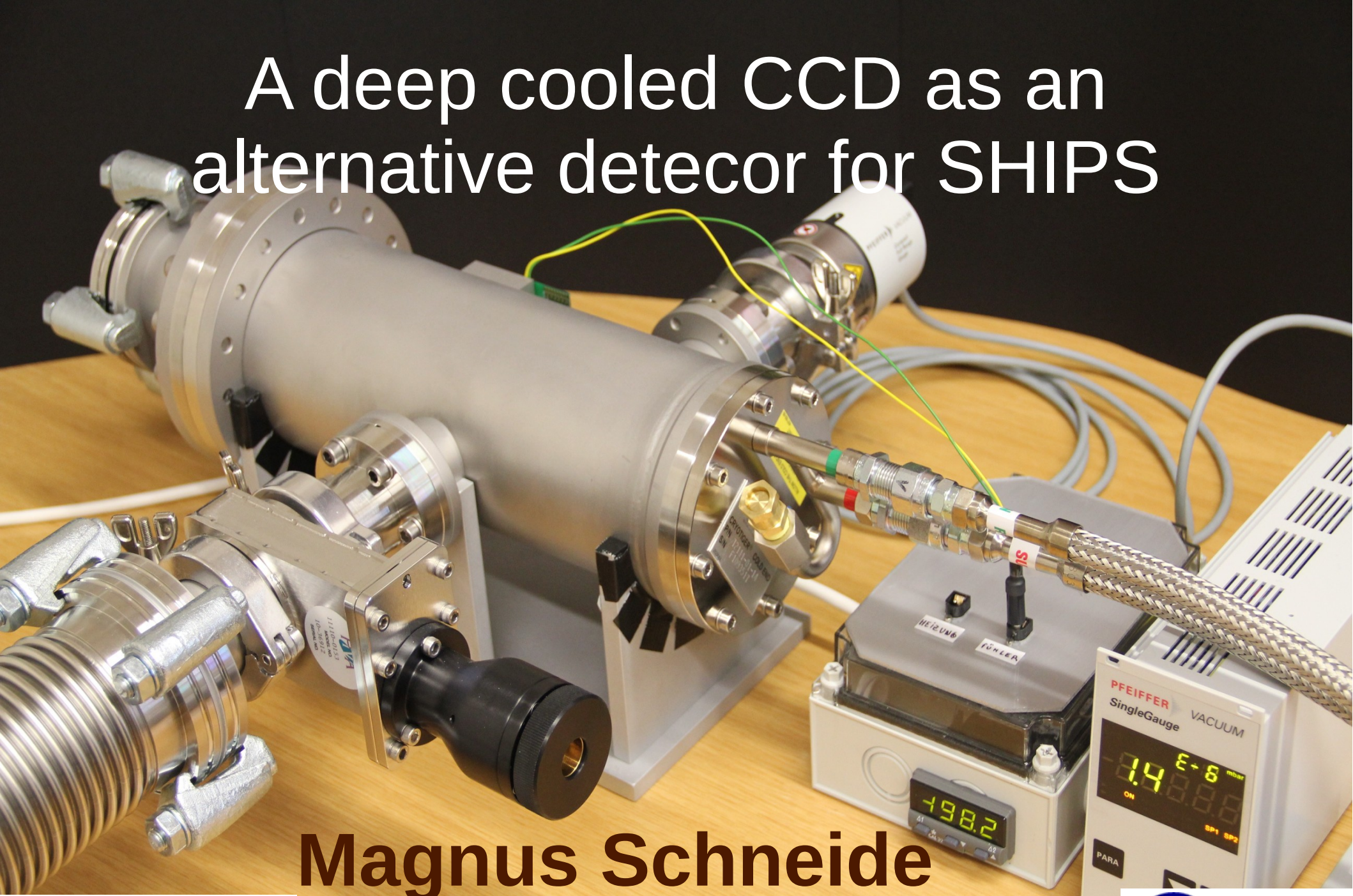
A deep cooled CCD as an alternative detecor for SHIPS



