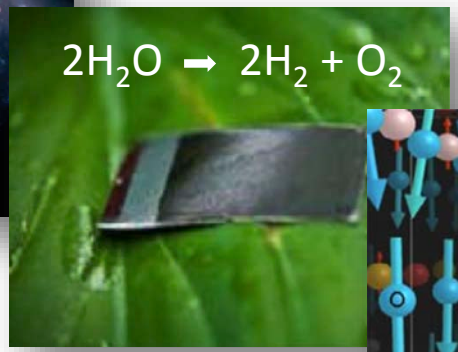
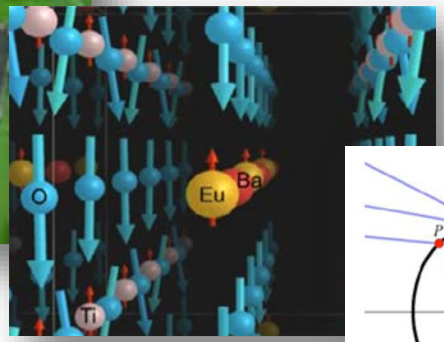
An Overview of Major Facilities Investments
Directorate for Mathematical and Physical Sciences

National Science Board

Astronomy



Chemistry



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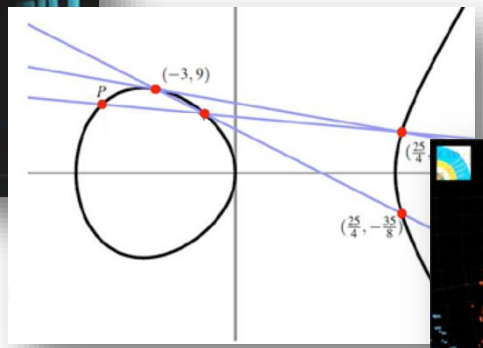
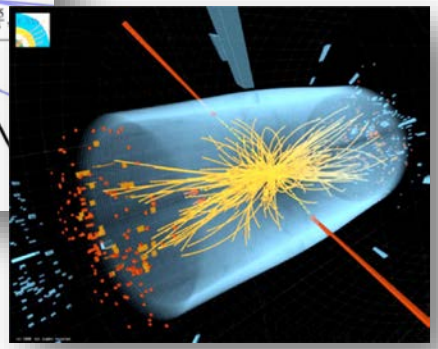


Mathematics

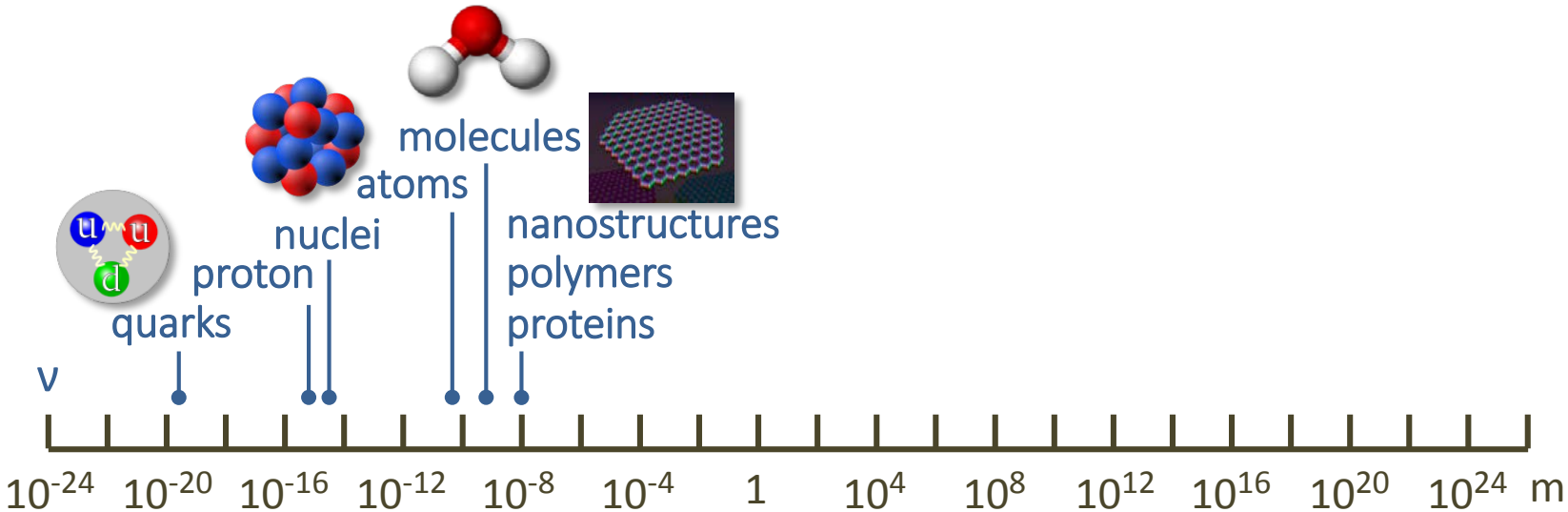


Physics

F. Fleming Crim
Assistant Director for Mathematical and Physical Sciences

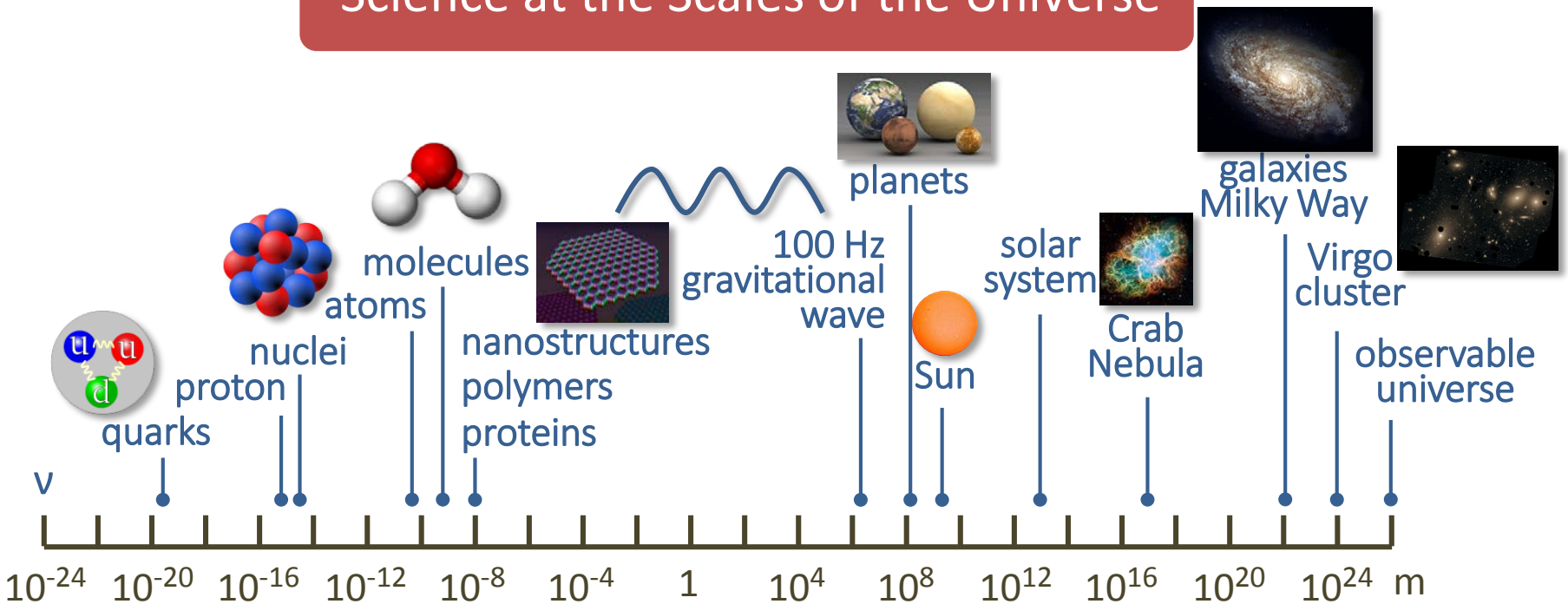
February 2, 2016

Science at the Scales of the Universe



Images from Wikipedia Commons

Science at the Scales of the Universe



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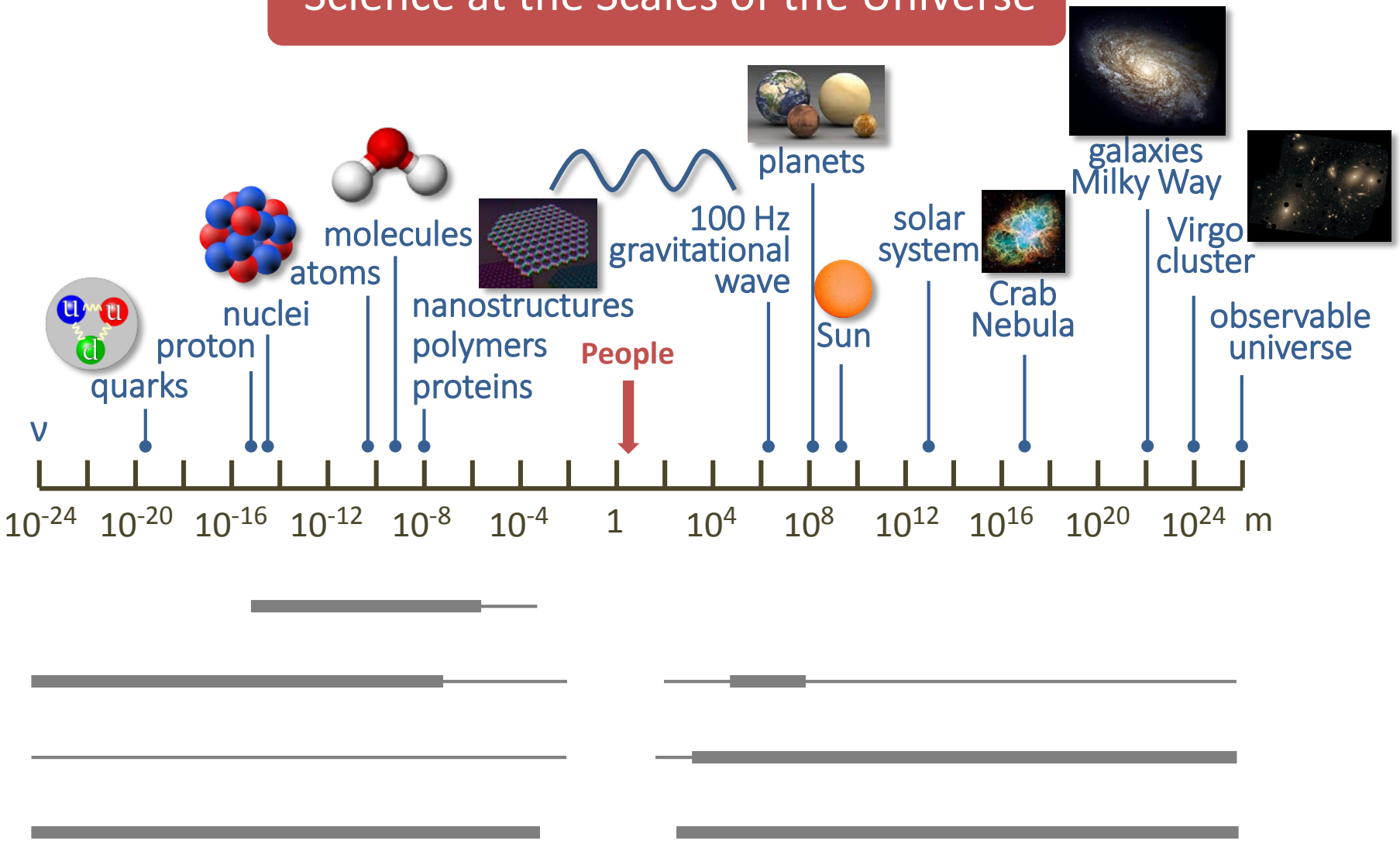
Science at the Scales of the Universe

