

# Future Missions: Ground & Space

Stephen Ridgway  
NASA HQ & NOAO  
July 27, 2006

Where have we come from?



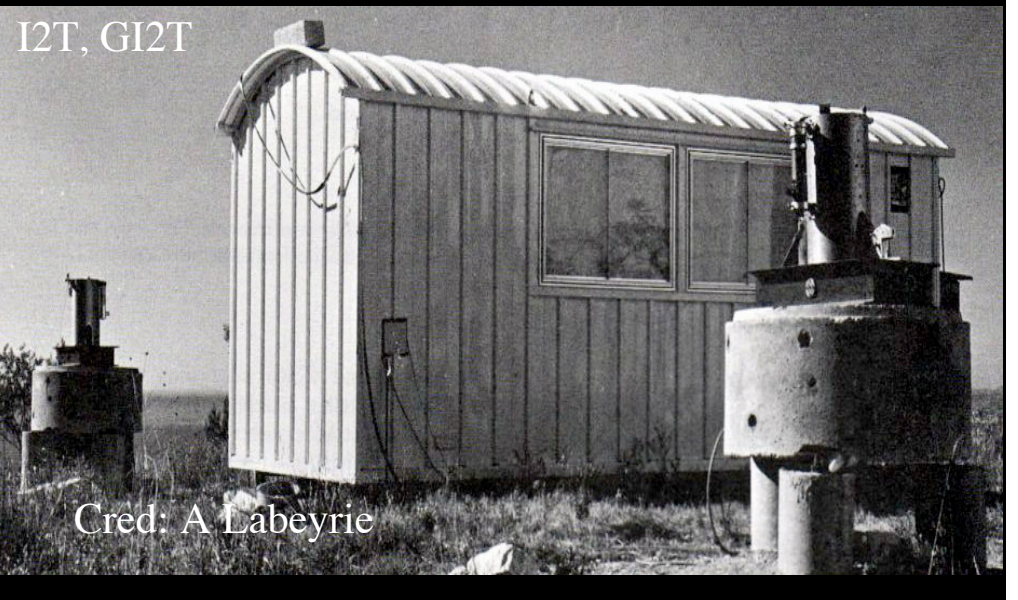
Courtesy: O. von der Lühe



## Some Pioneers



I2T, GI2T



Cred: A Labeyrie

In 1985, most of the world's interferometrists fit into a small room

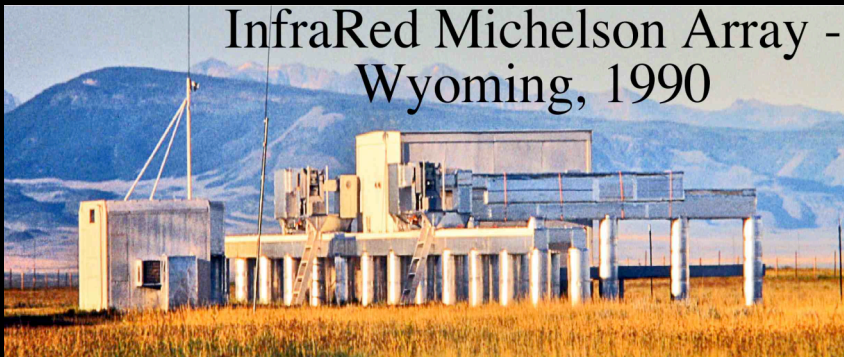


# Optical Interferometry - the Prototype Years

GI2T - France 1974-2005



InfraRed Michelson Array - Wyoming, 1990



Infrared Optical Telescope Array  
Arizona, 1994-2006



Palomar Testbed Interferometer 1994 -

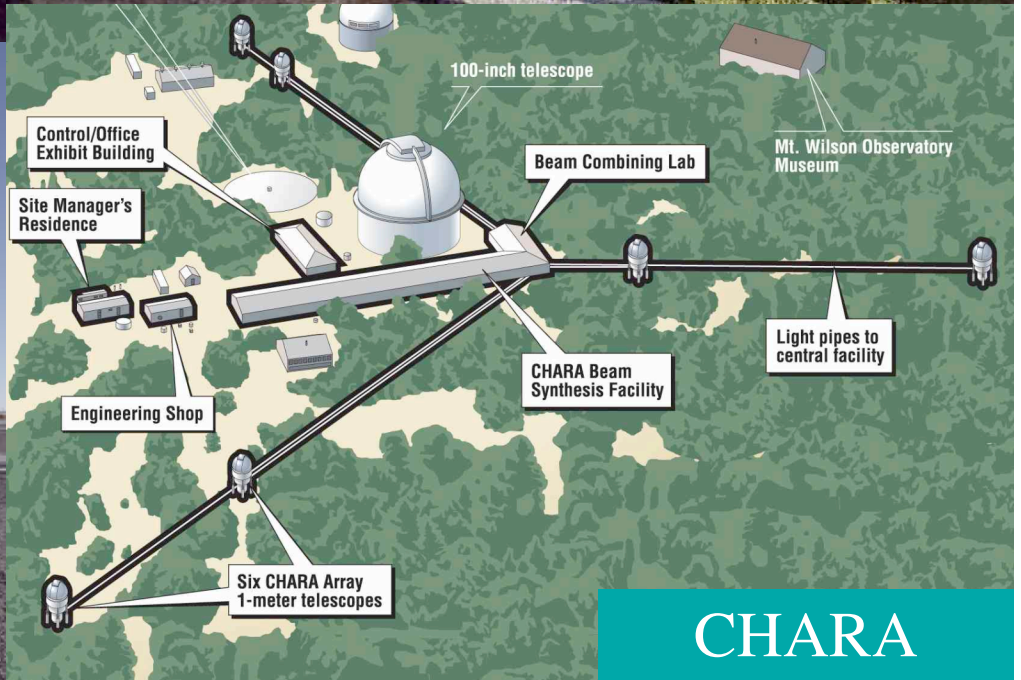


Cambridge Optical Aperture Synthesis  
Array, England, 1994 -



Where are we today?

# Optical Interferometry - Major Operating Facilities



# Conference 6268

Thursday-Tuesday 25-30 May 2006 • Proceedings of SPIE Vol. 6268



*Conference Chairs:*

**John D. Monnier**, Univ. of Michigan



**Markus Schöller**, European Southern Observatory (Chile)

**William C. Danchi**, NASA Goddard Space Flight Ctr.

*Photo not available*

