# FISICA: FAR-INFRARED SPACE INTERFEROMETER CRITICAL ASSESSMENT.

## SCIENCE DRIVERS DEFINITION AND TECHNOLOGY DEVELOPMENT

Giorgio Savini on behalf of the FP7-FISICA Consortium

# THE CONSORTIUM

Far Infrared Space Interferometer Critical Assessment

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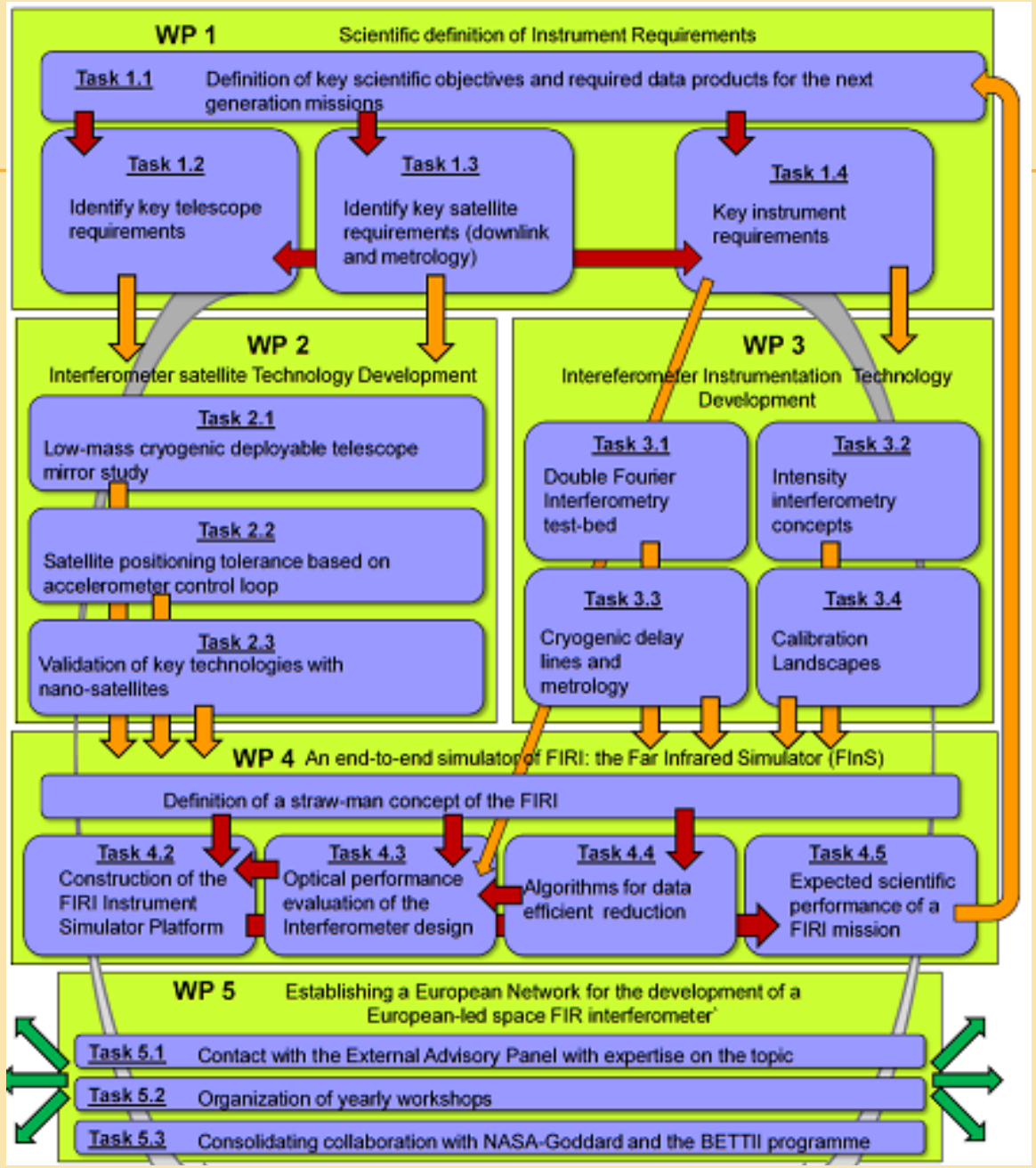
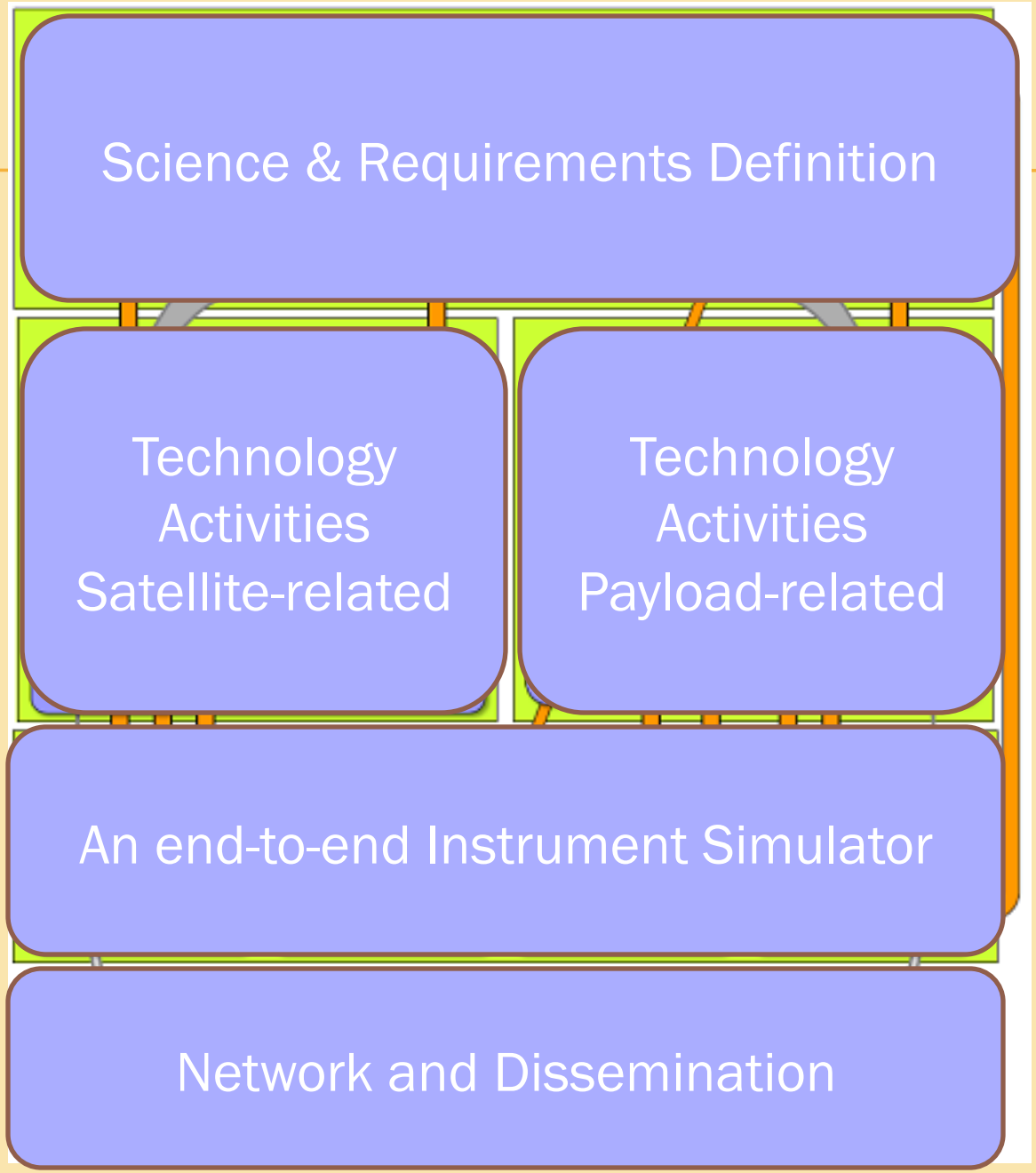
# FISICA ACTIVITIES



# FISICA ACTIVITIES

- Science & Requirements Definition
- Technology Activities
- Instrument Simulator Software
- Dissemination and Networking



