U.S. Astronomy Facilities For the 21st Century

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"Building the Foundation for U.S. Astronomy at m/cm Wavelengths in 2010 and Beyond"

- This foundation will require money
- Ground-based radio astronomy has historically relied on NSF funding
- It may be useful to point out some of the challenges which all new NSF astronomy projects will likely face within the next few years

Background

- The last 15 years have marked an exceptionally fertile period for the construction of U.S. astronomy facilities, including, for example
  - Non-NSF:

    Keck Magellan
    MMT II SMA
    (HST!!)
  - NSF:

    VLBA Arecibo Upgrade
    GBT Gemini
    EVLA ALMA

Background (con't)

- The MREFC account is now used to support the construction (only!) of all major NSF facilities:
  - As of September 2005*, active projects included; ALMA, Earthscope, HIAPER, Ice Cube, NEON, NEES, RSVP (since cancelled), SODV, Terascale Computing Systems, OOI, AARV, Advanced LIGO
  - "Horizon"* astronomy projects (some more imminent than others):

    ATST LSST TMT SKA
  - Since the MREFC account was established in the early 1990s, there has been increasingly intense competition for funds

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*** NSF Facilities Plan (2005):** http://www.nsf.gov/pubs/2005/nsf05058/nsf05058.pdf

Challenges for the Next m/cm-wave Facility

- Cost
- Operations Costs
- Time Frame
- Other Issues

Natural cost limits…

- Some recent NSF astronomy facilities:
  - VLBA (1993): $80M ($103M)
  - Arecibo Upgrade (1997): $25M ($113M)
  - GBT (1994*): $65M ($102M)
  - Gemini (1999): $96M ($119M)
  - ALMA (2012): $498M (?? $M)
  - SKA: ??
- There seems to be a natural comfort level for MREFC projects: Divisional funding level
- Higher costs are possible (*e.g.*, ALMA) but will be hard: Why?

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* Special appropriation; 1994 scheduled, 2000 actual

Impact of Operating New Facilities

- 10% of capital cost is rule of thumb (historically, astronomy is a bit less)
- Currently, those funds come out of Divisional budgets
- Costs to operate new, very large projects are currently pushed down into home Division -- budget stress results, especially for largest new facilities
- NSF is certainly aware of this issue, but when a solution might be proposed is unknown
- Astronomy has one additional issue to consider in developing new facilities
  - Historical tension between facilities and grants
  - A complex and difficult issue; advice abounds as to the “correct” level

MREFC Time Frame Issues

- Competition for MREFC funds is fierce
- MREFC pipeline is now massively full (~$2.5B); many (most?) are non-astronomy projects
- There has been relatively little change in the annual level of the MREFC account over the years
- $\rightarrow$ Difficult to predict the timing and fate of astronomy projects currently in the MREFC queue
- The question of OIR/radio balance will also likely be an issue in helping decide the next few large astronomy projects -- Underlying this is the much broader question of the extent and nature of Federal support for OIR astronomy

Closing Thoughts

- Scope and cost control: consider compatibility with what NSF can deliver, and when; the earlier this is done the better
- Address operations costs realistically and early; work with NSF to develop specific scenarios for offsetting closures
- Plan for potentially extended development and construction time frames
- Leverage will be essential for the largest MREFC projects:
  - International
  - Private support, *e.g.,* CCAT (but ops?)
  - Other U.S. agency support (*e.g.,*NASA, DOE)

Closing Thoughts (con't)

- The strategic context:
  - Does the U.S. approach to ground based astronomy need to change in fundamental ways? Can it be made more efficient? If so, how? What can the system bear?
  - Are there long-range opportunities? (*e.g, lunar outpost)*

Improving Prospects for SKA

- Focus -- what is it?
- Cost -- $nB/3 (FY06) must have n<2
- Engineer the instrument -- it is not too soon
- Optimize US organization
  - Goals
  - Representation