Cryogenic detector systems: recent work.

M.Borri
Daresbury Laboratory
UKRI-STFC

Outline:

- Photon-science: XH for x-rays and mid-IR*.
- Nuclear physics: Prospectus.
- Conclusion.

* not Ge sensor.

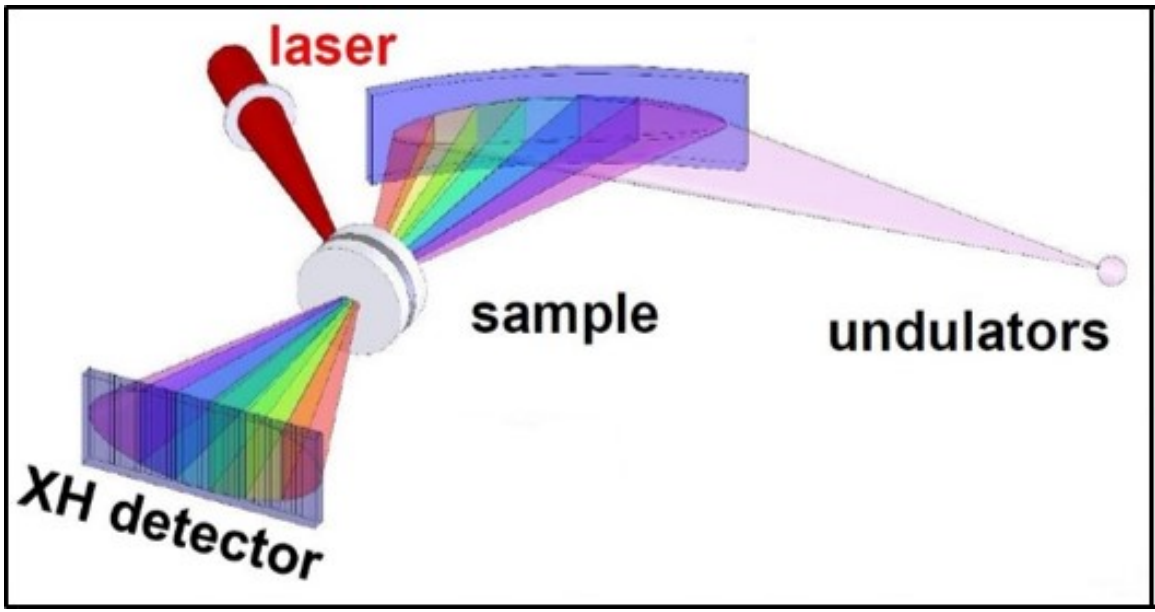
See also BEGe cryostat
I.Lazarus @ AGATA Week
Milan, 2017.

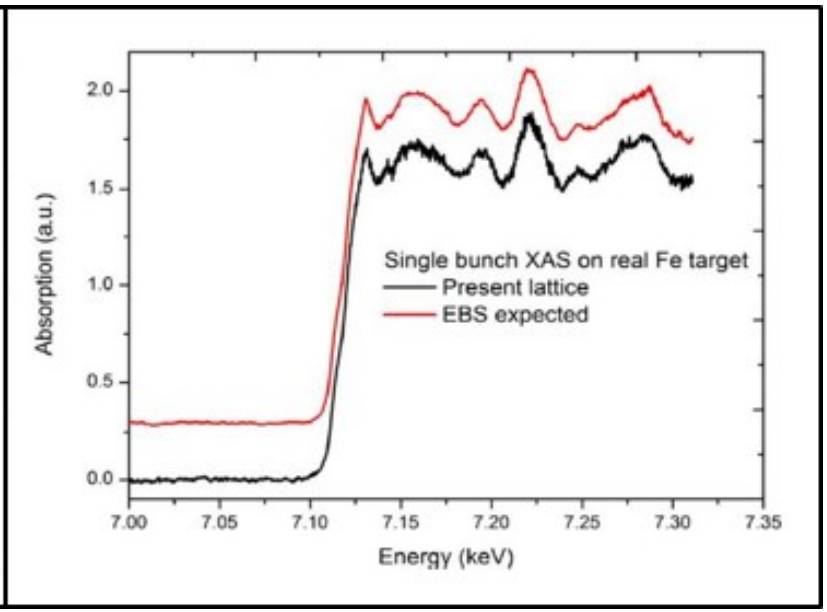
ESRF-ID24 upgrade.

- Extremely Brilliant Source ESRF: new lattice.
- ID24 refurbished to High Power Laser Facility (HPLF).
- Coupling 100J ns-Laser to 4th Generation Synchrotron.
- Pump-probe experiments in single shot.
- Experimental technique is Energy Dispersive EXAFS (EDE).
- ... And to upgrade XH.

