NSF's Large Facilities Portfolio and Pre-construction Planning Process

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Portfolio of Operating Facilities

- "Facility" = major multi-user research facilities described in NSF Budget Request to Congress
- 17 fully constructed and operating facilities:
  - 9 in Math & Physical Sciences
  - 5 in Geosciences
  - 2 in Engineering
  - 1 in Office of Polar Programs

Operating Facilities

- FY 2009 Budget Request for Major Facility Ops:
  - ~ $860 million,
  - 13% of total NSF Budget Request
- Total FY 2009 budget for research infrastructure:
  - ~$1740 million
  - ~25% of total NSF FY 2009 Budget Request
  - 27% of FY 2008 budget estimate
  - ~17% in 1989

Major Multi-user Facilities Under Construction

- New construction funded through Major Research Equipment and Facility Construction (MREFC) Account
- FY 2009 MREFC Budget Request:
  - ~ $148 million
  - ~2% of annual budget

That 2% attracts a lot of attention!

3 Projects Pending Construction

- Alaska Region Research Vessel
- Ocean Observatories Initiative
- National Ecological Observatory Network

- All three are “Legacy Projects”:
  - Approved by National Science Board 4-8 years ago
  - Approved without firm definition of scope and “risk adjusted cost” estimates
- ***NSF doesn’t do that anymore!***
  - Further construction funding requested only after definitions are firm

One Candidate for Future Construction

- Advanced Technology Solar Telescope
  - Remaining issues now being resolved:
    - National Environmental Policy Act
    - National Historic Preservation Act
  - Construction budget depends on start date

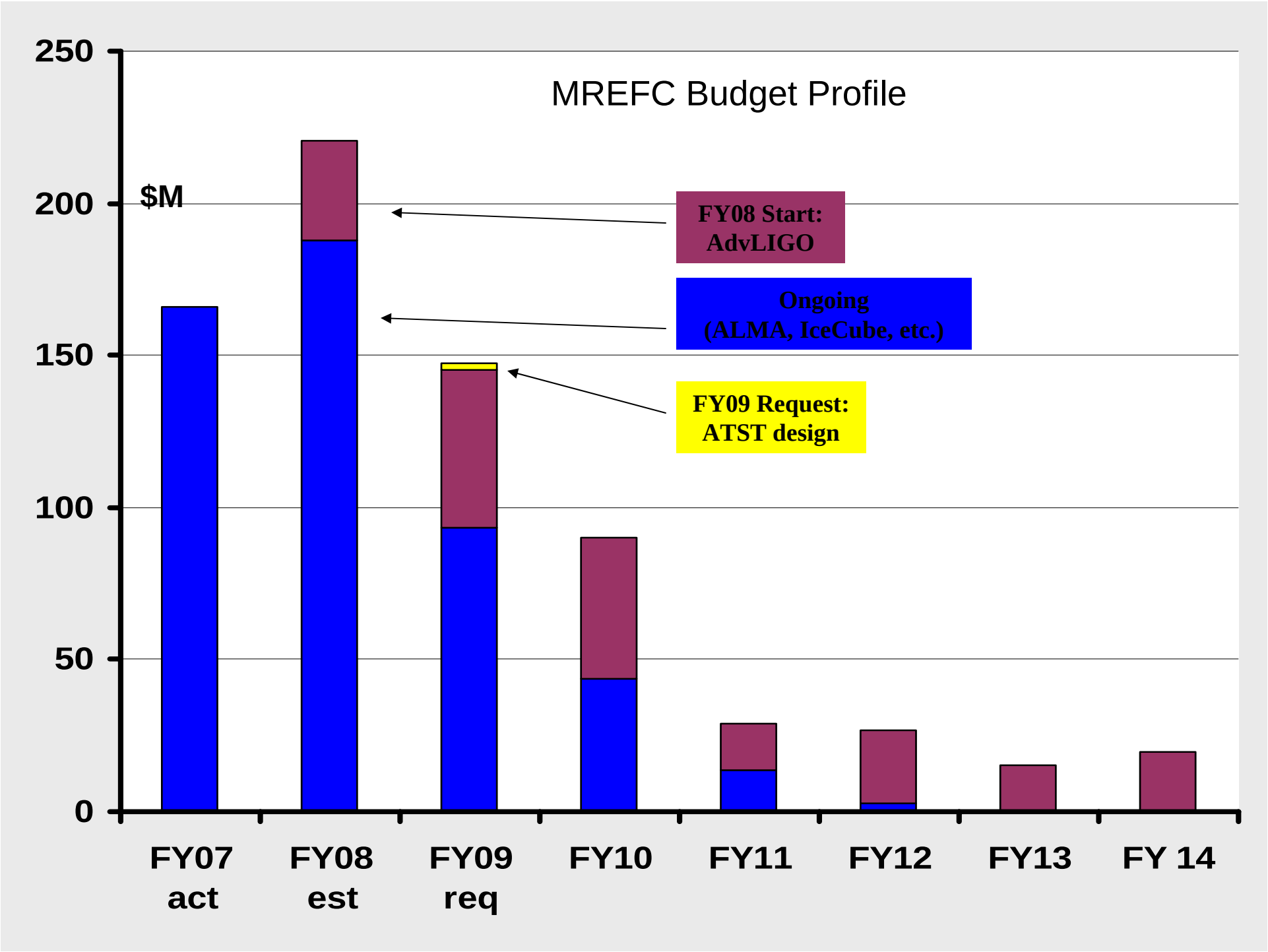
Major Research Equipment and Facility Construction (MREFC)