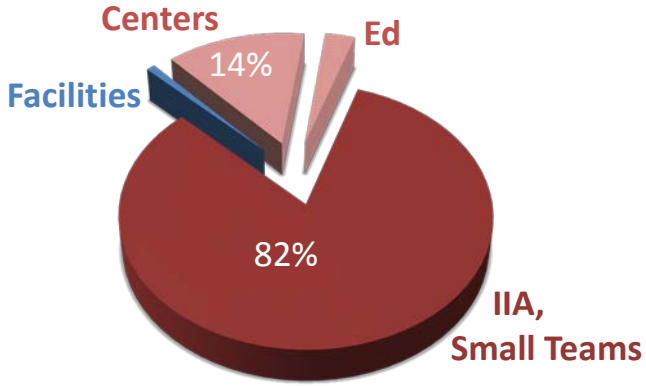


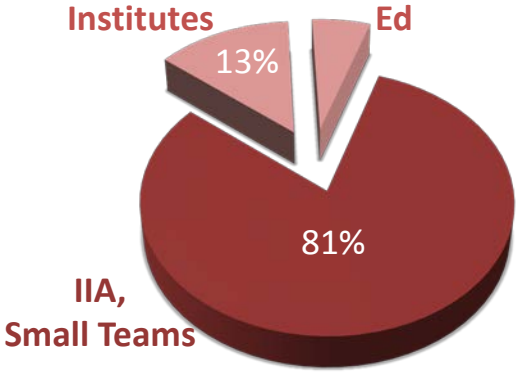
Images from Wikipedia Commons

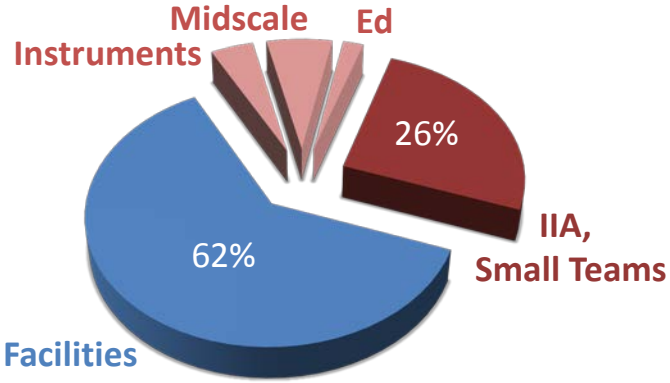
FY 2015

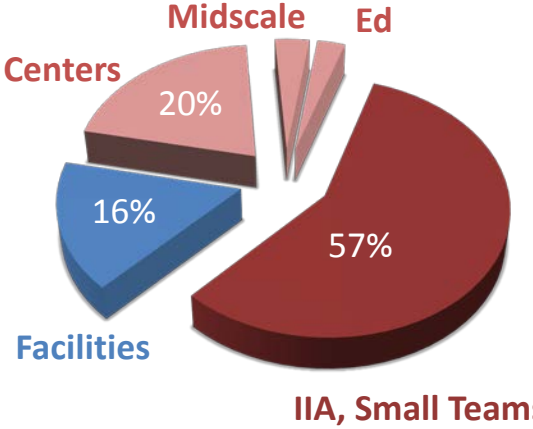
Mathematical and Physical Sciences (MPS)

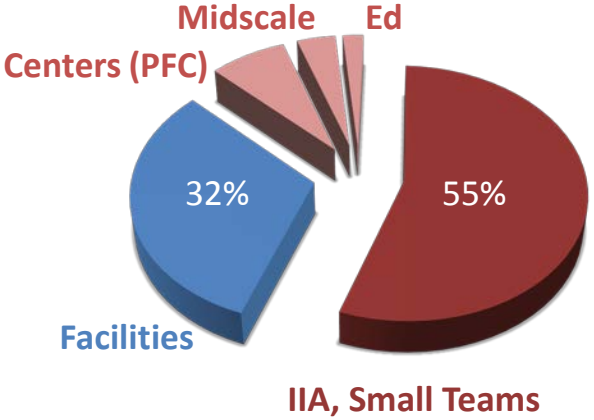
Astronomical Sciences (AST)	Chemistry (CHE)	Materials Research (DMR)	Mathematical Sciences (DMS)	Physics (PHY)
$ 244M	$ 244M	$ 307M	$ 232M	$ 275M