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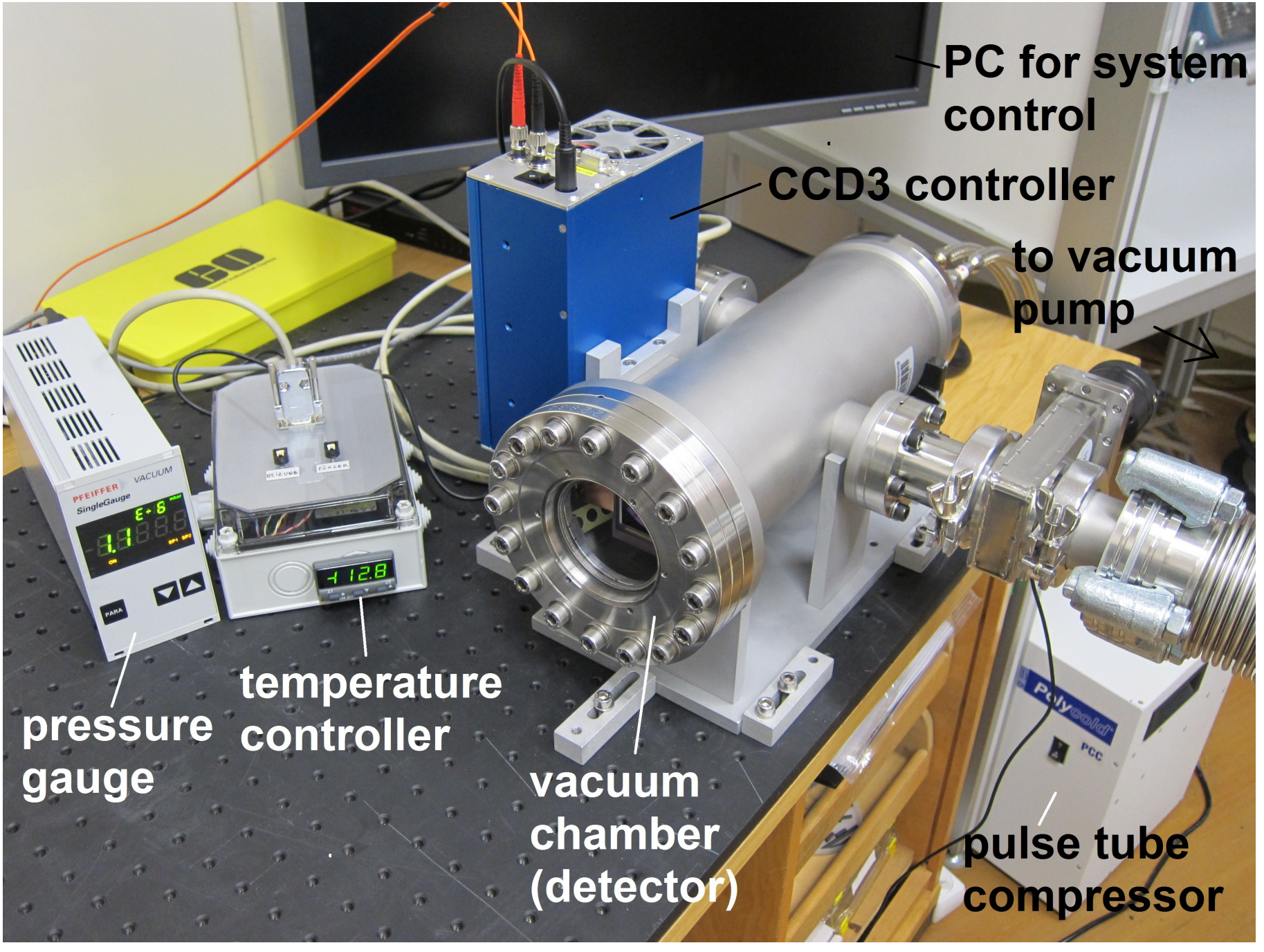
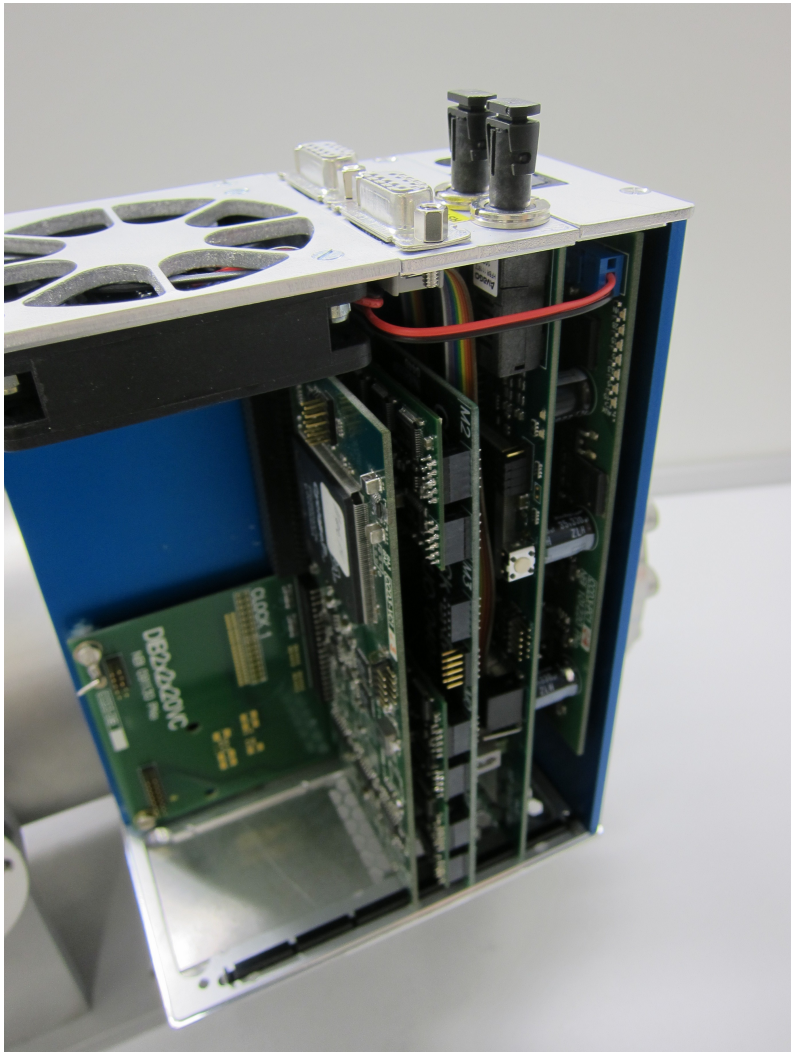
DER FORSCHUNG | DER LEHRE | DER BILDUNG

hamburger sternwarte

The detector system



The CCD3 controller



- Developed and manufactured by the Niels Bohr Institute of the University of Copenhagen
- 3rd generation CCD controller

