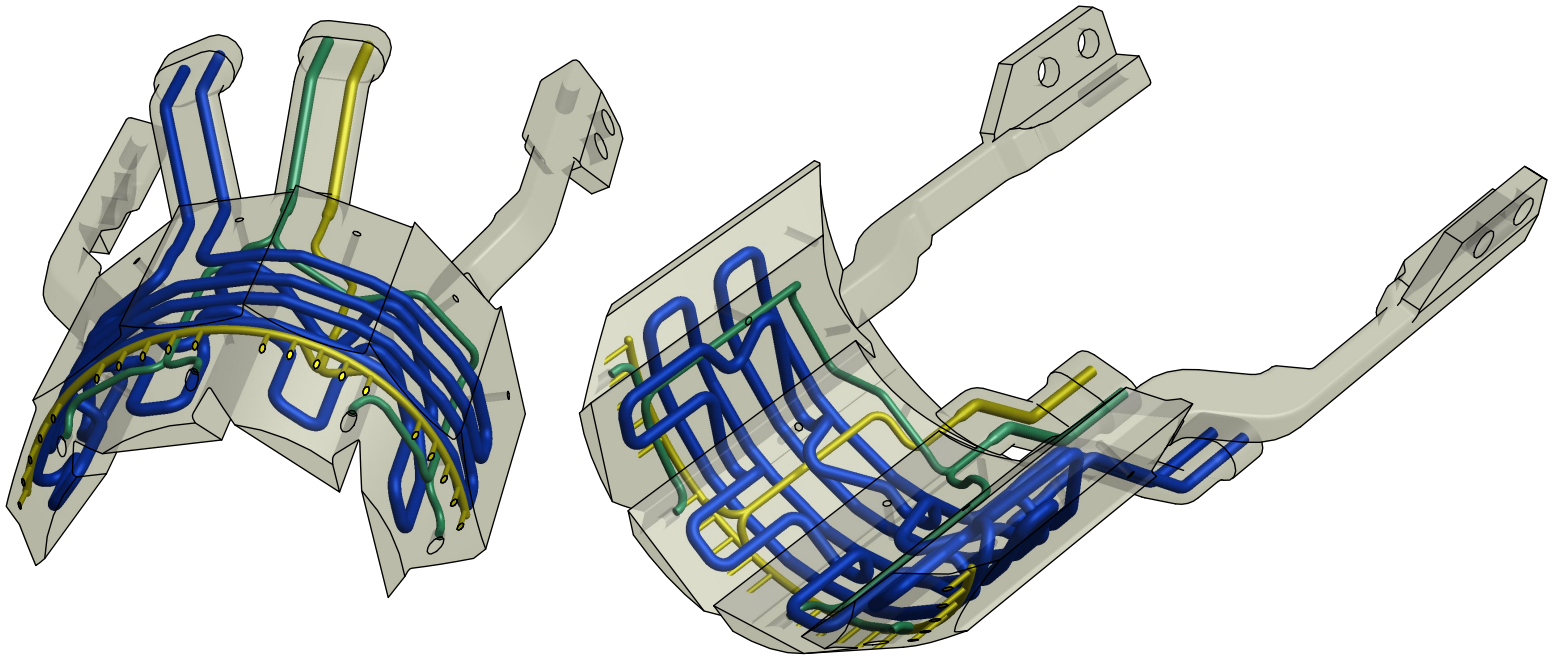
Mechanical Design



- No significant changes have been made to the design since last B2GM
  - defined inner envelope for Beampipe cooling
  - optimized cooling channel layout

Endflanges

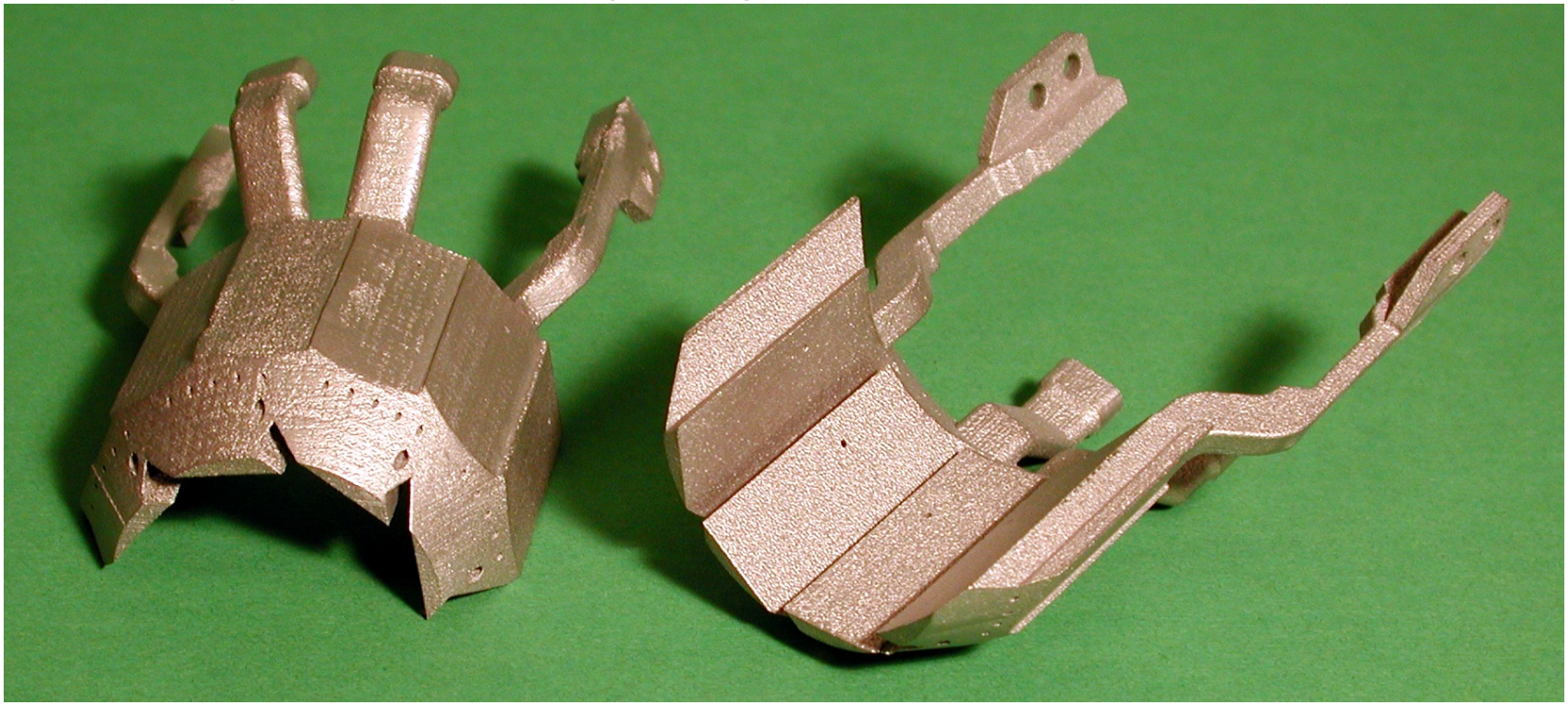
First prototypes of the endflange design have been ordered



- 6 pieces of the complete “final” geometry for the backward endflange
- stainless steel DMLS production
- integrated cooling channels:
  - CO2 channel (blue)
  - Switcher channel: air channel for carbon tubes to blow directly on switchers and sensitive area (green)
  - DCD channel: air channel to induce airflow in the PXD (yellow)

Endflanges

First prototypes of the endflange design have been ordered and received.



