What is an Integrated Detector Assembly?

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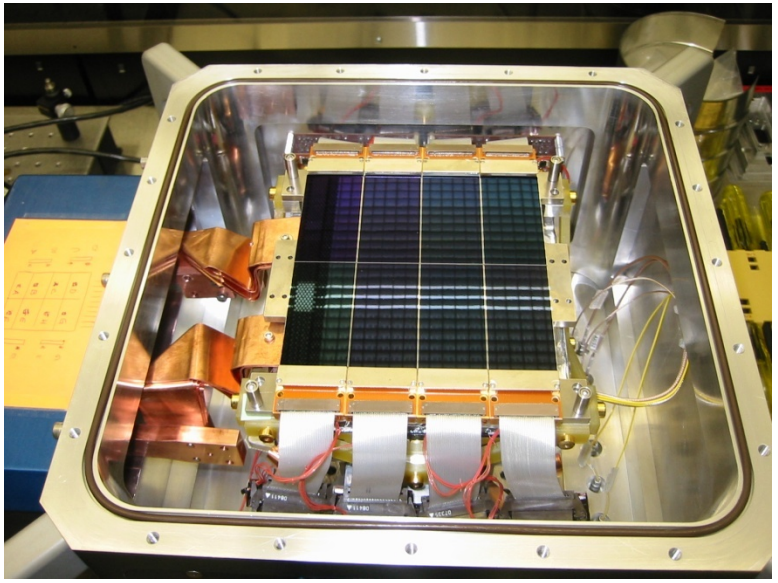
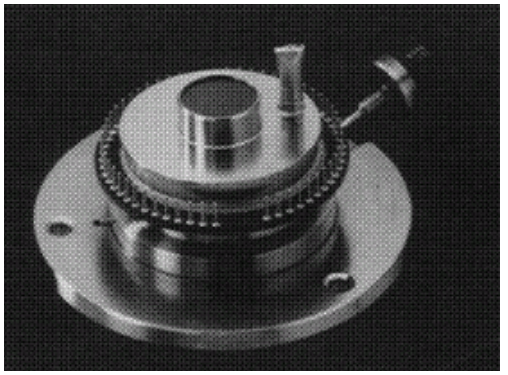
Various IDA's