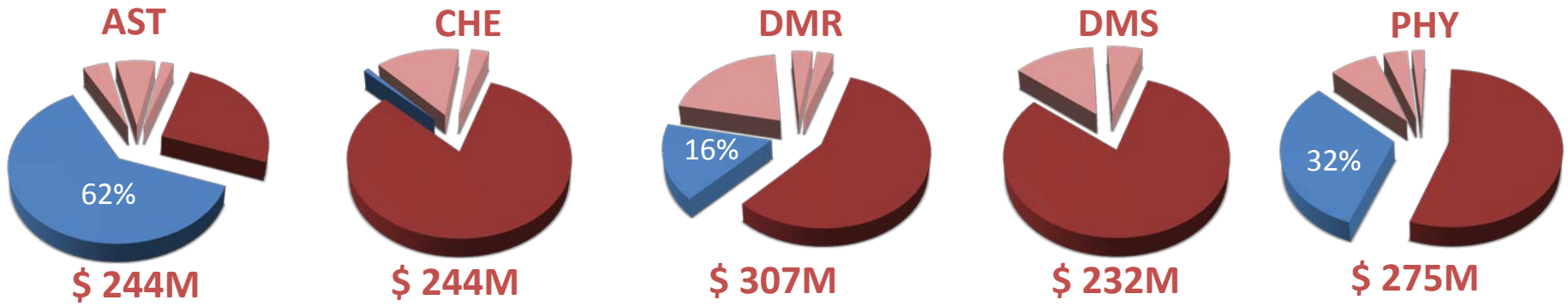




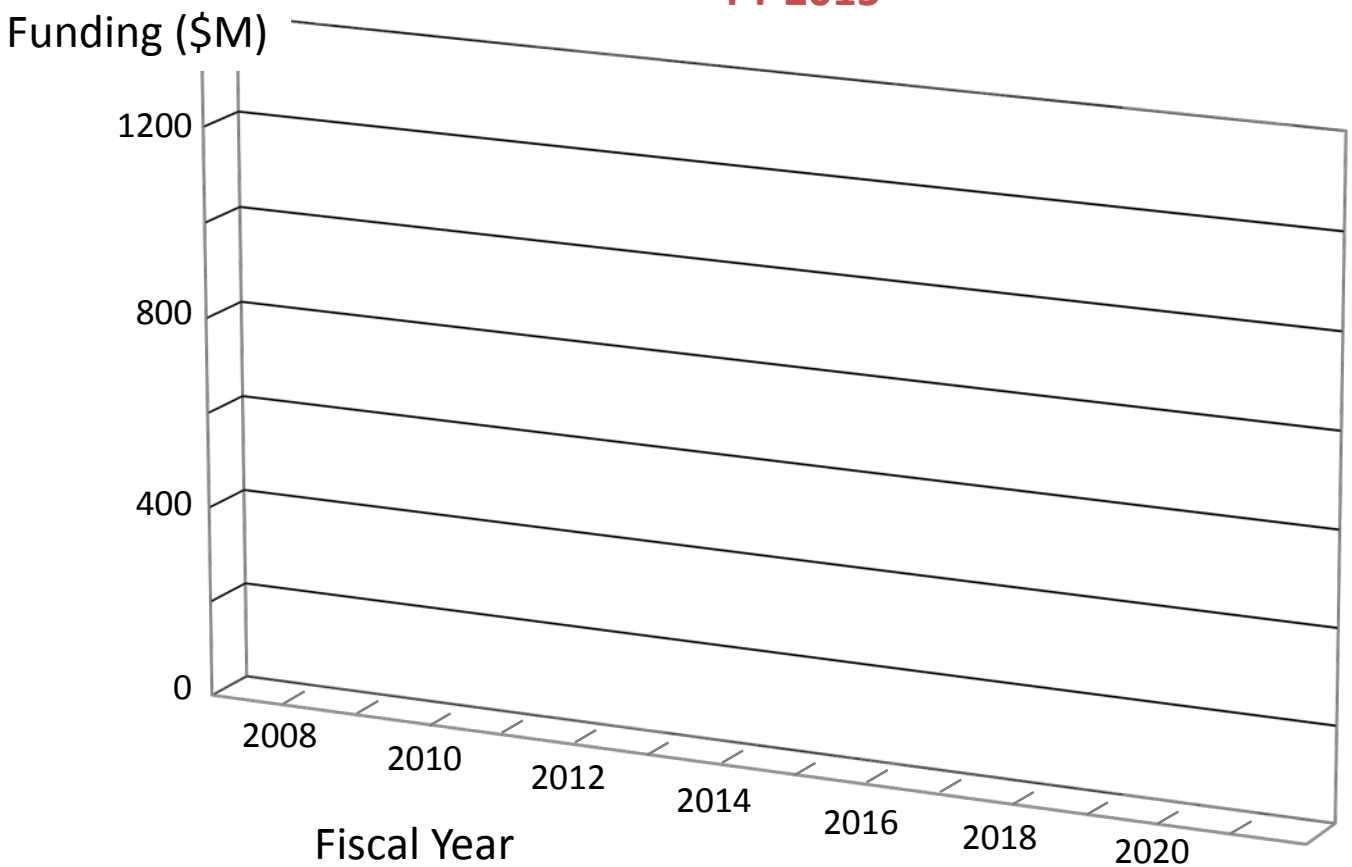


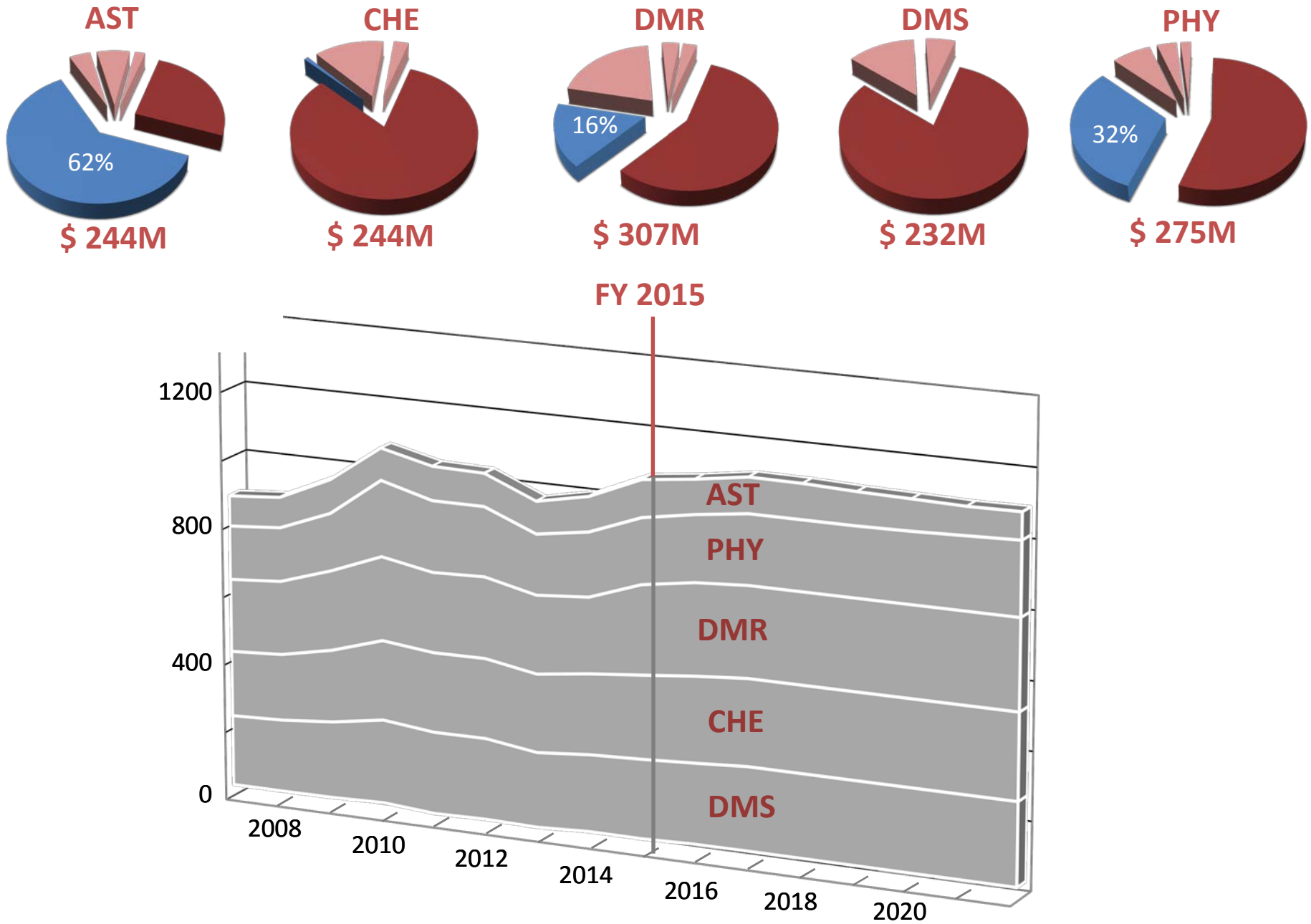





AST
62%
$ 244M
CHE
$ 244M
DMR
16%
$ 307M
DMS
$ 232M
PHY
32%
$ 275M

FY 2015


Funding ($M)
1200
800
400
0
2008
2010
2012
2014
2016
2018
2020
Fiscal Year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1200
800
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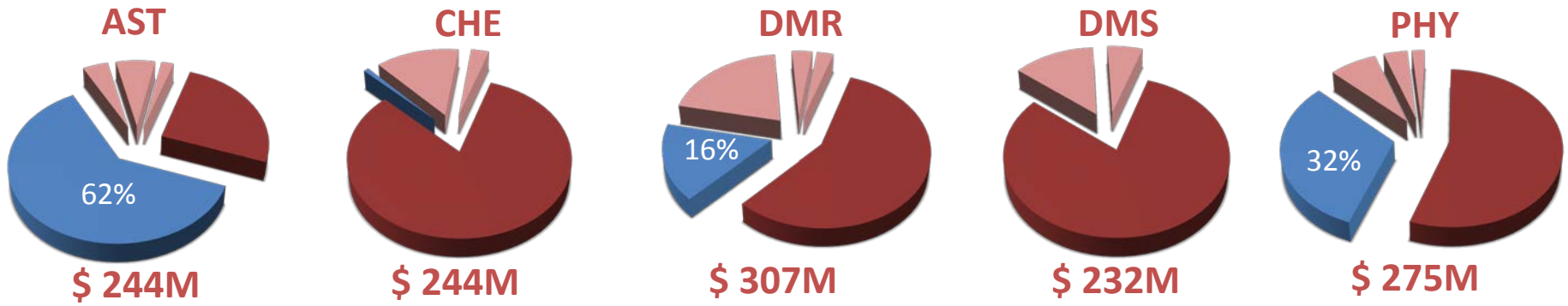
2010
2012
2014
2016
2018
2020
AST
PHY
DMR
CHE
DMS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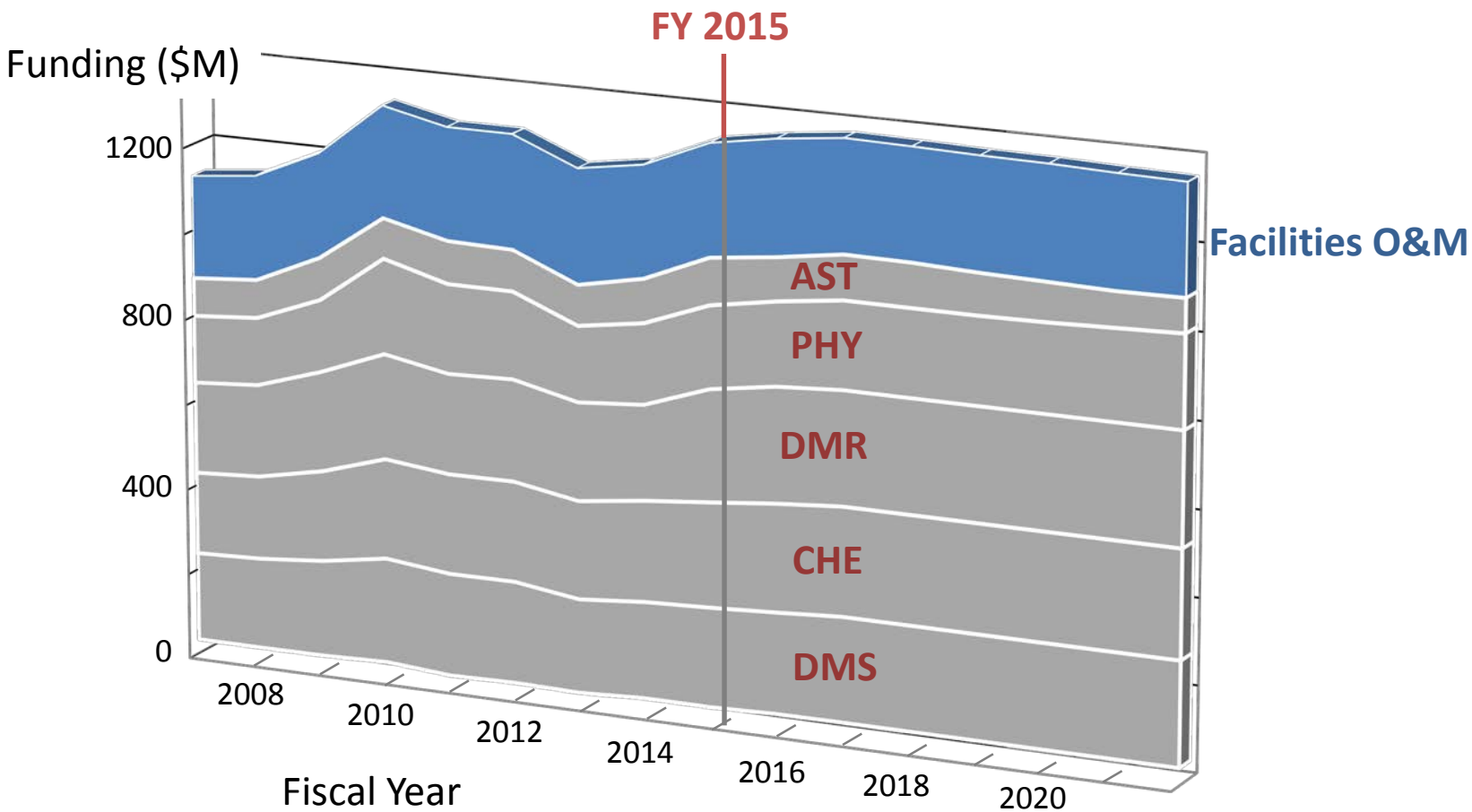
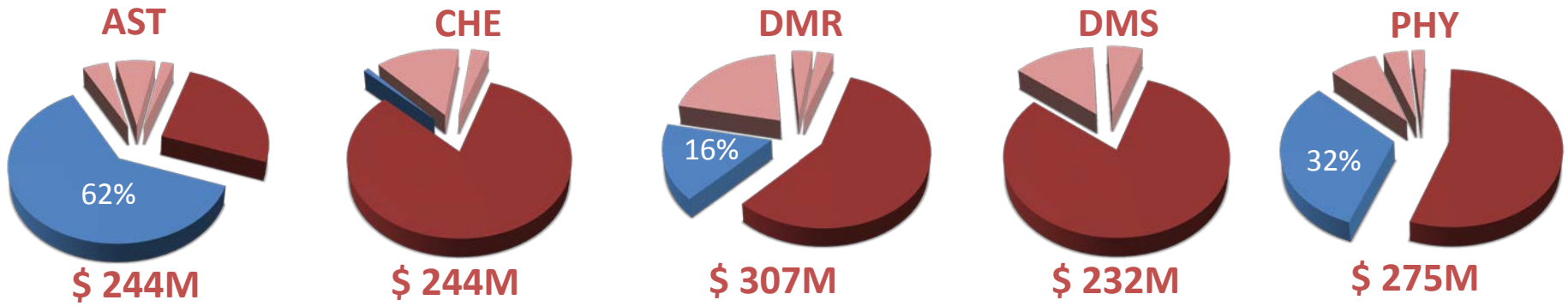

