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# Advanced techniques for planetary exploration payloads development

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## Main scientific questions:

- ❑ What is the distribution of minerals on a small scale
- ❑ Are there exposed hydrated or hydroxylated minerals at sub-polar latitudes?
- ❑ Are local outcrops of hydrated minerals proxies of volatile deposits just beneath the regolith layer?
- ❑ What is the local mineralogic appearance of other sites of interest?

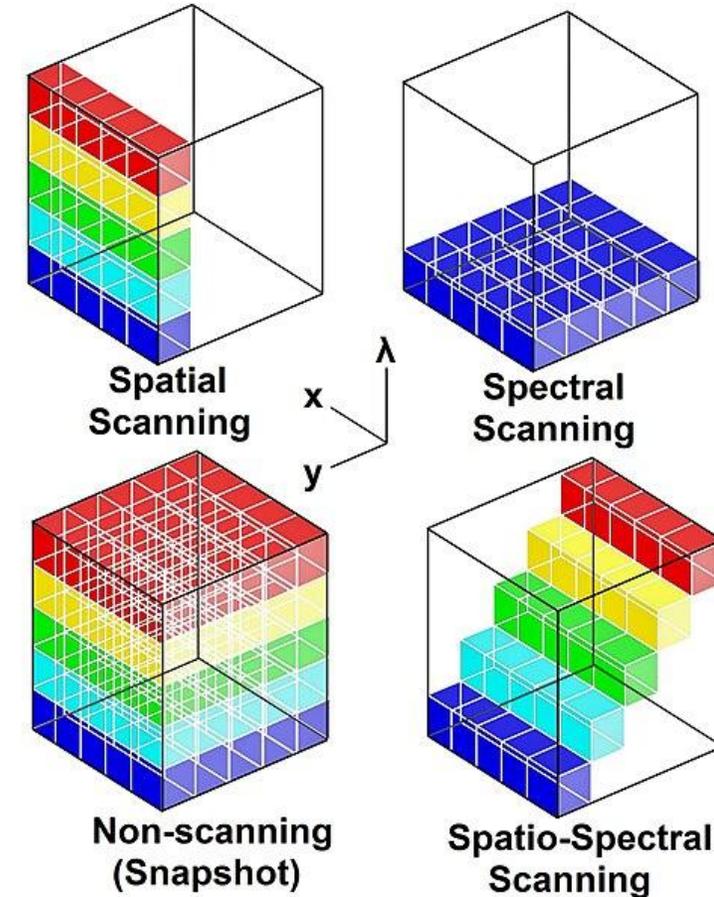
## Current state:

- ❑ Definition of the main scientific objectives and of possible optical sensors;
- ❑ Drafting of the optical paths;
- ❑ Preliminary study of the operating conditions and of the TCS.

- No imaging spectrometer has been employed on lunar rovers yet;
- Some multispectral mapping was conducted from orbit (Chandrayaan-1, LRO, etc.).



mini-TES instrument  
[https://en.wikipedia.org/wiki/Mini-TES#cite\\_note-1](https://en.wikipedia.org/wiki/Mini-TES#cite_note-1)



Acquisition techniques for hyperspectral imaging  
[https://en.wikipedia.org/wiki/Hyperspectral\\_imaging](https://en.wikipedia.org/wiki/Hyperspectral_imaging)

- One of the main challenges in the development of MINISPEC is the cooling of its IR sensor;
- Cooling of CCDs is usually achieved via cryo-coolers;
- Recent developments in TEC technology may allow for cryogenic operations.

