TOP
Readiness for DOE Reviews

25-JUL-2012

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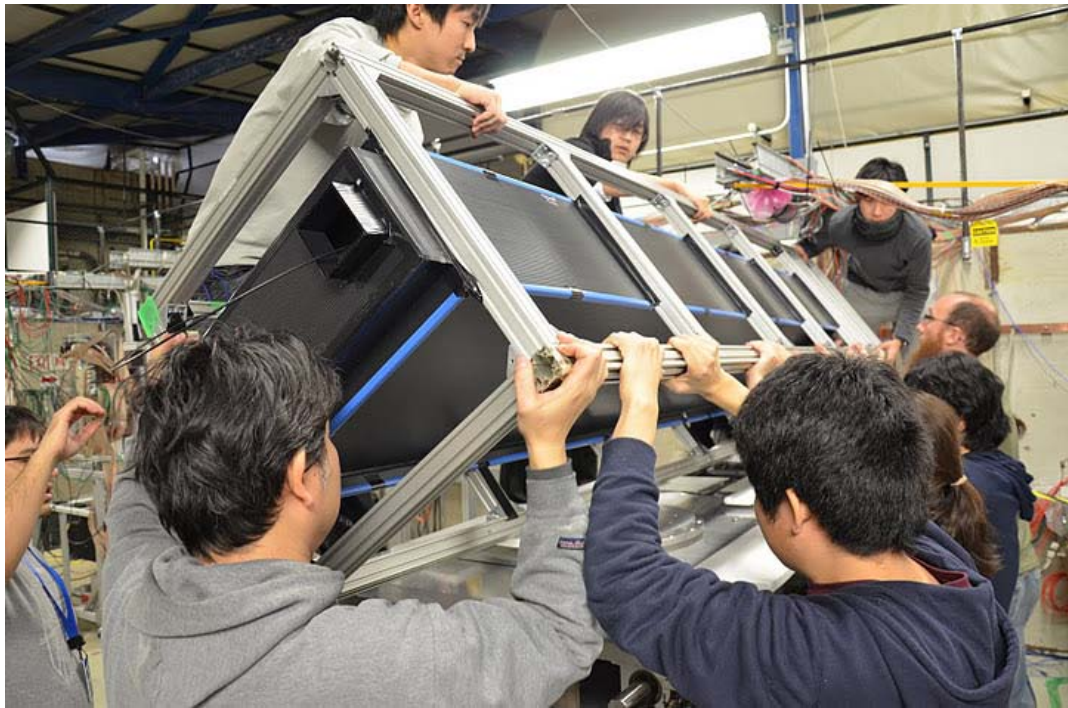