# SCIENCE NEEDS

Near

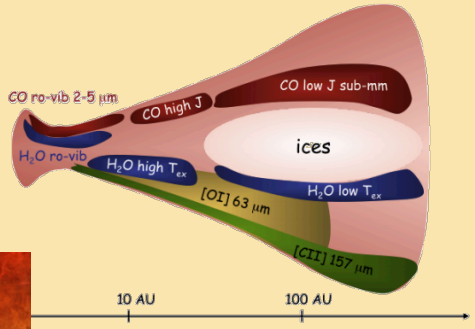
Dust and Debris-discs

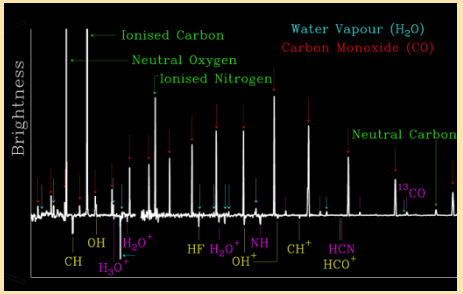
Star formation

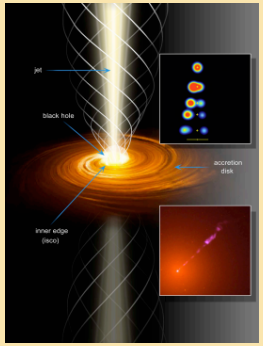
The nearby universe

The evolving universe

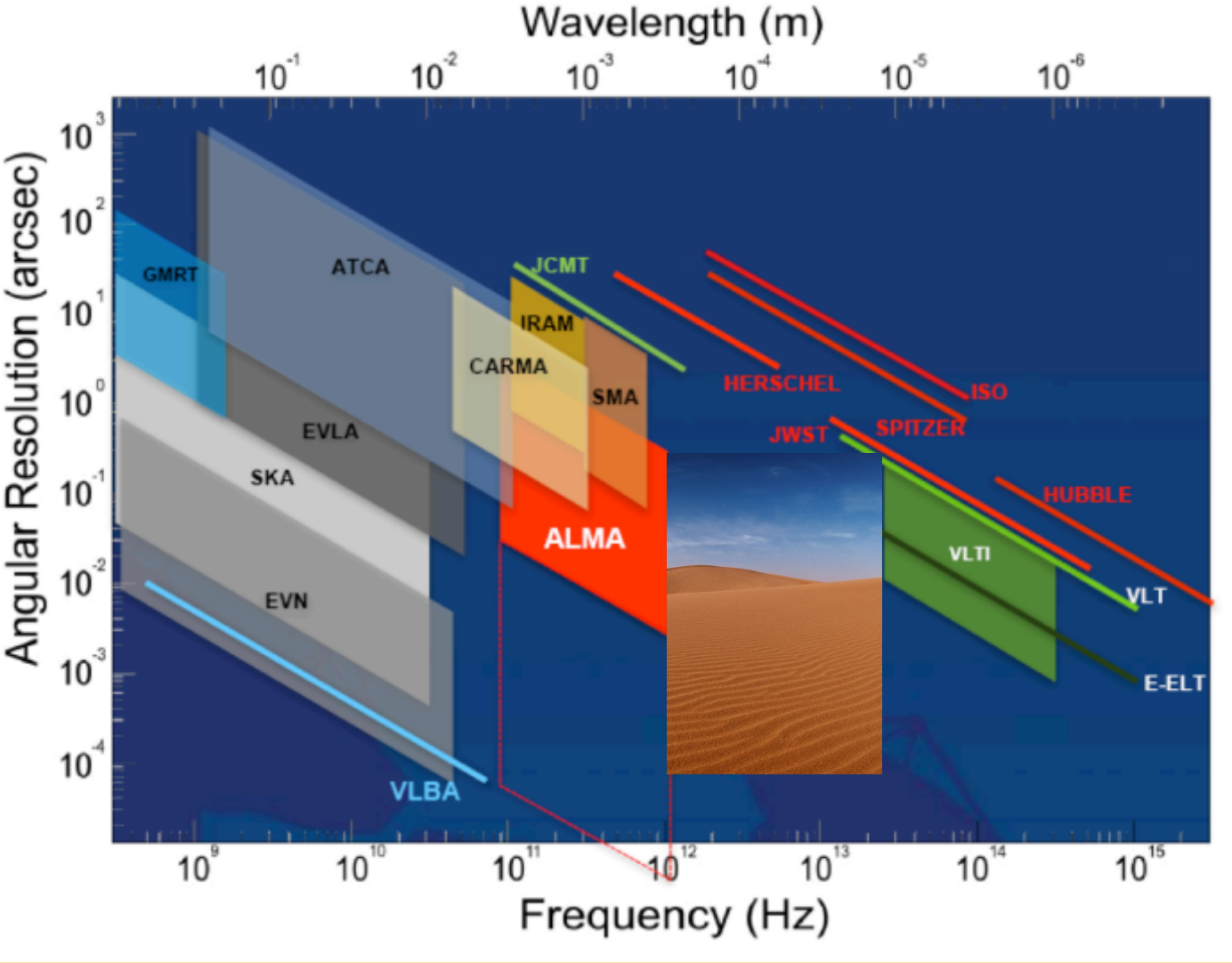
Far



# SCIENCE IN CONTEXT



# DATA PRODUCTS

| Instrument Characteristics | | |
|---|---|---|
| Primary diameter | 2 m | ext |
| Baseline Range | 0, 10-100m | ext |
| Optics Temperature | 4K cryo-cooled | (1) |
| Configuration | Rigid Truss or Tether | (3) |
| Mission Lifetime | 3-5Yrs | ext |
| Sky Coverage | +/- 20 deg. from ecliptic | (1,2) |
| Spectral Coverage (µm) | 25-50,50-100,100-200,200-400 | (1) |
| Detector Arrays (35/70/140/280µm) | 2x(28x28/14x14/8x8/4x4) | (*) |

Derived parameters:

| | | |
|---|---|---|
| Angular resolution | 0.1 (lambda/100um) arcsec | (1) |
| Field of View | 1 arcminute | (1,3) |
| Spectral resolution | ~3000-5000 | (1)ext. |
| Point Source Sensitivity (5s in 24hrs)<br>-) Spectral Line ($10^{-19}$ W/m$^2$)<br>-) Continuum (µJy) | (35 / 70 / 140 / 280) µm<br>0.7 / 0.4 / 0.3 / 0.3<br>3.5 / 5 / 7.5 / 12 | Ext. |
| Typical Observation Time | 1 day | (1) |

Initial numbers were based on an ideal-element sensitivity model
Consistent with a scaled version of the NASA-concept SPIRIT.

# INSTRUMENT REQUIREMENTS

## The Sensitivity Spreadsheet

Inter-connected sections with mutual dependencies.

Final Performances are gathered in the “performance sheet”.

Log | Inst Performance | Spacecraft | Interferometer | Telescopes | Inst Spectral | Inst_ColdOptics | Inst_detectors | Electronics&Data | SKY & Sources | Wavelengths | Enzo

| | SPACECRAFT SPECIFIC PARAMETERS | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Quantity | Description | Symbol | Value | Units | Value | Units | Comments | Dependencies |

| | INTERFEROMETER ARCHITECTURE PARAMETERS | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Quantity | Description | Symbol | Value | Units | Value | Units | Comments |

| | DETECTORS - PARAMETERS | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Quantity | Description | Symbol | Value | Units | Value | Units | Dependencies |

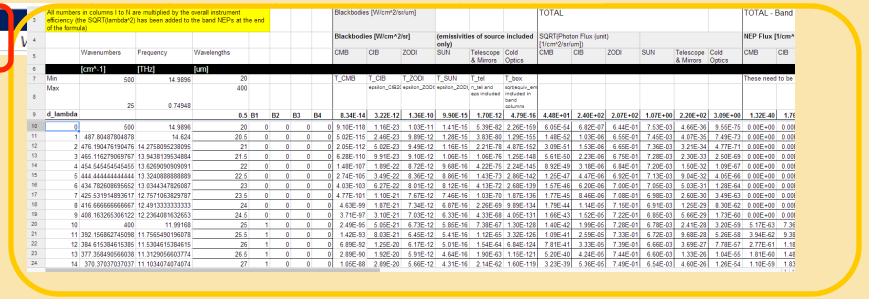
| | TELESCOPE PARAMETERS | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Quantity | Description | Symbol | Value | Units | Value | Units | Comments |

| | INSTRUMENT SPECTRAL ARCHITECTURE DEFINITION | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Quantity | Description | Symbol | Value | Units | Value | Units | Comments |

| | COLD OPTICS PARAMETERS | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Quantity | Description | Symbol | Value | Units | Value | Units | Comments |

| | ELECTRONICS and DATA Parameters | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Quantity | Description | Symbol | Value | Units | Value | Units | Comments |

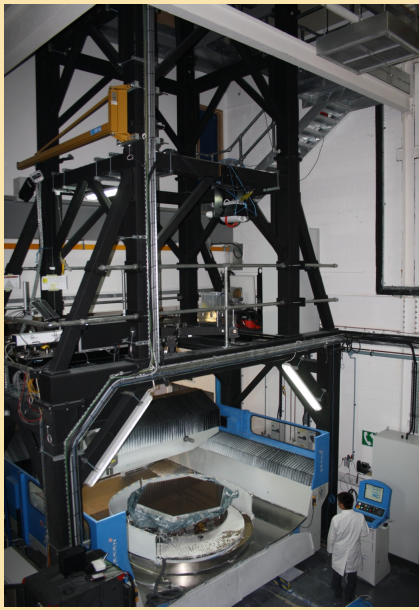
| | SKY & SOURCES PARAMETERS | | |
|---|---|---|---|
| | Quantity | Description | Symbol |



| | INSTRUMENT PERFORMANCE QUANTITIES | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Quantity | Description | Symbol | Value | Units | Value | Units | Comment |

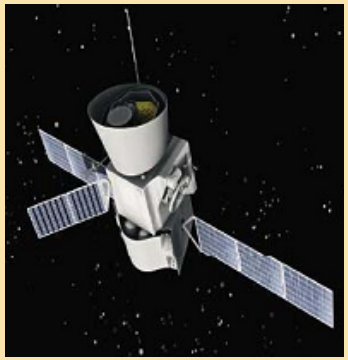
# SATELLITE-RELATED ACTIVITIES

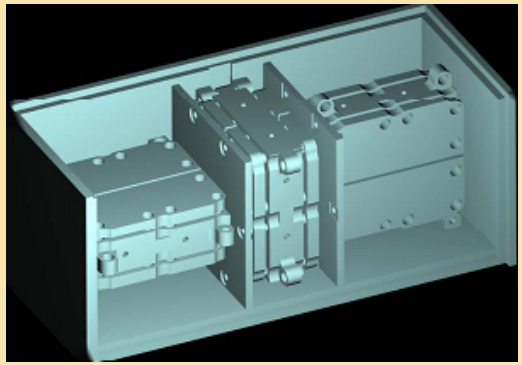
Study of tolerances and other implications of CFRPs for light-weight deployable mirrors

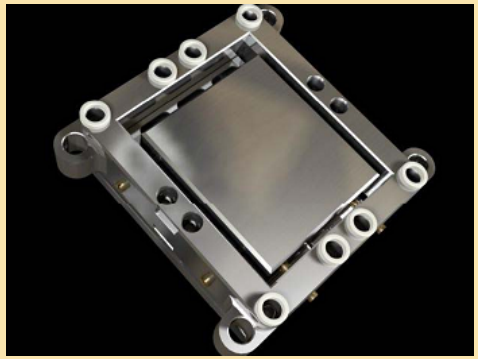



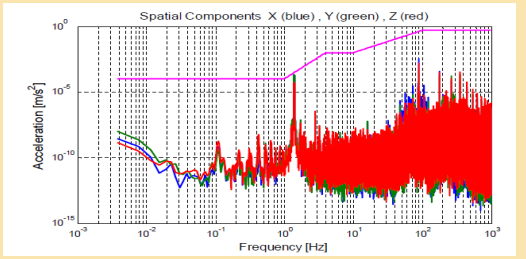
# SATELLITE-RELATED ACTIVITIES

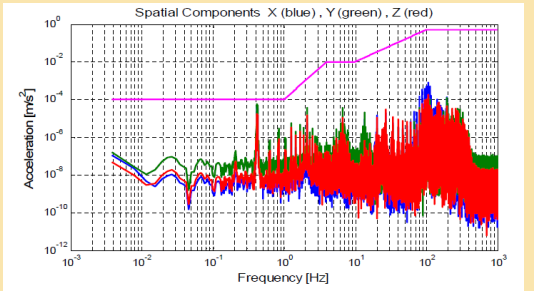
Satellite motion tolerances based on accelerometer control loop