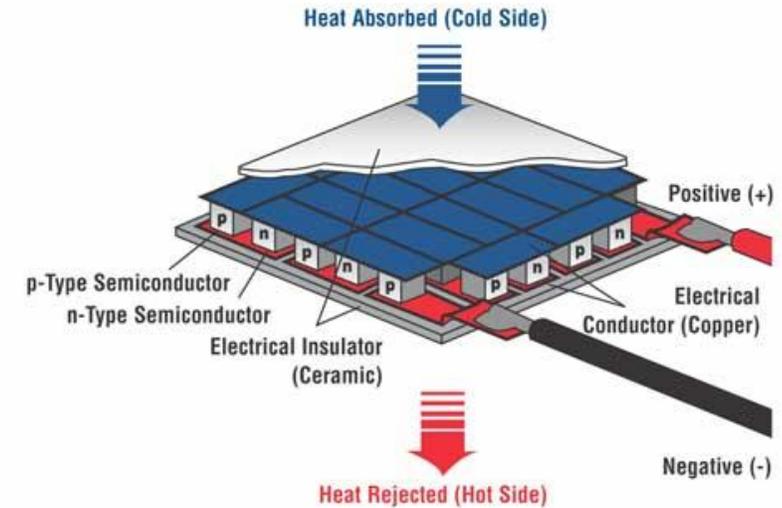


Diagram of a TEC

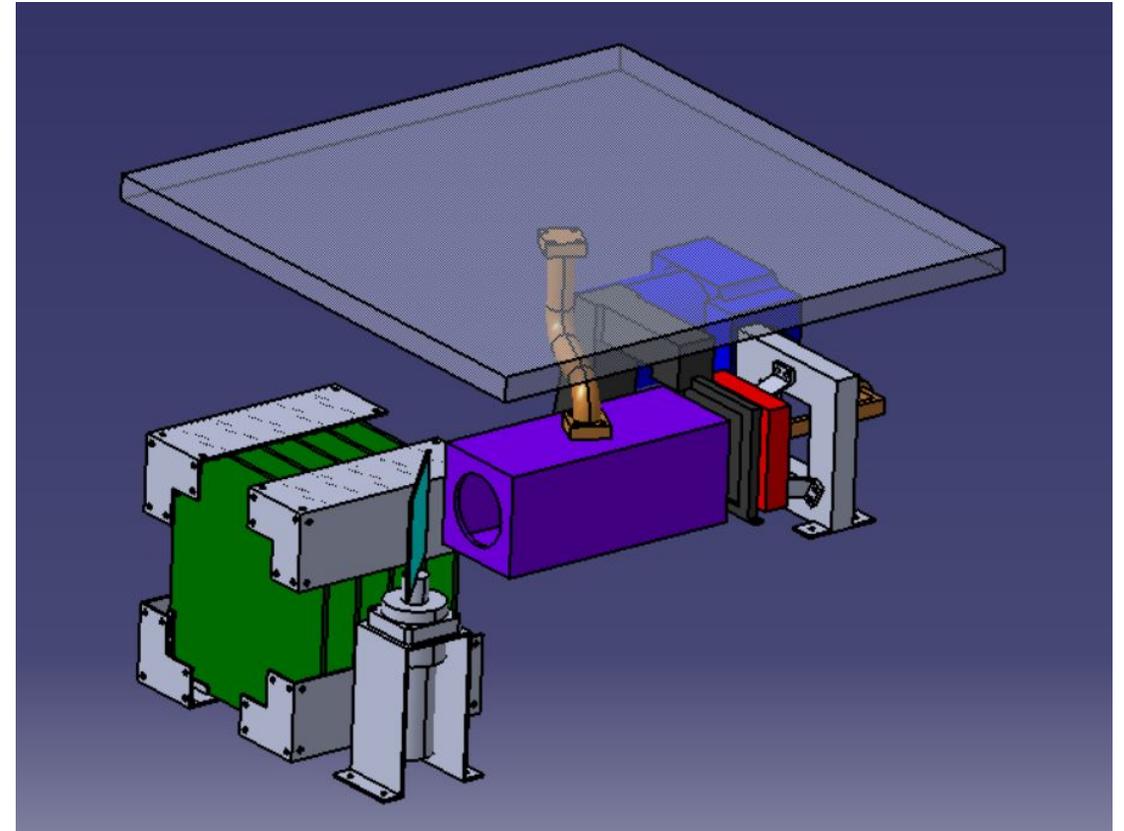
<https://www.lindenphotonics.com/understanding-thermo-electric-coolers-and-their-role-in-optical-transceivers>



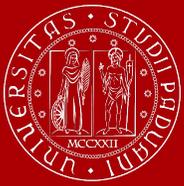
Sunpower CryoTel cooler

[https://www.sunpowerinc.com/products/stirling-cryocoolers/cryotel-cryocoolers?sc\\_lang=it-IT](https://www.sunpowerinc.com/products/stirling-cryocoolers/cryotel-cryocoolers?sc_lang=it-IT)

- Design, analysis, prototyping and testing of MINISPEC's optical bench;
- Comparative study of COTS and developmental cryo-cooling technologies and of the effect of various shading techniques;
- Feasibility analysis, sizing, manufacturing and testing of Bi-Sb alloy multi-TECs;
- Feasibility analysis and preliminary implementation of an IMU-based technique for the reconstruction of the data-cube.