## Advances in Stellar Interferometry

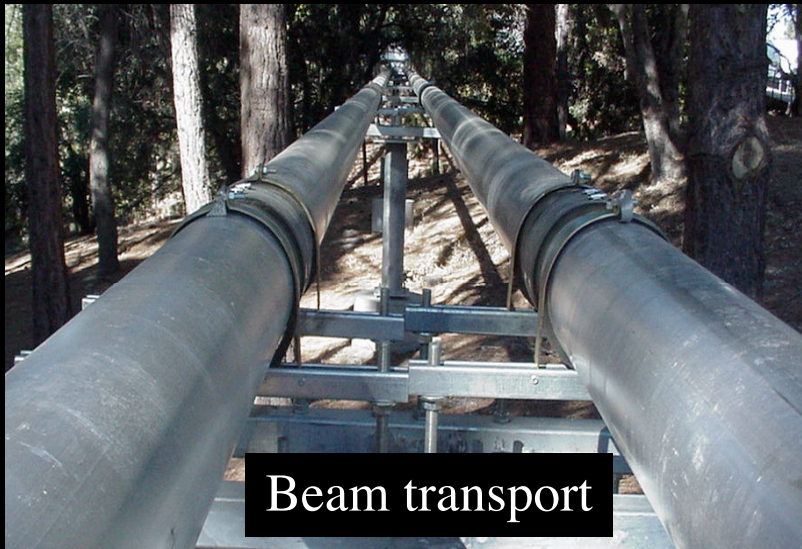
*Program Committee:* **Marc Barillot**, Alcatel Alenia Space (France); **Jean-Philippe Berger**, Lab. d'Astrophysique de l'Observatoire de Grenoble (France); **Michelle J. Creech-Eakman**, New Mexico Institute of Mining and Technology; **Francoise Delplancke**, European Southern Observatory (Germany); **G. Charmaine Gilbreath**, Naval Research Lab.; **Michael Ireland**, California Institute of Technology; **Oliver P. Lay**, Jet Propulsion Lab.; **Charles F. Lillie**, Northrop Grumman Space Technology; **Rafael Millan-Gabet**, California Institute of Technology; **Andreas Quirrenbach**, Univ. Leiden/Leiden Observatory (Netherlands); **Theo A. Ten Brummelaar**, Georgia State Univ./The CHARA Array; **Wesley A. Traub**, Jet Propulsion Lab.; **Gerd P. Weigelt**, Max-Planck-Institut für Radioastronomie (Germany); **John S. Young**, Univ. of Cambridge (United Kingdom)

- **160 Papers**
- **200+ authors**
- **One special session**
- **Two Discussion Sessions**



What have we learned?