The CCD3 controller

- Max. readout rate 100 Mhz
- Digitization 15 to 20 bit
- Read out noise < 1 e^-
- „Programmable“ FPGA

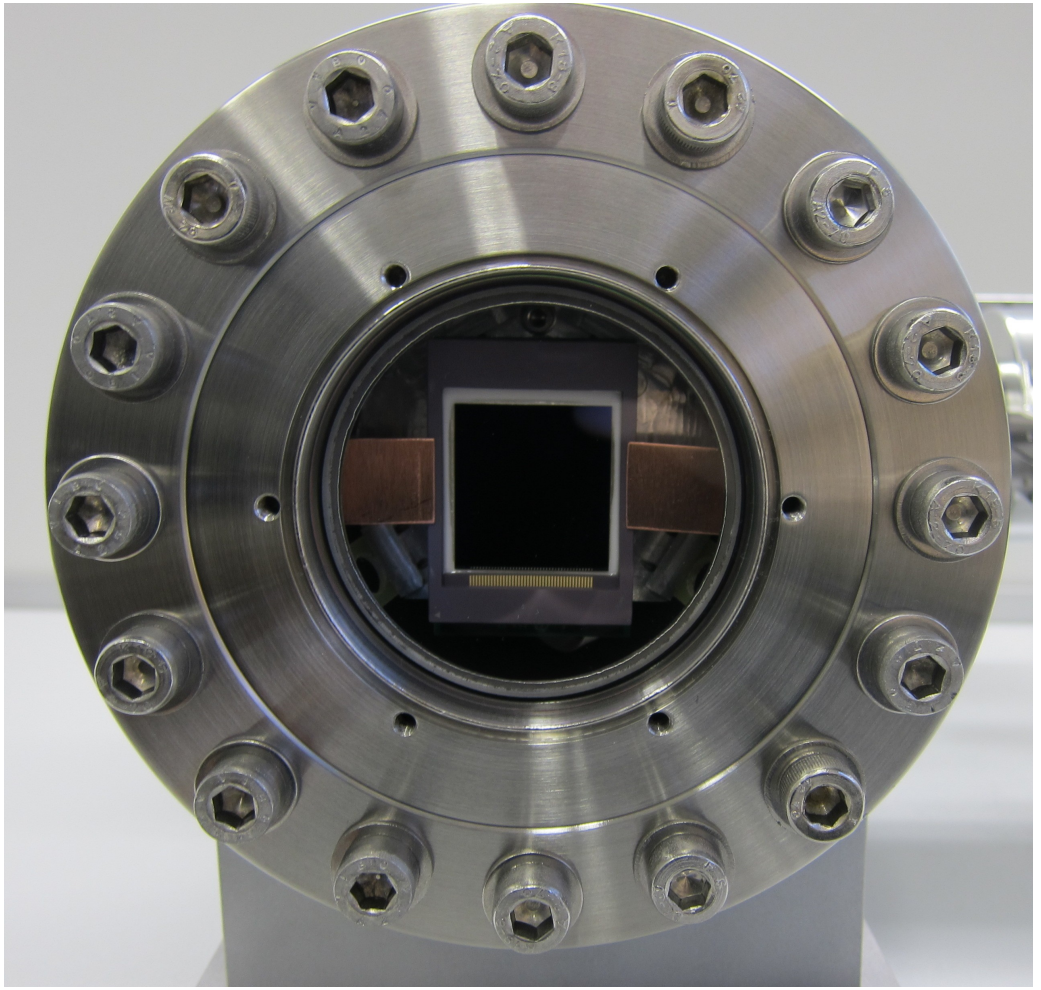
  (digital filtering / windowing)

- Can be customized for any CCD and optimized for each application!

SHIPS requirements

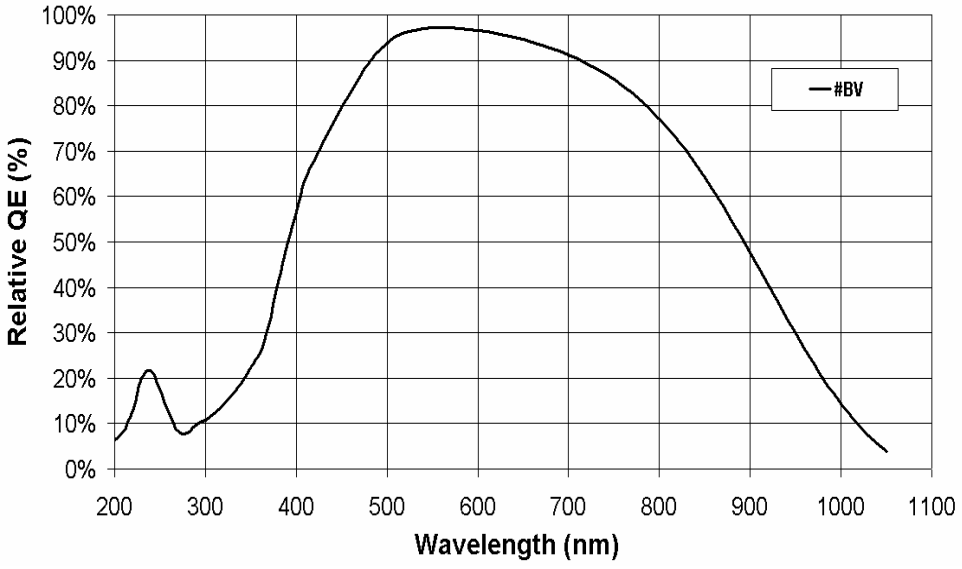
- Very low Dark current
  → longtime exposures
  → Read out noise < 1 e^-
- High Quantum efficiency
  → up to 90/95 % and more
- Very low Read out noise
  → Goal < 1 e^-