A light for science ESRF

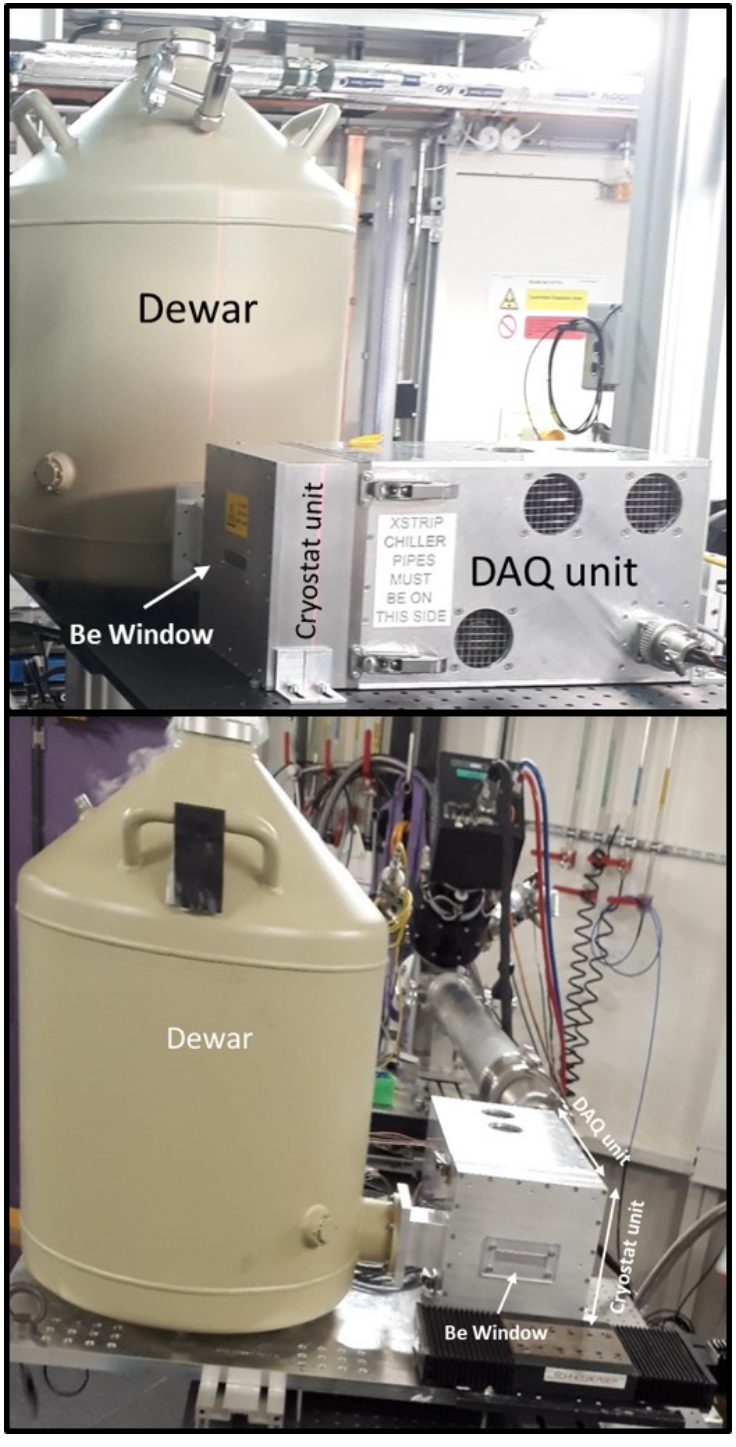
MIRION TECHNOLOGIES





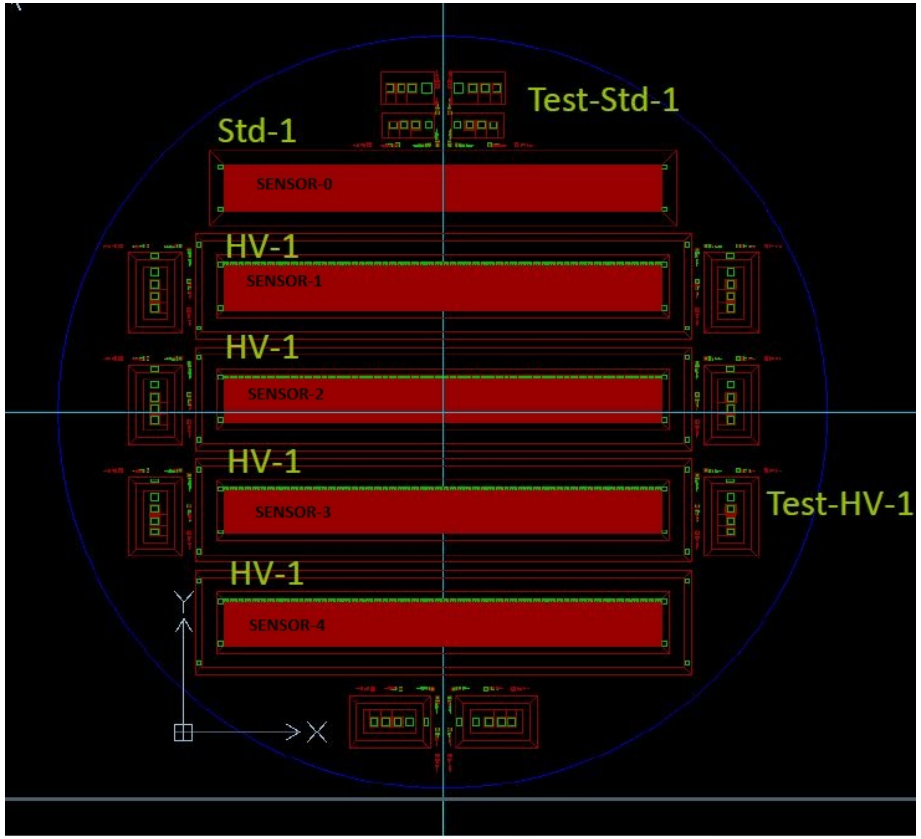
XH system.

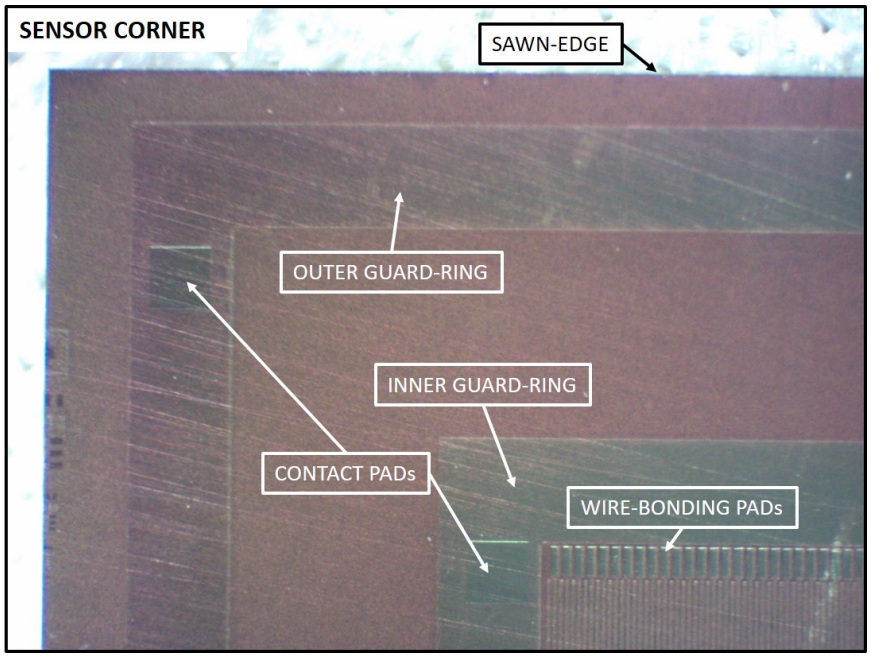
- Radiation Harsh Environment:
  10^{14} γ/s on Active Area;
- Cryostat Unit:
  Coolant is LN2;
  Ge Sensor @ T<-170C;
  Front-End Electronics;
  Pwr [10-14W] @ T>-40C;
- DAQ Unit:
  Operated in Atmosphere;
  FPGA + μProcessor;
  CTRL, CLK, DATA;
- Upgrade:
  New Ge Sensors;
  New Cryostat;

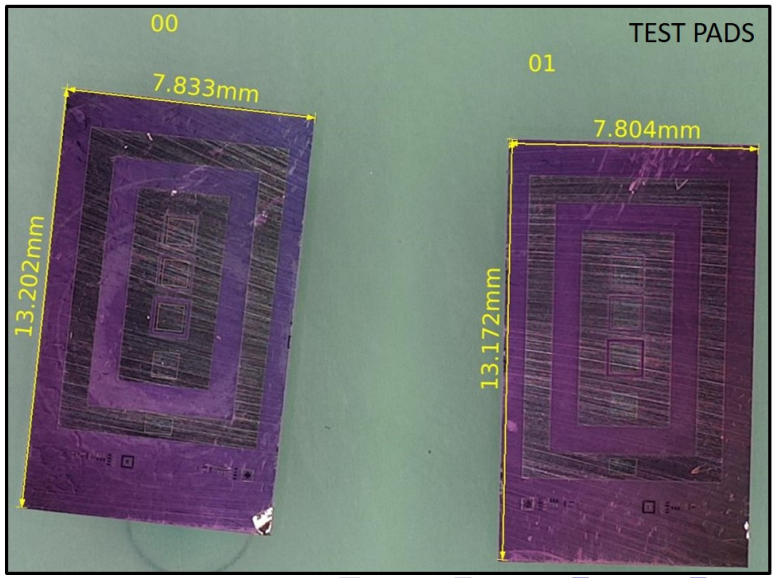


Micro-strip Ge sensors.