# Technical Challenges - refining the solutions



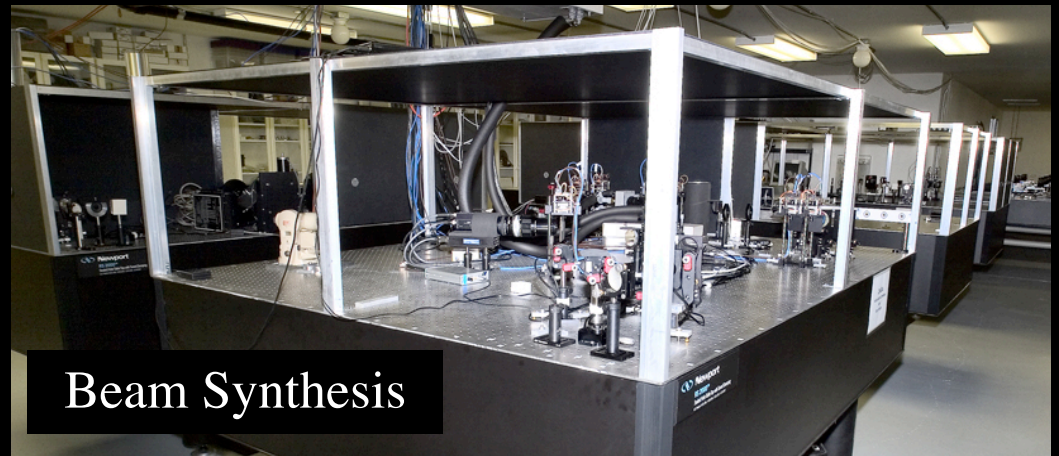
Beam transport



Path Control



Path Equalization



Beam Synthesis

Courtesy: H. McAlister

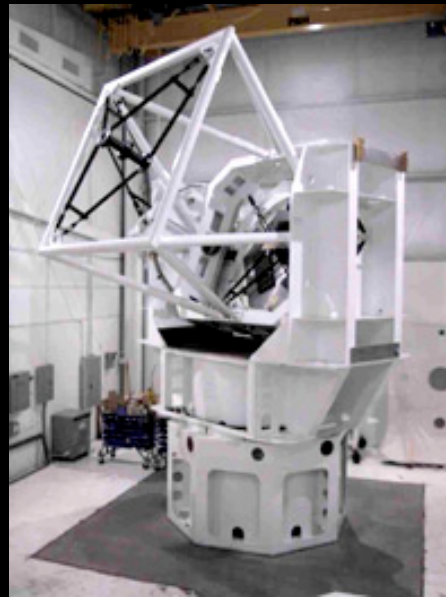
# The Secret of Interferometry - Good Telescopes



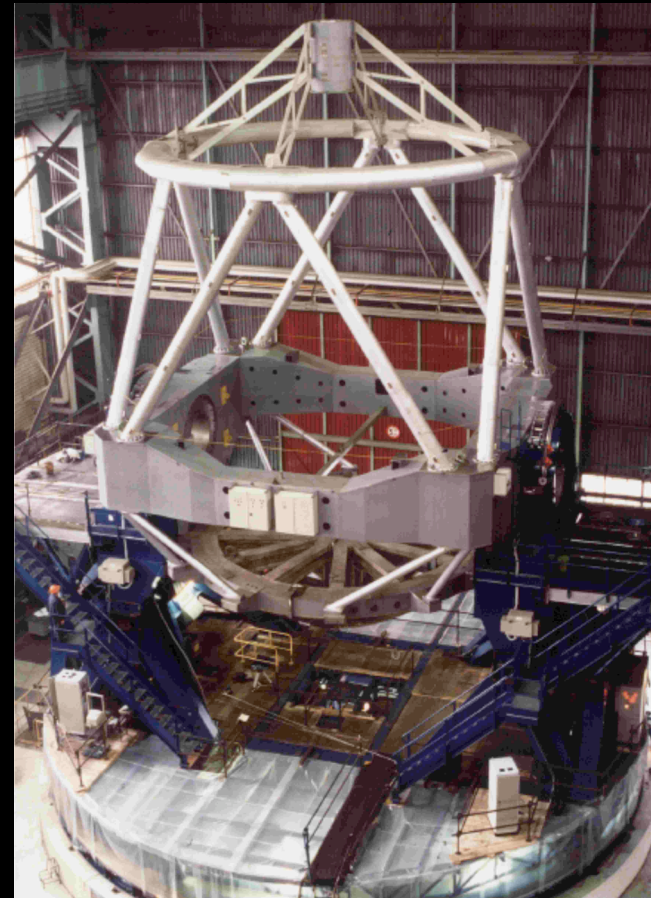
CHARA



ESO-VLTI



JPL



VLT

# Future Directions for Ground-Based Interferometry

- Conferences and Workshops
  - Liege, 2003-2005; Tucson, 2006
- Technical opportunities are understood
- As are the costs
- What is the science strategy?
  - Facility capability?
  - Key project?

# Possible Ground-based Arrays of the Future

(more of the same but bigger and better)

- Augmenting existing facilities - NPOI, CHARA, VLTI,...
- A dilute array for *high resolution and imaging* (the VLT analogy)
- A compact array for *high sensitivity* (an ELT alternative or successor?)
- A hybrid array (ELT with auxiliaries)
- A special purpose array - eg, for detection of exo-planets, imaging of stellar surfaces

# Possible Ground-based Arrays of the Future

(thinking outside the box)

- Large Binocular Telescope sequel
- OHANA
- .....

