Goals and Plans for LAPP2

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For the LAPPD Collaboration

Outline

1. Goals and Major Milestones
2. Organization of Pre-Production Project
3. Tasks and Responsibilities, Scope
4. Major Milestones for Tubes, Systems
5. Goals for Cost and Availability
6. Other Considerations

GOALS

1-Year Goal:

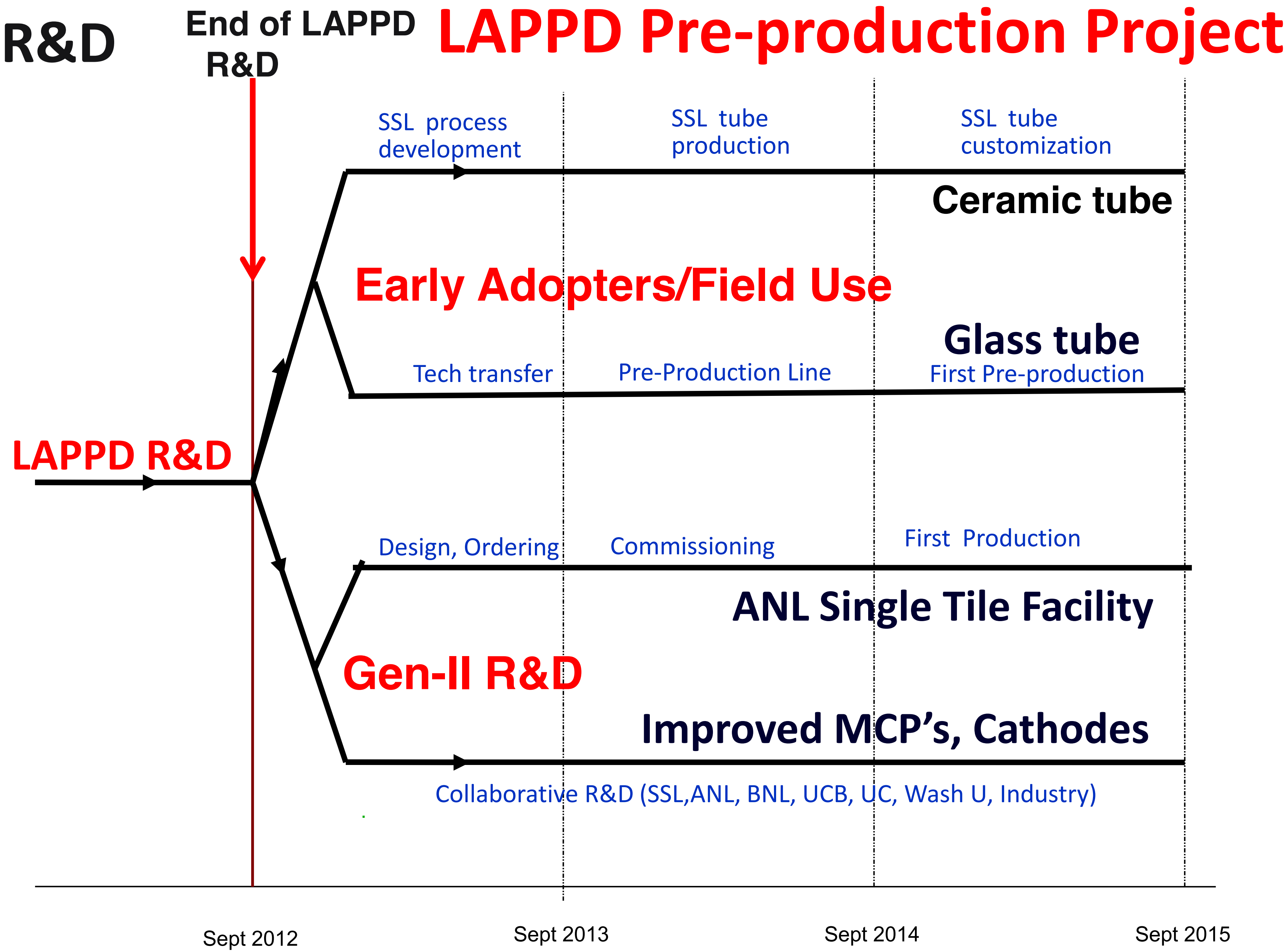
Several working sealed 8"-tubes

3-Year Goal:

4-6 complete systems in the field with early adopters*:

- CMS (pre-radiator TOF for vertex pileup separation)
- STAR at RHIC; ALICE at LHC (TOF for particle ID)
- KOTO at J-PARC (photon localization in xy, t)
- LARIAT at Fermilab- 4-station TOF in (test) beam line
- GLUE-X at JLAB- TOF for kaon ID
- Medical Imaging company/UC-BSD - PET cameras (SBIR)
- Nova Sci/Oak Ridge- neutron detectors (no photocathode)
- LAPPD folks- digital EM/Had/energy-flow calorimeters
- LAPPD folks- imaging (tracking) water neutrino detectors

* An incomplete list of groups that have approached us- not ordered



Organization of Pre-production Project

THE TWO- CERAMIC AND GLASS- PACKAGES

Glass: attraction is cost: cheap materials, frit seals, silk-screen anode, no-pin design- was aimed at *very* large areas;

Ceramic: SSL has decades of experience with a developed process for ceramic tubes that inform the glass effort:

- Materials, mechanical and thermal properties, design;
- QC, multi (many)-step cleaning, cleanliness required, scrubbing, in-situ testing before assembly;
- Photocathode deposition, monitoring, and validation;
- Vacuum-transfer assembly;
- Testing: life-time, gain mapping,
- Performance: I-V range, lifetime, resolution to 2 μm, charge-cloud, life-time, robustness (space certified);
- Transport, storage, handling.

The **ceramic tube has complementary applications:**

1. **Thick film anodes fired on ceramic allow high space resolution (down to 2μm), 2D readout with crossed delay-lines, complicated fine-line patterns;**
2. **Applications requiring ruggedness- space flight, military use, harsh vibro-acoustic environments (NASA, Air Force,….)**

TASKS AND RESPONSIBILITIES:

8" Tile/Tube Fabrication: SSL/ANL/Industry Facility Roles

Institution	Mission	Year 1	Year 2	Year 3
SSL/UC Berkeley	Process Development	1 Tube/Cycle 4-6 Weeks/Cycle	1 Tube/Cycle 2-4 Weeks/Cycle	Customization
ANL	R&D, Application-Specific Development		1 Tile/Cycle† 4 Weeks/Cycle	1 Tile/Cycle† 2 Weeks/Cycle
Industrial Partner‡	Pilot Production, Full-Scale Production Commercialization		1 Tile/Cycle 1 Week/Cycle	3 Tiles/Cycle 3-4 day turnaround
Total Available Tiles		1-4	10-20	50

Table 1: The roles of the collaborating partners in bringing the glass tile to commercial production.
Notes:
†Assuming the hiring of an experienced sealed-tube facility manager in 2013.
‡Assuming the industrial partner has access to an existing vacuum-transfer system that can be adapted to the LAPPD process.

MAJOR MILESTONES:

Sealed Tubes:

Year 1:

SSL: 1 Ceramic Tube, 1 Glass Tile .

ANL: Design and Procurement of 8" R&D Tile Facility
.