- Established in FY 1995 as a capital asset account to fund "big ticket" items:
  - avoids distorting the base program funding in the Research & Related Activities (R&RA) Account
  - funding restricted to construction, acquisition & commissioning of capital assets
  - no funding for pre-construction planning, ***operations & maintenance,*** **research utilization,** education outreach activities
- Projects with construction costs exceeding 10% of the annual budget of a particular directorate
  - Example: *Mathematical & Physical Sciences 2009 Budget Request = $1.40 Billion*

MREFC Account Features

- Provides *No Year* money for:
  - Construction, Acquisition, Commissioning
  - *No Year ➔ available until expended without fiscal year limitation*

- Administrative challenge to synchronize:
  - Technical evolution of project from an idea to an executable design
  - Selection, prioritization, and approval by NSF as a construction project
  - Planning and budgeting maturity, to ensure that resources requested match scope
  - Funding from non-MREFC funds (the “base program”) for preconstruction planning, which in itself is significant


MREFC Budget Profile
$M
250
200
150
100
50
0
FY08 Start:
AdvLIGO
Ongoing
(ALMA, IceCube, etc.)
FY09 Request:
ATST design
FY07
act
FY08
est
FY09
req
FY10
FY11
FY12
FY13
FY 14

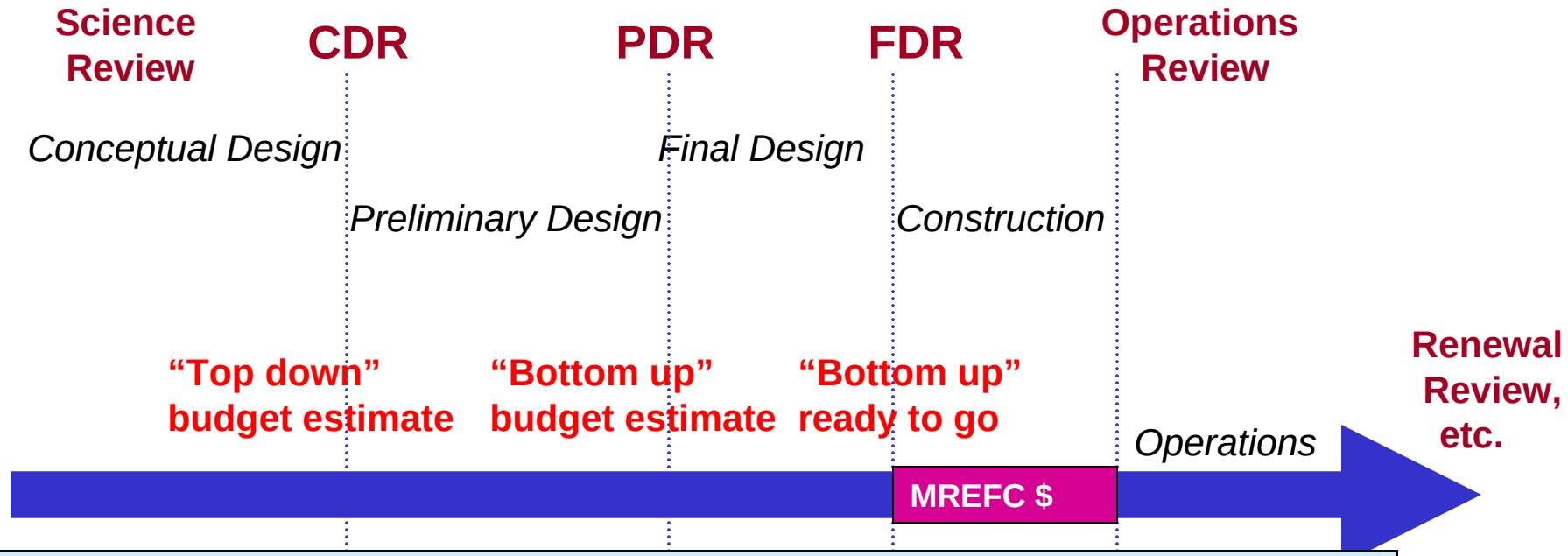
Sequential, Progressive MREFC Review Process

- **Review of Science Goals**
  - What science goals motivate a potential new facility?
- **Conceptual Design Stage**
  - Description of functional requirements needed to achieve goals, top-down parametric cost estimates, rules of thumb for risk and schedule estimation, first estimates of operations $
- **Preliminary Design Stage (or "Readiness Stage")**
  - Site-dependent description of all major functional elements, bottom-up cost estimates, algorithmic risk assessment, schedule derived from Project Mgt Control System, partnerships, refined ops $ est.
- **Final Design Stage (or "Board Approved Stage")**
  - Interconnections and fit-ups of functional elements, refined cost estimates based substantially on vendor quotes, construction team substantially in place

