

Hi-5 kickoff meeting

Liège, Oct. 2-3

Hi-5

High-contrast **I**nterferometry
up to **5** microns



Welcome!



LIÈGE
université



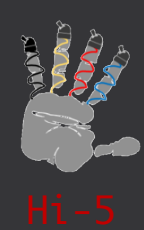
1817 - 2017

Welcome!



Older than Belgium!



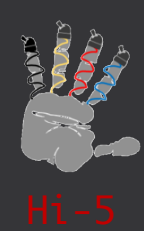


Lunch today

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

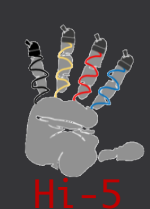
- OPTICON funding for 2-yr study
- Title: VLTI high-dynamic range imager
- Content: Performance testing in the laboratory and in simulation (data reduction); concept for VLTI instrument
- Deliverable: final report including performance analysis and implementation plan



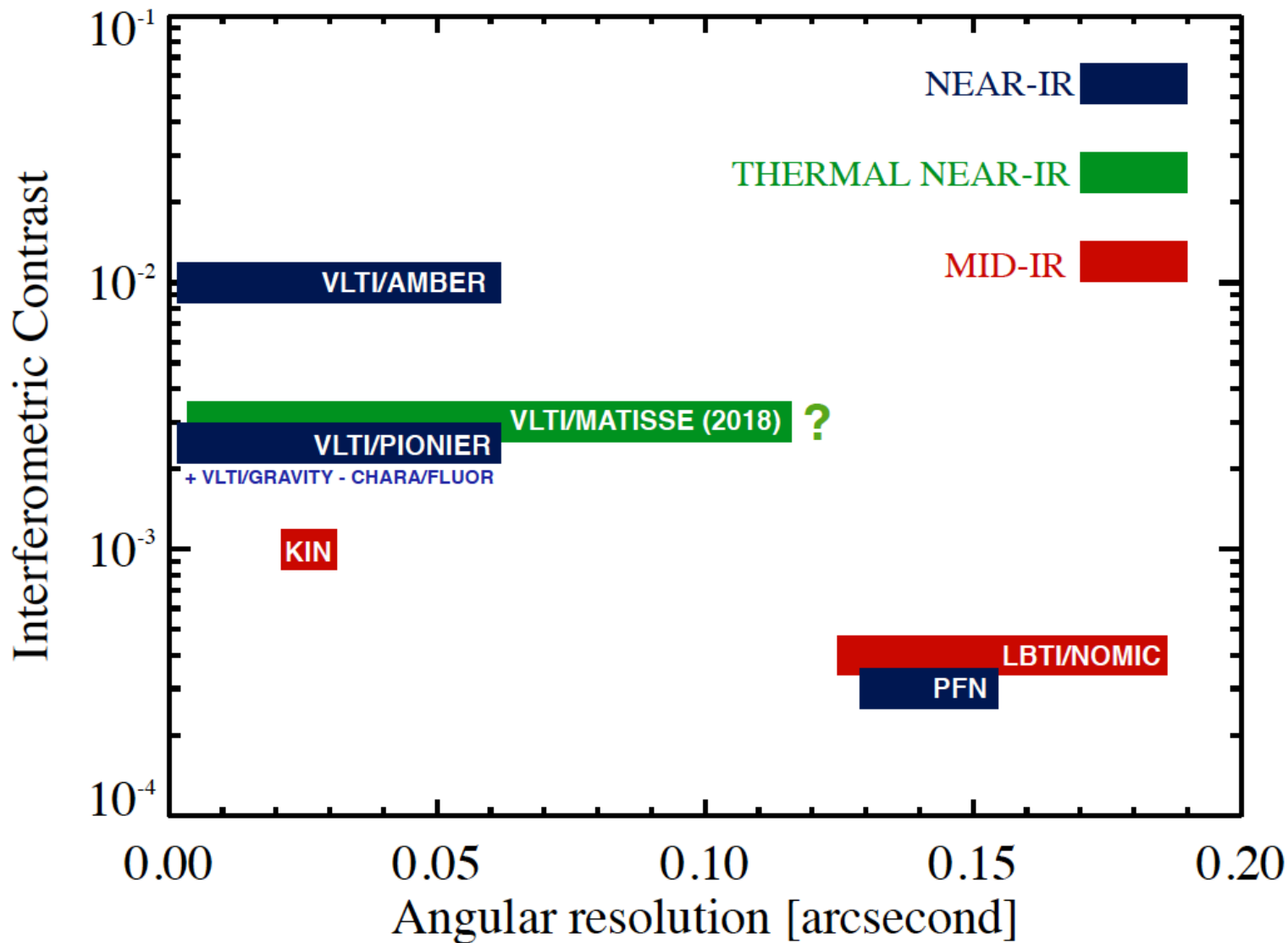


History of high-contrast stellar Interferometry

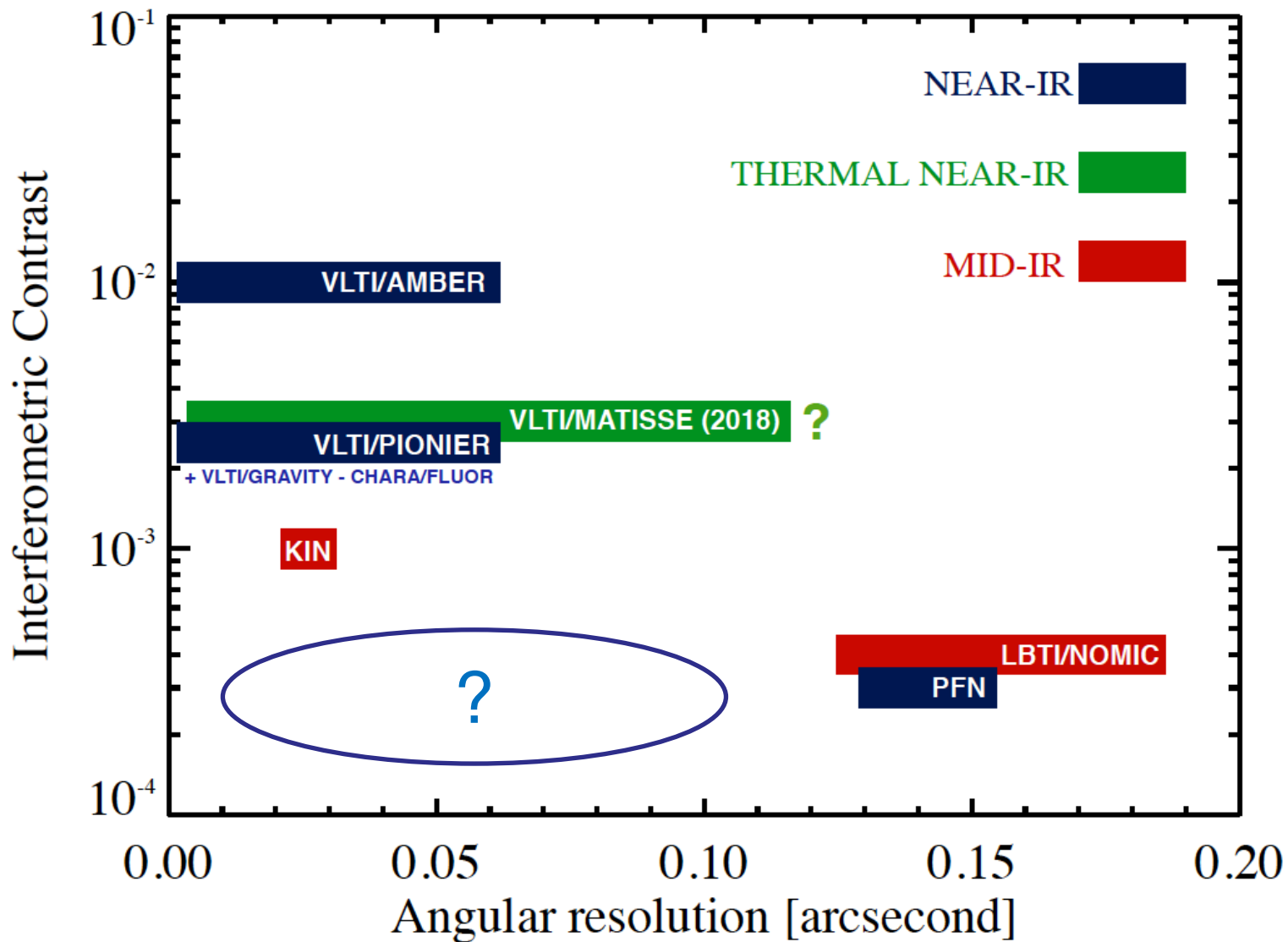
- Three nulling experiments
 - ✓ Keck Interferometer Nuller (KIN)
 - ✓ Palomar Fiber Nuller (PFN)
 - ✓ Large Binocular Telescope Interferometer (LBTI)
- Two high-precision V^2 instruments
 - ✓ CHARA/FLUOR (& VLT/VINCI)
 - ✓ VLT/PIONIER (& IOTA/IONIC)
- Several closure-phase instruments
 - ✓ CHARA/MIRC
 - ✓ VLT/PIONIER
 - ✓ Aperture masking experiments



