# Instrumentação para o Gemini

Cláudia Mendes de Oliveira

Participante do Comitê diretor do Gemini

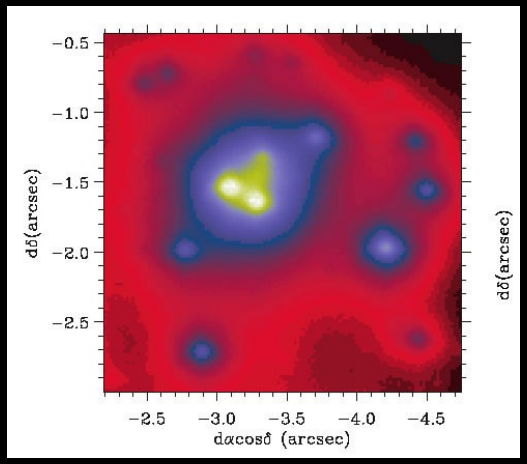
Reunião da SAB, agosto de 2005

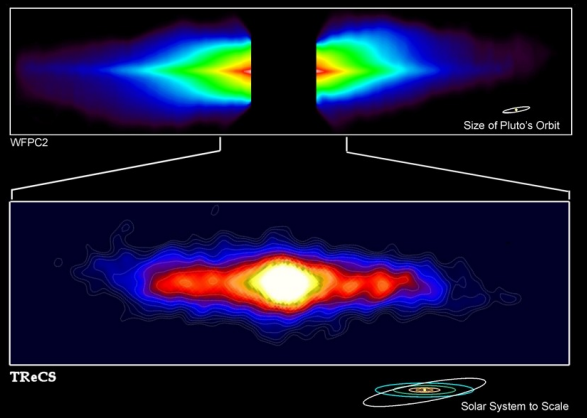
# Plano deste seminário

- Produção científica do Gemini
- Situação dos vários instrumentos existentes
- Decomissionamento de instrumentos
- Plano para os novos instrumentos Aspen
- O modo campanha de utilização dos instrumentos
- Futuro do Brasil no Gemini – oportunidade para participação em instrumentação

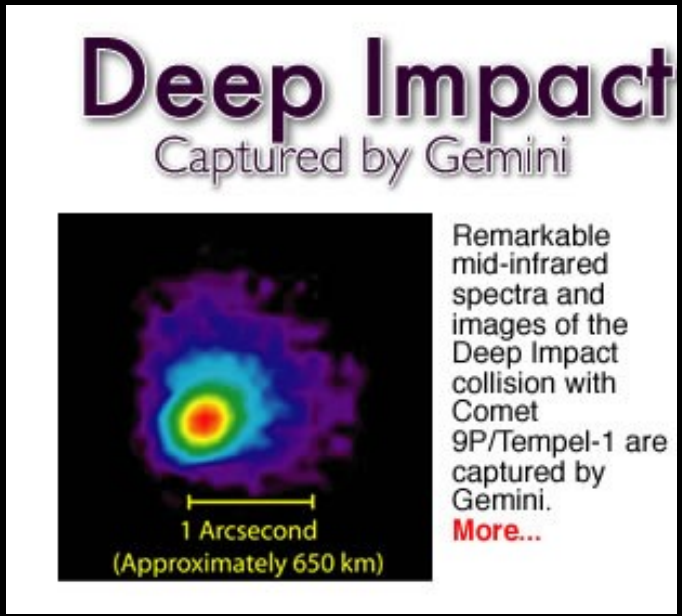
# Notícias

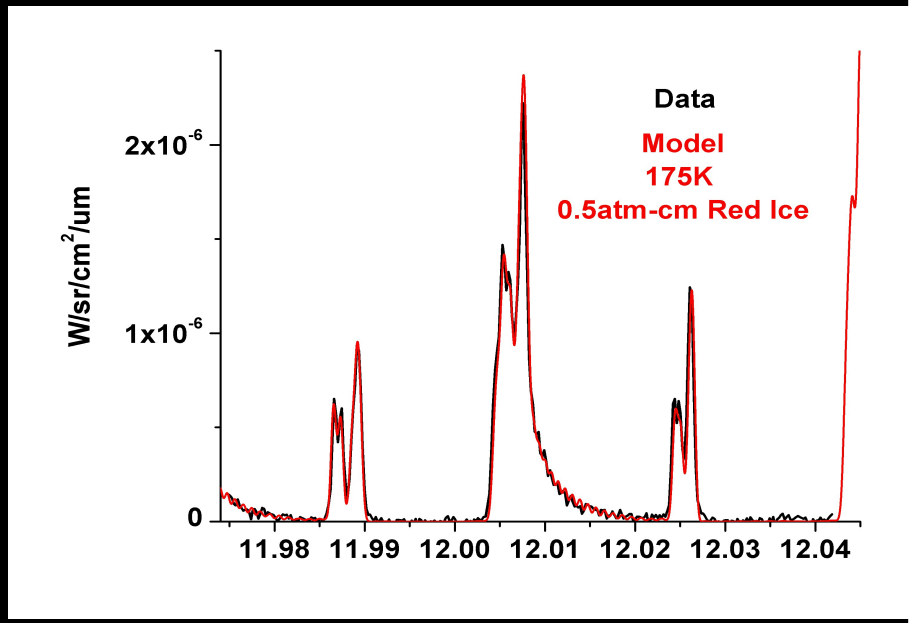
- Temos novos representantes para o GSC (Basílio Santiago) e para o Aura oversight committee para o Gemini (Thaisa Storchi-Bergmann)
- O ex-diretor do Gemini, Matt Mountain, foi para o HST e no momento temos um diretor interino, que é o Dr. Jean-Rene Roy
- Haverá também um novo diretor de Operações para o Gemini Sul. A vaga está aberta. A diretora no norte é a Inger Jorgensen.
- Tivemos a recente experiência de mandar dois engenheiros para o Gemini para trabalhar com o bhros que foi de grande sucesso. O instrumento acaba de ser comissionado e terá uma semana de "Science Verification" no próximo 22 de agosto.
- Houve um compromisso entre os parceiros, incluindo o Brasil, de se pagar os 75 milhões de dólares necessários para se fazer a maioria dos instrumentos Aspen. Somente a Inglaterra ainda não se comprometeu com seus 25%.



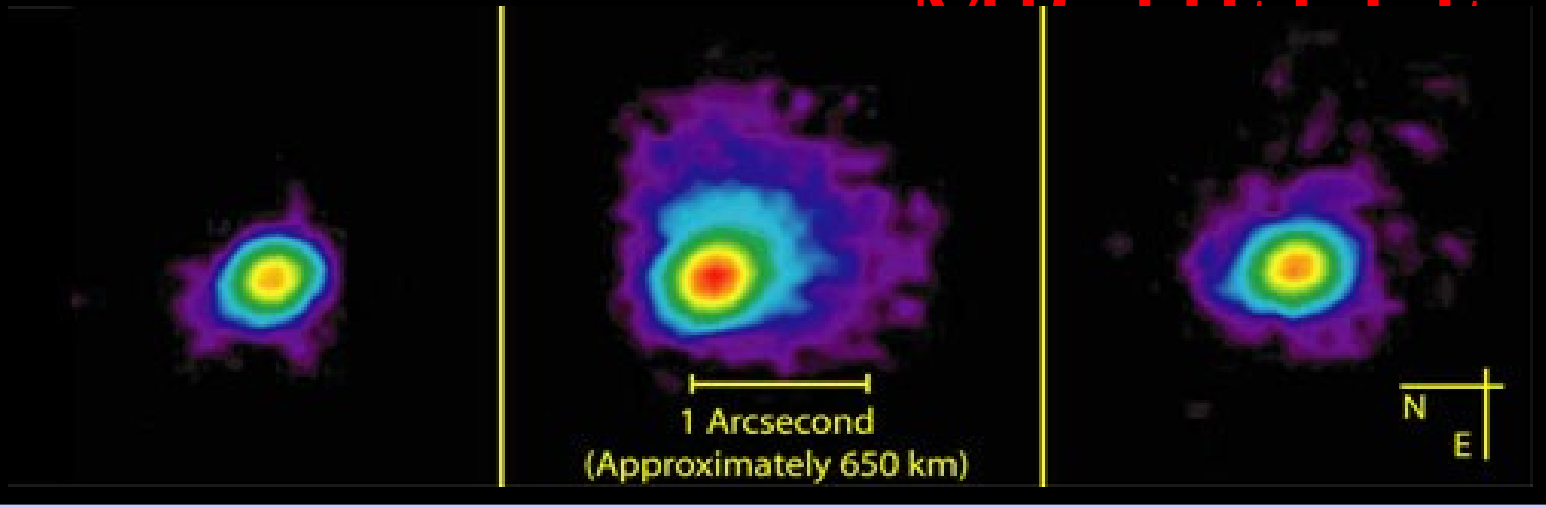




# Recent science highlights



# Deep Impact with MICHELLE



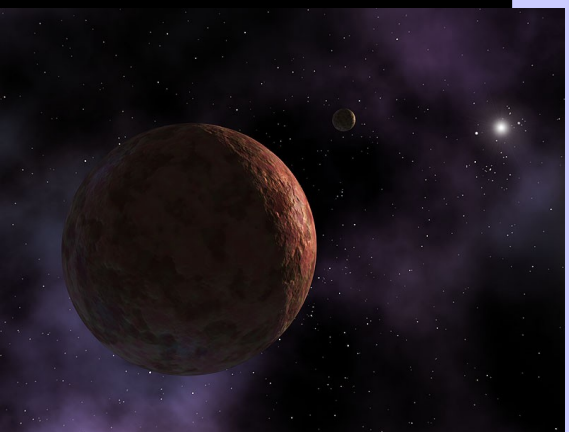

- Pre-, during and post-impact MICHELLE R ~ 200 spectroscopy
  - To constrain the dust properties in the coma
    - Grain size distribution
    - Silicate-to-amorphous carbon ratio
- Excellent data: Early analysis indicate that ejected debris from Tempel 1, a short period (5.5 yr) Jupiter Family comet, has the properties of long period comet (form Oort Cloud)
  - ***Post-impact appearance and strong evolution of Si and olivine features***

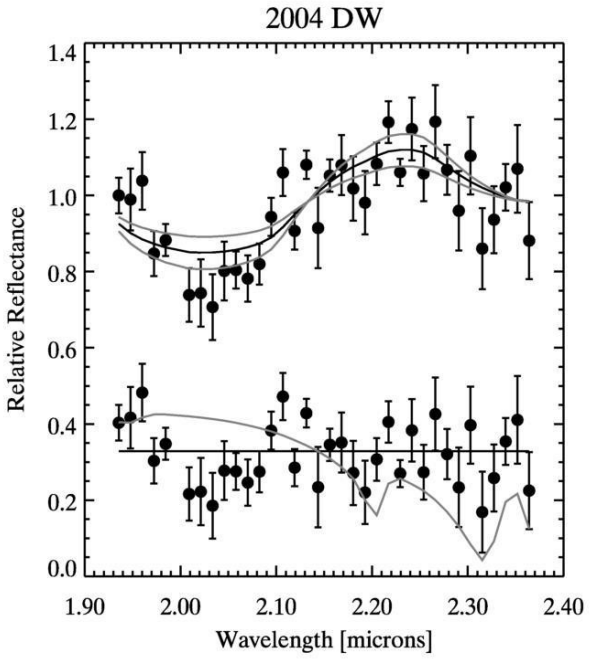
*Harker (UC San Diego) et al.: GN-2005A-DD-9. In collaboration with Subaru COMICS team led by Prof. Sugita (U of Tokyo)*