# The Large Binocular Telescope and Interferometer



## 25% Arizona

- The University of Arizona (Tucson)
- Arizona State University (Tempe)
- Northern Arizona University (Flagstaff)

## 25% Italy - Istituto Nazionale di Astrofisica

- Osservatorio Astrofisico di Arcetri (Florence)
- Osservatorio Astronomico di Bologna (Bologna)
- Osservatorio Astronomico di Roma (Rome)
- Osservatorio Astronomico di Padova (Padua)
- Osservatorio Astronomico di Brera (Milan)
- Other Italian Observatories and Universities

## 12.5% Research Corporation

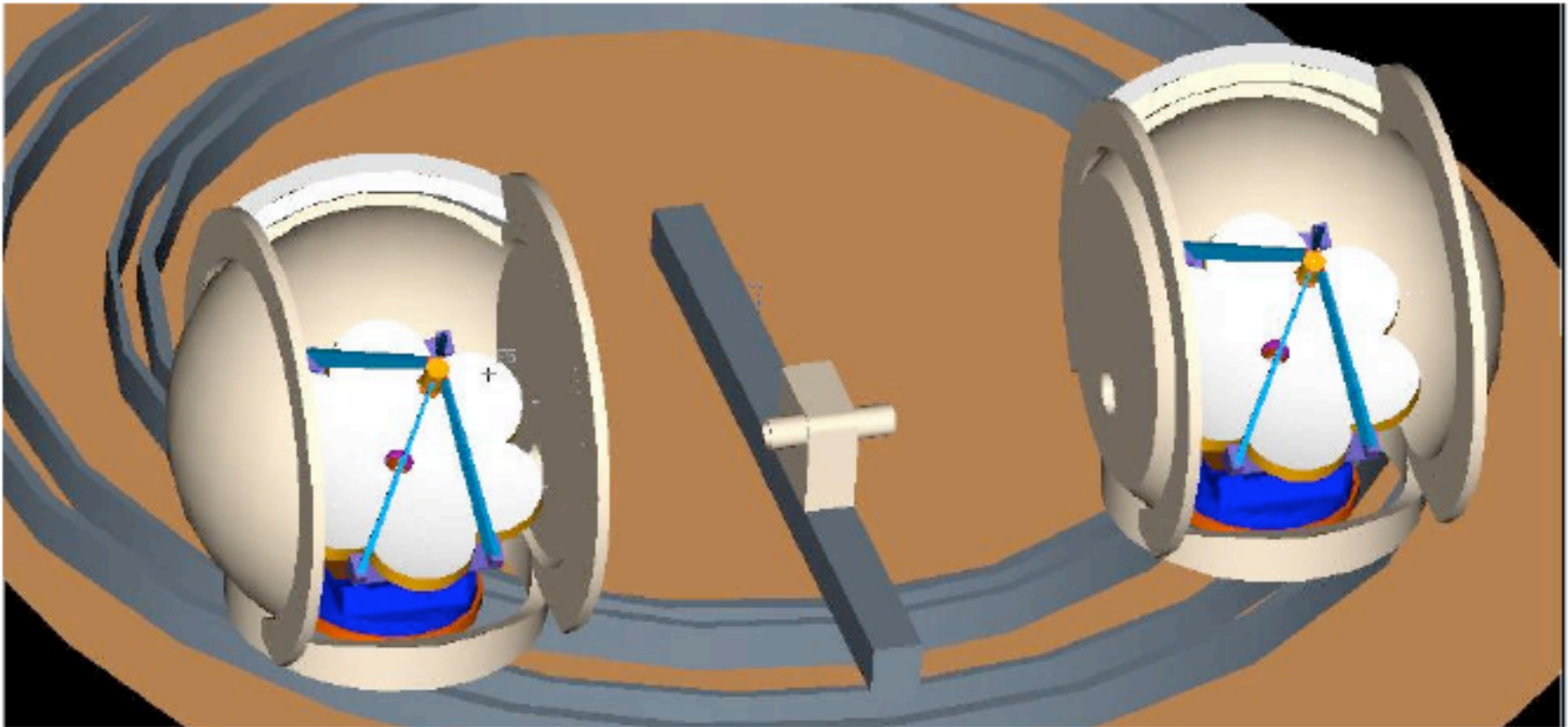
- The Ohio State University
- University of Notre Dame
- University of Minnesota
- University of Virginia

## 12.5% The Ohio State University

## 25% Germany - LBT Beteiligungsgesellschaft

- Max-Planck-Institut für Astronomie (Heidelberg)
- Landessternwarte (Heidelberg)
- Astrophysikalisches Institut Potsdam (Potsdam)
- Max-Planck-Institut für Extraterrestrische Physik (Munich)
- Max-Planck-Institut für Radioastronomie (Bonn)

