The LAPPD Program

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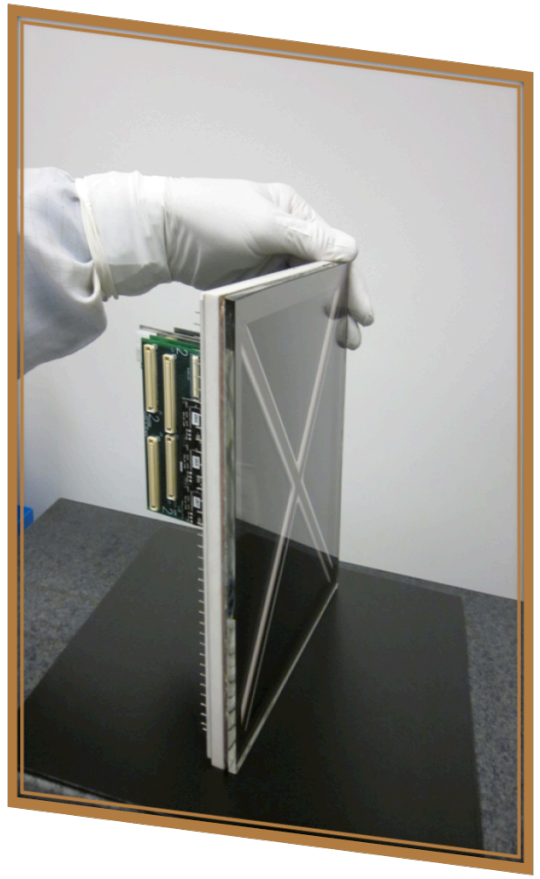
LAPPD Review
Argonne, December 18-19, 2012

LAPPD Beginnings

- First discussions on fast timing started around 2003; exploratory phase through UC and LDRD funding
- LAPPD collaboration started in 2009: from a bold idea to ...



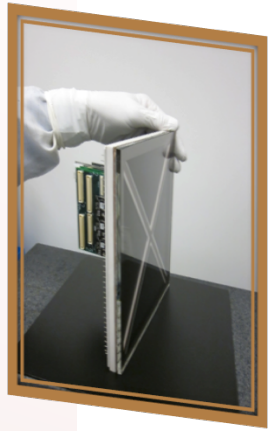
The Previous Three Years

LAPPD program was a new instrumentation initiative, not an ongoing program; no pre-existing group, started with transient seed funding

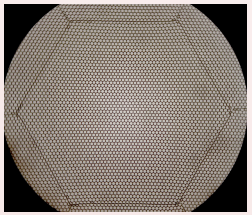
R&D 100 Award

SBIR/STTR ($3M)

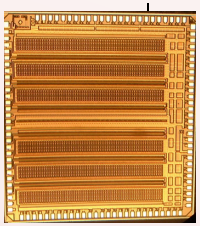
ALD Technology Licensed



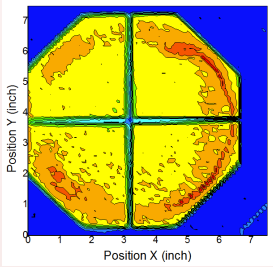
Met all sub-component milestones for constructing full device



MCP Technology select



PSEC4, fastest sampling chip, 17 GHz



7” Photocathode

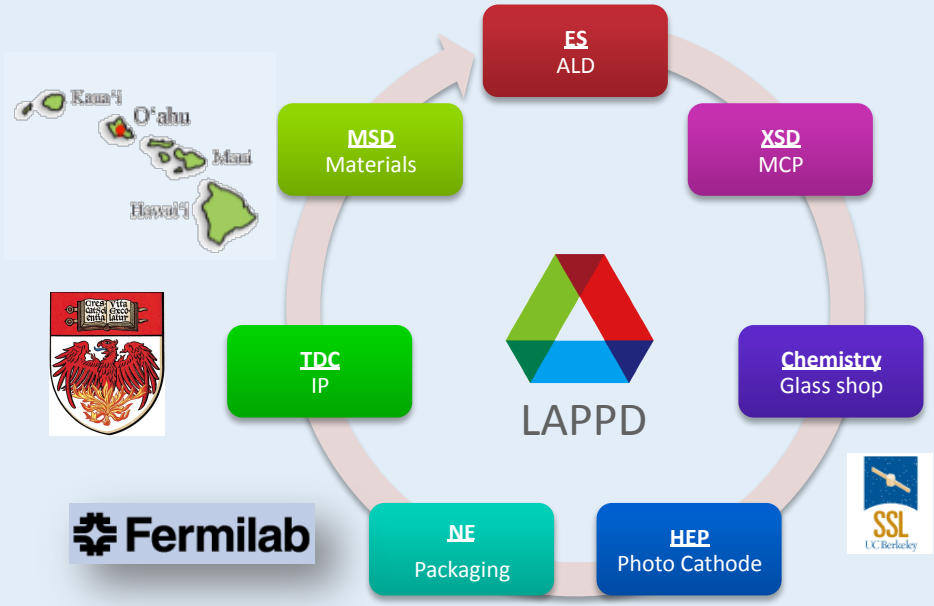
t=0 t=1yr t=2yr t=3yr

time

Partnerships in LAPPD

2012 R&D 100 The Oscars of Innovation 50th ANNIVERSARY

Primary Developer	2012 R&D 100 Winning Technology	Co-developers / Contributers
Argonne National Laboratory	Large Area Micro-channel Plates	Incom, Inc.; Berkeley Space Sciences Lab



2012 R&D 100 Award made possible through tight collaboration between University of Chicago, 7 divisions at Argonne, National Labs, Universities and Industry

