

A Perspective on the Future of Particle Physics

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MPS/NSF**

**Joint Meeting of the ALCPG and ILC GDE
FNAL, October 22, 2007**

Observations

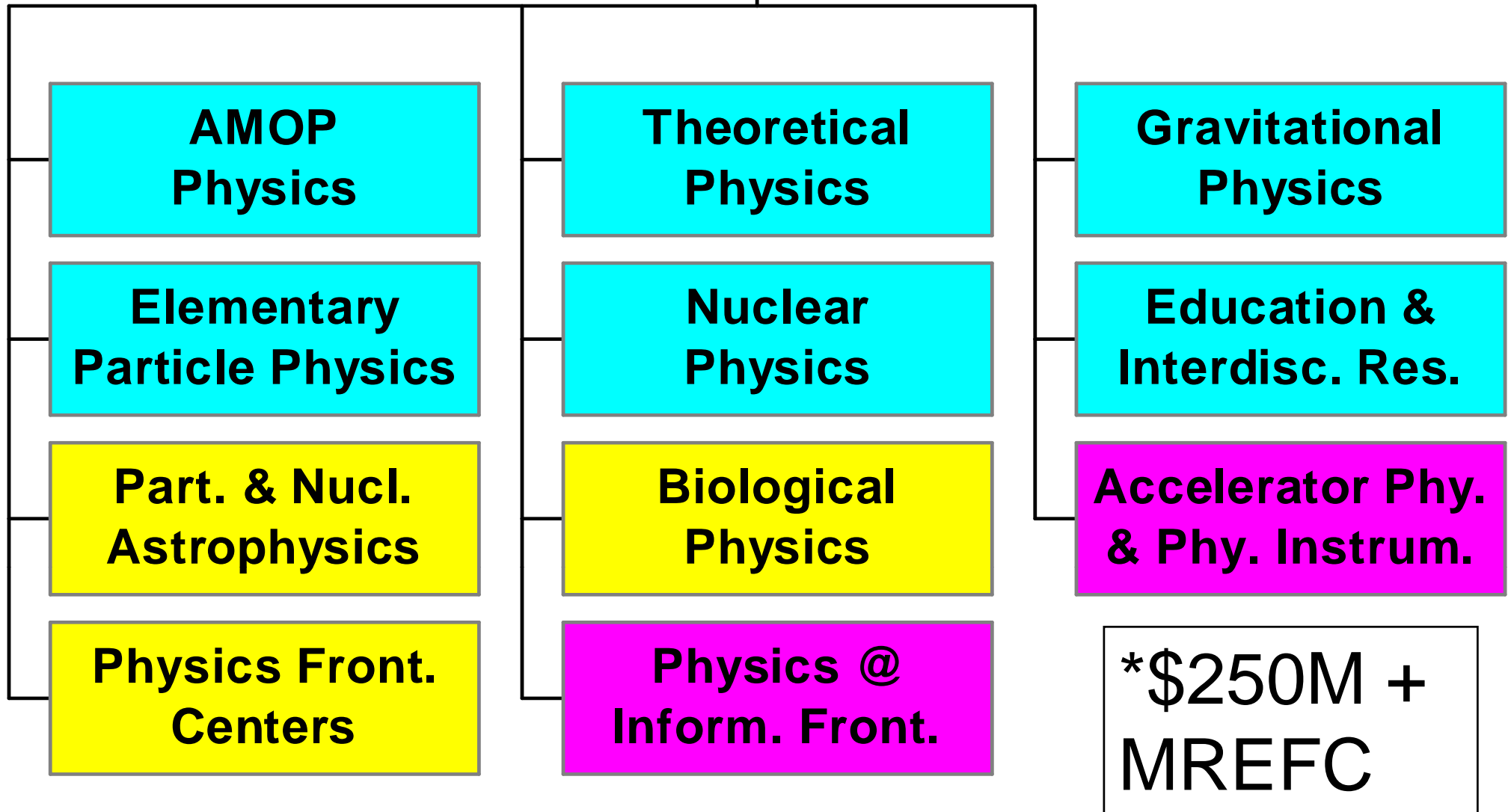
- **Opportunities for fundamental, transformative discoveries in particle physics have never been more numerous or compelling.**
- **Whereas the energy frontier collider remains the tool of choice, other approaches for major discovery have emerged to be important.**
- **The resources required for frontier facilities call for unprecedented preparation and coordination.**
- **A vigorous particle physics community is important for science and society.**

Future Facilities – A Coordinated Approach

ILC	DOE/HEP lead	NSF/PHY supporting role
DUSEL	NSF/PHY lead	DOE/HEP and DOE/NP supporting role
RIBF	DOE/NP lead	NSF/PHY supporting role

Scope and Budget* of PHY

Division of Physics



The Terascale and Beyond

- **Tevatron**
- **International Linear Collider**
- **Large Hadron Collider**
- **CLIC**
- **Muon Collider**
- **VLHC**
- **Rare Processes, e.g., MECO, KOPIO...**
- **IceCube**
- **Auger**
- **Proton Decay**