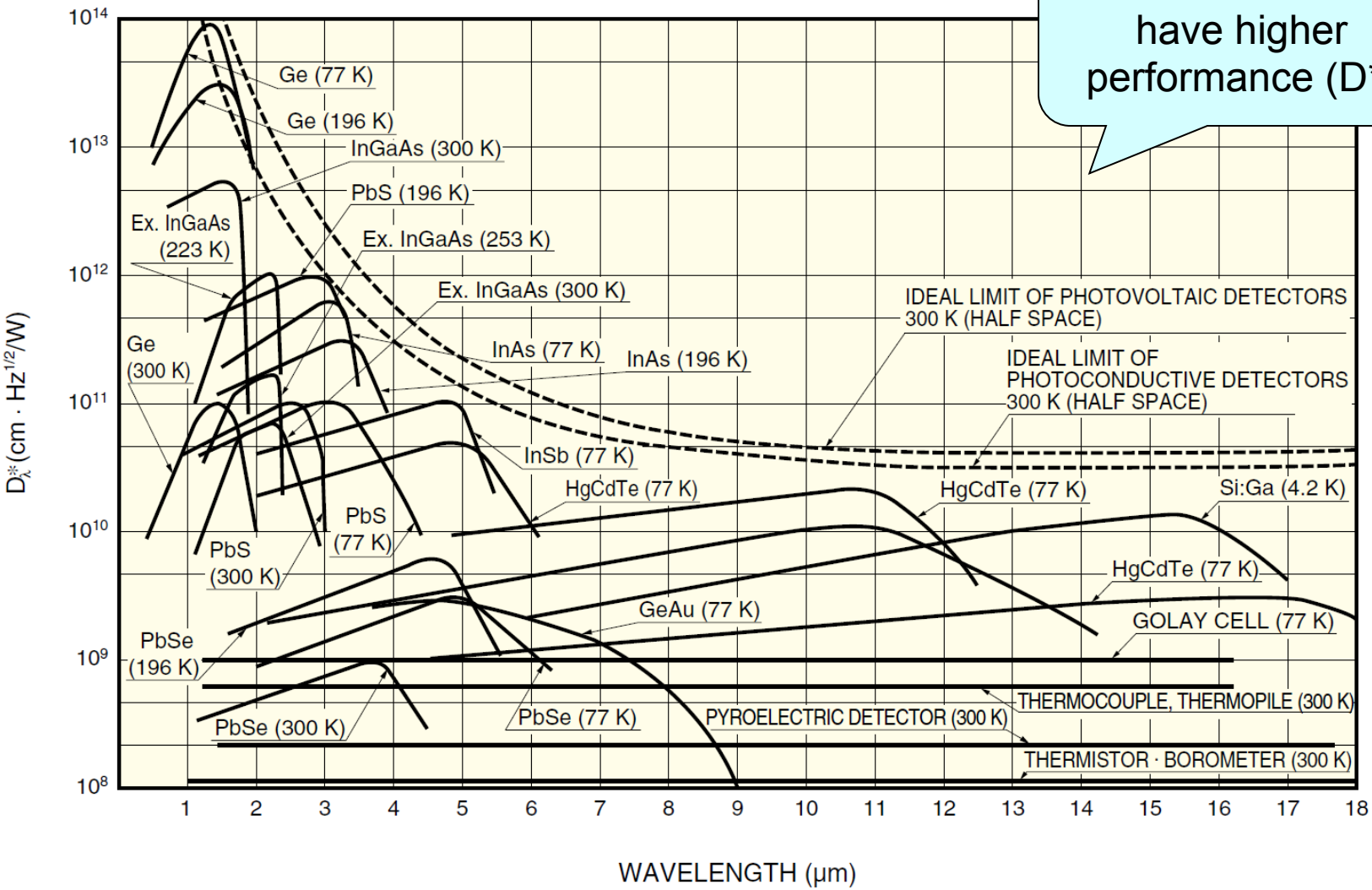


Why are they used?

- Integrated Detector Assemblies are used to cool optical detectors
- In comparison with uncooled detectors, Cooled detectors have higher quantum efficiencies, operate at much faster speed of detection (frame rates) and are significantly more sensitive
- The amount of cooling necessary for operation is based upon the particular detector semiconductor material used
- Without cooling, the detector would be 'blinded' or flooded by its own radiation
- D* : The merit function to assess detector performance
  - photo sensitivity per unit active area of a detector. Higher the better

Detectivity D*

All cooled sensors have higher performance (D*)