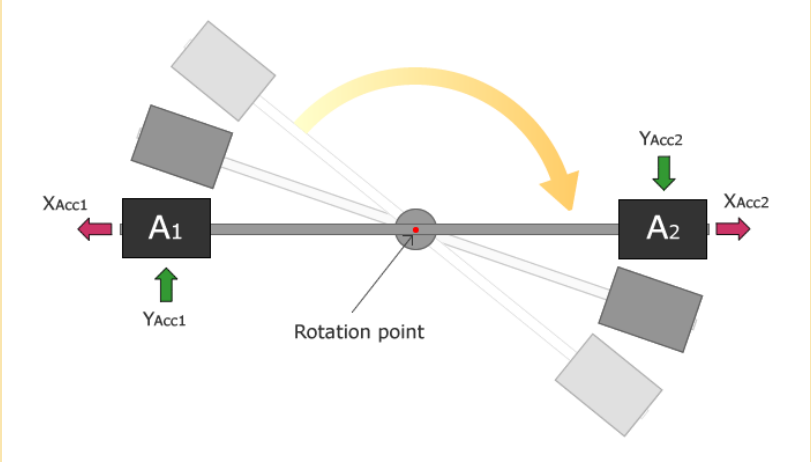


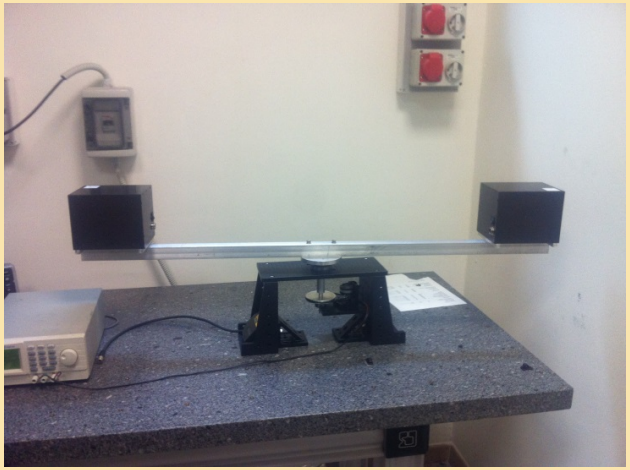






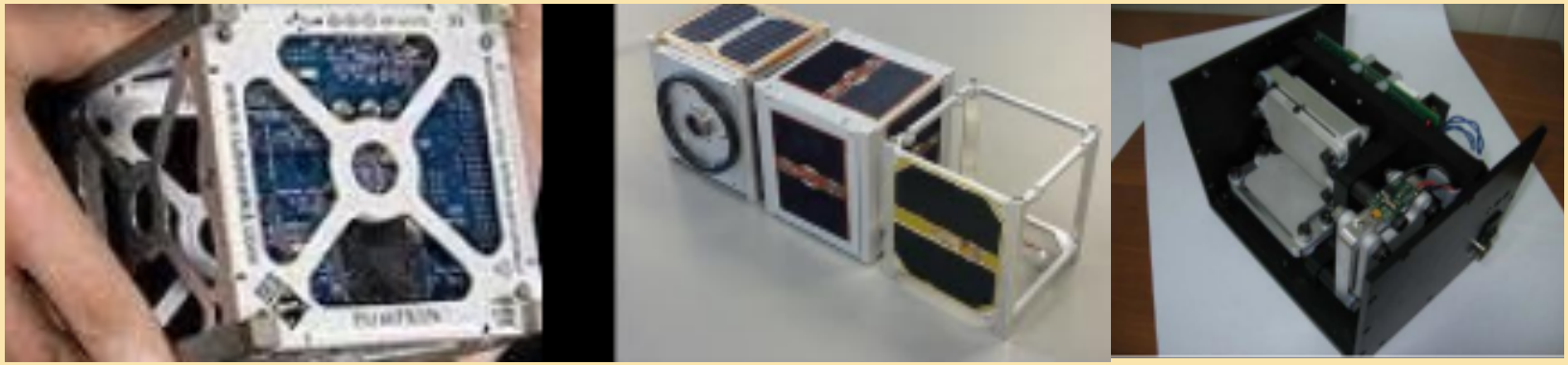



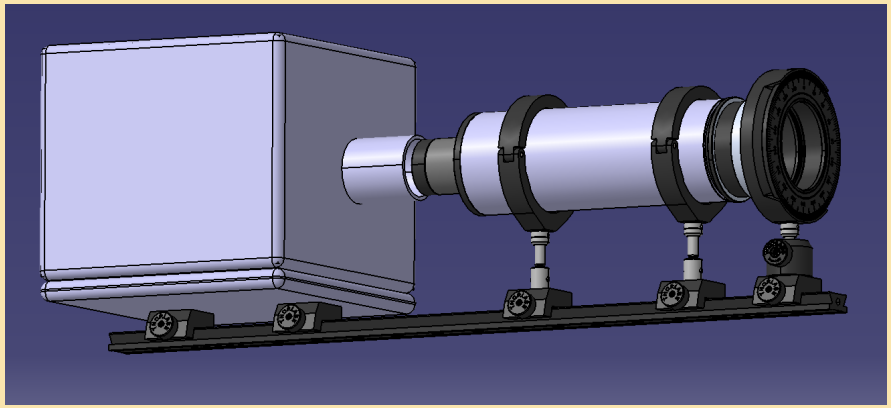



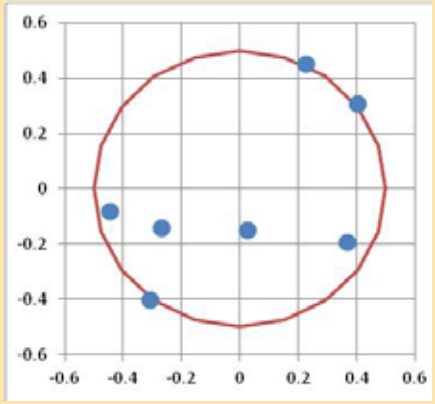
# SATELLITE-RELATED ACTIVITIES

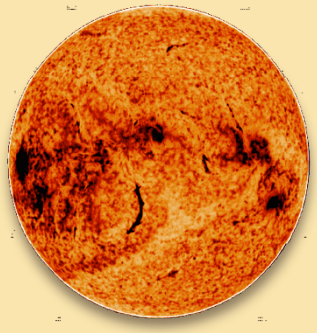
LAM
LABORATOIRE D'ASTROPHYSIQUE DE MARSEILLE

## Nano-satellite test-bench validation



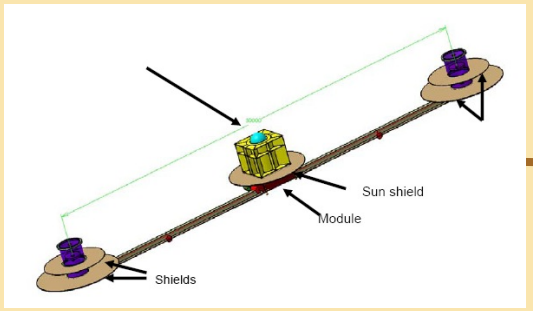


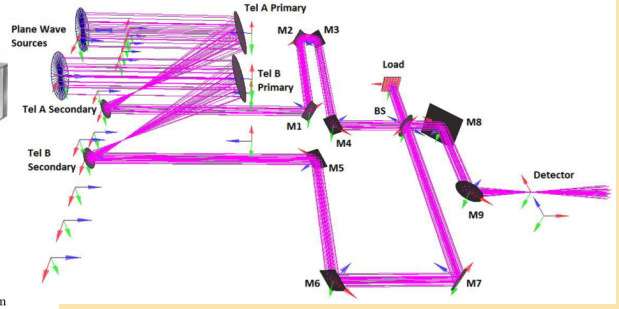


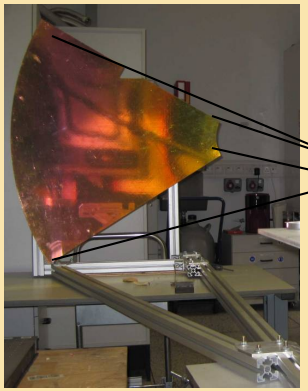



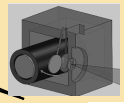
# PAYLOAD-RELATED ACTIVITIES

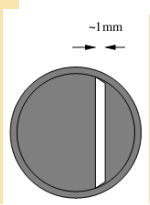
## A Double-Fourier Modulation test-bed for the 30-300um range