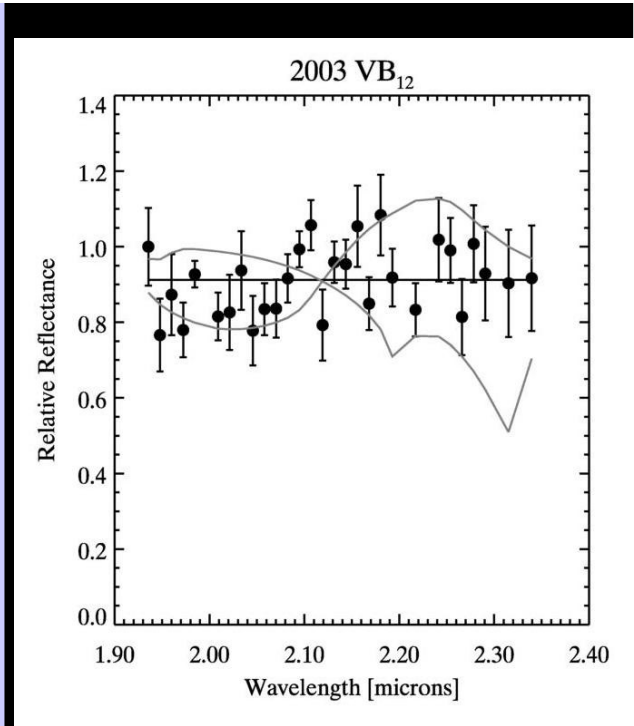
# Surfaces of Sedna and Orca

*Trujillo et al. 2004, ApJ*

- ***Orca***, Minor Planet KBO 2004DW
  - 3:2 resonance orbit with Neptune (like Pluto)
  - NIRI Reflectance spectrum of 2004DW (V~19)
    - Best fit of water ice model
      - Methane ice model is ruled out
- ***Sedna***, Minor Planet 2003$VB_{12,}$ first object between Kuiper Belt and Oort Cloud
  - 90 AU = twice distance of any other bound minor planet, ~1000 AU at aphelion
  - NIRI Reflectance spectrum of 2003 $VB_{12}$ = Sedna (V~21)
    - Spectrum largely featureless
      - Water and methane ices model fits not matching
  - ***Indicates highly processed surface by cosmic rays***

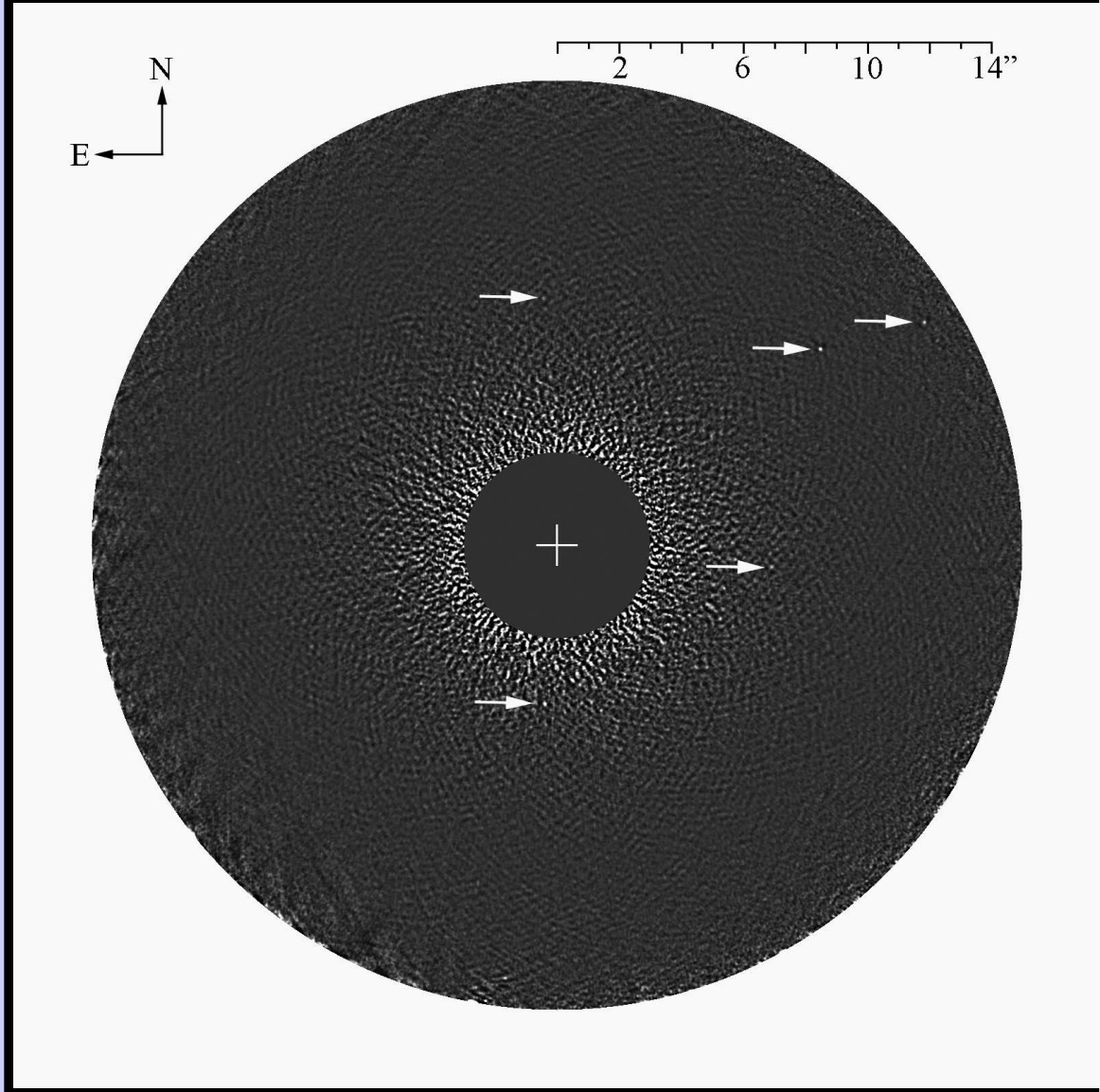




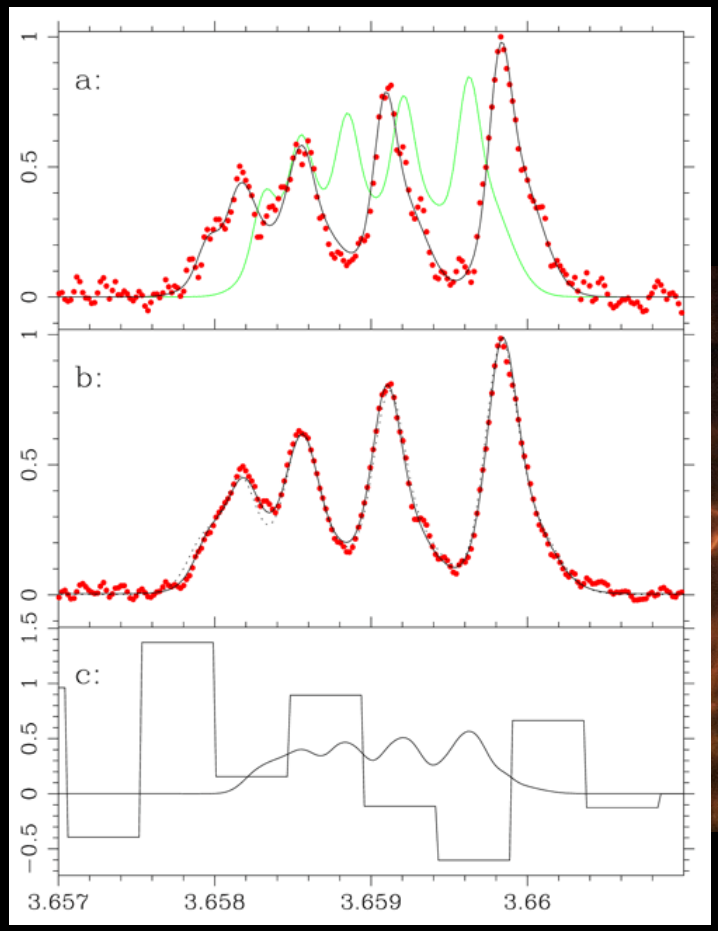
# Planet search around Vega

- NIRI/ALTAIR deep imaging of Vega to search for Jovian like planets
  - Program is part of the *Gemini Planet Survey* to image with AO several nearby bright stars (Doyon et al.)
- "Objects" pointed have contrast between 18 and 20 mag w.r.t. to the peak
  - ***Contrast between the Vega peak and the sky noise is 21 mag.***
  - Best contrast ever obtained before this image was $\Delta_{mag}$ ~ 12-14.



# Hyperfine Structure of [Al VI]

***PHOENIX spectrum at R ~ 75,000 of [Al VI] in the "Bug"Nebula***




***Very high excitation planetary NGC 6302, T* = 250,000 K***

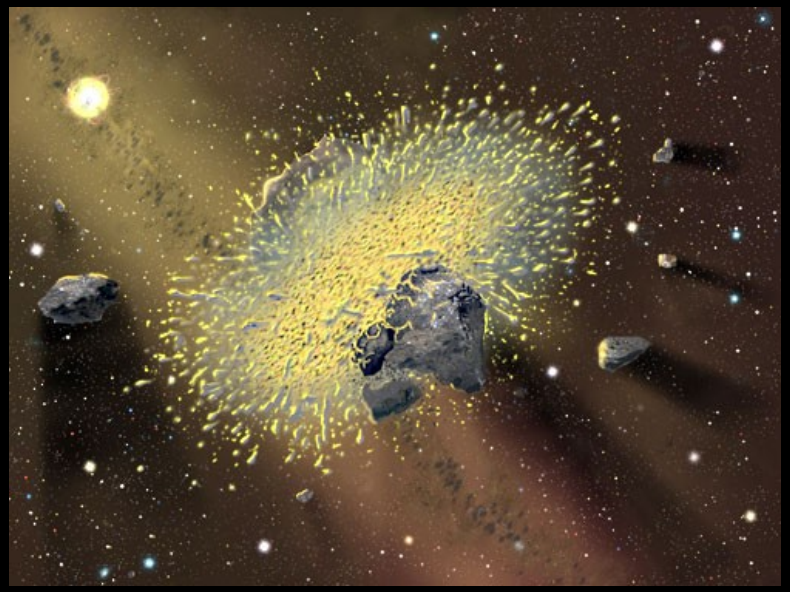
- Modeling multi-component [Al VI] lines at 3.66 micron
  - ***Empirical derivation of electric quadrupole constant***
  - ***First measure of such a constant in an atomic transition in any astrophysical object***
- Isotopic ratio Al-26/Al-27, signpost of recent nucleosynthesis
  - Al-26 radioactive; t ~ 7.2 x $10^5$ yr
  - Origin of Al-26 poorly known
    - Isotopic ratio poorly established
    - Range of process from nova to cosmic-ray collision with ISM clouds