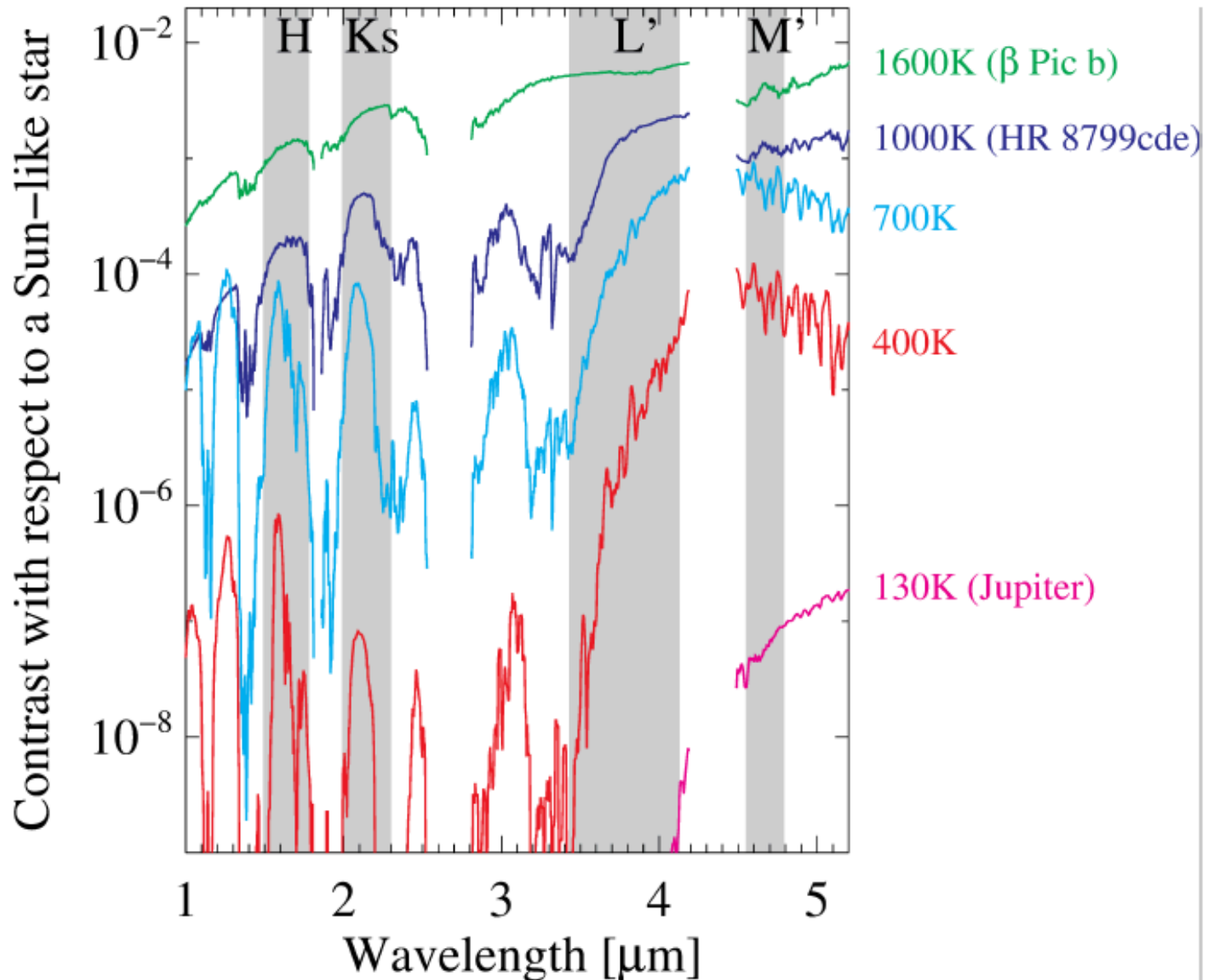
Status of high-contrast interferometers



Status of high-contrast interferometers

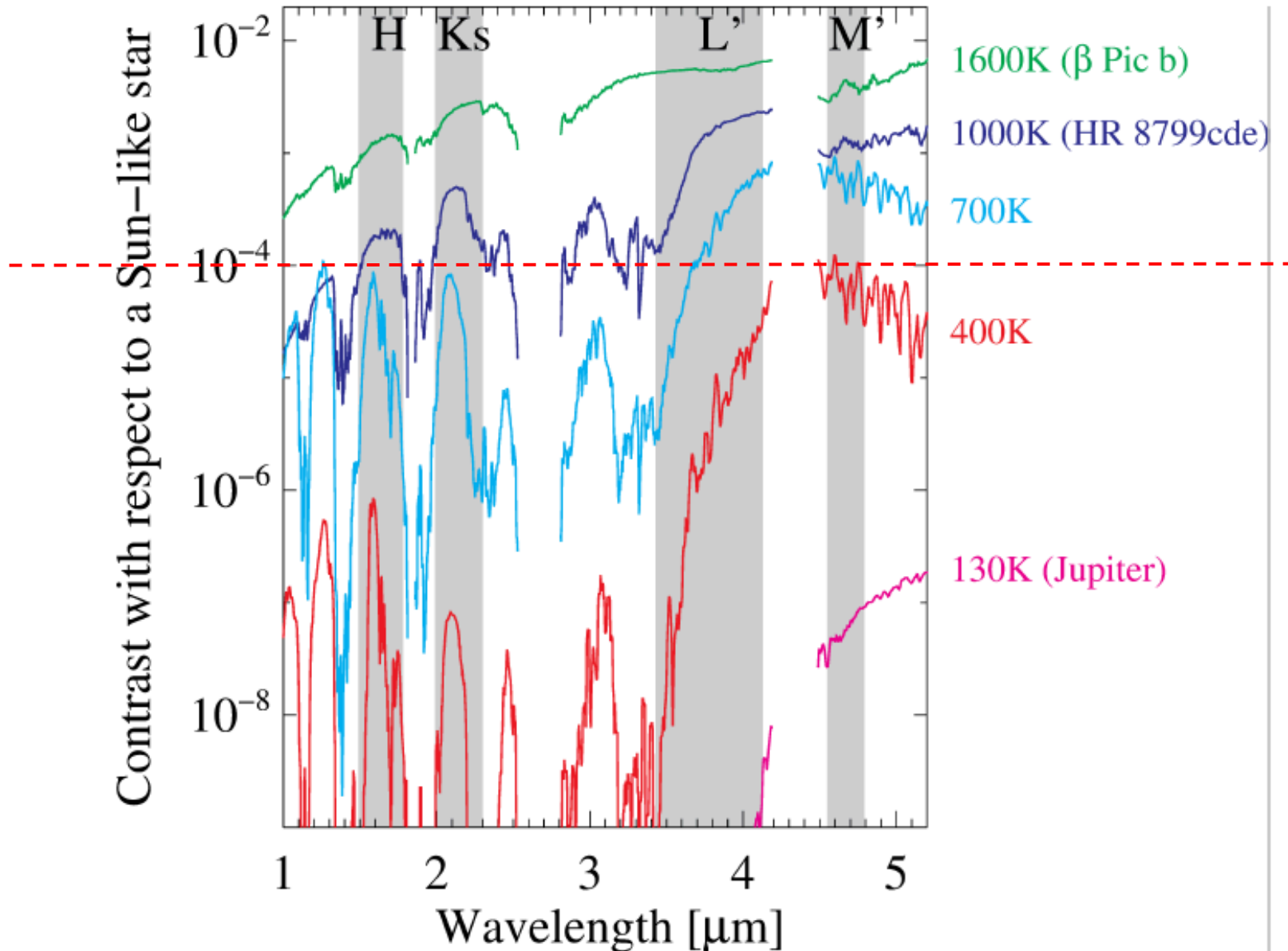


Which science in this parameter space?