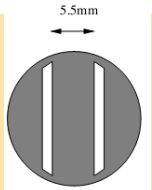


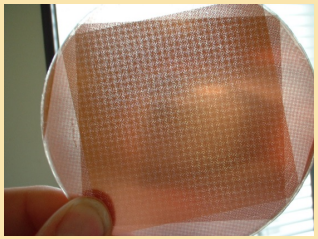



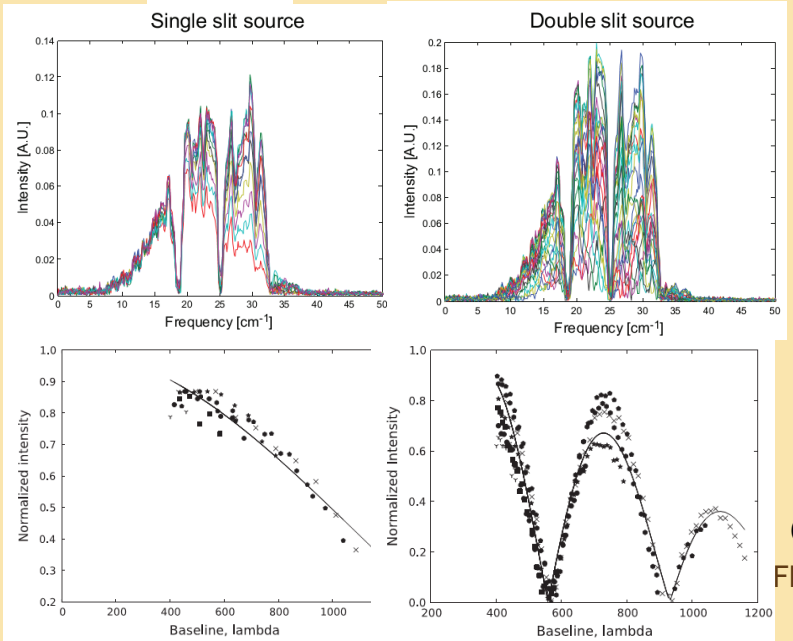







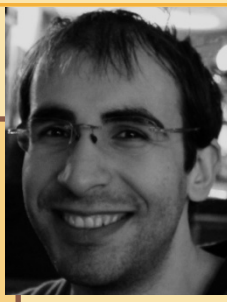



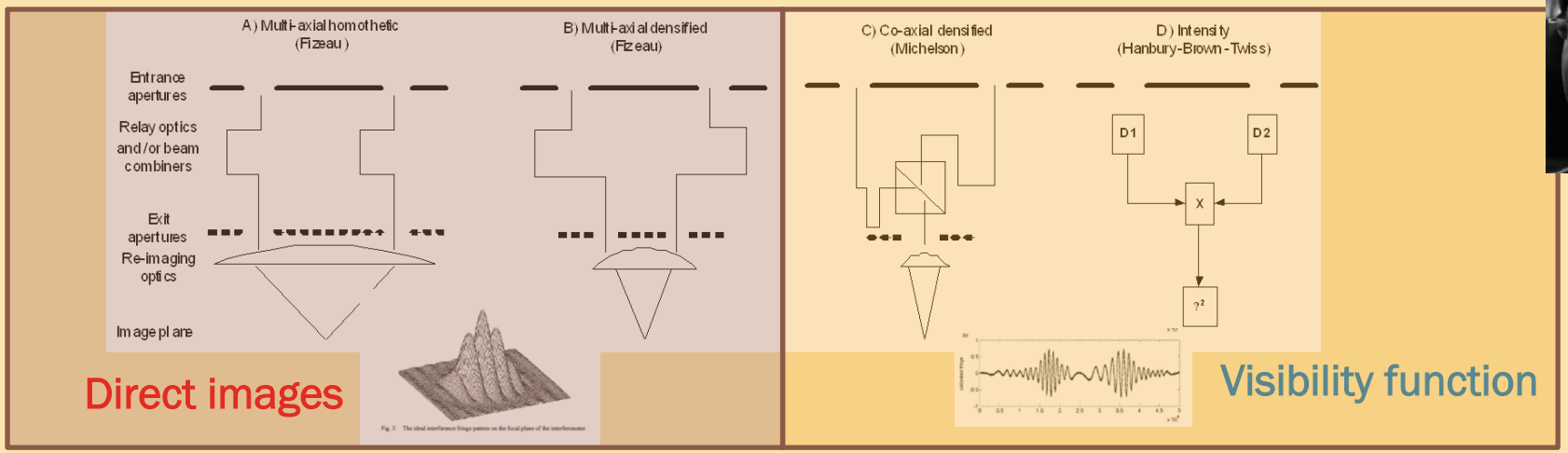



Grainger et al. 2012

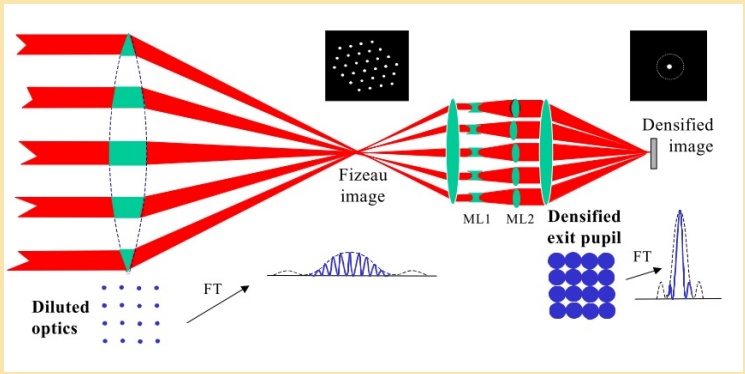
# PAYLOAD-RELATED ACTIVITIES

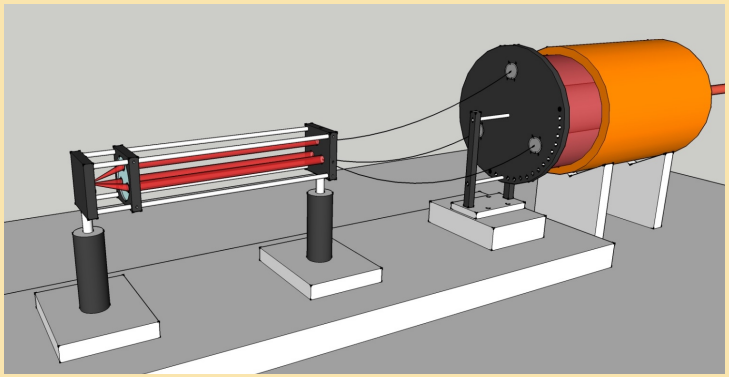
## Study of alternative techniques





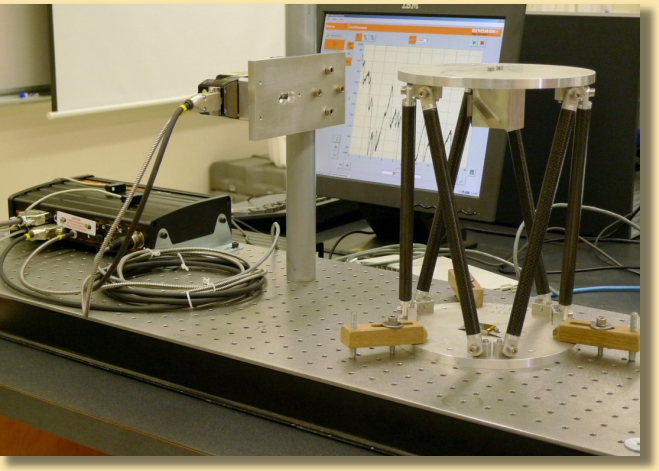

van der Avoort et al. (2007)