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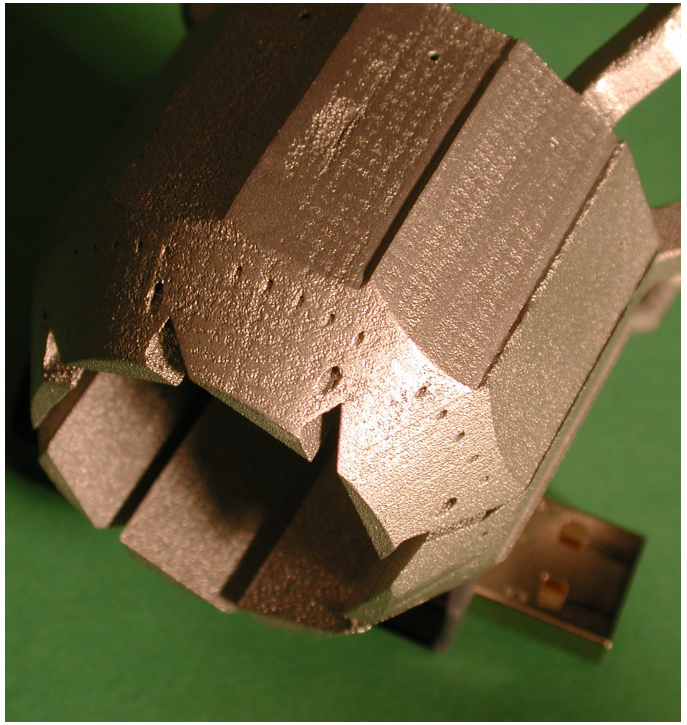
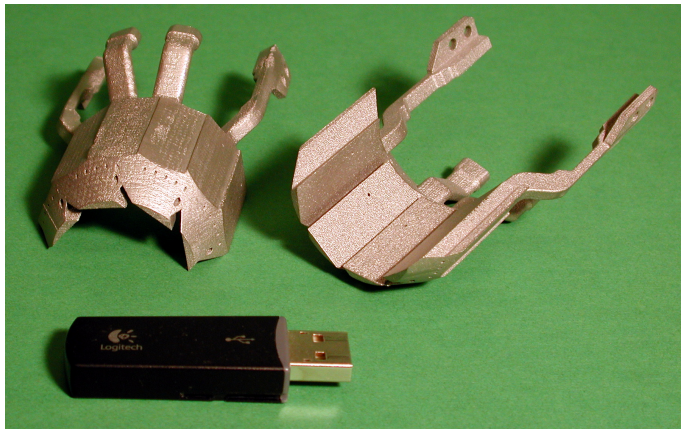
Endflanges

Characterisation currently performed by our workshop, first results:

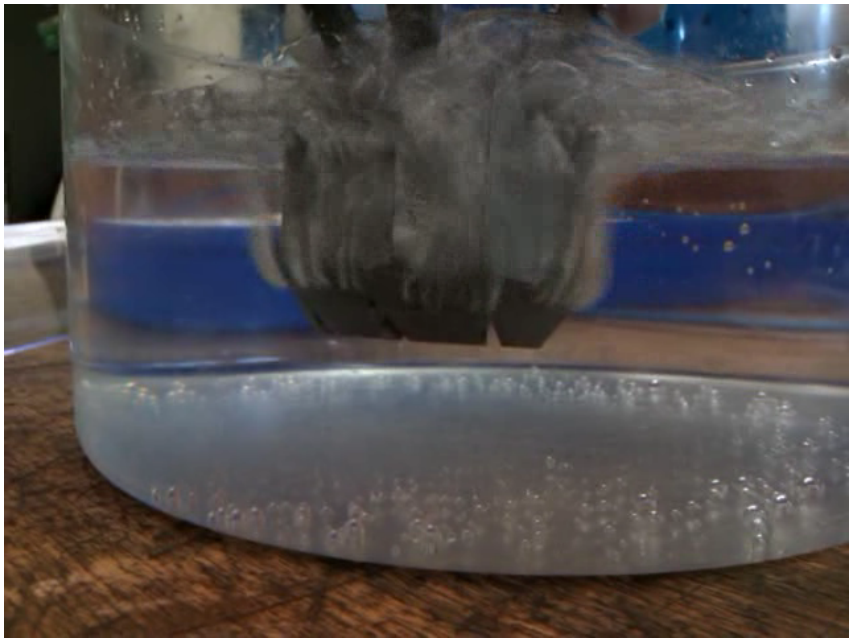
- rough surface due to production process
- all 6 pieces almost identical, but relatively large deviations from design geometry (up to 0.4 mm)
- we ordered stainless steel, but material is magnetic like normal steel.
- threading and soldering works without problems
- all channels are useable



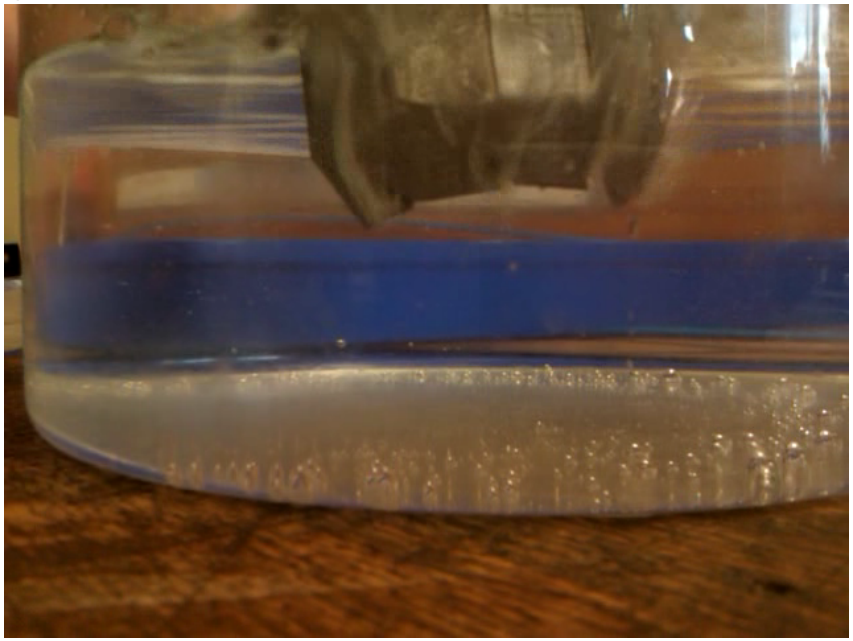


Airflow test

DCD channel



Switcher channel



Airflow tests were carried out for all prototypes

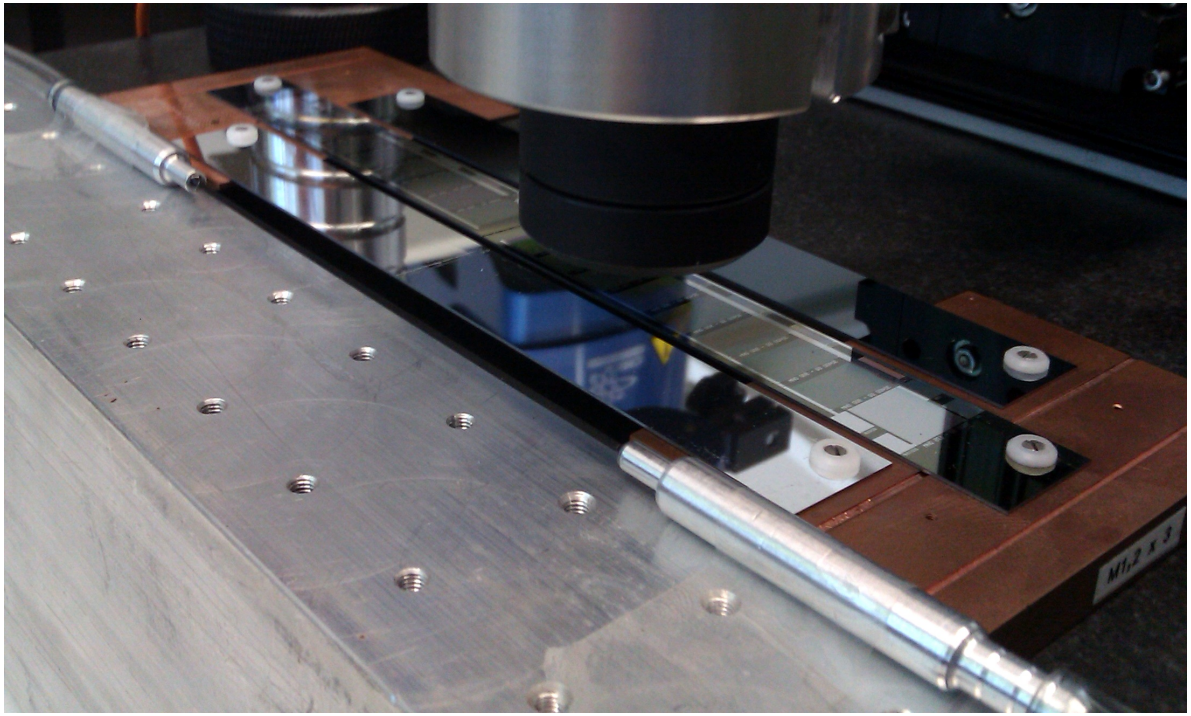
- pictures show 1 bar air pressure
- some of the small outlet don't work until $\sim$ 1.5 bar
- very similar results for all parts

Next Steps

- finish threading, solder pressure pipe to CO2 channel
- make leakage test of CO2 channel
- pressure test with 120 bar
- repeat leakage test
- send one set to Karlsruhe for cooling tests