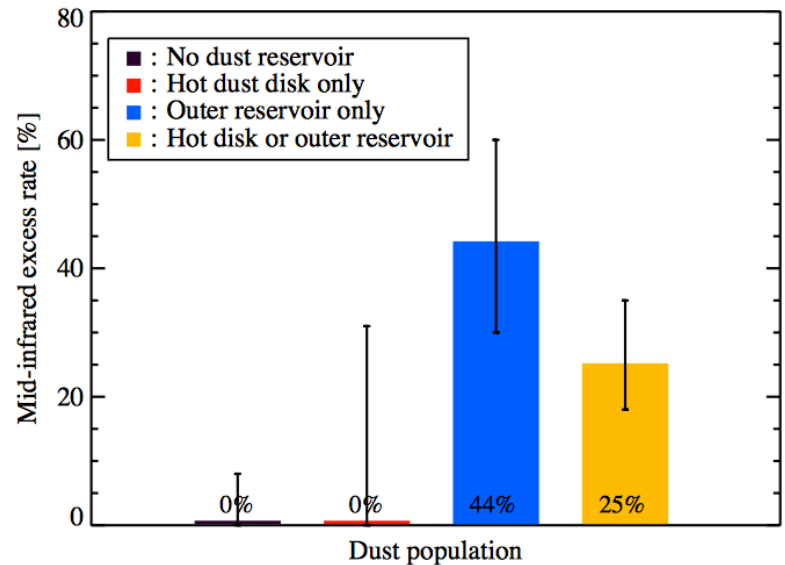
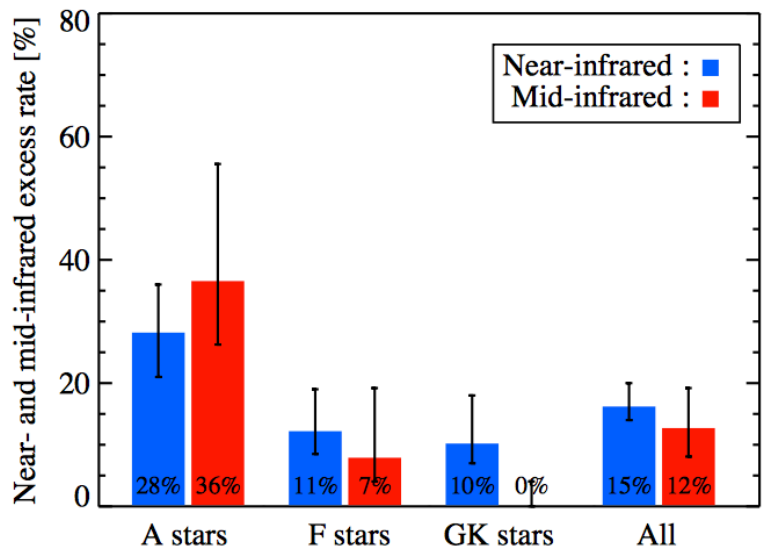
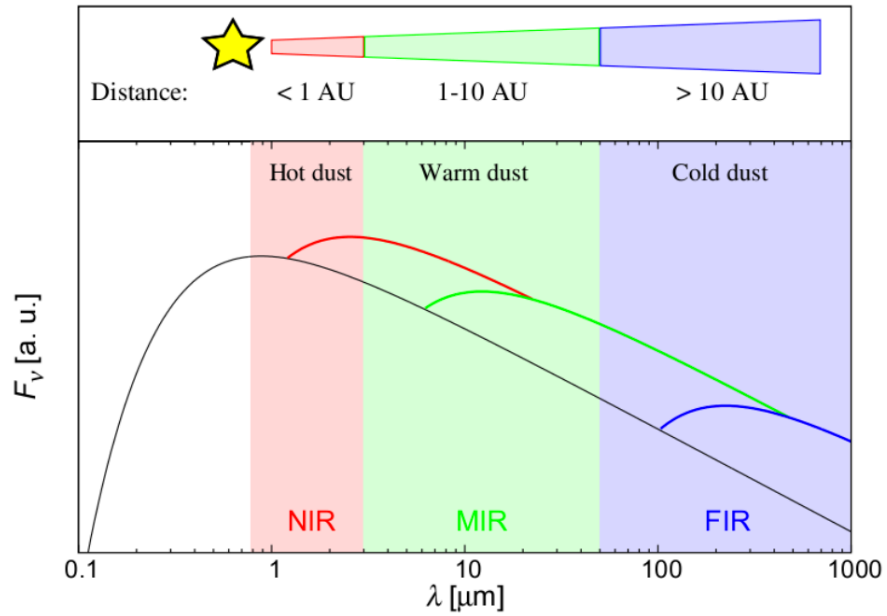


Which science in this parameter space?