- Size: 1024 strips.
- Strip pitch: 50 um with 25um gap.
- Strip length: 5mm.
- Sensor thickness: 1.5mm.
- Two guard-rings.
- Interleaved wire-boning pads.
- Back illuminated.

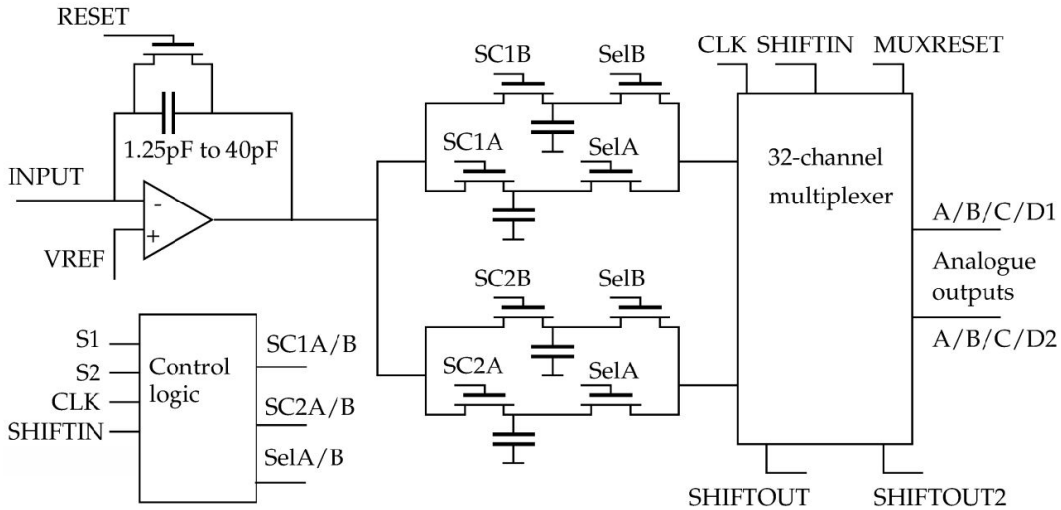




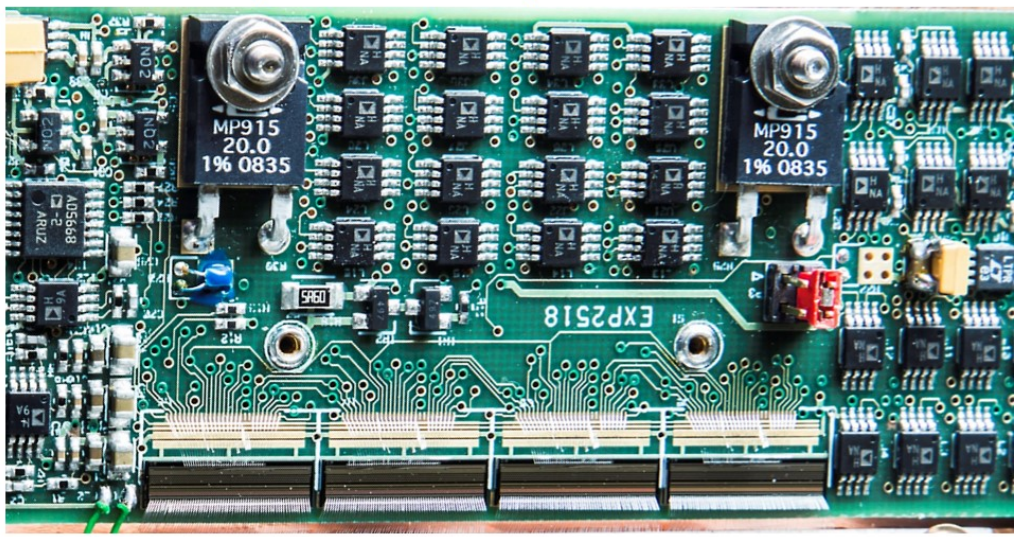


X3CHIP.

- STFC designed.
- Process: AMS 0.35um.
- Channels: 128.
- Analogue front-end:
  Charge integration;
  Charge sampling;
- Analogue output:
  32 chs per mux;
  4 mux per ASIC;