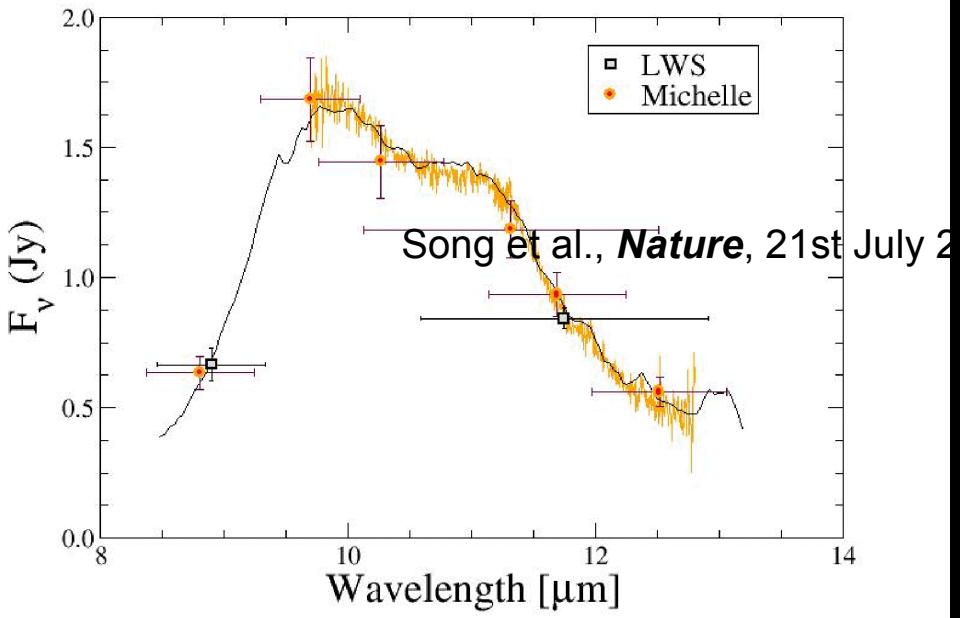
  Upper limit of Al-26/Al-27 < 3%
  - Very narrow coronal lines in PN
  - Ideal object to use hyperfine structure as diagnostic tool
- ***Technique works***
  - Need [illegible] S/N to easily [illegible] topic ratio

*Casassus et al., MNRAS, 2005*

# Colliding asteroids at 1 AU in BD +20 307

- Gemini MICHELLE & Keck LWS mid-infrared R ~ 1000 N-band spectroscopy of BD +20 307 (300 Myr old, d ~100 pc)
- ***Abundant dust signature modeled with T = 300 K SED, at ~ 1 AU distance from star***
  - ***Strongly indicative of rocky bodies or even planet size objects at earth-like distance***
-

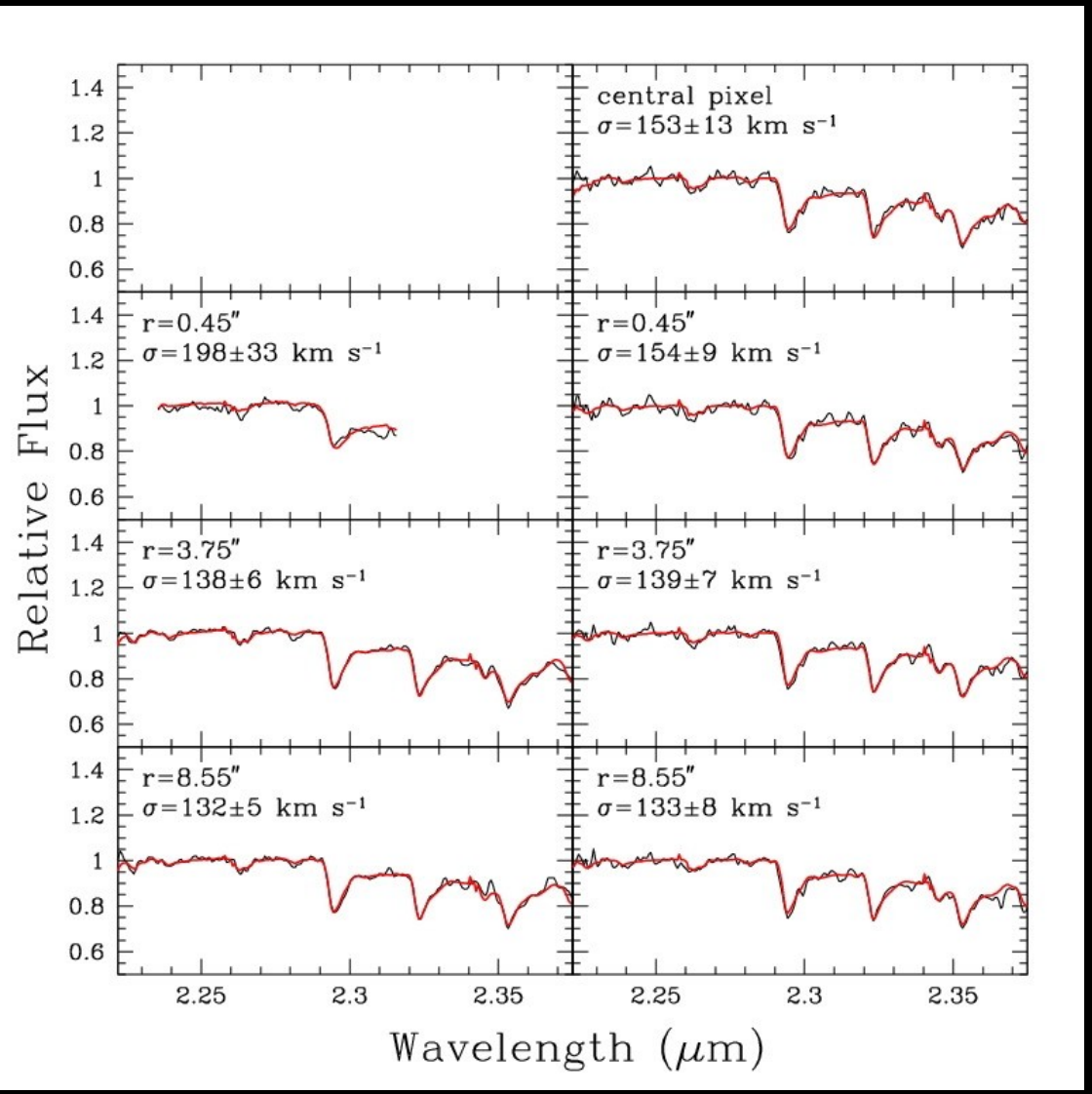





Song et al., ***Nature***, 21st July 2

# Cen A Ultramassive BH

*Silge et al. 2005, ApJ*



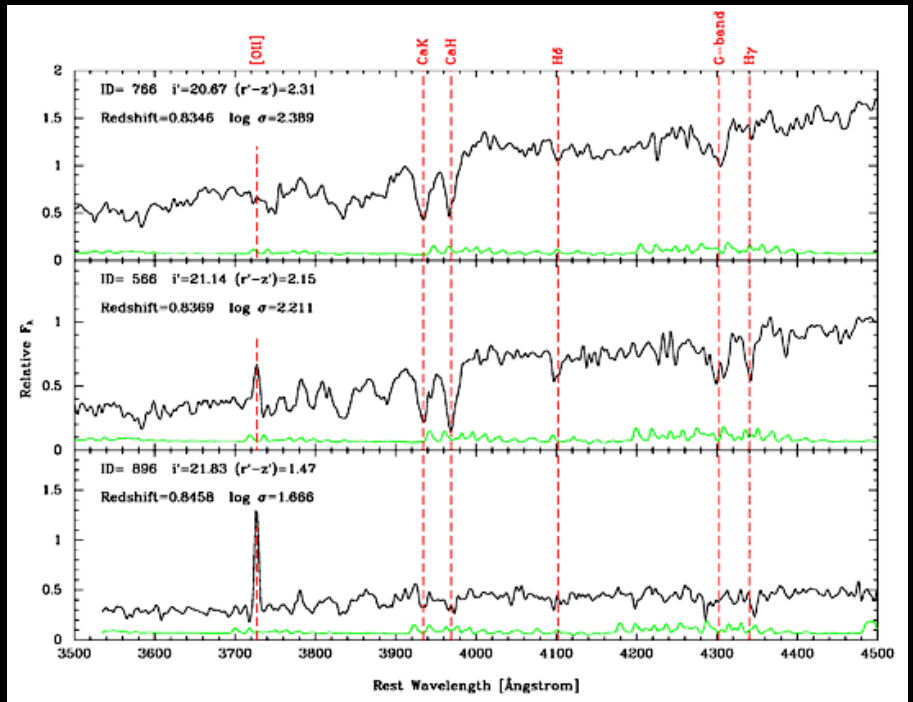

- Gemini/GNIRS unlocks new possibilities to study central BH in dusty galaxies.
- Central ***stellar*** * kinematics of the CO bandheads at 2.3 μm in Cen A
- BH mass using orbit-based models
  - ***BH mass of ~1.5-2.4 x $10^8$ $M_{sun}$ depending on orientation***
    - ***Edge-on model adopted***
- Cen A BH 5-10 times higher than predicted by correlation BH mass vs velocity dispersion
  - Suggest that its BH assembled first before its host component

(*) *Previous study based on gas kinematics*

# Galaxy clusters through half the age of the universe

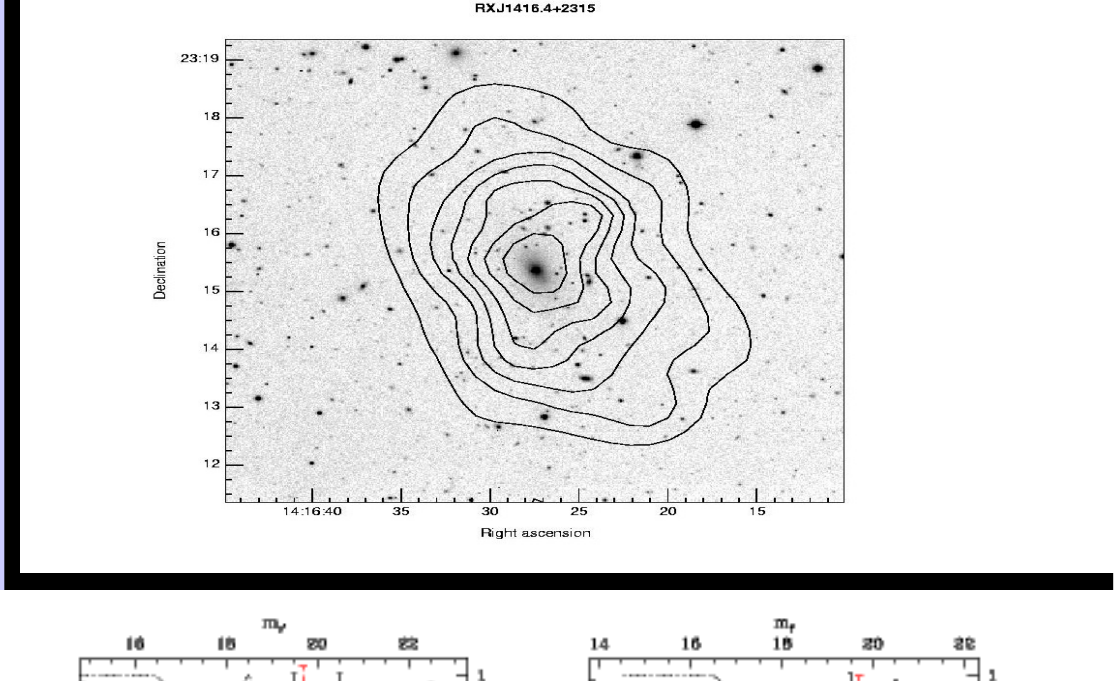
- Gemini/HST Galaxy Cluster Survey
  - 15 clusters with deep GMOS spectroscopy at $0.2 < z < 1$ chosen by their $L_X > 2 \times 10^{44}$ erg/s
- Results from RXJ0152.7-1357 ($z = 0.83$)
  - ***Galaxies of the two sub-clusters will NOT evolve passively into "today's" galaxies***
  - Small amount of new star formation

*Jorgensen et al. 2005, AJ; Barr et al. 2005, AJ*



# The kinematics of fossil groups

- Gemini/Blanco fossil group survey
  - 3 groups with deep GMOS spectroscopy at $0.1 < z < 0.2$ with $L_X < 2 \times 10^{43}$ erg/s
  - Survey is unique
    - First optical survey
    - High S/N spectra
    - Nearby groups to be done at Blanco in Aug-Sep/2005
    - Large range in $L_{gal}$
- Results from RXJ1520 (z = 0.13)
  - It is a fossil cluster, not a group and it is not the end-product of a compact group