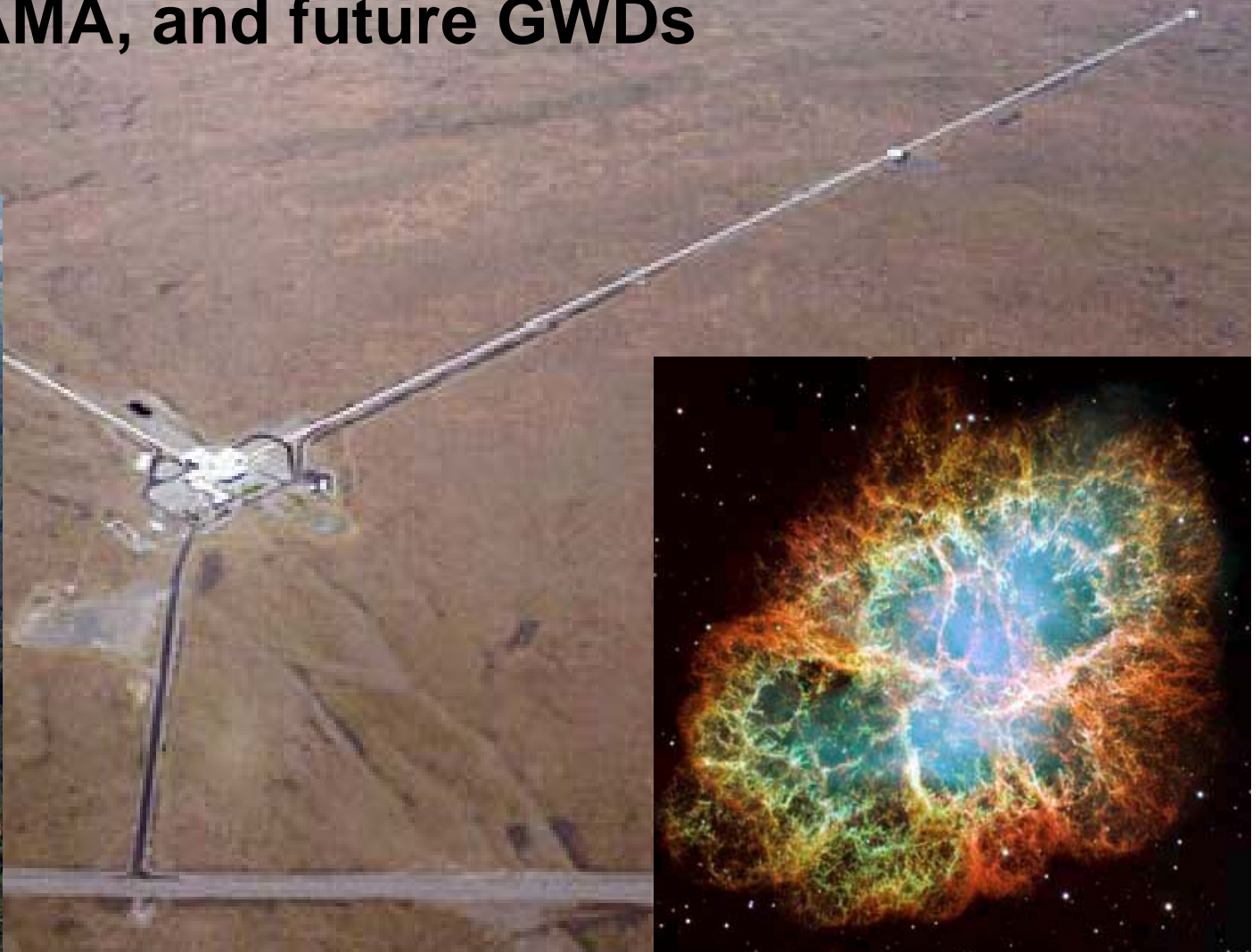
Astroparticle Physics Projects

- **Gravitational Waves: LIGO/AdvLIGO** (GEO, VIRGO, TAMA, 11 countries)
- **Cosmological Neutrinos: IceCube** (Germany, Sweden, Belgium)
- **Underground Infrastructure/Initial Suite: DUSEL**
- **Dark Matter: CDMS, XENON, WARP, ZEPLIN, DRIFT, COUPP** (DOE-HEP, INFN, PPARC, Germany, Poland)
- **Cosmic Rays: AUGER, HiRes, TA, Veritas, Milagro** (DOE-HEP, Japan, Korea, Canada, Ireland, Smithsonian, 17 more countries)
- **Neutrinos: Borexino, Double Chooz, CUORE** (DOE-NP, INFN, France, Germany, Brazil, Japan, Russia, Spain, UK)
- **Structure of the Universe: ACT, SPT**
- **B-Mode Polarization of CMB: QUIET**
- **Origin of the Elements: NSCL** (DOE-NP)



LIGO

Part of a global network of gravitational wave detectors, including GEO, VIRGO, TAMA, and future GWDs