# Roger Angel's Twenty-Twenty Concept

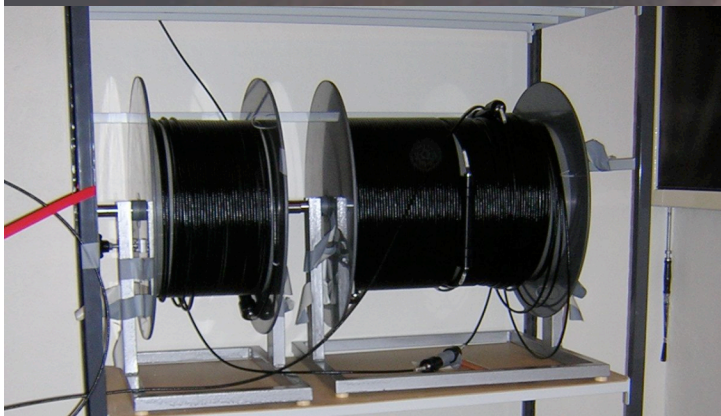
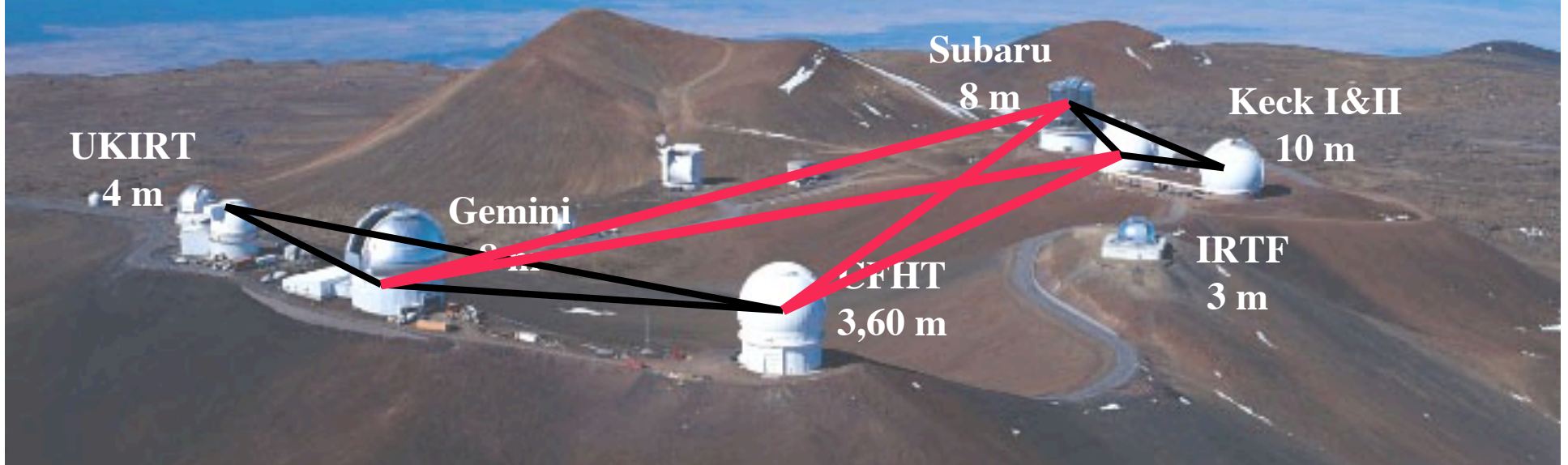




