NIRPS Backend Cryostat/Optomechanics

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Summary

- SPIROU cryostat
- Design Concepts
- Assumptions
- Lessons learned

Basics

- **Inspired by HARPS**
- **Extended to:**
  - NIR
  - 80K
- **Literature search**
  - Thermal measurement and control
  - Studied systems with microK level measurement and control
  - Find issues (eg Lakeshore metrology systems have documented dependence on electronics air temperature)
- **Selection of thermal control**
  - Methodology
  - Hardware

Assumptions

Ensure that we simplify what has to be monitored/controlled

- **No 'adjustments'**
  - Hard bolted or bonded at all material interfaces
  - Minimises chances of any physical changes
  - NO mechanisms/changers/options
- **Simple**
  - Minimal components and joints
  - Mechanical decoupling
    - Flexures
    - U-joints
  - Thermally cohesive
    - All optical element mounts designed to remain at same relative heights
    - Aluminum is the default structure wrt bench/mounts
    - Invar etc utilized to compensate when necessary (eg parabola mount)
  - Optics are flexure bonded/supported to minimise joint stiction

→ Thermal changes dominate instabilities

Thermal Control Methodology

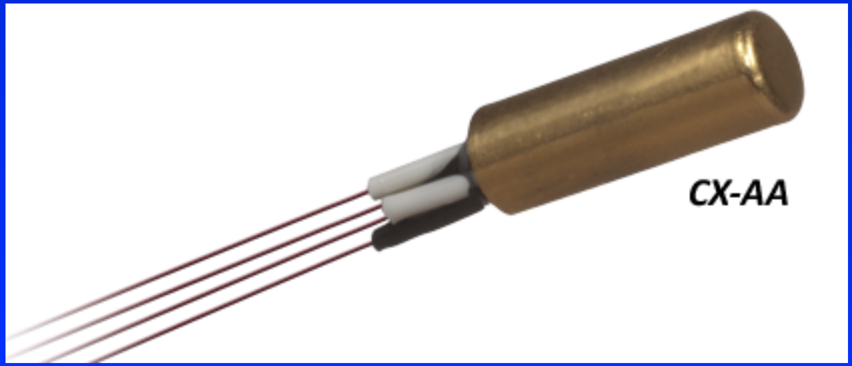
"With sufficient resolution in the control system, a well designed structure can be controlled to arbitrarily close to the measurement resolution"

- **Analysis of the optics/design and mechanical structure**

  → 1 to 2 mK stability level (24 hours)

- **Resolution of critical components << 1 mK (~0.02 mK)**
  - CERNOX® 4-wire sensors
  - Micro-K ® electronics for most critical components