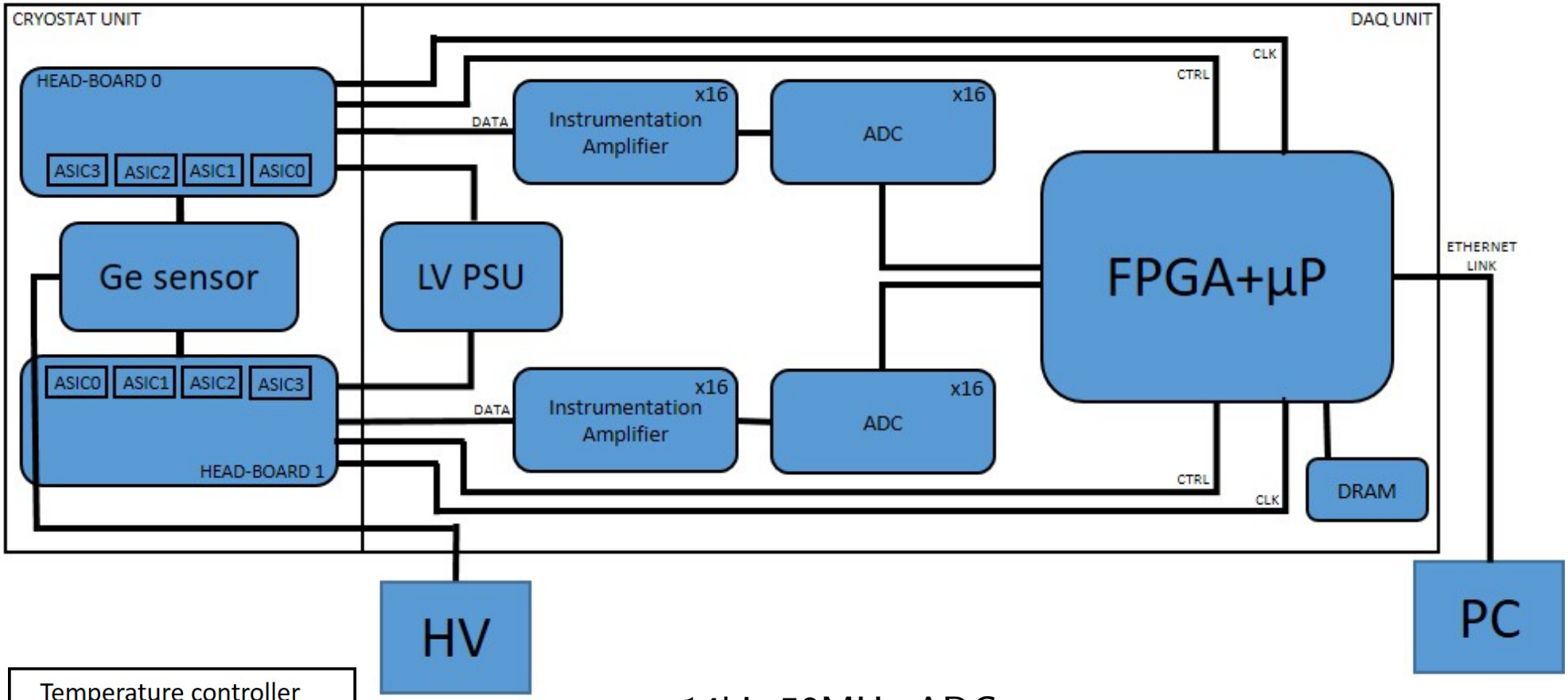


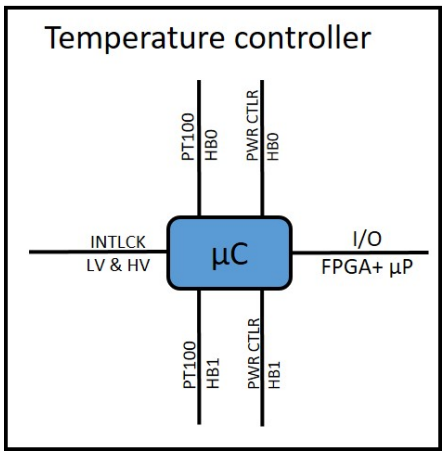
carrier board [aka head-board]



ASIC3 ASIC2 ASIC1 ASIC0

DAQ.

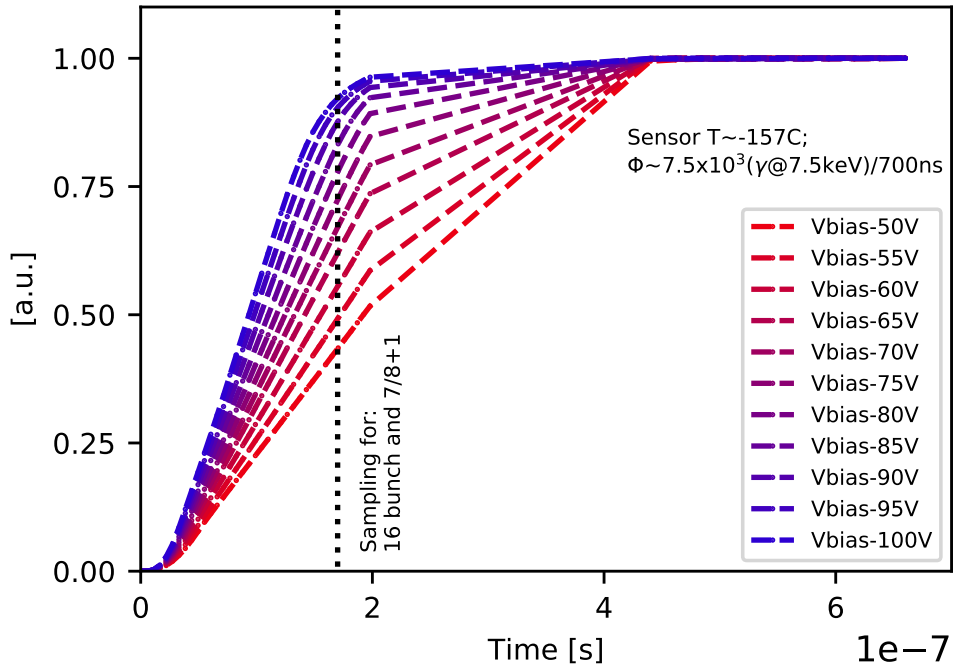


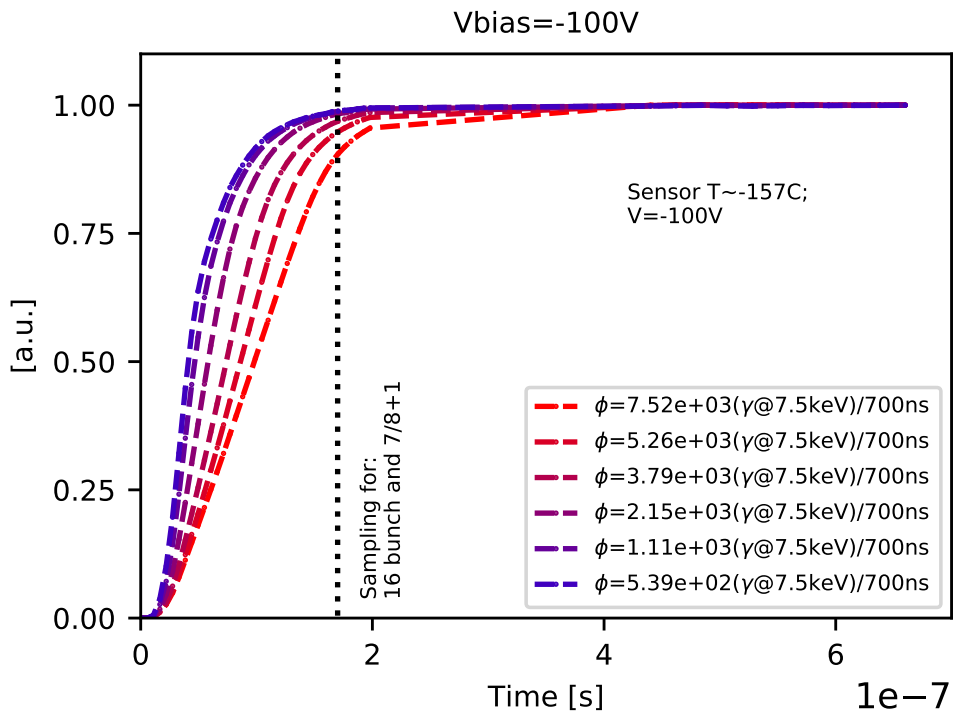


- 14bit 50MHz ADC.
- Virtex5 (FX70) FPGA.
- Embedded micro-processor 400MHz.
- 1GByte Ethernet link.

Prototyping: in-beam tests.

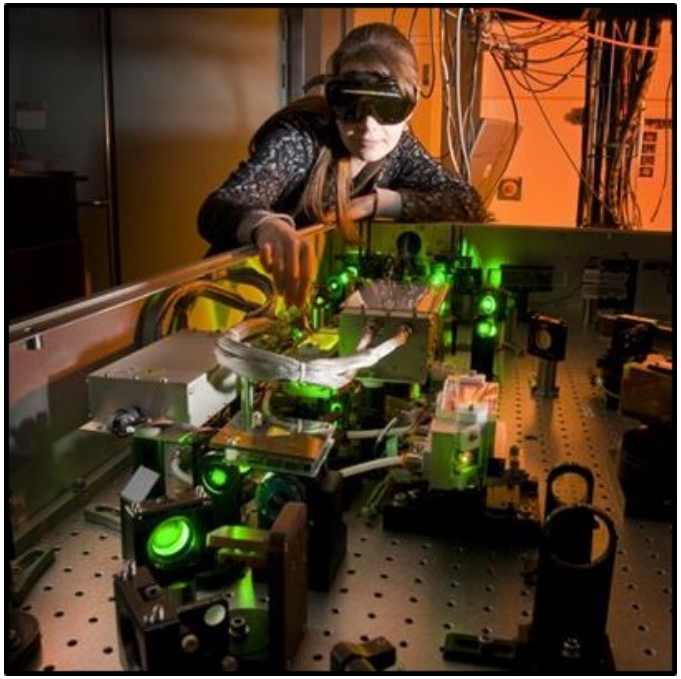
- Anticipate shut-down.
- Enable early testing while still developing new cryostat.
- First assembly:
  New sensors;
  Old cryostat;
- Study Q-collection time Vs fill-patern.
- In-beam tests:
  Q-collection time Vs Voltage;
  Q-collection time Vs Flux;

