LIÈGE université

Hi-5 kickoff meeting

Liège, Oct. 2-3

Hi-5

High-contrast Interferometry
up to 5 microns

Welcome!

LIÈGE
université

Welcome!

Older than Belgium!

Lunch today

Poivre et Sel

- When: 12:30pm
- Where: 33, rue de l'Université

Dinner tonight

As Ouhes

- When: 7:30pm
- Where: Place du Marché 21, 4000 Liège

Context

- OPTICON funding for 2-yr study
- Title: VLTI high-dynamic range imager
- Content: Performance testing in the laboratory and in simulation (data reduction); concept for VLTI instrument
- Delivrable: final report including performance analysis and implementation plan

History of high-contrast stellar Interferometry

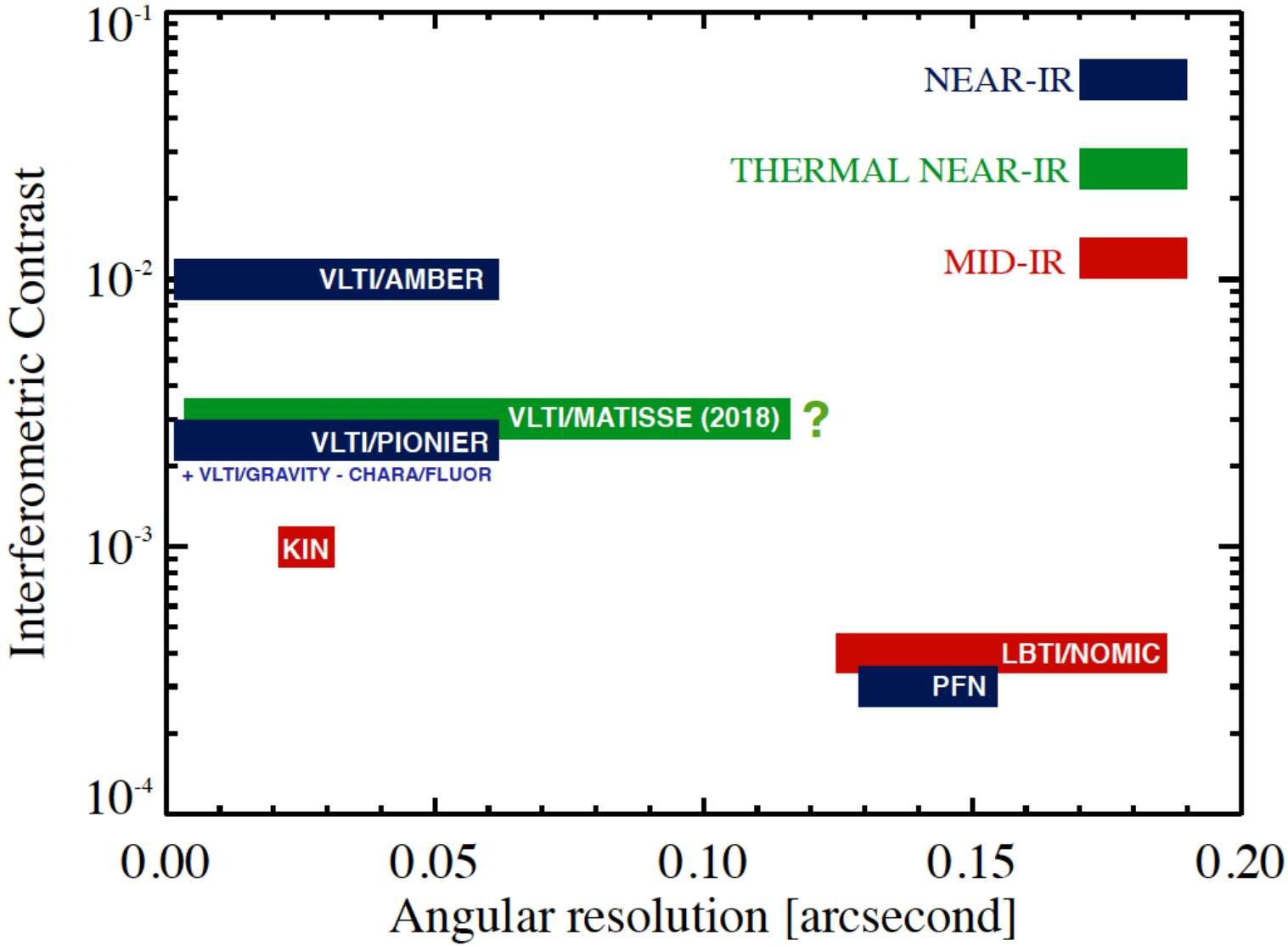
- Three nulling experiments
  - ✓ Keck Interferometer Nuller (KIN)
  - ✓ Palomar Fiber Nuller (PFN)
  - ✓ Large Binocular Telescope Interferometer (LBTI)

- Two high-precision V^2 instruments
  - ✓ CHARA/FLUOR (& VLTI/VINCI)
  - ✓ VLTI/PIONIER (& IOTA/IONIC)