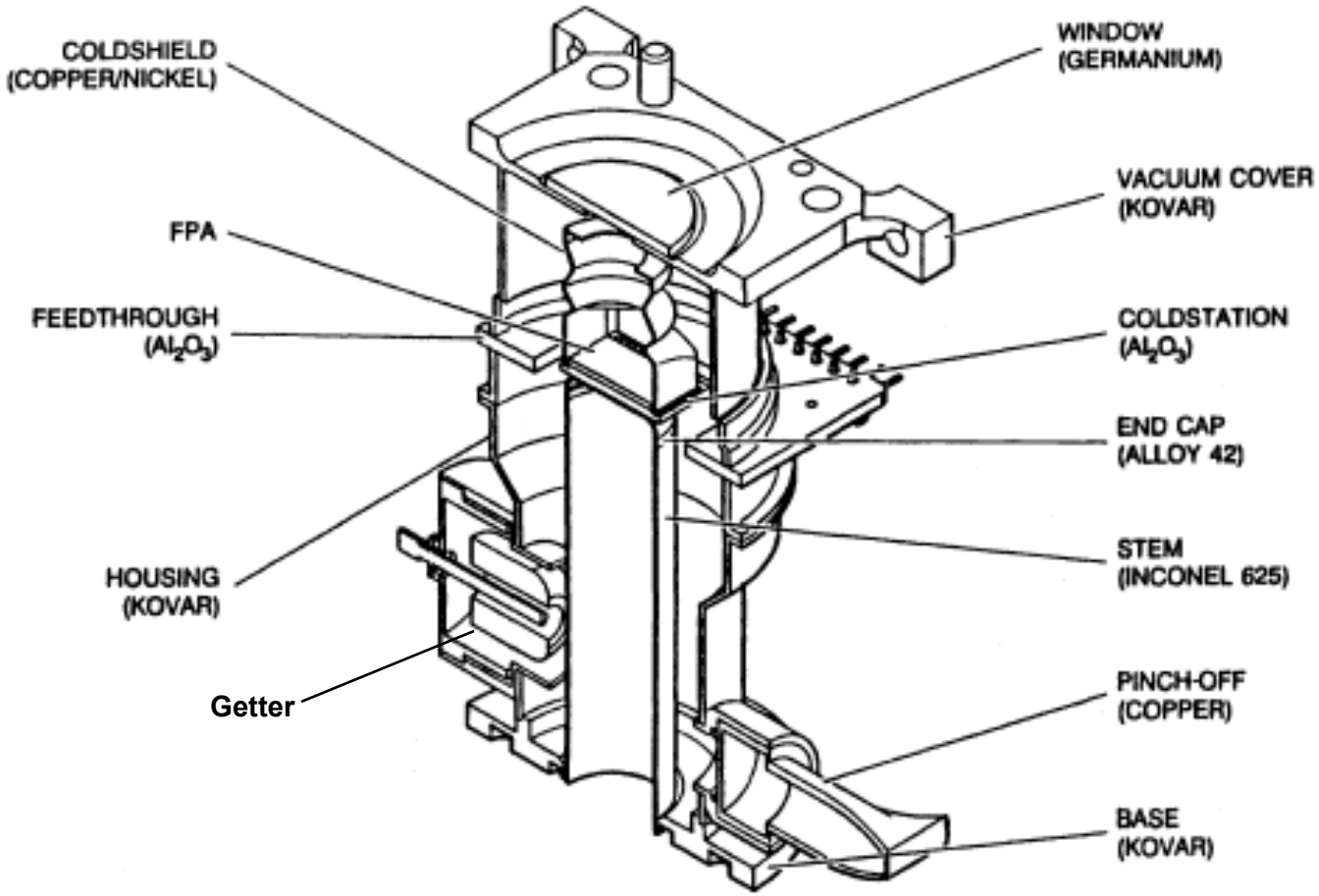
How Cold-Operating Temperatures

- Most cooled infrared detectors operate in the 60 K to 100 K range, depending on the detector type and performance level
- 77K is a very common temperature because this is relatively easily achievable with liquid nitrogen
- Liquid Argon is also common at 87 k
- Longer wavelength (15μm) operate about 4.2 K (Helium)

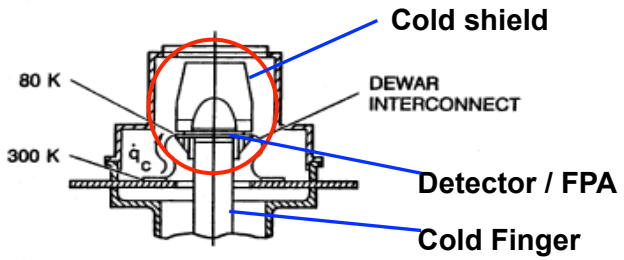
IDA Requirements

- Main Purpose
  - Vacuum chamber to prevent water in the air from condensing on the image plane
  - Aid cooling by limiting thermal conductivity with the surroundings, more efficient

Cut way of an Integrated Detector Assembly



IDA Merit Functions



- Minimize Cooled Mass
  - Everything that needs to be kept cool
  - Typically a detector or Focal Plane Array (FPA) and cold shield
    - Some systems also cool electronics or optics
  - Defines cool down time
- Minimize Steady State Heat Load
  - Cooling power required to maintain operating temperature in Watts
  - Largest Contributors
    - thermal conduction in the electrical wires
    - thermal radiation from the housing
    - thermal conduction from the cold finger

IDA Housing

- Also known as a Dewar
  - Named after Sir James Dewar for its invention
  - A vessel designed to provide very good thermal insulation
  - In form, a Dewar is a glass or metal bottle, with a double-wall construction.
- Dewars are actually very common in the consumer market
  - known as a thermos for keeping your drinks hot or cold.
- Hermetic Sealed
  - the quality of being airtight - impervious to air or gas
    - Vacuum inside IDA