First Vibration Tests

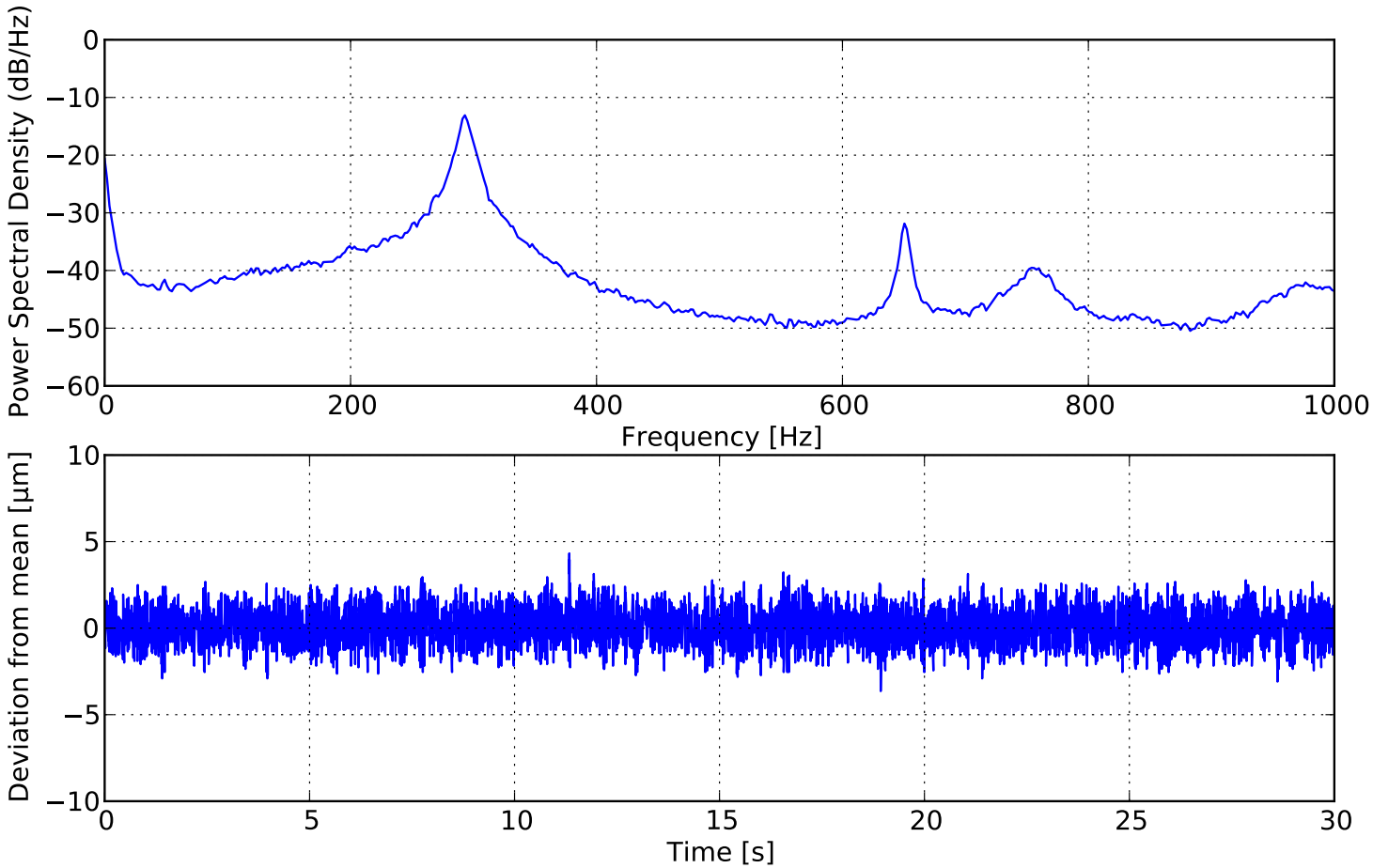
First simple test to check for vibrations of the module due to airflow



- 3 modules fixed to planar surface, using torque of 15 mNm
- sensitive area thinned to 50 μm for all modules
- carbon tube attached parallel to modules
- applied 1 bar of air pressure to both sides of tube

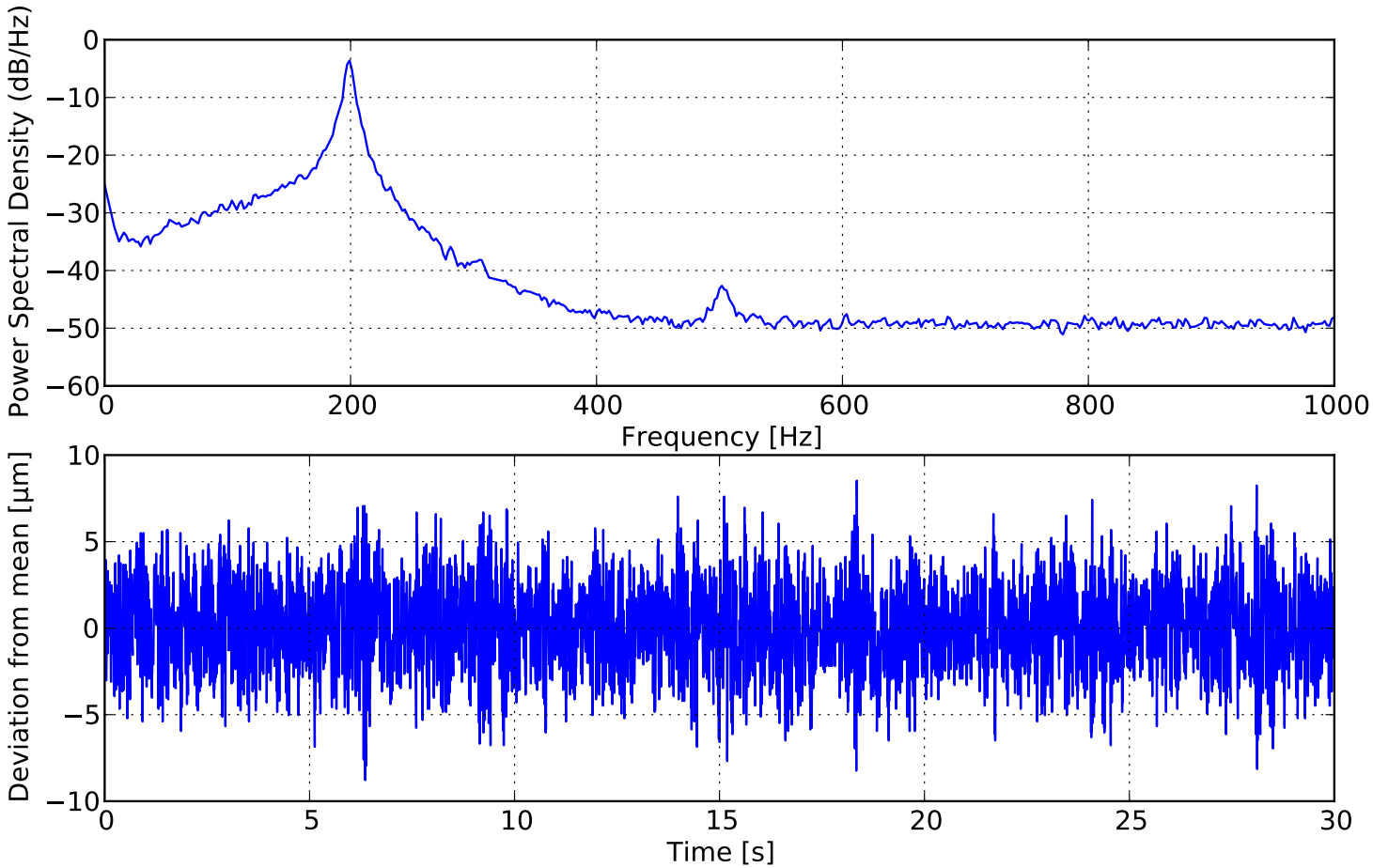
➡ measured frequency and magnitude of vibrations

Inner Layer Module



resonance frequency of $\sim 300\,\mathrm{Hz}$, amplitude of $\sim 3\,\mu\mathrm{m}$

Outer Layer Module

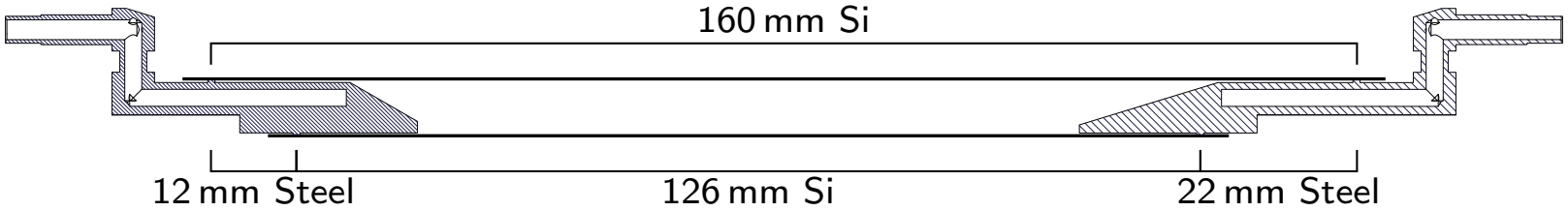


- resonance frequency of $\sim 200\,\mathrm{Hz}$, amplitude of $\sim 5\,\mu\mathrm{m}$