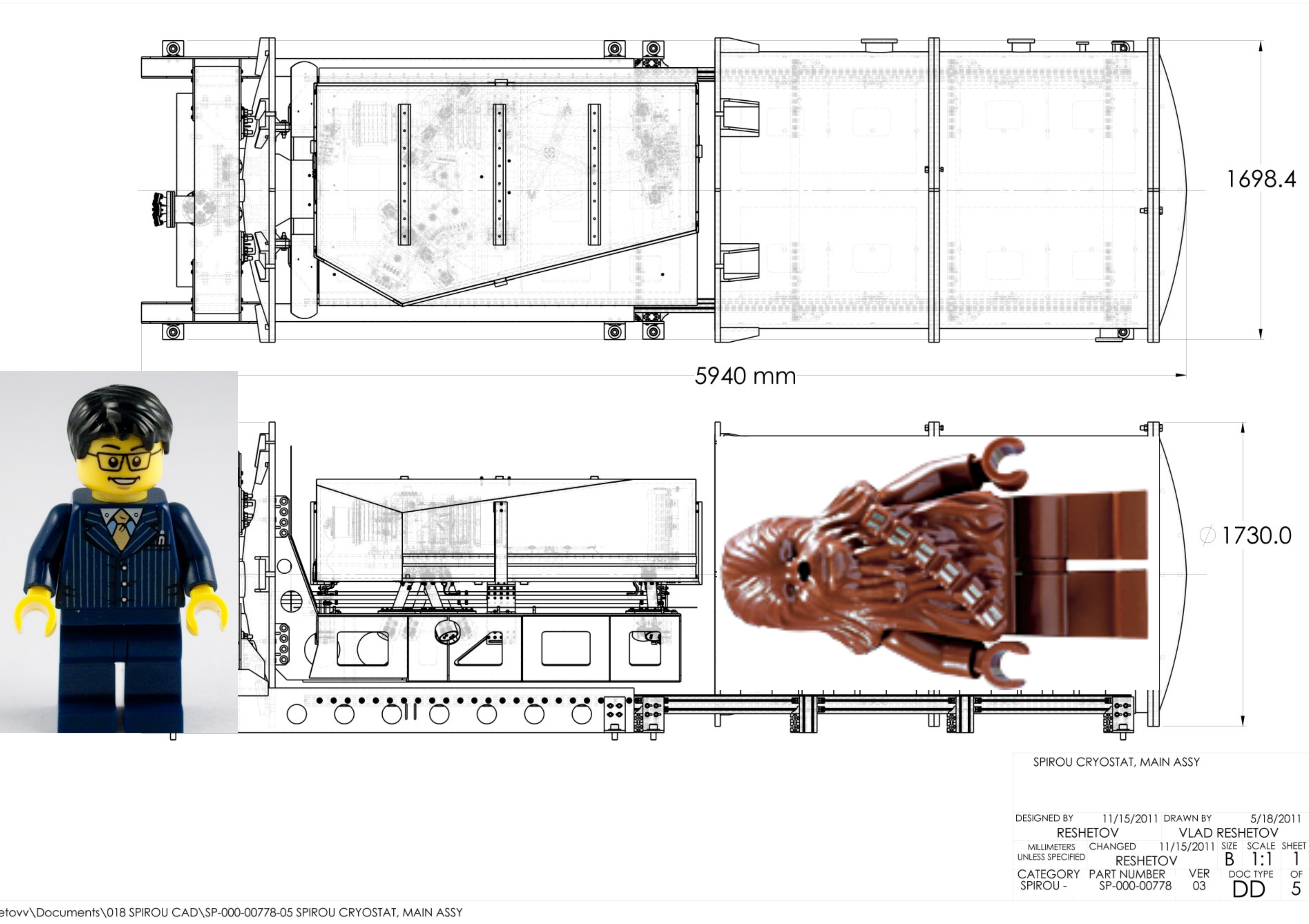
- **Precision of measurements << 1 mK (~0.1 mK) on time-scales of months**