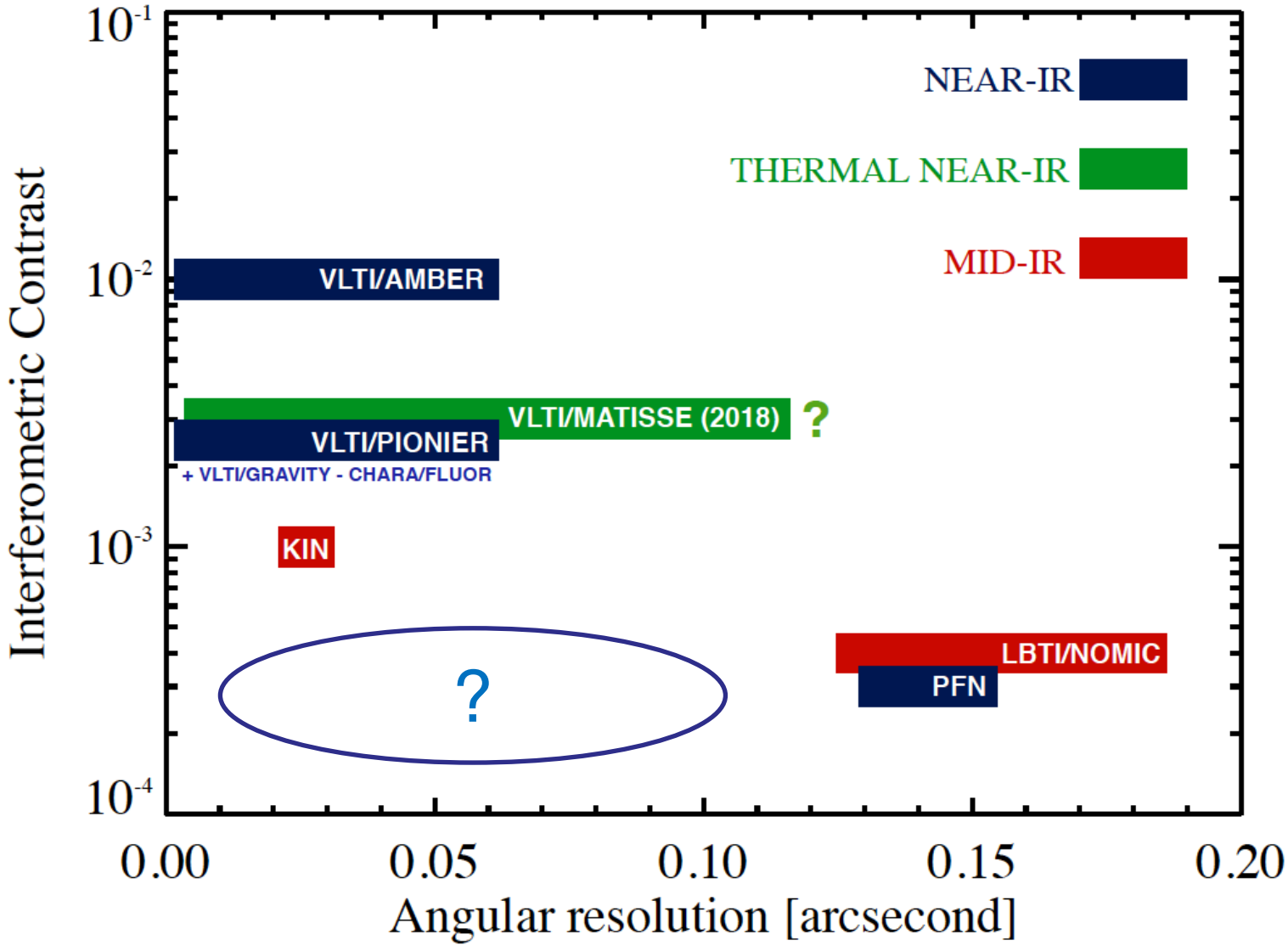
- Several closure-phase instruments
  - ✓ CHARA/MIRC
  - ✓ VLTI/PIONIER
  - ✓ Aperture masking experiments

Hi-5

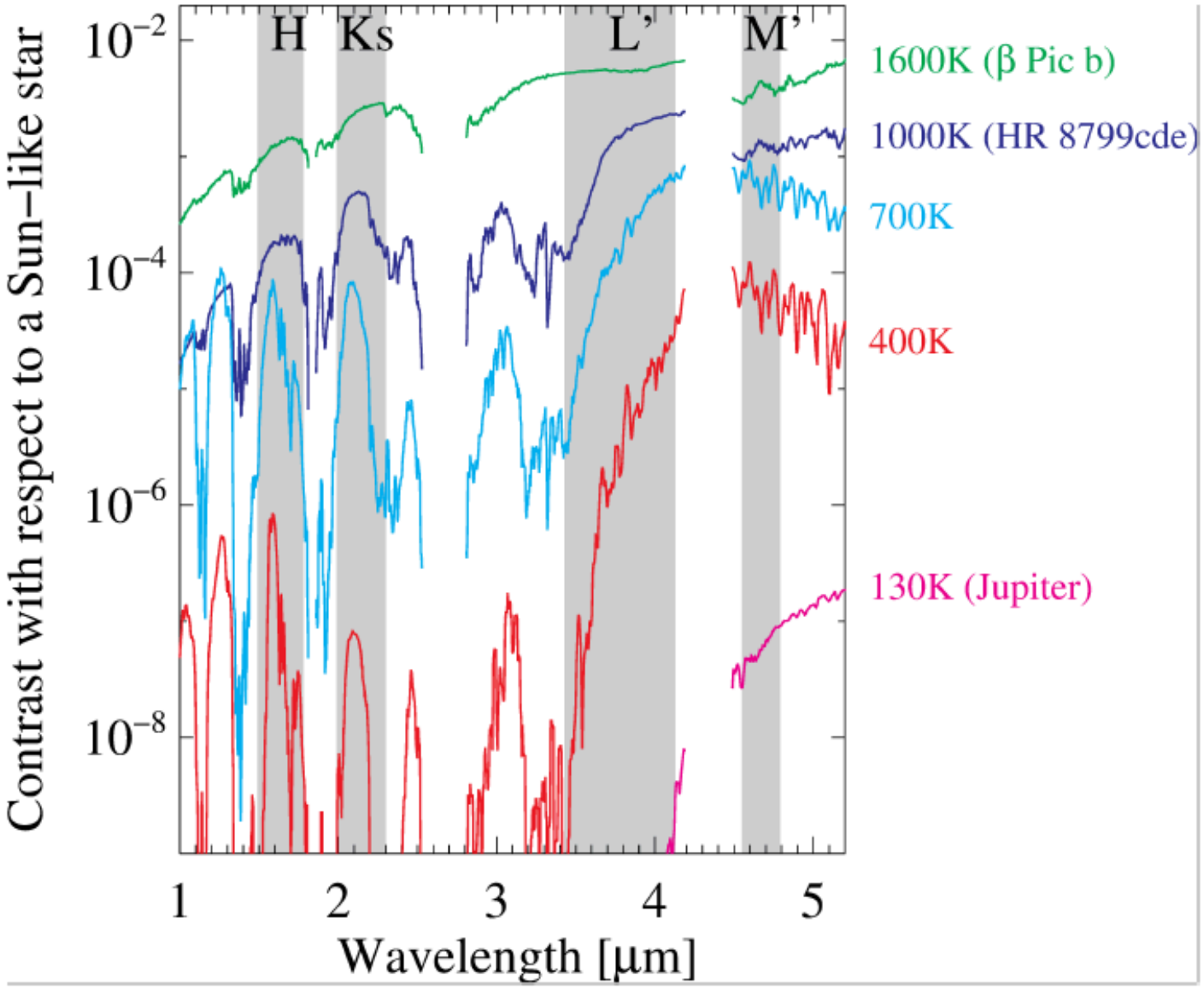
Status of high-contrast interferometers



Status of high-contrast interferometers



Which science in this parameter space?