Thermal Stability Tests

Goal: Verify Mechanical Design

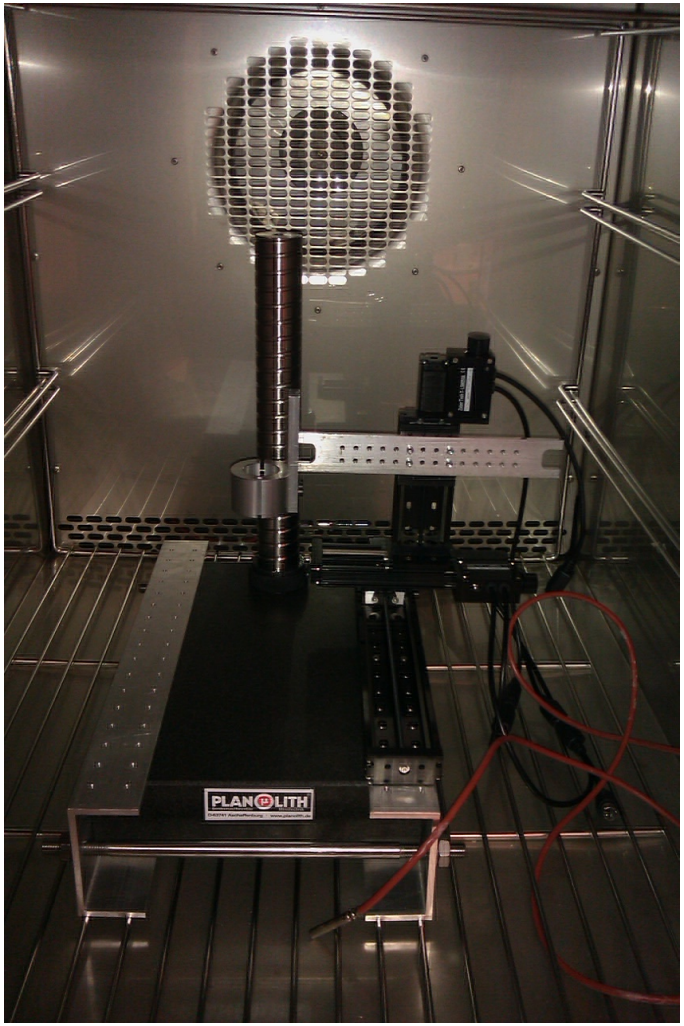
Baseline: Modules screwed to endflange to ensure good thermal contact and positional stability



- Difference between thermal expansion of inner and outer layer $\sim 20\,\mu$m for $\Delta T = 40\,^{\circ}$C
- we need to make sure that modules and glue remain stable over the whole temperature range

Precise position/distance measurement over "large" temperature range needed.

