

TIDAS-SPU: Infrared FTS imaging in the laboratory

Thermal Infrared Detector Array System - Signal Processing Unit

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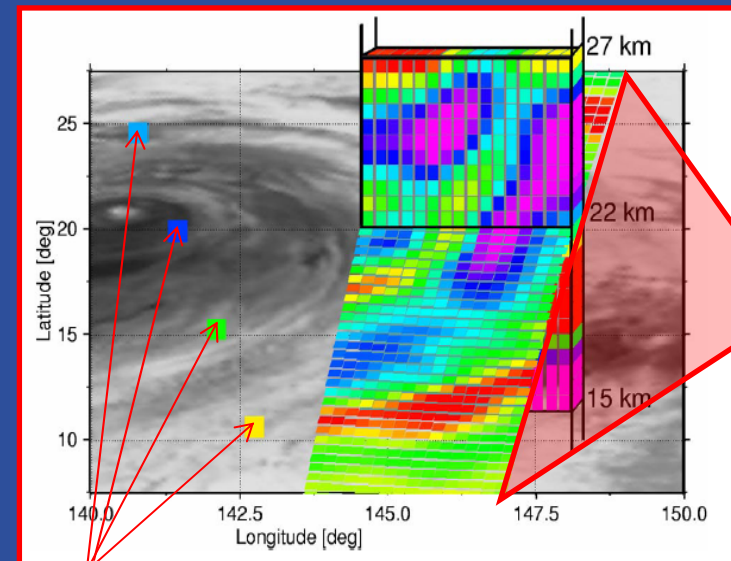
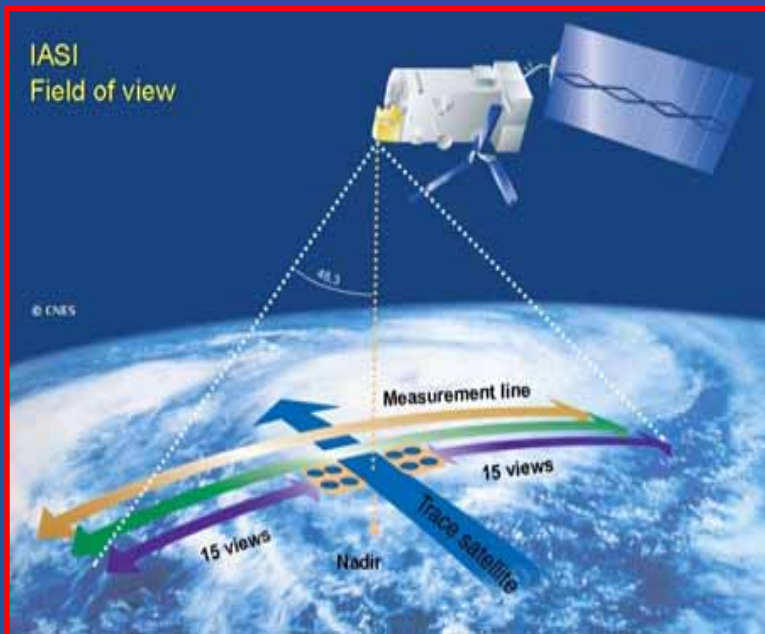
TIDAS-SPU Objectives

2-D Thermal Infra-Red Detector Array System and on-board Signal Processing Unit (TIDAS-SPU)

- Develop instrument science and design specification
- Implement and test TIDAS-SPU demonstration system (Molecular Spectroscopy Facility, RAL)
- In particular characterise:
 - performance of detector array over large signal dynamic range
 - fast interface electronics and on-board processing
- Perform technology assessment for a flight instrument

Motivation for study

- Improved global coverage in future nadir IR-FTS sounders from both polar orbiting and geostationary perspectives
- PREMIER (proposed ESA mission): more detailed observations of atmospheric structure from limb field of view