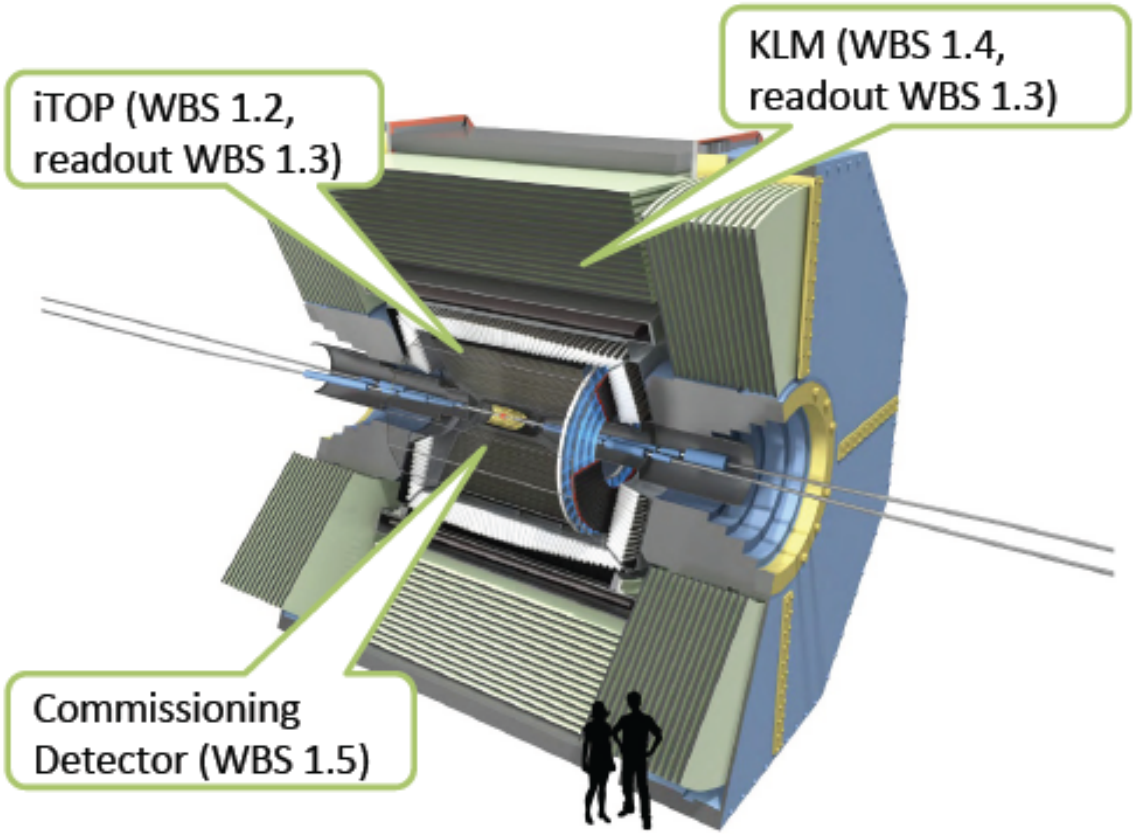
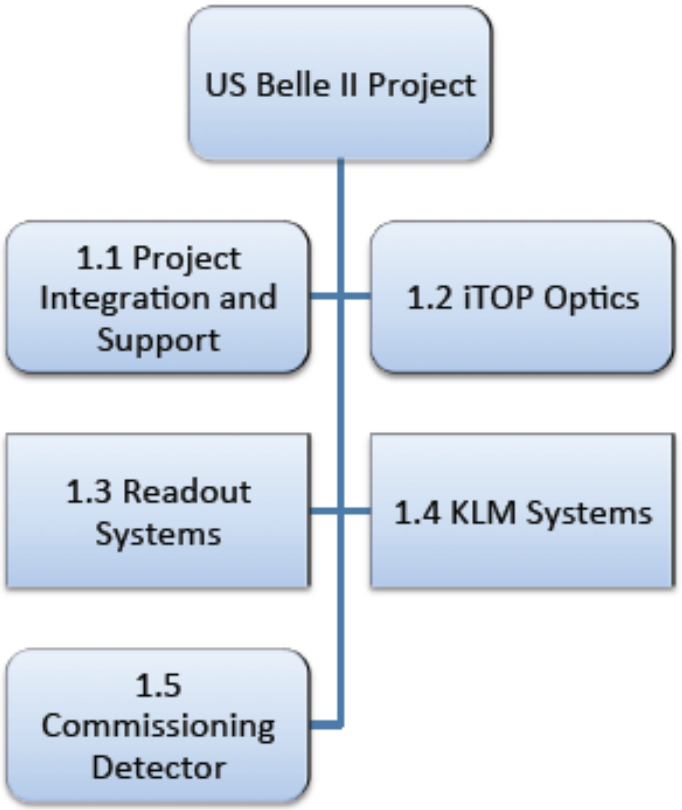
University of Hawai'i
For the TOP group