FY 09 Budget Request Introduced New Change to MREFC Process

- "No cost overrun" policy:
  - Requires that the cost estimate at PDR have adequate contingency to cover all foreseeable risks, and any cost increases not covered by contingency be accommodated by scope reduction

NSF Pre-construction Planning Process



Approximate DOE Translation:

CD 0	***CD 1***	***CD 2***	***CD 3***	***CD 4***
Approve mission need	Approve alternate selection and cost range	Approve performance baseline	Approve construction start	Approve operations start

Prioritization Process

- Sponsoring Division within NSF determines scientific and technical merit within a given field
- Sponsoring Directorate (aggregate of several Divisions, such as Earth Sciences) determines importance relative to other opportunities across related fields
- NSF Director and NSB determine importance to nation across all fields of research

NSF is reactive to community initiatives:

- *NSF does not have a prescriptive long term road map used by some mission-oriented agencies*
- *NSF maintains ability to respond at a variety of levels to community needs*
  - *Multiple funding mechanisms*
  - *Example: Major computing initiative funded through base program*
- *Is concerned that sustaining operation of long lived facilities may encroach on this flexibility to respond*

Concerns with current MREFC process (1 of 3)

- Availability of adequate funding for pre-construction development
  - 5-25% relative to construction cost
  - Funded by R&RA account, competes with research program
  - Discussions at NSB level about ways to address this need
- NSB evaluating possible selection/prioritization after CDR
  - Facilitates interagency, international, public/private partnerships during planning through statement of NSF intentions at highest level

More cautions: (2/3)

- Appropriation request is based on PDR budget estimate
  - Appropriation process takes ~ 2 years, so projecting costs forward adds uncertainty *(especially now, during period of extreme economic volatility!)*
  - Risk assessment process critical

More cautions (3/3)