Dewar Examples

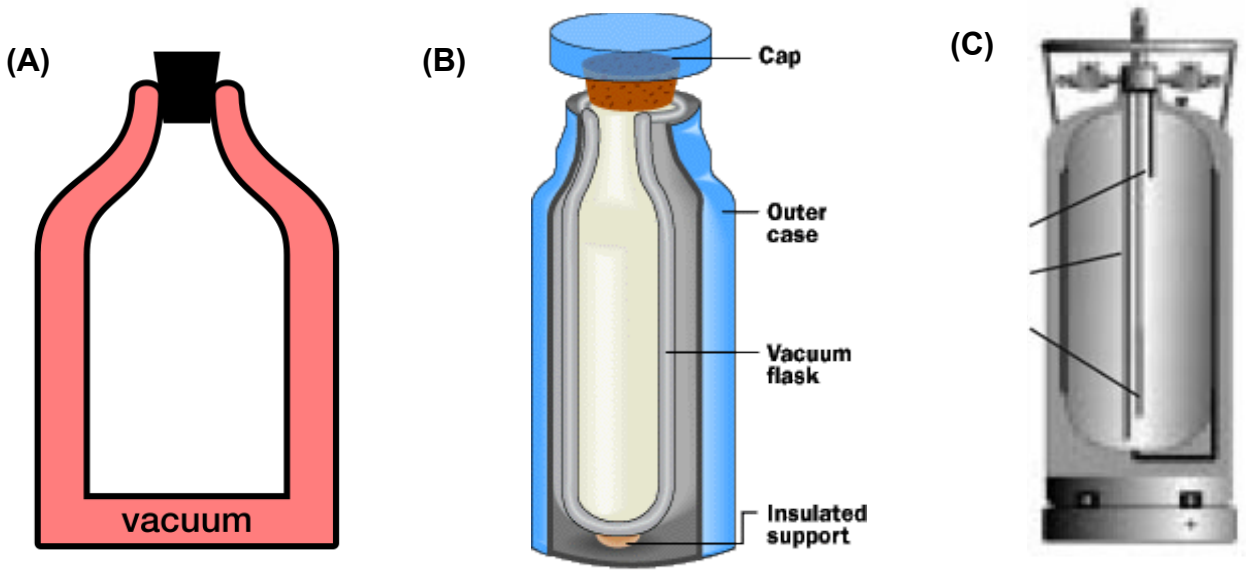
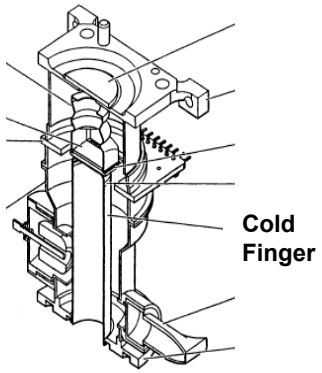


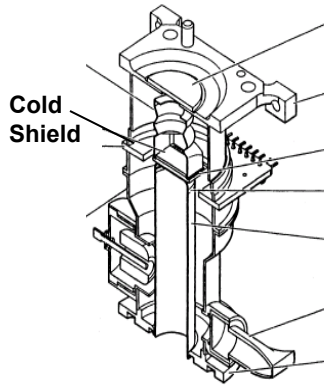
Figure 1: Simple to complex Dewar designs from left to right
a) Simple vacuum flask often seen in the laboratory environment
b) Cut away of basic thermos design for hot and cold drinks
c) Cut away of a liquid nitrogen storage Dewar