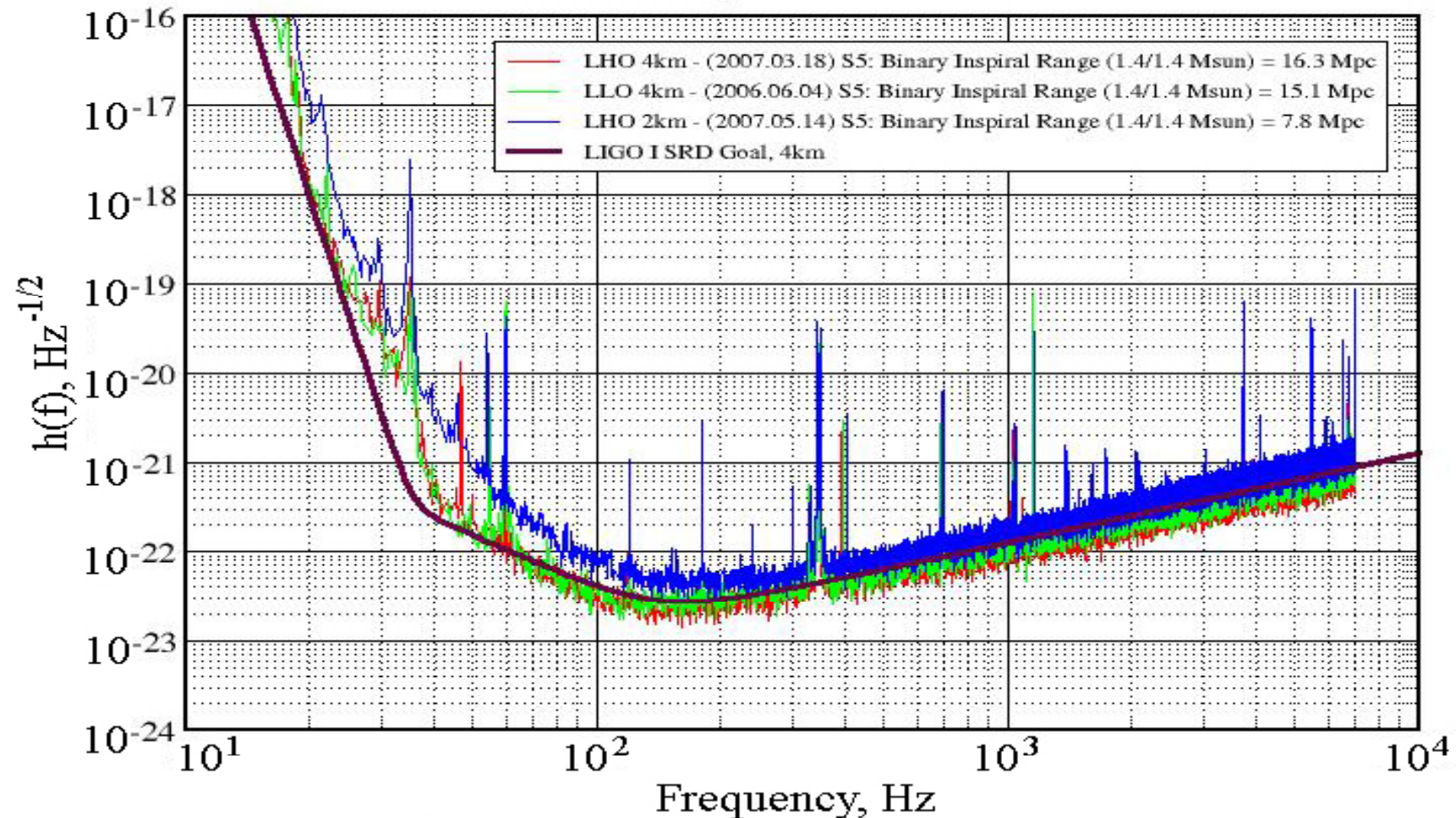
Science Goals of LIGO

- **First direct detection of gravitational waves**
- **Open a new window on the Universe**
- **Explore the strong-gravity régime of Einstein's General Theory of Relativity**
- **Explore space and time back through the inflationary epoch, all the way to the Big Bang, when all four fundamental forces of nature were unified.**

LIGO has just completed its mission-defining science run.

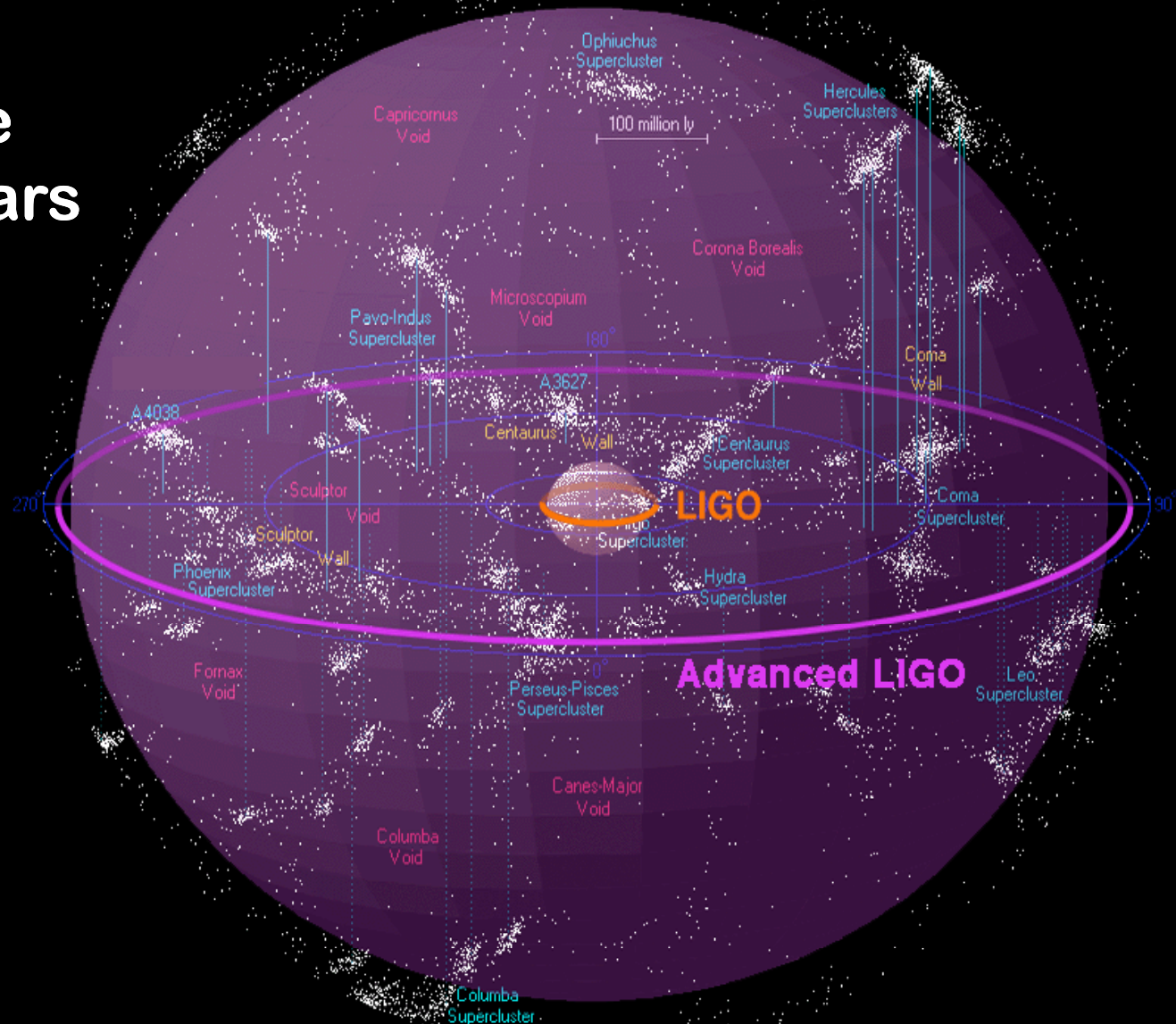
Strain Sensitivity of the LIGO Interferometers