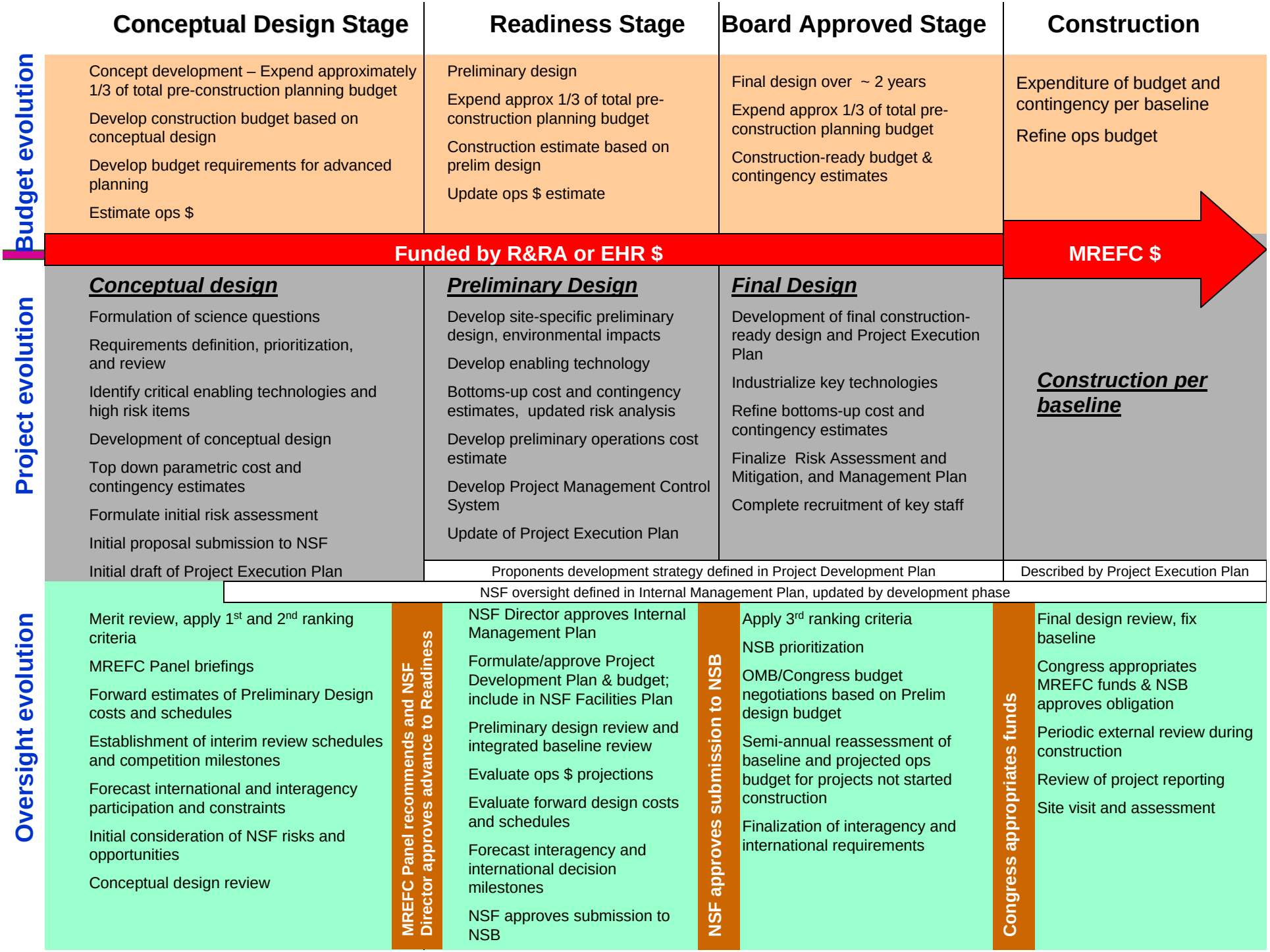
- Operating costs limit NSF's capacity to take on new construction
  - Consideration of new MREFC funding for construction part of portfolio analysis
    - Program balance
    - Opportunity costs
- Operating cost projections are often optimistic, and they are a long way in the future
- It's very hard to terminate currently operating facilities

