Funding Models

A Discussion

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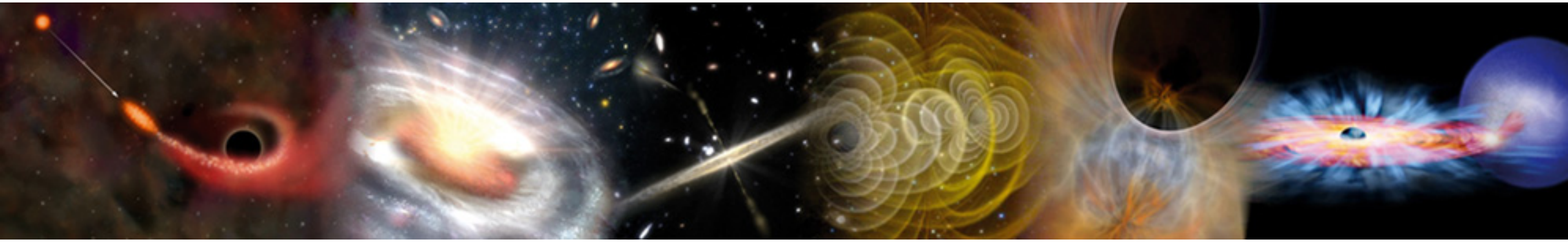
Outline

- Funding Sources
  - NSF
  - DOE
- European Models
- Proposal for Detector Development Program



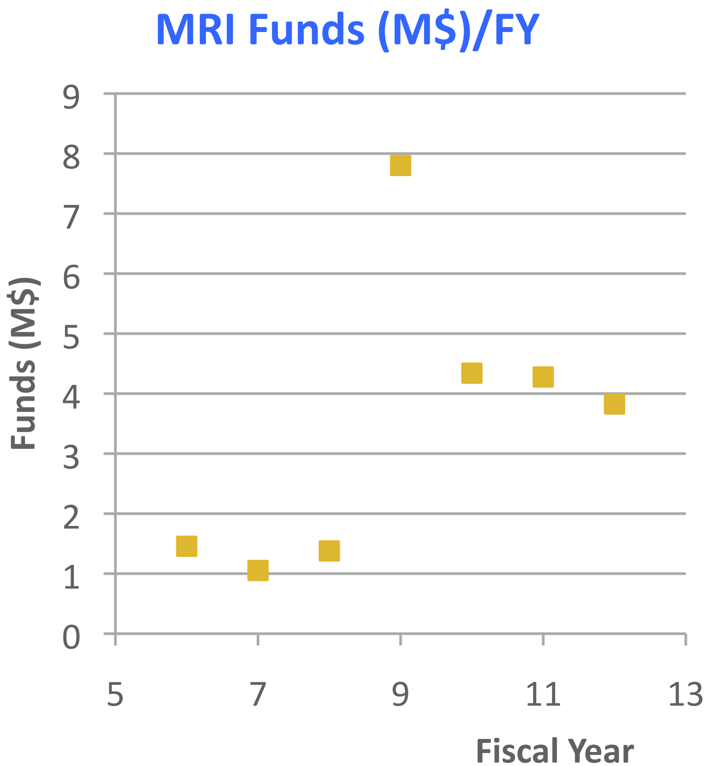
NSF Funding Opportunities

- NSF/PHY currently does not have a dedicated program in advanced instrumentation R&D
- Rather… possible support for instrumentation comes through:
  - Base Programs in Experimental Particle Physics (EPP) and Astro-Particle Physics (AP) with support from the Physics capitalization fund (APPI). Examples:
    - In EPP: ATLAS, CMS upgrades
    - In PA: CDMS, DArkSide, HAWC, XENON1T
  - NSF-wide solicitations
    - Major Research Instrumentation (MRI)
    - Integrated NSF Support Promoting Interdisciplinary Research and Education (INSPIRE)
      - Two tracks:
        Track 1: support ≤ 1.5 M and internal review;
        Track 2: support ≤ 3M; external review
    - Grant Opportunities for Academic Liaison with Industry (GOALI)