- **Quartz procurement status/plan**
- **Beam test and CRT status and plan (incl. Fuji-B4 status)**
- **Electronics status and plan**
- **Strategy for CD-3b review (CRT, LEPS test)**



US Requests to DOE





*WBS = Work Breakdown Structure

Department of Energy Support for US Belle II Groups Managed through the Critical Decision process

Milestone	MNS Schedule	Project Schedule
CD-0 Approve Mission Need	FY 2011	Aug 2011 (actual)
CD-1 Approve Alternative Selection and Cost Range	FY 2012	Jul 2012
CD-3A Approve Long-lead Procurements (KLM modules)		Aug 2012
CD-3B Approve Long-lead Procurements (iTOP quartz)		Dec 2012
CD-2/3 Approve Performance Baseline, Start of Construction	FY 2013	Jul 2013
CD-4 Approve Project Completion	FY 2015	Dec 2015

- US Gov't standard process; specific set of gates/reviews need to be passed to proceed

US Belle II has been thoroughly reviewed

- CD-1 Review 26 June 2012
- Peer Review 29-30 March 2012 (PNNL)
- Conceptual Design Review 15-16 March 2012 (KEK)
- 6th BPAC 26-27 February 2012
- Director's Review 15-16 December 2011 (PNNL)
- Focused BPAC 11-12 November 2011
- 5th BPAC 14-15 February 2011
- (OHEP) Intensity Frontier Review 10-11 August 2010

Basis of technical Review: TOP Testing History

- 2010 CERN Beam Test ("simple" focusing TOP)
  - < 2 m bar, focusing mirror, no expansion block
  - 4-channel SL10s
  - Constant fraction discriminators and CAMAC ADC/TDC
- 2011 Fermilab Beam Test ("imaging" TOP)
  - ~2.5 m bar, "block" expansion volume
  - 16-channel SL10s
  - Highly integrated, waveform sampling electronics
- 2011 – 2012 Bench/Electronics Tests
  - Tests with pulser inputs
  - Tests with 16-channel SL10 and laser scan

CD-1 Passed, requiring…

Requirement	Documentation	Status
Approve Acquisition Strategy	Belle-II Acquisition Strategy	✔
Approve Preliminary Project Execution Plan (PEP)	Belle-II Preliminary Project Execution Plan	✔
Appointment of the Federal Project Director (FPD)	Belle-II Preliminary Project Execution Plan, Section 7	✔
Establish and Charter Integrated Project Team (IPT)	Belle-II Preliminary Project Execution Plan, Appendix A	✔
Develop a Risk Management Plan	Belle-II Preliminary Project Execution Plan, Section 8.1	✔
Comply with the One-for-One Replacement		NA
Complete a Conceptual Design	Belle-II Conceptual Design Report	✔
Document High Perf. & Sustainable Bldg. & Sustainable Env. Stewardship considerations		NA
Conduct a Conceptual Design Review	Held 15-16 March 2012 at KEK	✔
Complete a Conceptual Design Report	Belle-II Conceptual Design Report	✔

Requirement	Documentation	Status
Prepare a Preliminary Hazard Analysis Report	Belle-II Preliminary Hazards Analysis Report	✔
Develop and Implement an Integrated Safety Management Plan	Belle-II Preliminary Project Execution Plan, Section 8.7	✔
Establish Preliminary Quality Assurance Program (QAP)	Belle-II Project-Specific Quality Assurance Program	✔
Identify general Safeguards and Security requirements for the recommended alternative	Belle-II Preliminary Project Execution Plan, Section 8.8	✔
Complete National Environmental Policy Act Strategy by issuing a determination (i.e., EA).	Categorical Exclusion (B3.6) for the US Belle-II Project	✔
Conduct Independent Project Review	Office of Project Assessment (SC-28)	This Review
Update PDS, or other funding documents for MIE and OE projects, and OMB 300s, if applicable.	Field Work Proposal	✔

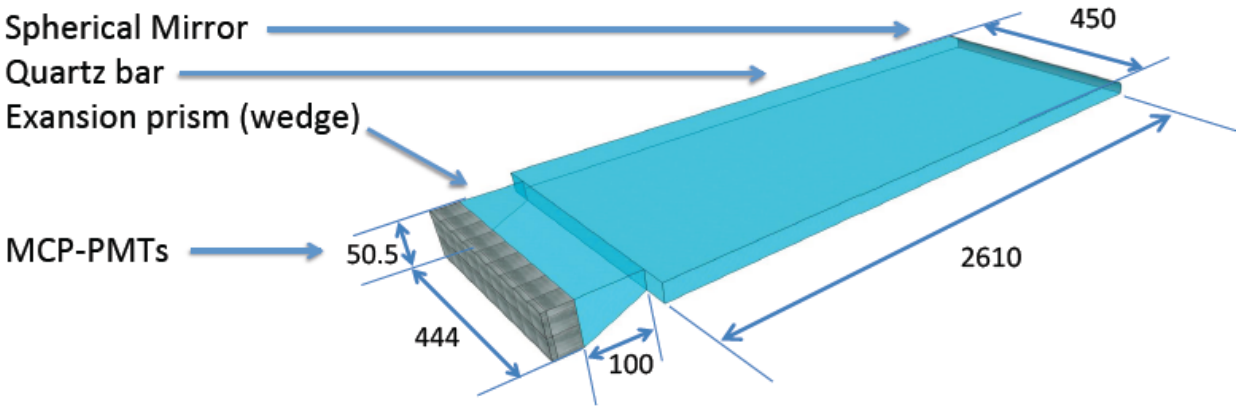
- However….