*Mendes de Oliveira, Cypriano and Sodré Jr. 2005*

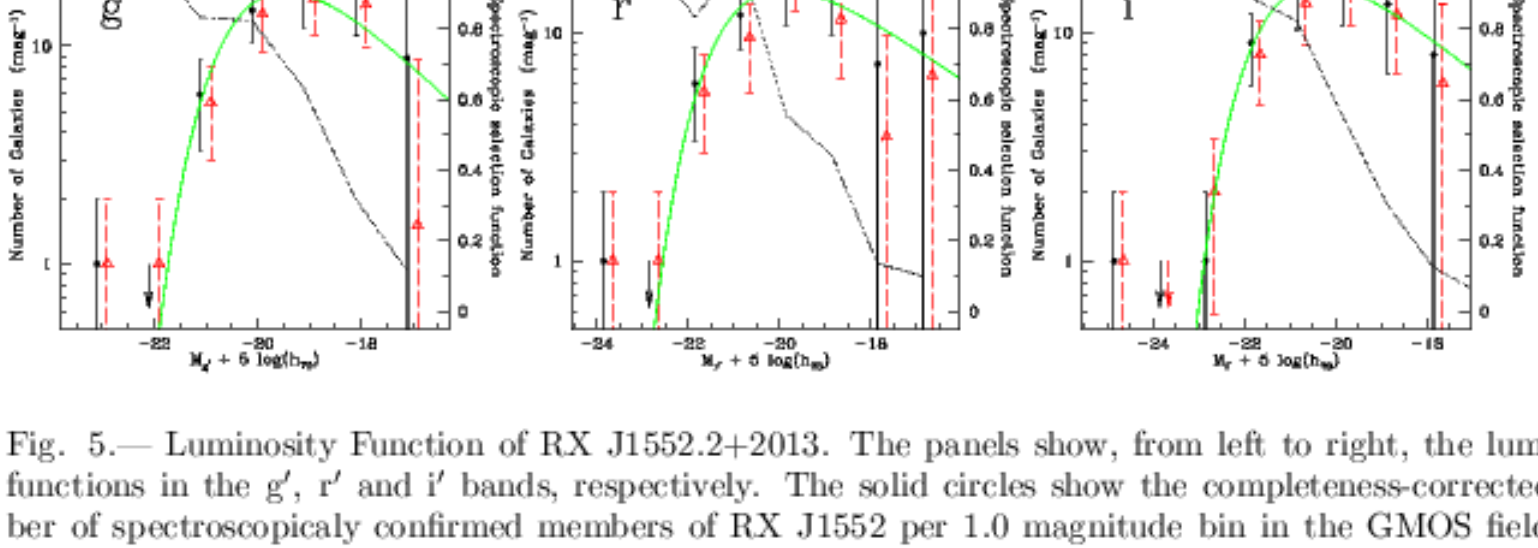



Fig. 5.— Luminosity Function of RX J1552.2+2013. The panels show, from left to right, the luminos functions in the g′, r′ and i′ bands, respectively. The solid circles show the completeness-corrected nu ber of spectroscopicaly confirmed members of RX J1552 per 1.0 magnitude bin in the GMOS field. T

# Gemini publication

**(~160 papers as of mid-July 2005)**

Publication rate is growing. Some instruments remain slow "performers" in terms of hours per publication.

The prediction of ~80 refereed papers in 2005 puts us "historically" at par with VLT and Subaru on a # per year per telescope basis.

# Science productivity & metrics:

How to measure? **Quantity**

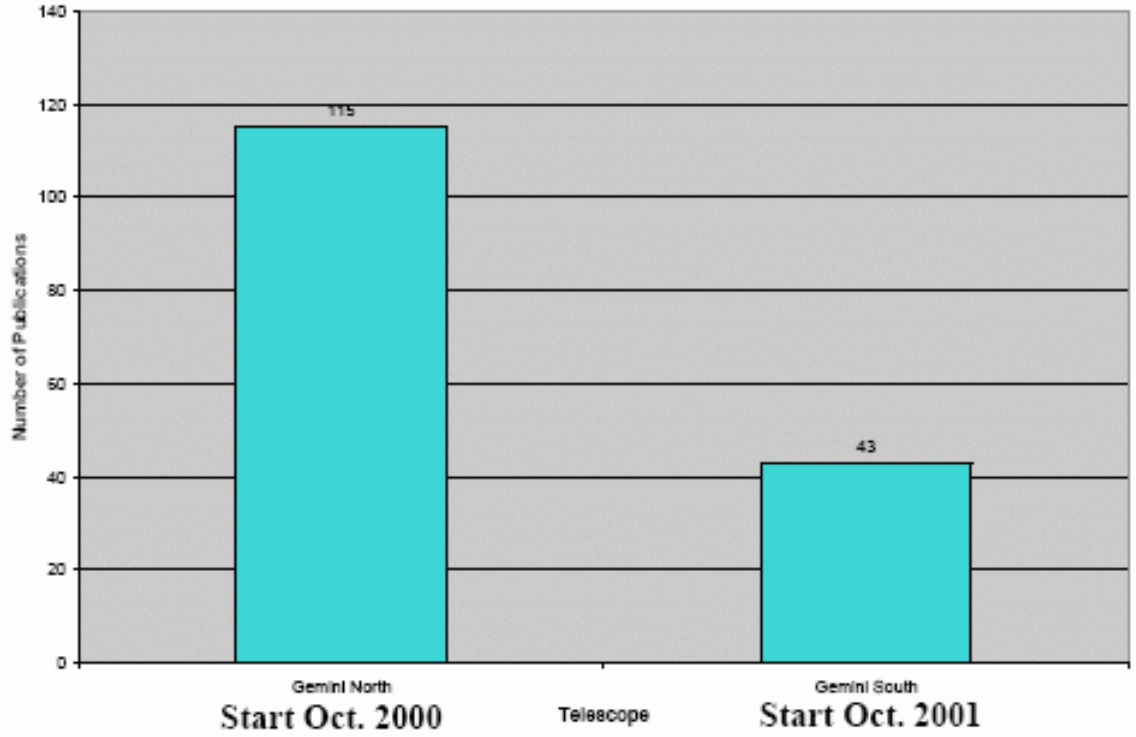
- Number of publications in well recognized refereed journals
  - ApJ, AJ, A&A, MNRAS, PASP, Nature, Science + selected articles in others
- Number of citations (ADS based)
  - Number of high impact papers (HIP)
- How do we compare to others? e.g. VLT, Keck and Subaru data

# … productivity: other metrics

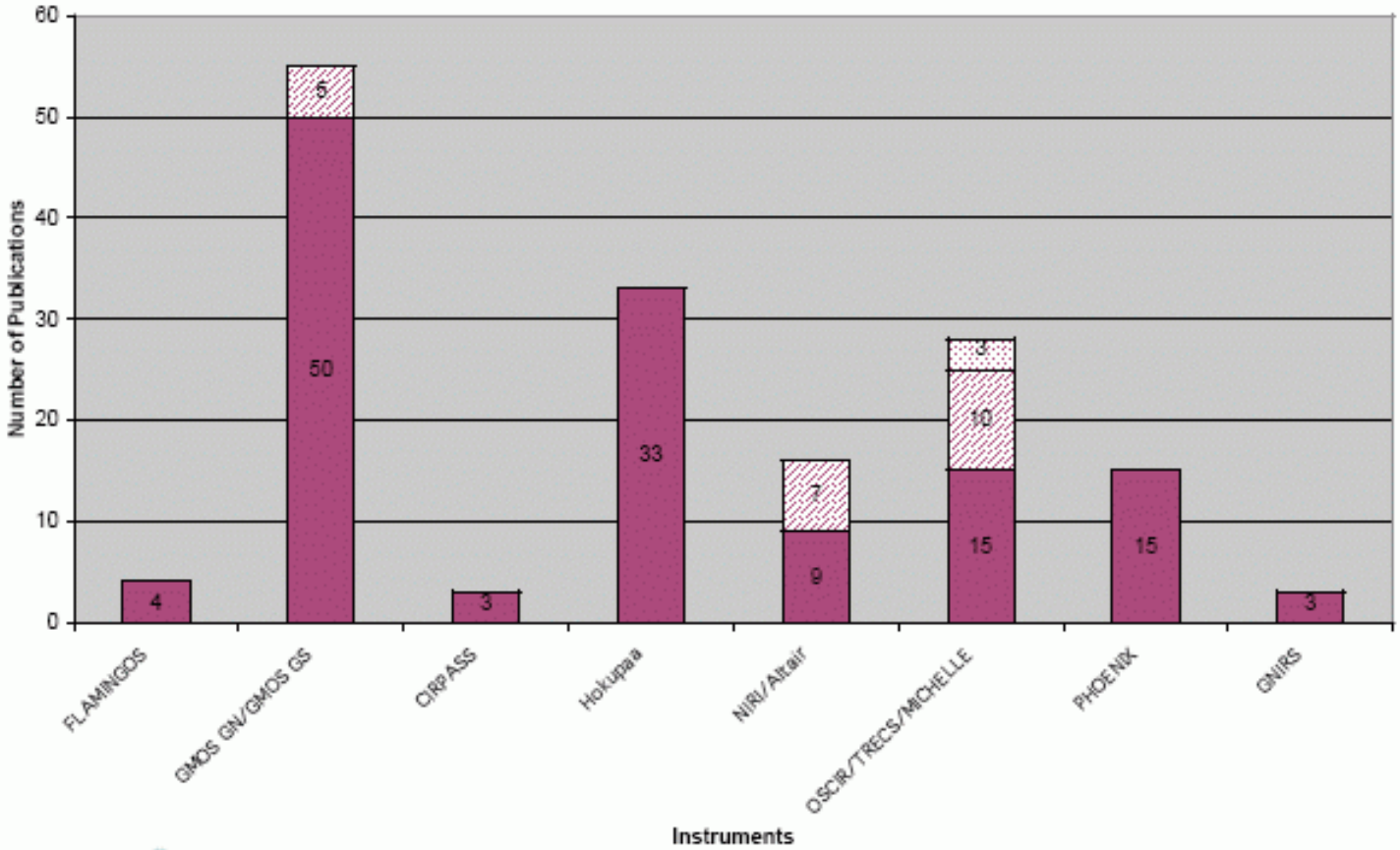
- How to measure? **Quality**
  - Impact of the journals where Gemini results are published
  - Uniqueness of science produced
  - Impact of innovation on papers
  - Effect of new and/or enabling technologies
    - E.g. nod & shuffle, AO technologies, data reduction tools, Gemini Science Archive
- How de we measure? **Cost**
  - Cost per paper/citation
  - Cost per hour of telescope time
  - Risk mitigation in new technology development
  - How do we compare?