From R. Ruchti, ANL Workshop

NSF: MRI

- There are two types of MRI proposals:
  - Track 1: Instrument Acquisition
  - Track 2: Instrument Development
- There are two levels in the MRI competition:
  - Larger: $1M ≤ request ≤ $4M
  - Smaller: $100k ≤ request < $1M
- Cost sharing is required: precisely 30% of the total project cost is required for PhD granting institutions



- Examples:
  - Novel Pixel Tracking Layer for ATLAS
  - Ultrafast Tracking Electronics for the ATLAS Trigger
  - Pixel Detector for Upgrade of CMS
  - Data Depot Network for Wide Area, Data Intensive Collaboration
  - Time Projection Chamber and Photomultiplier Array for MicroBooNE
  - Development of Nuclear Targets and Calibration Systems for MINERvA

From R. Ruchti, ANL Workshop

DOE Funding Opportunities

- University Program
  - ADR Program
  - Short term support for new ideas
  - Base funding
  - Support for longer term Detector R&D
- Laboratory Program
  - Base funding
  - Support for infrastructure and Detector R&D

- In addition, both programs have access to
  - One shot funding
  - Opportunistic funding based on availability
  - Special Projects
    - ILC Detector R&D
    - Large Area Photodetectors
    - Water Base Liquid Scintillator

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To the best of my knowledge, the ADR program has been phased out

Lab base funding is the largest fraction of the total funding available (~75%)

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CDRD FOA was not perceived as a success and also phased out

Supported Activities

- The DOE Detector R&D Program funds generic research and development in the areas of sensors, detector systems and data acquisition systems
- Provides support for test beams
- Provides support for core capabilities at national laboratories
  - ASIC support
  - Noble Liquid testing infrastructure
  - Microsystems fabrication
  - …
- Provides support for up to 50% of the total wage and benefit support for a few key technical people and physicists who have a history of playing an important and continuing role in detector development

- Structure leaves very limited room for development of a strategic long-term detector development program.

EUROPEAN STRATEGIES

LHC RD Program

- An often cited successful R&D program is the series of RD projects for the LHC experiments, mainly supported and reviewed by CERN

RD	Description	Year Completed
RD1	Scintillating Fibre Calorimetry at the LHC	1992
RD10	A Study to Improve the Radiation Hardness of Gaseous Detectors for Use at Very High Luminosities	1994
RD15	The Prism Plastic Calorimeter (PPC)	1990
RD24	Application of the Scalable Coherent Interface to Data Acquisition at LHC	1995
RD32	TPC for Heavy Ion Collisions	1994
RD40	Development of Quartz Fiber Calorimetry	1995
RD44	GEANT 4: an Object-Oriented toolkit for simulation in HEP	1998
RD48	Radiation Hardening of Silicon Detectors (ROSE)	2000
RD50	Radiation Hard Semiconductors for Very High Luminosity	In progress
RD51	Development of Micro-Pattern Gas Detectors	In progress