The CCD

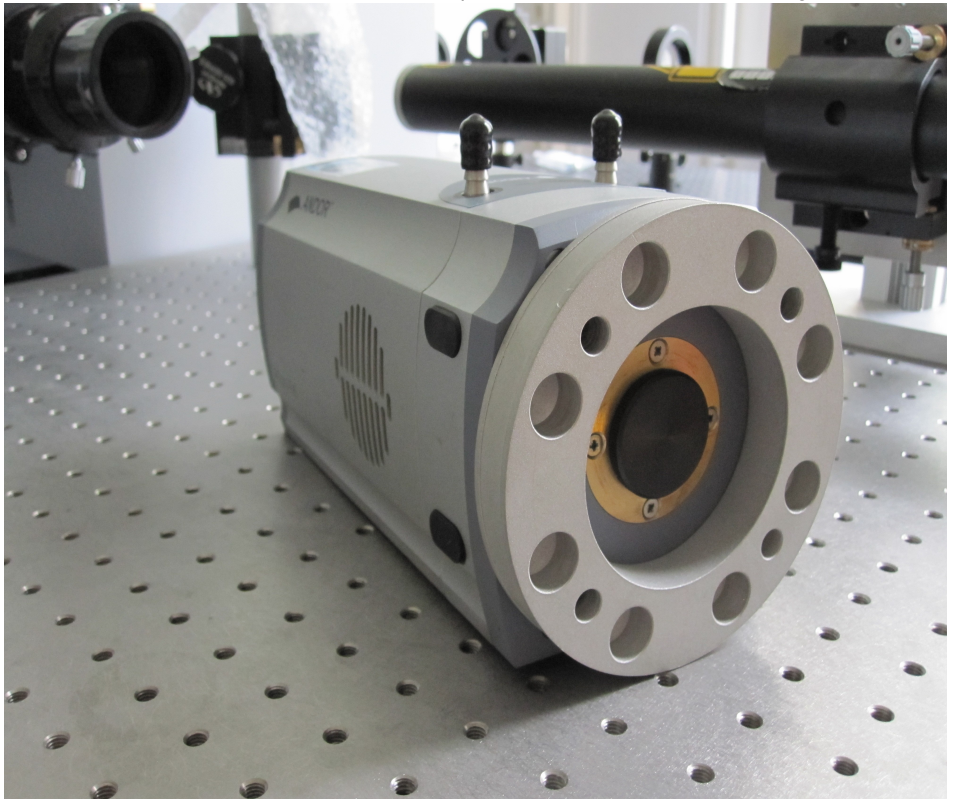


- E2V 42-40
- 2048x2048 pixel
- 13.5 µm / pixel
- Up to over 90% QE
- Back illuminated
- Very low noise output amplifiers
- DC @ -120 °C
  < 1 e^-

Andor iKon-M



i.s.: http://www.andor.com/ProductDetail.aspx?ProductID=75&SeriesId=75&Page=camera



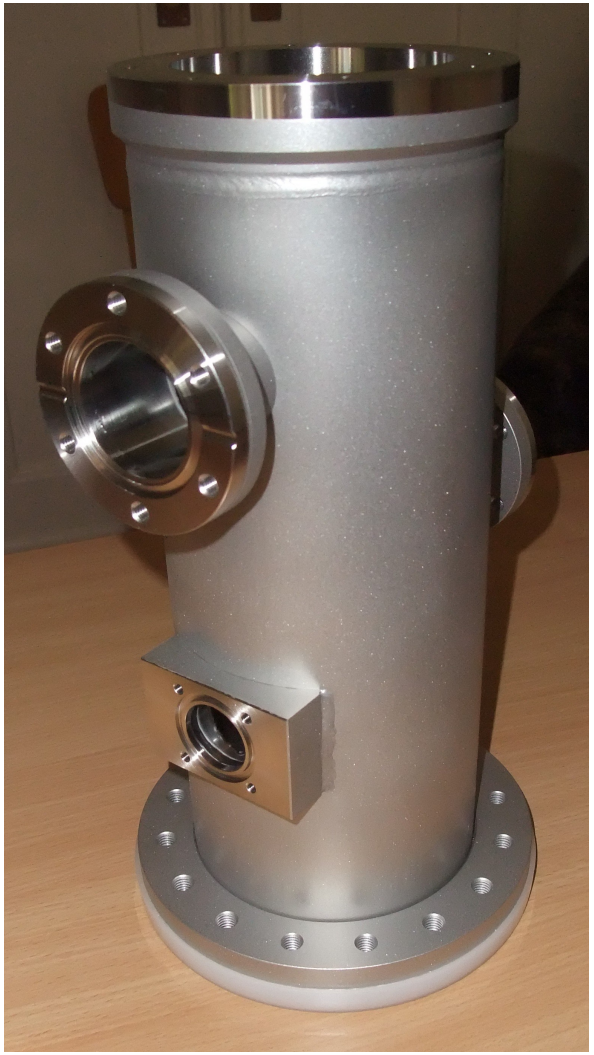
- e2V 47-10 AIMO back illuminated CCD
- Low Noise Output Amplifiers
- Read out noise about 3 e^- (5 kHz)
- 1024 x 1024 pixels
- 13 μm each pixel
- Up to over 95% QE
- Digitization 16 bit
- Air cooling up to -80°C
- Water cooling up to -100°C