Hi-5

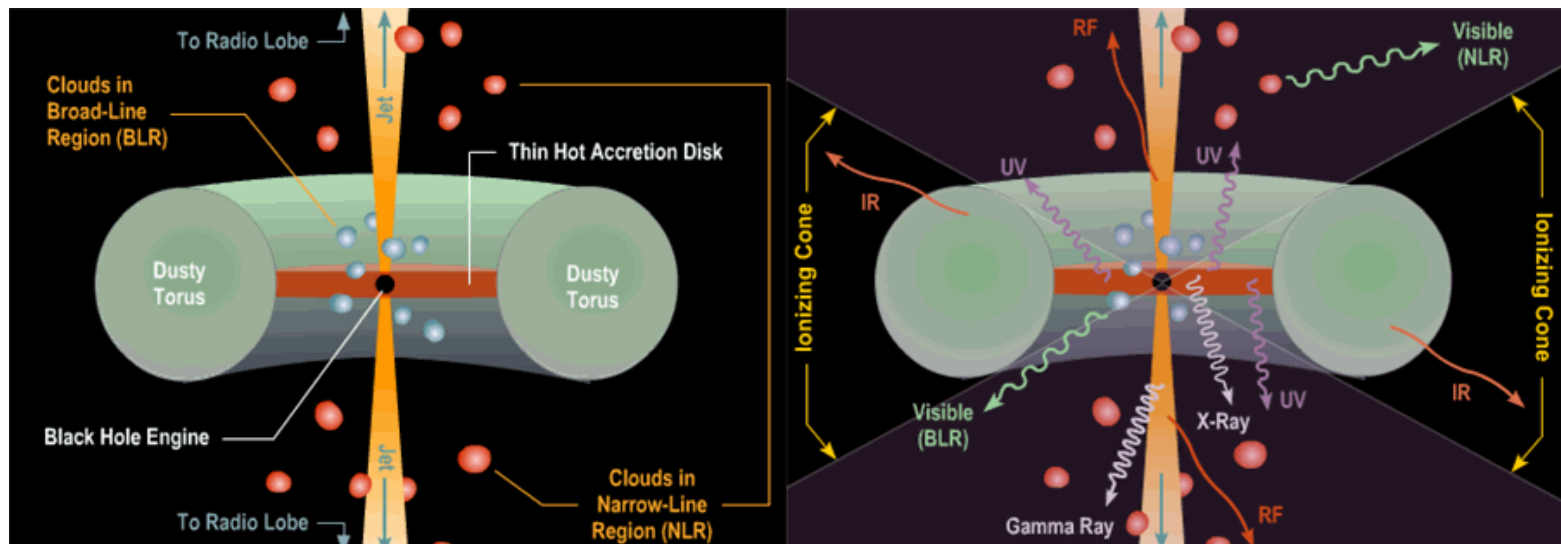


Which science in this parameter space?



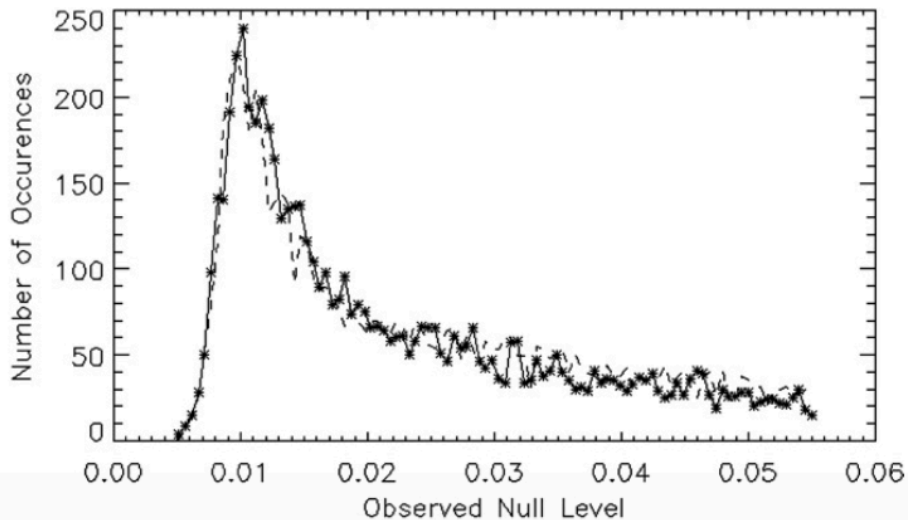
Which science in this parameter space?

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

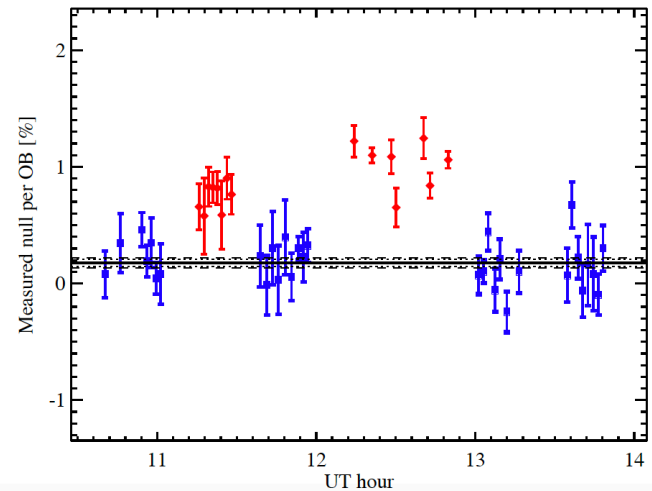


What limits the accuracy/contrast?

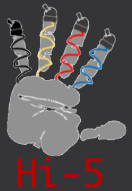
- Main limitations
 - ✓ Near-infrared: phase and polarization errors;
 - ✓ Mid-infrared: thermal background systematics;
- Thermal near-infrared a sweet spot for high-precision interferometry?



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



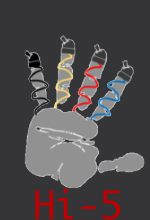
LBTI – ~0.05% (N band)
(Defrère et al. 2016)





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?)