Cold Finger

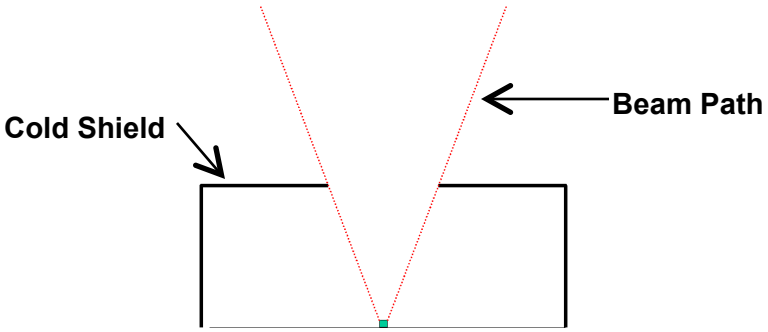


- Cold fingers are typically long, thin walled cylinders
- Minimize the thermal conductivity between the cooled mass and the outside world
- Cantilevered beam with additional mass at the end creates vibration concern
  - Do not want image blur
- Constructed out of a stiff material (stainless steel, inconel, titanium)

Cold Shield



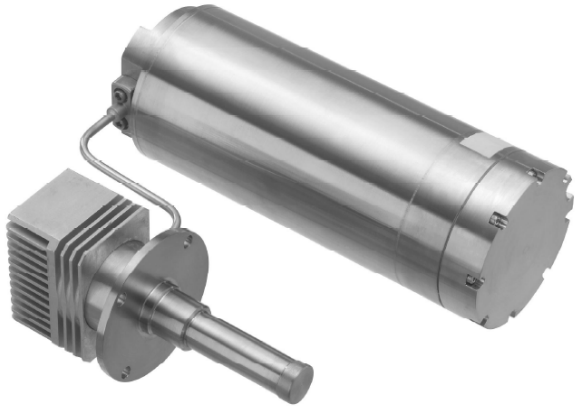
- One of the most important optical parts for an infrared detector
- Detector needs to be protected from infrared radiation from outside the imaging path
- Allows us to control what the detector sees



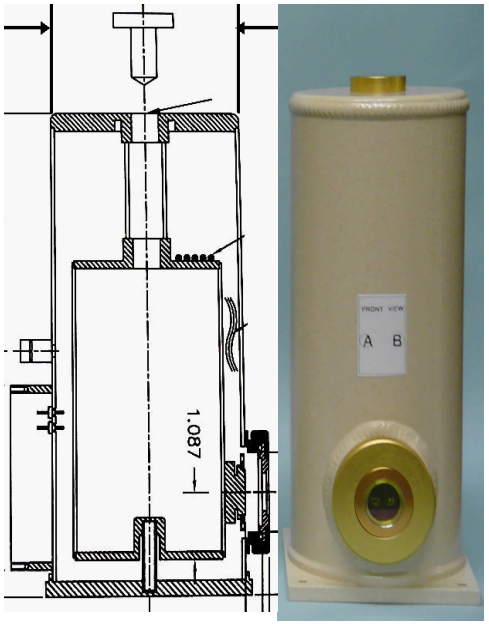
Outgassing

- Serious concern for any vacuum environment
- Material is losing mass/volume because particles are leaving in the form of gas
- Moisture, sealants, lubricants, and adhesives are the most common sources, but even metals and glasses can release gases from cracks or impurities
- Outgassed material can condense onto optical elements causing obscurations
- NASA maintains a list of low-outgassing materials to be used for vacuum applications