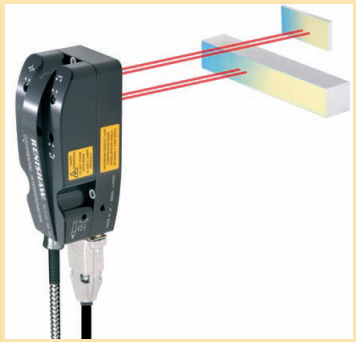


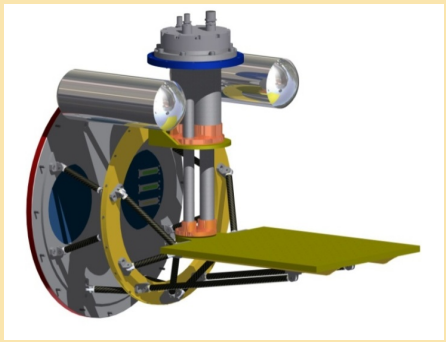



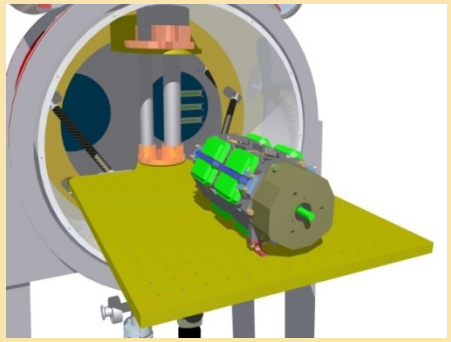
# PAYLOAD-RELATED ACTIVITIES

## Cryogenic (4K) delay-line metrology



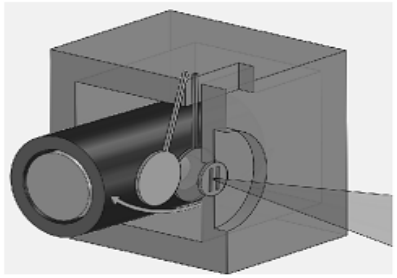


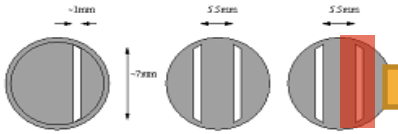


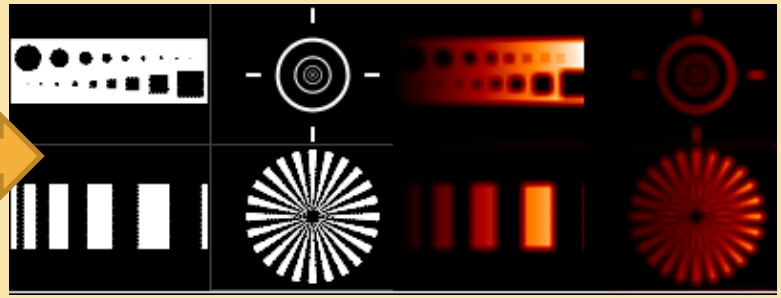


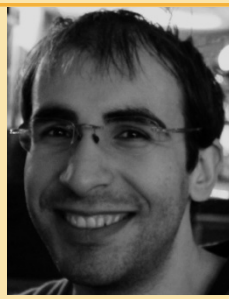

# PAYLOAD-RELATED ACTIVITIES

## Complex Calibration Sources

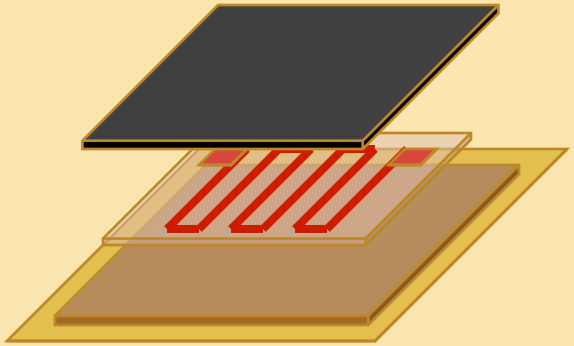


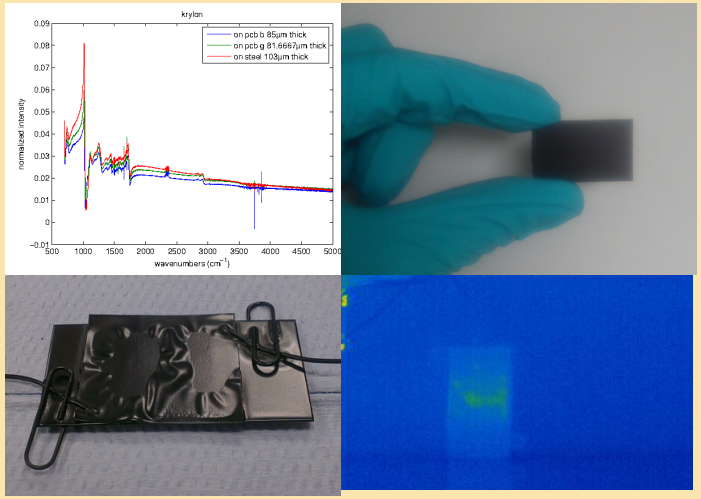


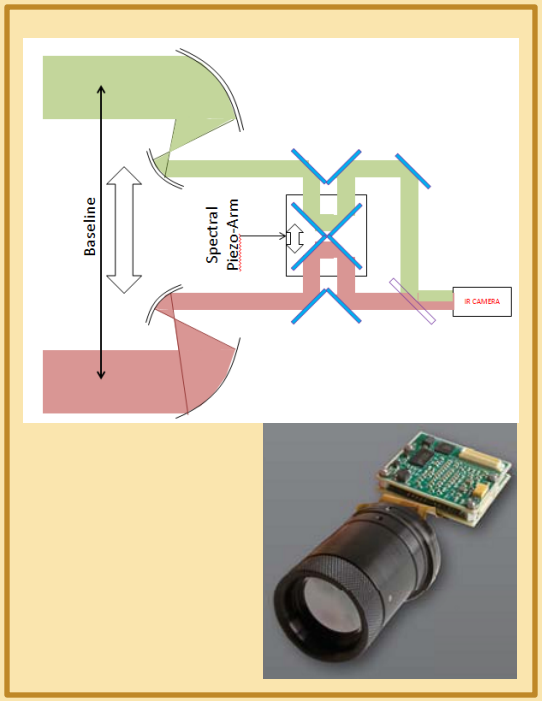





Polypropilene based copper dissipator

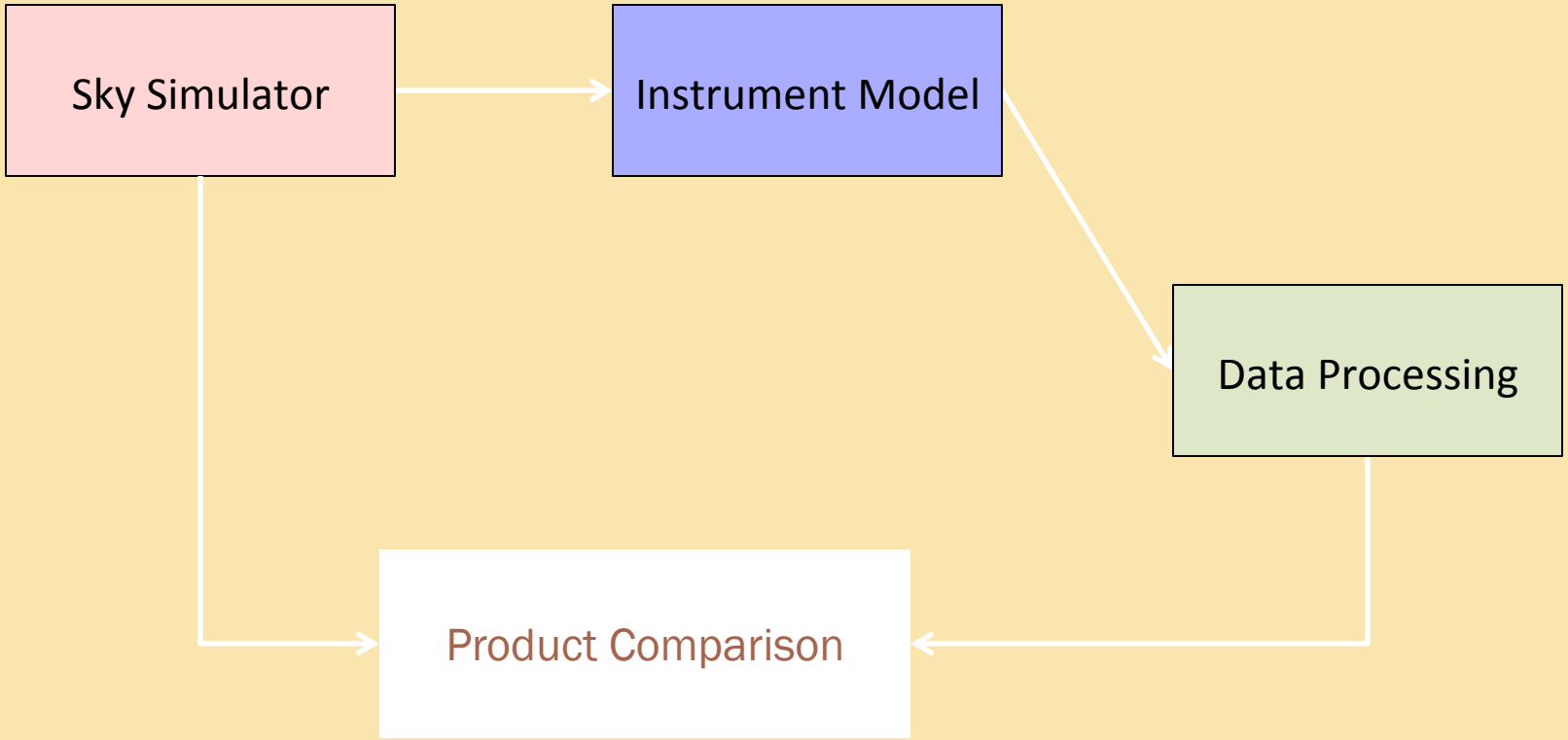




# FIINS (FAR INFRARED INSTRUMENT SIMULATOR) - 1

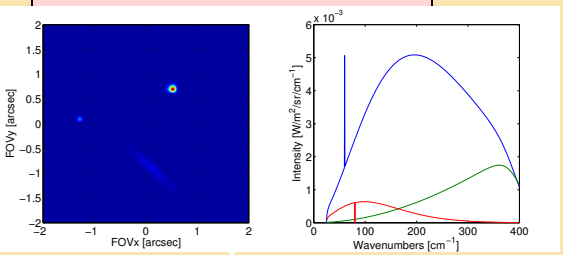
Based on the original work of Roser Juanola-Parramon (Doctoral Thesis)

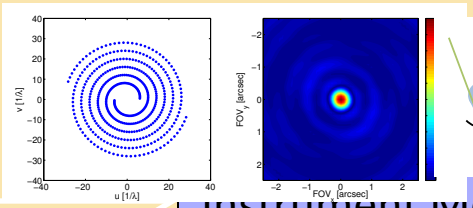


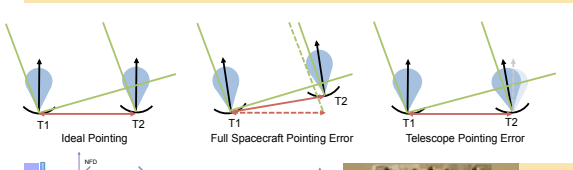
# FIINS (FAR INFRARED INSTRUMENT SIMULATOR) - 1

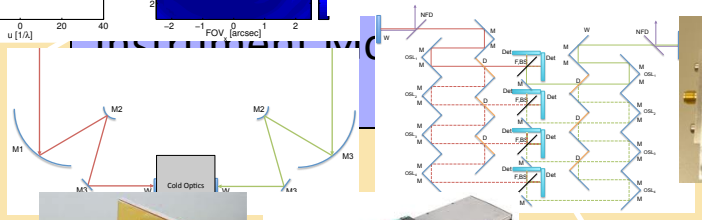
Based on the original work of Roser Juanola-Parramon (Doctoral Thesis)

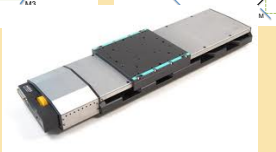
## Sky Simulator



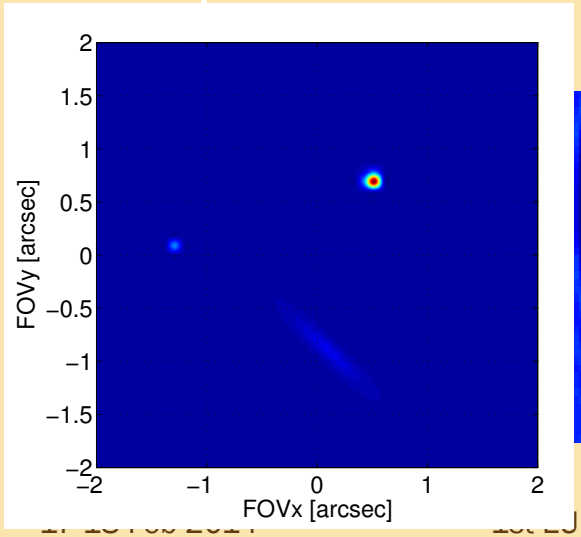



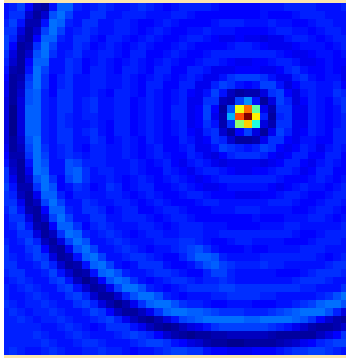


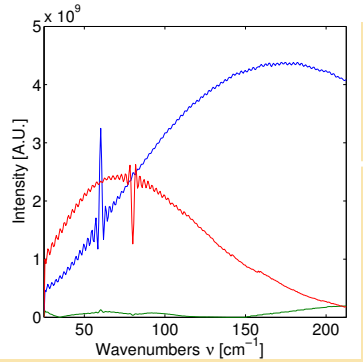


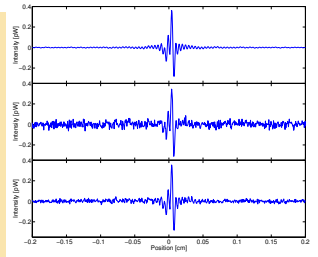
## Data Processing

$$Ig(\delta,b) = I_1 + I_2 + 2\sum_{i=0}^{N_{FOV}}\sum_{j=0}^{N_{FOV}}\sum_{k=0}^{N}|SkyC(\theta_{x,i},\theta_{y,j};\nu_k)|\cos[2\pi\nu_k\delta - 2\pi\nu_k(\mathbf{b}\cdot\boldsymbol{\theta})]$$