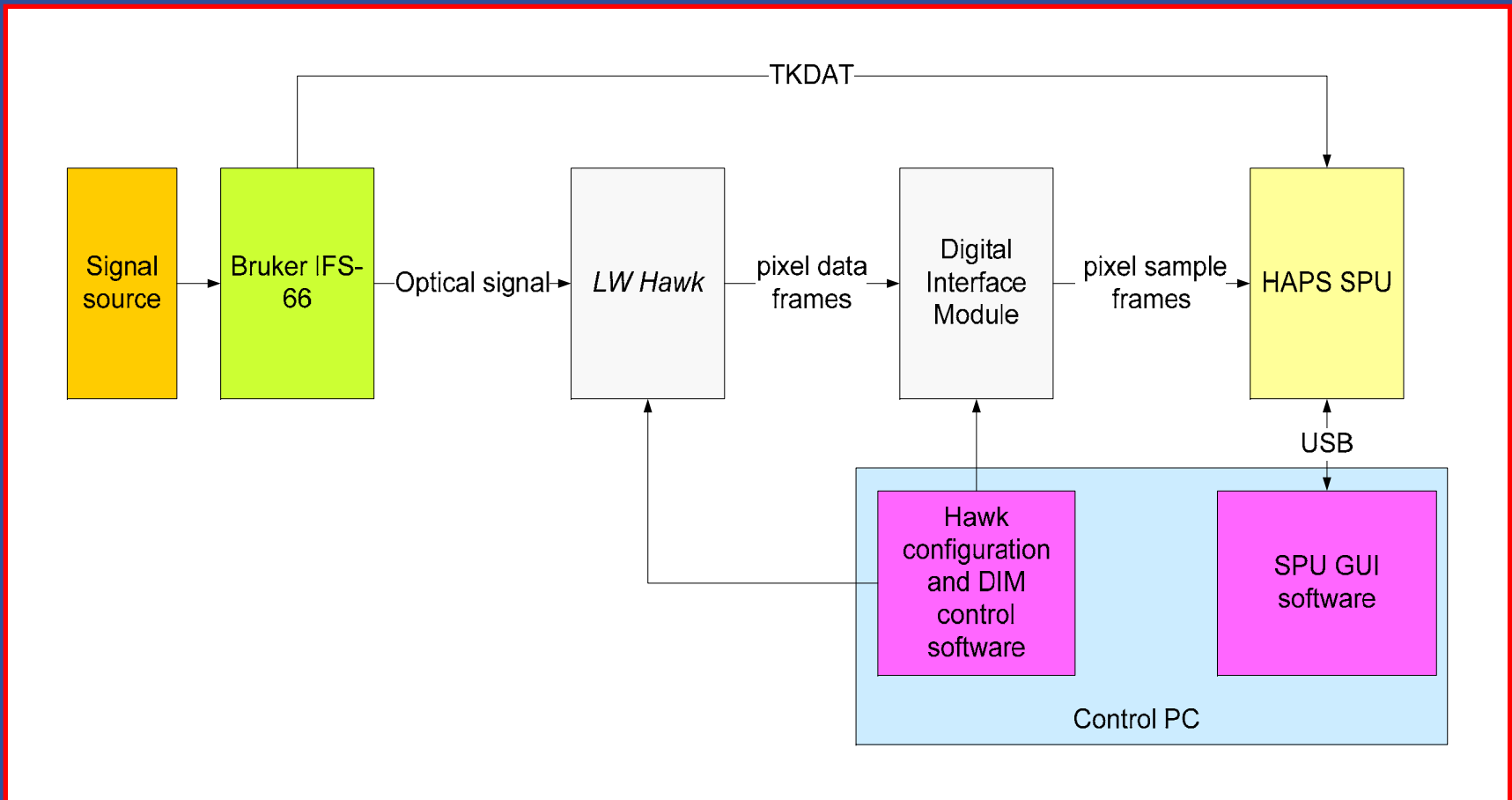


MIPAS
coverage

Figure courtesy of B. Kerridge

Expected
PREMIER
coverage

TIDAS-SPU system overview

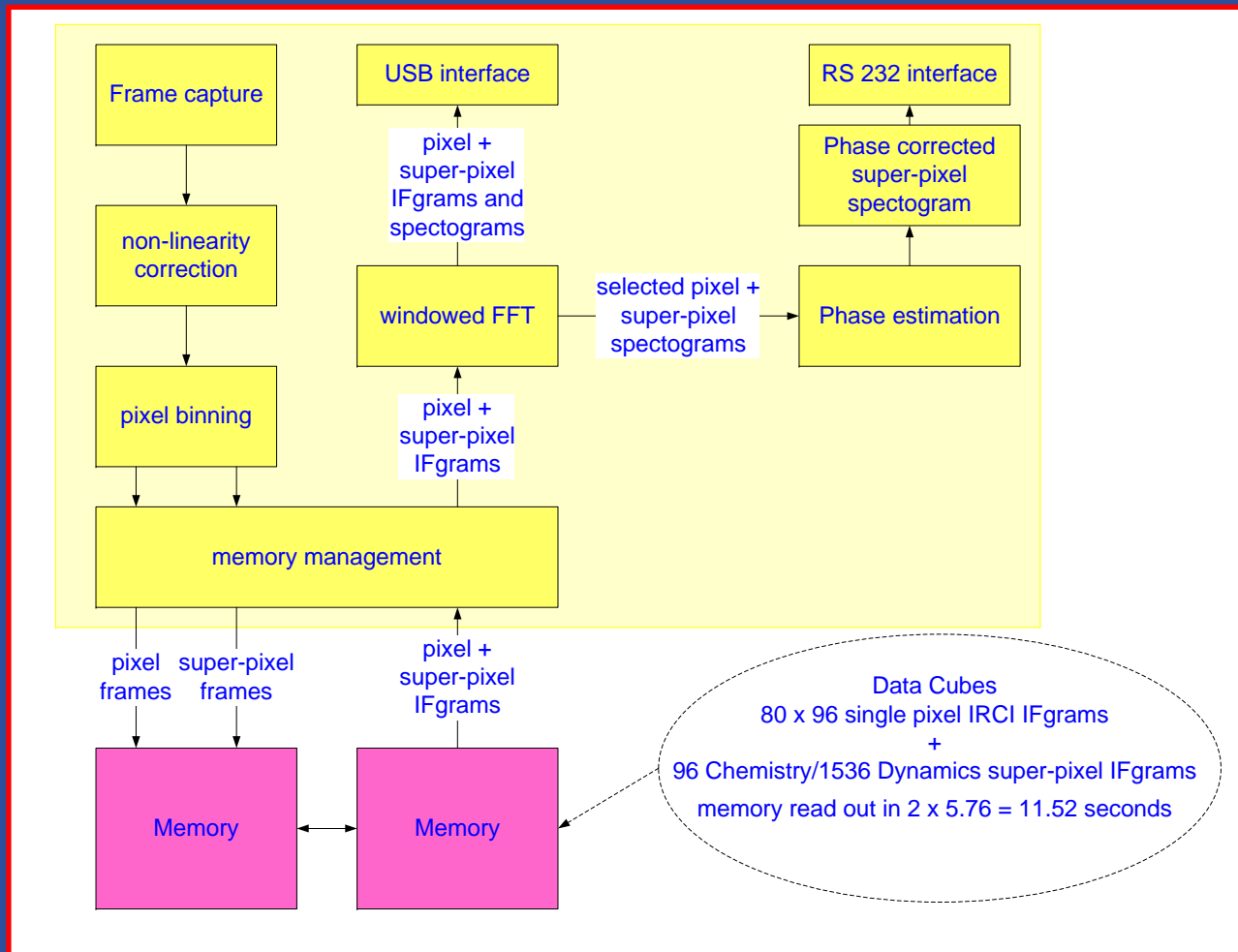


Selex HAWK IR detector array

- 640 x 512 pixel array with windowing mode available
- MCT detectors
- Selectable capacitors to vary dynamic range
- Compact lightweight dewar with Stirling engine
- 16 μm pitch
- Median NETD < 40 mK
- 4 output channels with read-out rate up to 10 MHz
- 14 bit ADC
- Spectral range: 8.0 - 9.4 μm (5.0 - 10.0 μm without cold filter)
- Flexible stare time