Industry-expectation from TTO:

Initial design mods and First Trials (if industrial partner has access to existing facility);

MAJOR MILESTONES:

Sealed Tubes:

Year 2:

SSL: 2 Ceramic Tubes, 1 Glass Tile

ANL: Commissioning of Tile Facility and production of 1 Tile

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Industry- expectation from TTO:

Commissioning and production of 1 Tile;

MAJOR MILESTONES:

Sealed Tubes:

Year 3:

SSL: Robust assembly of 1 Ceramic Tube/4 wks

ANL: Assembly of 1 R&D Tile per 2 wks

Industry- expectation from TTO:

Multi-tile batches; production of 3 Tiles/week

MAJOR MILESTONES:

Integrated Systems:

Year 1:

Hawaii/SSL: Assembly and test of 1 Ceramic Tube System

ANL/UC: Assembly and test of 1 Glass Tile System

Industry-expectation from TTO: Initiate working with the above at Hawaii/SSL and ANL/UC

MAJOR MILESTONES:

Integrated Systems:

Year 2:

Hawaii/SSL: Assembly and test of 3 Ceramic Tube Systems

ANL/UC: Assembly and test of 3 Glass Tile Systems

Industry- expectation from TTO: Working with the above at Hawaii/SSL and ANL/UC, tech transfer of electronics,DAQ;

MAJOR MILESTONES:

Integrated Systems:

Year 3:

Hawaii/SSL: Delivery of 1 Ceramic Tube System to an early adopter

ANL/UC: Delivery of 3 of 1 Glass Tile Systems to early adopters

Industry- expectation from TTO: Completion of 2 additional multi-tile glass systems via tech transfer

SCOPE/TASKS OF SSL/UC/UH/WU EFFORT

Plans and Goals: university tasks & subcontracts

(ANL/Total numbers in Bob's talk, Marcel's summary)

Institution	Tasks	Subcontract	Personnel*	Comment
Berkeley	Mech Design, Testing, Tube/Tile Assembly	600K/yr	3.5 FTE	inc. M&S
Chicago	Mech Design, Testing, Electronics, System Eng.	270K/yr	1.5 FTE	inc. M&S
Hawaii	Testing, Electronics, System Eng.	120K/yr	1.2 FTE	inc. M&S
Wash U	Cathode R&D	50K/yr	0.5 FTE	inc. M&S
Total		1040K/yr		

***FTE's on ANL subcontract**

COST COMPARISONS DEPEND ON CAPABILITY

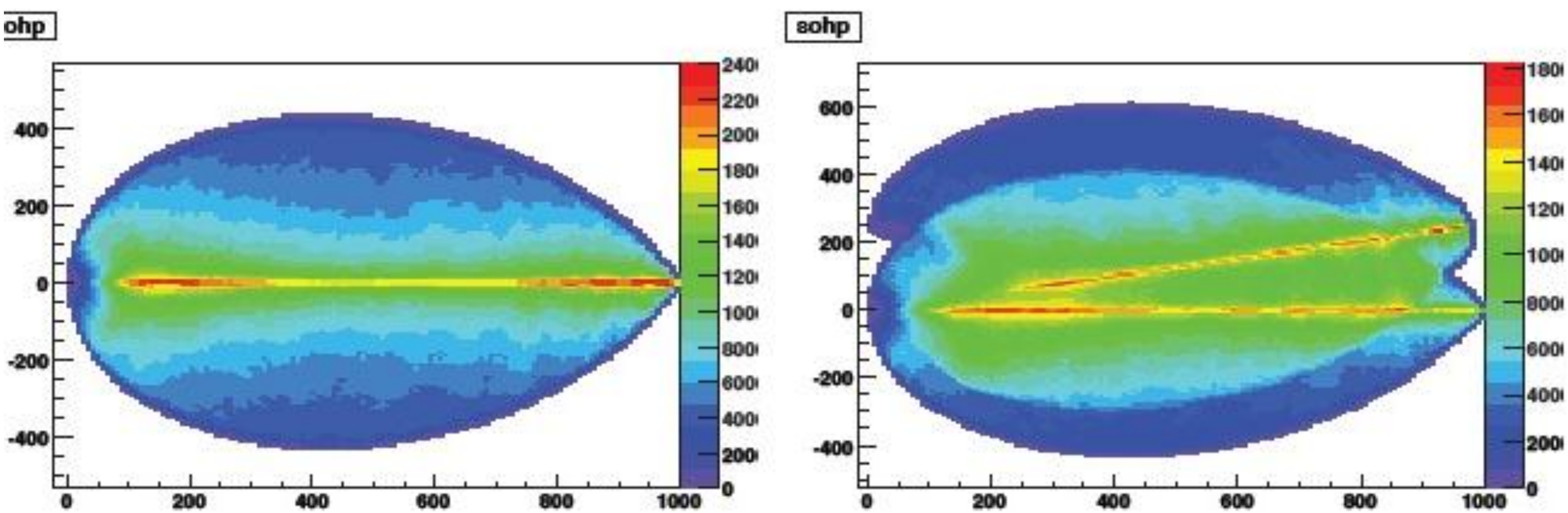
For example, using time resolution to be able to track in a water cherenkov ν detector could buy a factor of 5 gain in reach per given tonnage (1 Mton -> 200 Ktons)*