# EU - NETWORK

## DISSEMINATION

**WP 5** European Network creation for the development of a European-led space FIR interferometer

- **Task 5.1** Contact with the External Advisory Panel with expertise on the topic
- **Task 5.2** Consolidating collaboration with NASA-Goddard and the BETTII programme

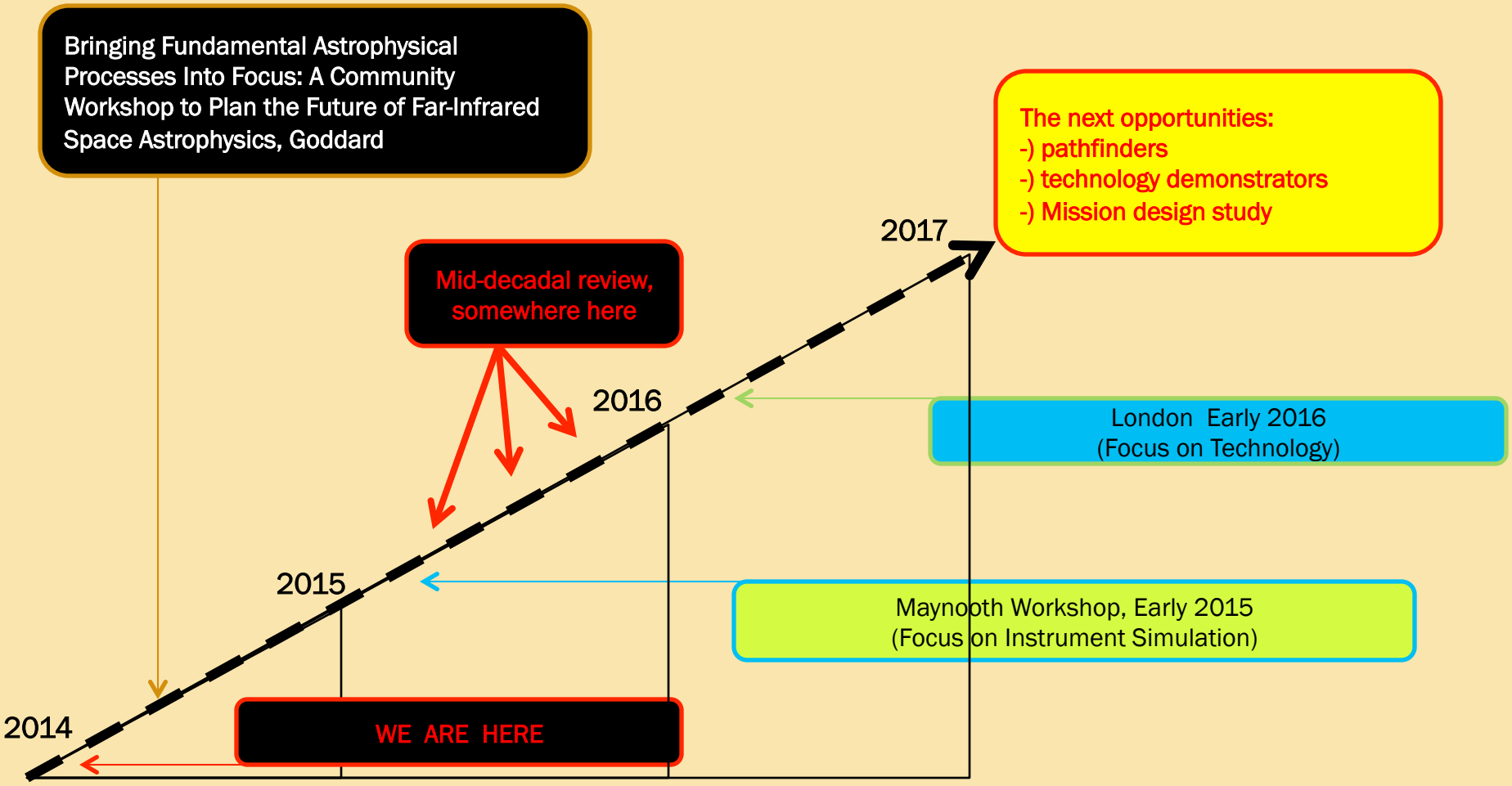
**WP 6** Dissemination of scientific results

- **Task 6.1** Organization of yearly workshops
- **Task 6.2** Participation to conferences

# EU - NETWORK

## DISSEMINATION

Yearly workshop as a reference and to allow focused approach



# CONCLUSIONS

- 2013 has been an exciting (not all good) year for the far-infrared
  - "Death" of Herschel, but not of its science
  - L2/L3 call – pooling of ideas and resources
  - The SPICA next step…

- FISICA-FP7 will focus on the identification and definition of the key data products required from the science + analysis of the requirements of a space interferometer to achieve these.

- Technological activities relevant to satellite and instrument have commenced

- While the program cannot be comprehensive of all techniques and existing technology groups interested in the FIR, the Networking and Dissemination elements allow for a regular note-comparing exercise in order to keep focus

- For information on the Consortium (and future related workshops):
  www.fp7-fisica.eu

- There is a plan (not yet implemented) to use the webpage as a repository of Far-Infrared science and mission concepts to allow the community to access relevant information as required.

# THANKS FOR YOUR KIND ATTENTION

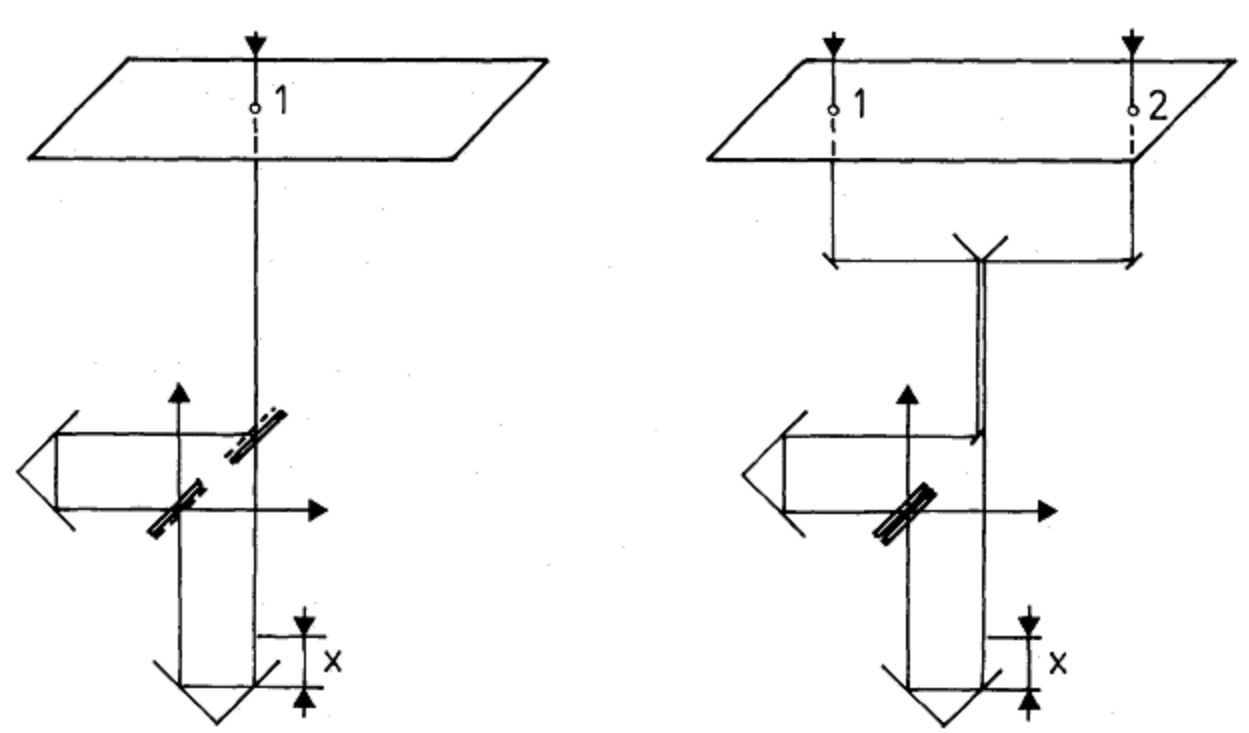
# ADDITIONAL MATERIAL

# DOUBLE-FOURIER MODULATION (DFM)

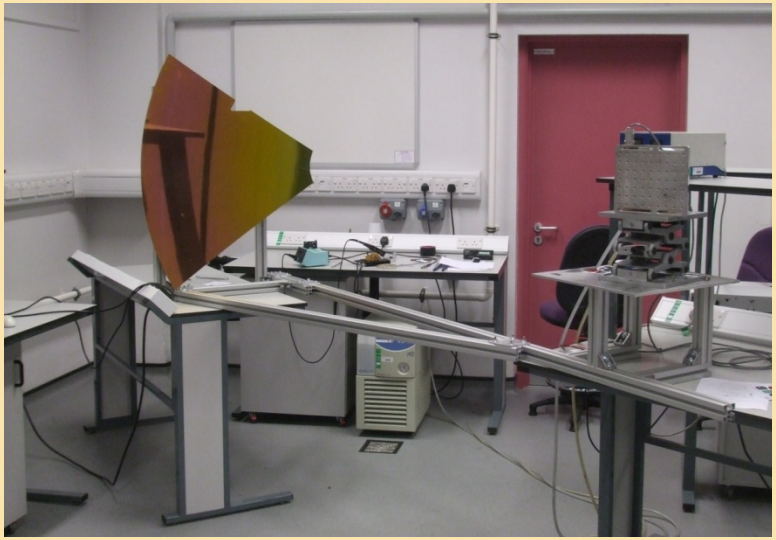
Astron. Astrophys. 195, 350–363 (1988)