FY 2015
Funding ($M)
1200
800
400
0
2008
2010
2012
2014
2016
2018
2020
Fiscal Year
Facilities O&M
AST
PHY
DMR
CHE
DMS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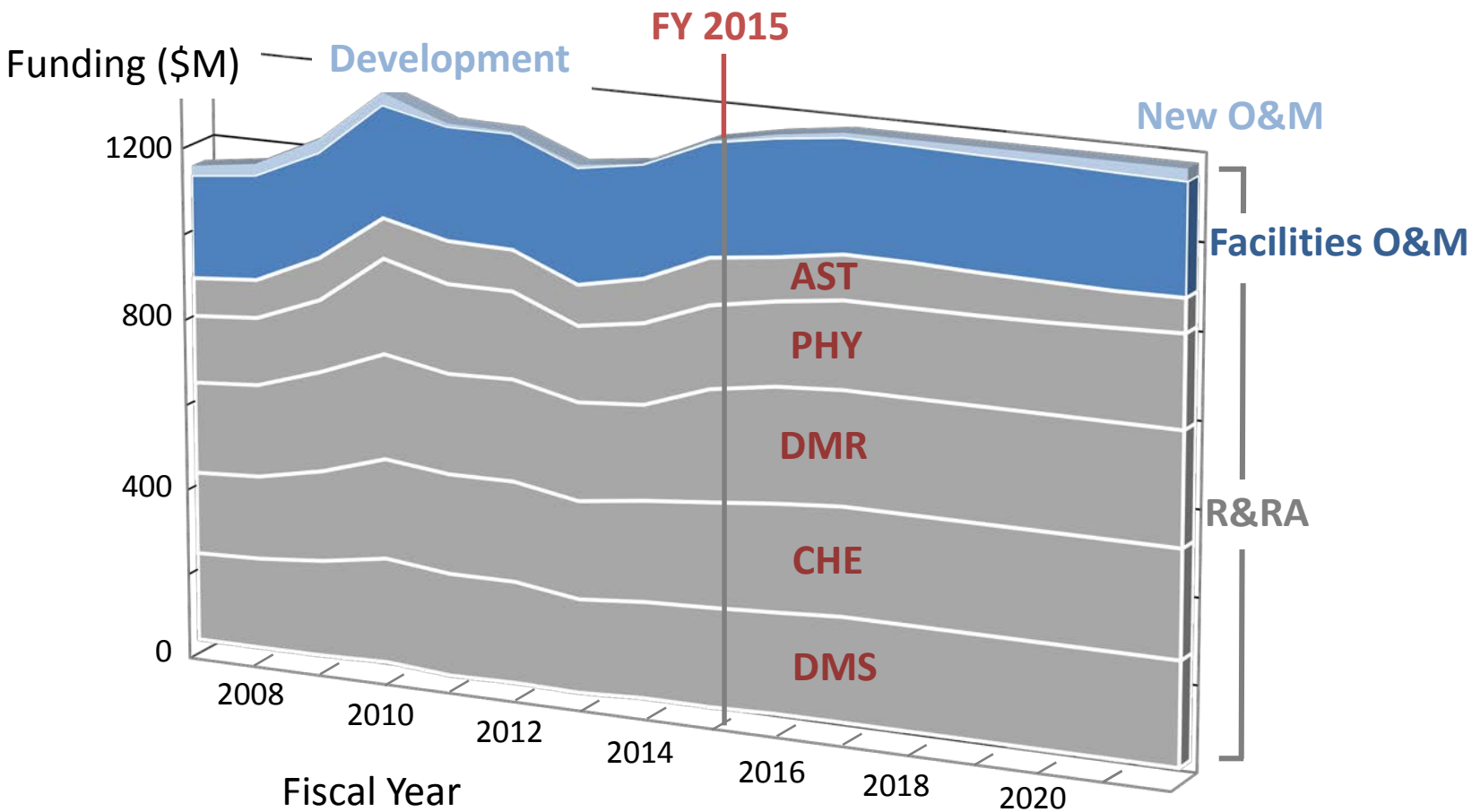
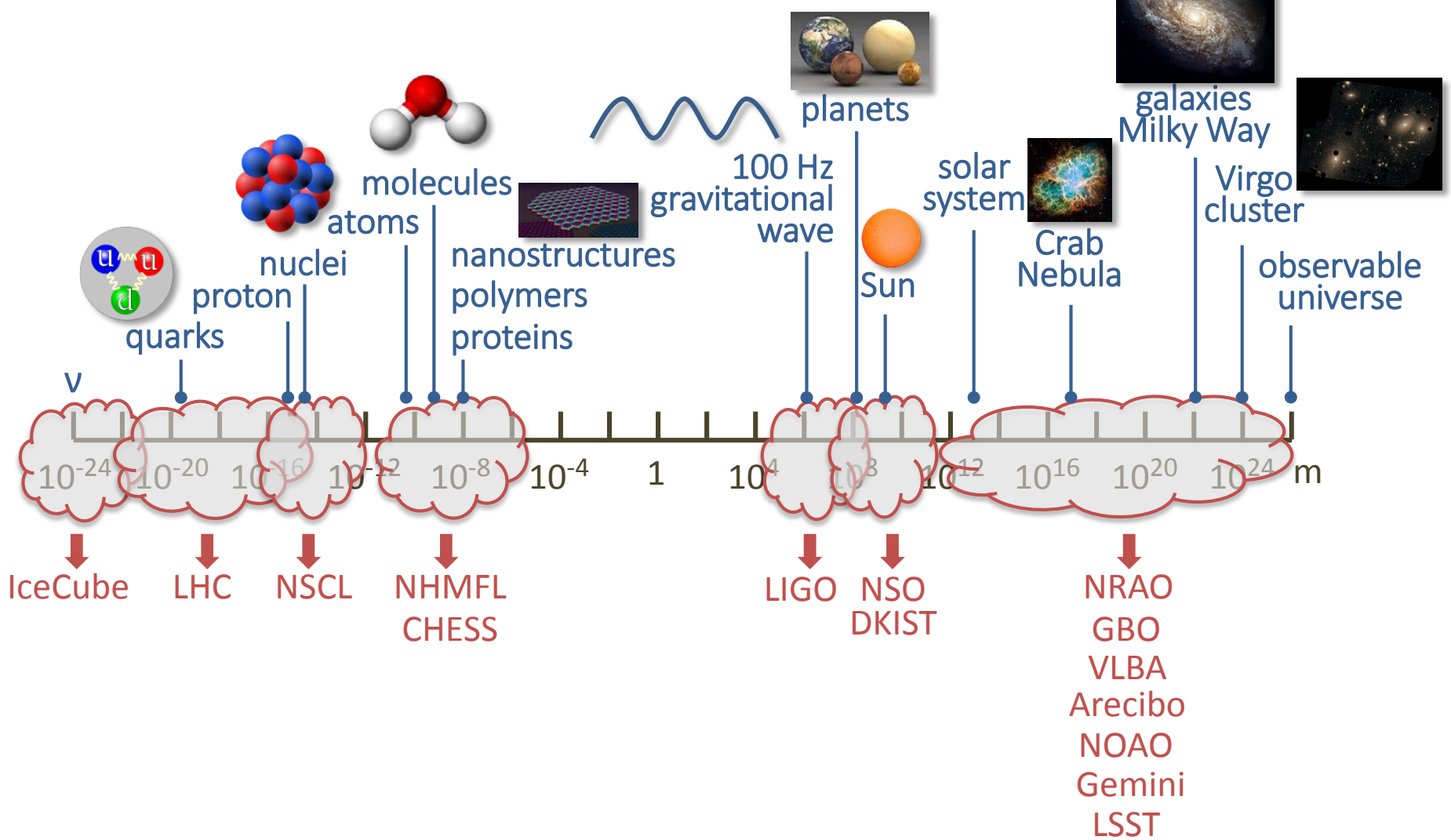
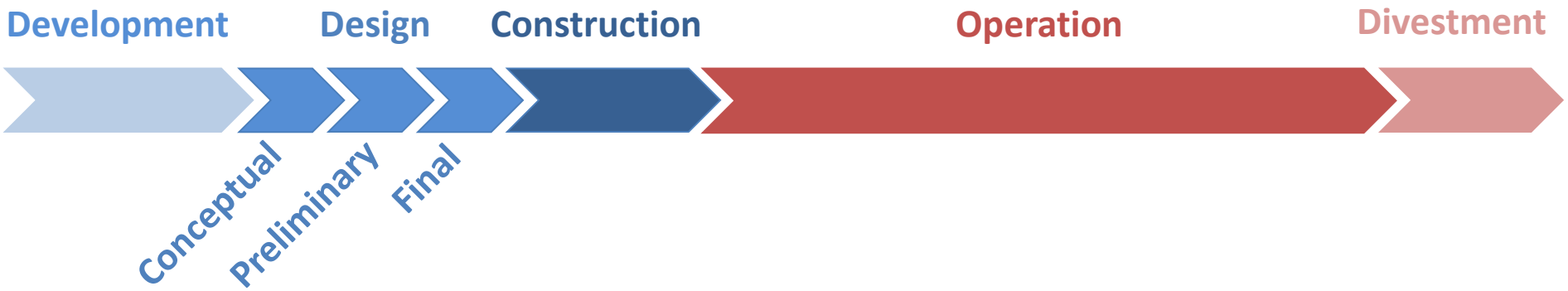
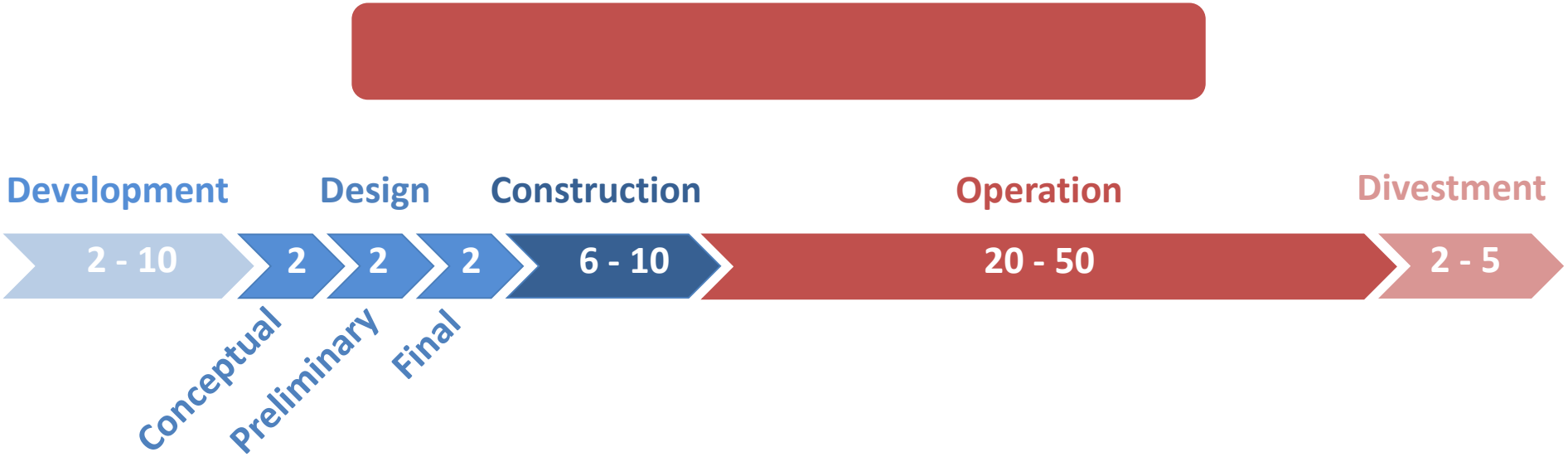

Funding ($M)
Development
FY 2015
New O&M
Facilities O&M
R&RA
AST
PHY
DMR
CHE
DMS
1200
800
400
0
2008
2010
2012
2014
2016
2018
2020
Fiscal Year

Science at the Scales of the Universe

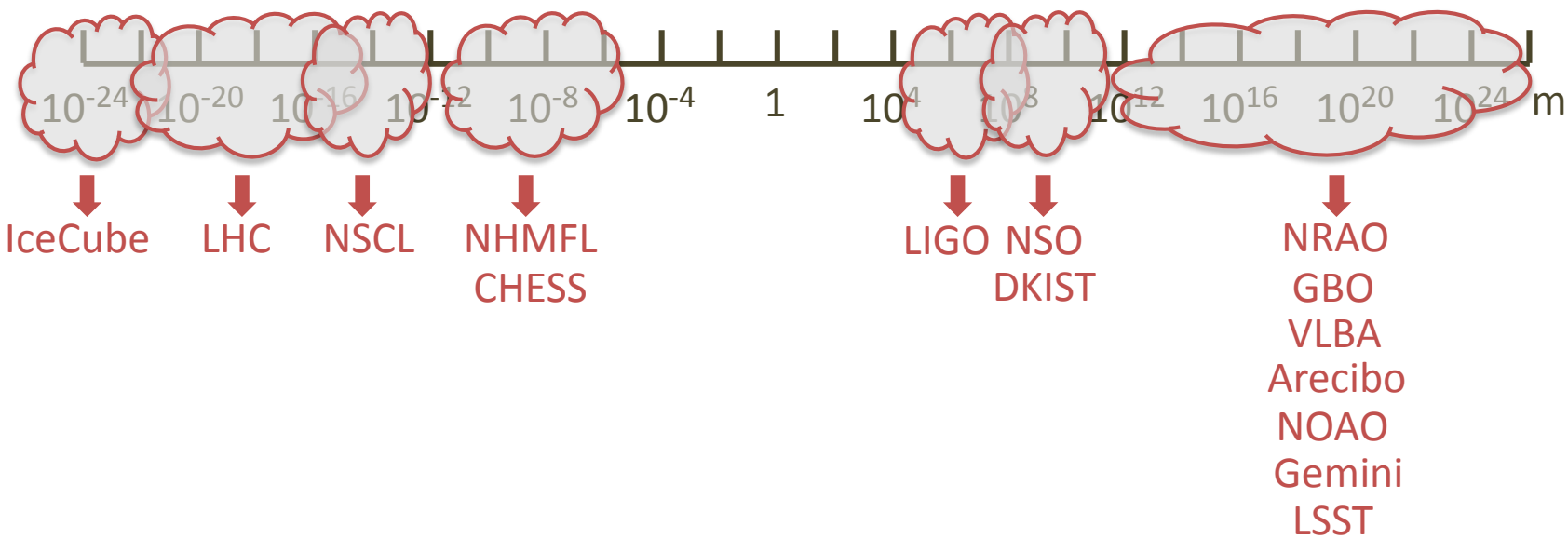


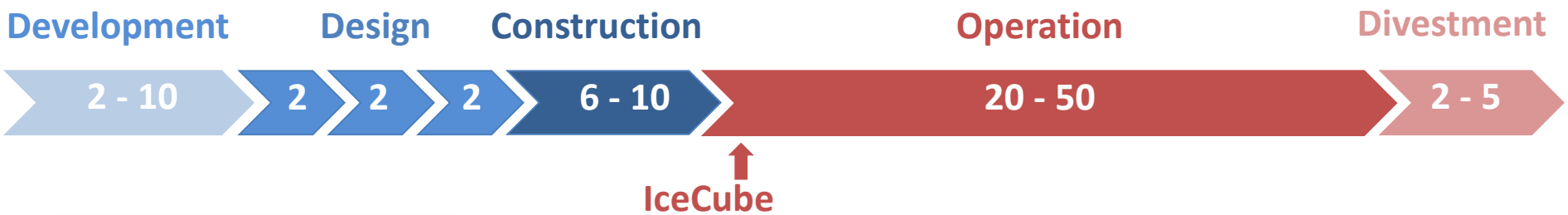
The Progress of a Major Facility

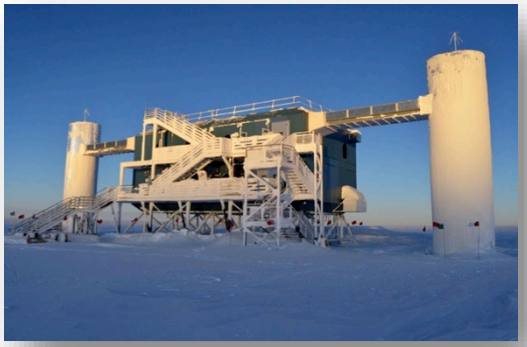



Development
Design
Construction
Operation
Divestment
2 - 10
2
2
2
6 - 10
20 - 50
2 - 5
Conceptual
Preliminary
Final