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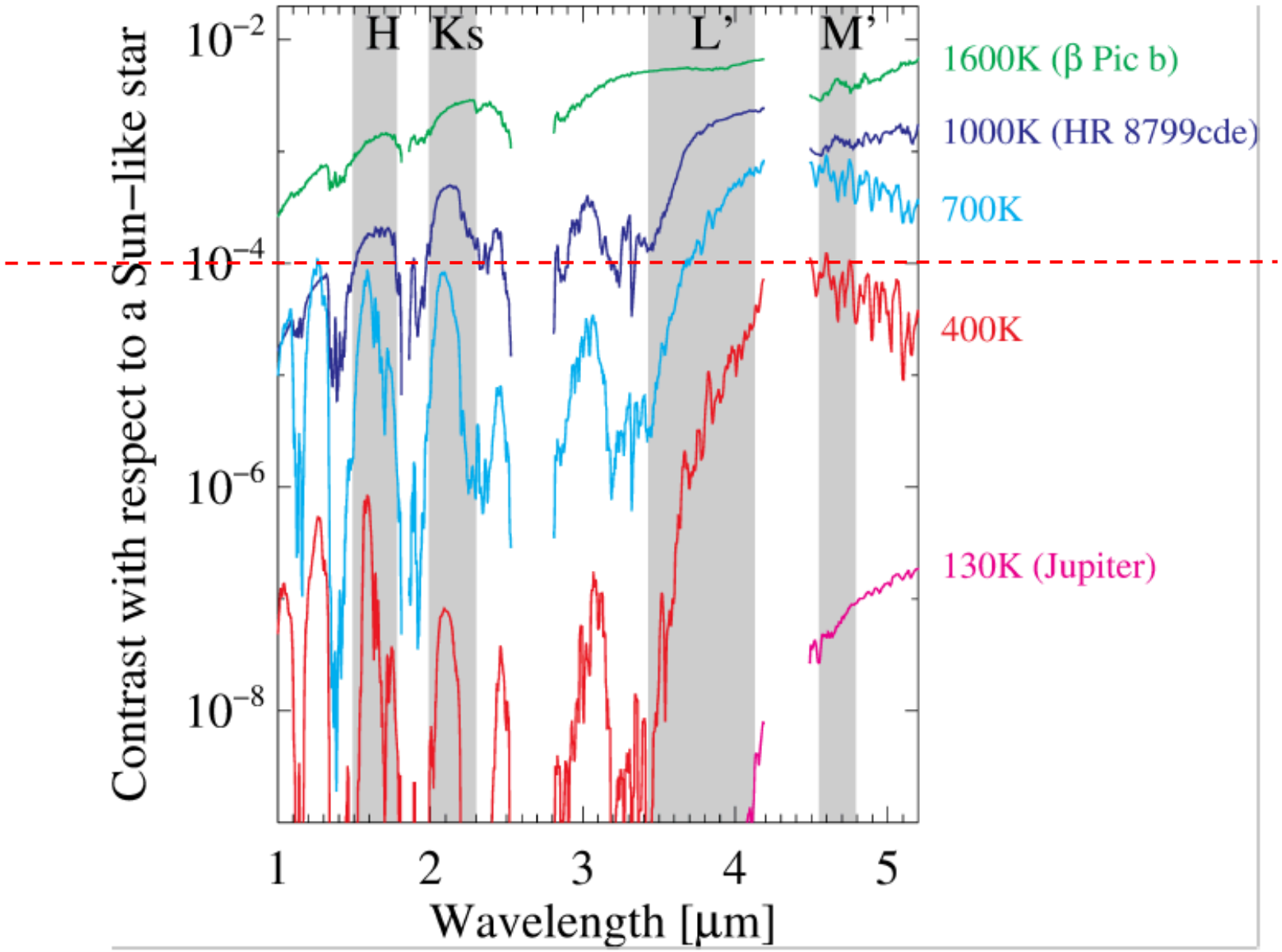