Matthias Schwarz

Operating requirements

- P < 10^{-5} mbar
  - To avoid liquid N2 boiling
  - To avoid molecules to grow on the CCD
- T < -100°C
  - Cold surface pumping
  - Getting rid of the vacuum pump

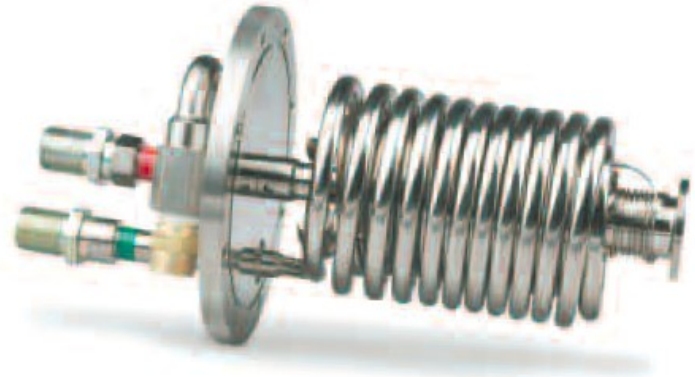
The vacuum chamber



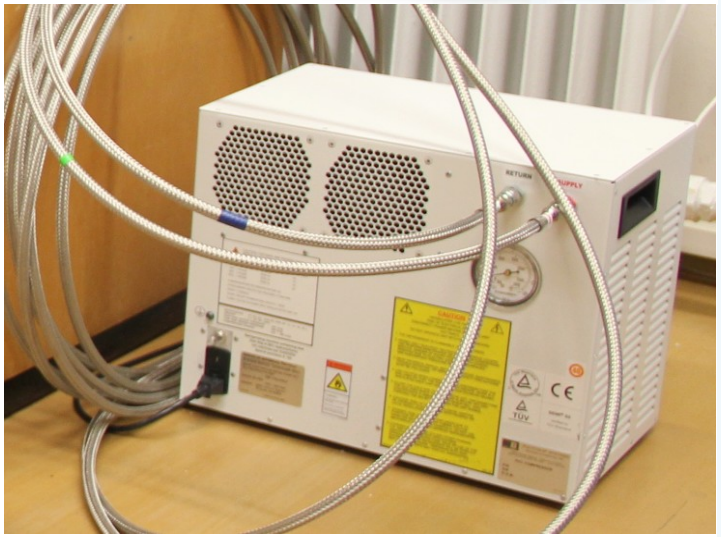
- DN 100 tube
- Cold end flange (top)
- DN 100 CF flange for window (bottom)
- Special flange for CCD3 controller (front bottom)
- 2 DN 40 CF flanges

  (i.e. for vacuum pump)