N.B. : Definition for counting papers same as for HST and ESO/VLT


## Publications by Telescope




## Publications and Gemini Instruments



# Instrument usage, papers & output

| | | |
|---|---|---|
| **Hokupa'a-36 (adaptive optics imager)** | **33#** | **24** |
| **OSCIR (mid infrared imager)** | **15** | **23** |
| **GMOS-N (optical MO/IFU spectro.)** | **50** | **47** |
| **NIRI (near infrared imager, spectro.)** | **9+7** | **56** |
| **PHOENIX (near infrared HR spectro.)** | **15** | **58** |

Counted 2000B-2004B

OSCIR and Hokupa'a have the best paper output , also oldest history

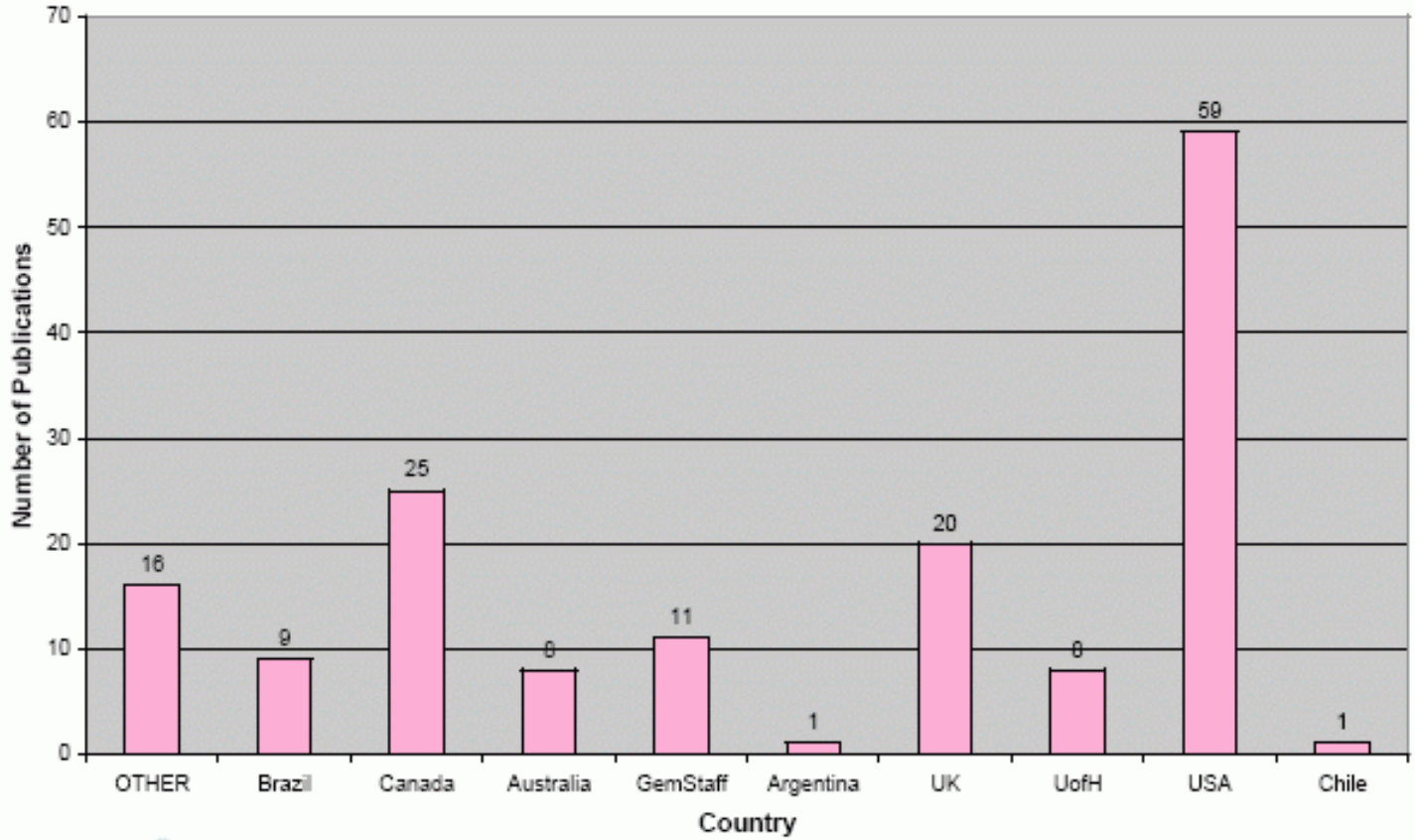
# includes 11 papers based on archival 2000 Hokupa'a-36 GC survey

# Instrument usage, papers & output
# "Young" instruments

| | | |
|---|---|---|
| **T-ReCS (mid infrared imager & spectrograph)** | **10** | **29** |
| **MICHELLE (mid infrared imager & spectrograph)** | **3** | **29** |
| **GNIRS (near infrared spectro.)** | **2** | **[none charged]** |
| **GMOS-S (optical MO/IFU spectrograph.)** | **5** | **162** |

These instruments have short history, more time is needed for a reliable assessment of their productivity (counted 2003A-2004B)

## Publications per country of first author



# Current assessment of publications

Strong differences between instruments (measure in hours per paper)

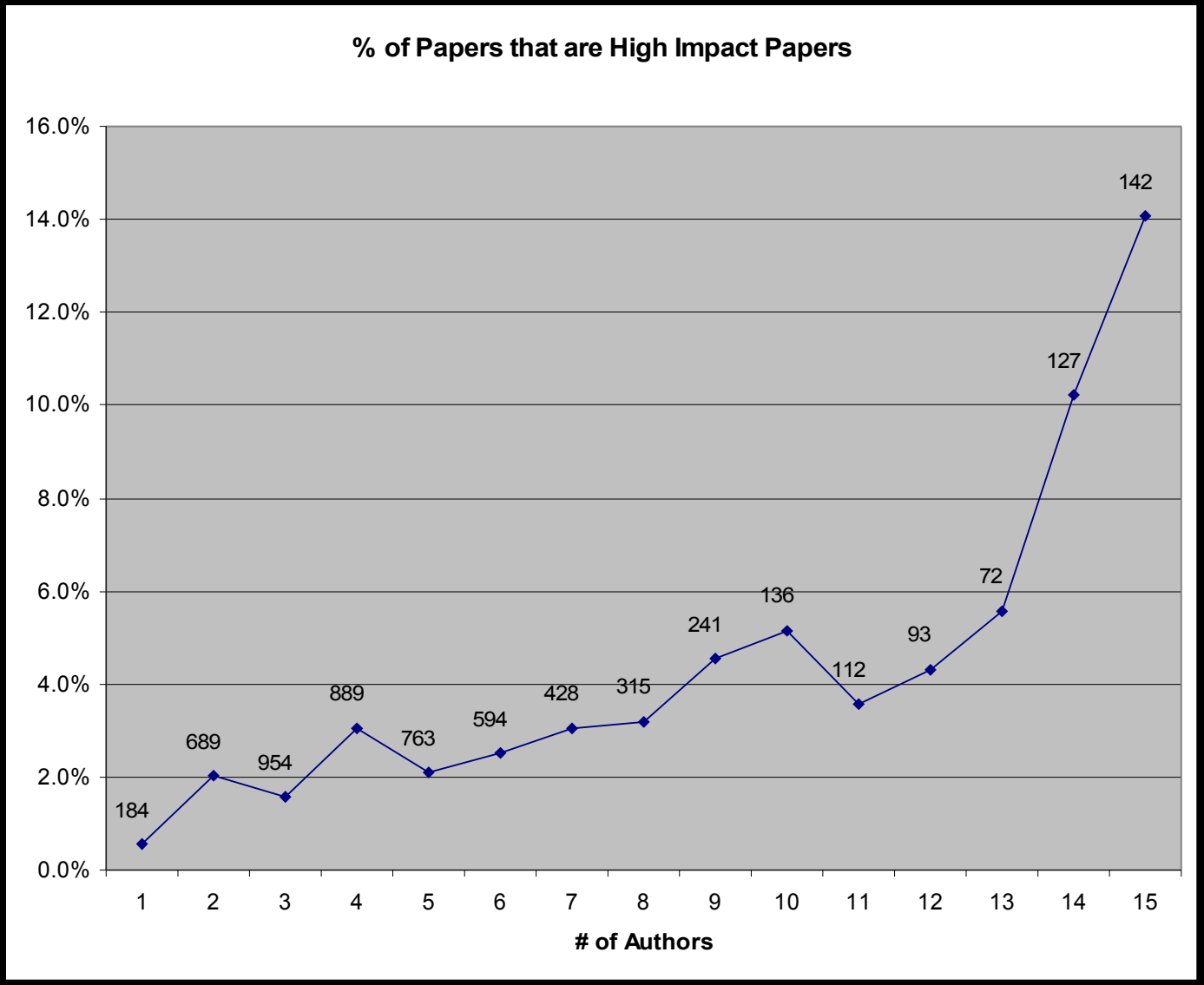
- PHOENIX (same history on telescope as GMOS-N) is lagging, but is picking up (slowly)
- GMOS-South appears slow in ramping up *(short* history)

The IR instruments are more “productive”

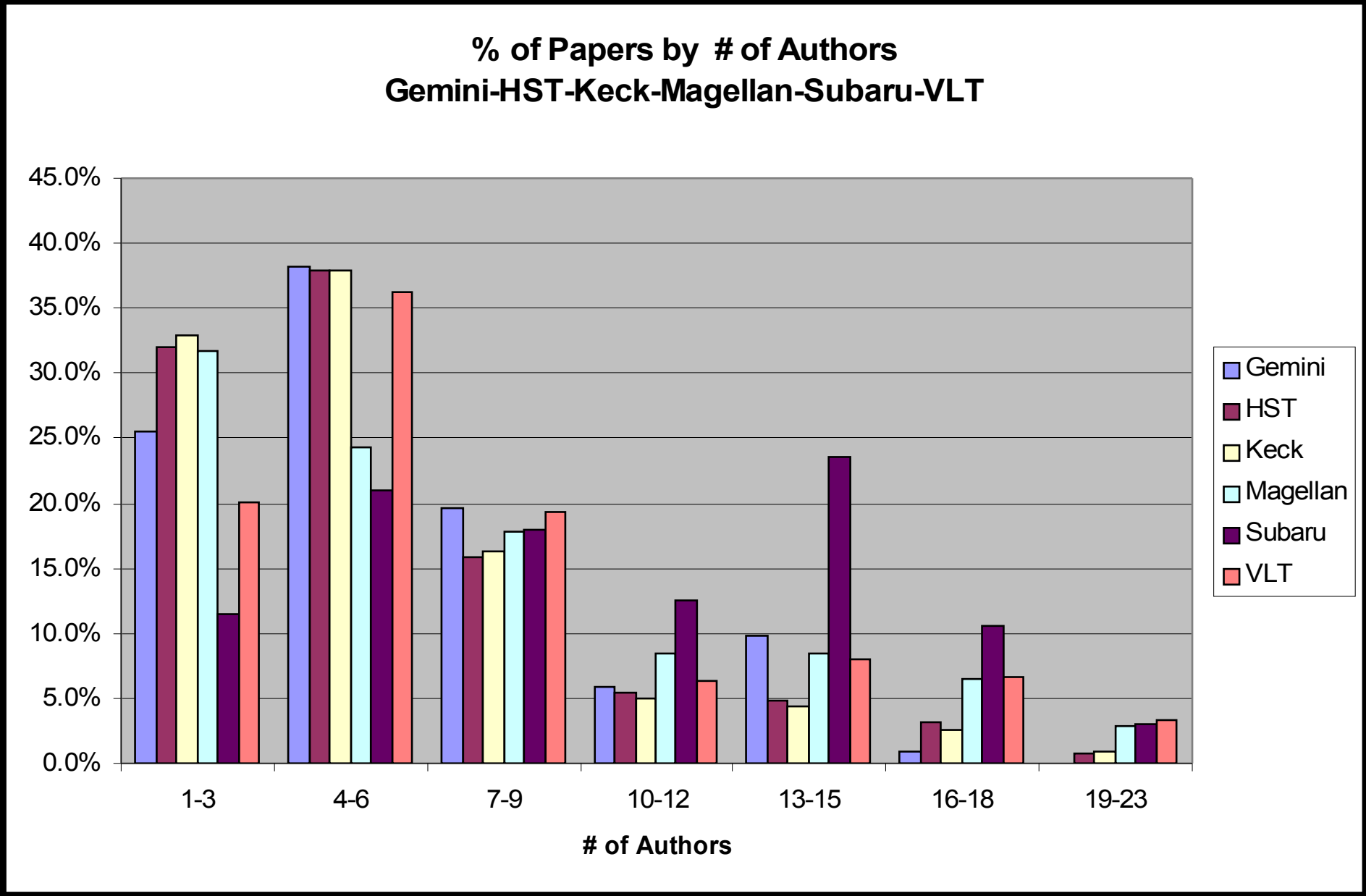
- ***25 hours/paper*** for mid-IR instruments
- **38 hours/paper** for near-IR instruments
- ***58 hours/paper*** for OPTICAL instruments (mainly GMOS-N)
- **AVERAGE IS 43 HOURS PER PAPER**
- ~1/4 of papers are AO based