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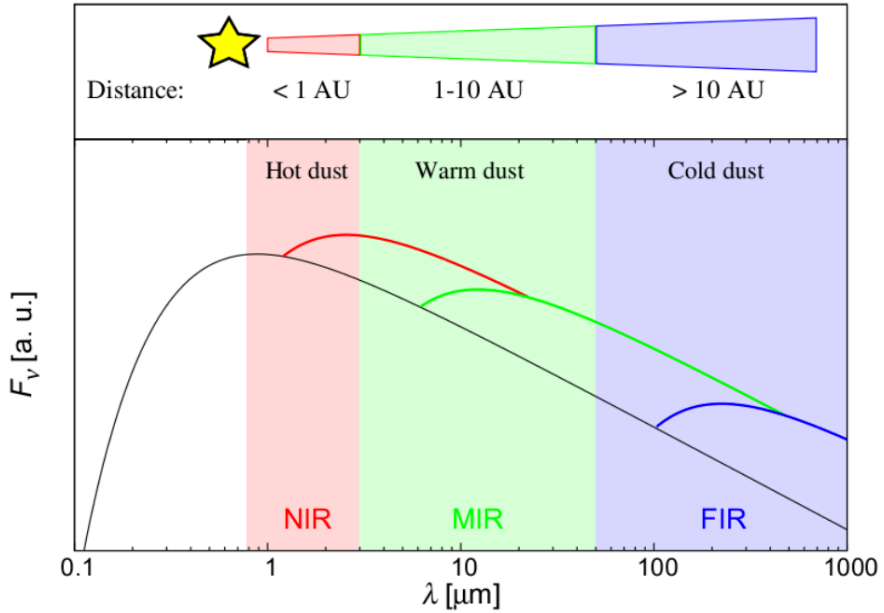
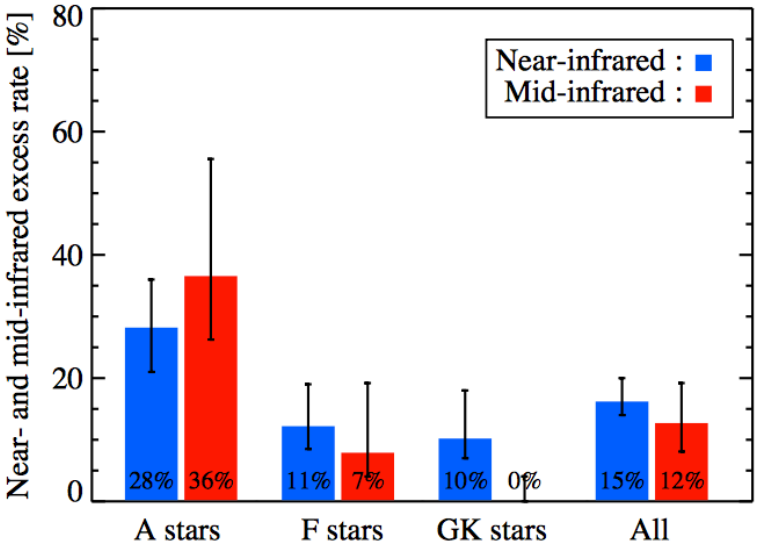
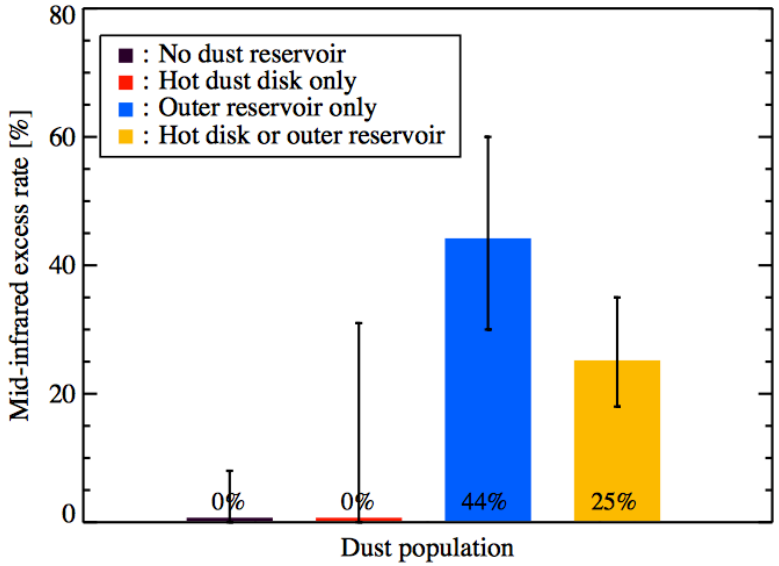
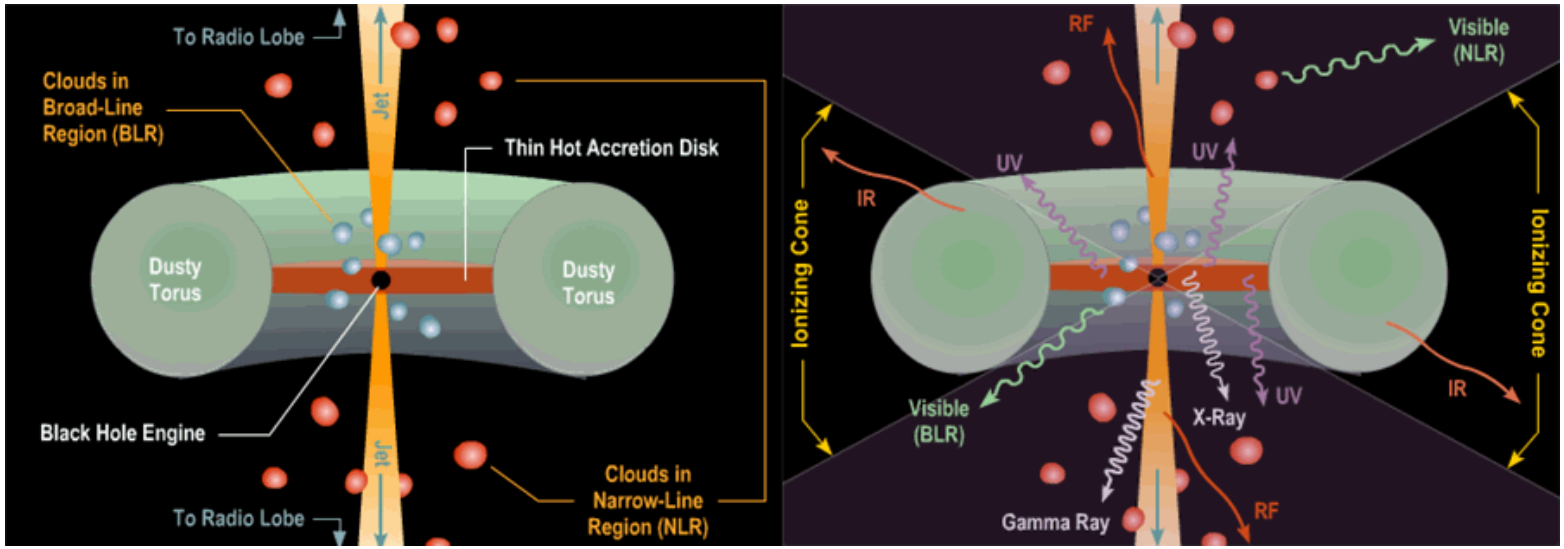






Which science in this parameter space?

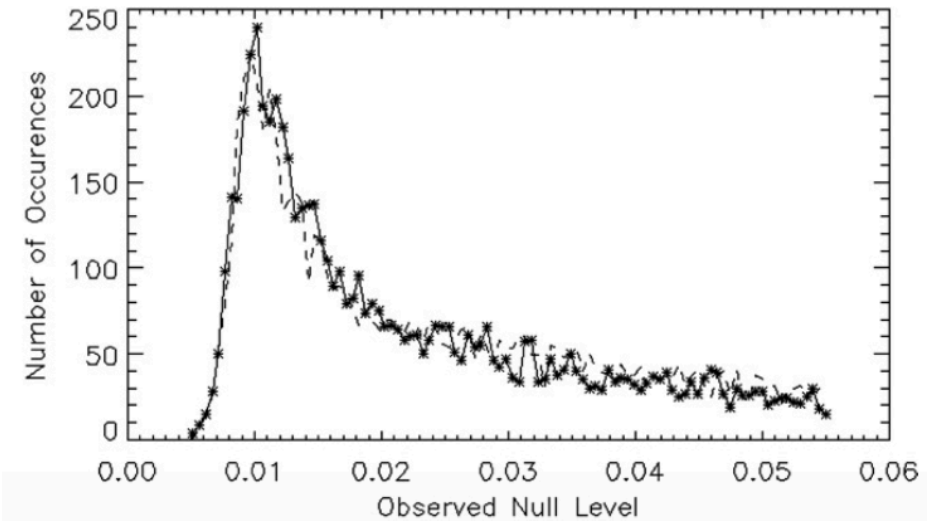
- AGNs and cosmological constant at high-precision.
- Pushing the limiting magnitude with P-Rex and NAOMI?