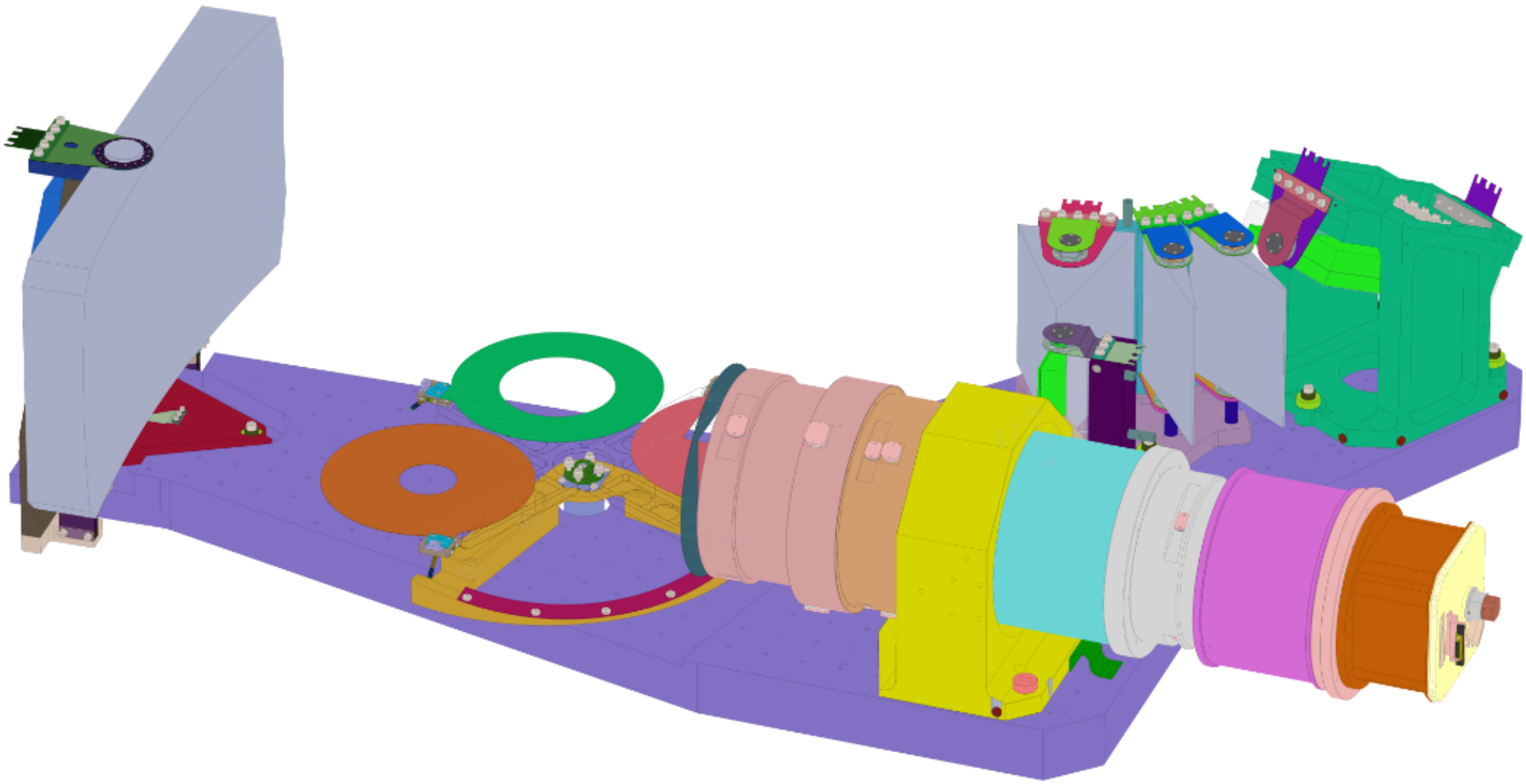


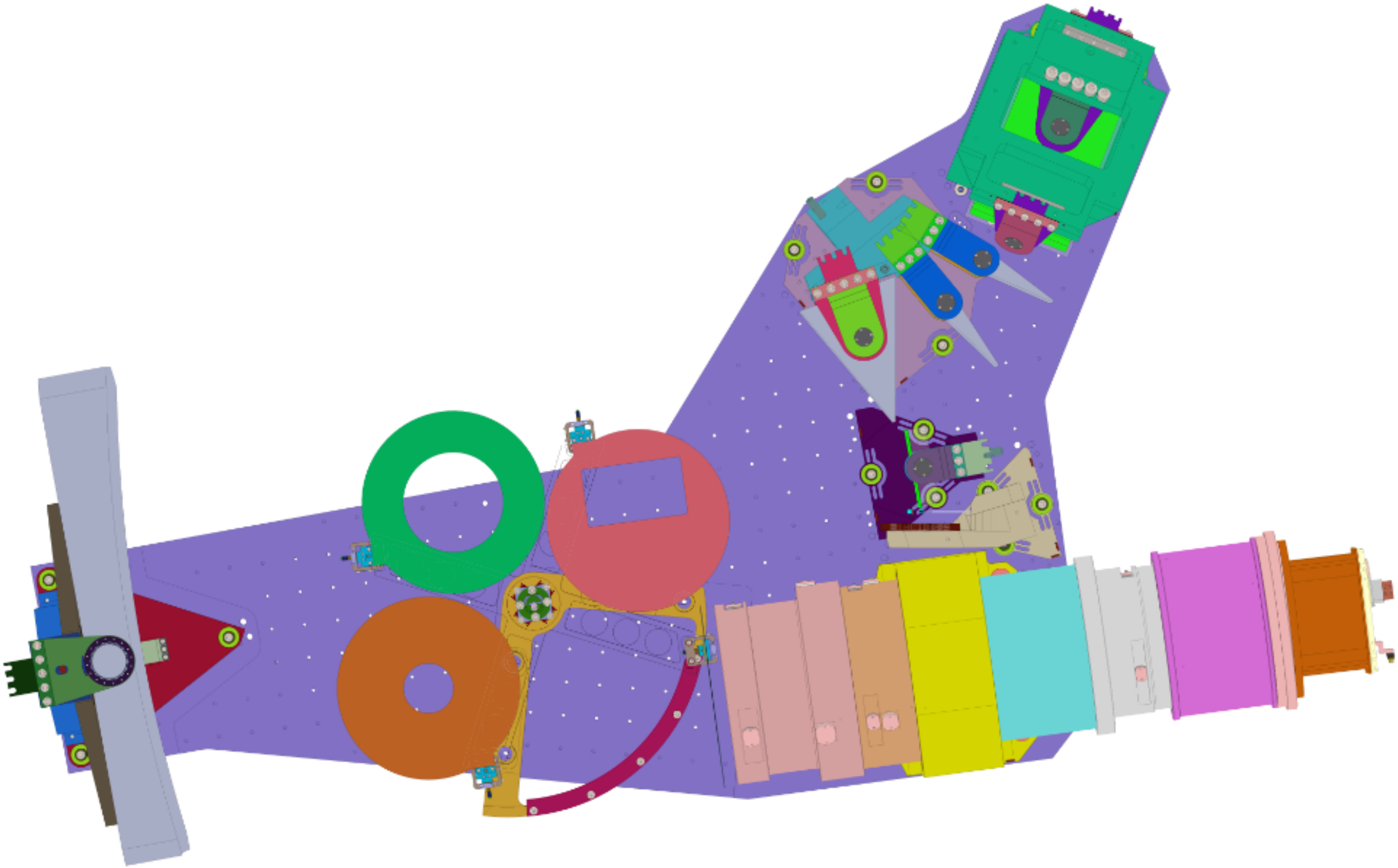
Thermal Control Methodology

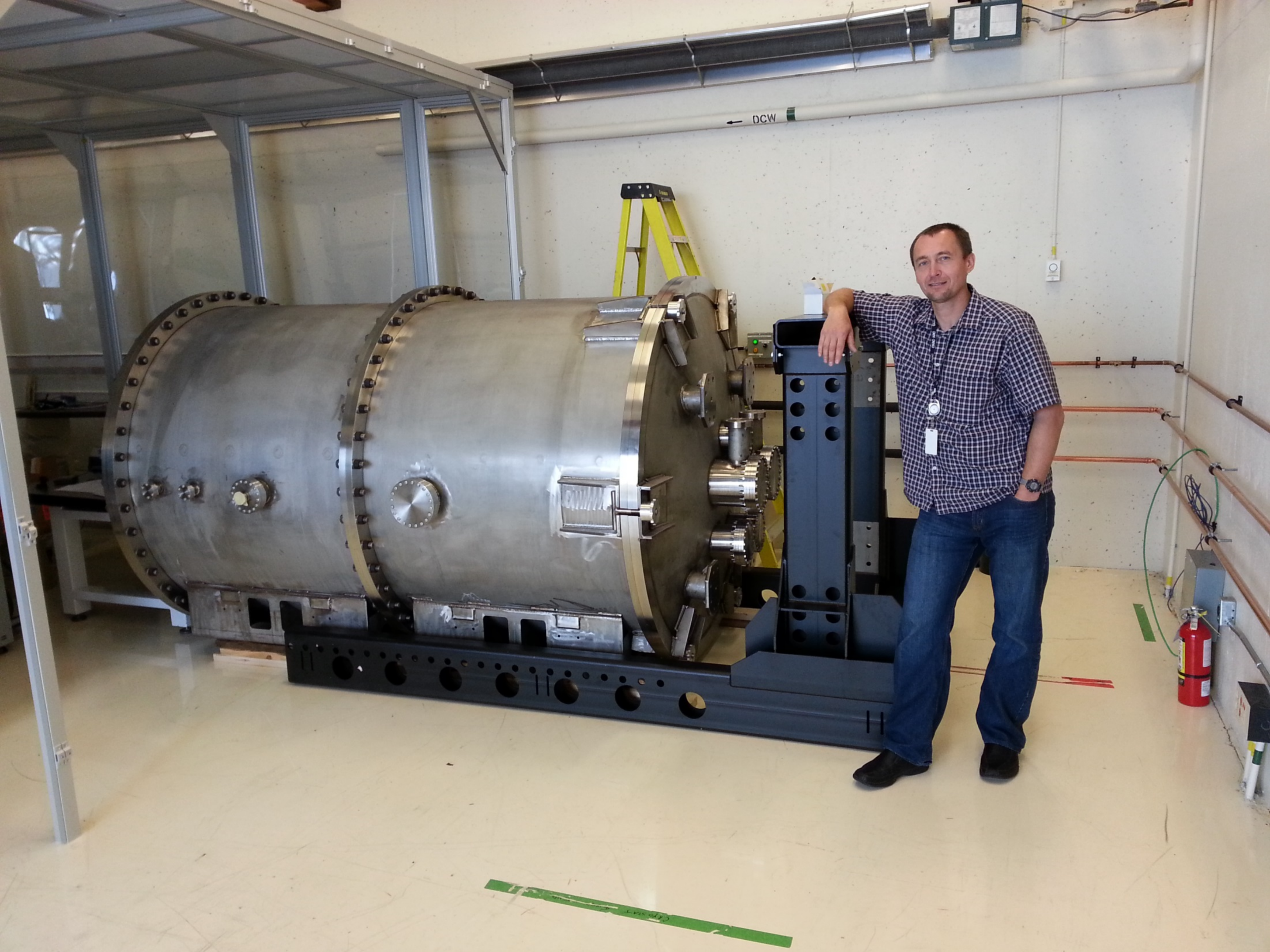
Layered approach

- Bench/shields
  - Supported on independent thermal isolation
  - Multiple radiation shielding
    - Optical bench/mounts: controlled to < 1 mK
    - Passive radiation shield
    - Active radiation shield: controlled to < 10 mK
    - Passive radiation shield
- Housing (cryostat)
  - Internal radiation shielding
  - External potential insulation (with optional heaters: ~0.1 C)
- Lots of measurement points
  - 12 at < 1mK (Micro-K)
  - 24 at 1mK (Lakeshore)