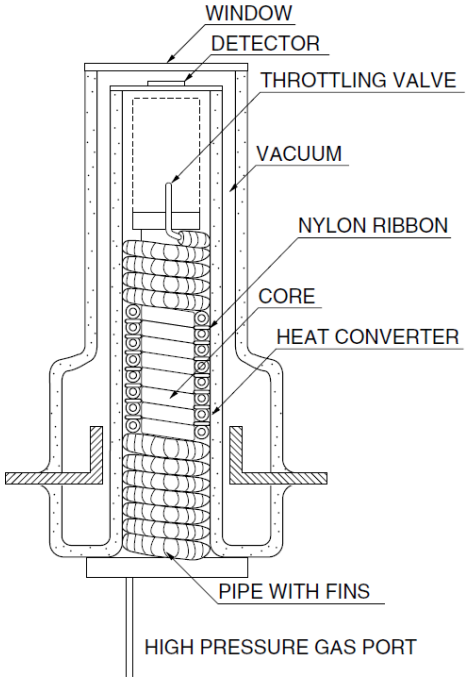
How Detectors are Cooled



Pulse Tube: Works like a compressor

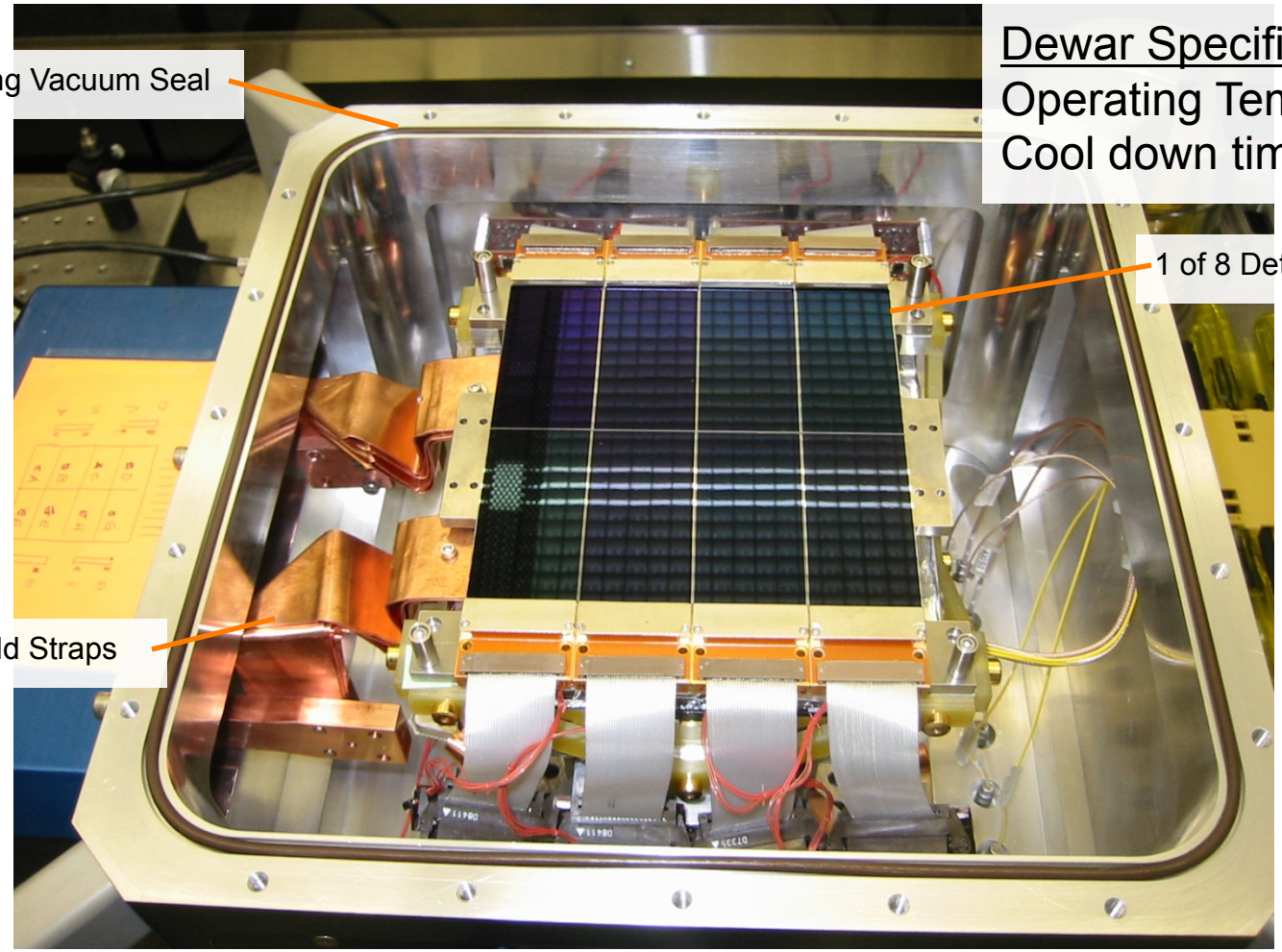


Liquid fill Dewar: pour in liquid nitrogen or argon



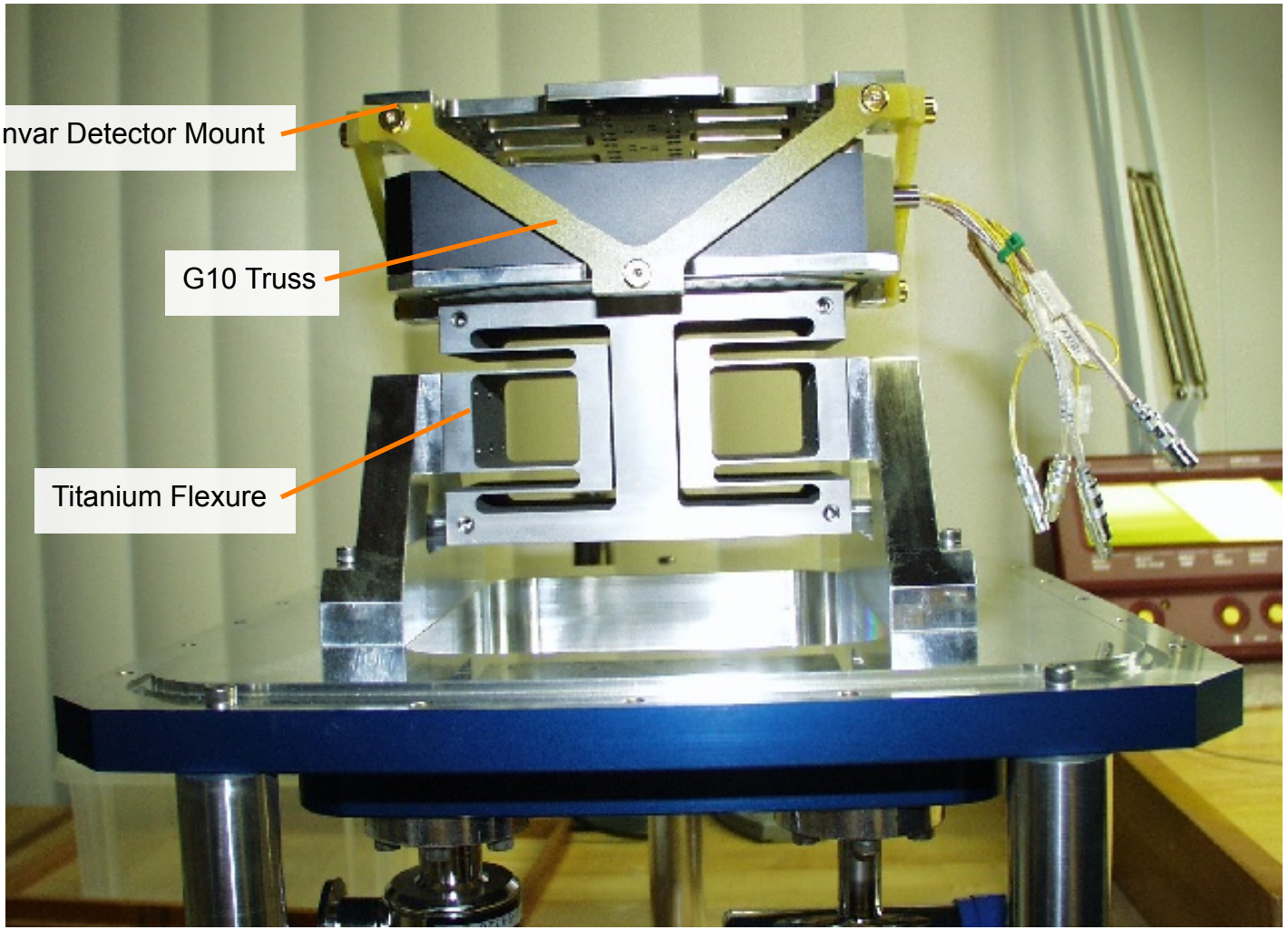
Joule-Thompson Cryostat: harness energy from phase change

IMACS 8K x 8K Dewar and Detector System for Magellan I 6.5m telescope



Dewar Specifications
Operating Temp: 170K
Cool down time: 5 hour

IMACS 8K x 8K Dewar Cont.



Thank You!

Any Questions?