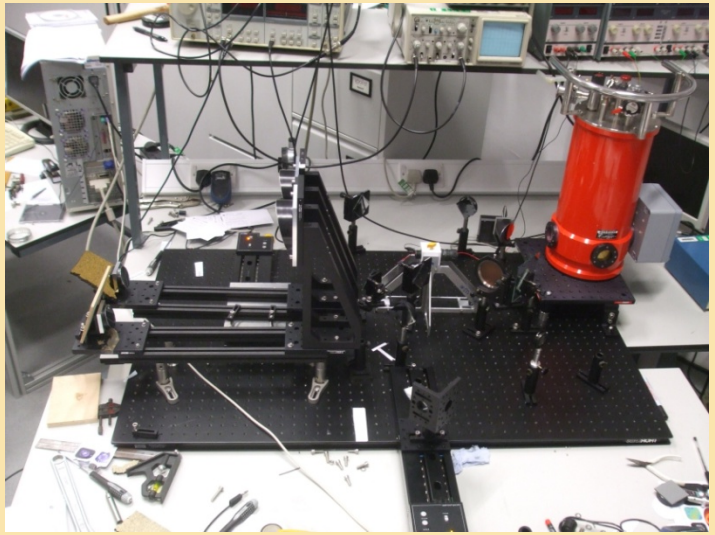
**Double Fourier spatio-spectral interferometry: combining high spectral and high spatial resolution in the near infrared ***

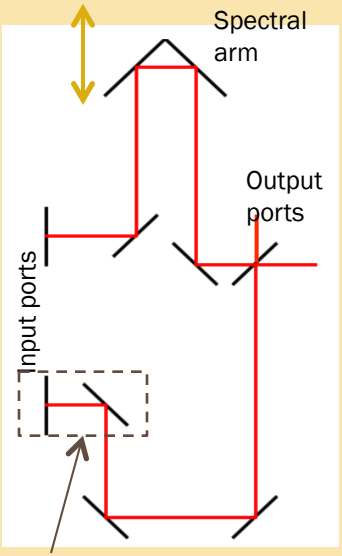
J.-M. Mariotti [1] and S.T. Ridgway [2]

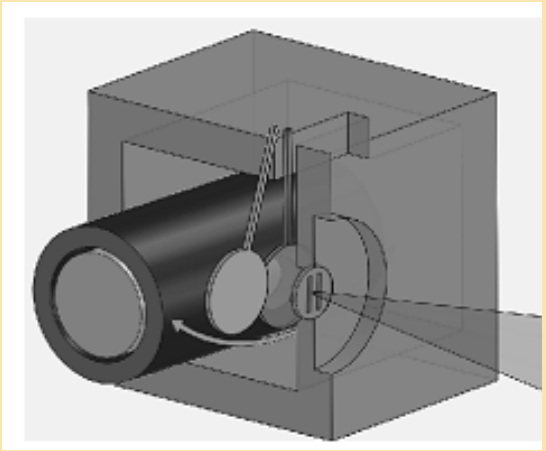


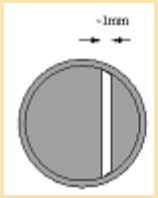
# A TEST-BED FOR THE FIRI OPTICS DEVELOPMENT

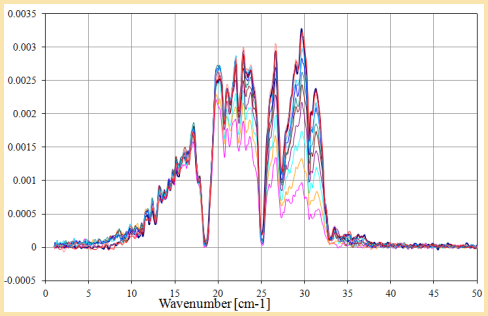


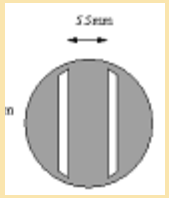


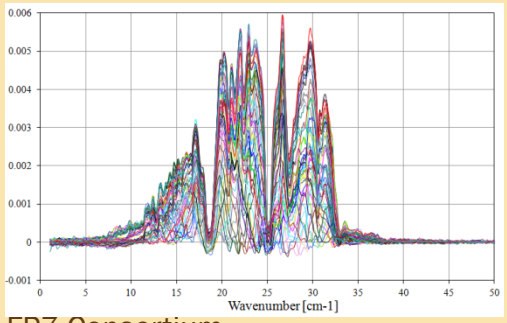




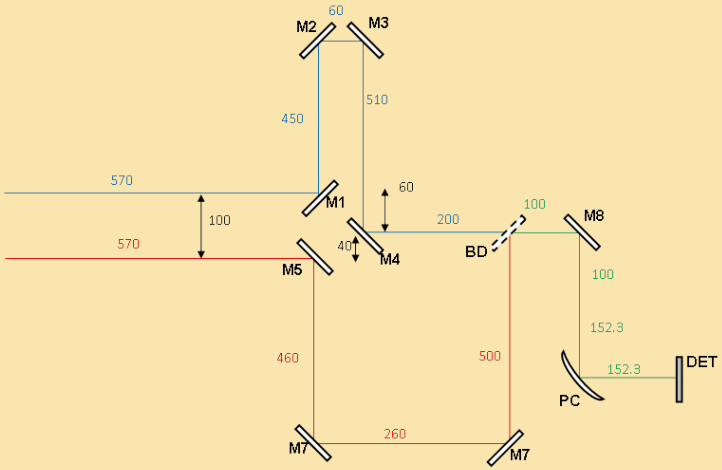


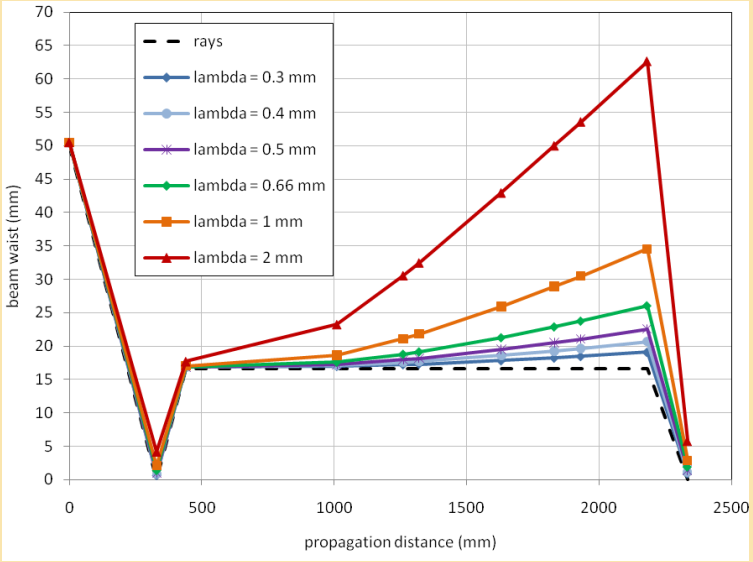





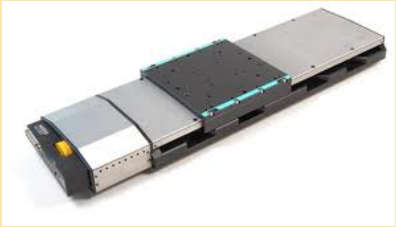
# TEST-BED UPGRADES PLANNED - MID & FAR INFRARED

## Detailed optical modelling



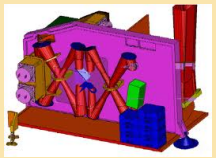



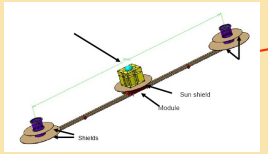

## Upgrade metrology

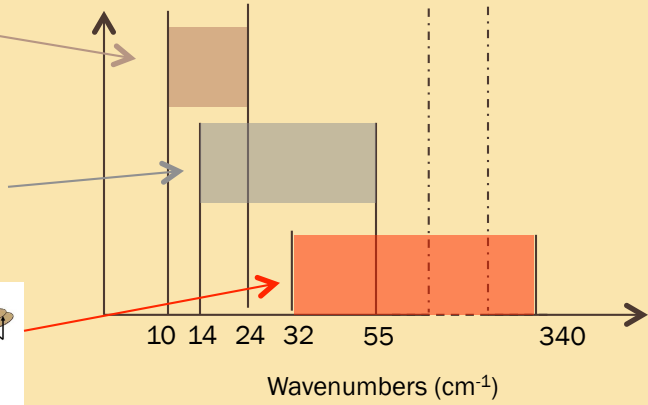


# TEST-BED UPGRADES PLANNED - MID & FAR INFRARED

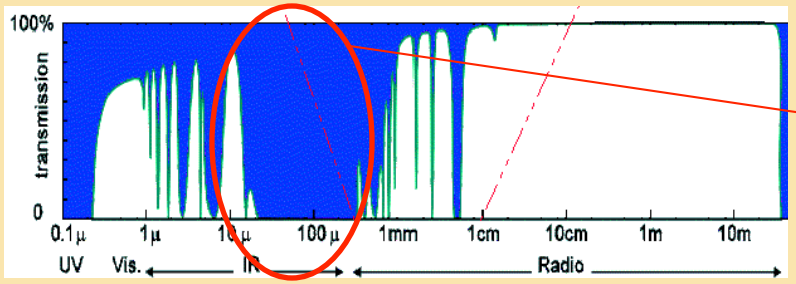
A wide-band beam splitter (or maybe two)