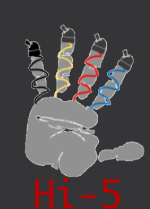




Goals of the workshop

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





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 -- VLT 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)

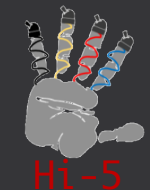
16:20 -- PFI status and possible synergies (S. Kraus)

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)

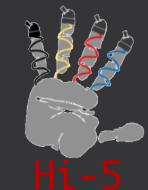
14:30 -- Prospects with the Crossed Cube Nuller (F. Henault)

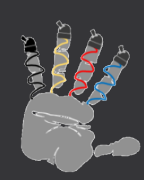
15:00 -- Detectors, beam combination strategies, and data reduction (D. Defrère)

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

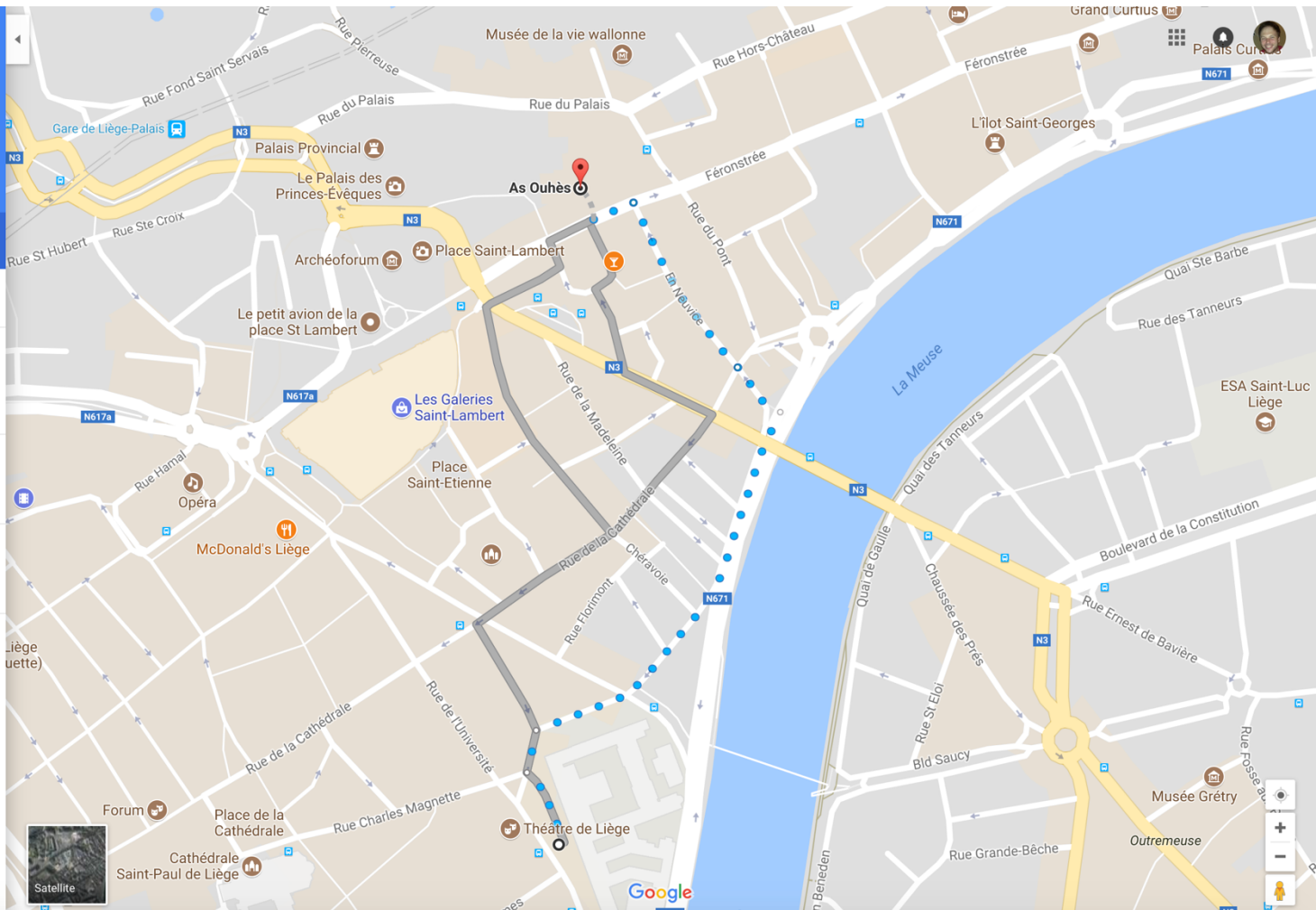
Place du Vingt Août 5-7, 4000 Liège

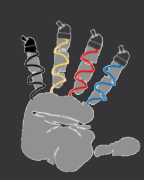
 As Ouhes, Place du Marché 21, 4000 Liège

 Ajouter une destination

OPTIONS

- Envoyer l'itinéraire vers votre téléphone
- via N671** **10 min**
 Principalement plat
 750 m
[DÉTAILS](#)
- via Rue de la Cathédrale** **9 min**
 750 m
- via Rue de l'Etuve et Rue de la Cathédrale** **9 min**
 750 m





Science case

Hi-5

Exoplanets

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

Exozodiacal disks

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

Extragalactic astrophysics

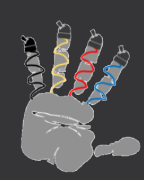
- ✓ Dust parallaxes (precise diameter, low resolution and L-band)
- ✓ BLR characterization (high-resolution and L band)
- ✓ AGNs morphology (low resolution and N band)

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?			