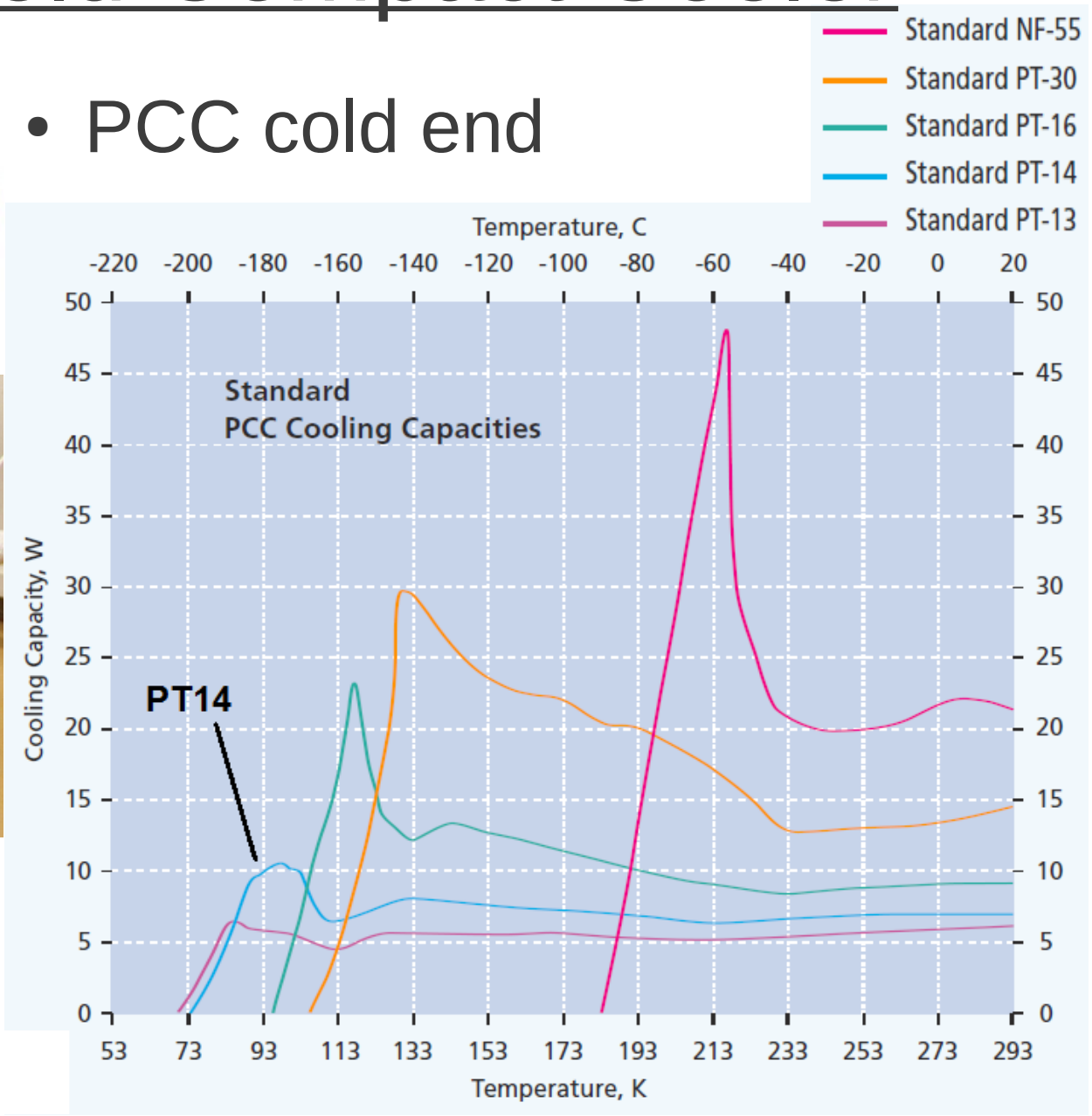
The Polycold Compact Cooler



- PCC cold end

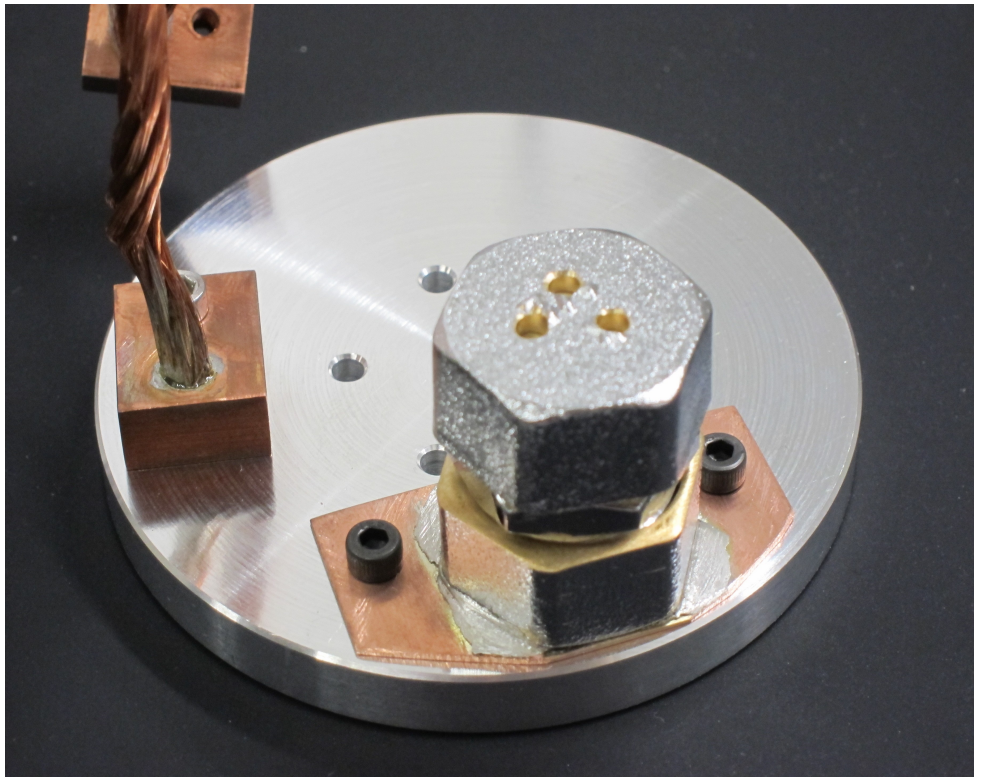


- Pulse tube compressor



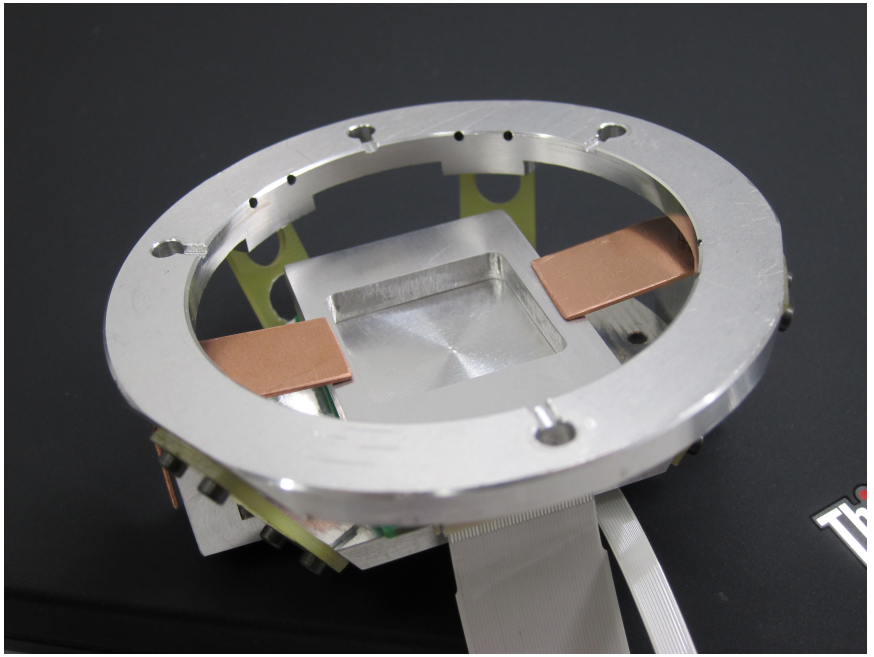