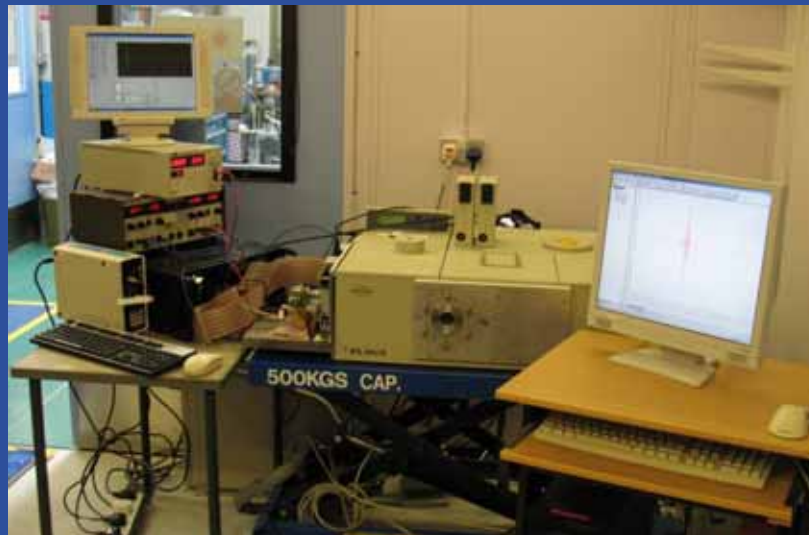


Signal Processing Unit

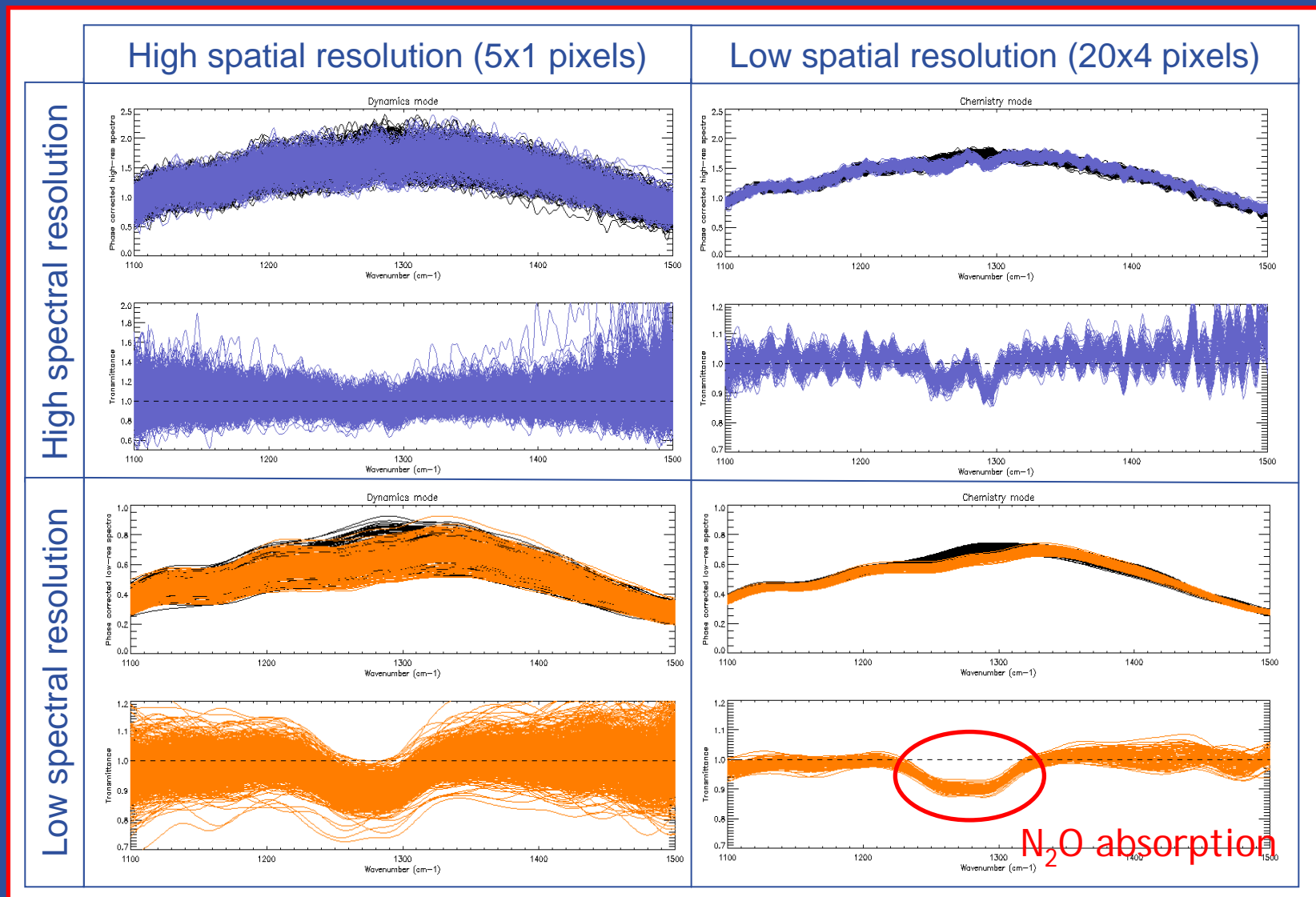


TIDAS-SPU final test phase:

- Experimental work at STFC-RAL MSF in February/March 2011
- Demonstrated successful acquisition of interferograms by TIDAS-SPU system
- Use of Bruker He:Ne laser output to resample interferogram data onto a regular OPD grid