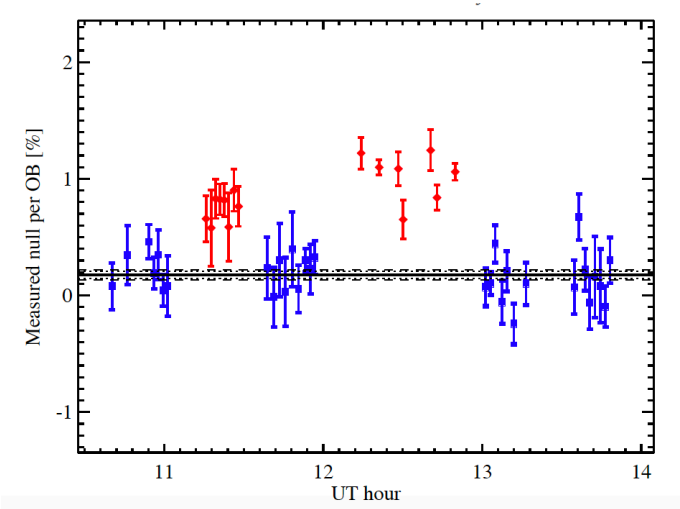
What limits the accuracy/contrast?

- Main limitations
  - ✓ Near-infrared: phase and polarization errors;
  - ✓ Mid-infrared: thermal background systematics;

- Thermal near-infrared a sweet spot for high-precision interferometry?



PFN – ~0.01% (K band)
(Mennesson et al. 2011)



LBTI – ~0.05% (N band)
(Defrère et al. 2016)

Hi-5

Goals of the workshop

- Define the instrumental and science requirements (spectral resolution, null accuracy, limiting magnitudes)
- Identify possible architectures and recombination schemes
- Refine the science case
- Implementation pathway and timeline (upgrade of PIONIER/MATISSE or new instrument?)

Goals of the workshop

Define goals of the study

- Test & compare available technologies

✓ Lithium niobate vs chalcogenide beam combiners
✓ In-lab characterization of intensity balance, chromaticity, polarization, etc

- Explore impact of data processing

✓ Statistical NSC method has potential to significantly relax constraints on beam combination & fringe tracking
✓ Develop framework for multi-telescope NSC method + lab tests

Hi-5

Monday Oct 2

DAY 1

10:00 -- Introduction (D. Defrère)

10:30 -- MATISSE status and expected precision (A. Matter)

11:00 -- PIONIER heritage and lessons learned (J.P. Berger)

11:30 -- KIN/PFN/LBTI heritage and lessons learned (E. Serabyn)

12:00 -- VLTI status, fundings, and future post 2nd-generation instruments (A. Mérand)

12:30 -- Lunch break (Poivre et Sel)

14:00 -- Exozodiacal disks (O. Absil)

14:30 -- Forming exoplanets and YSOs (S. Kraus)

15:00 -- Extragalactic astronomy at high-precision (K. Tristram)

15:30 -- Break

16:00 -- Detection limits with PIONIER and GRAVITY (A. Gallenne)

16:20 -- PFI status and possible synergies (S. Kraus)

16:40 -- FKSI (W. Danchi)

17:00 -- Discussions (instrumental requirements, synergies with LBTI, MATISSE, PFI, ELTS, ..)

18:00 -- Adjourn

19:30 -- Dinner downtown (restaurant "As Ouhes")

Tuesday Oct 3

DAY 2

09:00 -- Activities and plans in Cologne (L. Labadie)

09:30 -- Activities and plans in Jena/Postdam (S. Minardi)

10:00 -- Activities and plans in Grenoble (G. Martin)

10:30 -- Break

11:00 -- Activities and plans in Sydney/Canberra (M. Ireland)

11:30 -- P-REx: the piston drift reconstruction experiment (J.U. Pott)

11:50 -- Fringe tracking with GRAVITY (A. Mérand)

12:15 -- Lunch break

14:00 -- Photonic nulling interferometry and experience with Dragonfly/GLINT (B. Norris)

14:30 -- Prospects with the Crossed Cube Nuller (F. Henault)

15:00 -- Detectors, beam combination strategies, and data reduction (D. Defrère)