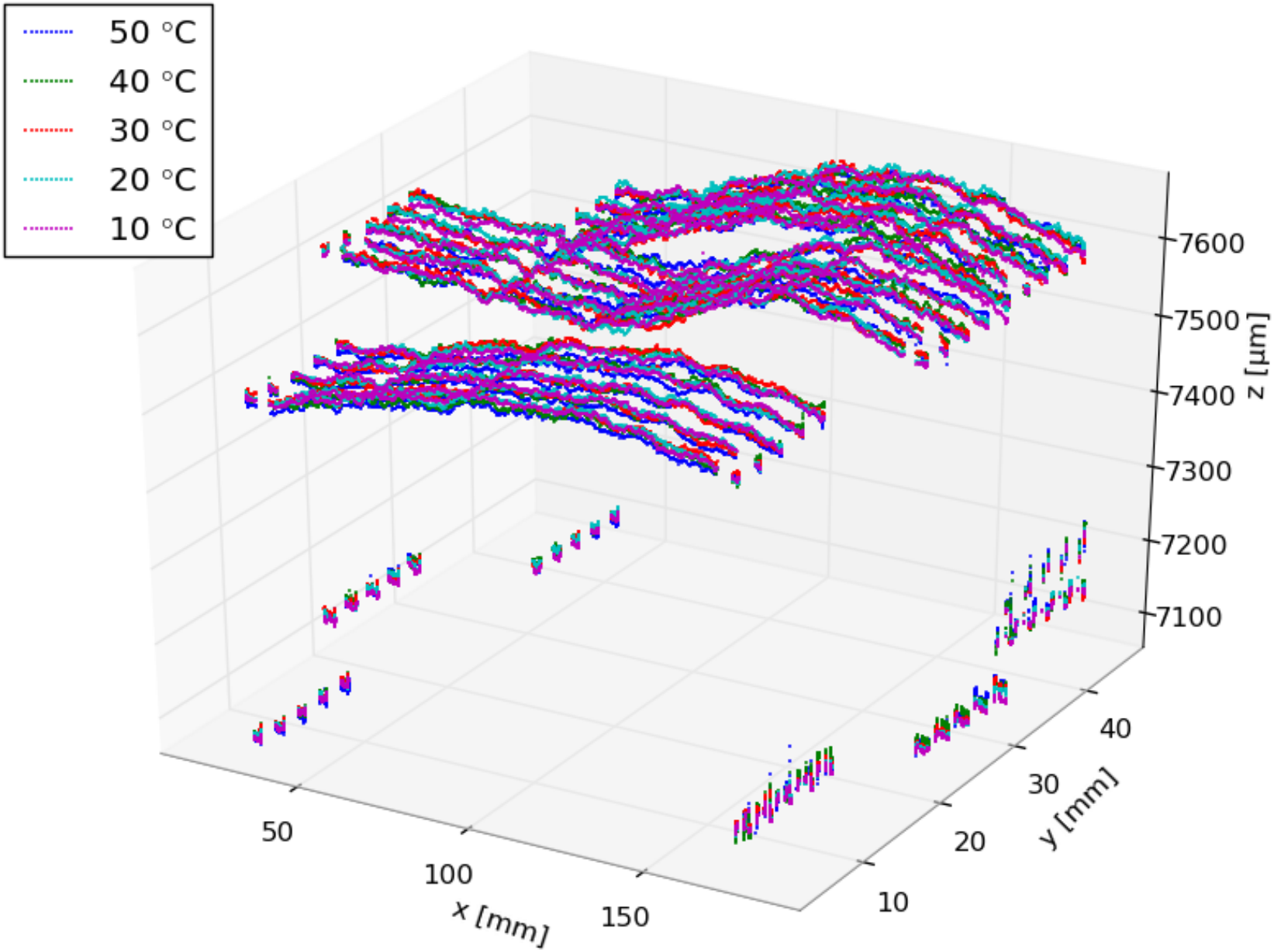
The Setup



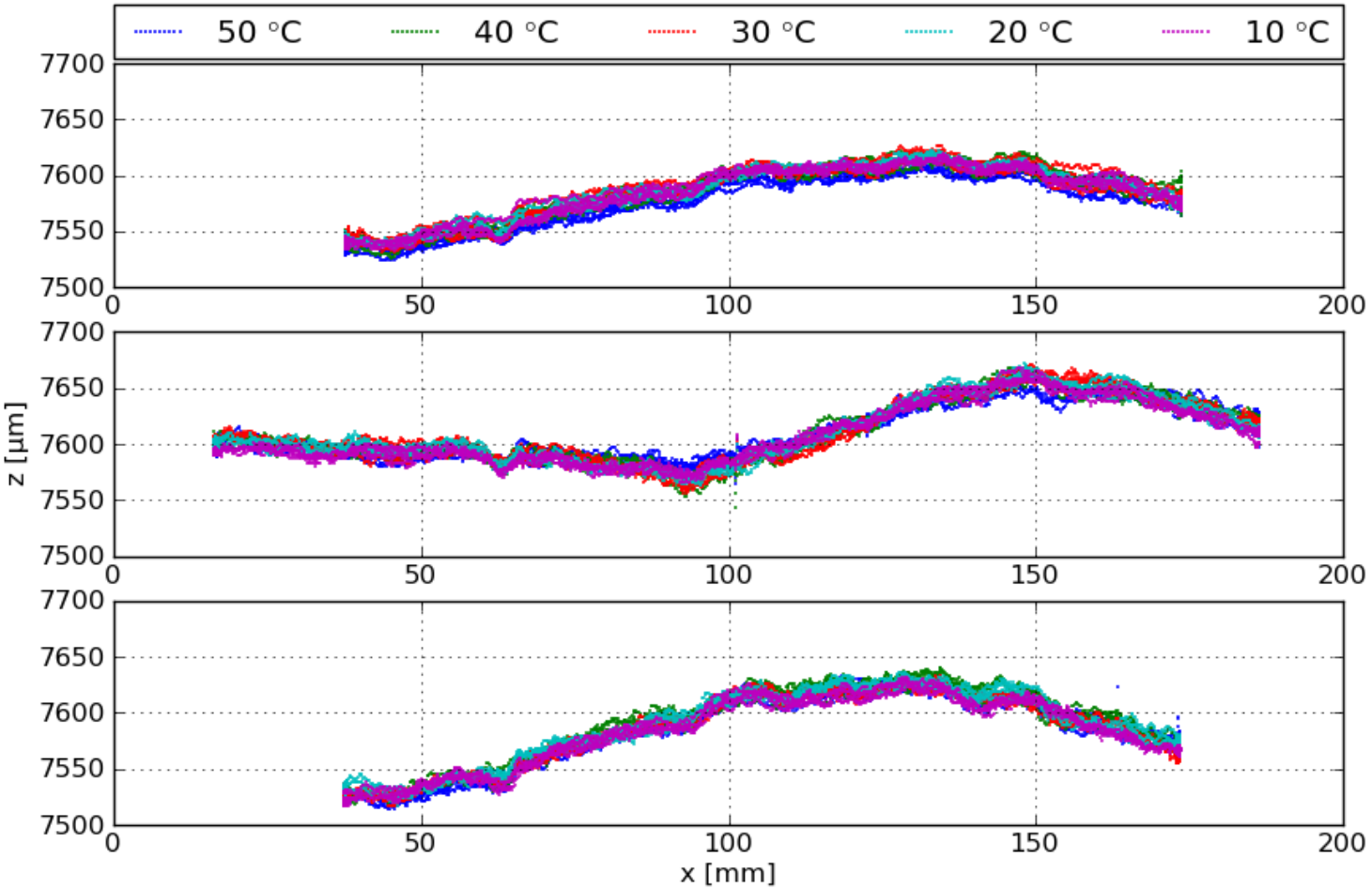
We have prepared a setup to profile modules during temperature cycling

- granite reference plane with $\pm 2\,\mu$m planarity
- range of 200 mm $\times$ 50 mm in XY-Plane, $< 2\,\mu$m repeatability
- Z-range of 3 mm, resolution of $< 1\,\mu$m
- possibility to adjust Z-position by 50 mm
- temperature Range from 0 °C to 50 °C

Results

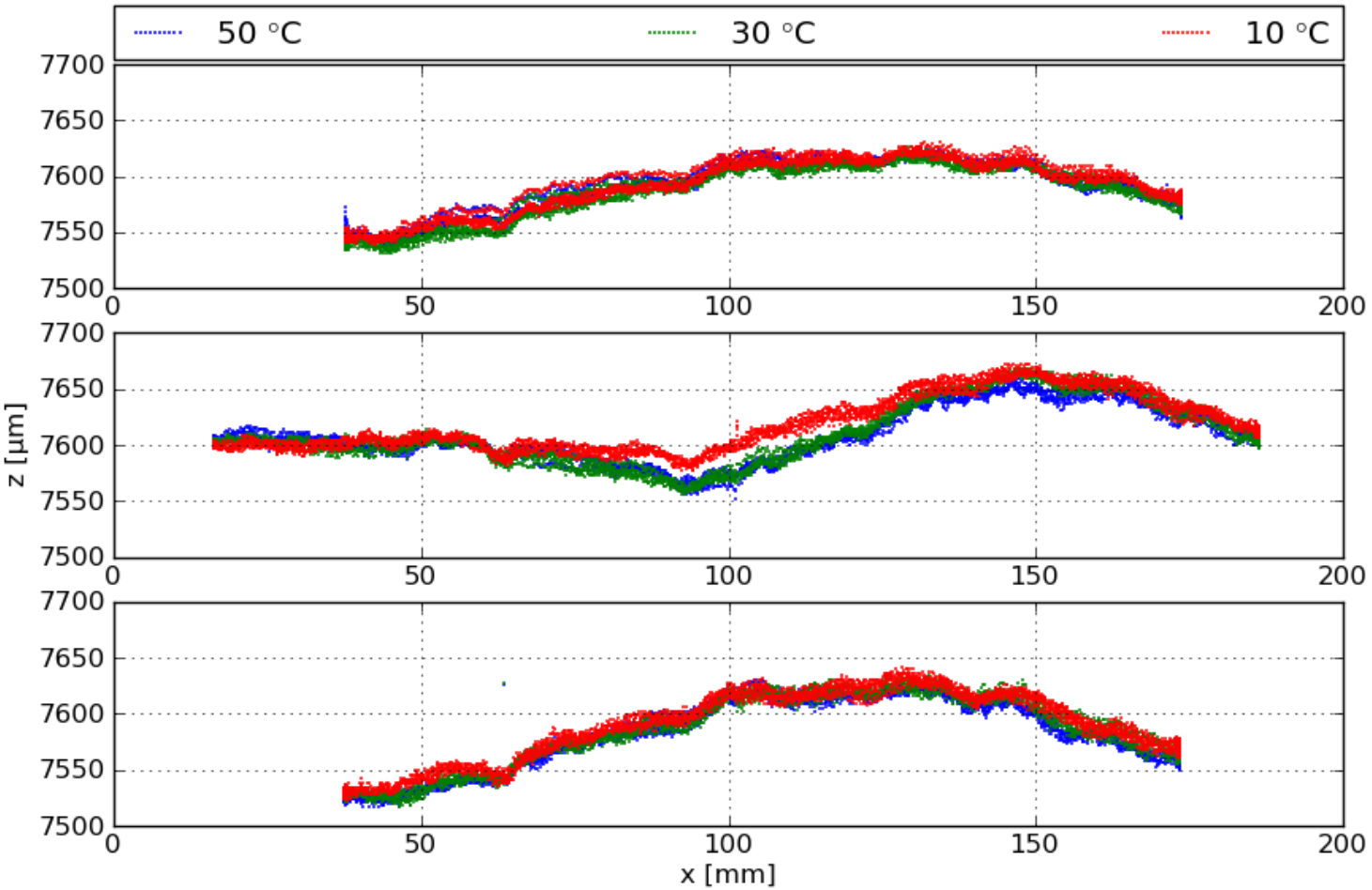

50 °C
40 °C
30 °C
20 °C
10 °C
7600
7500
7400
7300
7200
7100
z [µm]
50
100
150
x [mm]
10
20
30
40
y [mm]

Results



Modules stable of large temperature range due to low torque

Results



Deviation at 10 °C, but not visible in next scan

Conclusions

First metal prototypes for the endflange recieved

- some issues with precision and material
- cooling channels look promising
- pressure tests scheduled
- hopefully ready for cooling tests soon