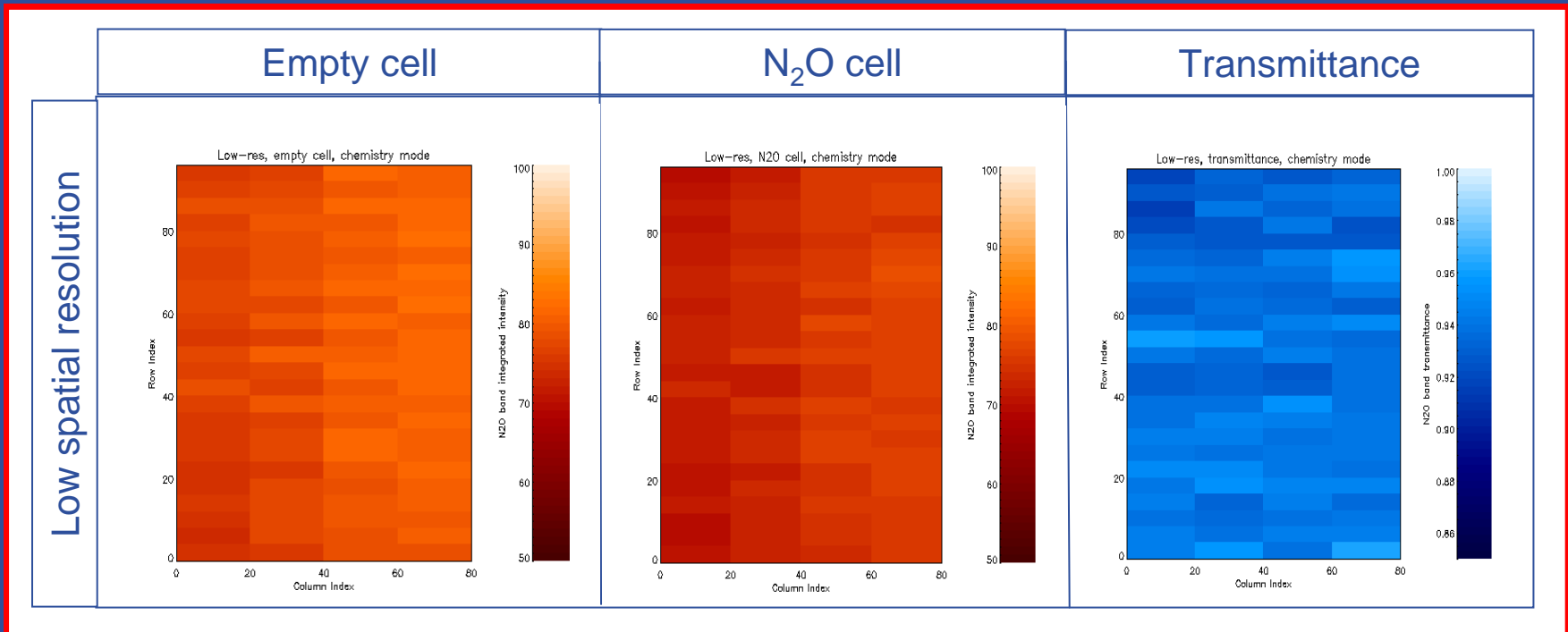


Individual TIDAS-SPU spectra



N₂O absorption

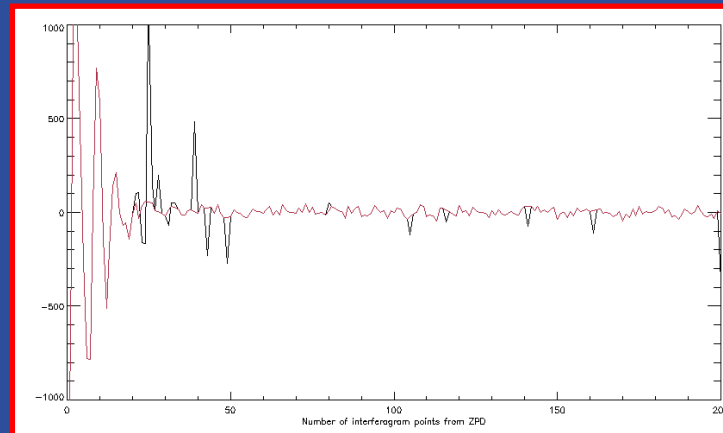
TIDAS-SPU pixel intensity maps



- Colours correspond to intensity integrated over the N₂O absorption band
- Transmittance = N₂O/empty