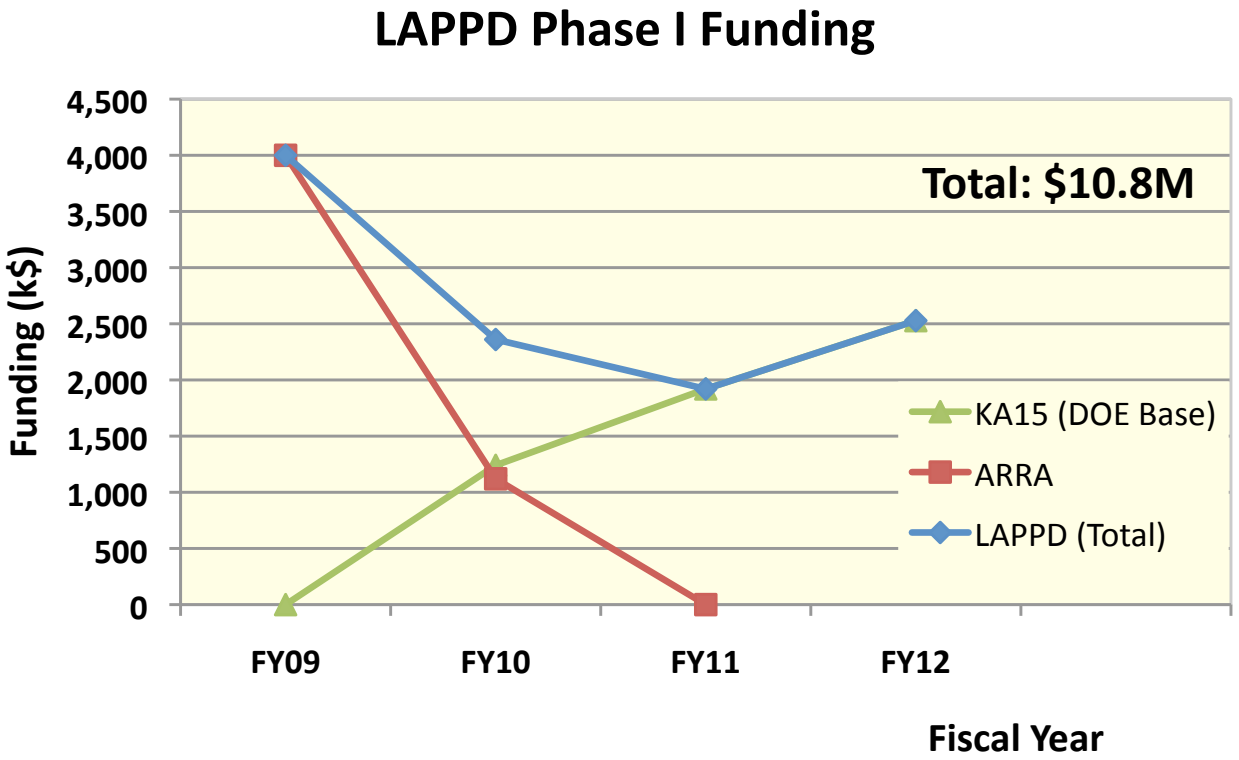
Enabled by DOE-HEP

Three patents;
One license for ALD process

http://www.rdmag.com/Awards/RD-100-Awards/2012/06/R-D-100-2012-Winners-Overview/

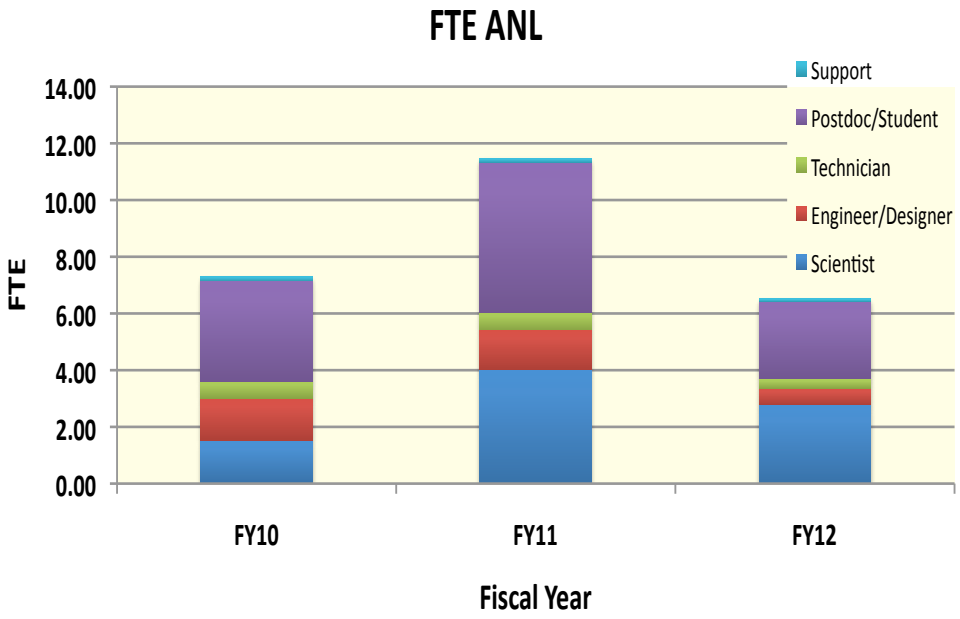
Budget Phase-I

- Project started with ARRA funding; last ARRA funding received in FY10



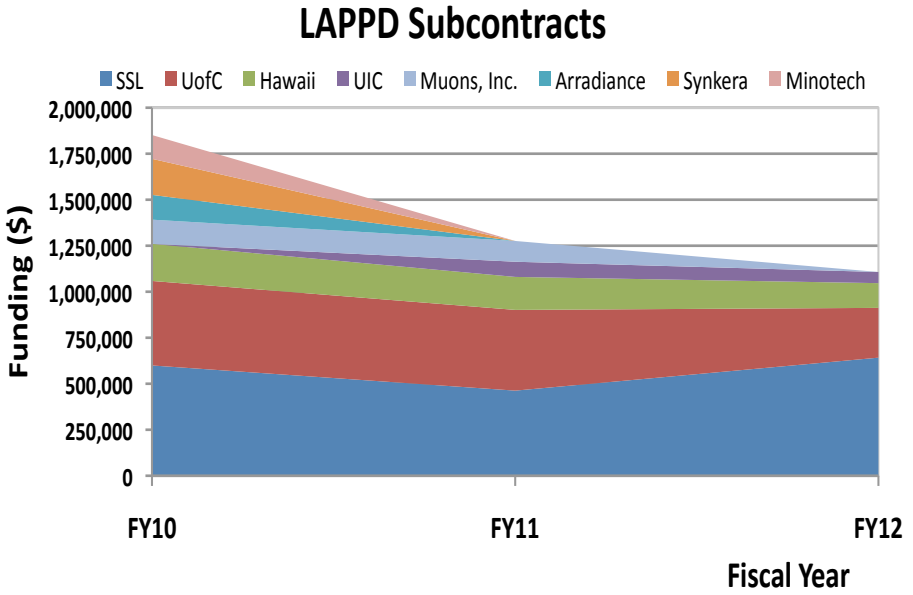
- Note: KA15 funding ($5.7M) came from DOE base funding, not organizational (ANL) base funding