S5 Performance - May 2007 LIGO-G070366-00-E



Advanced LIGO promises a 1000-fold increase in event rates

- LIGO has a range of ~ 60 M light years for NS-NS mergers;
- AdvLIGO will have a range $\sim 10x$ greater and sample a volume of space $\sim 1000x$ larger.



IceCube

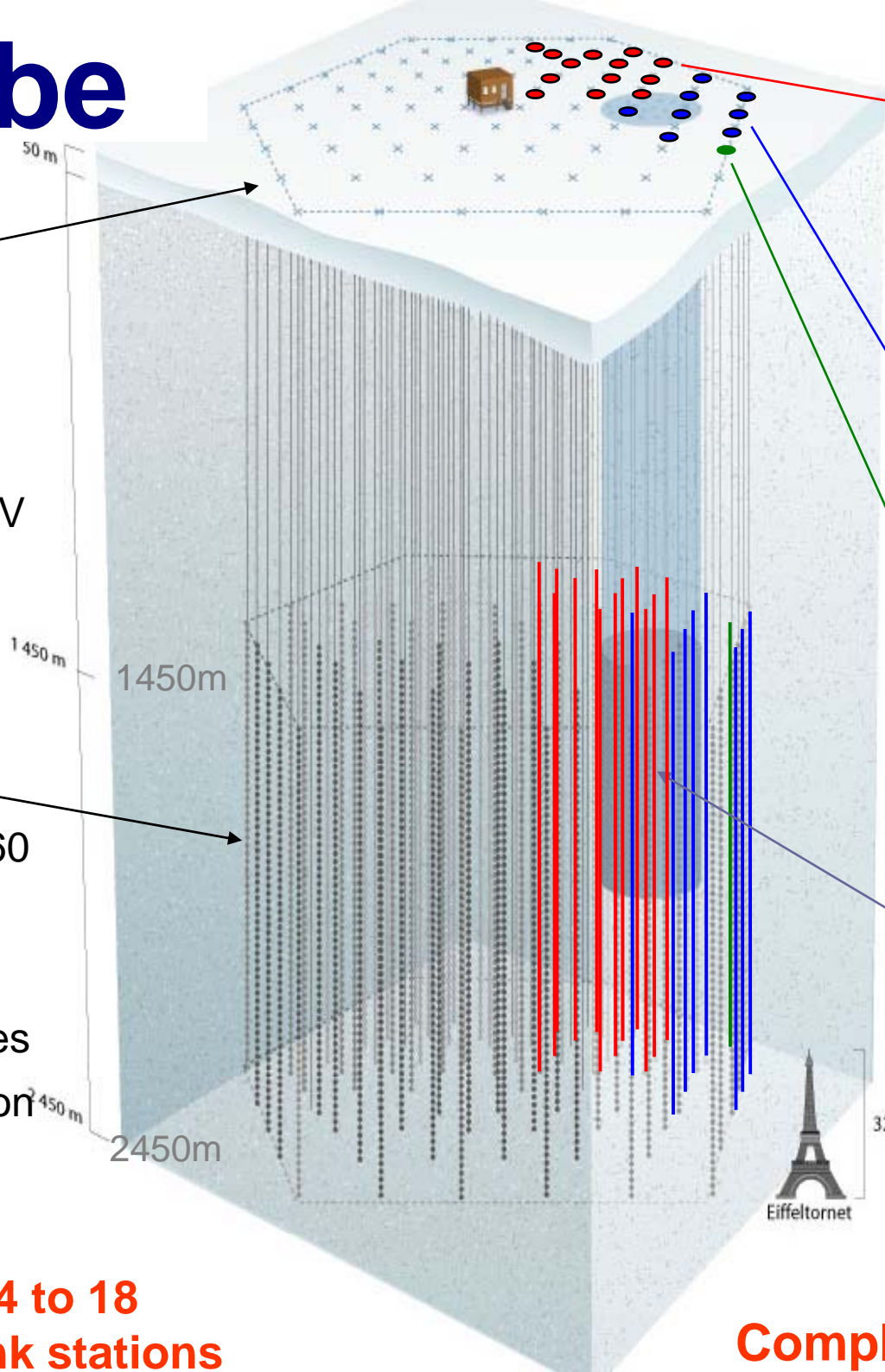
IceTop

Air shower detector
80 pairs of ice
Cherenkov tanks
Threshold ~ 300 TeV

InIce

Goal of 80 strings of 60
optical modules each