Simple vibration test carried out

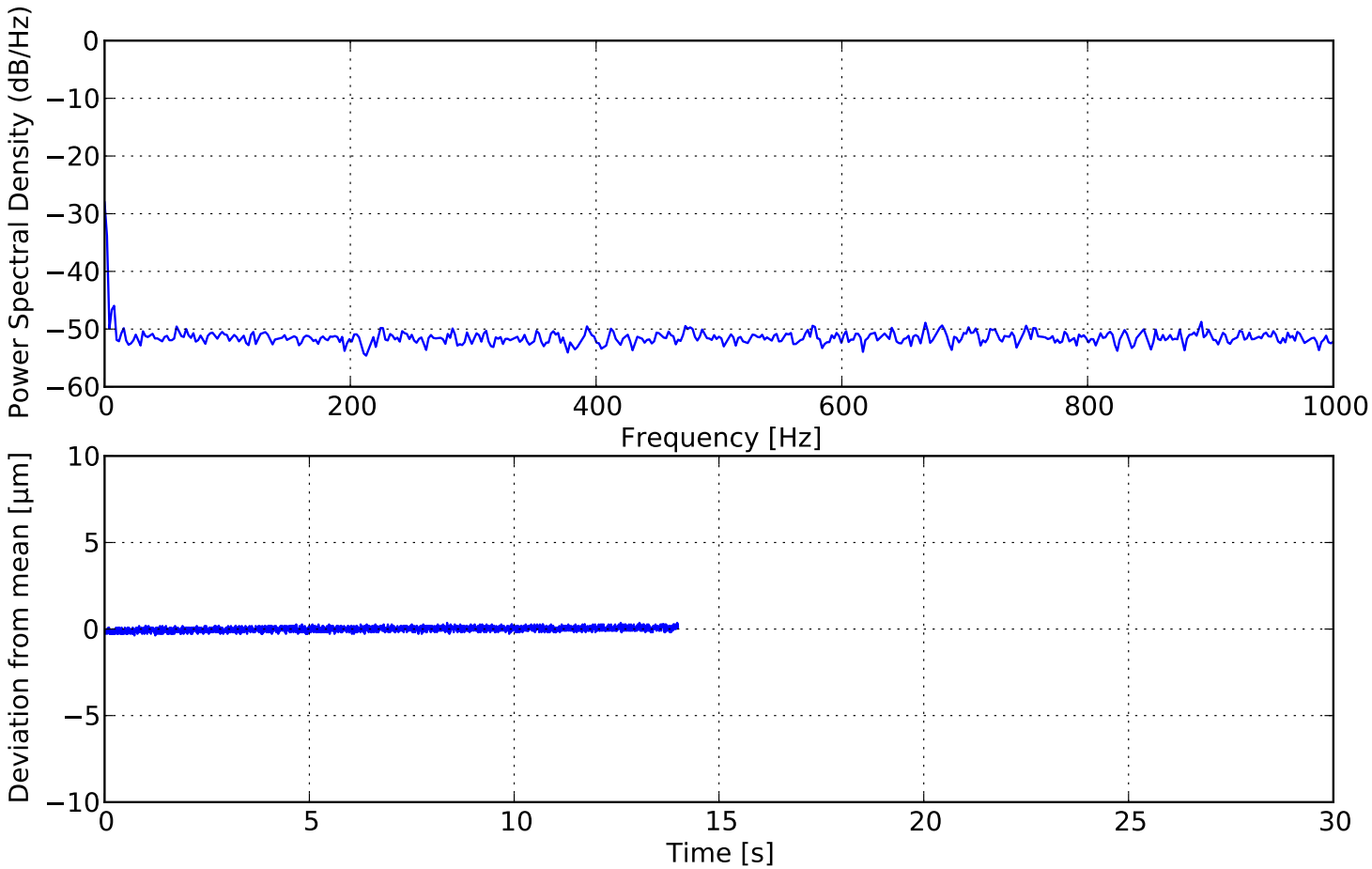
- airflow cooling seems to be feasible
- more detailed study needed (realistic geometry)

Thermal stability checked

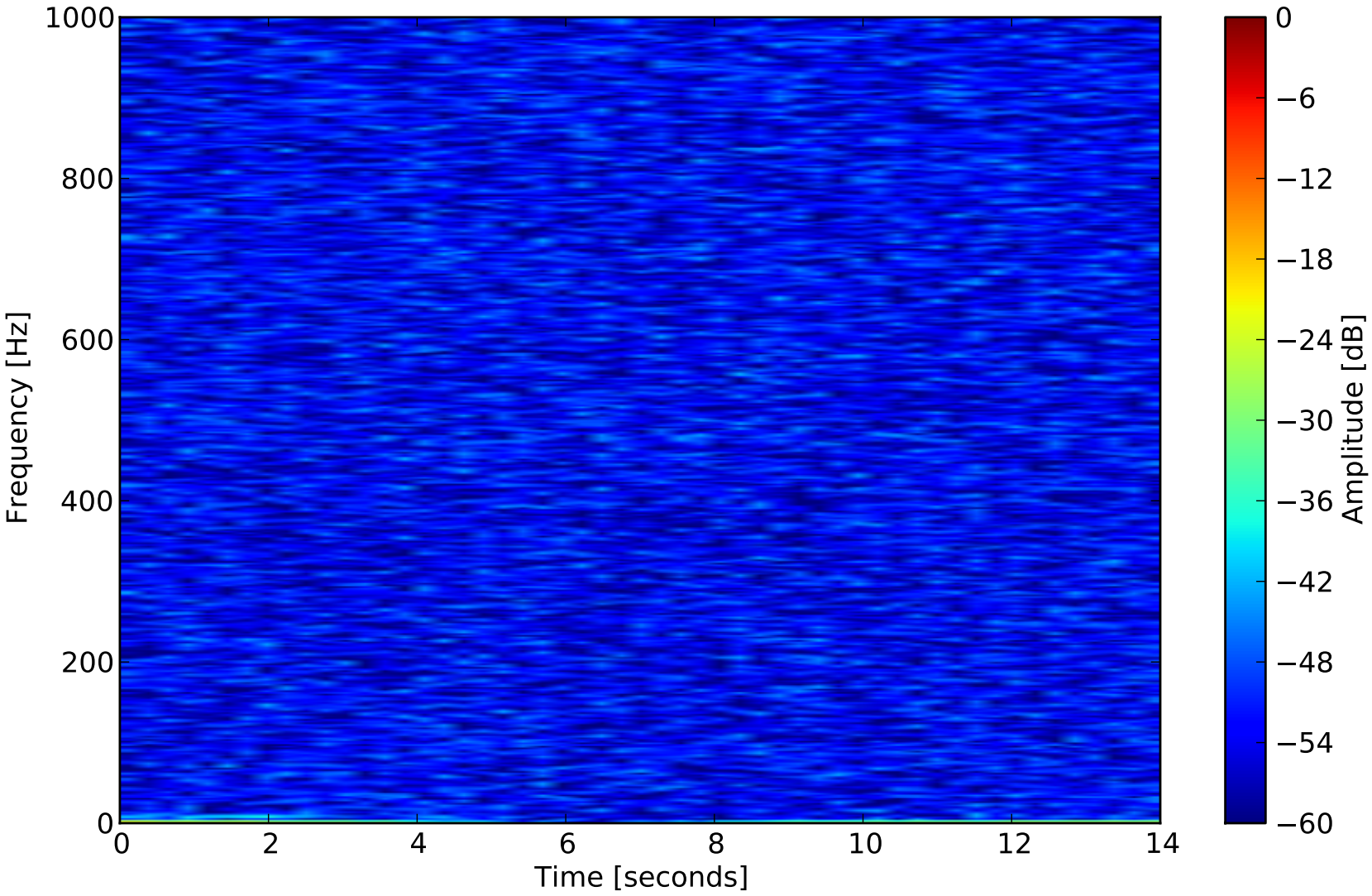
- screwed modules very stable
- further studies including heat-conductive paste