# The 'OHANA Project

Phase II

Phase III



## Mauna Kea Participants

Keck

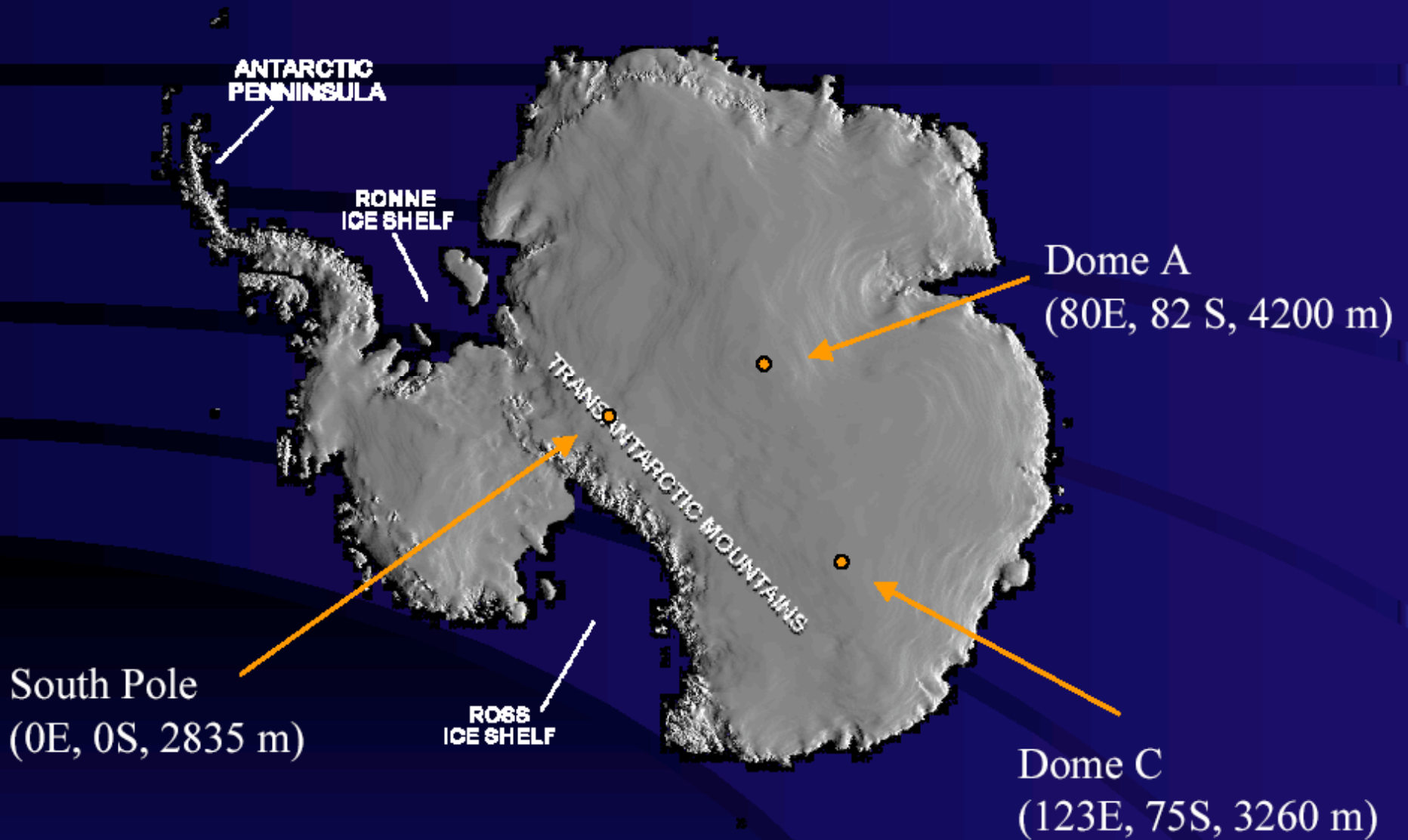
CFHT

Gemini

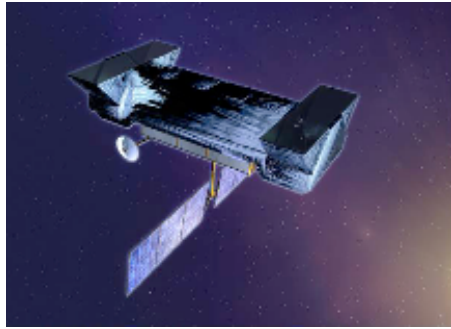
Subaru

UKIRT

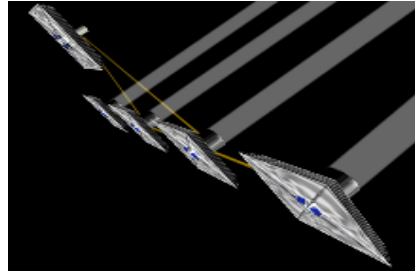
# Infrared Interferometry from Antarctica



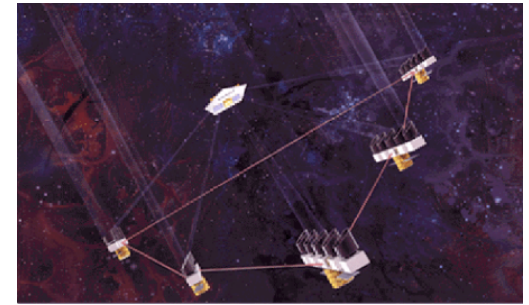
# Space Interferometry - Coming to a Future Near Yours