CD-1 Passed, with caveats…

- Serious concerns raised by technical reviewers
  - Detector performance with final optics not convincing demonstrated
  - Data verification for mirror/corners
  - Performance with multi-track/realistic backgrounds
  - Demonstrate works with final PMTs/electronics
- Next preparation steps critical
  - Quartz procurement
  - Beam test/cosmic ray test status/plans
  - Electronics status/plans
- Will come back to CD-3a schedule/strategy

Quartz Procurement items

- Bars
  - Contract in place for full production
  - 10 blanks already produced and “delivered” (US-J funded)
    - Up to 8 more will be ordered with US-J FY12 funds
  - 2 polished bars ordered – delivery ~December (DOE $$)
- Mirrors
  - Specifications settled – tilted mirror(?), 100 mm long
  - Nagoya has ordered prototype – due any day
  - PNNL issuing RFP for another prototype now (DOE $$)
- Prisms
  - Specifications less settled, but time to prototype
  - PNNL issuing RFP for prototype “option 5” design (DOE $$)




02/10/2012

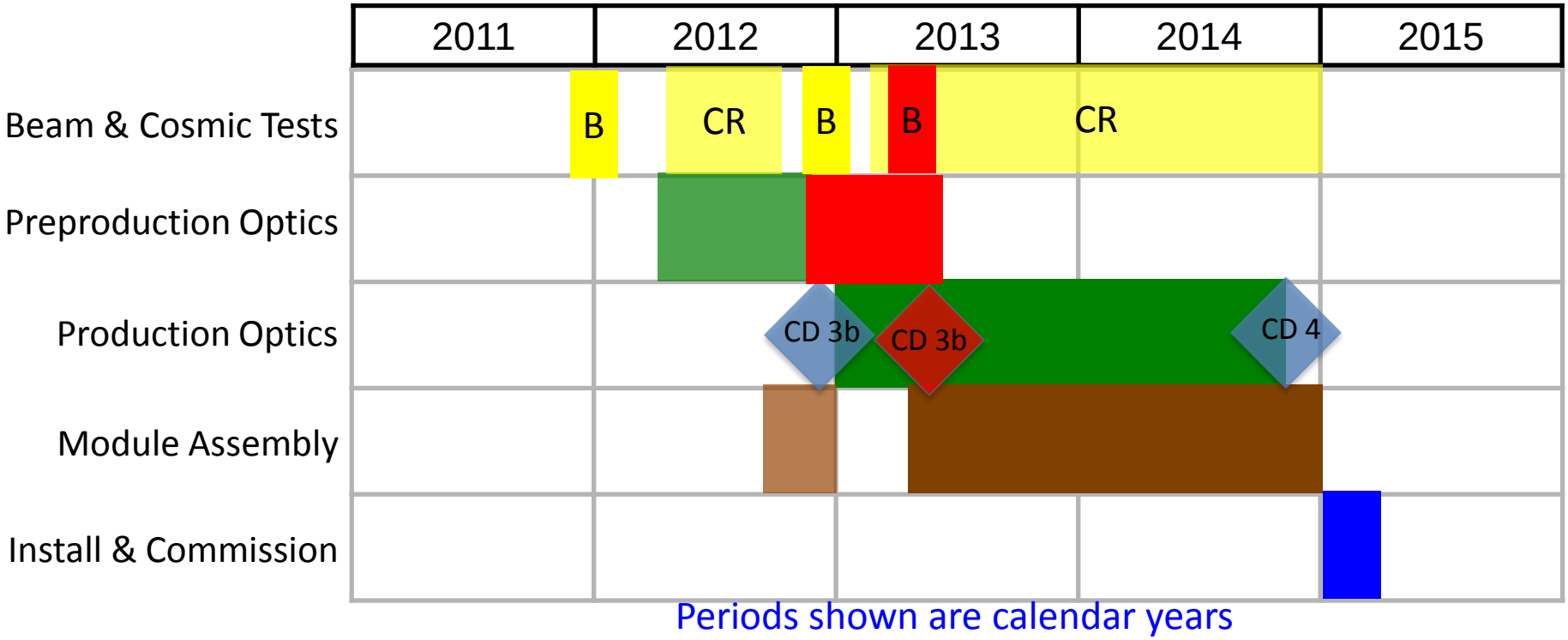
02/10/2012

Outstanding Optics R&D

- Finalize mechanical design for quartz bar box to set final specifications for quartz prism