www.ferrotec-europe.de

Inside the vacuum chamber

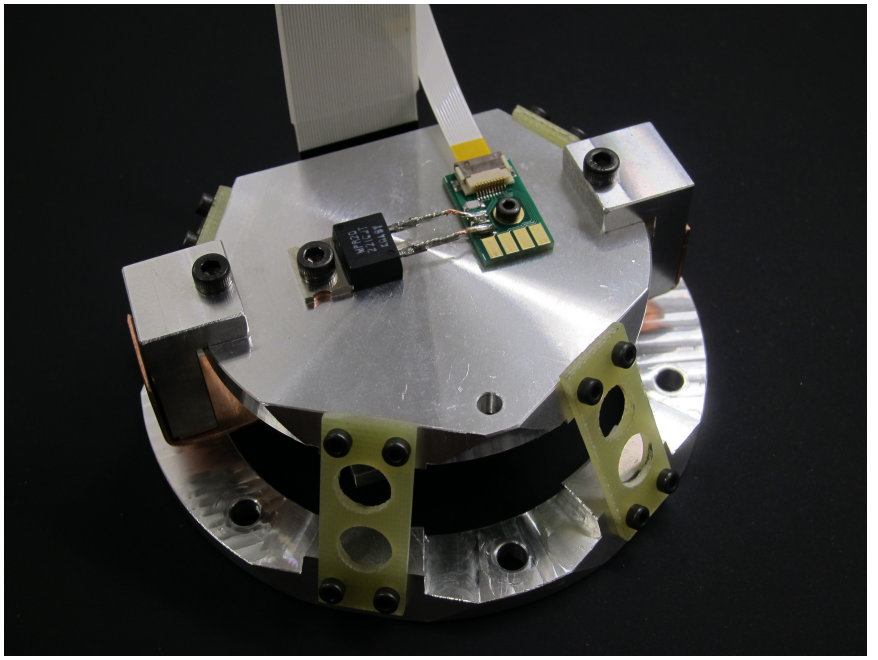


- Cold reservoir on the PCC cold end
- Charcoal container
- Coldfinger (heat transport from CCD to PCC)

