Macho Mengi “Many Eyes”

NSBESAT 2 Ground-based Interferometric Telescope Research
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Project Overview

• Introduction
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• Project Design Concept
• Project Scope
• Funding
• Macho Mengi Project Team
  *(Roles and Responsibilities handout)*
• Questions and Comments
Background

• NSBE's small satellites projects is for NSBE members to gain first hand experience at designing, building, and operating satellites.

Phase I
  – **NSBESAT 1**: Single space telescope

Phase II
  – **NSBESAT 2**: Formation of space telescopes that use interferometry to act as one large space telescope.
Why space telescopes?

• Gives our Community direct access to the Space Program
  – Specifically target:
    • Communities
    • Grade Schools
    • Universities
    • Astronomers and Astrophysicist

What’s so interesting about space?
Telescope Technology

Basic Telescope  Observatory  Hubble  MOST  James Webb

Multi-Satellite Telescope
Basic Operation
Very Large Telescope Interferometer (VLTI)
**Interferometry**: A technique of collecting light from several telescopes and combining them to reveal details much smaller than those visible by a single telescope.

1. Light beams from each telescope, corrected for atmospheric turbulence, are brought together and combined.

2. Computers process data from light sensors to form an image similar to that which would be obtained using a larger telescope than the individual ones.
Disc model deduced from VLTI/MIDI observations

VLT Melipal + VISIR Image
A Disc Around An Aged Star

ESO Press Photo 43/07  (27 September 2007)

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**Simply Long-Baseline Interferometer**

**Star Light**

- Star
- Star Light
- Telescope #1
- Telescope #2
- Optical "Delay" Line
- Beam combiner
- "Baseline" B
- "Delay" B sinθ
- 90°
- Original image shows "Fringes"
- Computer Image reconstruction
The VLT Interferometer with ANTU and MELIPAL
The Innermost Region of the Active Galaxy NGC 1068 (VLTI + MIDI)

ESO PR Photo 13/04 (5 May 2004)

© European Southern Observatory
Angular Resolution

- **Angular resolution** describes the resolving power of any image-forming device (optical or radio telescope, microscopes, cameras, or an eye).

- The term **resolution** or **minimum resolvable distance** is the minimum distance between distinguishable objects in an image.

The angular resolution $R$ can usually be approximated by:

**Single telescope case**

$$R = \frac{\lambda}{D}.$$

$\lambda$ = wavelength of the observed radiation

$D$ = diameter of the telescope's mirror or lens.

**Telescope array case**

$$R = \frac{\lambda}{B}.$$

$B$ = length of separation of the telescopes in the array (baseline).
Angular Resolution
(Calculated examples)

Wavelength: 580 nm - yellow light

<table>
<thead>
<tr>
<th>Diameter/Baseline (m)</th>
<th>R (arcsecond)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.120</td>
</tr>
<tr>
<td>1.8</td>
<td>0.066</td>
</tr>
<tr>
<td>2.4</td>
<td>0.050</td>
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<tr>
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<tr>
<td>640</td>
<td>0.00019</td>
</tr>
<tr>
<td>1609</td>
<td>0.000074</td>
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</tbody>
</table>

VLTI Auxiliary telescope
Hubble
VLTI Main telescope
COAST Cambridge Optical Aperture Synthesis Telescope
VLTI Interferometer
SUSI Sydney University Stellar Interferometer

.001 arcsecond -- Equivalent to resolving a target 2 meters (6.6 ft) across at the distance between the Earth and Moon.
Project Goals and Objectives

⇒ **Our primary goal:** Have a minimum of three NSBE members with the necessary experience to become subject matter experts to contribute with the development of NSBESAT 2.

- **Our objective:** Have a complete and working small ground-based interferometric telescope to be used as a “proof of concept prototype” and training tool for NSBESAT 2.
Project Design
Concept
Macho Mengi

Requirements:

- Four reflective telescopes
- Transportable
- Moveable baselines and formations
- Stable
- Configured for visible light

Design:

- Similar to COAST interferometer
Four small telescopes look at the star. After path compensation light beams are merged using mirrors & beamsplitters. Detectors convert them into electronic signals. Computers are used to reconstruct the image of the star.

**COAST Interferometer Testbed**
**Univ. of Cambridge**

*Built 1988*
Image reconstructions of Capella, from data obtained on the nights of the 13th (a) and 28th (b) September 1995.

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NSBESAT 2 Ground-based Interferometric Telescope Research
DL restriction on ATs
## Project Scope

<table>
<thead>
<tr>
<th>Project Includes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Designing, building and operating a ground-based interferometric telescope</td>
</tr>
<tr>
<td>Training NSBE members on use of interferometric telescopes</td>
</tr>
<tr>
<td>Comparison between interferometric and non-interferometric telescopes</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Project Excludes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Astronomy research – although aspects of astronomy will be learned this particular project is an engineering and physics research project.</td>
</tr>
<tr>
<td>NSBESAT 1 and 2 satellite design</td>
</tr>
</tbody>
</table>
Funding

- Funding Authority for this project shall be in accordance with the existing chapter bylaws of the NSBE Houston Space Chapter.

- The bulk of our financing should come from corporate sponsors, donors, and federal grants.

- Once we have a better idea of our design and specifications - receiving donated equipment would be our best bet.
Funding
Donated Equipment

- **Key Philosophy:** “Linking Needs with Benefits”

- **We are not looking for "junk", but sometimes companies are willing to donate some of their latest products for key benefits:**
  
  - **Free Advertising at Major Events**
  - **Tax write-offs:** NSBE HSC is a 501(c) non-profit organization
  - **Free testing:**
    - The process can be as simple as reporting to them how well their product performed under real world conditions.

- **Companies may be more willing to donate components out of their manufactured surplus rather than giving cash.**

- **The value of donated components may far exceed whatever they would have given in actual dollars.**
Macho Mengi Project Team

Project Committee

OPTICS DIRECTOR
MECHANICAL DIRECTOR
PROJECT DIRECTOR
SOFTWARE DIRECTOR
INSTRUMENTATION DIRECTOR

PROJECT COMMITTEE

PROJECT STAKEHOLDERS

OPTICS GROUP
MECHANICAL GROUP
SOFTWARE GROUP
INSTRUMENTATION GROUP
PROCUREMENT TEAM LEADER

OPTICAL ENGINEERING
MECHANICAL ENGINEERING
SOFTWARE SUPPORT
INSTRUMENTATION ENGINEERING
PARTS & FUNDS PROCUREMENT
CORPORATE RELATIONS

CONSULTANT
CONSULTANT
CONSULTANT
ELECTRICAL TECHNICIAN
RECORDS CLERK

ANALYST
ANALYST
ANALYST
ANALYST
NEWSLETTER

*See Handout for Roles and Responsibilities
Macho Mengi Team

- **Kevin Calvin:**
  - **Optics Director**

- **Chemuttaai Lang’at:**
  - **Mechanical engineer**

- **Darnell Cowan:**
  - **Acting Mechanical Director**

- **Dr. Robert Howard:**
  - **Consultant**

- **Michael McCullar:**
  - **Project Director**

Visit NSBE’s Houston Space Chapter Homepage:
http://www.nsbe-hsc.org
Questions?