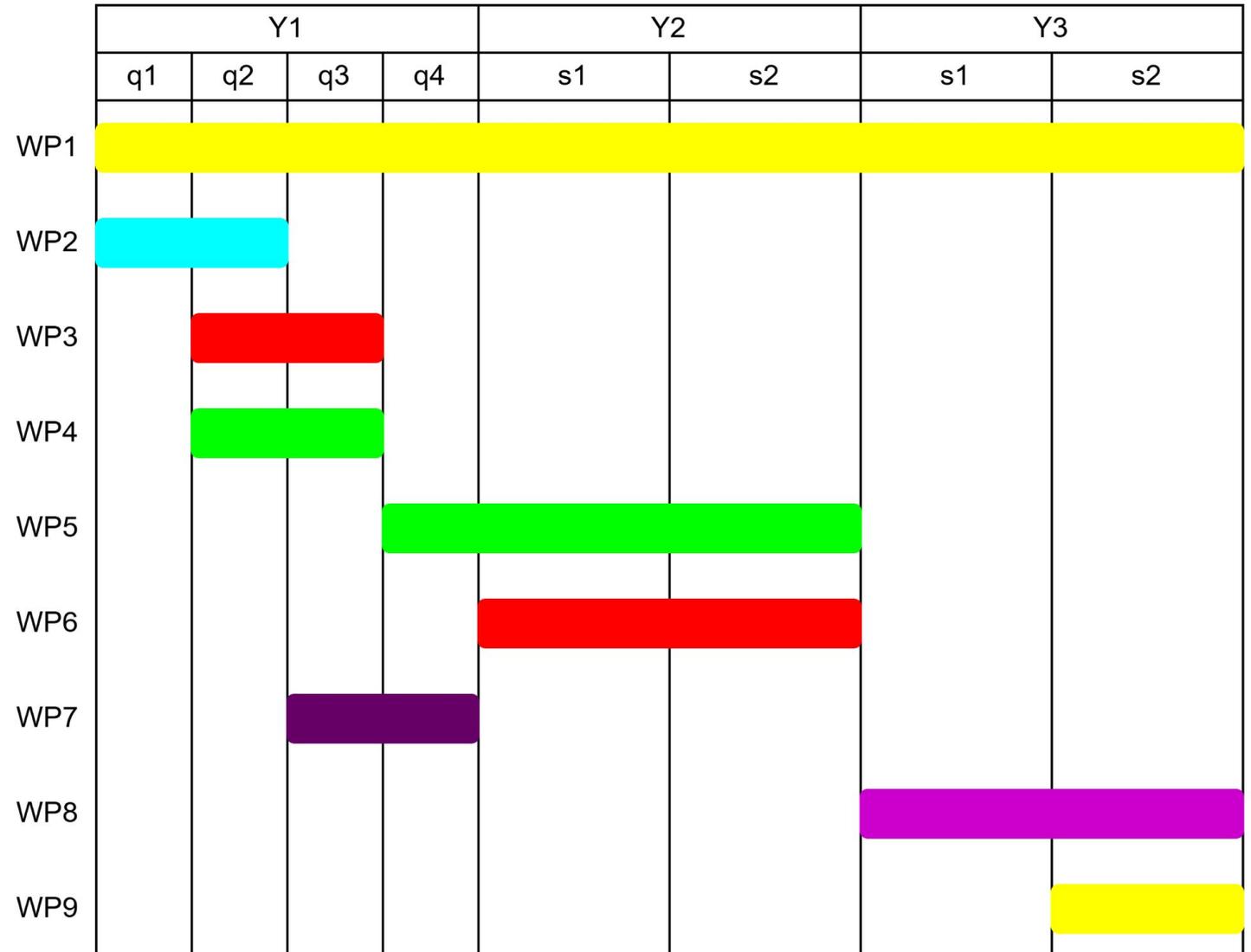
Preliminary layout for the MINISPEC instrument



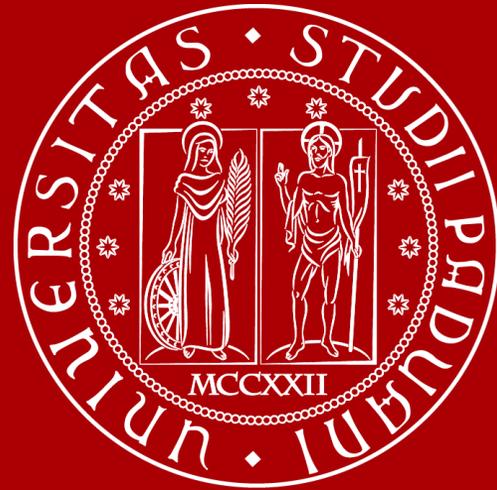
# WBS & GANTT



WBS ID	Work Package	Effort [h]
WP1	Project management and dissemination	225
WP2	Background review and requirements capture	450
WP3	Comparative study of thermal control solutions	675
WP4	Optical bench concept design and preliminary analyses	675
WP5	Detailed design, analysis, prototyping and testing of the selected optical path	900
WP6	TEC/cryocooler sizing and testing	675
WP7	IMU-based data-cube reconstruction, feasibility and preliminary integration	450
WP8	System integration and testing	225
WP9	Writing of the thesis and final deliverables	225



Thanks for the attention



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