Inside the vacuum chamber

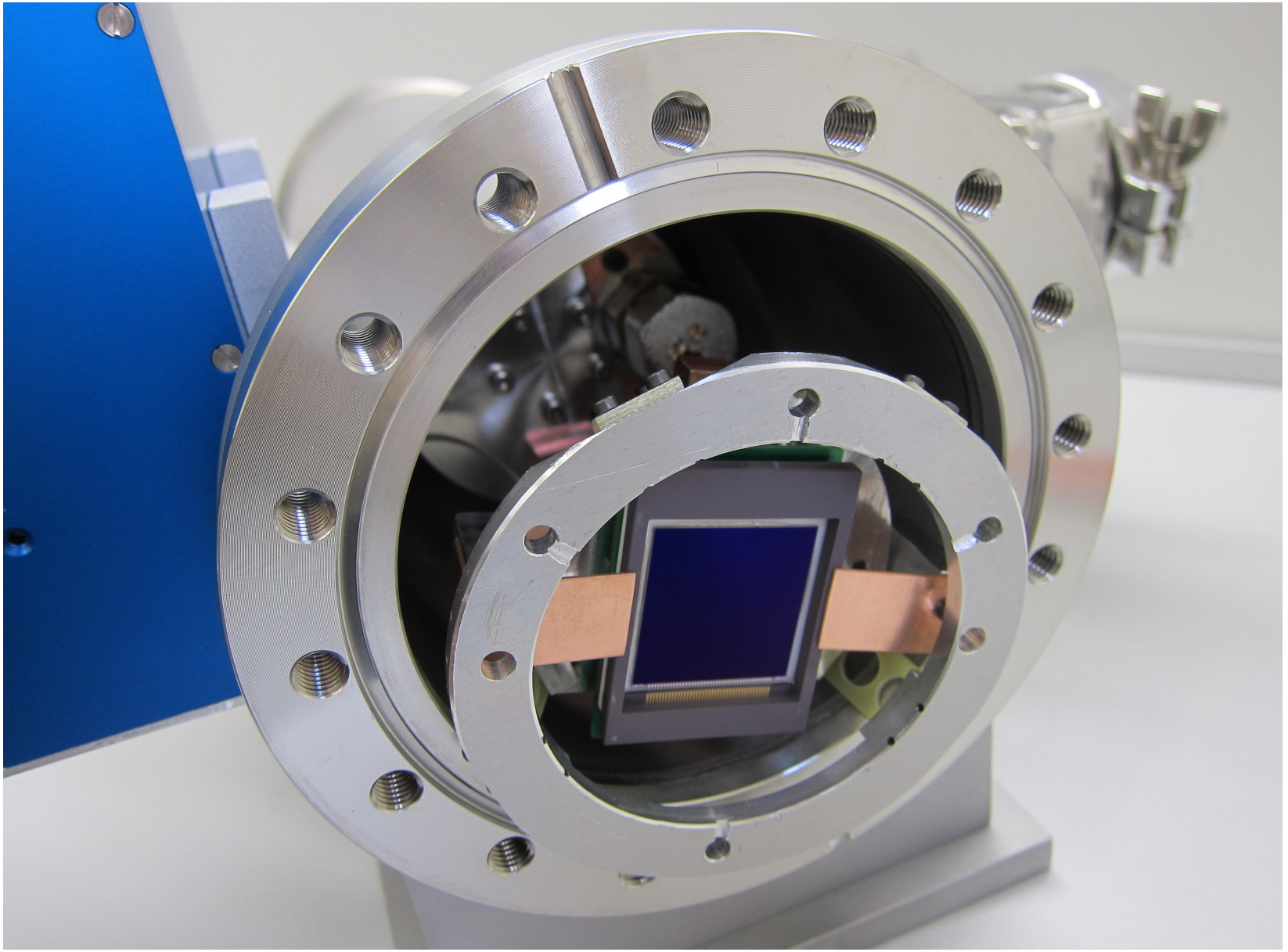


- CCD cold reservoir with mounted CCD dummy

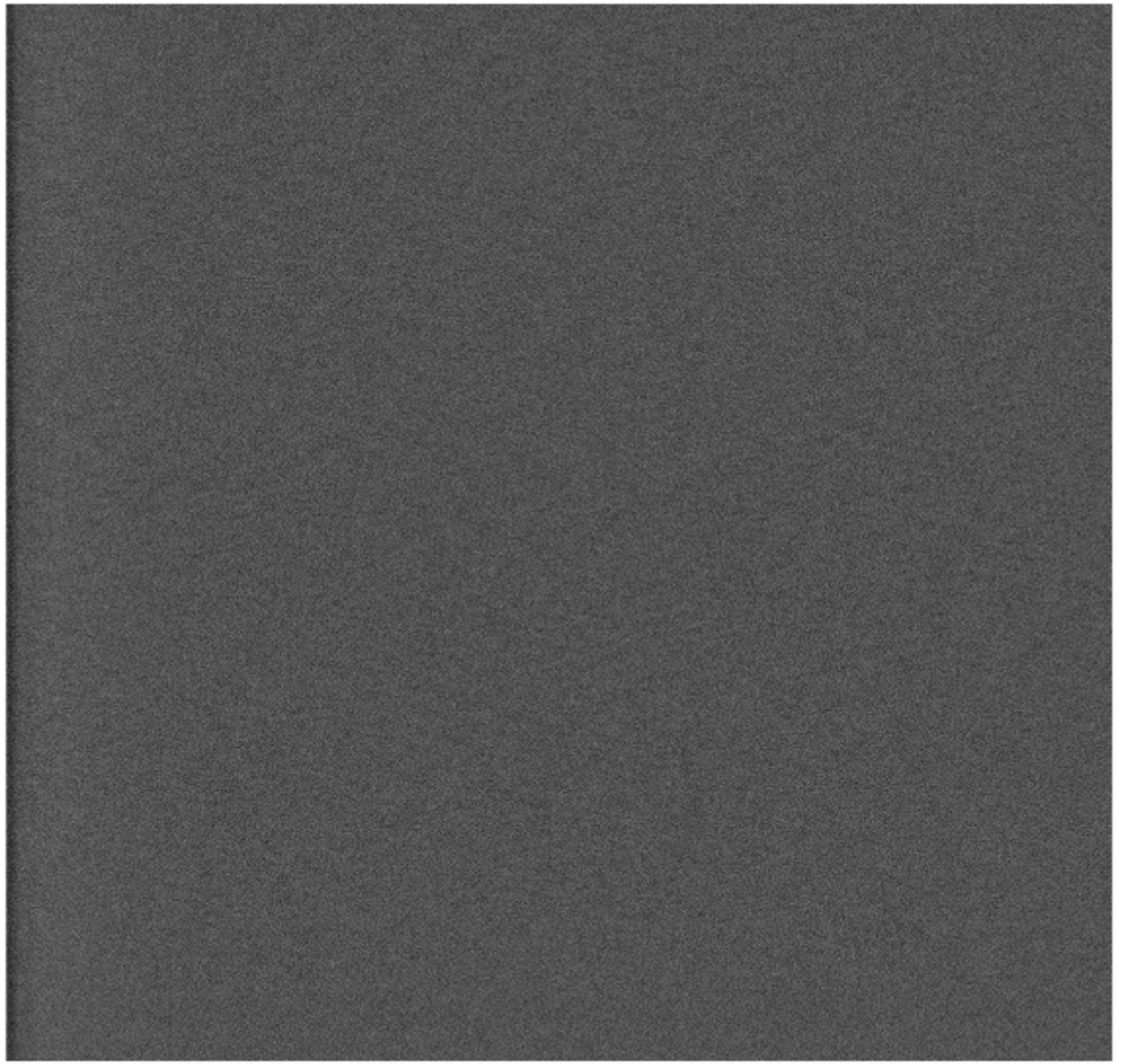


- Temperature sensor and heater at the bottom of the CCD cold reservoir

Inside the vacuum chamber



The first (bias) test image



- T = -120°C
- Non optimized default setup
- No visible defects on the CCD

Conclusions

- The detector system works!
- Optimization of the heat transport to reach lower temperatures is in progress.
- Next step: Optimizing the CCD3 controller for different applications with the CCD 42-40.
- First astronomical (astroparticle) imaging tests will follow soon during optimization period!

...for any further questions, please contact:

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