Paraphrasing from "**FROM THE GROUND UP: BALANCING THE NSF ASTRONOMY PROGRAM**"

- *Maximize the integrated science impact for the overall US financial investment*
- *Emphasize high operating efficiency*
- *Leverage facilities to provide training to scientists and engineers, and education to the public*
- *Pursue partnerships strategically for construction and operation of next-generation large facilities*

Additional Resources and Background Material

- FY 2009 Budget Request to Congress, http://www.nsf.gov/about/budget/fy2009/index.jsp
- 2008 Facility Plan, NSF 08-24, http://www.nsf.gov/pubs/2008/nsf0824/nsf0824.pdf
- "Setting Priorities for Large Research Facilities Projects Supported by the National Science Foundation." NSB-05-77, http://www.nsf.gov/pubs/2005/nsb0577/index.jsp
- "Setting Priorities for Large Research Facilities Projects Supported by the National Science Foundation." (Brinkman Report), National Academies Press, http://www.nap.edu/catalog.php?record_id=10895
- Large Facilities Manual, http://www.nsf.gov/pubs/2007/nsf0738/nsf0738.pdf


Conceptual Design Stage
Readiness Stage
Board Approved Stage
Construction
Budget evolution
Concept development – Expend approximately 1/3 of total pre-construction planning budget
Develop construction budget based on conceptual design
Develop budget requirements for advanced planning
Estimate ops $
Preliminary design
Expend approx 1/3 of total pre-construction planning budget
Construction estimate based on prelim design
Update ops $ estimate
Final design over ~ 2 years
Expend approx 1/3 of total pre-construction planning budget
Construction-ready budget & contingency estimates
Expenditure of budget and contingency per baseline
Refine ops budget
Funded by R&RA or EHR $
MREFC $
Project evolution
Conceptual design
Formulation of science questions
Requirements definition, prioritization, and review
Identify critical enabling technologies and high risk items
Development of conceptual design
Top down parametric cost and contingency estimates
Formulate initial risk assessment
Initial proposal submission to NSF
Initial draft of Project Execution Plan
Preliminary Design
Develop site-specific preliminary design, environmental impacts
Develop enabling technology
Bottoms-up cost and contingency estimates, updated risk analysis
Develop preliminary operations cost estimate
Develop Project Management Control System
Update of Project Execution Plan
Final Design
Development of final construction-ready design and Project Execution Plan
Industrialize key technologies
Refine bottoms-up cost and contingency estimates
Finalize Risk Assessment and Mitigation, and Management Plan
Complete recruitment of key staff
Construction per baseline
Proponents development strategy defined in Project Development Plan
Described by Project Execution Plan
NSF oversight defined in Internal Management Plan, updated by development phase
Oversight evolution
Merit review, apply 1st and 2nd ranking criteria
MREFC Panel briefings
Forward estimates of Preliminary Design costs and schedules
Establishment of interim review schedules and competition milestones
Forecast international and interagency participation and constraints
Initial consideration of NSF risks and opportunities
Conceptual design review
MREFC Panel recommends and NSF Director approves advance to Readiness
NSF Director approves Internal Management Plan
Formulate/approve Project Development Plan & budget; include in NSF Facilities Plan
Preliminary design review and integrated baseline review
Evaluate ops $ projections
Evaluate forward design costs and schedules
Forecast interagency and international decision milestones
NSF approves submission to NSB
NSF approves submission to NSB
Apply 3rd ranking criteria
NSB prioritization
OMB/Congress budget negotiations based on Prelim design budget
Semi-annual reassessment of baseline and projected ops budget for projects not started construction
Finalization of interagency and international requirements
Congress appropriates funds
Final design review, fix baseline
Congress appropriates MREFC funds & NSB approves obligation
Periodic external review during construction
Review of project reporting
Site visit and assessment