**SIM**



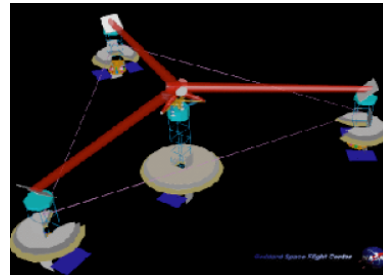
**TPF-I/Darwin**



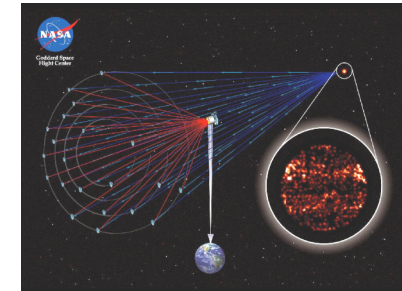
**Planet Imager**



**SPIRIT**



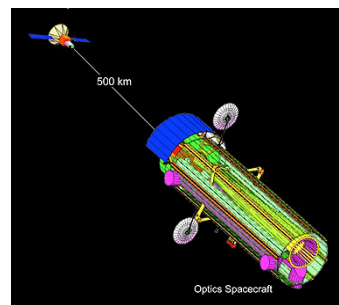
**SPECS**



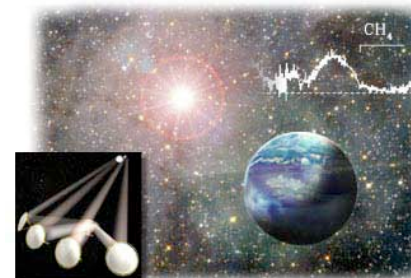
**Stellar Imager**



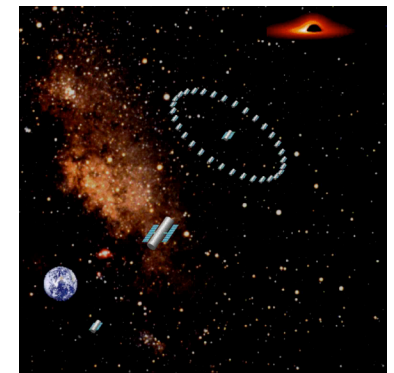
**ST-9 or Smart-3**



**MAXIM Pathfinder**

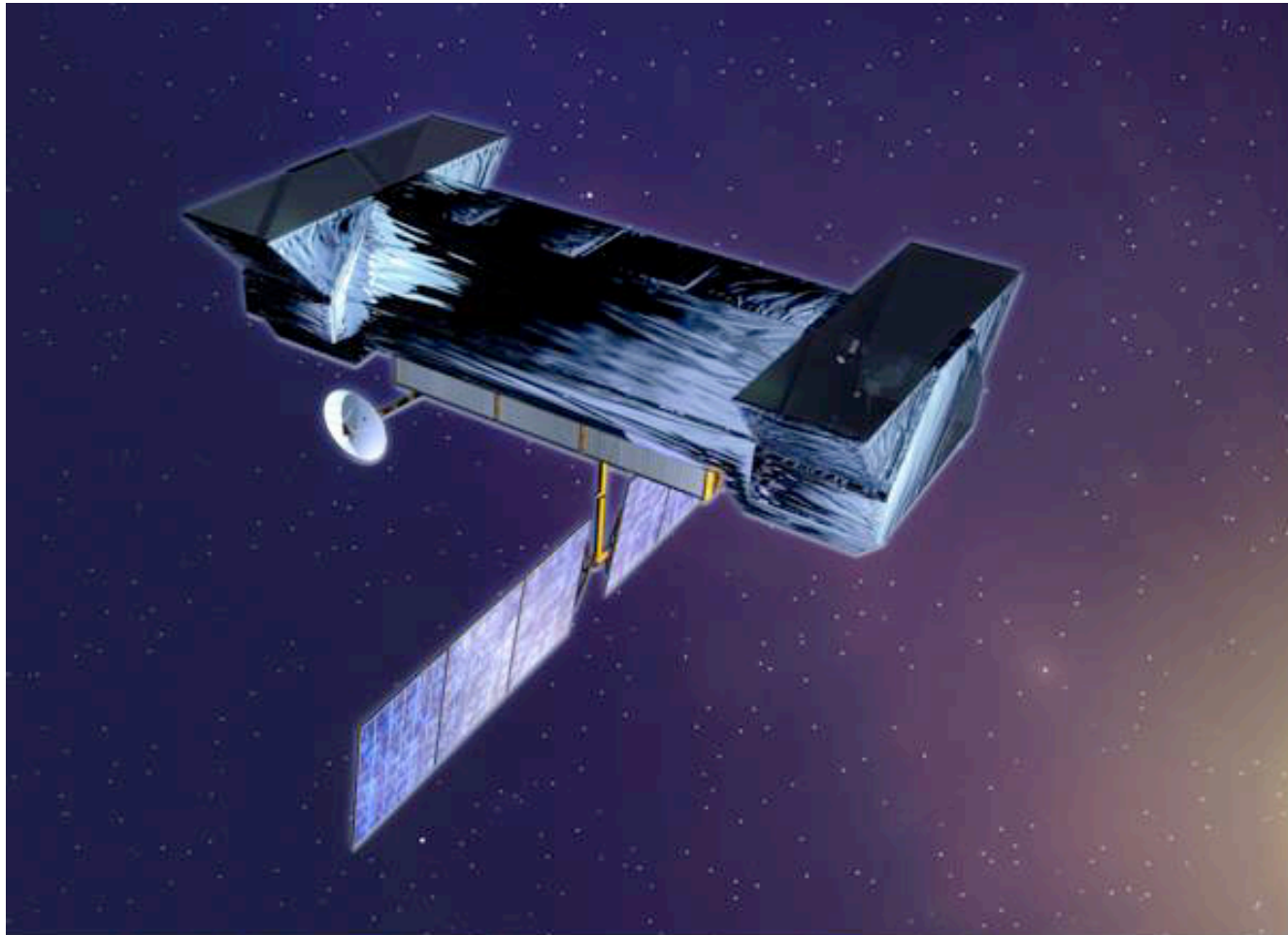


**Life Finder**

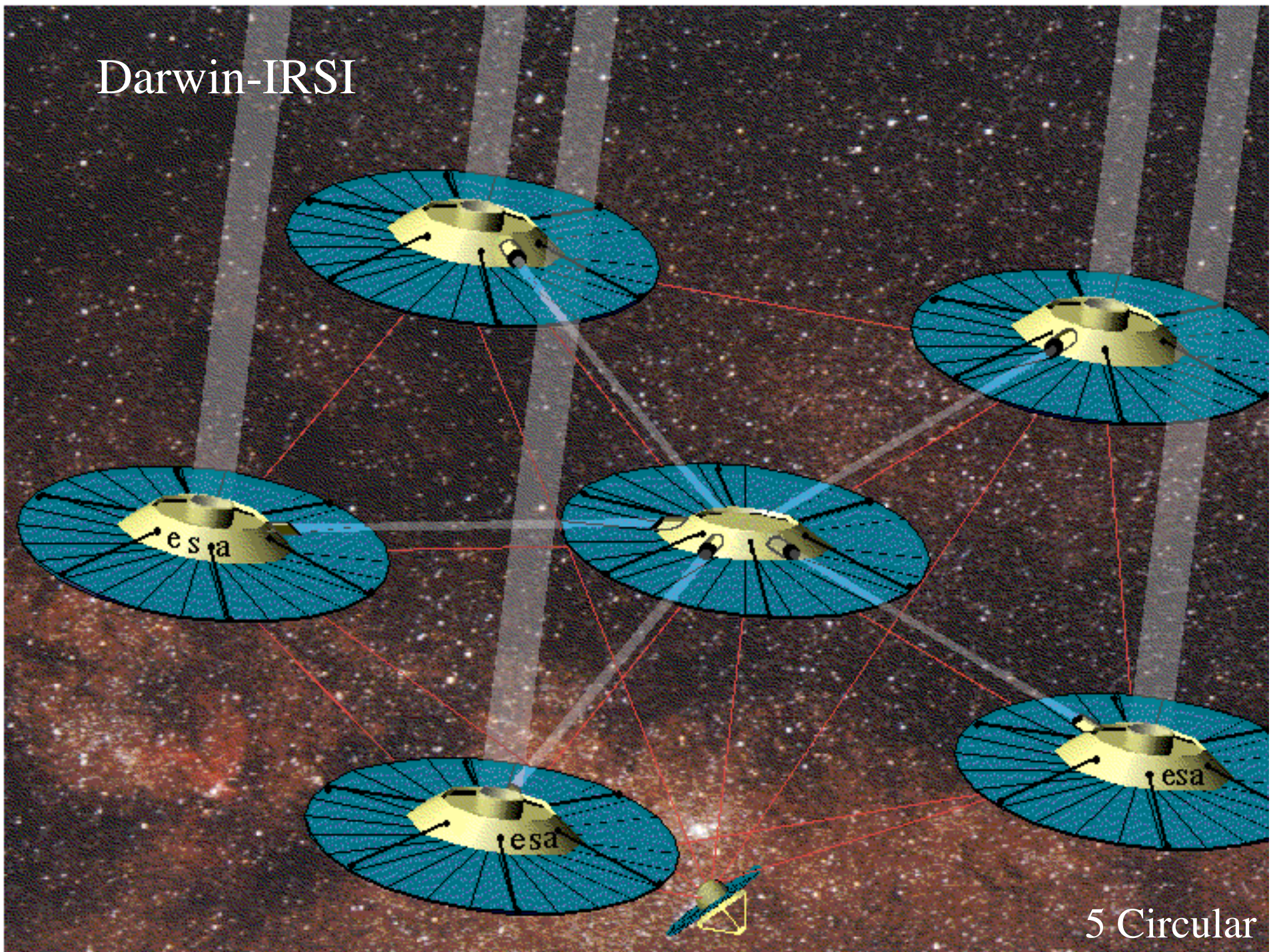


**Black Hole Imager**

# SIM-ScienceQuest the Space Interferometer Mission



# Darwin-IRSI



5 Circular

# The Astronomy and Astrophysics Decade Review

- How has interferometry fared in the past?
- What are the prospects for 2010?

## 36<sup>th</sup> Liège International Astrophysical Colloquium:

Under the High Patronage of H.M. The King of Belgium

Sponsored by: AMOS, FNRS, Communauté Française, Etilux, Gillam, SSTC, ULg

"FROM OPTICAL TO MILLIMETRIC INTERFEROMETRY :  
SCIENTIFIC AND TECHNOLOGICAL CHALLENGES"

Liège, July 2-5, 2001

## The Power of optical/IR Interferometry: Recent scientific results and Second generation VLTI instrumentation

an ESO workshop



Garching bei München - April 4-8, 2005



Joint European and National Astronomy Meeting  
"Distant Worlds" 4-7 July 2005 Liège, Belgium

Proceedings

Technology Roadmap for Future Interferometric Facilities

## Science Case for Next Generation Optical/Infrared Interferometric Facilities (the post VLTI era)

23 - 26 August 2004, Liège University,  
Colonster Castle, Sart Tilman

37<sup>th</sup> Liège International Astrophysical Colloquium

With the support of



Panel Discussion

### The Future of Optical Interferometry

Monday 29 May - 4:45 to 5:30 pm

Organized by Jean Surdej, Univ. de Liège (Belgium) and  
Stephen Ridgway, National Optical Astronomy Observatory (USA)

A panel discussion will address the future of interferometry, including science directions for today and tomorrow, how to better integrate interferometry into "mainstream" astronomy, augmentations of existing facilities, possible future array projects of scale, and planning processes in the national and international communities.

## Interferometry Future Directions Workshop

Sponsors: AURA, NOAO, CHARA

Place: Tucson

Date: ~ September 2006

Goals: Science opportunities, concept  
development, technical roadmap, Decade  
strategy white paper