Resources Phase-I

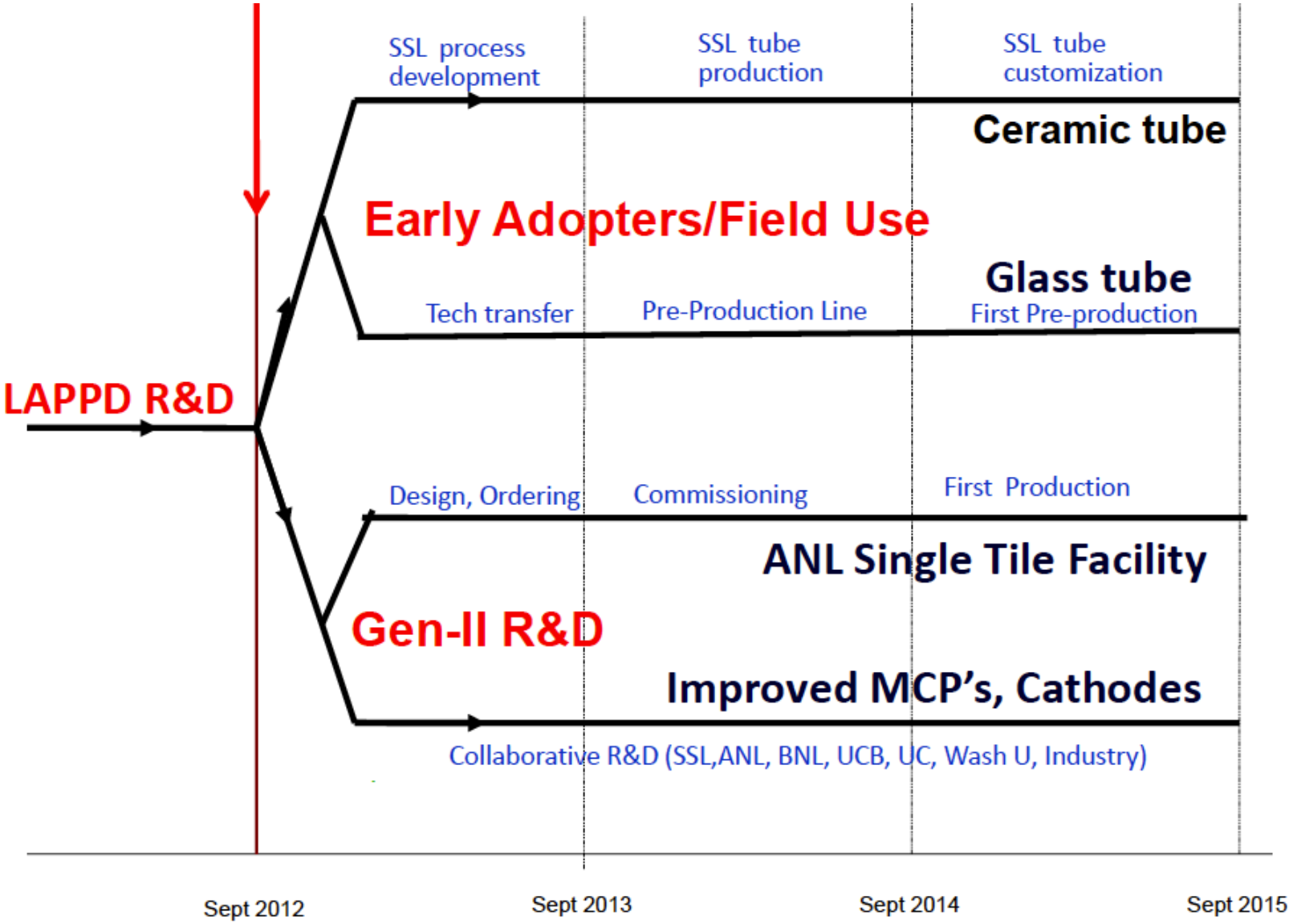


- Exploratory work carried mainly by post-docs and scientists from many different divisions: Materials Science, Energy Systems, Advanced Photon Source, Nuclear Engineering, Chemistry, …

- Because of the front-loaded budget, broad-based exploration at start
- For critical-path components, two parallel efforts so as not to have a single-point failure
- Initial projects phased-out quickly when promise was not apparent



LAPPD Future Path



Mission

- LAPPD Program has a dual mission:

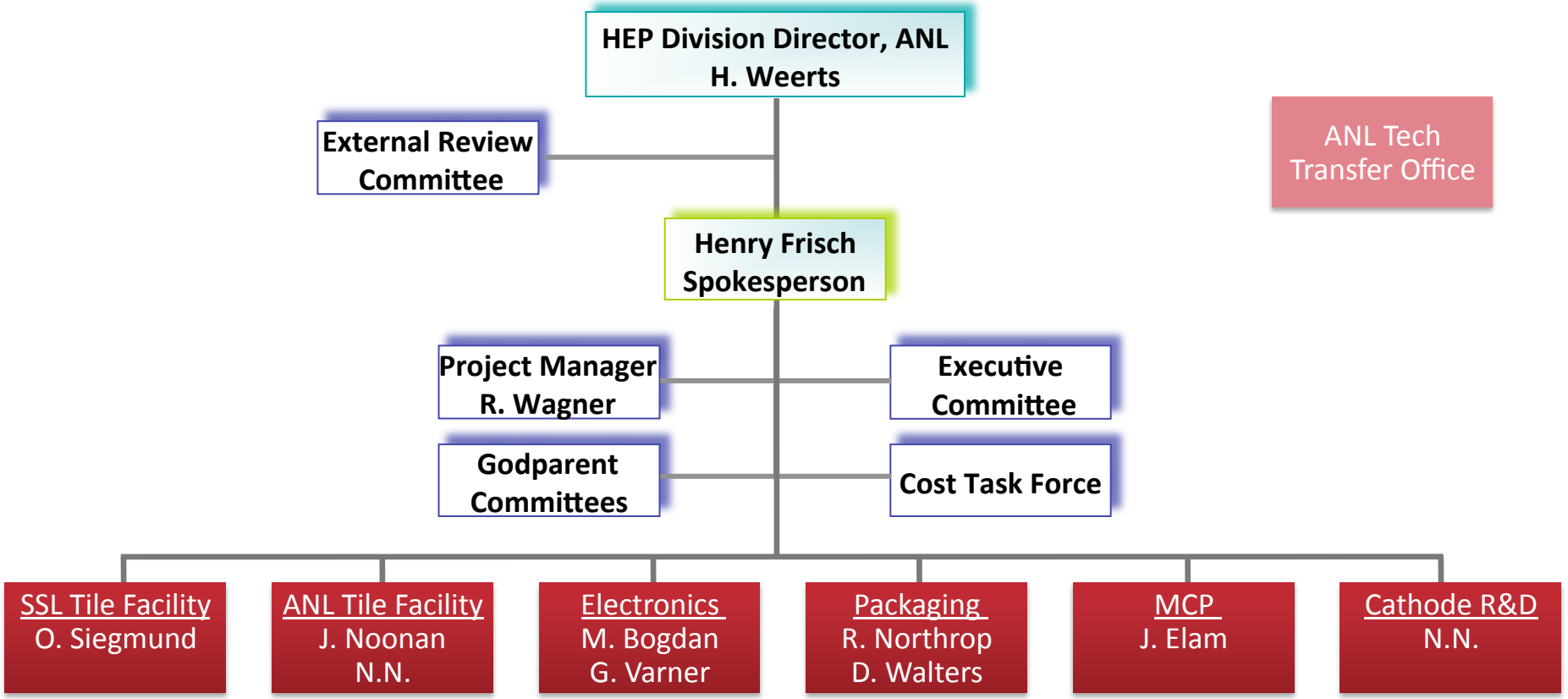
  A) Produce 20x20cm^2 photo-detectors and scalable integrated systems with enhanced capability for early adopters and transfer production process to US industry