17 m between modules
125 m string separation



2006-2007:
13 strings deployed

Current configuration
- 22 strings
- 52 surface tanks

2005-2006: 8 strings

2004-2005 : 1 string

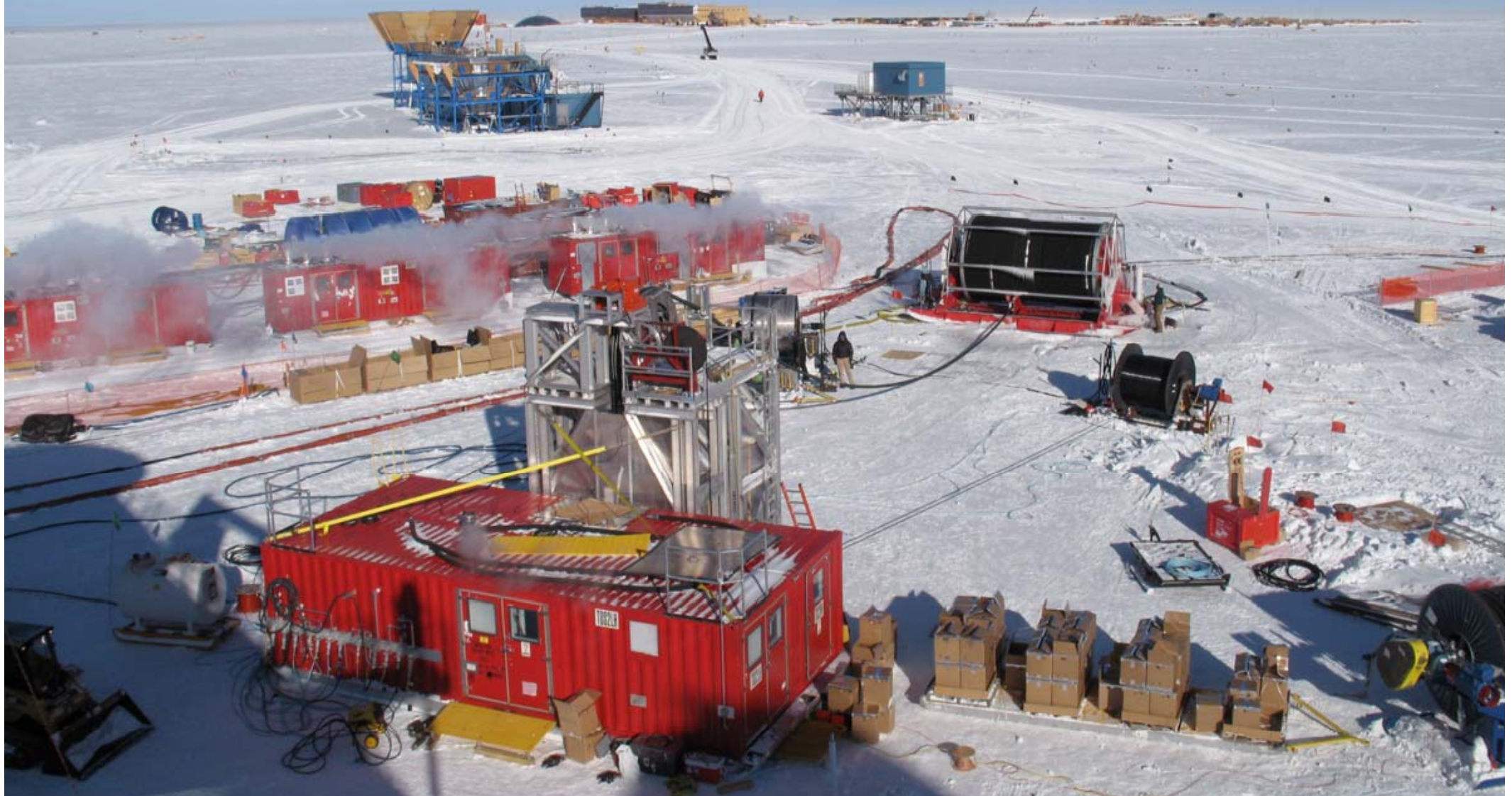
AMANDA-II
19 strings
677 modules

AMANDA now
operating as part
of IceCube

2007/08: add 14 to 18
strings and tank stations

Completion by 2011.

IceCube Construction & Transition to Operations: Status Report to NSB/SOPI Mtg (May 14, 2007)