Paper output in line with rough partner shares as measured by institutional affiliation of first authors

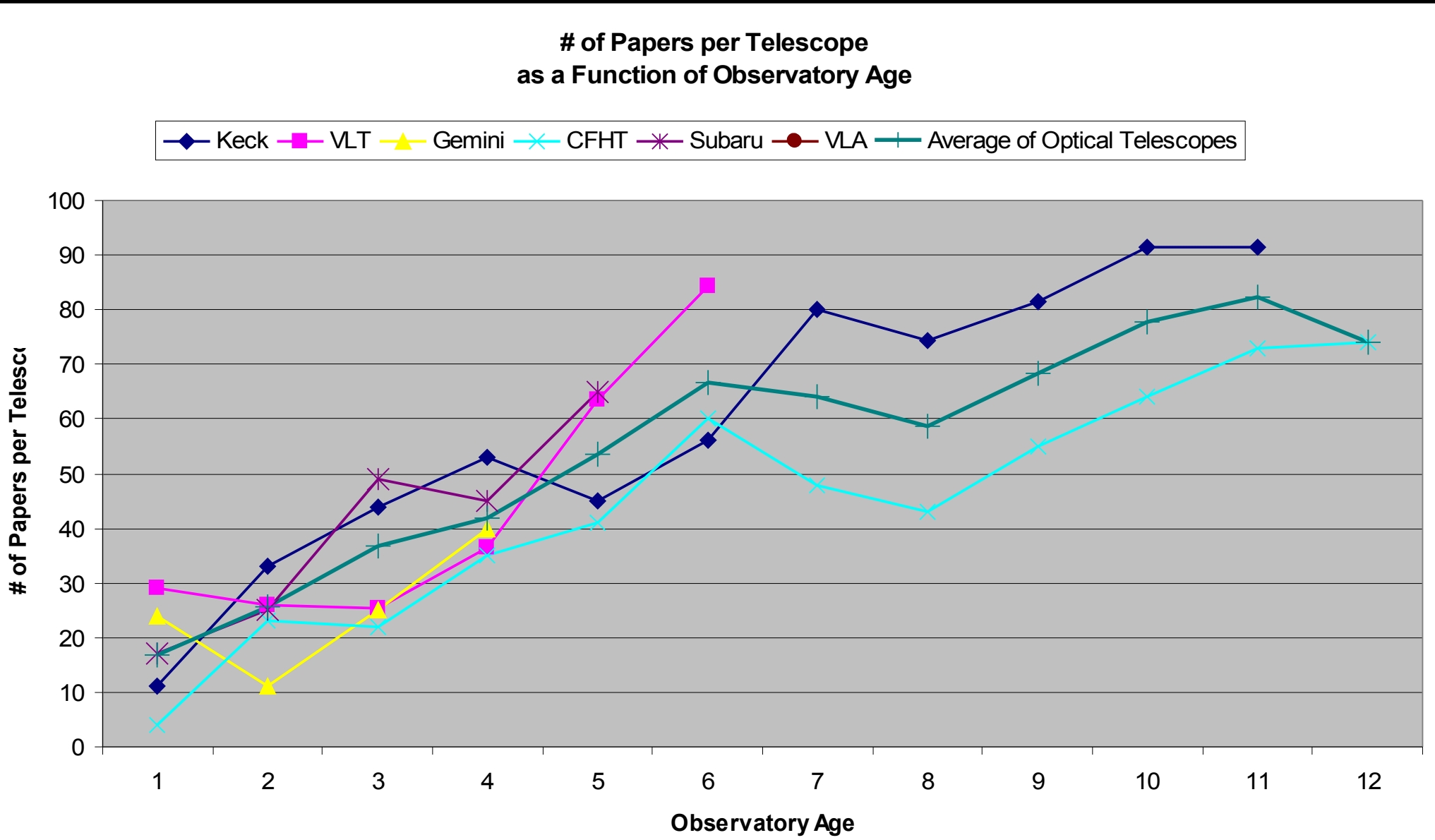
- **Gemini staff are involved in 48 (24%) of the papers**
  - **“first author” of 11 papers**
  - **co-authors on 37 papers**




***Impact correlates strongly with size of team***


% of Papers by # of Authors
Gemini-HST-Keck-Magellan-Subaru-VLT
45.0%
40.0%
35.0%
30.0%
25.0%
20.0%
15.0%
10.0%
5.0%
0.0%
1-3
4-6
7-9
10-12
13-15
16-18
19-23
# of Authors
Gemini
HST
Keck
Magellan
Subaru
VLT

# Compared history of paper output (II)



# Conclusions of publication assessment

**Gemini matches the historical growth of VLT, but under-produces compared to early Keck and Subaru**

**Goal for 2006 will be 130+ papers** total from GN and GS

If that happens Gemini will surpass all at age 5

**Goal for 2008 and after is 200+ papers** total per year

This means 100 papers per telescope, or about one paper per 20 hours of queue observing time

# Conclusions of publication assessment

## Strategies for observatory and NGOs, for trying to increase publication rates

- Need to promote programs well matched to Gemini capabilities

  (task of TAC members)
- Foster well organized and focused teams (for higher impact)
- Involve Gemini staff astronomers closely
- DD time to be used strategically
  - New opportunities (e.g. GDDS startup, Deep Impact, Spitzer follow-up)
  - Quick response
- Regular follow-up with PIs with significant Gemini dataset
- Promote publicly available datasets through the Gemini Science Archive

Situation of the various existing instruments (including those which are about to be comissioned)

# Core Instruments

- Gemini-S
  - GMOS-S - popular dark-time instrument
  - GNIRS - popular bright-time instrument
  - FLAMINGOS-2 - unique NIR MOS capability
  - MCAO - leverages unique capabilities from several instruments
- Gemini-N
  - GMOS-N - popular dark-time instrument
  - NIRI - essential for AO imaging and spectroscopy, unique Gemini assets
  - ALTAIR/LGS - leverage unique capabilities from several instruments

# Swapped Instruments

Gemini-N

- NIFS
- MICHELLE
- TEXES

Gemini-S

- T-ReCS
- NICI
- bHROS
- GSAOI

# Swap instruments – Gemini North

**NIFS – near-infrared integral-field spectrograph to be used with the adaptive optics facility, ALTAIR. Field of view: 3 x 3 arcsec, R=5300, covering J,H,K, 29 0.1” slitlets. Velocity resolution of 55 km/s. Main science goals: black holes in the center of galaxies, inner narrow-line regions of nearby Seyferts.**

**MICHELLE – Mid infrared (7-26 micron) imager and spectrometer, with several gratings (R=200-3000) and an echelle (R=10000-30000).**

TEXES – Spectrograph for the 5-25 micron wavelength region. Can be used in high-resolution cross-dispersed mode, R=100,000, medium resolutions R=15,000 and R=4000 (0.2 micron coverage) or source acquisition imaging with 0.4” pixels and 25” x 25” field of view.

# Swap instruments – Gemini South

**T-ReCS – Thermal-region Camera Spectrograph is a mid-infrared imager and long-slit spectrograph. Broad-band (N,Q) and Narrow-band filter imaging, low-resolution long-slit Spectroscopy R=100-80 (10-20 microns). Medium-res. long slit spectroscopy R=1000, 10 mi.**

**NICI – dual-channel near infrared (1-2.5) coronographic imager with a dedicated adaptive optics system. Each imaging channel has 20+ filters together with several beam-splitting options, occulting mas and Lyot stop choices.**

**bhros – Bench mounted high resolution optical spectrometer. High resolution (R=150,000) echelle spectrograph, fed by optical fibers.**

**GSAOI – Gemini South Adaptive Optics Imager is a NIR adaptive optics camera that will be used with the Multi-conjugate adaptive optics (MCAO) system.**

# Decomissioning plan

# Proposed Near Term Decommissioning List

Acquisition Camera - not frequently used for science programs

GPOL - despite delivery several years ago, has never received high enough priority compared to facility instruments to commission - not likely to change for at least several more years

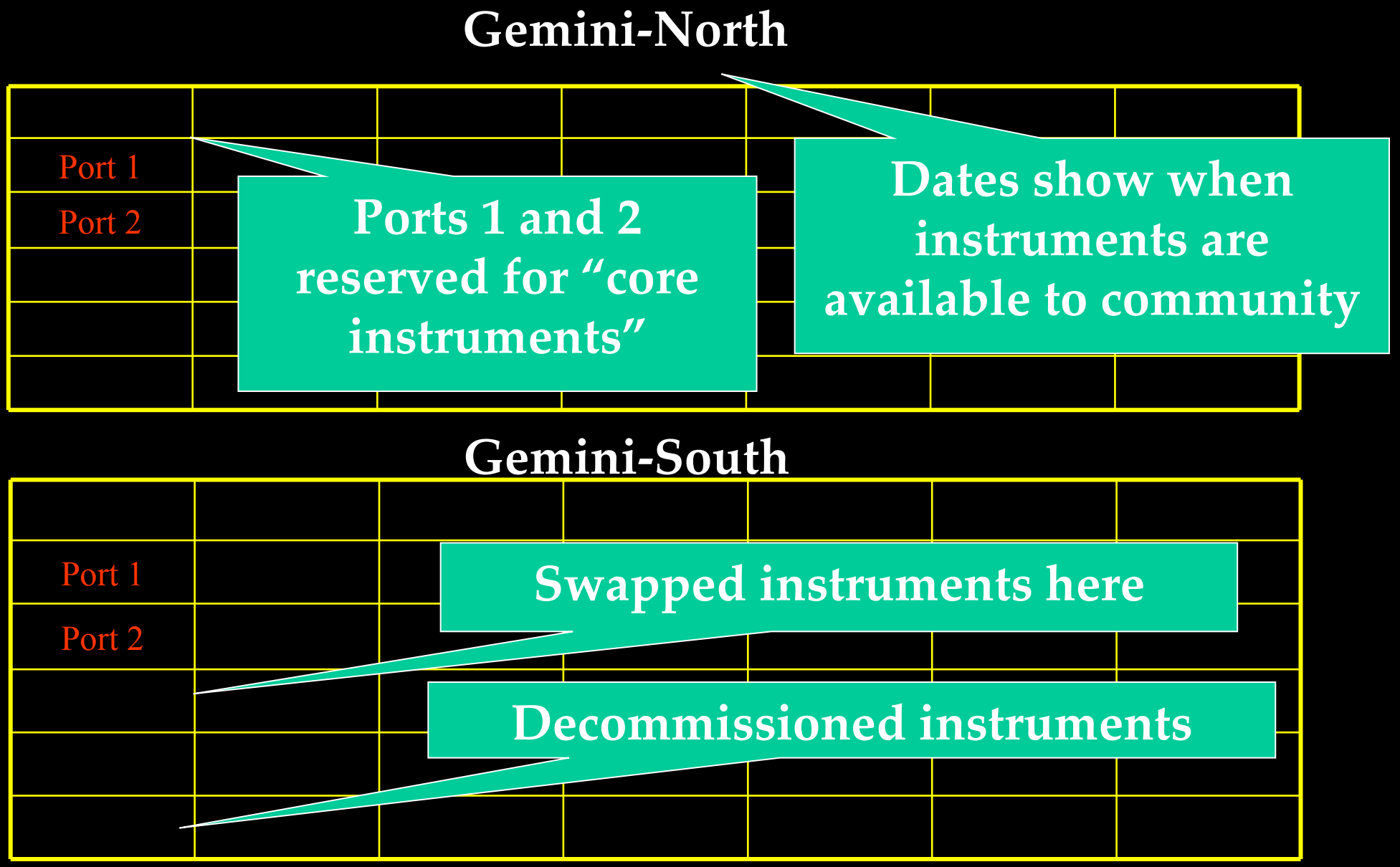
PHOENIX - transfer to SOAR under existing sharing agreement

Hokupa'a-85 - never planned to use once NICI is available

# Factors to Consider When Decommissioning an Instrument

- Gemini has finite resources to maintain delivered instruments
- Scientific productivity and competitiveness of instruments
- Are the capabilities being considered for decommissioning unique to Gemini Observatory? (MIR, no similar capabilities)
- Delivery and commissioning schedules of new instruments which may displace older instruments
- Need to give PI's long advance warning before we decommission instruments so they can factor that into observing plans
- Contractual commitments in the form of GT to instrument builders
- Prefer to keep the number of instruments per telescope per semester "active" to ≤4 and instrument swaps to ≤2 at each telescope
- Instruments that don't meet a minimum time allocation (e.g. 16 nights per semester) for a whole year should be decommissioned.