  B) Enable and carry out R&D to further improve the performance of MCP based detectors and reduce their cost

- Two Thrusts support each mission

  1. **Production of sealed tubes (glass and ceramic) at SSL**
     - Early production of sealed tubes for field testing
     - Unique capability for specialized tubes
     - R&D informs single tile production facility
  2. **ANL Single Tile Production facility**
     - Process to be industrialized
     - Establish in-house capability
     - Enable rapid R&D and in-depth studies

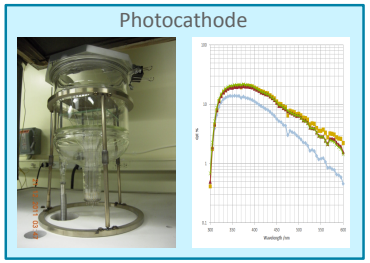
Organization

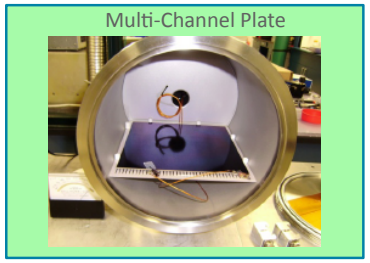


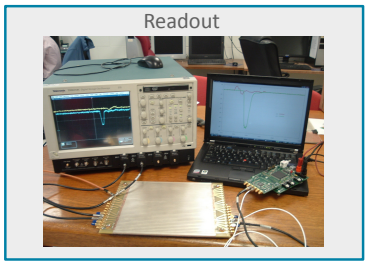
- The ANL photocathode effort lost its lead scientist to BNL
- Experienced sealed tube engineer needed on base support; job description written, ready to post

Schedule

- It is difficult to schedule R&D, but a resource loaded schedule for Phase II has been developed
- Schedule broken down in six tasks
  - MCP Uniformity, Stability, Lifetime and production
  - Readout Electronics
  - Photocathode Development
  - Detector Seal Improvement
  - 8” Glass Tile System
  - SSL-Berkeley Tile System