15:30 -- Break

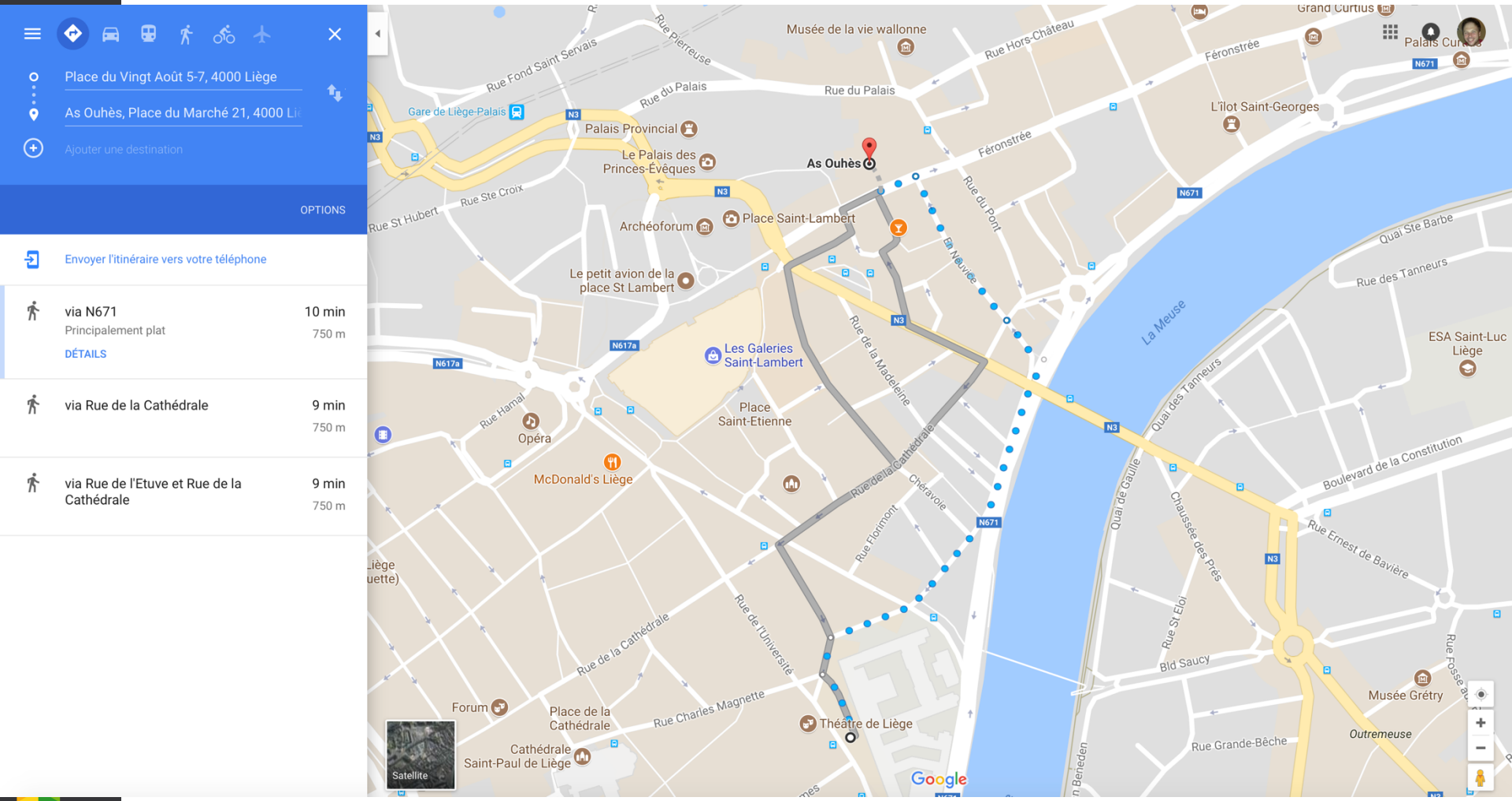
16:00 -- Hi-5 planning, fundings, paper, conclusions, and action items

17:30 -- Adjourn

Hi-5

As Ouhes

Place du Marché 21, 4000 Liège



Science case

Exoplanets

- ✓ Forming exoplanets (long baselines and ~1000 spectral resolution)
- ✓ Young exoplanets

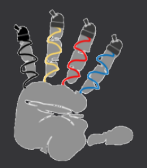
Exozodiacal disks

- ✓ Understanding the hot exozodi phenomenom (correlation between hot and warm dust);
- ✓ Measurement of southern stars;

Extragalactic astrophysics

- ✓ Dust parallaxes (precise diameter, low resolution and L-band)
- ✓ BLR characterization (high-resolution and L band)
- ✓ AGNs morphology (low resolution and N band)

Out-of-box ideas?

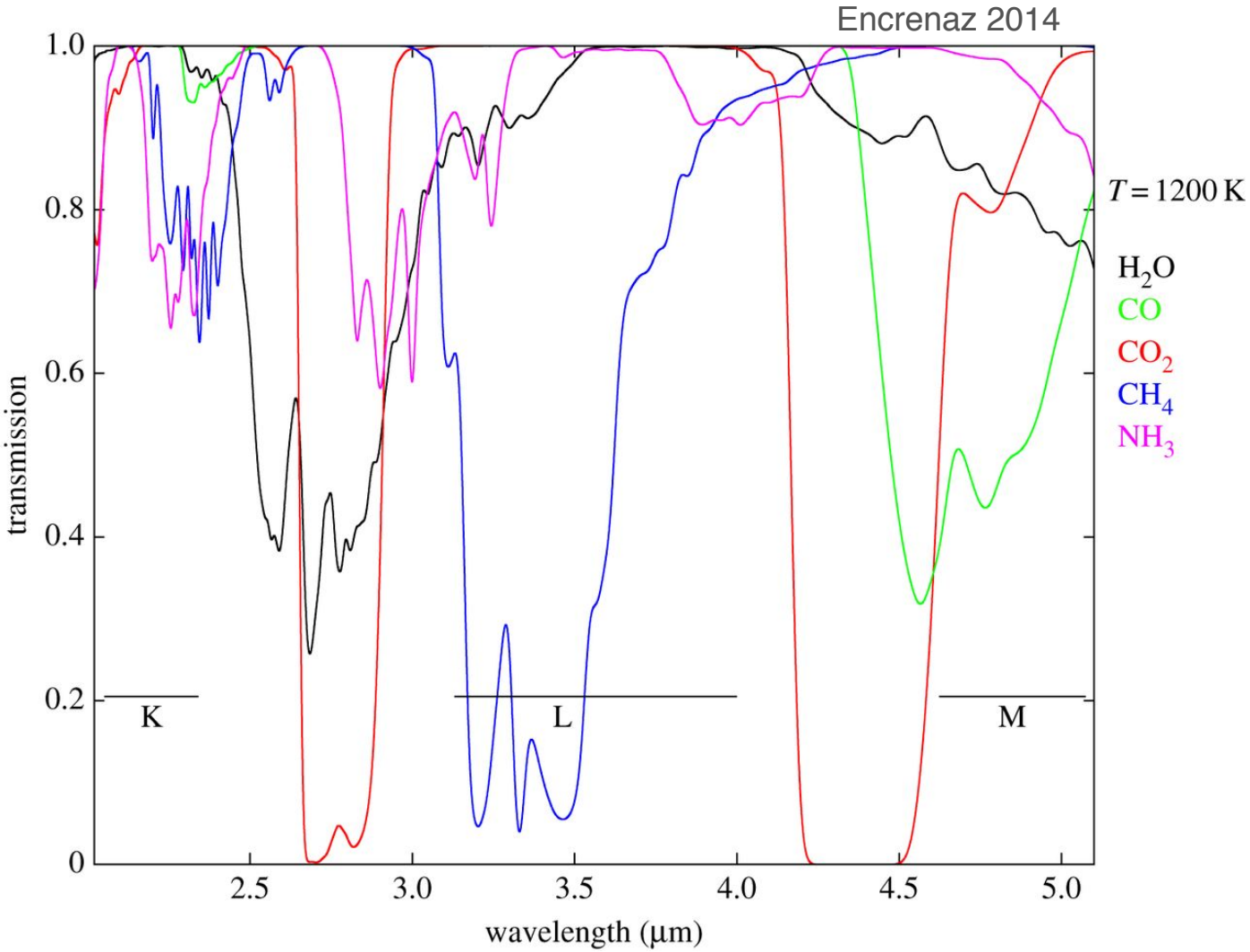


Instrumental and science requir.