http://greybook.cern.ch/programmes/experiments/

LHC RD Program

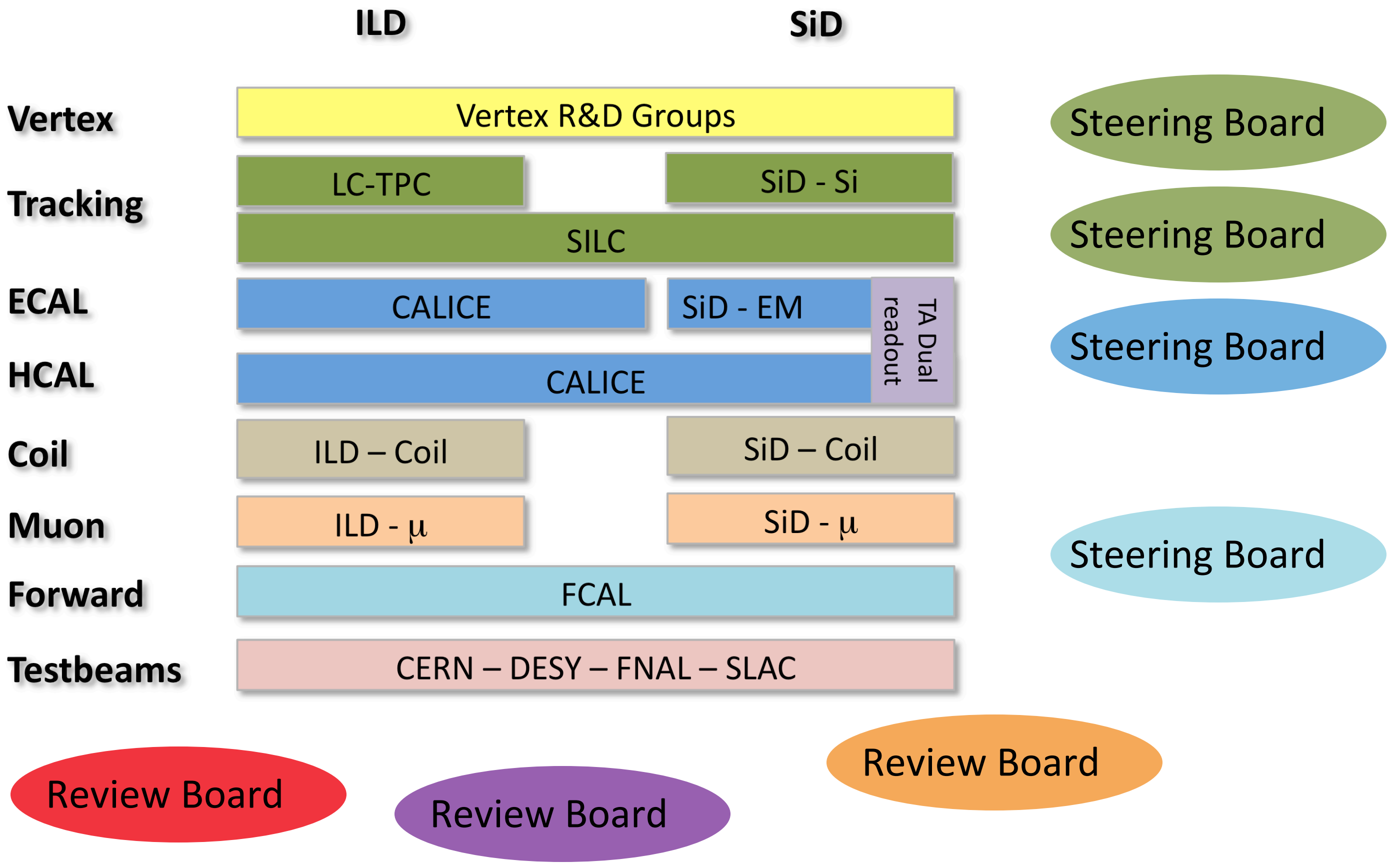
- RDnn projects targeted towards the LHC experiments to address critical R&D questions.
  - All R&D carried out within a very well-defined approved scope: LHC
  - Questions addressed were critical to enable the physics program
  - Each R&D project with clear deliverables; when completed, project terminated
  - R&D very targeted and quite horizontal in nature
- Program had well-defined main sponsor: CERN
- Review essentially controlled by CERN (LHCC)

- Impact of these RD collaborations has gone well beyond the LHC experiments and has tremendously benefited the field in general

- Few RD projects still continuing with a broader mandate
  - RD50: Silicon Hardness for Very High Luminosity LHC
  - RD51: Micro-Pattern Gas Detectors
  - RD52: Dual Readout Calorimetry

ILC R&D Program

- The matrix of detector R&D is quite convoluted
  - R&D for ILD mainly carried out within horizontal R&D collaborations
  - R&D for SiD mainly carried out by the concept