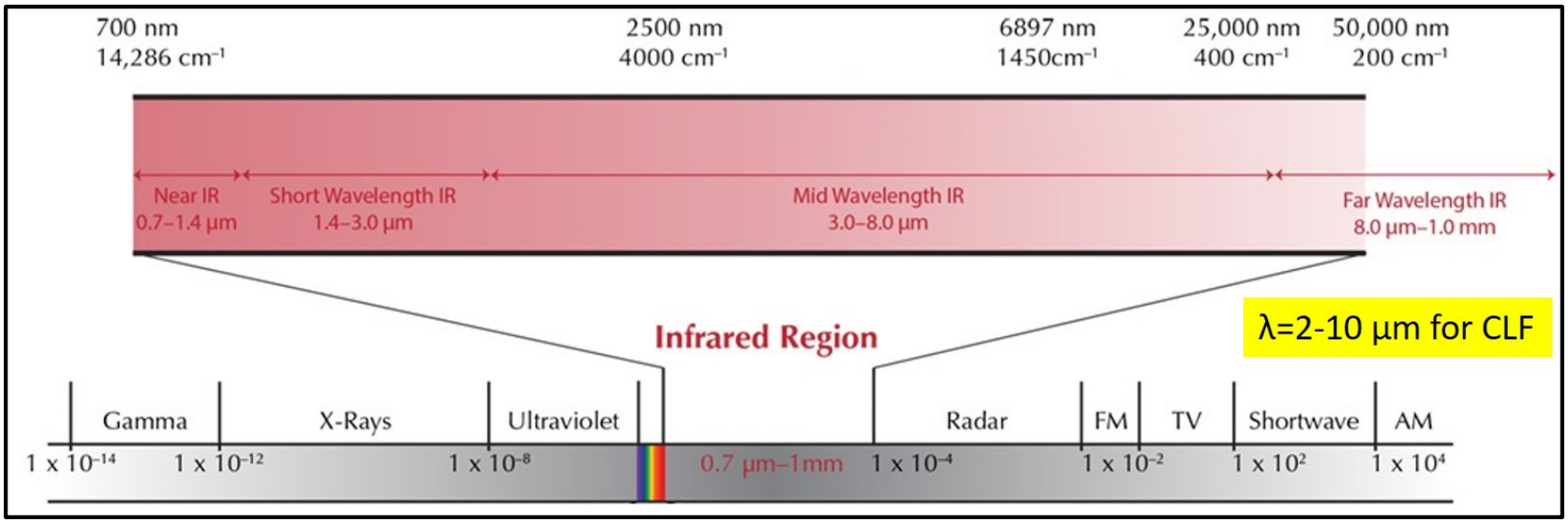




Mid-IR system.

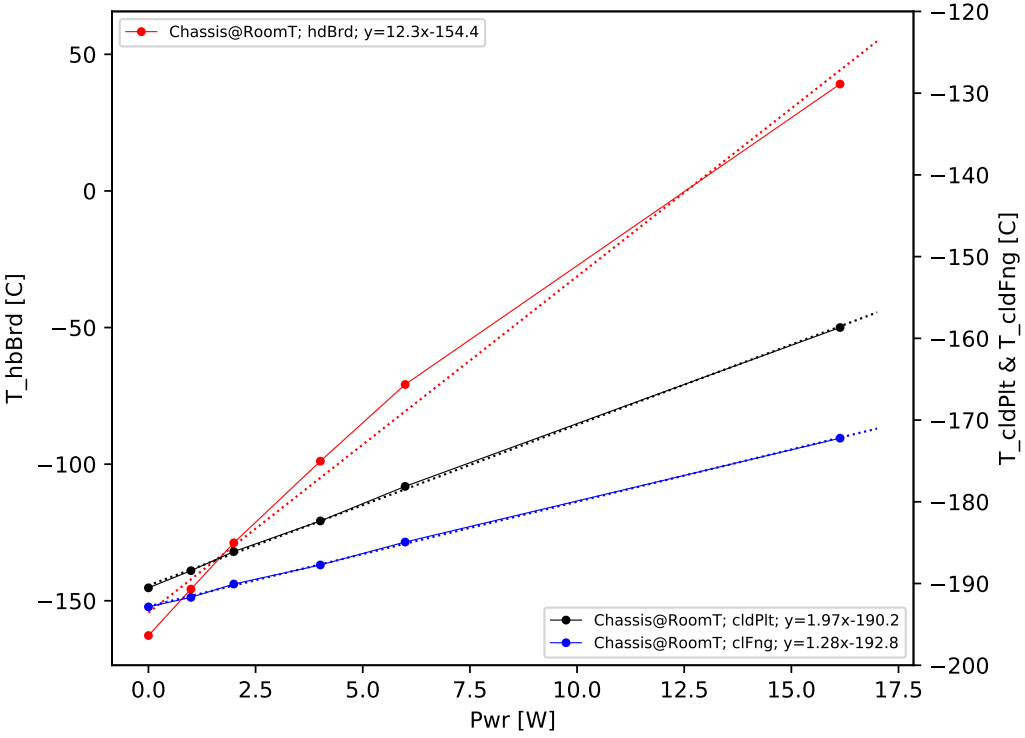
- STFC Central Laser Facility.
- Electronic and structural dynamics at quantum level.
- Ultrafast [s]: 10^{-3}-10^{-15}.
- Chemistry, physics and biology.
- Mid-IR detectors with STFC Technology.
- Sensor selection ongoing: not Ge!