Operating Facilities – by Division and Directorate

Facility	Directorate	Division
NEES - National Earthquake Engineering Simulator	ENG	CMS
NNIN - National Nanotechnology Infrastructure Network	ENG	ECS
NCAR - National Center for Atmospheric Research	GEO	ATM
EarthScope (collaboration of IRIS, UNAVCO, and Stanford University)	GEO	EAR
IRIS - Incorporated Research Institutes for Seismology	GEO	EAR
IODP - Integrated Ocean Drilling Program	GEO	OCE
UNOLS - Academic Research Fleet	GEO	OCE
Gemini Observatory	MPS	AST
NAIC - National Atmospheric and Ionospheric Center (Arecibo Observatory)	MPS	AST
NOAO - National Optical Astronomy Observatory and Nat Solar Observatory	MPS	AST
NRAO - National Radio Astronomy Observatory	MPS	AST
NHMFL - National High Magnetic Field Laboratory	MPS	DMR
CESR - Cornell Electron Storage Ring & Synch Light Src	MPS	PHY/DMR
LHC - Large Hadron Collider	MPS	PHY
LIGO - Laser Interferometer Gravitational Wave Observatory	MPS	PHY
NSCL - National Superconducting Cyclotron Laboratory (Michigan State)	MPS	PHY
Polar Facilities and Logistics	OPP	OPP

Major Multi-User Research Facilities Funding

(Dollars in Millions)

	FY 2007 Actual	FY 2008 Estimate	FY 2009 Request	Change over FY 2008 Estimate Amount	Change over FY 2008 Estimate Request
Academic Research Fleet	$87.95	$70.66	$83.96	$13.30	18.8%
Cornell Electron Storage Ring	14.71	13.71	8.50	-5.21	-38.0%
EarthScope[1]	11.63	17.61	26.29	8.68	49.3%
Gemini Observatory	20.00	20.00	22.00	2.00	10.0%
Incorporated Research Institutes for Seismology	11.77	11.75	12.20	0.45	3.8%
Integrated Ocean Drilling Program[2]	36.81	39.26	47.74	8.48	21.6%
Large Hadron Collider	18.00	18.00	18.00	-	-
Laser Interferometer Gravitational Wave Observatory	33.00	29.50	28.50	-1.00	-3.4%
National High Magnetic Field Laboratory	26.55	26.50	31.50	5.00	18.9%
National Nanotechnology Infrastructure Network	13.32	13.50	13.50	-	-
National Superconducting Cyclotron Laboratory	18.50	18.50	20.50	2.00	10.8%
Network for Earthquake Engineering Simulation	20.74	22.17	23.02	0.85	3.8%
Other Facilities[3]	12.57	12.47	19.47	7.00	56.1%
Polar Facilities and Logistics[4]	317.46	323.54	352.25	28.71	8.9%
MREFC Projects[5]	189.60	260.96	200.08	-60.88	-23.3%
Federally Funded R&D Centers[6]					
National Astronomy and Ionosphere Center	10.46	12.15	11.40	-0.75	-6.2%
National Center for Atmospheric Research	85.12	87.54	95.87	8.33	9.5%
National Optical Astronomy Observatory and the National Solar Observatory	39.28	38.55	41.83	3.28	8.5%
National Radio Astronomy Observatory	47.03	44.52	49.79	5.27	11.8%
Grand Total	$1,014.49	$1,080.89	$1,106.40	$25.51	2.4%

On-going construction in FY09 Budget Request

MREFC Account Funding

(Dollars in Millions)

	FY 2007 Actual	FY 2008 Estimate	FY 2009 Request	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	FY 2014 Estimate
Ongoing Projects								
AdvLIGO	-	$32.75	$51.43	$46.30	$15.21	$23.73	$15.50	$19.78
ARRV	2.58	42.00	-					
ALMA[1]	64.30	102.07	82.25	42.76	13.91	3.00	-	-
EarthScope[2]	25.93	-	-					
IceCube	24.38	25.91	11.33	0.95	-			
NEON	-	3.00	-					
OOI	-	5.91	-					
SODV[2]	42.83	-	-					
SPSM	6.19	9.10	-					
New MREFC Funding								
ATST	-	-	2.50	-				
MREFC Account Total	$166.21	$220.74	$147.51	$90.01	$29.12	$26.73	$15.50	$19.78