Development
Design
Construction
Operation
Divestment
2 - 10
2
2
2
6 - 10
20 - 50
2 - 5

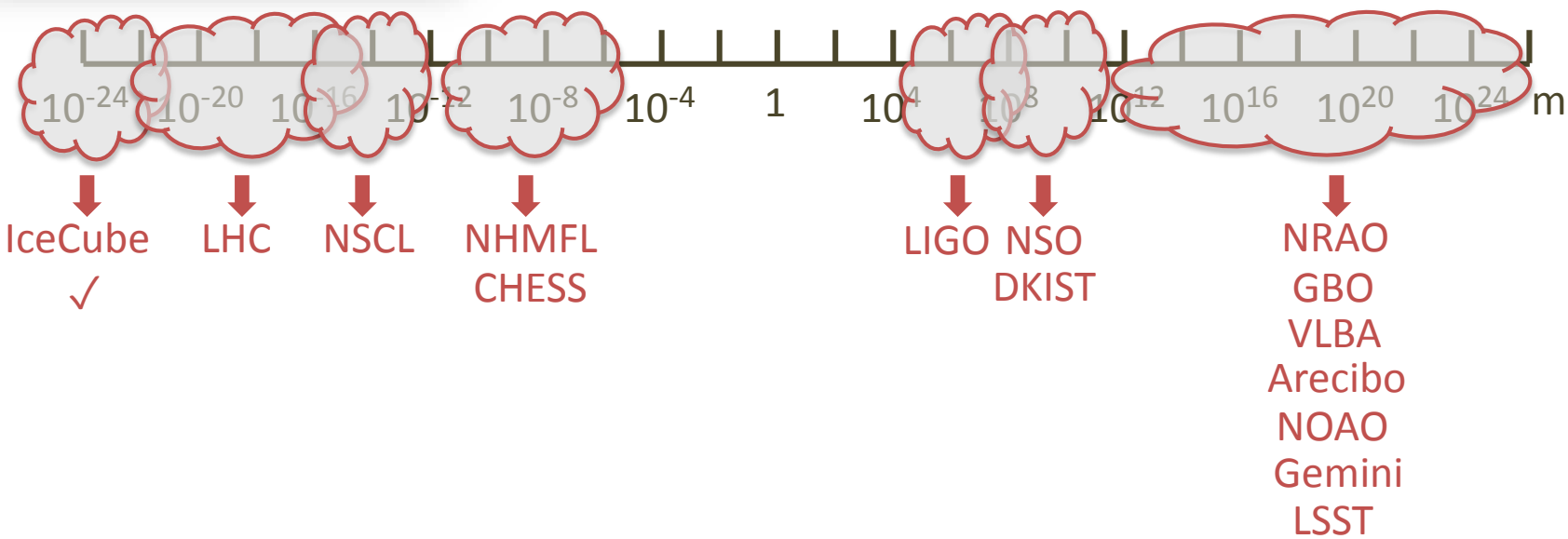

10^{-24}
10^{-20}
10^{-16}
10^{-12}
10^{-8}
10^{-4}
1
10^{4}
10^{8}
10^{12}
10^{16}
10^{20}
10^{24}
m
IceCube
LHC
NSCL
NHMFL
CHESS
LIGO
NSO
DKIST
NRAO
GBO
VLBA
Arecibo
NOAO
Gemini
LSST

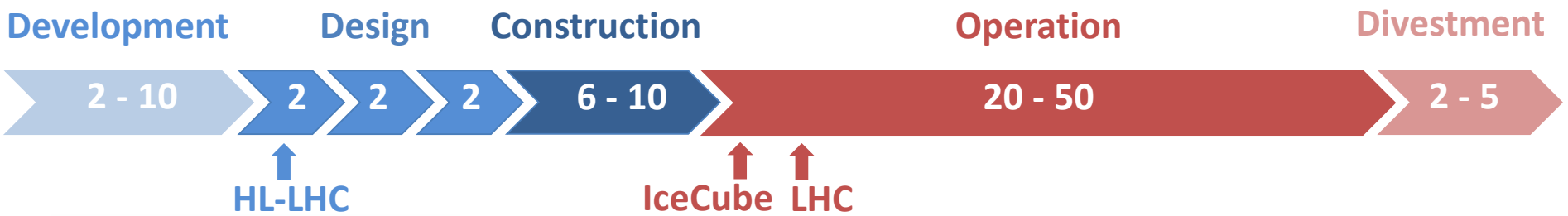


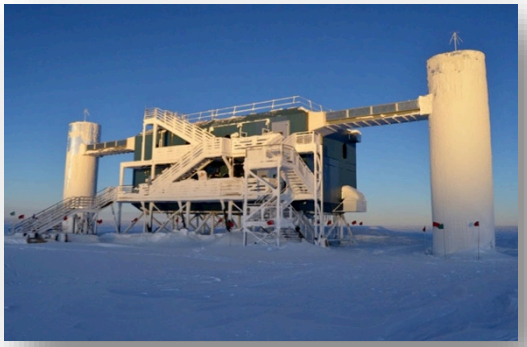


IceCube (PHY)

- Observe high energy neutrinos with detectors at South Pole
- Joint with GEO/PLR and international partners
- NSF: $ 7M/yr
- Competition underway







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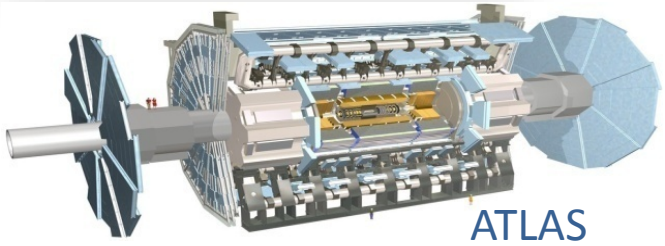
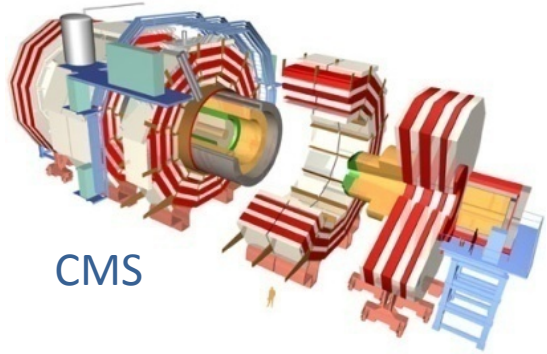


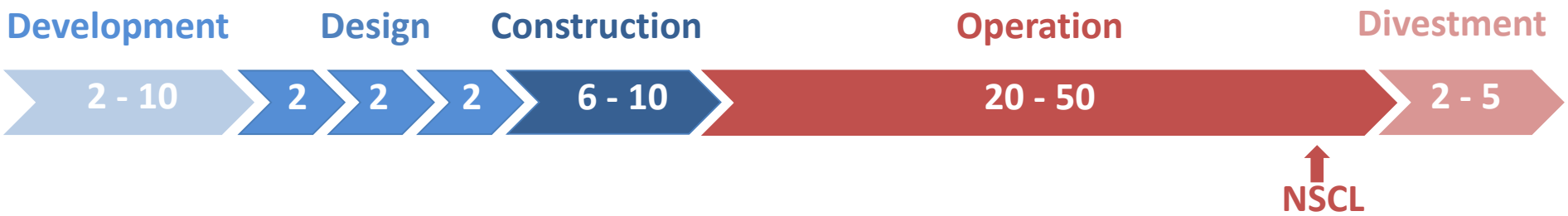


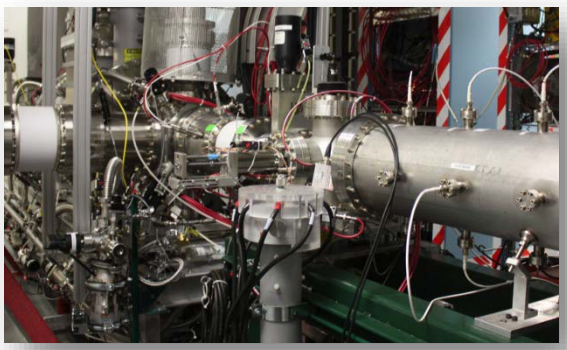
Large Hadron Collider (PHY)

- Collider probes fundamental forces in the Universe
- NSF supports 134 scientists, 114 graduate students on the ATLAS and CMS detectors
- NSF: $ 18M/yr
- Higgs discovery and new physics

High Luminosity – LHC (PHY)

- Upgrade to ATLAS and CMS in conceptual design

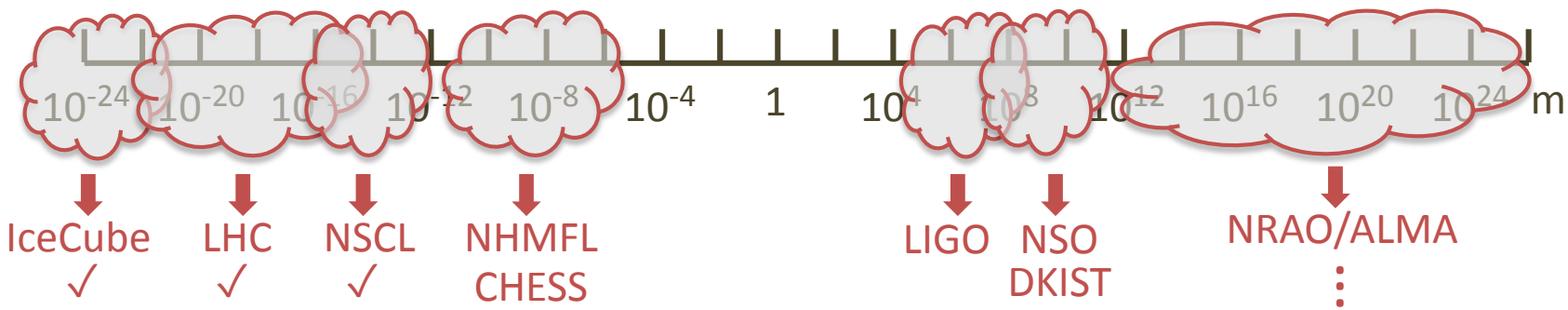


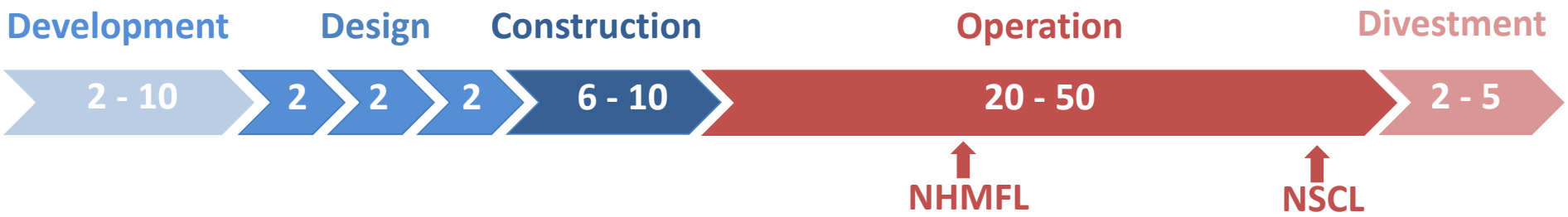


NSCL

National Superconducting Cyclotron Laboratory (PHY)