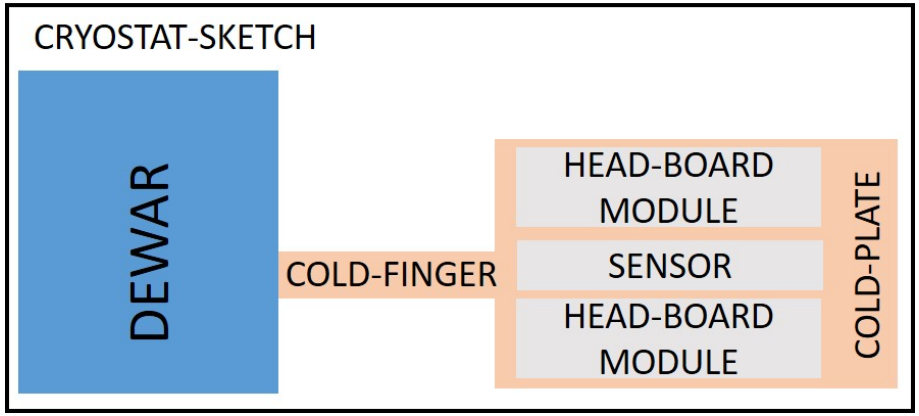




Starting point

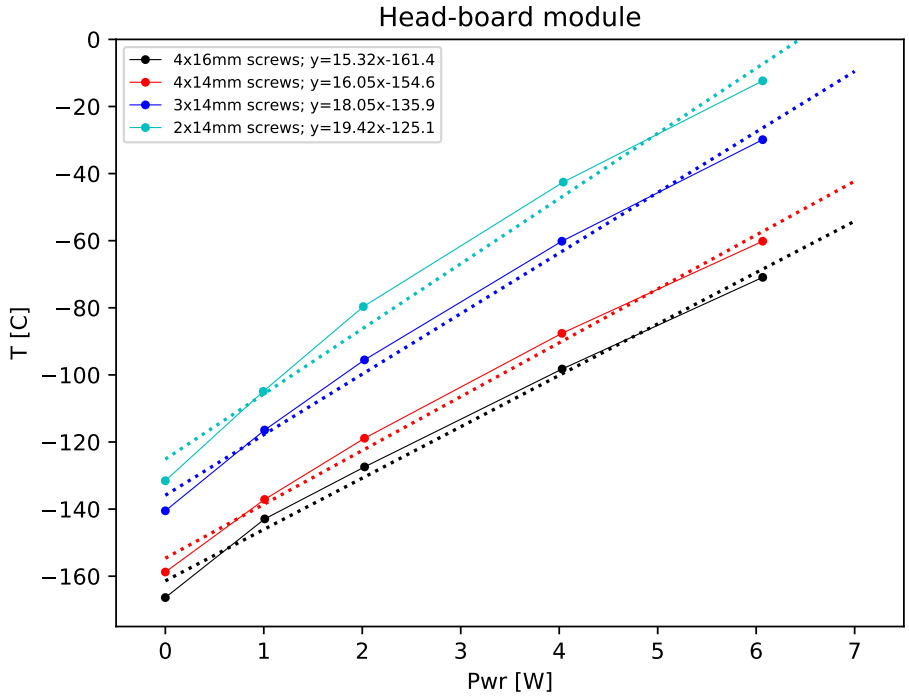
- XH system: not upgraded cryostat.
- Max 4 XCHIPs to r/o up-to 512 strips.
- Sensor T: -297C (or below?).
- Mod the current design to build a demonstrator.

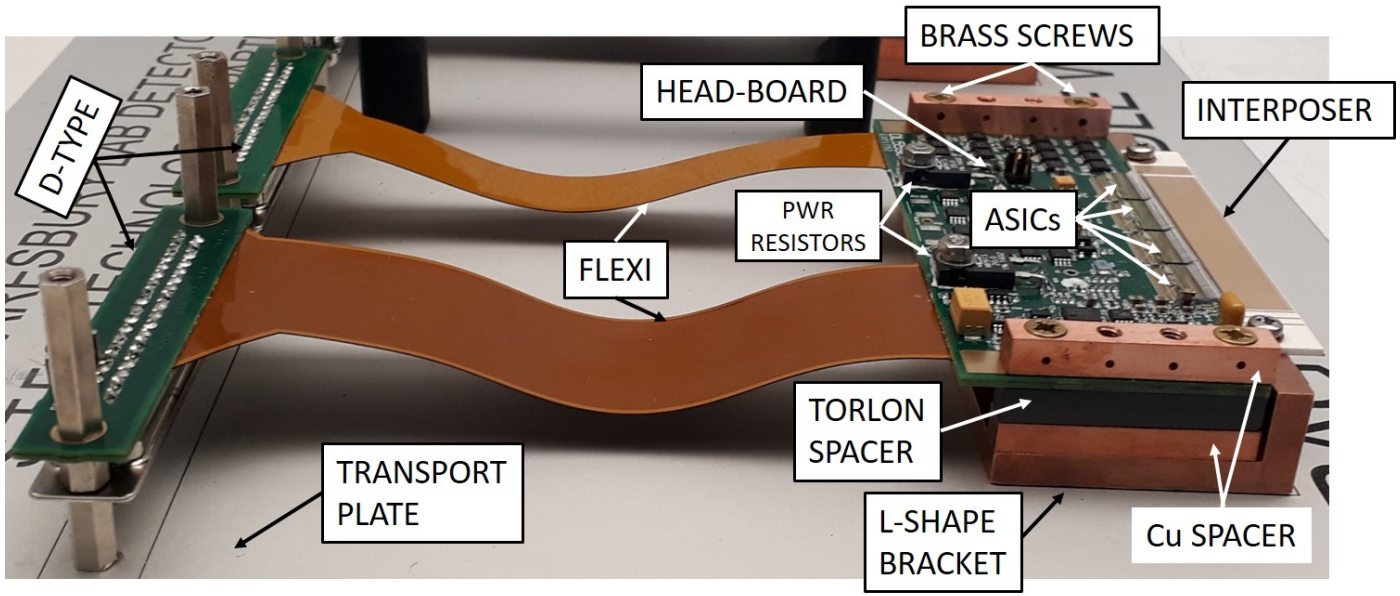




Study on head-board module.

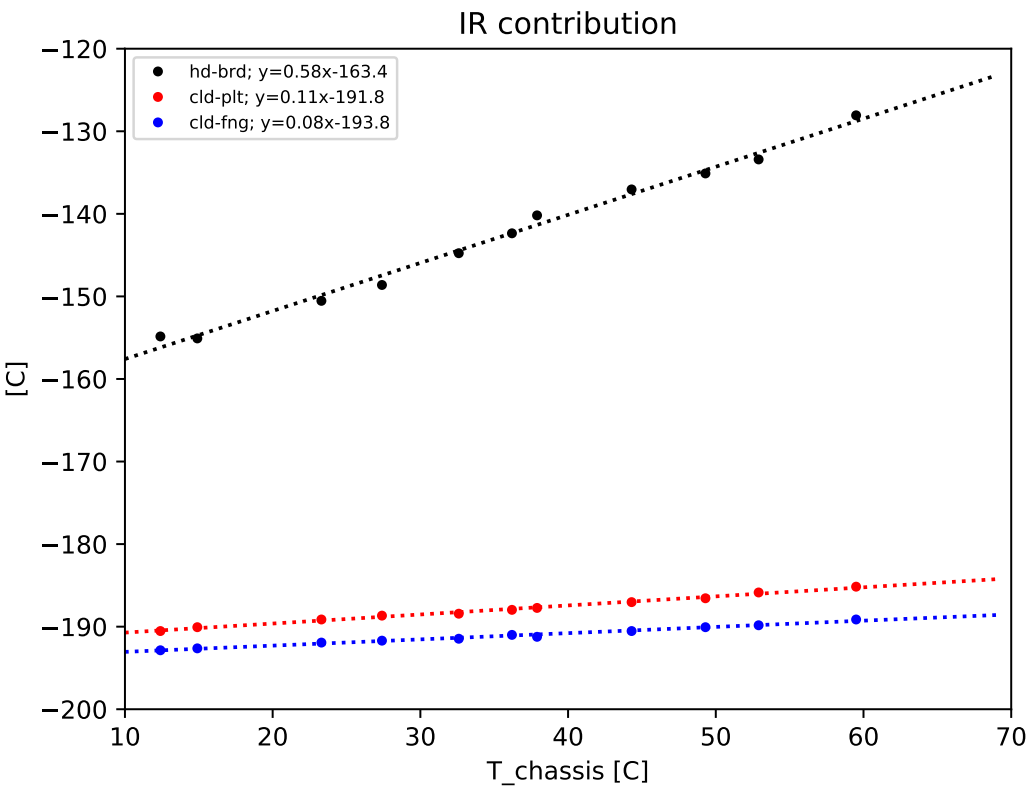
- 4 XCHIP, pwr [W]: 5-7.
- T_{HB} > -40C.
- Increased thermal resistivity.
- Torlon spacer non-linearity becomes dominating factor.