- Control held by R&D collaborations, but that is very limited

European Framework Program: EUDET

- EUDET was a Detector R&D program to develop research infrastructure for detector R&D in Europe for the International Linear Collider.
- Supported by the European Union in the 6th Framework Program
- Funding: €21.5M, of which €7M from EU
- Participation: 31 partner institutes from 12 countries
- Funding period: 2006-20010
- Very successful in building infrastructure for detector development

Activities
Management of Infrastructure Initiative
Detector R&D Network
Access to DESY Test Beam Facility
Access to R&D Infrastructure
Test Beam Infrastructure
Infrastructure for Tracking Detectors
Infrastructure for Calorimeters

- The EUDET project was officially closed on 31st December 2010 followed by AIDA

EUDET Detector R&D towards the International Linear Collider

European Framework Program: AIDA

- Advanced Infrastructures for Detectors at Accelerators (AIDA)
- Supported by the European Union in the 7th Framework Program
- Targets infrastructures required for detector development for future particle physics experiments: SLHC, Linear Colliders, neutrino facilities, B-factories in line with European strategy
- Project coordination: CERN
- Funding: €26M, of which €8M from EU
- Participation: 80 partner institutes from 23 countries
- Funding period: 2011-2014

- Broad base of infrastructures covered:
  - Test beams, irradiation facilities, common software tools, common microelectronics tools and engineering coordination offices.
  - AIDA will work closely with industry to develop new technology to lead to new applications for society.

AIDA

Advanced European Infrastructures for Detectors at Accelerators

AIDA Structure

- Work Package structure for AIDA

WP1: Project management and communication
Scientific coordinator Laurent Serin, LAL-CNRS, Deputies : T. Benhe (DESY) & P. Soler (STFC)
Svet Stavrev, CERN administrative coordinator

Networking

WP2: Common software tools (Frank Gaede, DESY, Pere Mato, CERN)

WP3: Microelectronics and interconnection technology (Hans-Gunter Moser, MPG, Valerio Re, UNIBG)

WP4: Relation with industry (Jean-Marie Le Goff, CERN)

Transnational access

WP5: Transnational access DESY (Ingrid Gregor, DESY)

WP6: Transnational access CERN (Horst Breuker, CERN)

WP7: Transnational access European irradiation facilities (Marko Mikuz, JSI)

Joint research

WP8: Improvement and equipment of irradiation and test beamlines (Michael Moll, CERN)

WP9: Advanced infrastructure for detector R&D (Marcel Vos, IFIC Valencia, Vincent Boudry, LLR-CNRS)

AIDA
Advanced European Infrastructures for Detectors at Accelerators

Elements To Be Supported Under Detector R&D

- University base funding for key instrumentation capabilities
- Laboratory base funding for staff with key skills and for key facilities
- Test beams
- Instrumentation development

Supported Element	Typical Funding Source(s)	Review mechanism		
University key personnel	Det R&D Core	University Comparative Review ?		Could a more integrated approach between universities and labs lead to a more efficient program?
University infrastructure	Det R&D Core	University Comparative Review ?		
Laboratory key personnel	Det R&D Core	Lab Comparative Review		
Laboratory infrastructure	Det R&D Core	Lab Comparative Review		
Test beams	Det R&D Core	Driven by need		