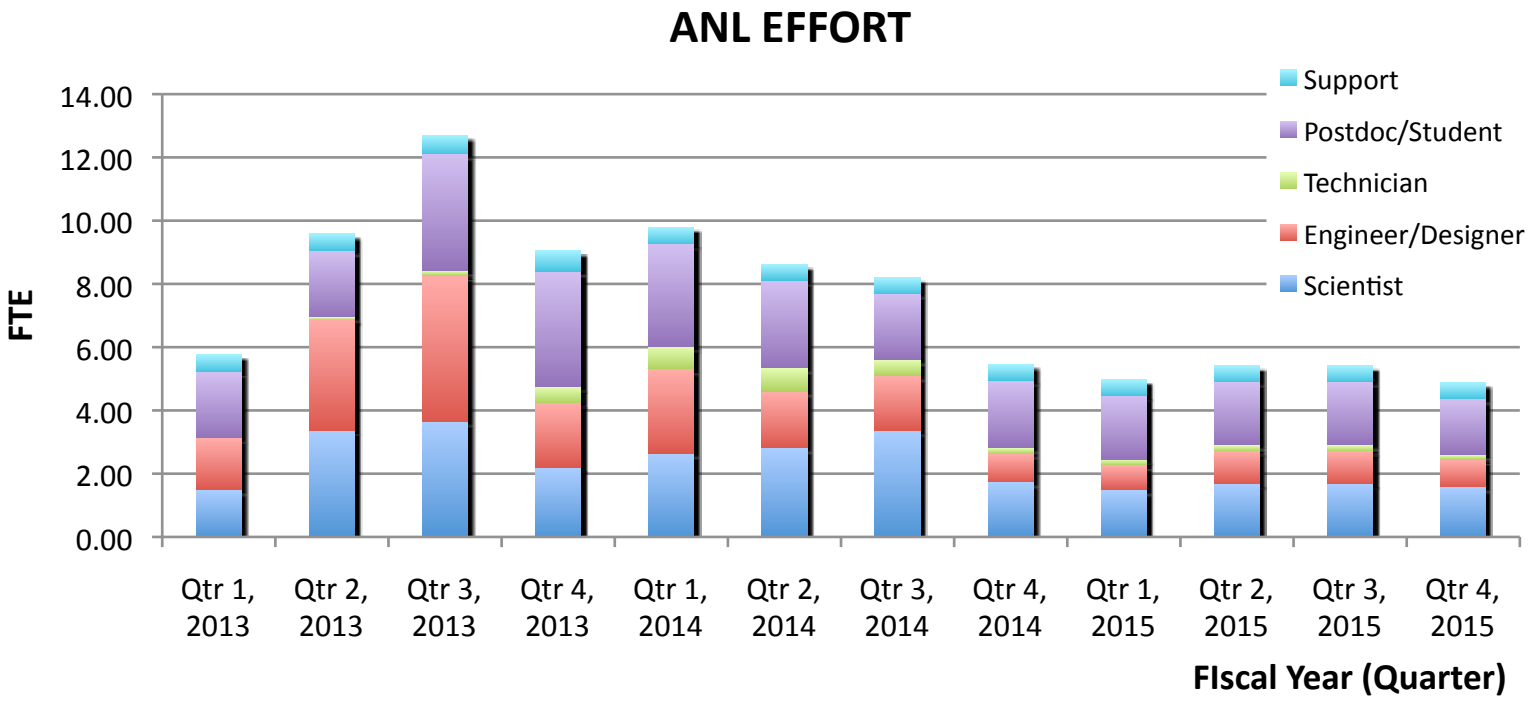






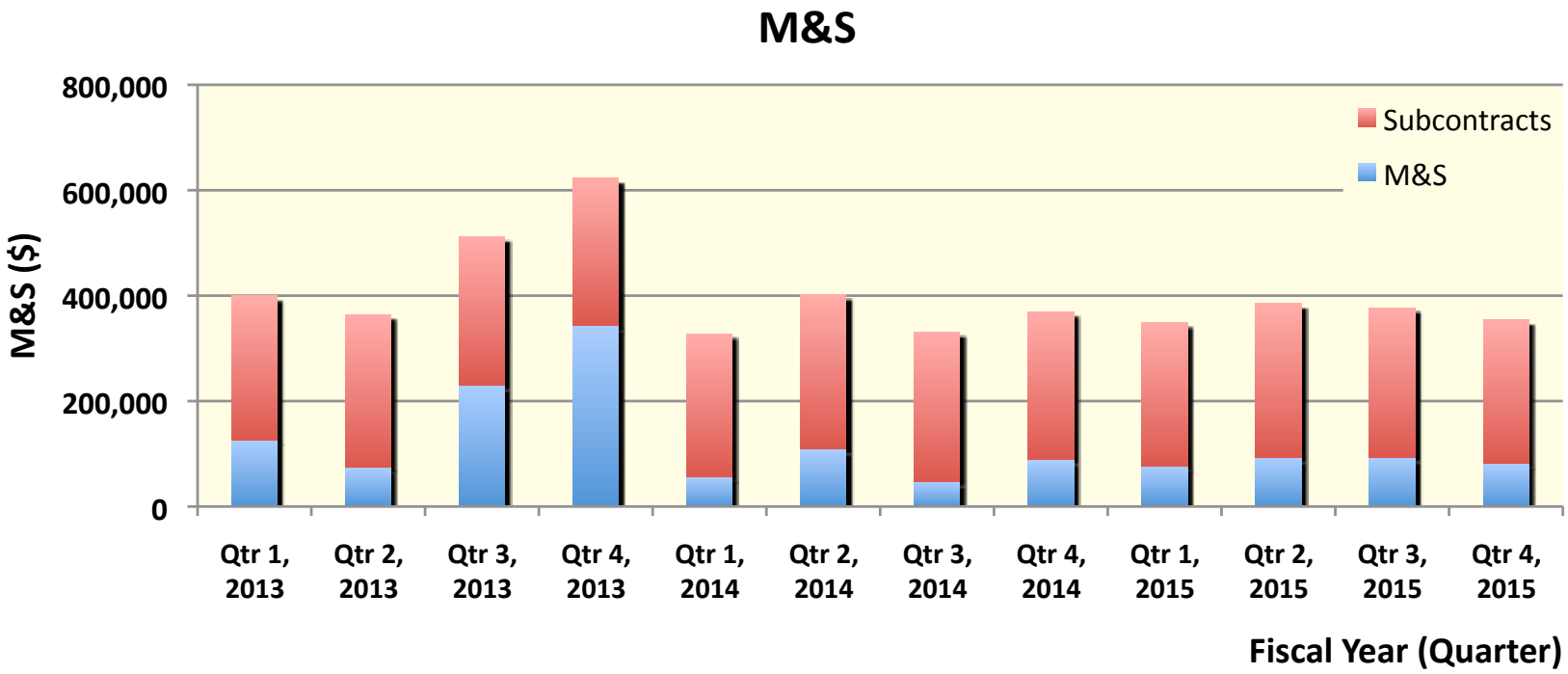
- Note: in our estimates it has been assumed that our request to approximately double the base support for KA25 has been granted.
- This will provide flexibility and enable the hire of an experienced sealed tube engineer and make it part of our base program

Resources



- Key resources:
  - One post-doc for the further MCP development; two post-docs for tile production
  - Substantial engineering up front; resources available
  - Effort at collaborating institutions included as subcontracts

M&S



- M&S profile has two components: equipment for single tile facility and materials for production of tiles
- Subcontracts to SSL Berkeley($50k/month), University of Chicago ($23k/month) and University of Hawaii ($10k/month)

Total Project Cost

($)	FY 13	FY 14	FY 15	Total
FTE	$2,210,796	$1,884,567	$1,166,424	$5,261,786
M&S	$773,414	$302,509	$344,939	$1,420,863
Subcontracts	$1,126,070	$1,127,200	$1,119,700	$3,372,970
Total	**$4,110,280**	**$3,314,276**	**$2,631,063**	**$10,055,619**

- Budget is a 'bottoms-up' estimate, based on experience of last 3 years
- No contingency included

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Total	**$4,110,280**	**$3,314,276**	**$2,631,063**	**$10,055,619**
With increase in KA25 base	($500,000)	($500,000)	($500,000)	($1,500,000)
With Successful SBIR/STTR	--	($600,000)	($600,000)	($1,200,000)
Total	**($500,000)**	**($1,100,000)**	**($1,100,000)**	**($2,700,000)**
TOTAL	**$3,610,000**	**$2,210,000**	**$1,530,000**	**$7,310,000**

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Milestones

- Program milestones as reported in Henry's talk.
  - Year 1: 1 Ceramic and 1 Glass Tile (SSL); Procurement of 8" Tile Facility (ANL)
    Assembly and test of one integrated system at SSL and ANL each
  - Year 2: 2 Ceramic and 1 Glass Tile (SSL); 1 Tile with ANL Tile Facility
    Assembly and test of multiple integrated systems at SSL and ANL each
  - Year 3: Producing tiles and delivery of systems to interested parties

- Milestones specific to Single Tile Production Facility schedule:
  - t_0 + 4 months: Reviewed design of vacuum transfer
  - t_0 + 5 months: Reviewed design of Tile sealing system
  - t_0 + 6 months: Reviewed design of Photocathode system
  - t_0 + 6 months: Reviewed design of MCP bake and scrub system
  - t_0 + 6 months: First small form factor tile
  - t_0 + 11 months: Produced 10 small form factor tiles
  - t_0 + 18 months: Successful 8" Tile production with ANL production facility

- t_0 means: contingent upon start of senior sealed vacuum tube engineer
- For schedule t_0 = January 1, 2013 has been assumed

Review Process

Internal Reviews

- LAPPD program monitors itself through internal 'Godparent' committees
- Committee members are internal and external scientists: Materials Scientists, Industry, Basic Energy Sciences

External Reviews

- DOE program reviews
- Dedicated Reviews such as this one

Cost Task Force

- Recently added cost task force to evaluate production cost of photodetectors
- Members from industry

ANL Technology Transfer Office

- Experienced staff to aid in the technology transfer

Internal Reviews to date

Electronics and Integration	Feb-10 Oct-10 Apr-11 Jul-12
Photocathodes	Feb-10 Oct-10 Apr-11 Jul-12
MicroChannel Plates	Mar-10 Oct-10 Apr-12
Hermetic Packaging	Feb-10 Oct-10 Jun-11

http://psec.uchicago.edu/godparents.php

Dedicated Tile Facility Review, March 2012

Reviews

Photocathode Godparent Committee

Kathy Harkay (ANL/APS), Jeffrey Elam (ANL/ES), John Noonan (ANL/APS), Anton Tremsin (SSL), Gary Varner (Hawaii), Matt Wetstein (ANL/UC)