Issues affecting system performance

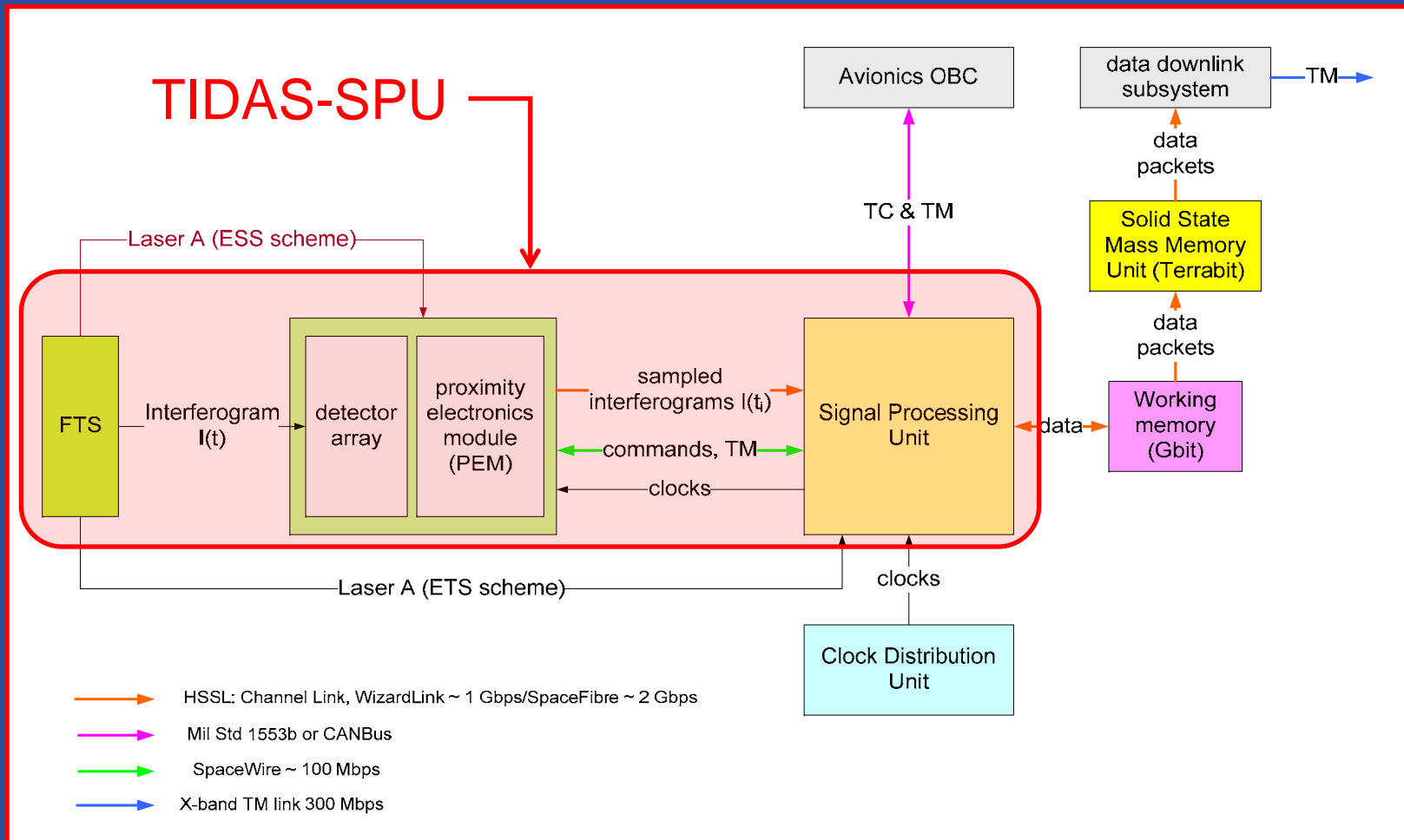
- Hawk read-out rate vs. scan mirror speed
- Available buffer memory
- Modulation efficiency
- Intrinsic detector noise (Selex pre-testing indicated SNR ~1200)
- Vibrations caused by detector cooling engine
- Electrical pick-up/spikes in raw interferogram data (see figure) - removed by replacing affected points with mean value of points either side of each spike



Outlook: areas in which TIDAS-SPU may be improved

- On-board memory capacity
 - Currently limits spectral resolution (through maximum number of points in interferogram) and dynamic range (via limit on data word length)
 - Matter of adding more SRAM chips - may require design of a custom PCB to hold them
- Data transfer rate
 - USB interface currently limits this, but could be either made to work more efficiently or replaced by a higher rate interface (e.g. PCI)
 - Would enable higher spectral resolution measurements to be processed without needing to compromise on the time between recording successive interferograms

Outlook: TIDAS-SPU in context of flight processor



Summary

- Demonstrated ability of TIDAS-SPU system to read off raw data from the Hawk array and produce spectra on-line from interferogram data-cubes
- Potential for improvements in
 - Spectral resolution (through increased on-board memory)
 - Data transfer rate
 - More on-board processing: gain ranging, interferogram interpolation (currently performed off-line)
- Developed the capability to use a similar setup for the spectral characterisation of further infrared detector arrays