Current Types of Detector R&D

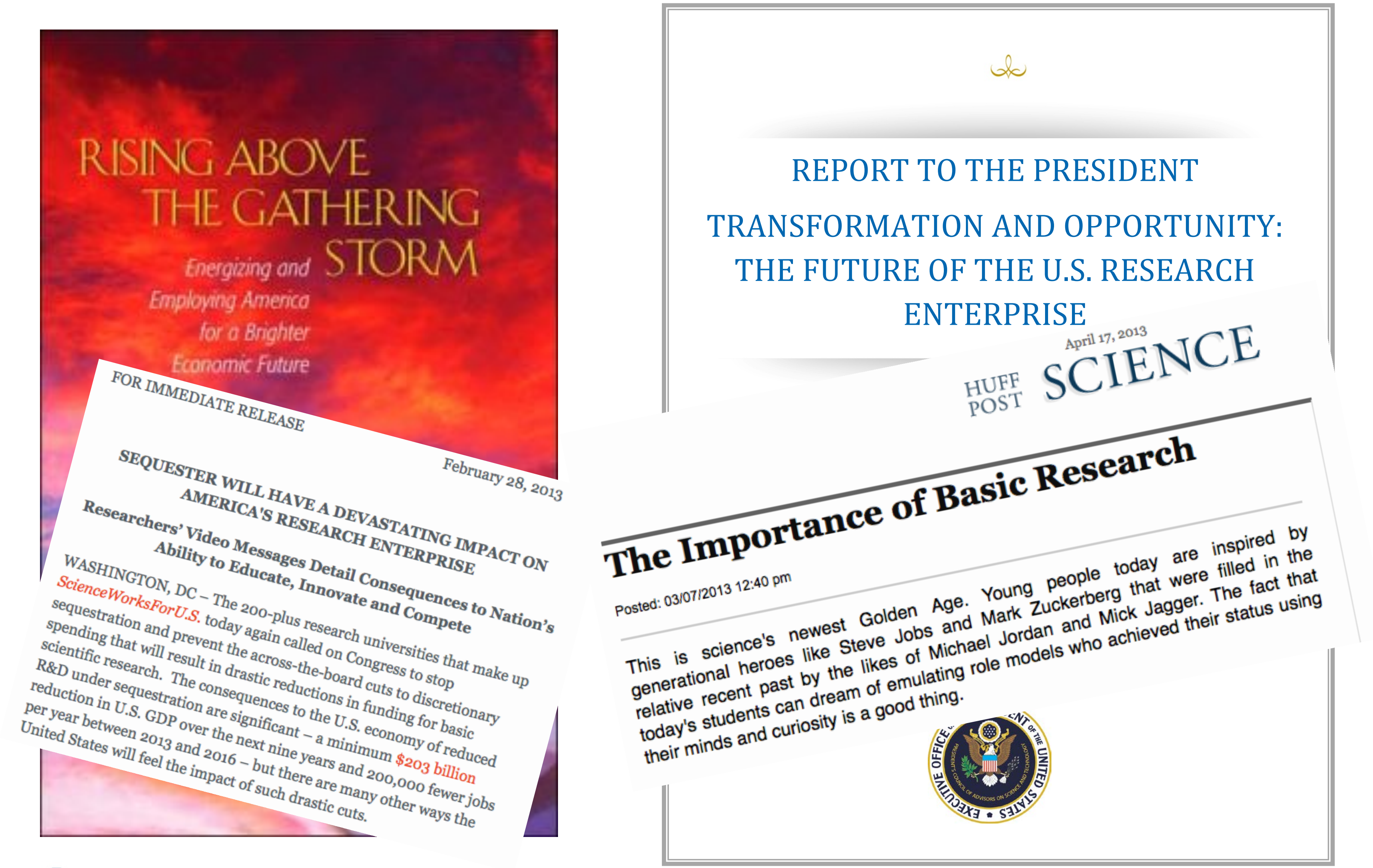
- Program Directed R&D (pre-CD0)
  - R&D motivated by well-defined physics projects that are close to receiving CD0
  - R&D often on relatively short-time scale and incremental improvement
  - Examples: LHC Phase II upgrades, DECAM CCD R&D, ...
- Generic detector R&D
  - R&D motivated by proposed physics projects that are relatively far away from receiving CD0
  - Timescales for R&D varies from short to long
  - Examples: vertex detector technologies, dual readout, MKIDs (ILC, ORKA, CLIC, Muon Collider, post-LSST)
- Mid-term focused detector R&D
  - R&D targeting specific challenges for new projects
  - Example: LAPPD

- Program Directed R&D post-CD0 falls under project funding and project oversight

Current Types of Detector R&D

Type of R&D	Typical Funding Source(s)	Review mechanism		
Project-specific, pre-CD0	Program Directed R&D	Program Review		
“Generic” near-term “Generic” long-term	Det R&D Core	KA25 program review		
Directed R&D	Directed R&D	Ad-hoc		

The Importance of Basic Research



PCAST Report

(Action #3.1) Each agency should have a strategic plan that explicitly addresses the different kinds of research activities that can contribute to its mission, specifically addressing the axes of evolutionary vs. revolutionary research, disciplinary vs. interdisciplinary work, and project-based vs. people-based awards. The elements of such plans should be explicitly supported by different kinds of merit review mechanisms (Action #3.2).