Thank you
for your attention

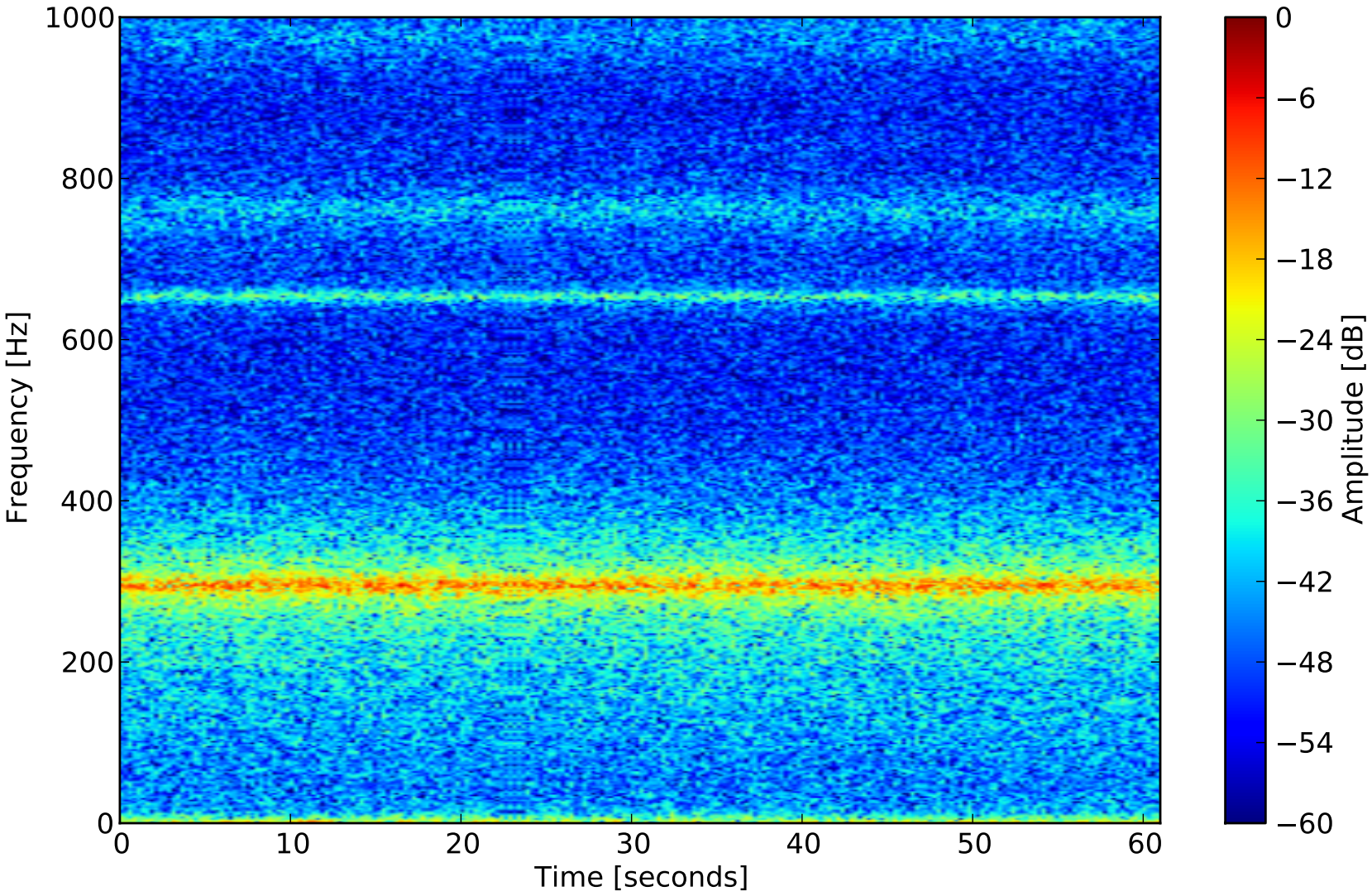
Vibrations, no Airflow



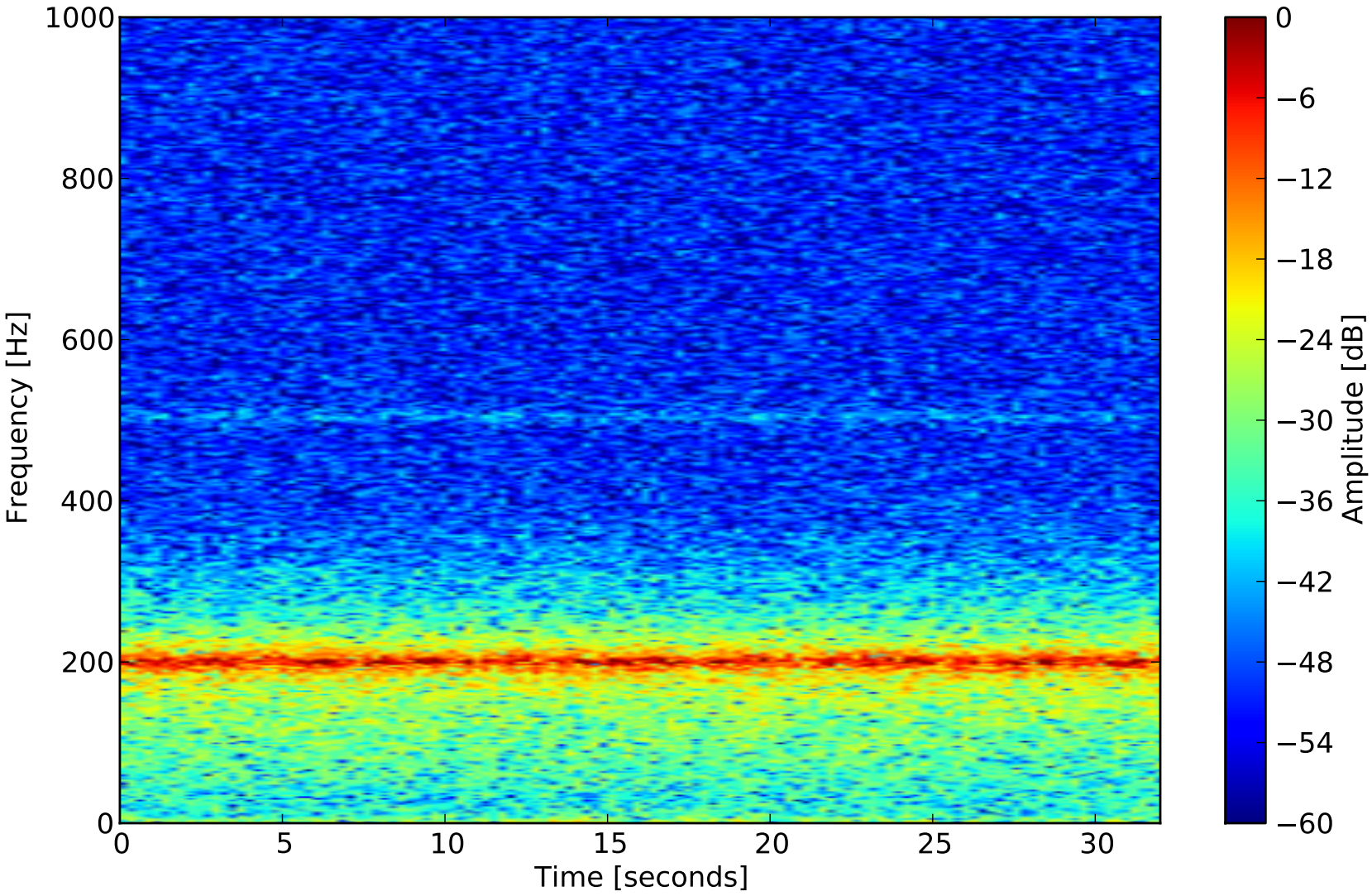
Spectrogram, no Airflow



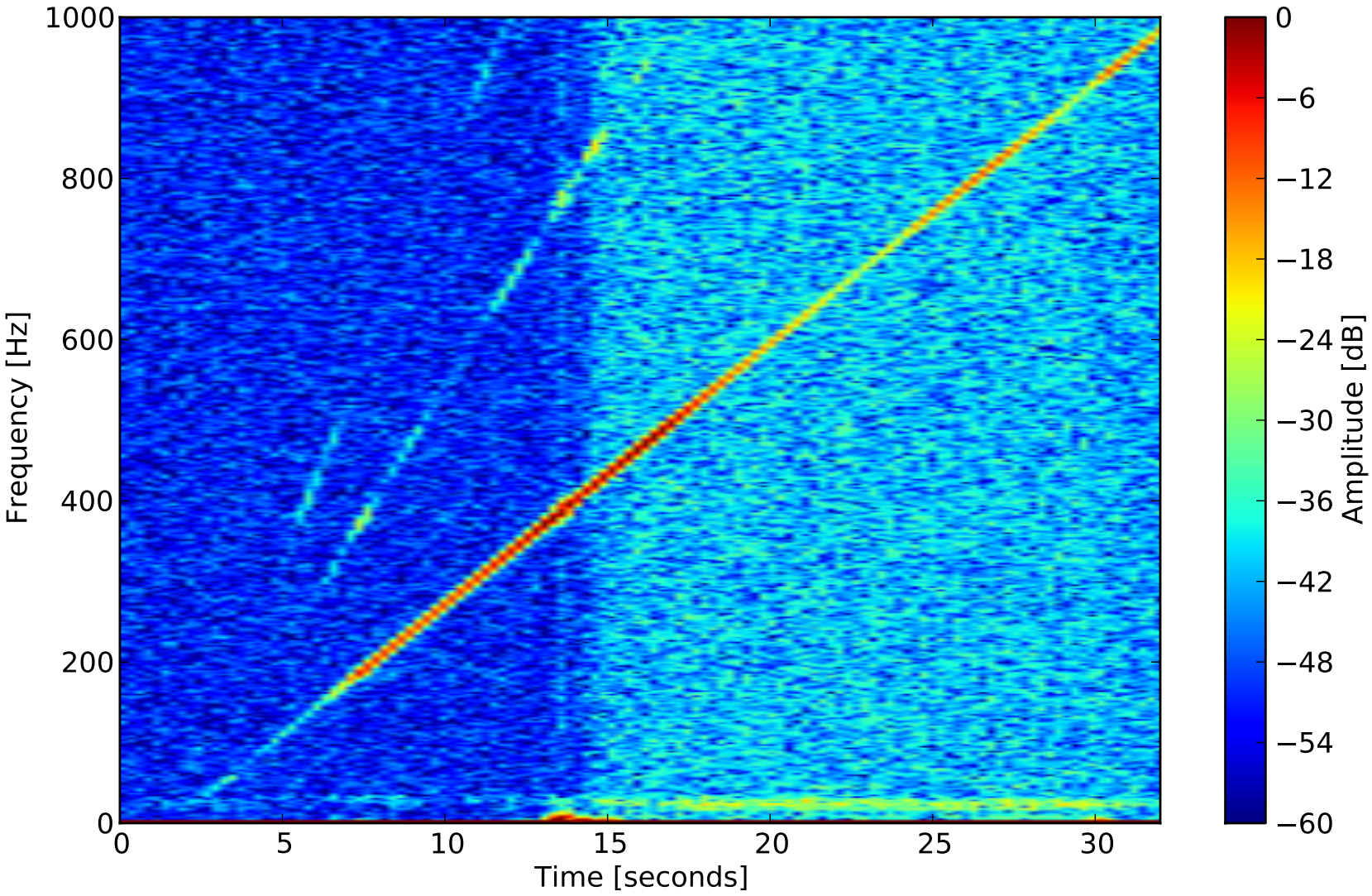
Spectrogram, Inner Module



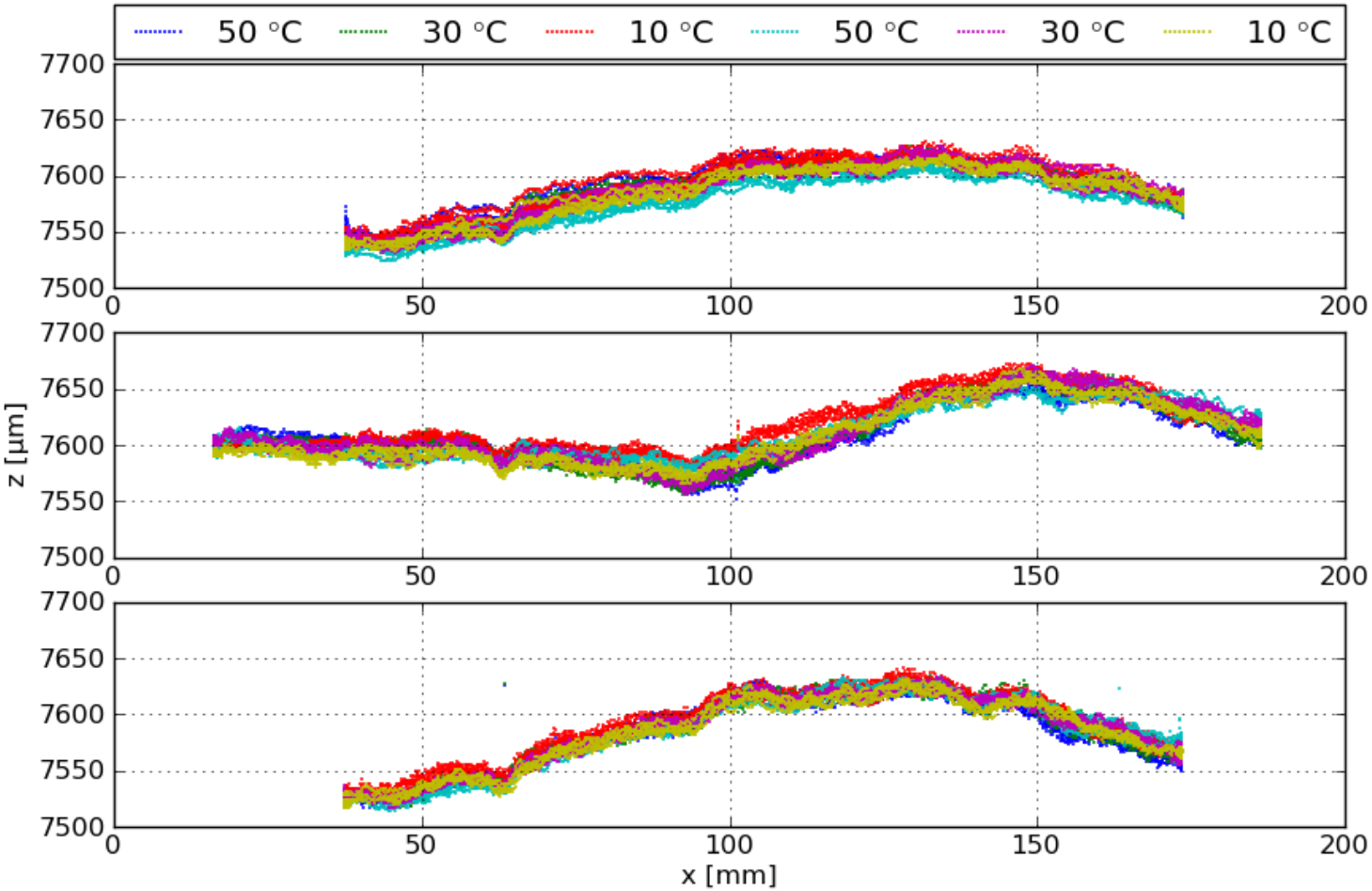