- Short-lived isotopes and astrophysics – unique facility
- Transitioning to DOE sponsored Facility for Rare Isotope Beams
- $ 22.5M/yr
- (Final) renewal in process for May, 2016





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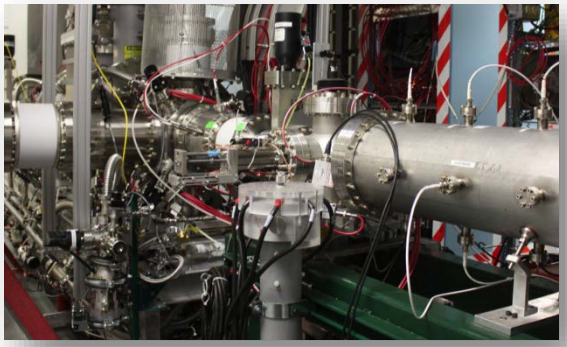


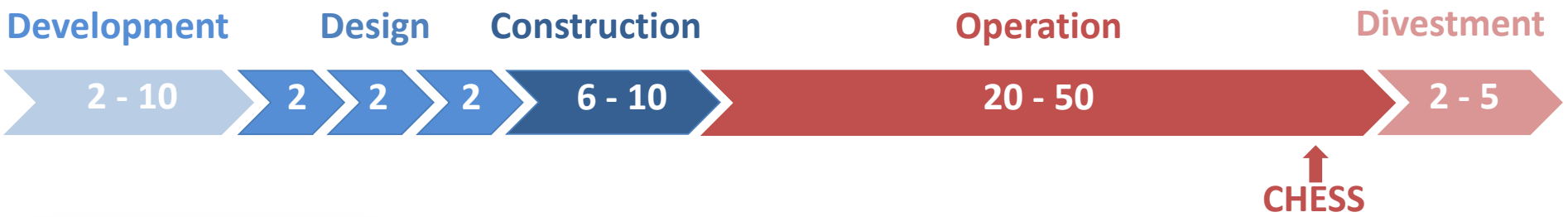
NSCL

- Short-lived isotopes and astrophysics – unique facility
- Transitioning to DOE sponsored Facility for Rare Isotope Beams
- $ 22.5M/yr
- (Final) renewal in process for May, 2016

National High Magnetic Field Laboratory (DMR)

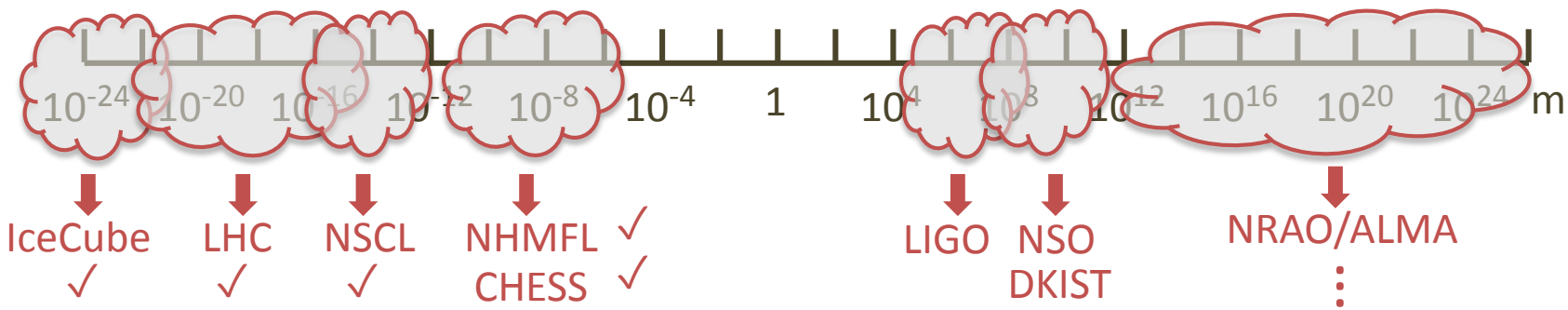
NHMFL

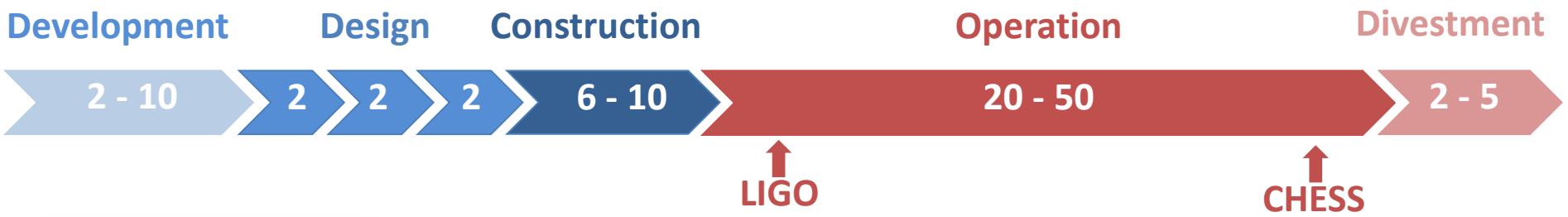
- High magnetic field research and capabilities for materials research, condensed matter physics, and other areas
- Joint among Florida State, Florida, Los Alamos
- $ 35M/yr
- Renewal in process for May, 2017



Cornell High Energy Synchrotron Source (DMR)

- Synchrotron for materials and biological research
- Joint with BIO, ENG and NIH
- NSF: $ 20M/yr
- Yearly reports to NSB on status





CHESS

Cornell High Energy Synchrotron Source (DMR)

- Synchrotron for materials and biological research
- Joint with BIO, ENG and NIH
- NSF: $ 20M/yr
- Yearly reports to NSB on status

LIGO

Laser Interferometer Gravitational-Wave Observatory (PHY)

- Detect gravitational wave predicted by general relativity
- New multi-messenger observations of the Universe
- Upgrade completed Fall 2015 with eventual 10X sensitivity increase (1000X volume probed)
- $ 40M/yr
- NSB recompetition discussion in 2016

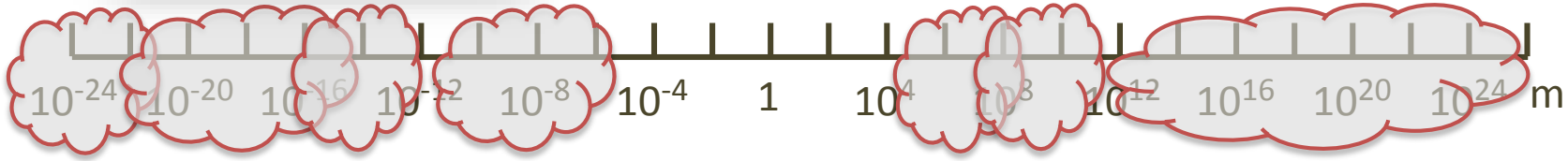
Development	Design			Construction	Operation	Divestment
2 - 10	2	2	2	6 - 10	20 - 50	2 - 5

NSO

NSO/AURA

National Solar Observatory (AST)

- Sunspot (Dunn), Kitt Peak (McMath Pierce)
- Global Oscillations Network Group (GONG) in the solar synoptic survey program
- $ 20M/yr



IceCube ✓

LHC ✓

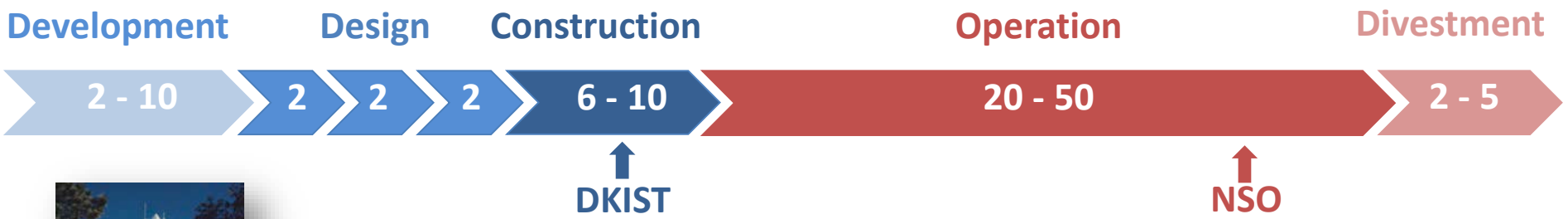
NSCL ✓

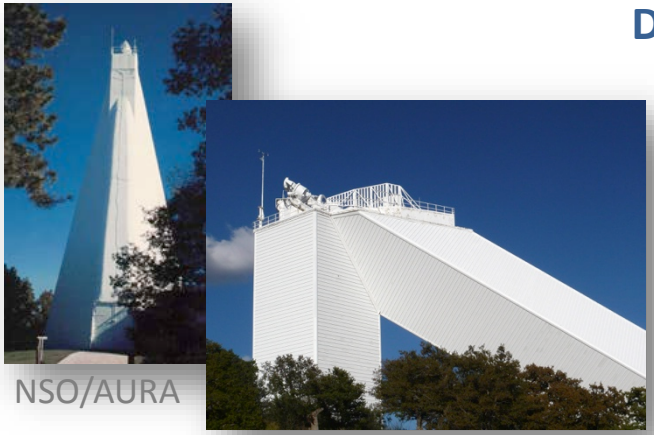
NHMFL ✓
CHESS ✓

✓ LIGO

NSO ✓
DKIST

NRAO
GBO
VLBA
Arecibo
NOAO
Gemini
LSST





NSO/AURA

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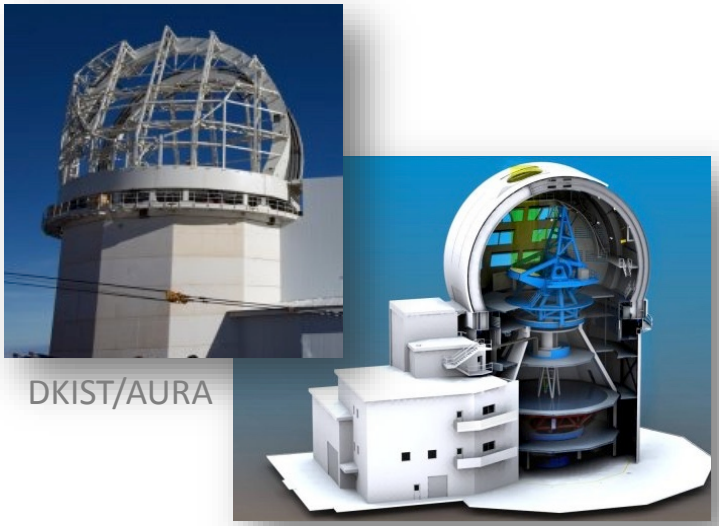

DKIST/AURA

Daniel K. Inouye Solar Telescope (AST)

- Observe the Sun with unprecedented resolution
- Planned operation for two Hale cycles (22 yr each)
- Under construction on Maui, mid-2019 completion
- $ 344M project cost
- $ 17M/yr in full operation

Development	Design			Construction	Operation	Divestment
2 - 10	2	2	2	6 - 10	20 - 50	2 - 5

NRAO

ALMA

NRAO/VLA

National Radio Astronomy Observatory (AST)

- Radio astronomy of all types of astronomical objects
- ALMA, VLA, Development Laboratory, Headquarters
- International Partnership: Europe, Asia, North America
- NSF: $ 75M/yr (competition, NSB action in 2015)