# Long Range Deployment Plan



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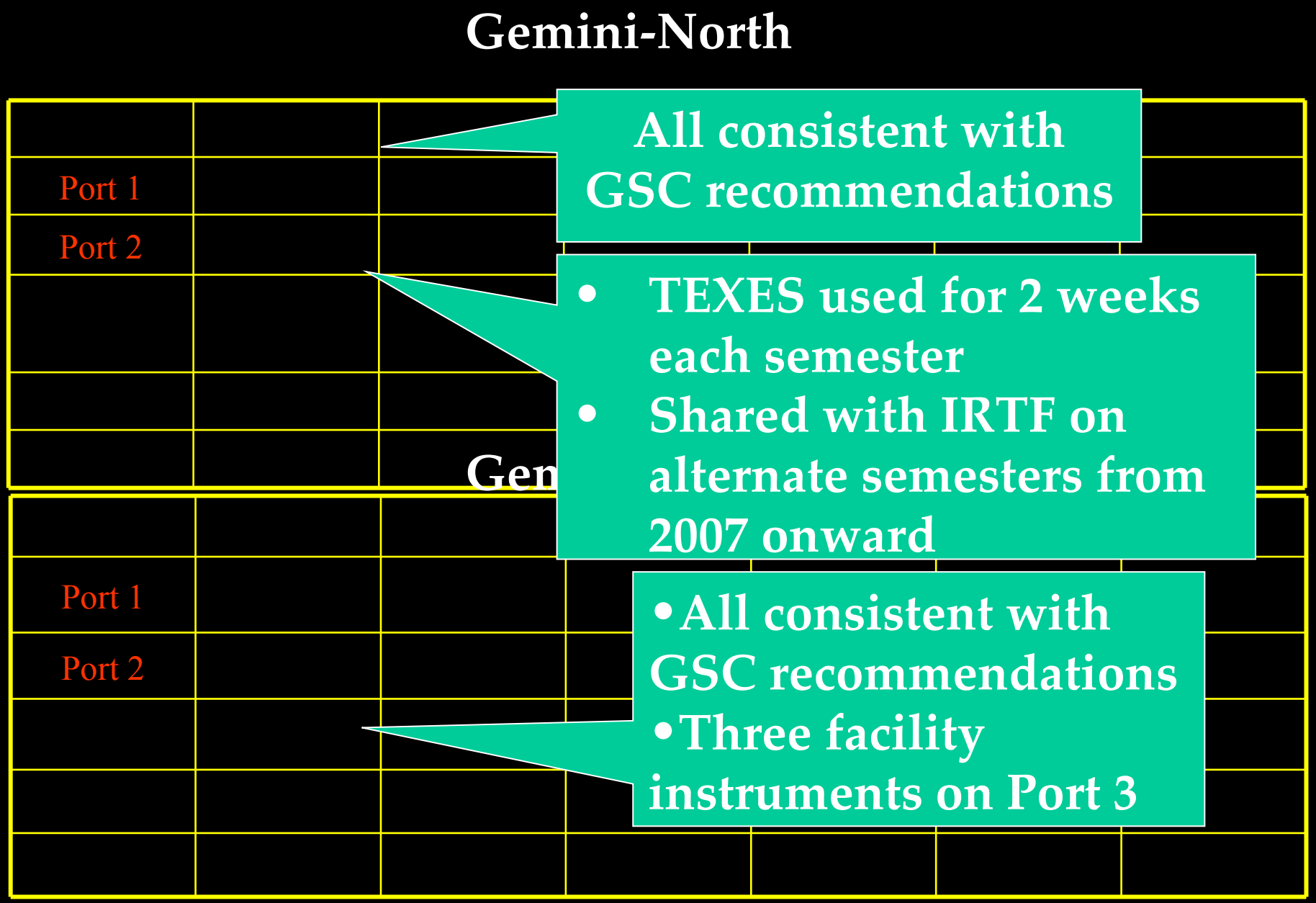
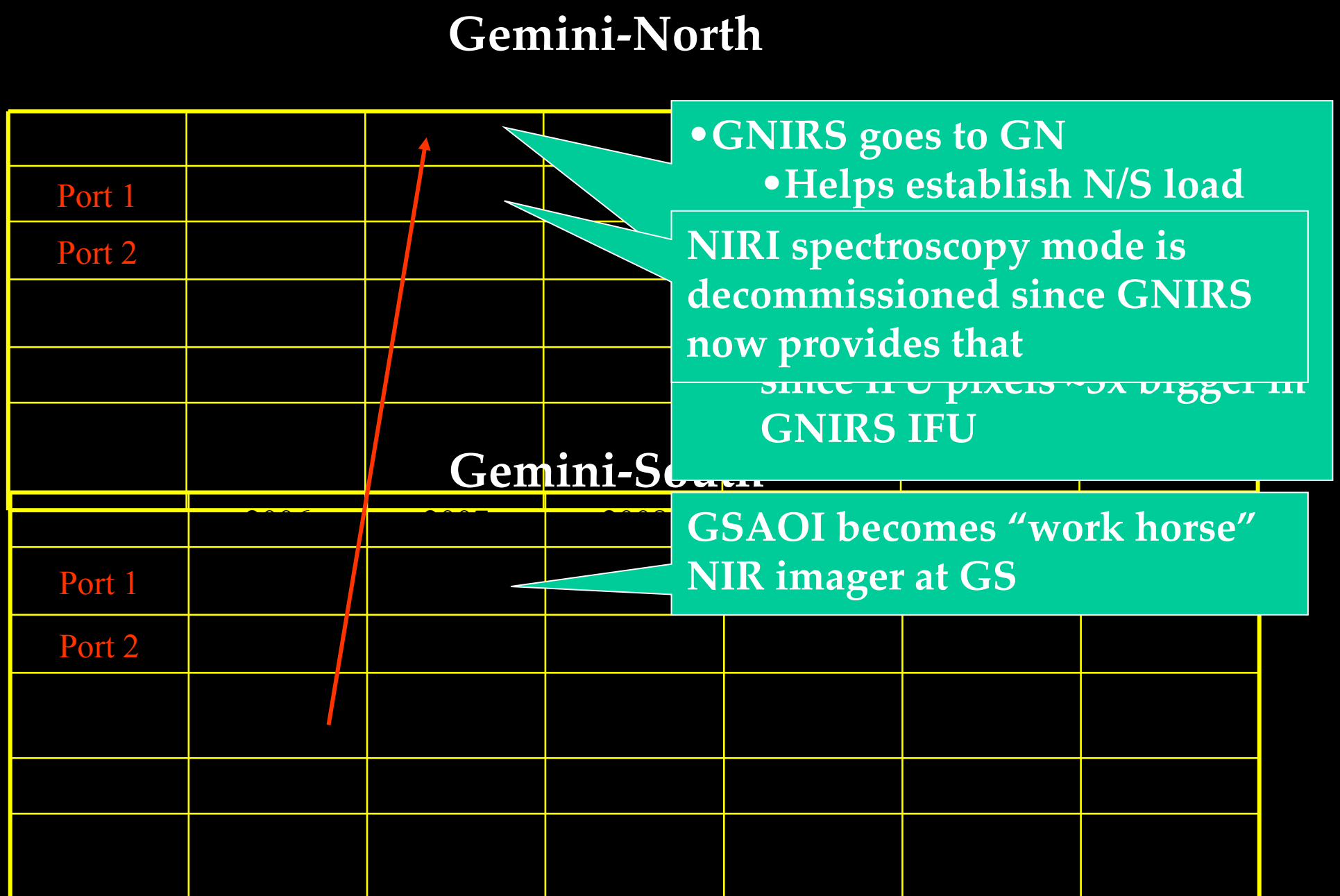


# Long Range Deployment Plan



# Long Range Plan

## Gemini-North

| | | | | | | |
|---|---|---|---|---|---|---|
| Port 1 | | | | | | |
| Port 2 | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |

## Gemini-South

| | | | | | | |
|---|---|---|---|---|---|---|
| Port 1 | | | | | | |
| Port 2 | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |

# New Aspen instruments

# Completion of Aspen instrument studies

As planned, all of the Aspen design and feasibility studies were completed in February/2005

Standard Source Selection process used throughout, including -

- Independent committee evaluating each proposal
- Scores derived for various review criteria
- All advisory to Gemini Director

# Comitês que revisaram os projetos dos instrumentos

GLAO - March 8/9

- Brent Ellerbroek (Chair)
- Jerry Nelson
- Francois Wildi
- Elizabeth Barton
- Francois Rigaut
- Matthieu Bec
- Mike Sheehan
- Maxime Boccas

ExAOC - March 10/11

- Richard Myers (Chair)
- John Hart
- Pedro Gigoux
- Wes Traub
- Francois Rigaut
- Olivier Guyon
- Brent Ellerbroek
- Judy Pipher

# Comitês que revisaram os instrumentos

HRNIRS - March 14/15

- Gordon Walker (Chair)
- Chris Tinney
- Rick Murowinski
- Kim Gillies
- Tom Greene
- Tom O'Brien
- Derrick Salmon
- Larry Ramsay

WFMOS - March 21/22

- Fred Chaffee (Chair)
- William Rambold
- Connie Rockosi
- David Koo
- Noboru Itoh
- Peter Gray
- Mike Sheehan
- Derrick Salmon

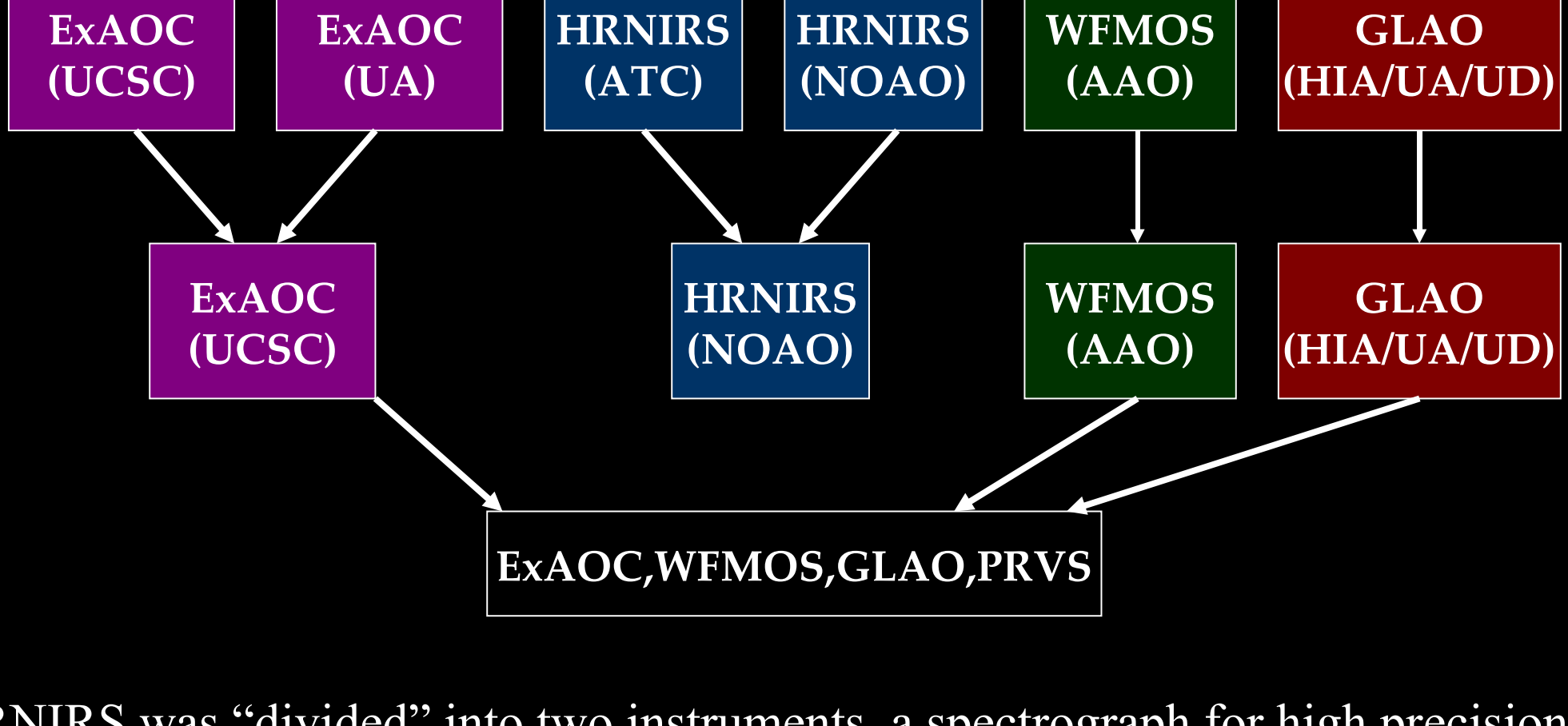
# After all review studies were completed