	Forming exoplanets	Exozodis	Extragalactic astronomy
Contrast/ accuracy		10^{-4}	
Spectral resolution	1000	Low	
Baseline length	Long	Short	
Limiting magnitude		Bright	Faint
Polarization			
Field-of-view			
6T?			

Instrumental and science requir.

1. Spectral resolution? How many modes?



Instrumental and science requir.

1. Spectral resolution? How many modes?

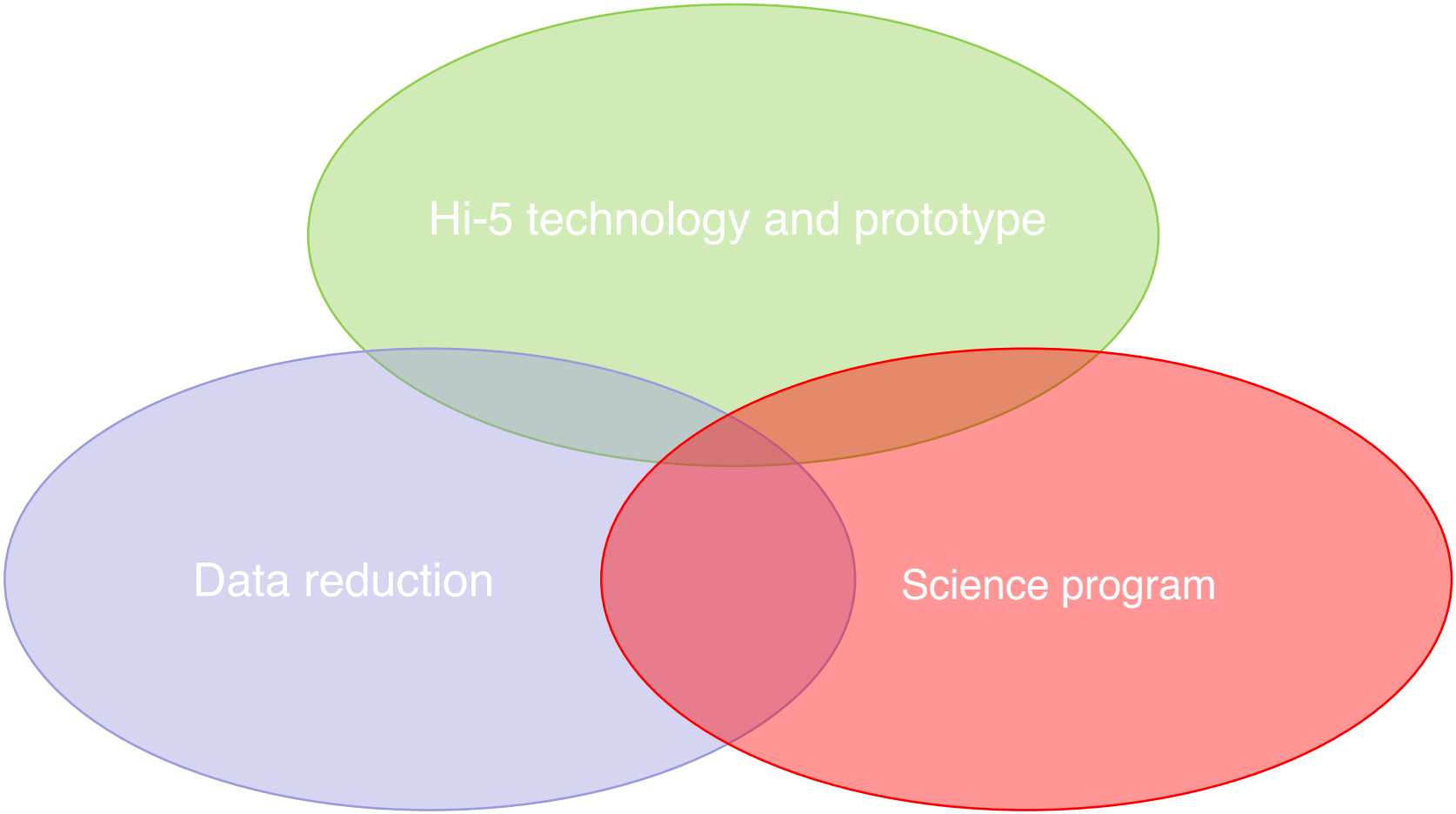
Encrenaz 2014

molecule	$\Delta\nu=2B_0$ cm^{-1}	λ (S_{max}) 2–5 μm	S_{max} cm^{-2} am^{-1}	R 2–5 μm	λ (S_{max}) 5–16 μm	S_{max} cm^{-2} am^{-1}	R 5–16 μm
H_2O	29.0	2.69 (ν_1, ν_3)	200	130	6.27 (ν_2)	250	55
HDO	18.2	3.67 (ν_1, $2\nu_2$)	270	150	7.13 (ν_2)		77
CH_4	10.0	3.31 (ν_3)	300	300	7.66 (ν_4)	140	130
CH_3D	7.8	4.54 (ν_2)	25	280	8.66 (ν_6)	119	150
NH_3	20.0	2.90 (ν_3)	13	170	10.33,	600	50
		3.00 (ν_1)	20		10.72 (ν_2)		
PH_3	8.9	4.30 (ν_1, ν_3)	520	260	8.94 (ν_4)	102	126
					10.08 (ν_2)	82	110
CO	3.8	4.67 (1–0)	241	565			
CO_2	1.6	4.25 (ν_1)	4100	1470	14.99 (ν_2)	220	420
HCN	3.0	3.02 (ν_3)	240	1100	14.04 (ν_2)	204	240
C_2H_2	2.3	3.03 (ν_3)	105	1435	13.7 (ν_5)	582	320
C_2H_6	1.3	3.35 (ν_7)	538	2300	12.16 (ν_{12})	36	635
O_3	0.9				9.60 (ν_3)	348	1160

Tuesday: discussions

1. Planning and needs
2. Possible pathway to Hi-5
3. Goals of the OPTICON study
4. Hi-5 collaboration and paper
5. Funding opportunities
6. Action items

Planning and needs



Hi-5 prototype

- Demonstrate concept and high-contrast interferometry

- Test & compare available technologies

✓ Lithium niobate vs chalcogenide beam combiners
✓ In-lab characterization of intensity balance, chromaticity, polarization, etc

- Prototype location?