Matt Wetstein

Track Reconstruction Using an "Isochron Transform"

Results of a toy Monte Carlo with perfect resolution

Color scale shows the likelihood that light on the Cherenkov ring came from a particular point in space. Concentration of red and yellow pixels cluster around likely tracks



Single track

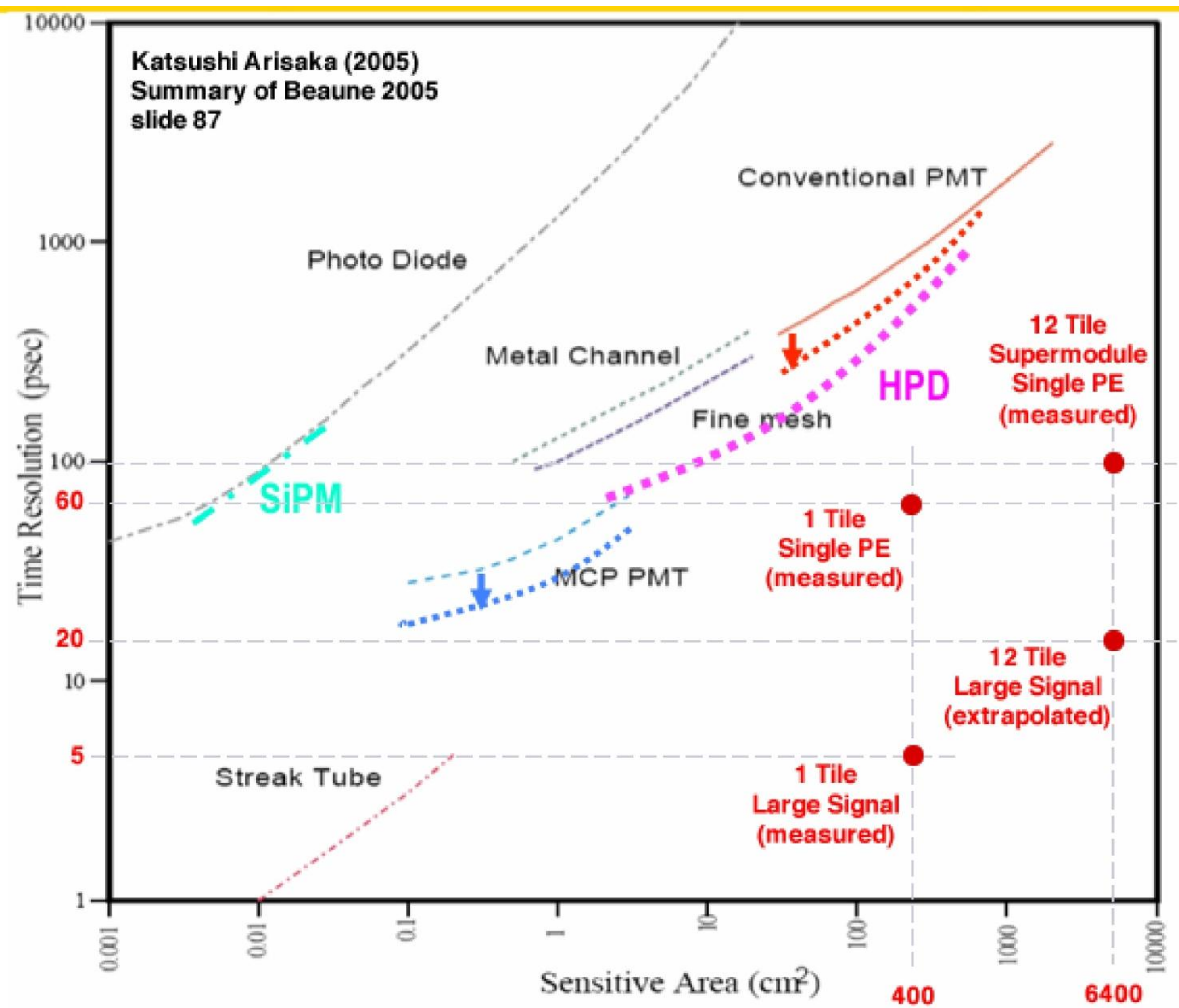
Two tracks displaced from a common vertex