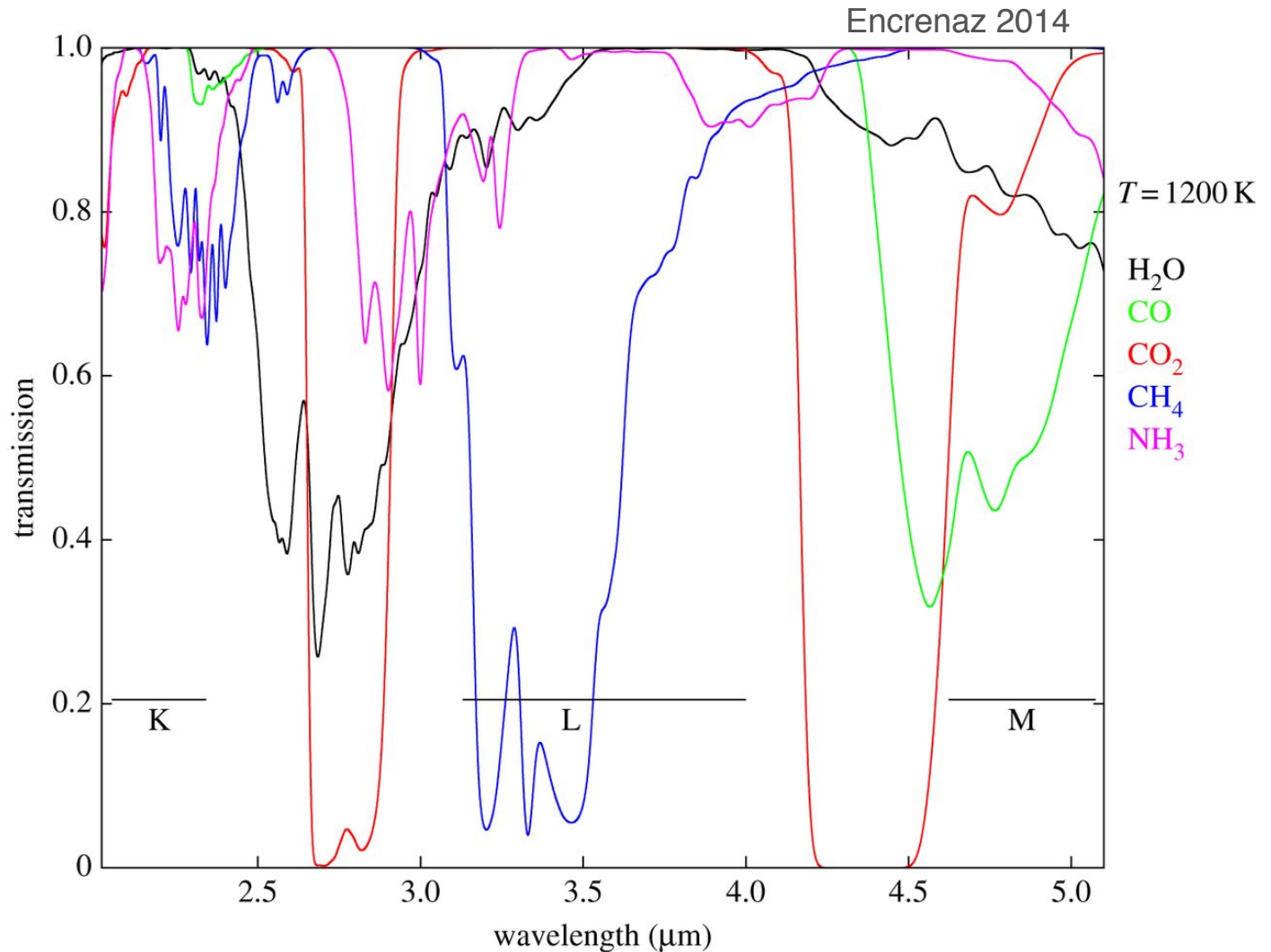


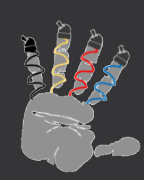
Hi-5



Instrumental and science requir.

1. Spectral resolution? How many modes?





Hi-5

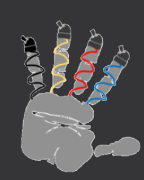
Instrumental and science requir.

1. Spectral resolution? How many modes?

Encrenaz 2014

molecule	$\Delta\nu=2B_0 \text{ cm}^{-1}$	$\lambda (S_{\max}) \text{ 2-5 } \mu\text{m}$	$S_{\max} \text{ cm}^{-2} \text{ am}^{-1}$	$R \text{ 2-5 } \mu\text{m}$	$\lambda (S_{\max}) \text{ 5-16 } \mu\text{m}$	$S_{\max} \text{ cm}^{-2} \text{ am}^{-1}$	$R \text{ 5-16 } \mu\text{m}$
H ₂ O	29.0	2.69 (ν_1, ν_3)	200	130	6.27 (ν_2)	250	55
HDO	18.2	3.67 ($\nu_1, 2\nu_2$)	270	150	7.13 (ν_2)		77
CH ₄	10.0	3.31 (ν_3)	300	300	7.66 (ν_4)	140	130
CH ₃ D	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 ₂ H ₂	2.3	3.03 (ν_3)	105	1435	13.7 (ν_5)	582	320
C ₂ H 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