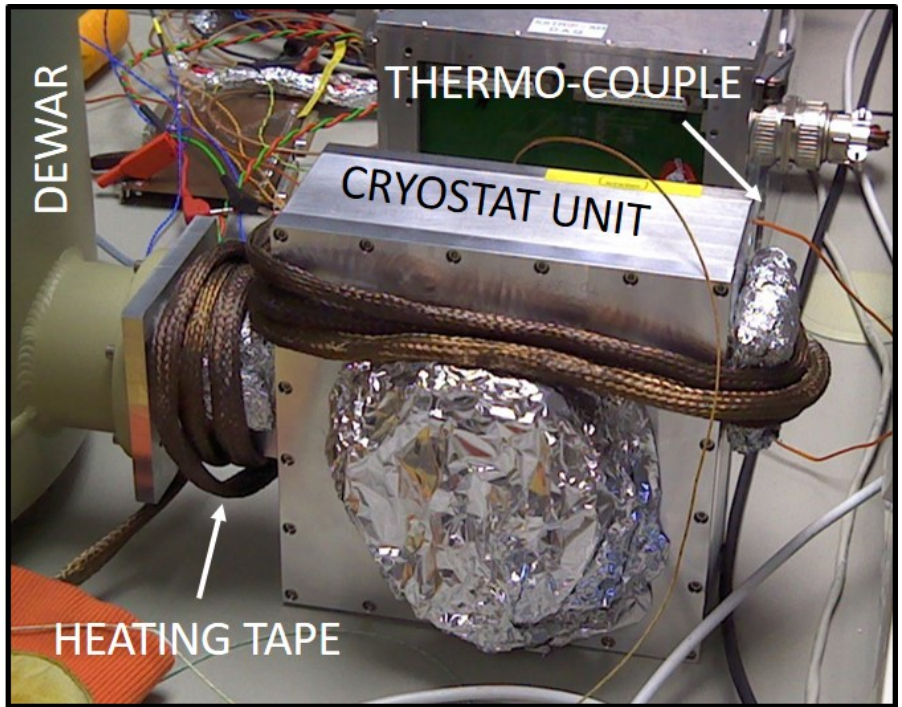




Low IR contribution.

- Low IR contribution to T.
- No IR-shield installed.
- Heated chassis and checked effect on components.
- To repeat with IR-shield.

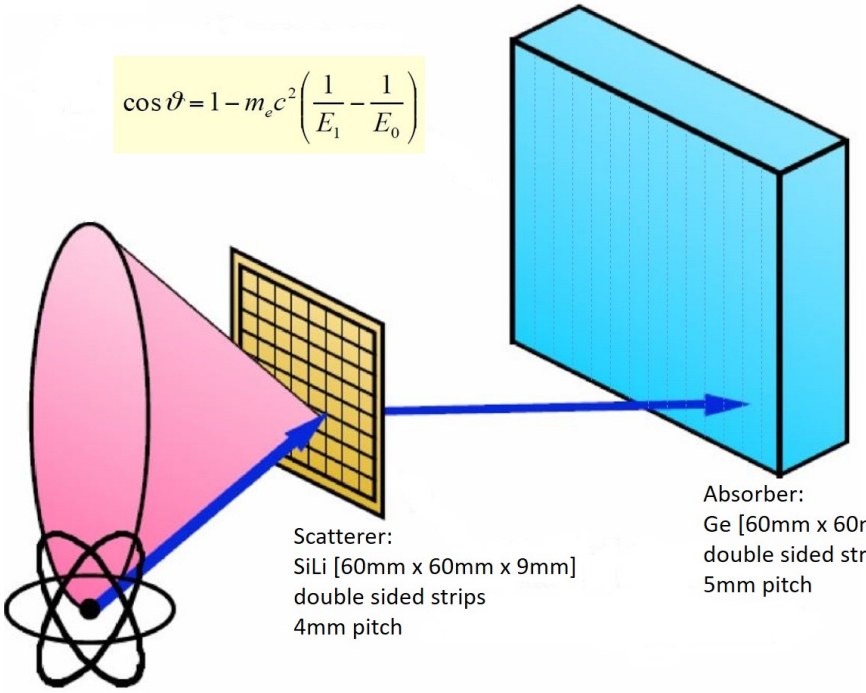


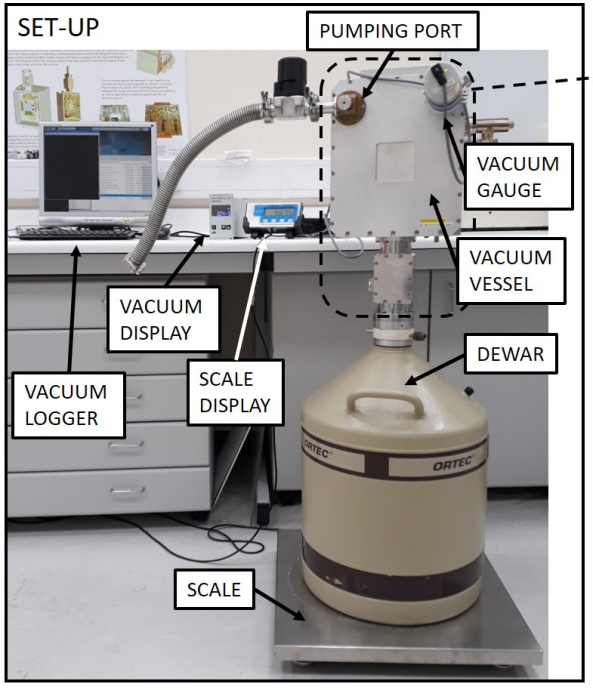


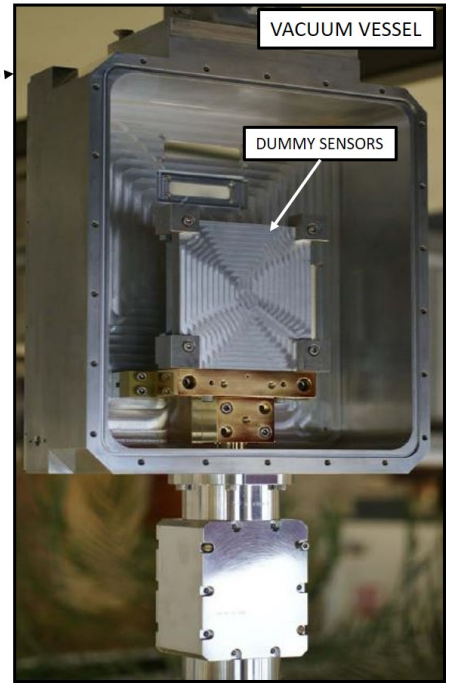
Prospectus.