IceCube ✓

LHC ✓

NSCL ✓

NHMFL ✓
CHESS ✓

✓ LIGO

NSO ✓
DKIST ✓

NRAO ✓
GBO
VLBA
Arecibo
NOAO
Gemini
LSST

Development	Design			Construction	Operation	Divestment
2 - 10	2	2	2	6 - 10	20 - 50	2 - 5

NRAO

GBT/VLBA

ALMA

NRAO/VLA

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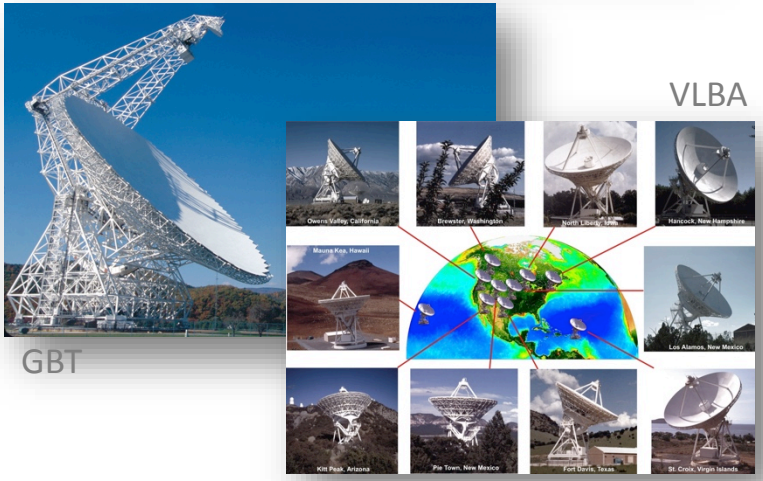


VLBA

GBT

Robert C. Byrd Green Bank Telescope (AST)
Very Long Baseline Array (AST)

- Long-baseline radio interferometry (VLBA)
- World's largest, steerable single-dish telescope (GBT)
- Building partnerships for the future
- Separated from NRAO to facilitate partnerships
- $ 11.5M/yr

Development	Design			Construction	Operation	Divestment
2 - 10	2	2	2	6 - 10	20 - 50	2 - 5

Arecibo

NAIC

Arecibo Observatory (AST)

- Radio astronomy, solar system radar astronomy, space and atmospheric sciences
- World's largest single-dish telescope
- Joint with GEO/AGS and NASA
- NSF: $ 8M/yr

IceCube ✓

LHC ✓

NSCL ✓

NHMFL ✓
CHESS ✓

✓ LIGO

NSO ✓
DKIST ✓

NRAO ✓
GBO ✓
VLBA ✓
Arecibo ✓
NOAO
Gemini
LSST

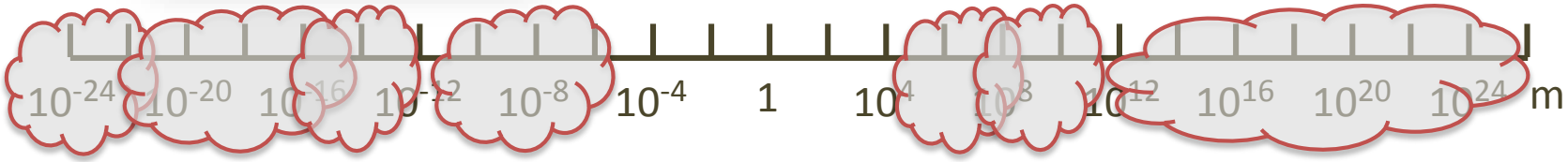
Development	Design			Construction	Operation	Divestment
2 - 10	2	2	2	6 - 10	20 - 50	2 - 5

NOAO

National Optical Astronomy Observatory (AST)

NOAO/AURA

- Ground based optical and infrared astronomy
- Kitt Peak and Cerro Tololo Interamerican Observatory
- Remaking itself for the modern era
- $ 22M/yr (competition, NSB action in 2015)
- Partnerships for Mayall, WIYN telescopes



IceCube ✓

LHC ✓

NSCL ✓

NHMFL ✓
CHESS ✓

✓ LIGO

NSO ✓
DKIST ✓

NRAO ✓
GBO ✓
VLBA ✓
Arecibo ✓
NOAO ✓
Gemini
LSST

Development	Design			Construction	Operation	Divestment
2 - 10	2	2	2	6 - 10	20 - 50	2 - 5

Gemini NOAO

NOAO/AURA

National Optical Astronomy Observatory (AST)

- Ground based optical and infrared astronomy
- Kitt Peak and Cerro Tololo Interamerican Observatory
- Remaking itself for the modern era
- $ 22M/yr (competition, NSB action in 2015)
- Partnerships for Mayall, WIYN telescopes

Gemini/AURA

Gemini Observatory (AST)

- One observatory, two telescopes (8 m optical, infrared)
- Hawaii (Maunakea) and Chile (Cerro Pachón)
- Recent direct imaging of an exoplanet
- International partnership (Argentina, Brazil, Canada, Chile)
- NSF: $ 20M/yr
- NSB action February 2016

Development	Design			Construction	Operation	Divestment
2 - 10	2	2	2	6 - 10	20 - 50	2 - 5

LSST

Large Synoptic Survey Telescope (AST)

- Under construction on Cerro Pachón, 2020 completion
- Image the entire visible sky twice a week
- Large, curated data sets
- Partnership with DOE and private donors
- NSF: $ 473M, DOE: $ 168M, private $ 39M

IceCube ✓

LHC ✓

NSCL ✓

NHMFL ✓
CHESS ✓

✓ LIGO

DKIST ✓

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GBO ✓
VLBA ✓
Arecibo ✓
NOAO ✓
Gemini ✓
LSST ✓

Development	Design			Construction	Operation	Divestment
2 - 10	2	2	2	6 - 10	20 - 50	2 - 5
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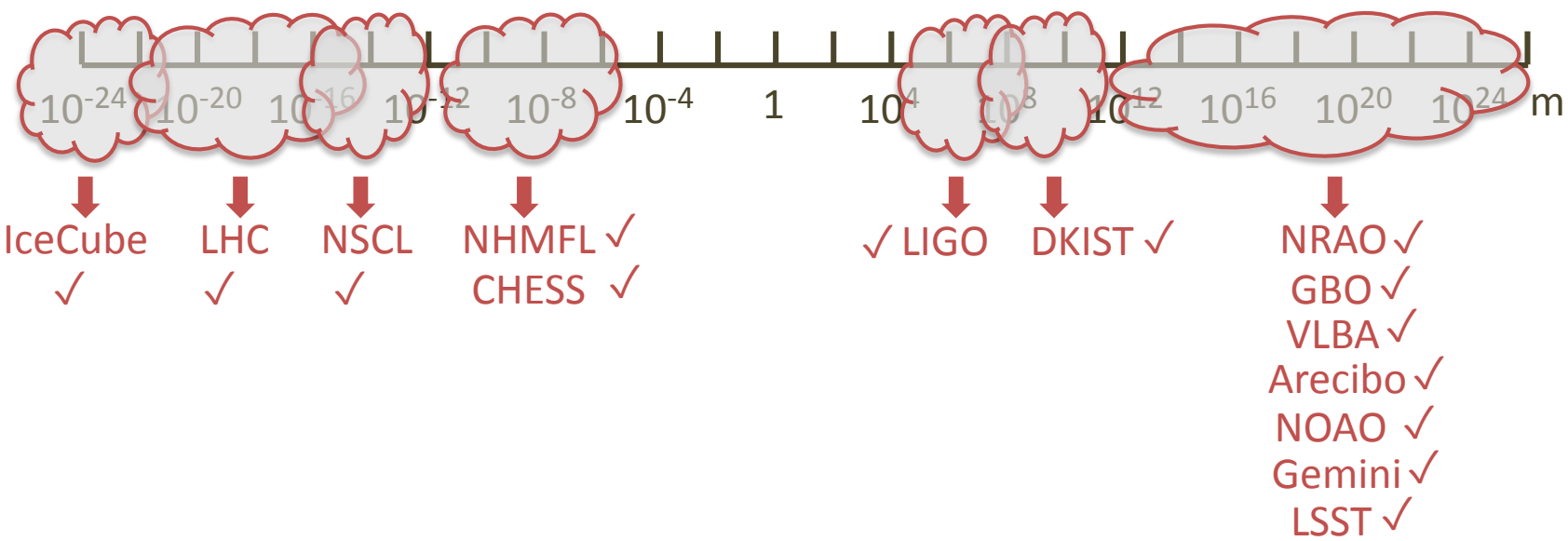