*** Matt, Mayly + students actively working on this**

COST COMPARISONS DEPEND ON CAPABILITY

Correlated time-space points can lower overall cost- for applications that don't need time-space resolution it's very unlikely MCP-PMTs will ever be as cheap as PMT's. However:

The dt/A Arisaka plot



GOALS/CONSIDERATIONS FOR COST

1. Comparison costs are:
   1. For space-time imaging (comparable performance):
      1. Hamamatsu 1x1" (Belle) 8K$ (8K/sq-in)
      2. Photonis Planacon 2"x2" 11-12K$ (3K/sq-in)
   2. For photocathode coverage with no imaging, xy-t corr.
      1. Hamamatsu 8"-PMT (LBNE-RIP) 1.2-1.5K$
      2. Bejing 20" Hybrid- ?? (possible imaging, but bulky)
2. For glass package, main cost is in assembly- parts are cheap (MCA's are the most expensive, but cheap per in^2)
   1. Break into big markets- e.g. PET, Homeland Security (neutrons) for volume (proposal for 50K/yr for DUSEL) & (SBIR on PET)
   2. Non-vacuum transfer assembly (SBIR on Tubulation, inhouse effort at APS)
   3. Establishing Cost Task Force, including industrial partners;
   4. Gain from imaging for large neutrino detectors is factor of 5-6 per cathode area; for PET is ~1/100 in dose rate;
   5. Large-volume goal is fab cost~4K$/Tile (50K for a 12-tile Supermodule at 0.5 m^2)

OTHER CONSIDERATIONS

a. Due to history, a CR gives only fraction of prev. yrs. Funding- uncertainty slows progress (we have held back ordering parts, e.g.) ;

b. We have SBIR/STTR's pending
   a. Expect little impact on base funding need;
   b. May have impact on non-base, could add tasks (depends on who, what if pos. or neg. for each.).

c. Transition from 3-yr R&D to 3yr-Field Use has led to some organizational changes:
   1. Added new Cost Task Force to the twice/year Godparent internal review committees and Collaboration Mtgs- (these have kept us on track);
   2. Considering a more formal Collaboration structure – Executive Committee for major decisions.

The End

BACKUP SLIDES

Milestones:
R&D on MCP, Cathode, Systems Performance

- Year 1 (FY13)
  - 10-micron Multi-Multi, L/D=120, OAR> 90%,
  - X-ray analysis of K_2CsSb crystal, amorphous
  - Deeper buffer, 2 psec resolution
- Year 2 (FY14)
  - Cost optimization of large-area; 6-micron Multi-Multi
  - Cathode QE > 30%
  - Large-area and psec system optimizations; 1 psec
- Year 3 (FY15)
  - MCP- TBD
  - Cathode-TBD
  - Systems-TBD
  - Other-TBD

The Ultimate End