- Compton camera.
- Nuclear medicine.
- Low dose diagnostics.
- Single Photon Emission Computed Tomography (SPECT).
- Scatterer and absorber in same cryostat.
- Cryostat characterization ongoing.
  -Vacuum;
  -Temperature;

$$\cos\vartheta = 1 - m_e c^2 \left(\frac{1}{E_1} - \frac{1}{E_0} \right)$$







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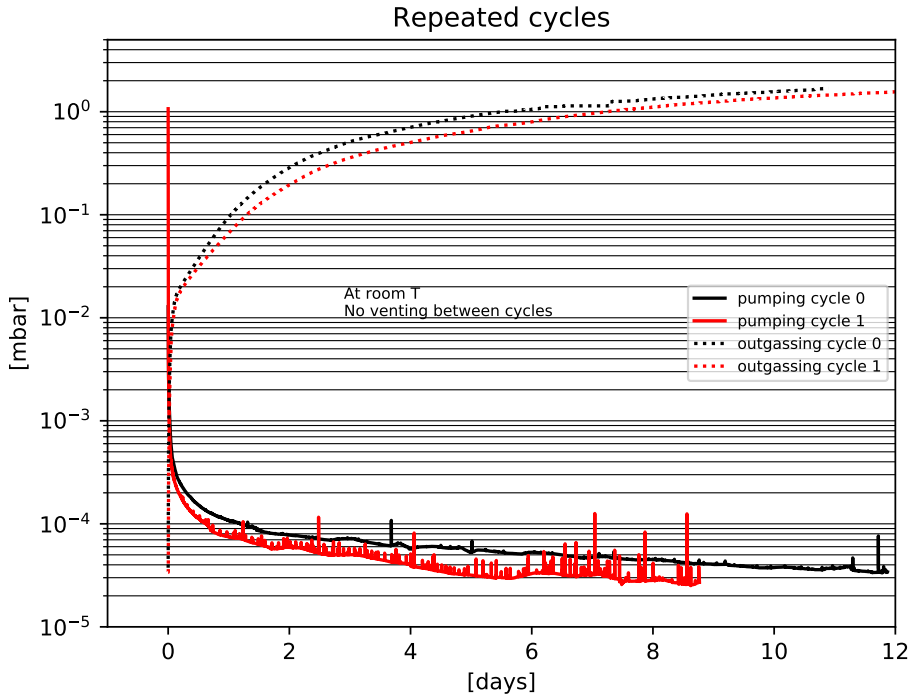
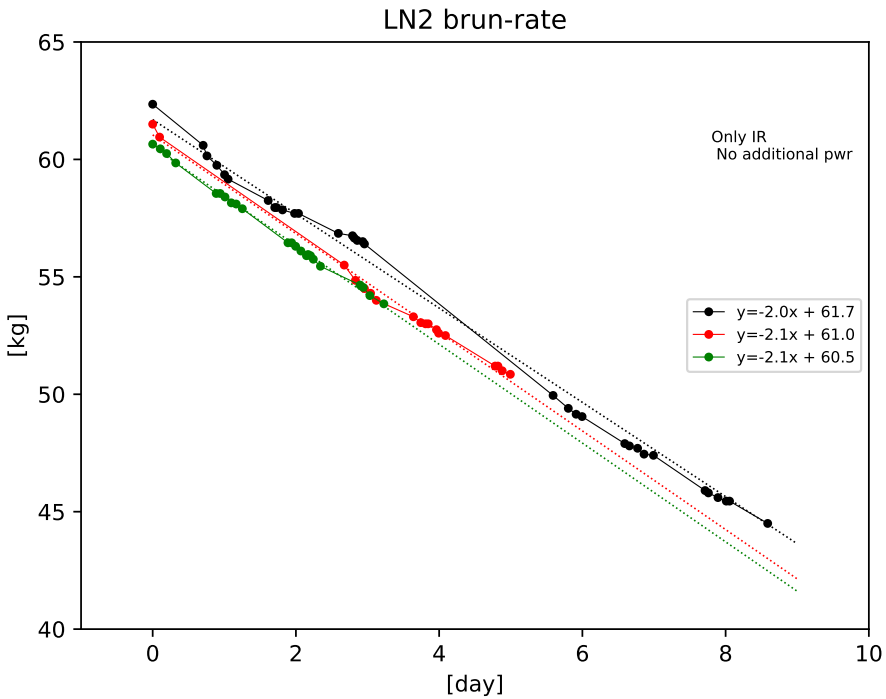
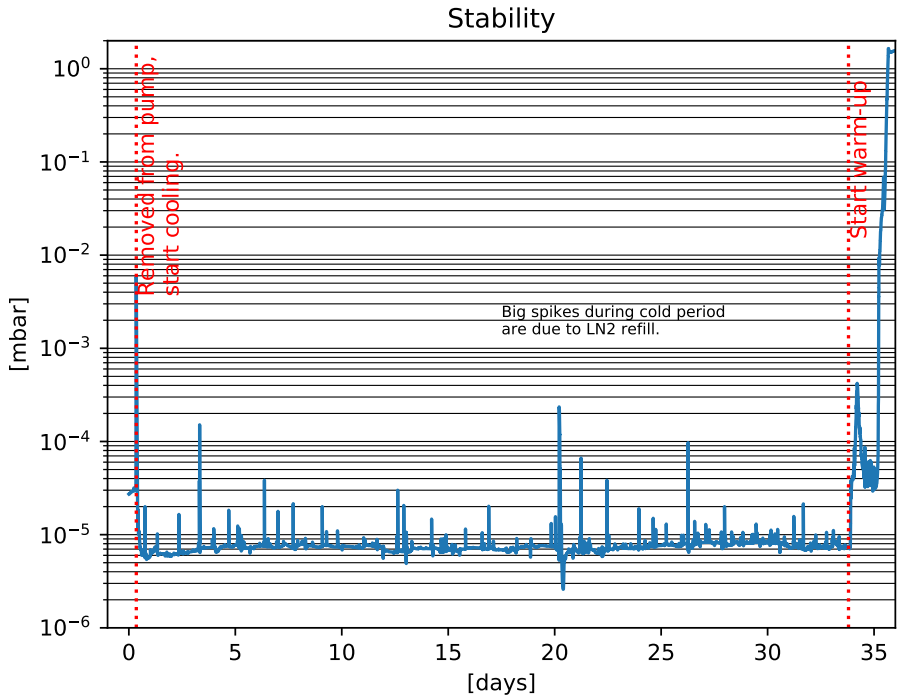
Vacuum tests.

- P measured in vessel.
- Comparing P cycles.
- Base-line pressure in vessel.
- LN2 burn-rate @ 0W.
- Next:
  -T_{min}VsVac;
  -Pump-speedVsTemp;
  -TempVsPwr;







Conclusion.

- Results of the XH system for X-rays.
- T optimisation for a possible demonstrator for Mid-IR.
- Characterisation of Prospectus cryostat.