Spectrogram, Outer Module



Test Spectrogram using Sound sweep 20 - 1000 Hz

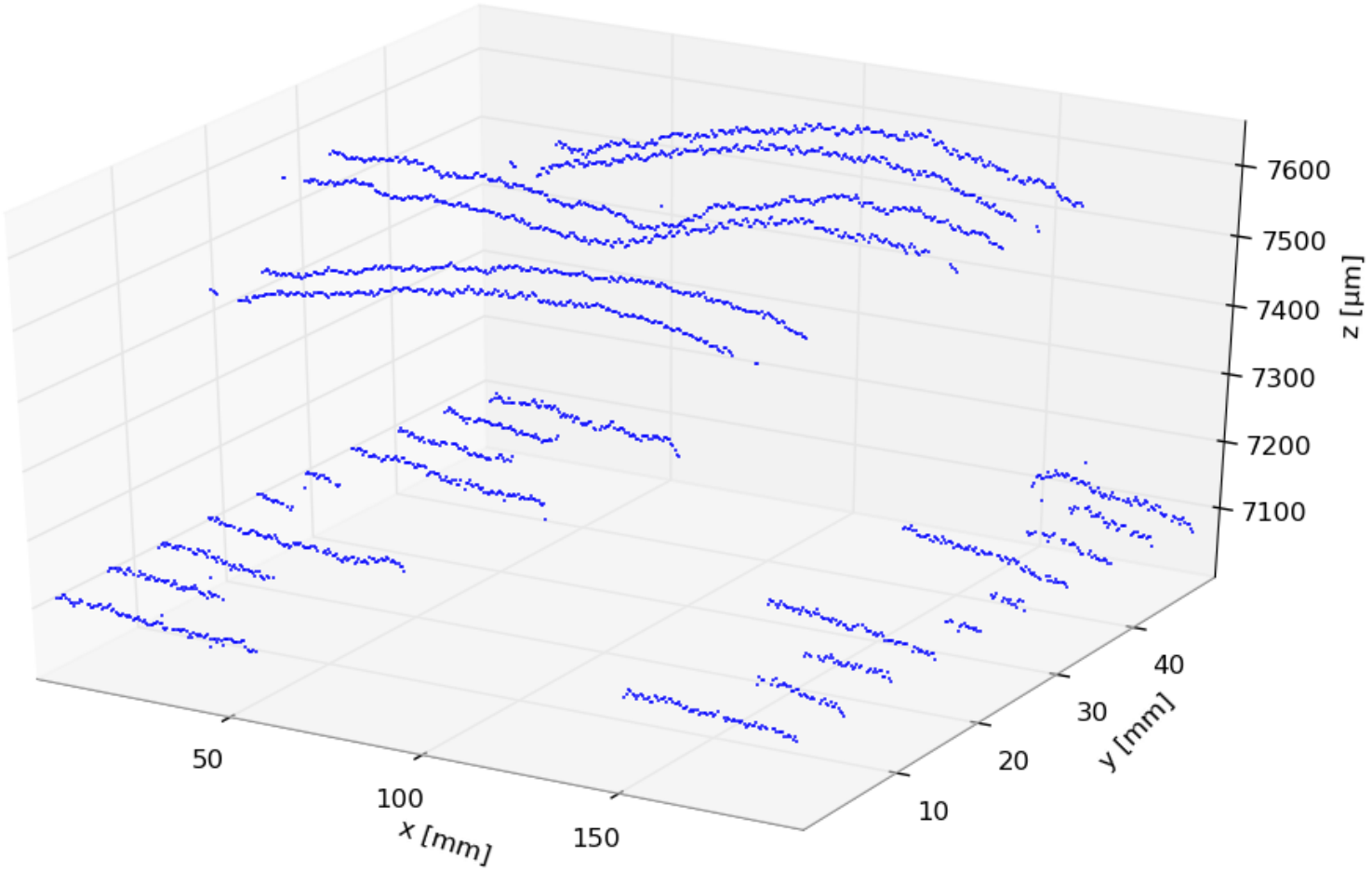


Repeatability of thermal tests



Results of two subsequent scans match nicely

Simple profiling of whole setup



Simple profiling of whole setup (XZ Projection)