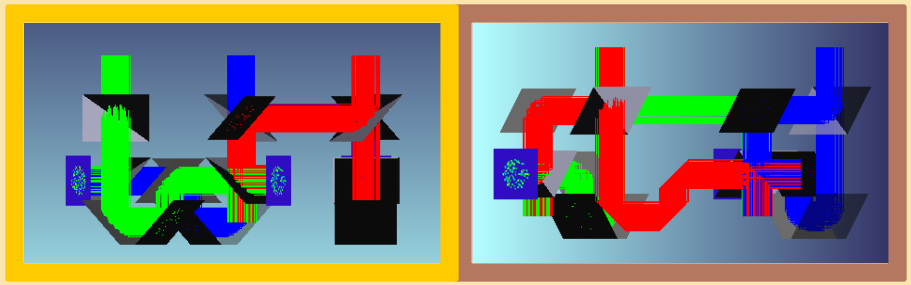


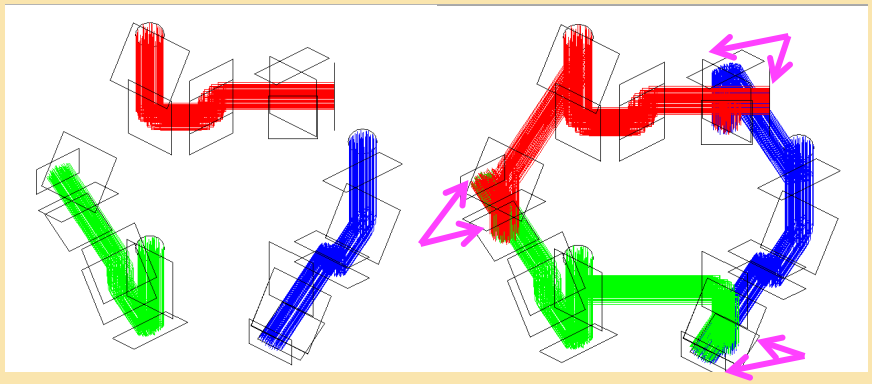

Optical bench conversion

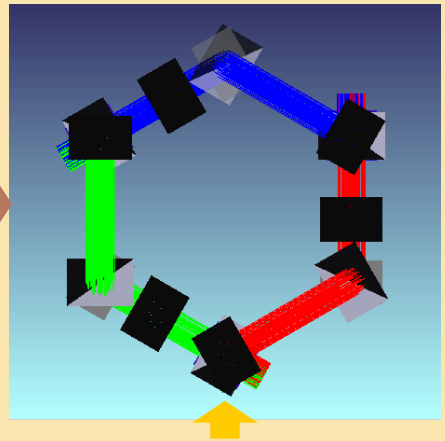



# TEST-BED UPGRADES PLANNED – 3 BEAMS?

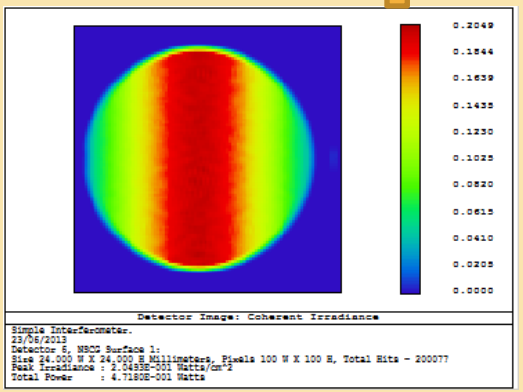
Detector planes

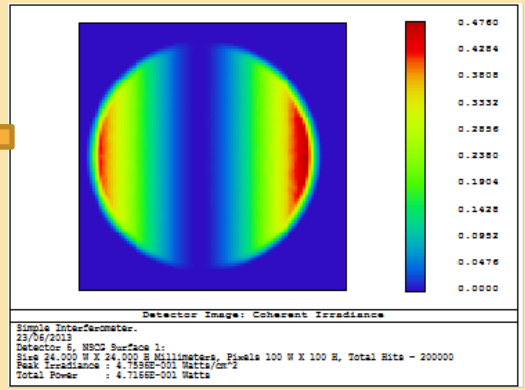




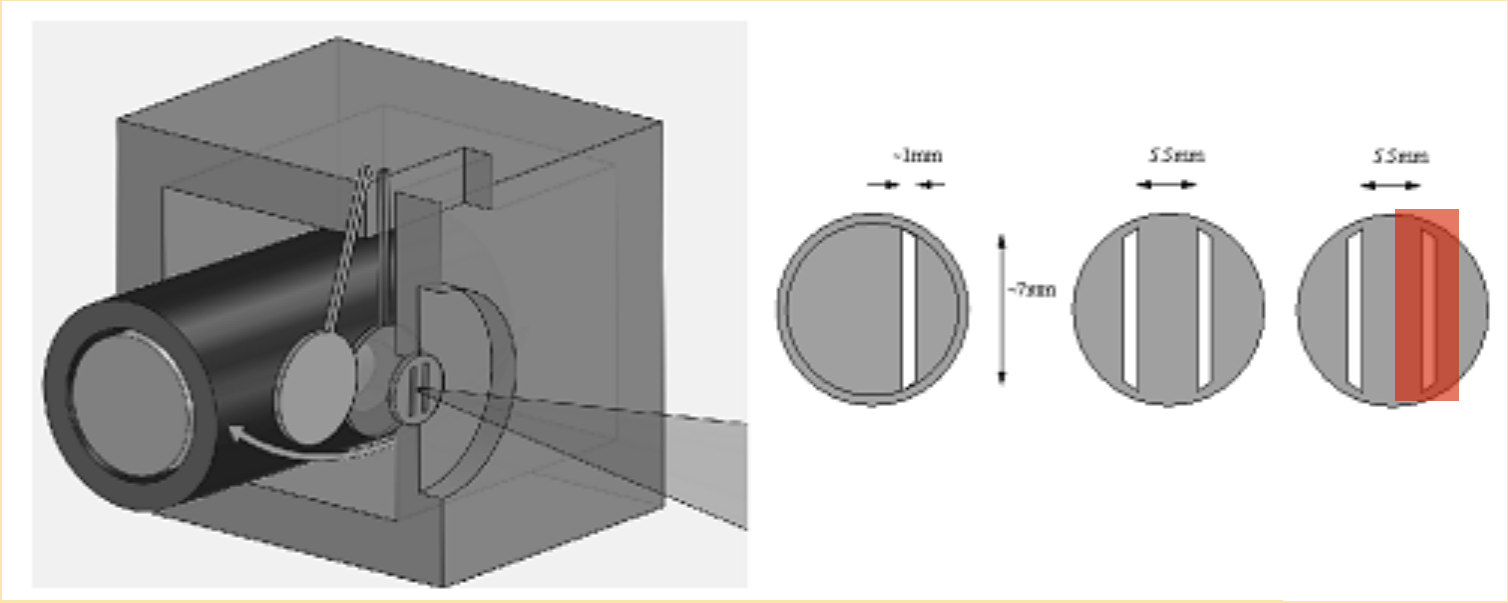


With additional K-mirrors for image rotation.



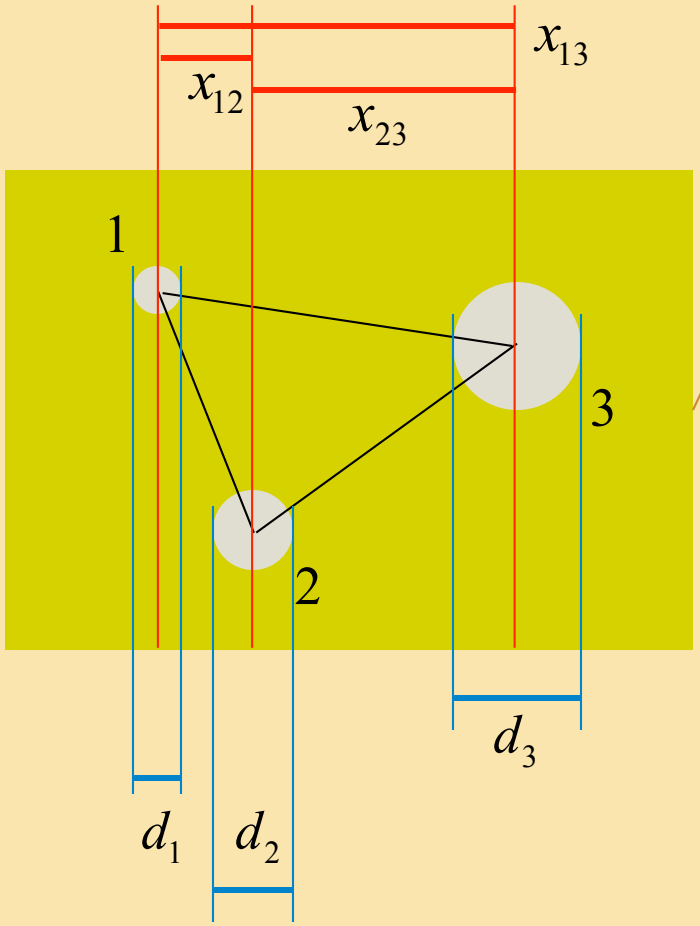



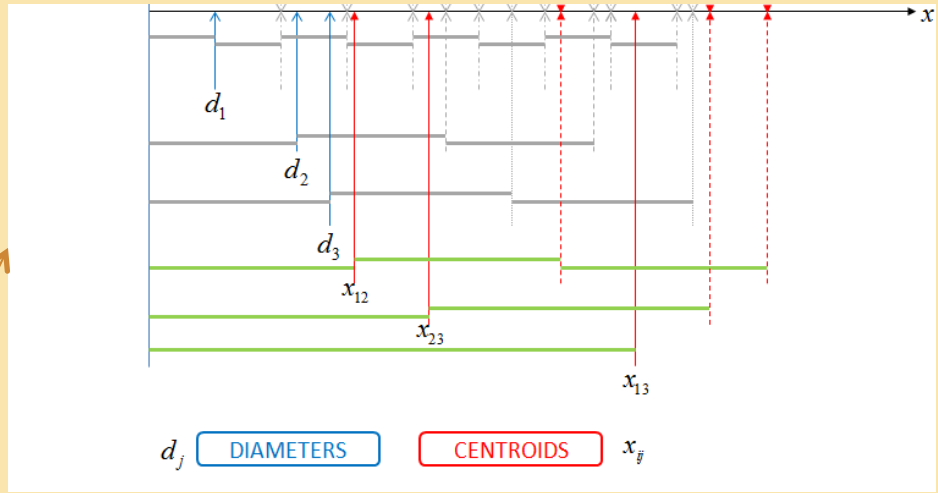
# CALIBRATION SOURCES (FROM SIMPLE TO COMPLEX)



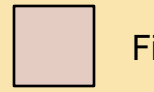

Grainger et al. 2012

# CALIBRATION SOURCES (FROM SIMPLE TO COMPLEX)



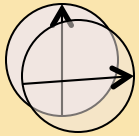




Potentially covered by



Filters

Diaphragms



Variable FP-etalon

# CALIBRATION SOURCES (FROM SIMPLE TO COMPLEX)