Gemini then developed a “package” of instruments (75M budget) which was proposed to the Board

The GSC had input on which “package” to pick during a telecom which happened in the beginning of June. The decision was not unanimous.

The Board approved the “package” during a telecom in the middle of June but the resolution that resulted from the meeting was not approved yet.

# Decisão sobre instrumentos de Aspen




HRNIRS was “divided” into two instruments, a spectrograph for high precision velocity measurements and a multi-slit (MOS) spectrograph, which will stay as a backup plan, in case the negociations about WFMOS with the japonese do not go forward as expected. There will be recompetition for the PRVS

# Brazilian situation

The  MCT has agreed to pay for our fraction in the 75M budget for Aspen instrumentation development and the increase in the operating costs (which will turn the observatory into 100% survey-mode).

# The campaign mode

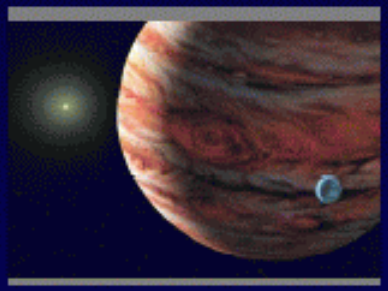
- How can brazilians do science in survey mode?

How to divide the teams? How to do the time allocations?
How to distribute the data after the survey is completed?

Specific model for NICI

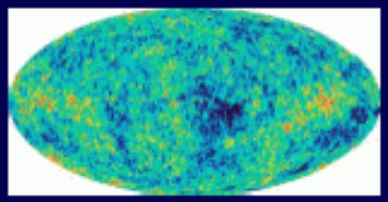
# The Aspen Science Goals

- **All the high-priority Aspen science goals require *large, multi-year observing campaigns*:**



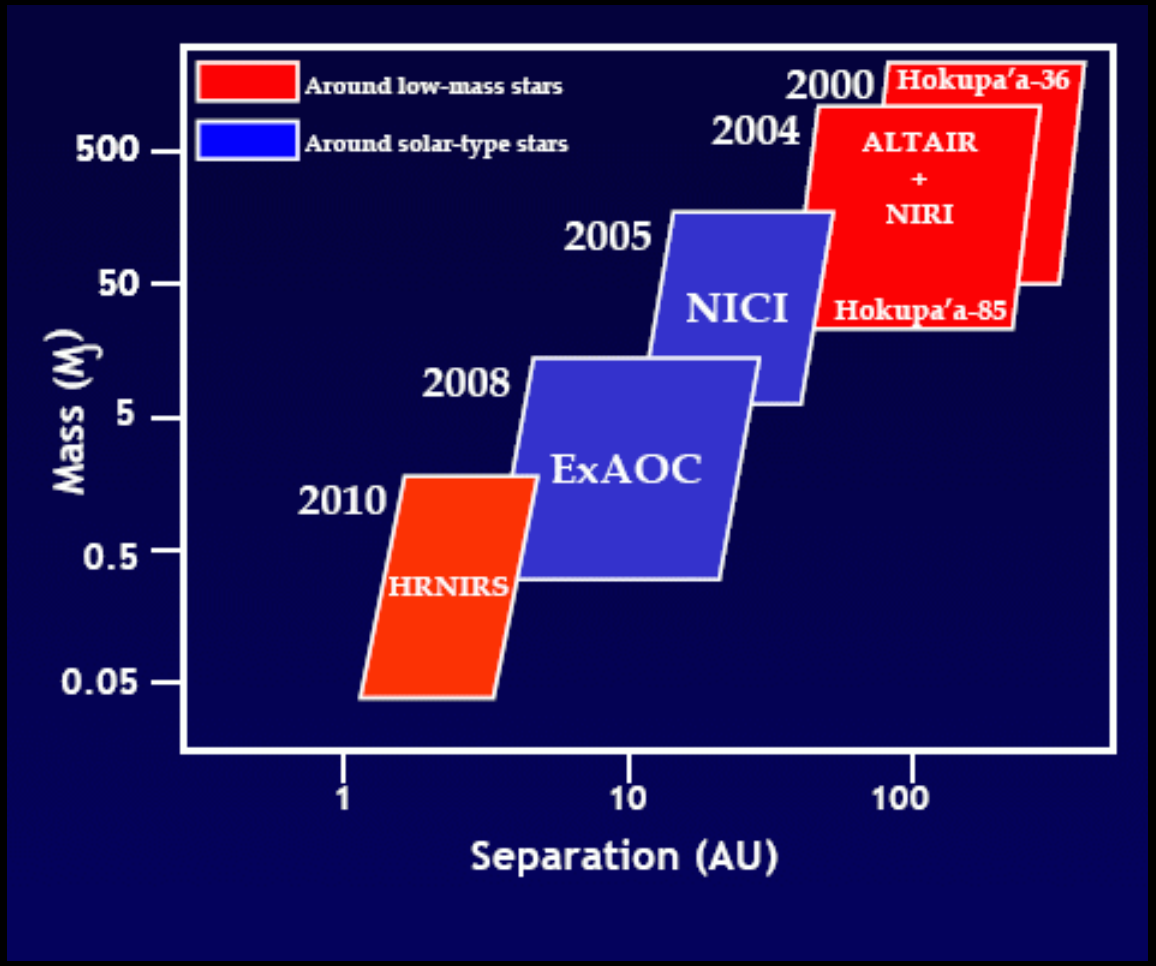
- ExAOC planet search: 150-200 nights, including multi-year follow-up for confirmation
- HRNIRS planet search: ~200 nights spread over several years

- WFMOS galactic archaeology: ~300 nights



- WFMOS dark energy: 150-200 nights

(note that these are usable nights!)


Around low-mass stars
Around solar-type stars
2000
Hokupa'a-36
2004
ALTAIR
+
NIRI
2005
NICI
Hokupa'a-85
2008
ExAOC
2010
HRNIRS
500
50
5
0.5
0.05
Mass (MJ)
1
10
100
Separation (AU)

# Breaking Ground with NICI

- ***The primary NICI science goal of planet discovery requires a large, systematic survey to have any real chance at success.***
- **NICI needs a *science team*, *data reduction pipeline*, and a *significant allocation of time* to successfully complete a planet survey**

**We have a choice:**

- **Allocate time in the usual way to PIs from the different partners, one semester at a time, send them the raw data, and sit back and wait for the planets. *Or…***
- ***Design a NICI planet-finding campaign, as we plan to do for the future Aspen instruments, including team formation, software, data handling, time allocation, etc.***

# Campaign Data Distribution

## The following guidelines apply to Campaign data:

- Public data releases of reduced data should be limited, and contain only well-calibrated, well-documented, complete data products.
- Raw and/or pipeline reduced data distribution to team(s) should be automated as much as possible
- Data should be distributed through the Gemini Science Archive, and should be compatible with the Virtual Observatory
- Proprietary time for raw data will have to be determined at the time of the AO (must be Board approved).
- Campaign targets are "protected" so that PI programs don't observe the same objects.

# Short-term Plans: NICI

*(modified)*

| | |
|---|---|
| Feb. 2005 | • OpsWG discusses the proposed strategy for doing campaign science and approves the Top-Level Principles<br>• CfP for 2005B |
| Mar. 2005 | • Concepts presented to partner communities for comment and feedback |
| Apr. 2005 | • GSC reviews OpsWG/Gemini recommendations<br>• Planet Finding Science Working Group formed<br>• Competitive down-select on ExAOC and HRNIRS complete |
| May 2005 | • Board approves campaign strategy<br>• PFSWG meets and decides on survey parameters<br>• NICI AO drafted, approved, and released |
| Aug. 31, 2005 | • 2006A CfP, Call for NICI SV proposals (possibly assigned to campaign team instead) |
| Sept. 30, 2005 | • NICI Survey proposals due |
| Oct. 2005 | • Campaign team selected |

# Short-term Plans: NICI

| | |
|---|---|
| Nov. 2005 | • Team membership finalized<br>• Team meets and adopts a schedule/management plan<br>• NICI commissioning and SV data taken |
| Jan. 2006 | • Team exercises data reduction software and decides on observing techniques, based on NICI SV results.<br>• Telescope schedule constructed. Team identifies members that can participate in observing runs. |
| Feb. 2006 | • First NICI Campaign observing time<br>• OpsWG reviews effectiveness of process thus far |

- Brazilian participation in NICI campaign

We have proposed to participate in the proposal for free. So, any brazilian can participate in the survey teams and no time will be deducted from Brazilian time (true also for Argentina).

To be approved in Nov/2005 Board meeting

- Brazilian participation in ExAOC campaign

We have proposed to participate in the campaign with 2.5 hours per semester. So, any brazilian can participate in the survey teams and 2.5 hour per semester will be taken away from brazilian time, during the whole duration of the survey.

To be approved in Nov/2005 Board meeting

- Brazilian participation in WFMOS campaign

What should we suggest?

To be discussed in Nov/2005 Board meeting.

# The Future of Brazil in Gemini

# Opportunity for instrumentation development

**Brazil wants to participate in the development of instrumentation.**

**What are the steps we should follow?**

**1) Send people to be formed abroad?**

2) Bring visiting instrumentalists?

3) Send engineers to Gemini to help out with existing instruments? (like Rene/Rodrigo did for bhros)

4) Identify sub-projects in which we could easily collaborate with larger teams (parts of the AeG system, polarimetric module of ExAOC, for a few examples).

5) Identify unique features we want to specialize on

6) Create network of departments/institutions/companies which would be interested in completing a project together

# Conclusões

A experiência do Brasil no Gemini tem sido positiva, tendo nos dado acesso a dois telescópios de grande porte com instrumentos excelentes, que nos possibilitam fazer ciência de ponta.

Nosso número de publicações está acima da média de outros parceiros, levando em consideração nossa fração de tempo. No entanto, sempre os mesmos times têm pedido tempo no Gemini. Devemos motivar novos usuários!

# Conclusões

Precisamos decidir como será nossa participação no "modo campanha" dos novos instrumentos ASPEN

Não estamos tirando proveito do fato de termos o direito de participar em instrumentação no Gemini.

Como mudar isto?