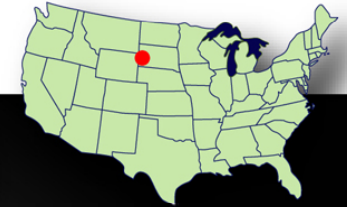
Drill camp 2006/2007 season

First String Installed at IceCube

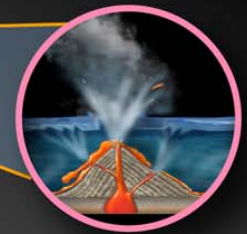


DUSEL

Deep Underground Science and Engineering Laboratory at Homestake, SD



Engineering



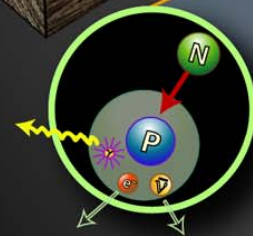
Geoscience



Biology



Astrophysics



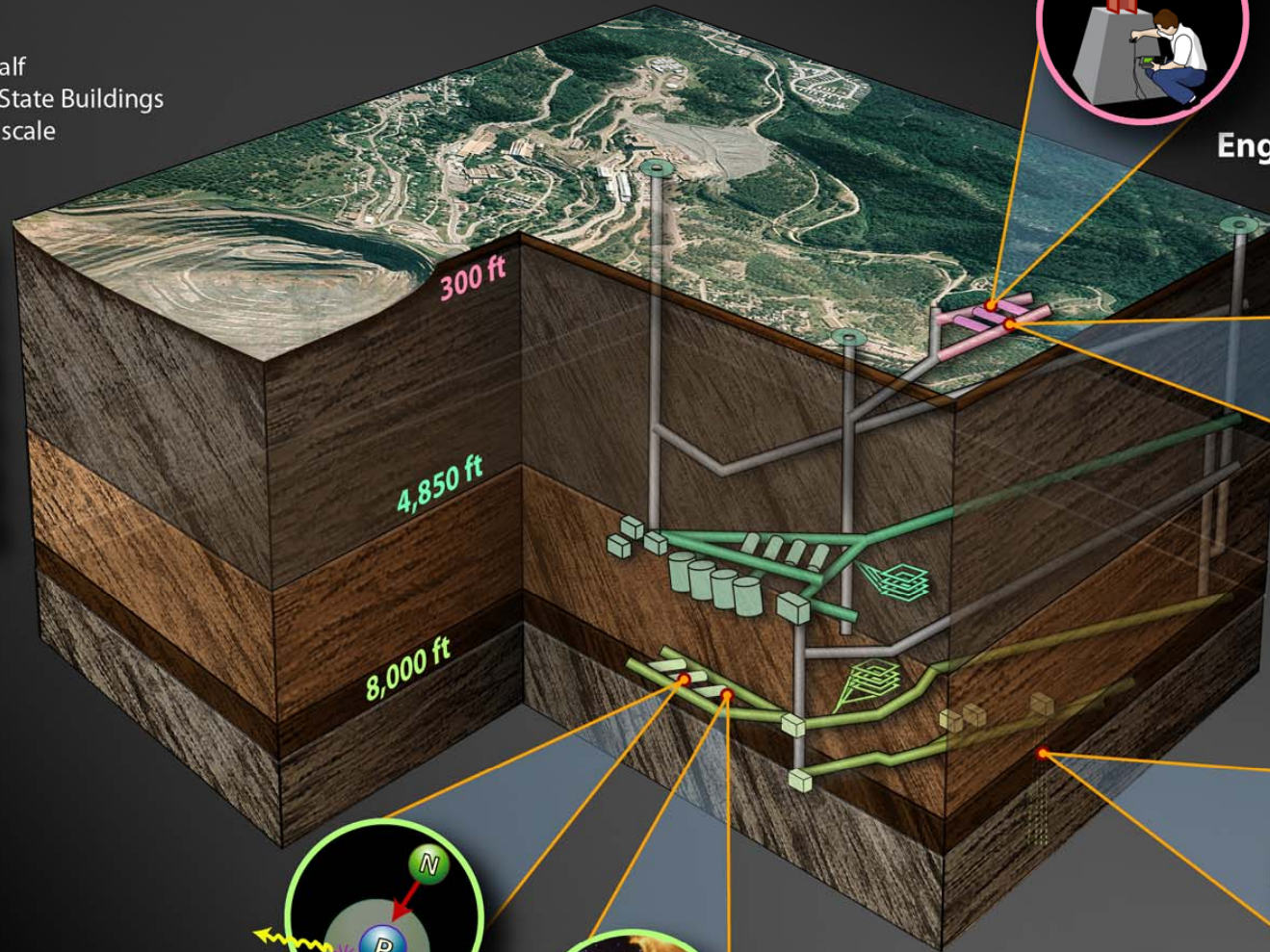
Physics

Six and a half
Empire State Buildings
for scale

Shallow
Lab

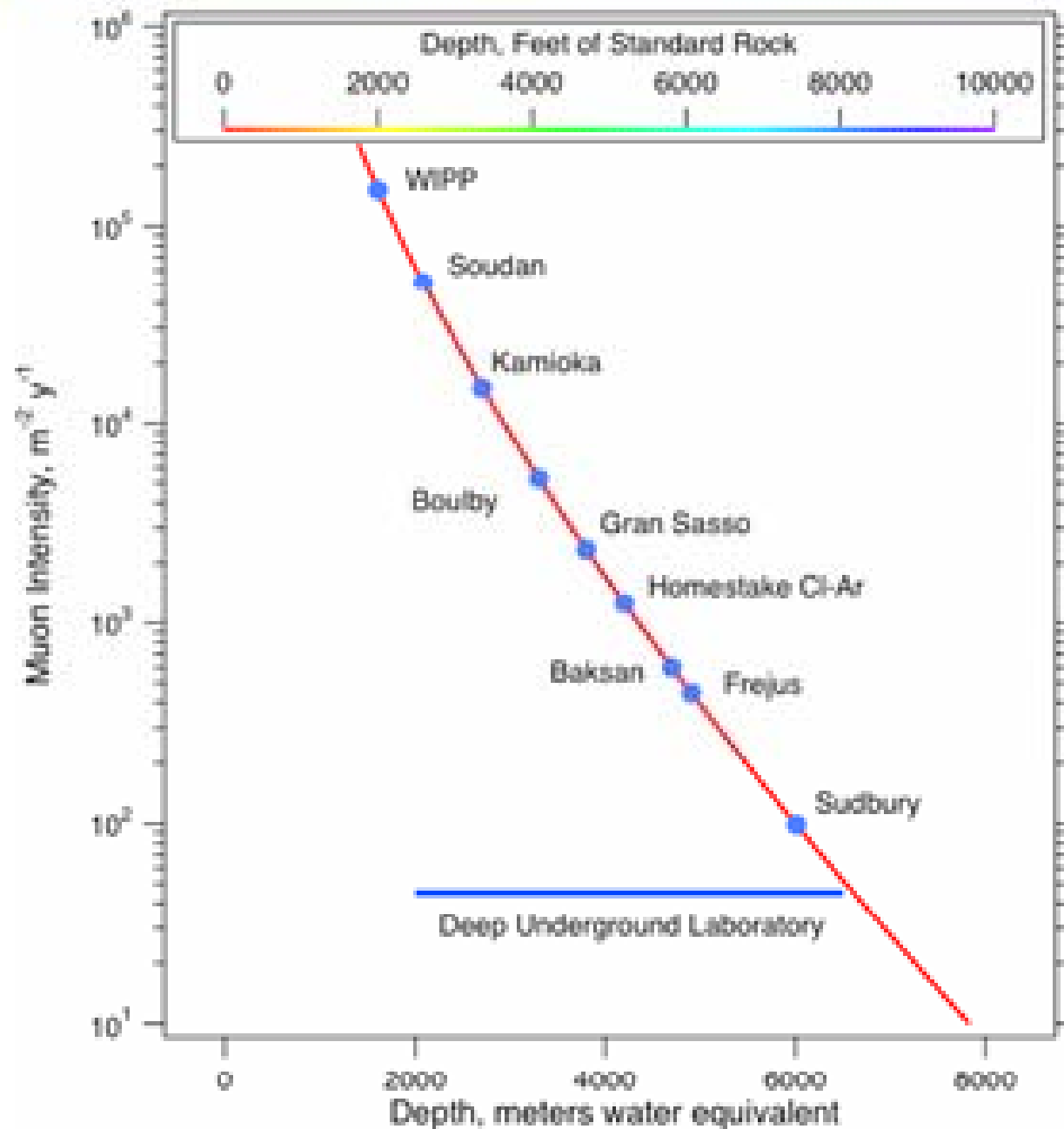
Mid-level

Deep
Campus



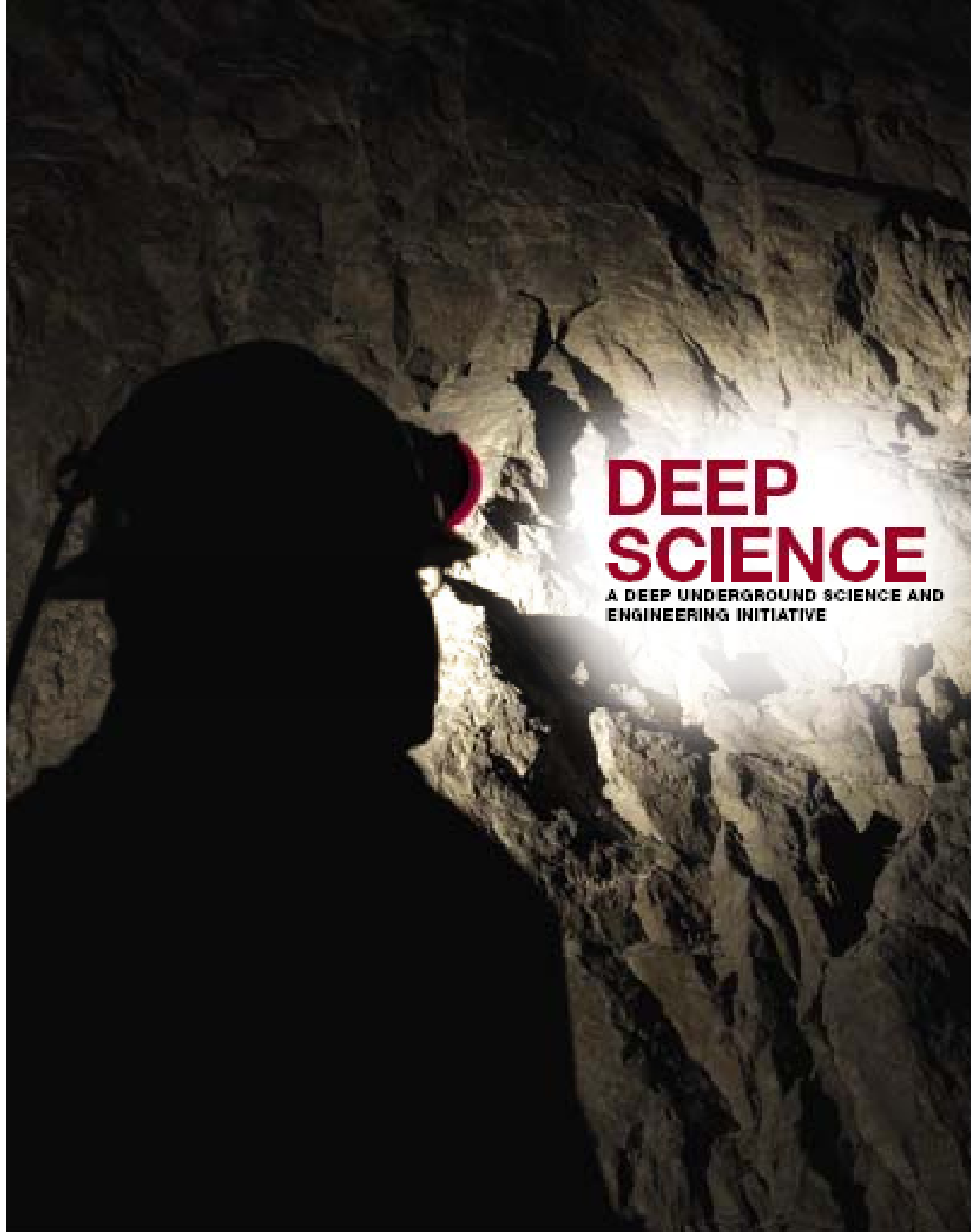


DUSEL Depth



Community Planning Activities

- **Bahcall report (2001)**
- **NSAC Long-Range Plan (2002)**
- **NESS 2002**