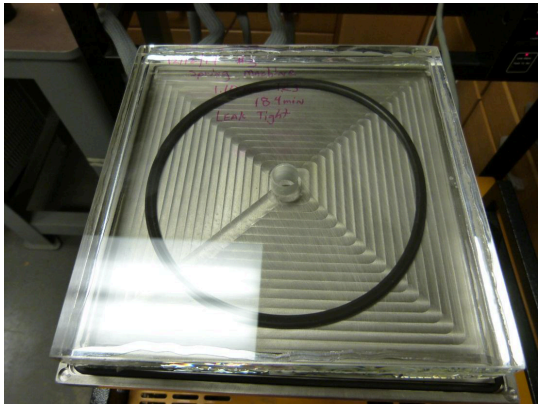
- The review committee notes that there was a clear lack of vision from the LAPPD project management on how resources should be allocated going forward. At this stage the committee notes that it makes little sense to discuss PC development plans in the abstract ....

Single Tile Facility Review Team

Karen Byrum, Chair (ANL), Paul Hink (Photonis), Dan Leopold (Wash. U.), Jason McPhate (SSL), Scott Moulzolf (U. of Maine), John Smedley (BNL)

- The review committee concluded there were no showstoppers in the design, but identified possible risks in the design, in the plans and in the ability for the facility to be adapted. These possible risks are outlined in the report along with the committee's recommended mitigations.
- **Risk**: *The expected base pressure is 10^{-9} Torr, which is one to two orders of magnitude higher than can be achieved with an all metal sealed UHV chamber that is baked at high temperatures ...*

Critical Path and Risks



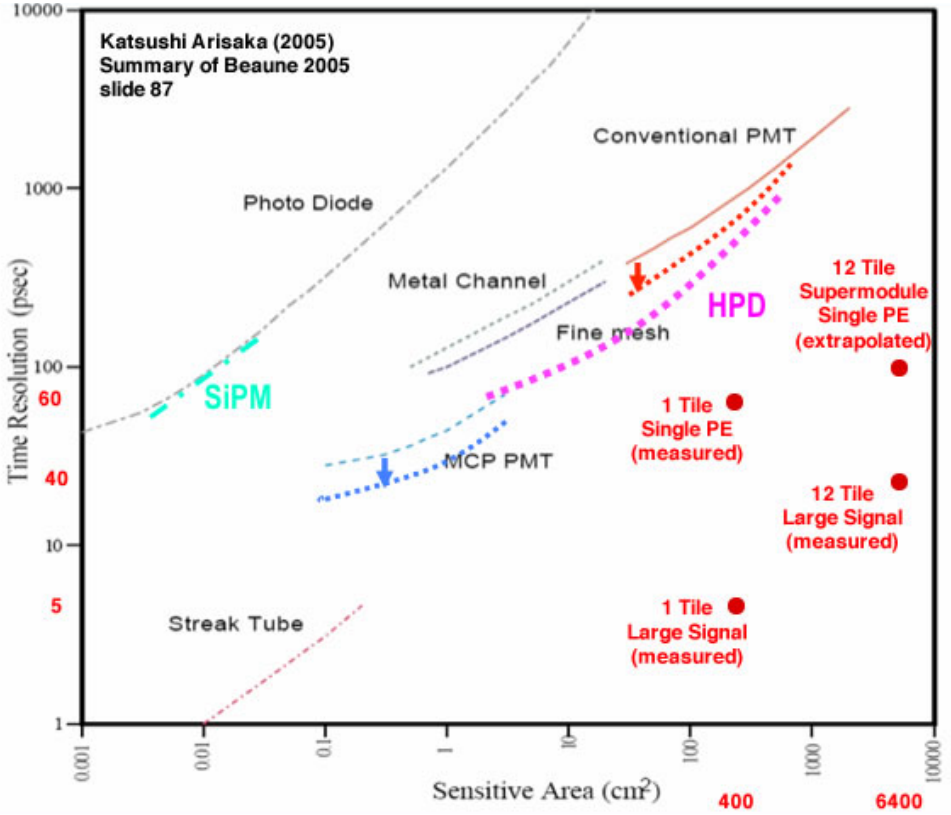
- Most of the risks have been mitigated by demonstration and validation of each critical step in the process separately: vacuum transfer, seal, readout, MCP scrub, 8” photocathode
- The critical path and the main technical risk is the photocathode: preserve the photocathode performance for sealed device with proper lifetime
- **To be successful in the next step of the program – and the schedule assumes – hiring of a senior scientist with experience in sealed photodetector fabrication is crucial**
- In order to press the technological advantages it is important that the program keeps its momentum.
- Candidates have been identified for an experienced sealed tube engineer. As soon as we get the commitment from DOE, we will be able to proceed with this process.

Moving Barriers

- Over the last three years, with very focused effort, with significant DOE investment, moved performance barriers by at least an order of magnitude
  - Timing resolution improved by factor of 10 for same area
  - Area coverage improved by factor of 100 for same timing resolution

- Performance has been measured
- No technical showstoppers have been identified
- Many more successes are anticipated

- One of the keys to this success has been to bring advances in other science disciplines to an established technology and 're-invent' it.