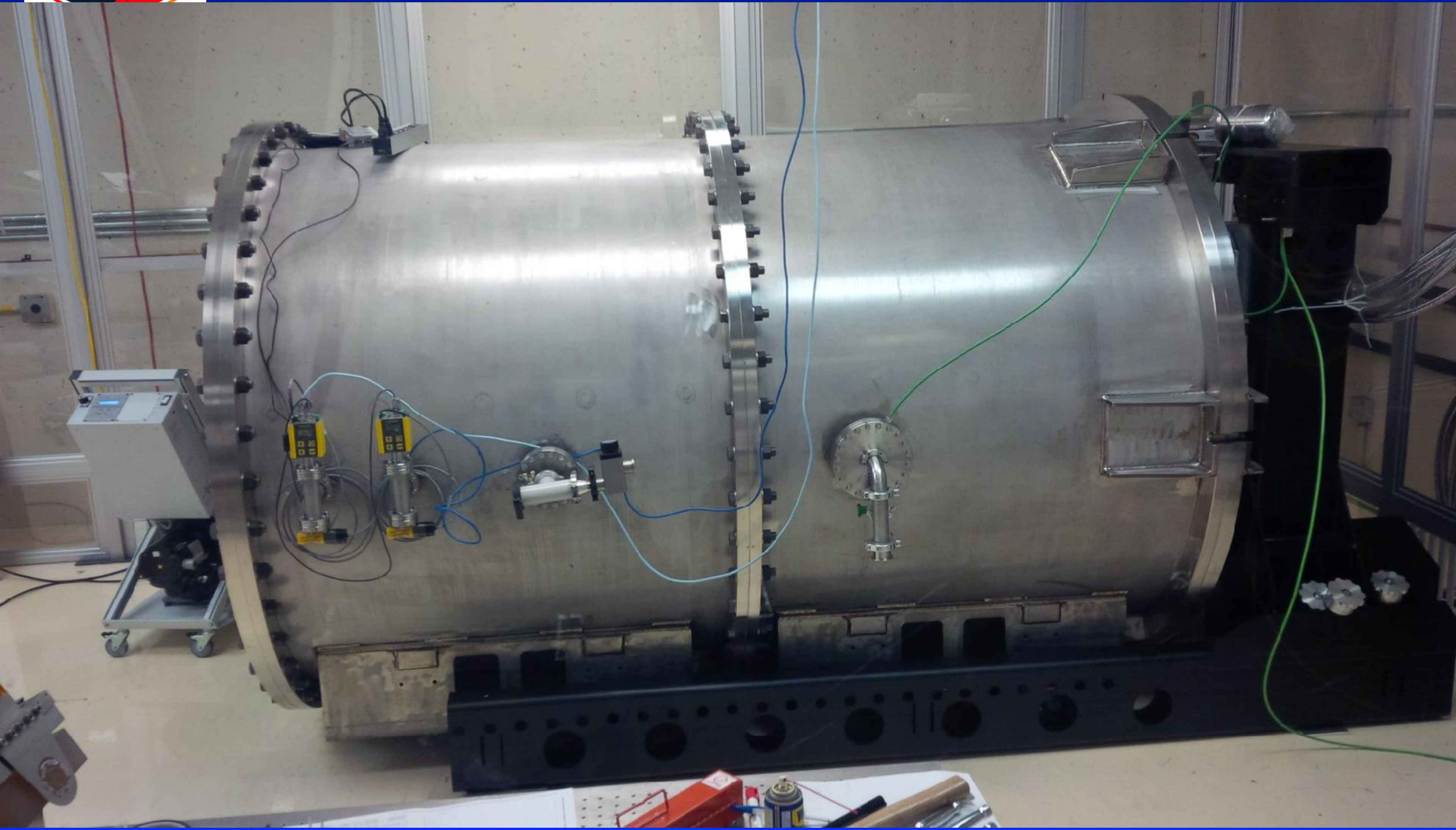

1698.4
5940 mm
∅ 1730.0
SPIROU CRYOSTAT, MAIN ASSY
DESIGNED BY 11/15/2011
RESHETOV
DRAWN BY 5/18/2011
VLAD RESHETOV
MILLIMETERS UNLESS SPECIFIED
CHANGED 11/15/2011
RESHETOV
SIZE B
SCALE 1:1
SHEET 1
CATEGORY SPIROU -
PART NUMBER SP-000-00778
VER 03
DOC TYPE DD
OF 5
etovv\Documents\018 SPIROU CAD\SP-000-00778-05 SPIROU CRYOSTAT, MAIN ASSY






DCW

NRC·CNRC Canada



Lessons (???)

- **Small, small, small**
  - I love the AO system
  - Keep the cryostat smaller
    - Less thermal mass to worry about
    - Easier to work on/transport etc
- **Simple**
  - Mounts
  - Control
  - operation
- **Choose wisely**
  - Quality components where it counts, such as the thermometry
  - Avoid temptation to try and be too complex (unless it turns out to be absolutely necessary)
  - Build early and test
  - Add incrementally as/if necessary