- Prototype hardware (detector)?

- Manpower?

Data reduction

- Explore impact of data processing

✓ NSC method has potential to significantly relax constraints on beam combination & fringe tracking

✓ Develop framework for multi-telescope NSC method + lab tests

- ESO-compliant software?

- Manpower?

Science program

- Define clear science objectives not covered by other instruments
- Identify precursor science (PFI, direct imaging, Euclid?)
- Build target lists
- Manpower?

Possible pathway

Build upon an existing infrastructure

- Upgrade of PIONIER or MATISSE vs new instrument?
- Take advantage of GRAVITY fringe tracking

➤ 1st step

- Scanned or ABCD beam combiner (e.g., PIONIER)
- Dynamic range ~10^{-3}

➤ 2nd step

- Add nulling capabilities + custom data processing
- Dynamic range ~10^{-4}

➤ Long-term perspective

- Add high-resolution spectroscopy based on astrophotonics?
- Upgrade from 4 to 6 telescopes?

Hi-5 collaboration and paper

- Team organization, collaboration, project visibility

- Paper: topical issue on the future of interferometry to appear in Experimental Astronomy :

✓ ~12 pages

✓ Deadline Nov. 30

✓ Draft here

https://www.overleaf.com/10476622qfrxwjwssvjp

Funding opportunties

1. ERC synergy grant

SYNERGY GRANTS

Who can apply?

A group of **two to maximum four Principal Investigators (PIs)** – of which one will be designated as the corresponding PI (cPI) – working together and bringing different skills and resources to tackle ambitious research problems. **No specific eligibility criteria regarding the academic training** are foreseen for ERC Synergy Grants. PIs must present an **early achievement track-record** or a **ten-year track-record**, whichever is most appropriate.

Proposals will be evaluated on the **sole criterion of scientific excellence** which, in the case the ERC Synergy Grants, takes on the additional meaning of **outstanding intrinsic synergetic effect**.

What proposals are eligible?

- *Criteria*
  Applications can be made in **any field of research.**
  The ERC's grants operate on a 'bottom-up' basis without predetermined priorities. In the case of the ERC Synergy Grants, applications must demonstrate that the proposed research **cannot be carried out by a single PI working alone.**

OPEN CALLS

Synergy Grants | ERC-2018-SyG
Information for applicants
Timeframe ongoing evaluations
FAQ
Deadline: 14-11-2017

ON-GOING EVALUATIONS

Timeframe Synergy Grant 2018

UPCOMING CALL

see open call

DOCUMENTS

ERC Work Programme 2018
ERC Synergy Grants 2018 – Information for applicants

Funding opportunties

2. Action ASHRA-2018

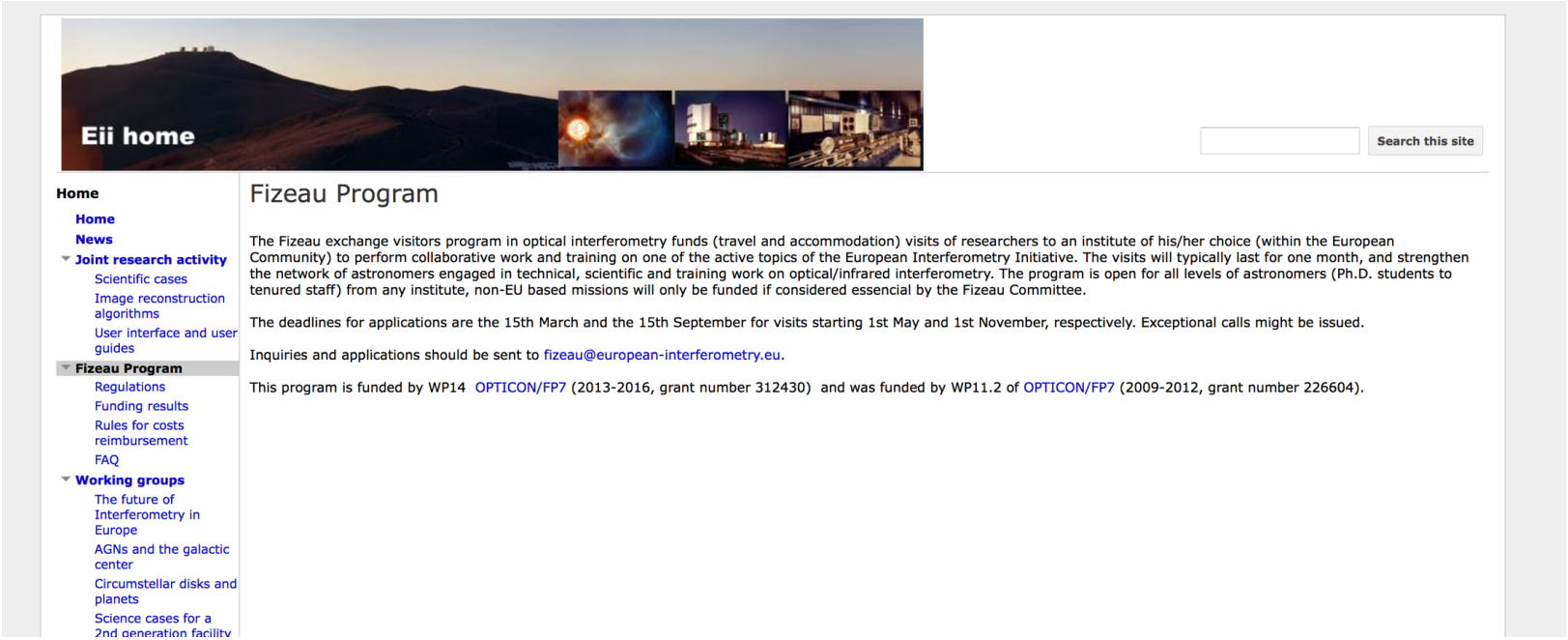
- ✓ Participation at conferences and meetings
- ✓ R&D money
- ✓ Rather short (~2 pages)
- ✓ Deadline October 20

Funding opportunities

3. Fizeau program

- ✓ Exchange between institutes
- ✓ Cover travel and accomodation
- ✓ Two calls per year (March and September)

http://www.european-interferometry.eu/fizeau-program



Goals of the OPTICON study

- Delivrable: final report including performance analysis and implementation plan

- Tentative content of report

✓ Solid science motivation and target list

✓ Predicted performance

✓ Technology comparison

✓ Implementation plan