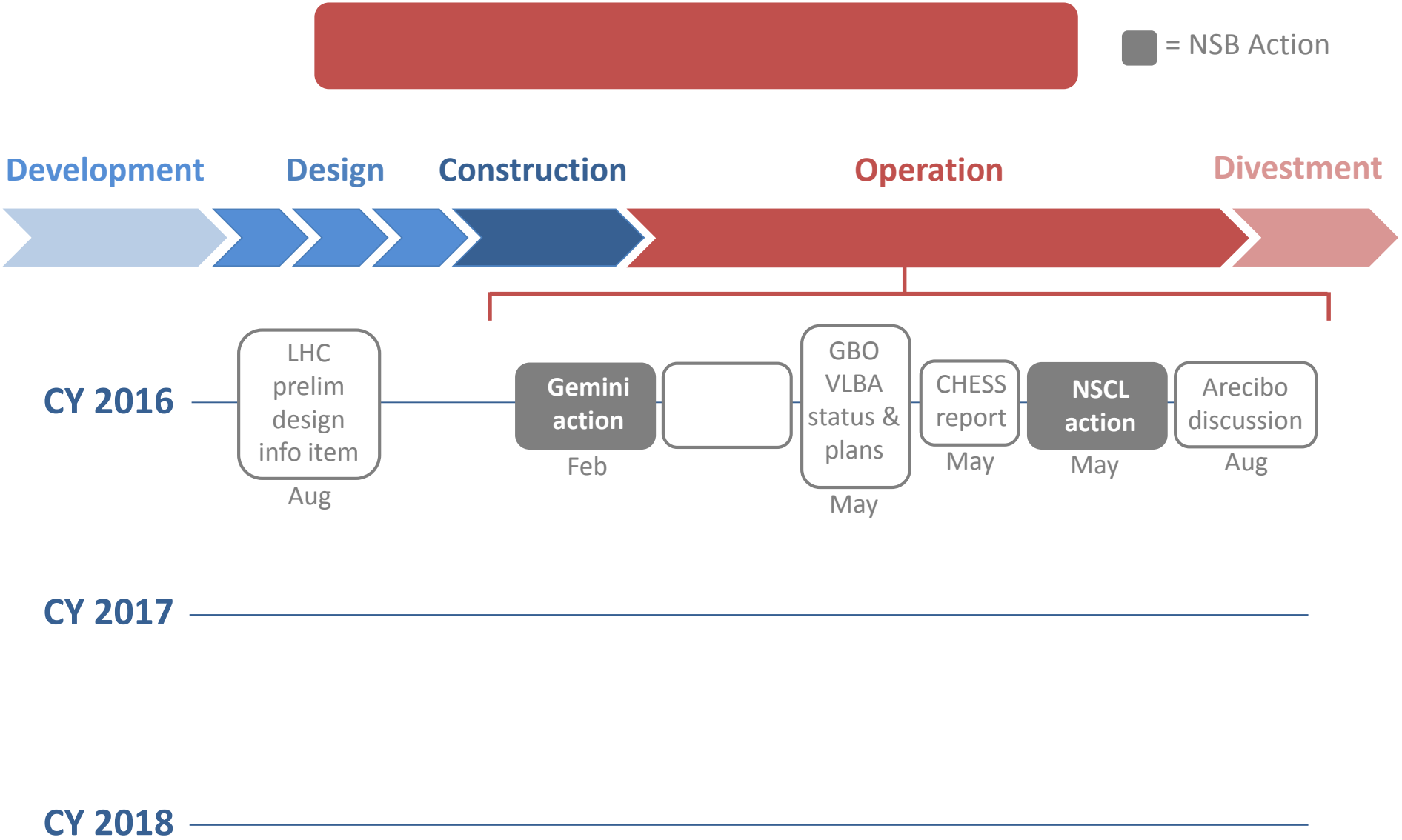
= NSB Action
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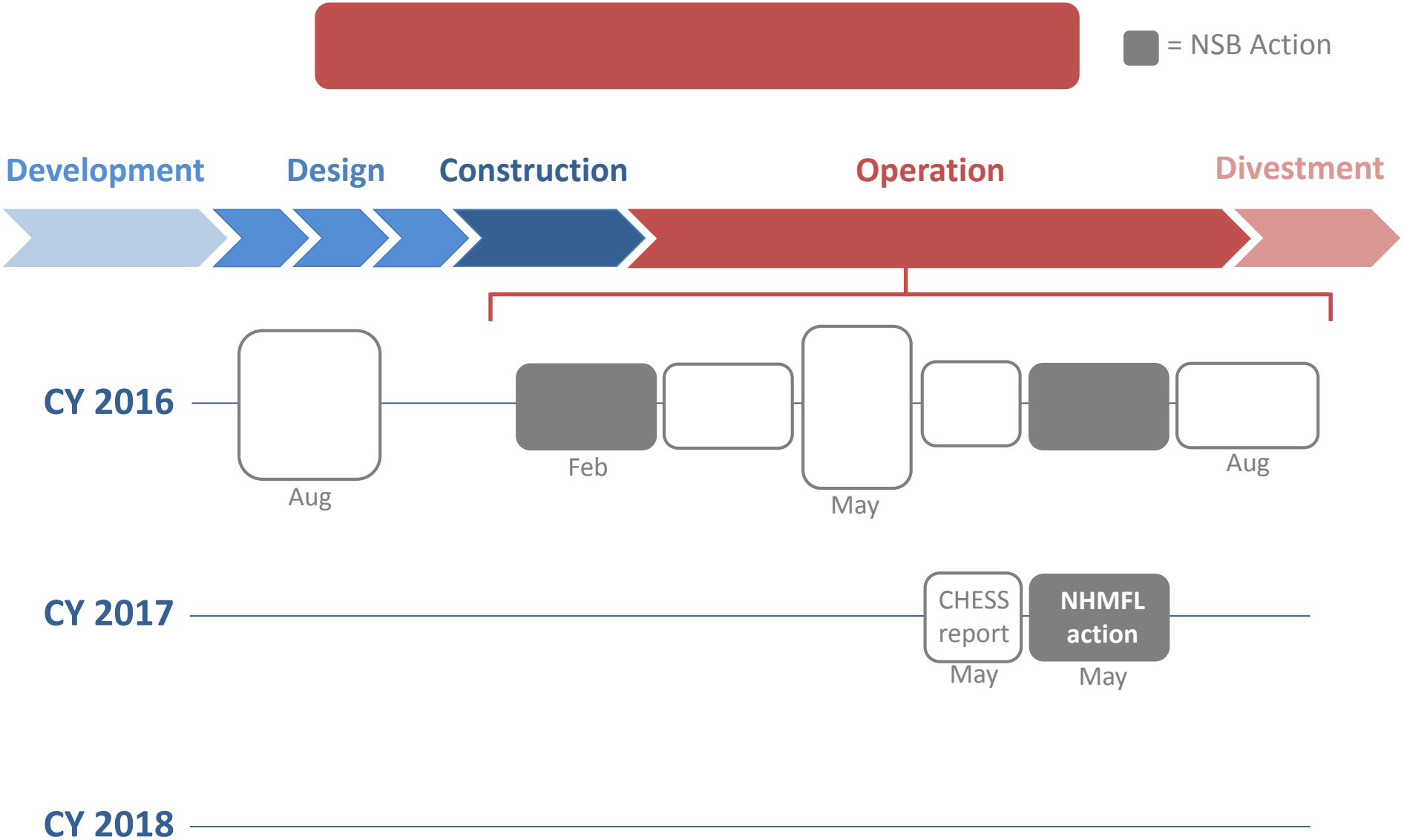
Gemini action
Feb
GBO VLBA status & plans
May
CHESS report
May
NSCL action
May
Arecibo discussion
Aug
CY 2017
CY 2018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NHMFL action
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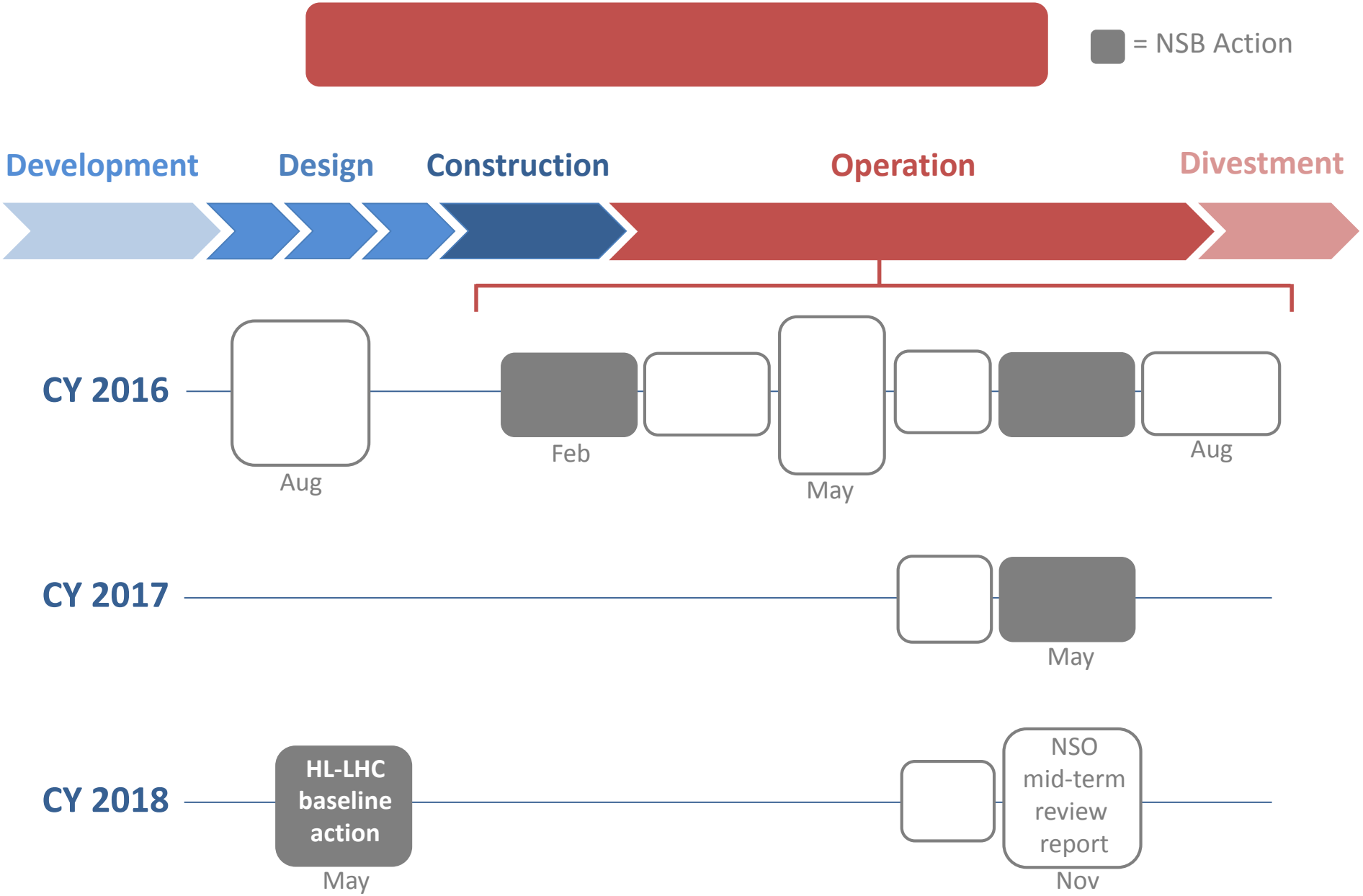
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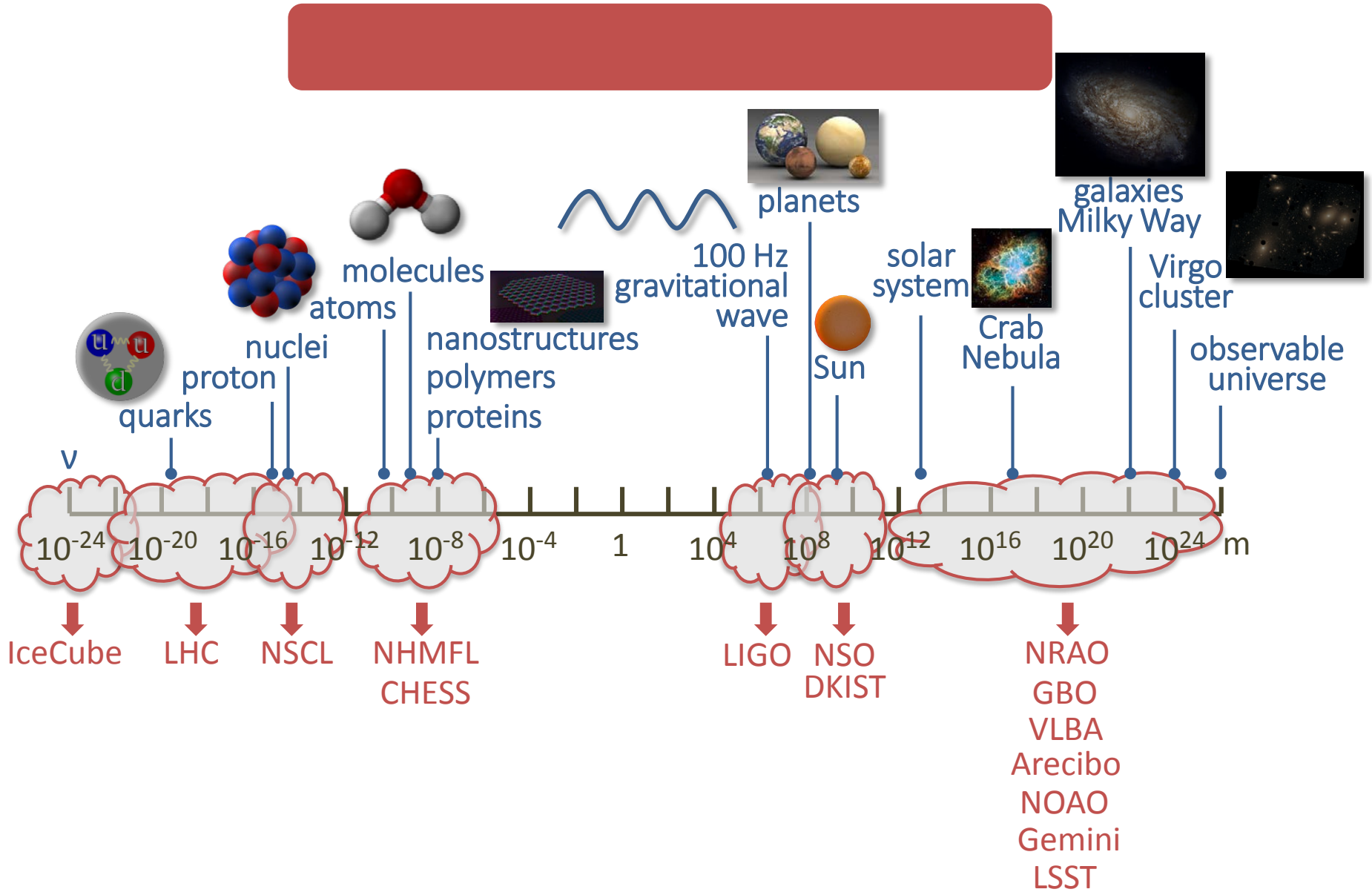
HL-LHC baseline action
May
NSO mid-term review report
Nov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