- **On one hand it is said that basic research is absolutely critical for the health of the field and the nation and, on the other hand, when relating to our own field, the investment in the basic research and development of instrumentation which is at the heart of what we do, is under pressure.**

PCAST Report

- This report shows how a loss of global competitiveness can be avoided by ... positioning the Nation's great research universities and the National Laboratories as central engines of innovation

- When no single business can capture all the economic benefits that come from a new product, technology, or way of doing business, corporations with obligations to shareholders will tend to underinvest in innovation. When international competition is fierce, private firms will be more interested in R&D investments that give them an immediate competitive advantage and there-fore will choose to invest preferentially in low-risk endeavors—those closer to the development and implementation end of the spectrum.

- **Message from DOE: "We have to out-innovate the competition"**

A Model

- Propose to allocate 5% of the DOE-HEP budget to the core Detector R&D program:
  - University base funding for key instrumentation capabilities
  - Laboratory base funding for staff with key skills and for key facilities
  - Test beams
  - Instrumentation development = detector R&D program
- Detector R&D program with three components:
  1. Targeted R&D, à la CERN RD program, to address the main challenges of the priority research directions;
     - Well articulated R&D proposal
     - R&D has to be in the framework of current program
     - Deliverable is working detectors within a timeframe of 3(-5) years
  2. Directed R&D to address a key technological challenge
     - R&D carried out in support of the HEP mission; can lead to new project proposal
     - Deliverable is demonstration within 3 years, prototype within 5 years
  3. Generic development
     - Good ideas

A Model: Homework

- Targeted RD:

  It would be useful if the conveners could identify what they consider key R&D topics for each frontier and each technology sector. These should go into the summary white papers (can be with value judgment)

- Especially those key R&D areas where the US would (re-) establish a leadership position should be highlighted.

- The overview of these topics should be used to identify common threads and these should be incorporated in the overall summary and perhaps the executive summary.

A Model

- In addition, propose to allocate ~1% of the DOE-HEP budget to the exploration of potential transformative instrumentation or techniques using emerging technologies in collaboration with other science disciplines (and industry): Grand Challenges
  - Program will be on a competitive basis; Proposal submitted to review committee
  - Two (at most three) grants awarded for a 5 year period; reviewed annually
  - Proposals should be high risk – high reward
  - Preference given to multi-disciplinary proposals
  - Demonstration of proof-of-principle in 5 years

- Expect coordination and solicitation of proposals to proceed through CPAD and to be reviewed by an external committee.

Investing in Innovation

- We have to resist the desire to minimize our investment in the development of new technologies, which lie at the heart of our program.

- The investment in Detector R&D has to increase to ensure the long-term future of the field.

- The Detector R&D program lends itself to a very targeted restructuring

- There is currently no mechanism and no incentive for the field to start a multi-disciplinary approach to the development of new technologies. It should.

Strawman Model For Detector R&D

Type of R&D	Project-specific	Near-term, "incremental"	Mid-term, "demonstration"	Long-term, "generic"
Typical Funding Source(s)	Project funds (post-CD0) Program Directed R&D (pre-CD0)	Facility Ops	Directed R&D	Det R&D Core Special FOAs
Review mechanism	Lehman/CD Program review	Ops Review	Ad-hoc	Comparative Review
Recent Examples	LHC Detector upgrades DM G2 R&D ILCRD	BaBar IFR upgrade	LAPPD	ADR CDRD

From Glen Crawford, ANL Meeting

AIDA Governing Structure