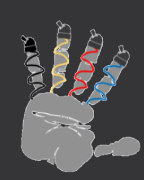
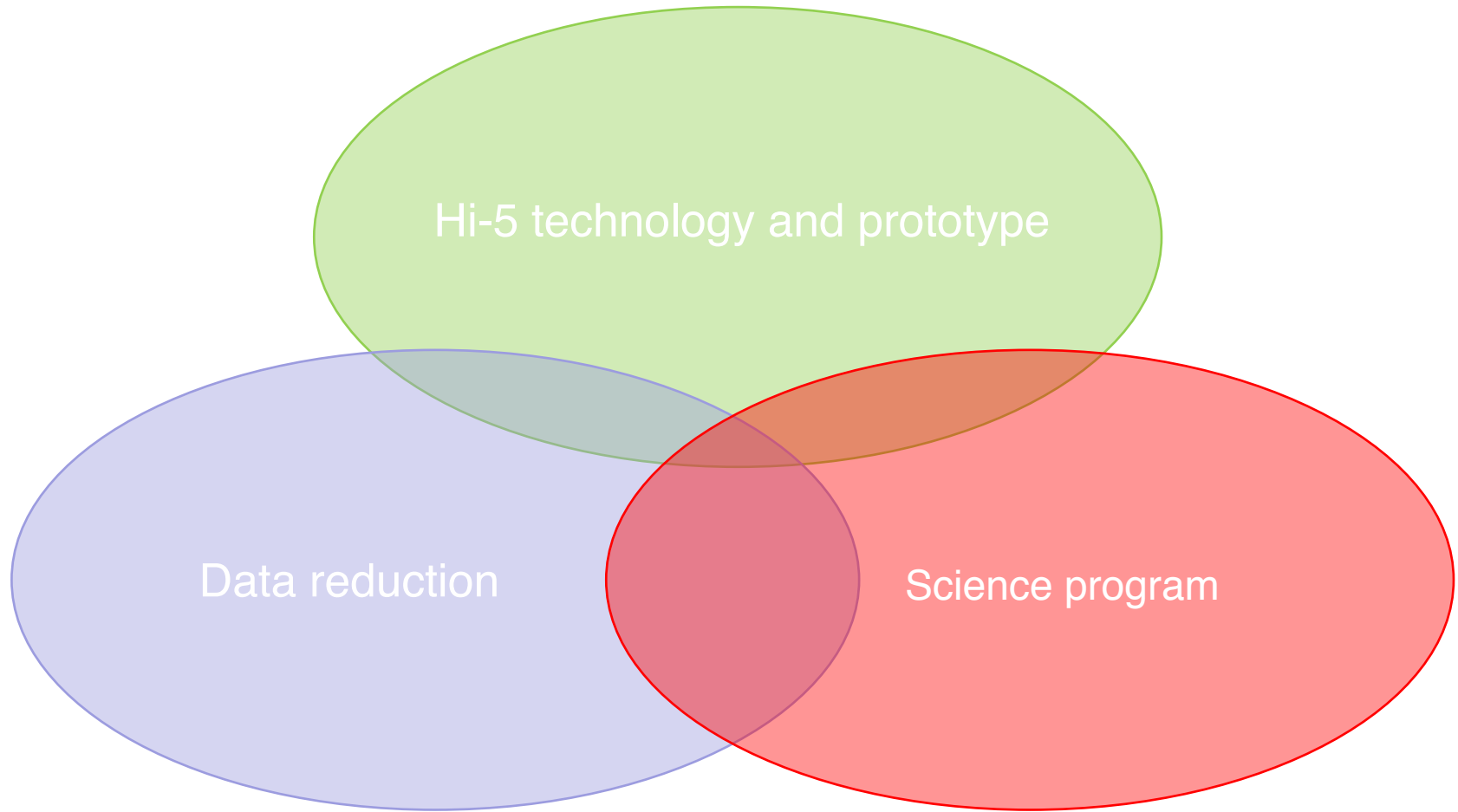
Hi-5

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

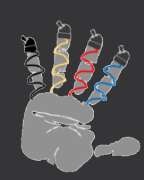


Planning and needs



Hi-5





Hi-5

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?



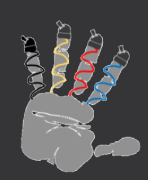


Data reduction

Hi-5

- 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?





Hi-5

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

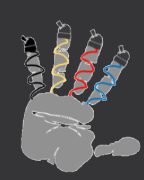
- * Scanned or ABCD beam combiner (e.g., PIONIER)
- * Dynamic range $\sim 10^{-3}$

➤ 2nd step

- * Add nulling capabilities + custom data processing
- * Dynamic range $\sim 10^{-4}$

➤ Long-term perspective

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



Hi-5

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 opportunities

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

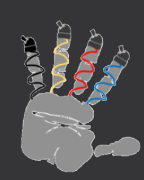
see open call

DOCUMENTS

[ERC Work Programme 2018](#)

[ERC Synergy Grants 2018 –
Information for applicants](#)





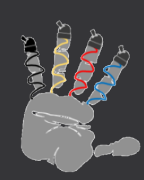
Hi-5

Funding opportunities

2. Action ASHRA-2018

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





Hi-5

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>

The screenshot shows the EII website interface. At the top, there is a banner image with the text "Eii home" and a search bar labeled "Search this site". Below the banner, the "Fizeau Program" section is highlighted in the left navigation menu. The main content area contains the following text:

Fizeau Program

The Fizeau exchange visitors program in optical interferometry funds (travel and accommodation) visits of researchers to an institute of his/her choice (within the European Community) to perform collaborative work and training on one of the active topics of the European Interferometry Initiative. The visits will typically last for one month, and strengthen the network of astronomers engaged in technical, scientific and training work on optical/infrared interferometry. The program is open for all levels of astronomers (Ph.D. students to tenured staff) from any institute, non-EU based missions will only be funded if considered essential by the Fizeau Committee.

The deadlines for applications are the 15th March and the 15th September for visits starting 1st May and 1st November, respectively. Exceptional calls might be issued.

Inquiries and applications should be sent to fizeau@european-interferometry.eu.

This program is funded by WP14 [OPTICON/FP7](#) (2013-2016, grant number 312430) and was funded by WP11.2 of [OPTICON/FP7](#) (2009-2012, grant number 226604).

Home

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 - Scientific cases
 - Image reconstruction algorithms
 - User interface and user guides
- Fizeau Program**
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 - Funding results
 - Rules for costs reimbursement
 - FAQ
- Working groups
 - The future of Interferometry in Europe
 - AGNs and the galactic center
 - Circumstellar disks and planets
 - Science cases for a 2nd generation facility



Goals of the OPTICON study

- Deliverable: final report including performance analysis and implementation plan
- Tentative content of report
 - ✓ Solid science motivation and target list
 - ✓ Predicted performance
 - ✓ Technology comparison
 - ✓ Implementation plan