- **Connecting Quarks to the Cosmos (NRC, 2003)**
- **HEPAP Long-Range Plan (2003)**
- **Neutrinos and Beyond (NRC, 2003)**
- **EarthLab (2003)**
- **DOE 20-yr. Facility Plan**
- **Physics of the Universe—A Strategic Plan for Federal Research at the Intersection of Physics and Astronomy (NSTC) 2004**
- **The Neutrino Matrix (Four APS Divisions) 2004**
- **Quantum Universe—The Revolution in 21st Century Particle Physics, HEPAP, 2004**
- **A lot more activity in 2005-6: NuSAG, DarkMatterSAG, EPP2010, DEEP SCIENCE, workshops.**



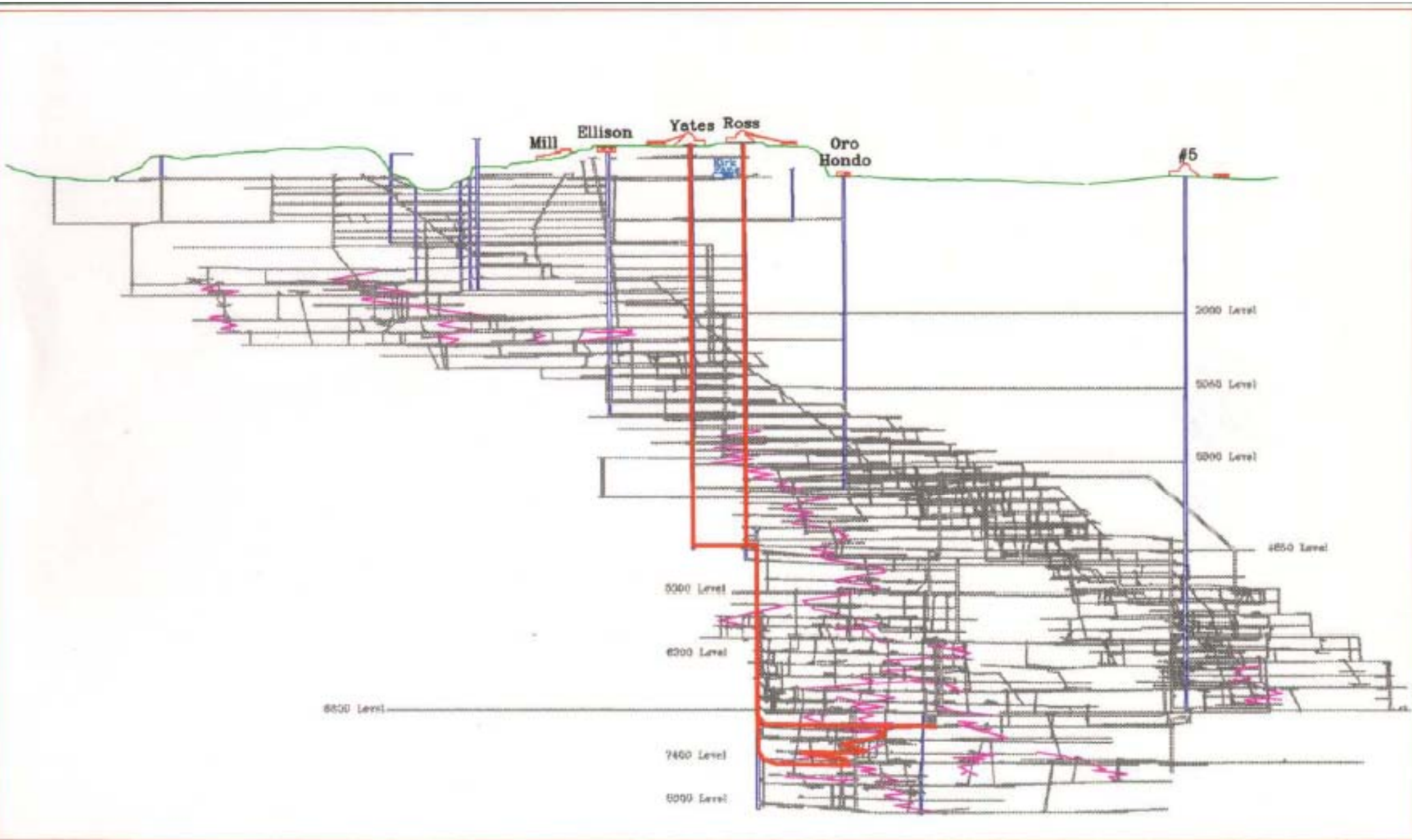
DEEP SCIENCE

A DEEP UNDERGROUND SCIENCE AND
ENGINEERING INITIATIVE

www.dusel.org

NSF/Community Process

- Town Meeting at NSF, March 2004
- Solicitation (S1): define site-independent science scope and infrastructure needs; unify the community (awarded in Dec 2004)
- Solicitation (S2): develop conceptual designs for 1 or more sites (2 awarded July 2005)
- Solicitation (S3): full technical design for an MREFC candidate (1 awarded - Homestake)
- Town Meeting at NSF, November 2007
- Solicitation (S4): technical design of initial suite



- Shafts / Vinzes —
- Main Ramps —
- NSF Tour Route —



HOMESTAKE GOLD MINE
 1000 W. 10th St.
 Lead, SD 57601
 Phone: 605/238-2222
 Fax: 605/238-2223

Homestake Mine
 Longitude View
 Looking East
 Svc. No.