  - Many details in and around the prism/readout interface region that need to be finalized and tested before prism production
- Outstanding issues for the mirror
  - Tilted mirror marginally better, but *some concerns remain*
    - Mechanics of applying spring load in –Z direction on tilted surface
    - Reconstruction algorithms for continuum of impact positions, momenta and angles has not been demonstrated and may be more difficult for the tilted mirror design
- Analyzed data with final optics will be needed for DOE approval for production
  - Earliest reasonable date for building prototype with final optics is around December
- DOE is working with us to relieve "CD approval" pressure on the production of the optics
  - Schedule is still tight, but we have some relief in early U.S. FY13

TOP (Quartz-driven) Schedule

- Key drivers/constraints
  - CD-3b and **passing of FY13 Energy and Water bill** required to start production
  - Delivery of iTOP System to support KEK installation date – Feb 2015
- Increasing preproduction prototyping (time and quantities of optics)



Periods shown are calendar years

Cosmic Ray and Beam Campaigns

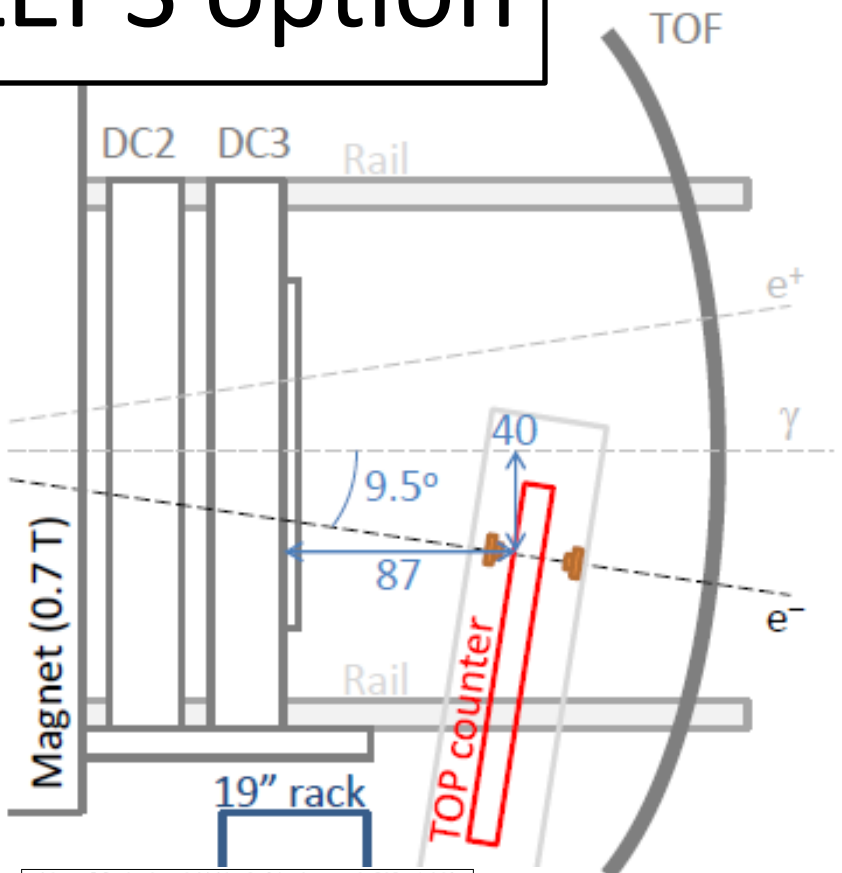
- Need to address serious concerns of referees
- 3-prong strategy:

1. Beam tests at LEPS
   - Demonstrate available optics, new PMT, different conditions/angles
2. Cosmic Ray tests in Fuji Hall
   - Commissioning platform for readout electronics
   - Will use to confirm/first cal constants assembled production modules
3. Final confirming beam-test
   - Demonstrate iTOP concept/TOP detector performance

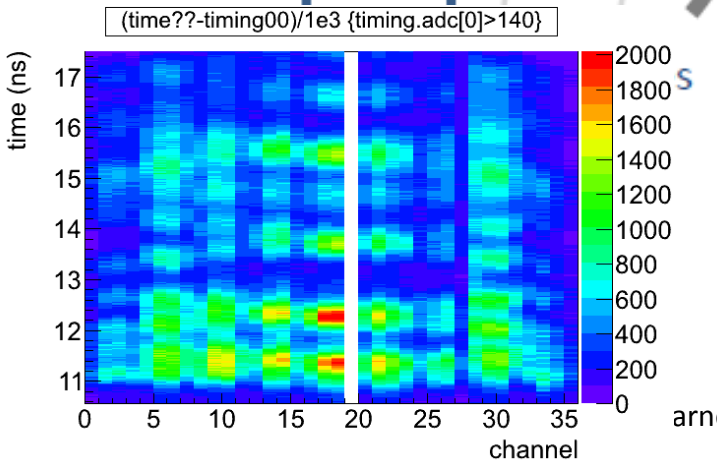
➔Optics has evolved

➔ Electronics (firmware) needs development/manpower

LEPS option

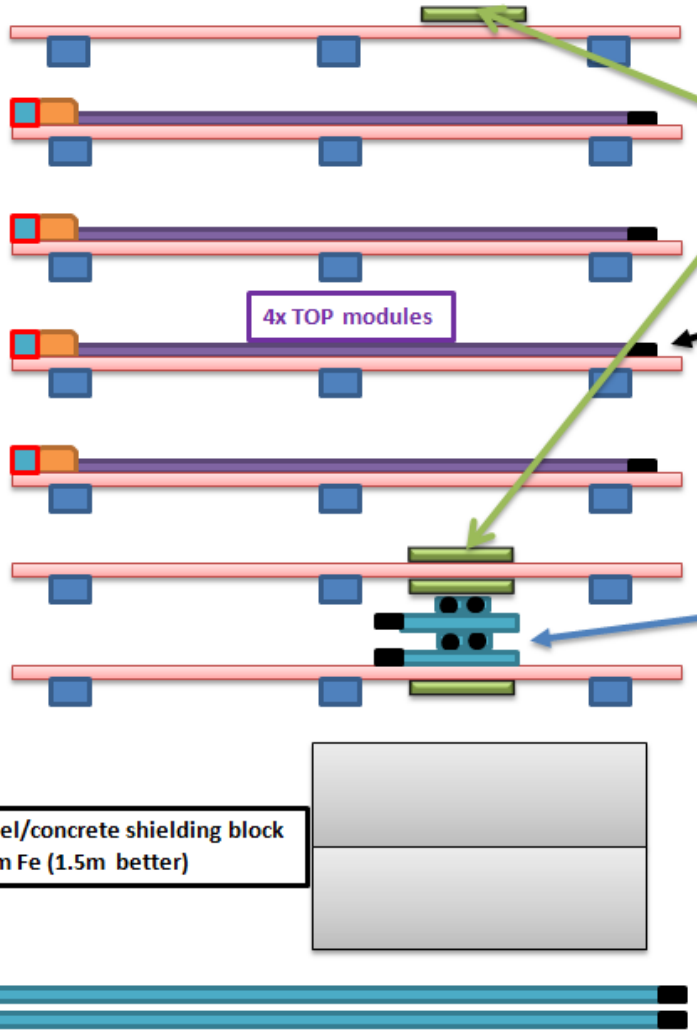


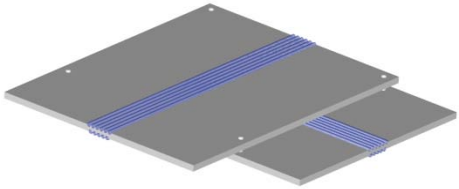
- Max. 2.4 GeV γ on 1.5 mm thick Pb to produce an e^-e^+ pair
- Trigger by scintillators (5 x 5 mm^2)
  - Trigger rate: ~80 Hz
- Tracking by the LEPS DCs
- EM shower cut by the LEPS TOF array



Cosmic Ray Telescope (Fuji Hall, KEK)