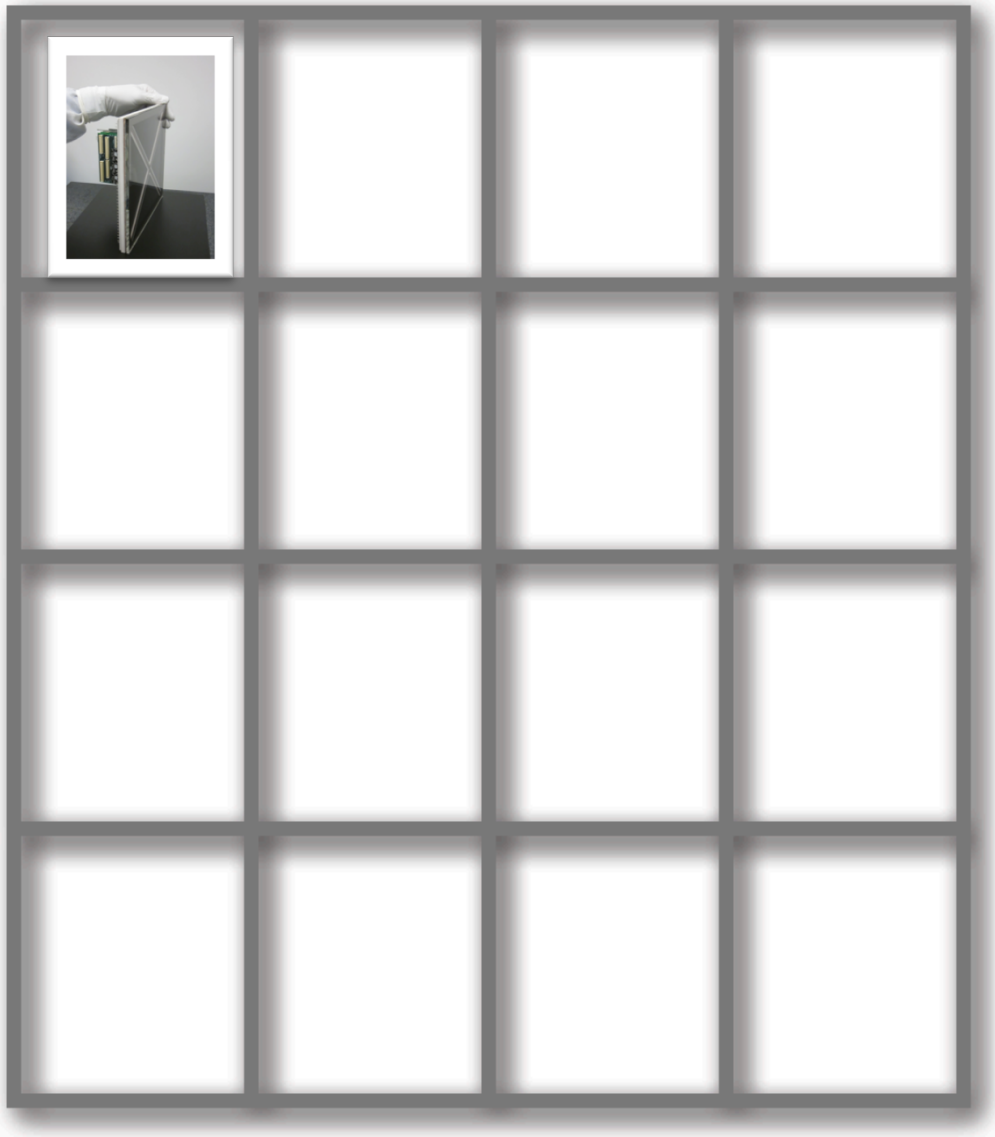


Return On Investment

- DOE-HEP has enabled the achievements to date
- Support led to the development of detector techniques that have led to a capabilities in a completely new domain: gains of orders of magnitude
- Creates the possibility for the US to again take a leadership position in the development of cutting edge technology
- The potential of this new technology is only at the beginning of being explored with implications not only for HEP, but for basic sciences in general and society as a whole

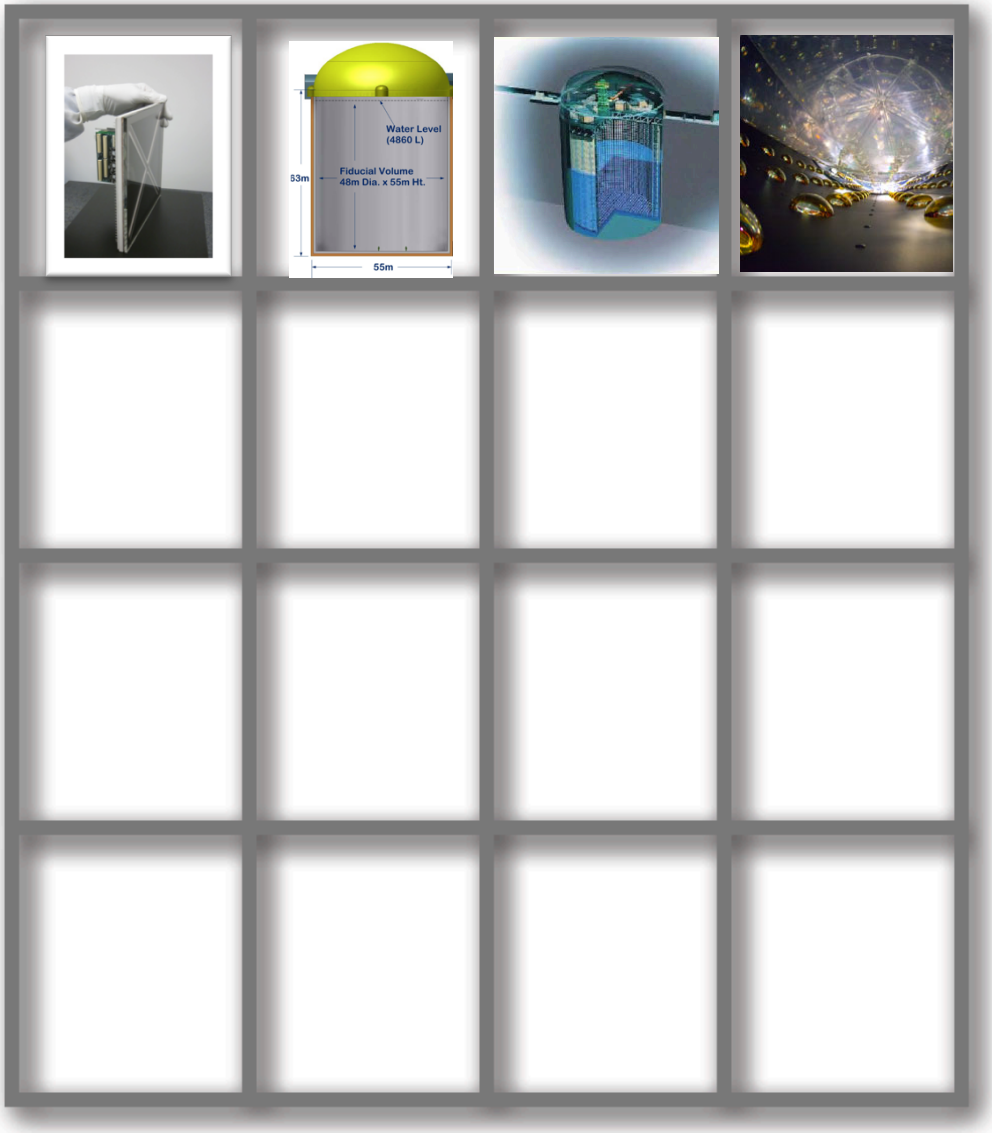
Potential

- Large Area photo-detectors with extended capability



Potential

- Large Area photo-detectors with extended capability
- Neutrino Experiments



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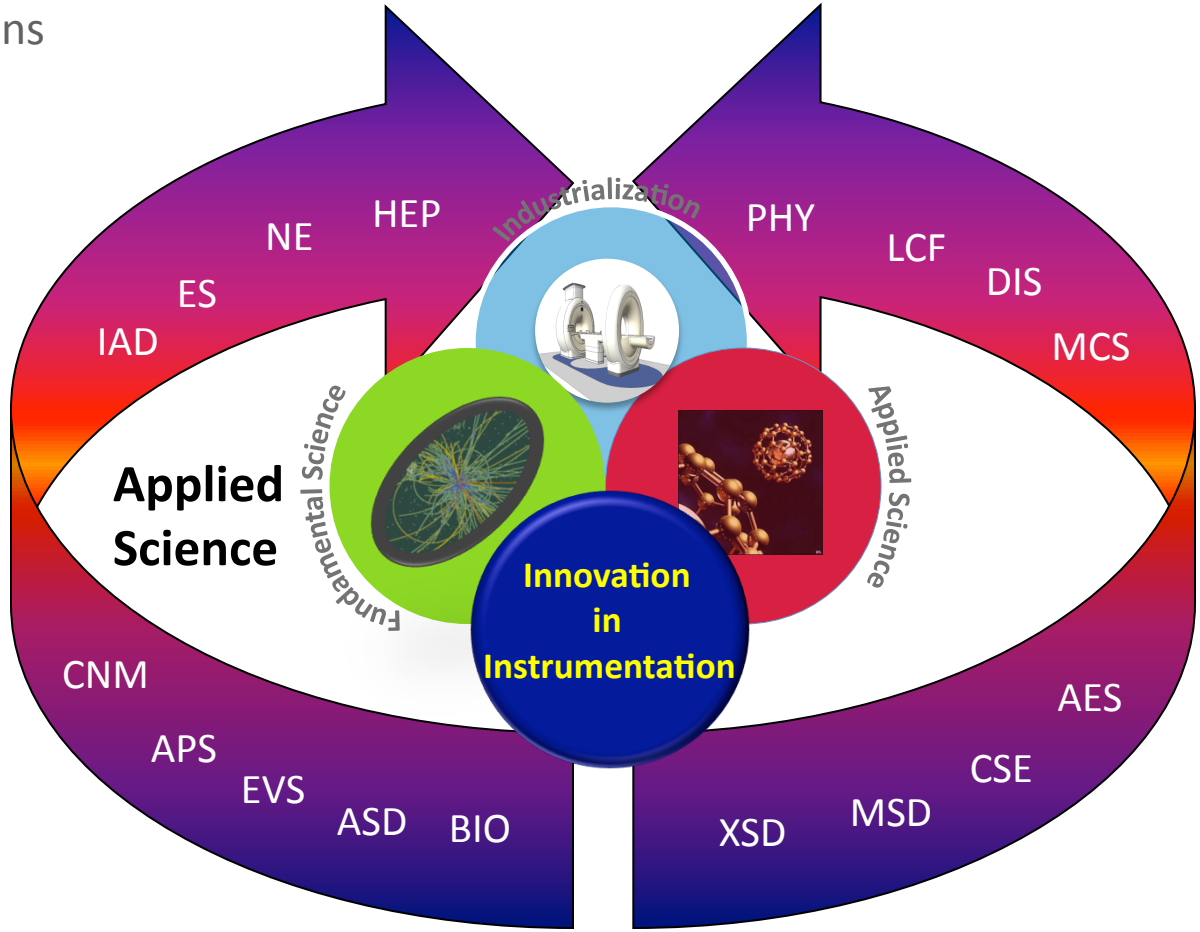
- TOF – PID applications
  - EIC detectors
  - PANDA, Glue-X
  - ORCA, KOTO

Potential

- Large Area photo-detectors with extended capability
- Neutrino Experiments
- TOF at collider detectors
- TOF – PID applications
  - EIC detectors
  - Glue-X
  - PANDA
- Broader impact
  - X-ray detectors
  - PET
  - Neutron detection
  - Homeland security

Multi-disciplinary Approach

- LAPPD project refocuses on technological innovation by bringing to bear advances in other sciences on the development of new instrumentation for science through a multi-disciplinary approach
- Path to restoring US capabilities; technology has the ability to leapfrog into new domains



Opportunities

REPORT TO THE PRESIDENT

TRANSFORMATION AND OPPORTUNITY: THE FUTURE OF THE U.S. RESEARCH ENTERPRISE

Executive Office of the President

President's Council of Advisors on Science and Technology

NOVEMBER 2012

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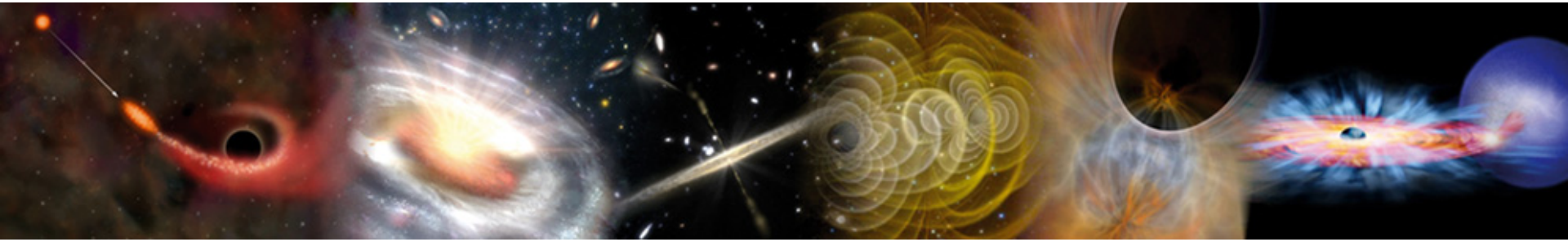
Prescience of DOE-HEP program office

Opportunity aligned with national priorities

http://www.whitehouse.gov/administration/eop/ostp/pcast/docsreports

Summary

- Within 3 years, with very strong DOE support, significantly moved performance barriers of photodetectors
- The project focused on two goals: the production of 8” tiles for the experimental program and transfer technology to industry, and further improvement of the performance and lowering of the cost per device
- The potential of this detector development goes well beyond HEP
- Rapid feedback to this review is requested



Budget

	FY13		FY14		FY15	
	Labor	M&S	Labor	M&S	Labor	M&S
Project Management	$217,004	$25,000	$217,004	$25,000	$217,004	$25,000
3" Tile System	$279,052	$168,012	$19,345	$3,264	$0	$0
MCP	$402,821	$99,847	$414,742	$113,970	$329,064	$111,632
Electronics	$363,621	$84,751	$135,312	$42,375	$135,312	$42,375
8" Tile System	$498,679	$453,574	$732,812	$89,269	$562,645	$246,238
Photocathode Improvement	$192,607	$25,971	$174,829	$22,336	$369	$283
Detector Seal Improvement	$140,578	$13,561	$0	$0	$0	$0
Total	**$2,094,362**	**$870,716**	**$1,694,044**	**$296,214**	**$1,244,394**	**$425,528**