Side View



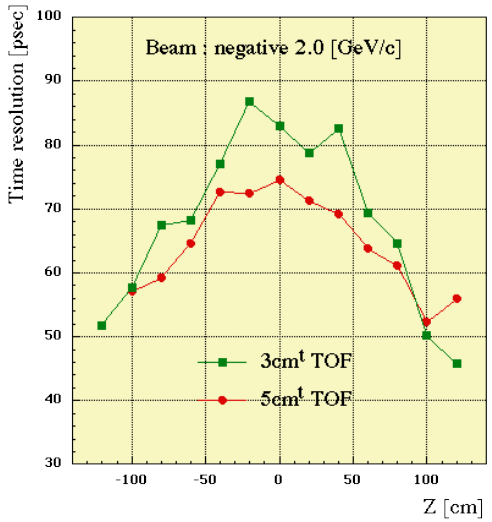


~1mm resolution
Sci Fi tracker over
~2 meters
< ~1mrad

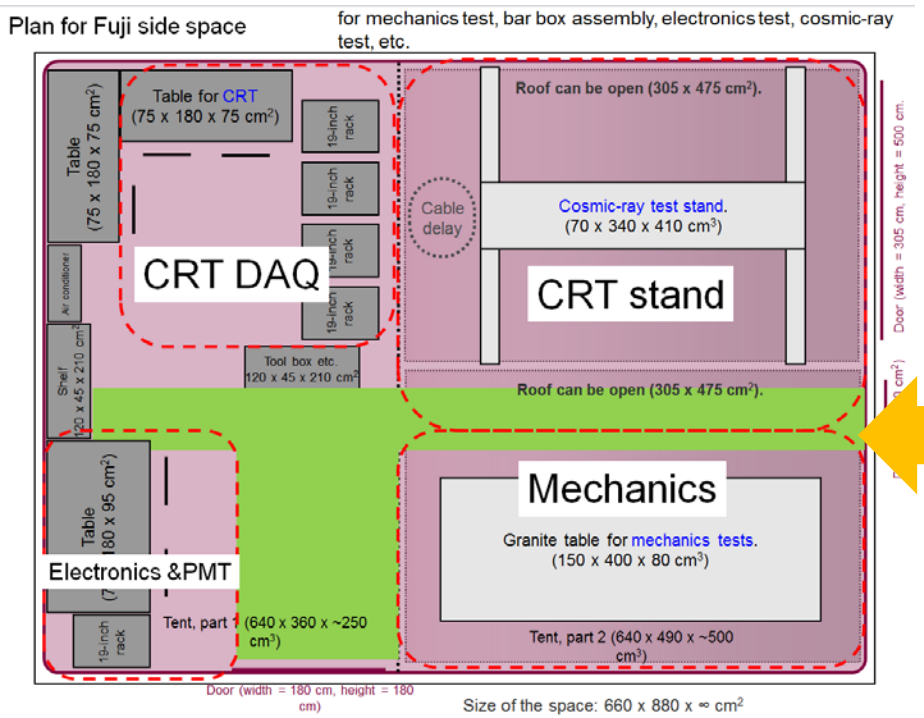
CRT rack

60ps/$\sqrt{4}$

~30ps

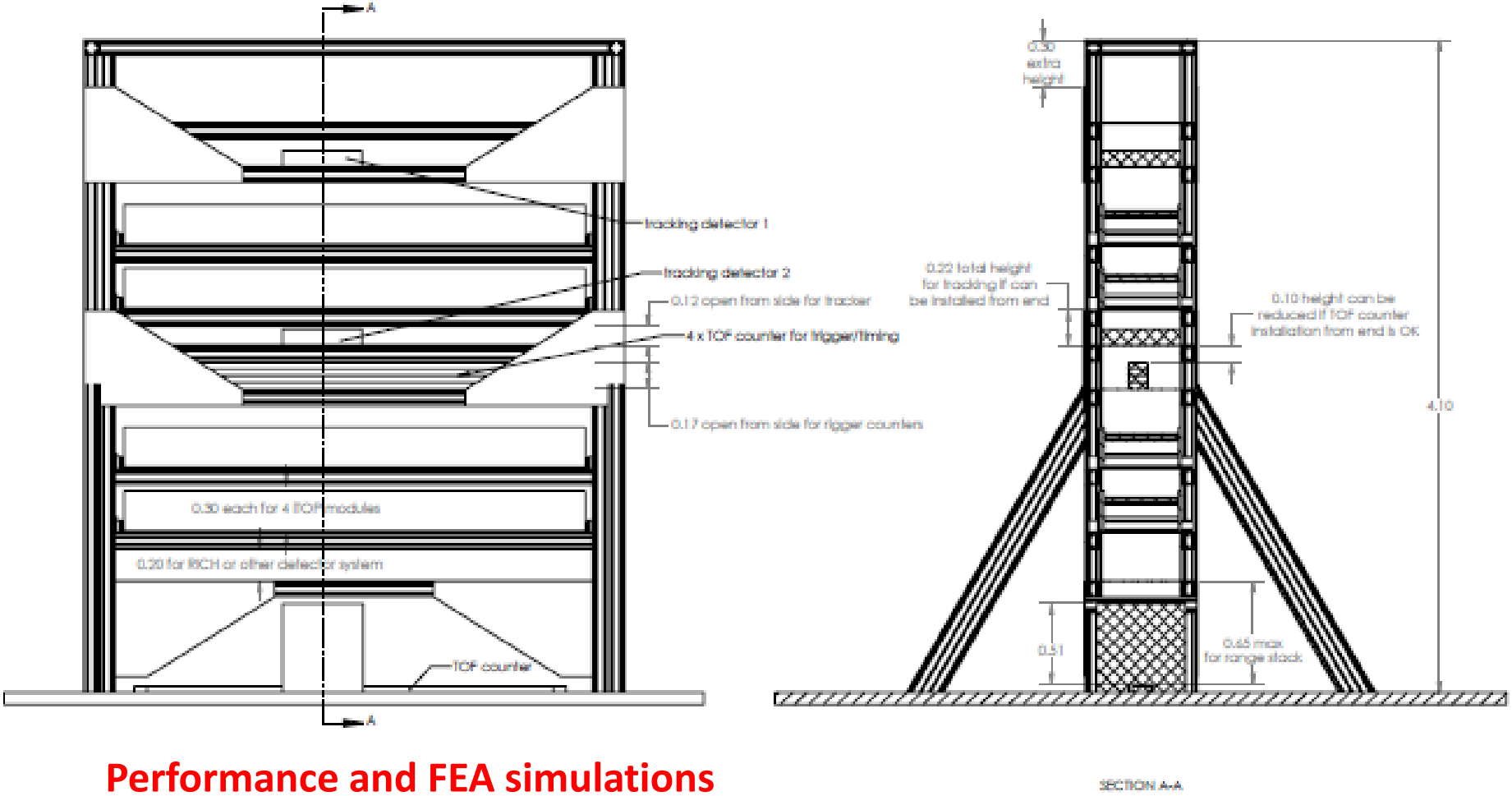


Tent already ready



- Preparation / Test area
  - Cosmic-Ray Test (CRT), HV test, QBB, FrontEnd,…
- A highly utilized space:
  - CRT stand: 400cmx490cmx500cm(H)
  - CRT DAQ, HV test, …: 300cmx300cmx250cm(H)
  - Electronics & PMT, …: 250cmx200cmx250cm(H)
  - Mechanics: 240cmx490cmx500cm(H)

Cosmic Ray Telescope (optimizing)

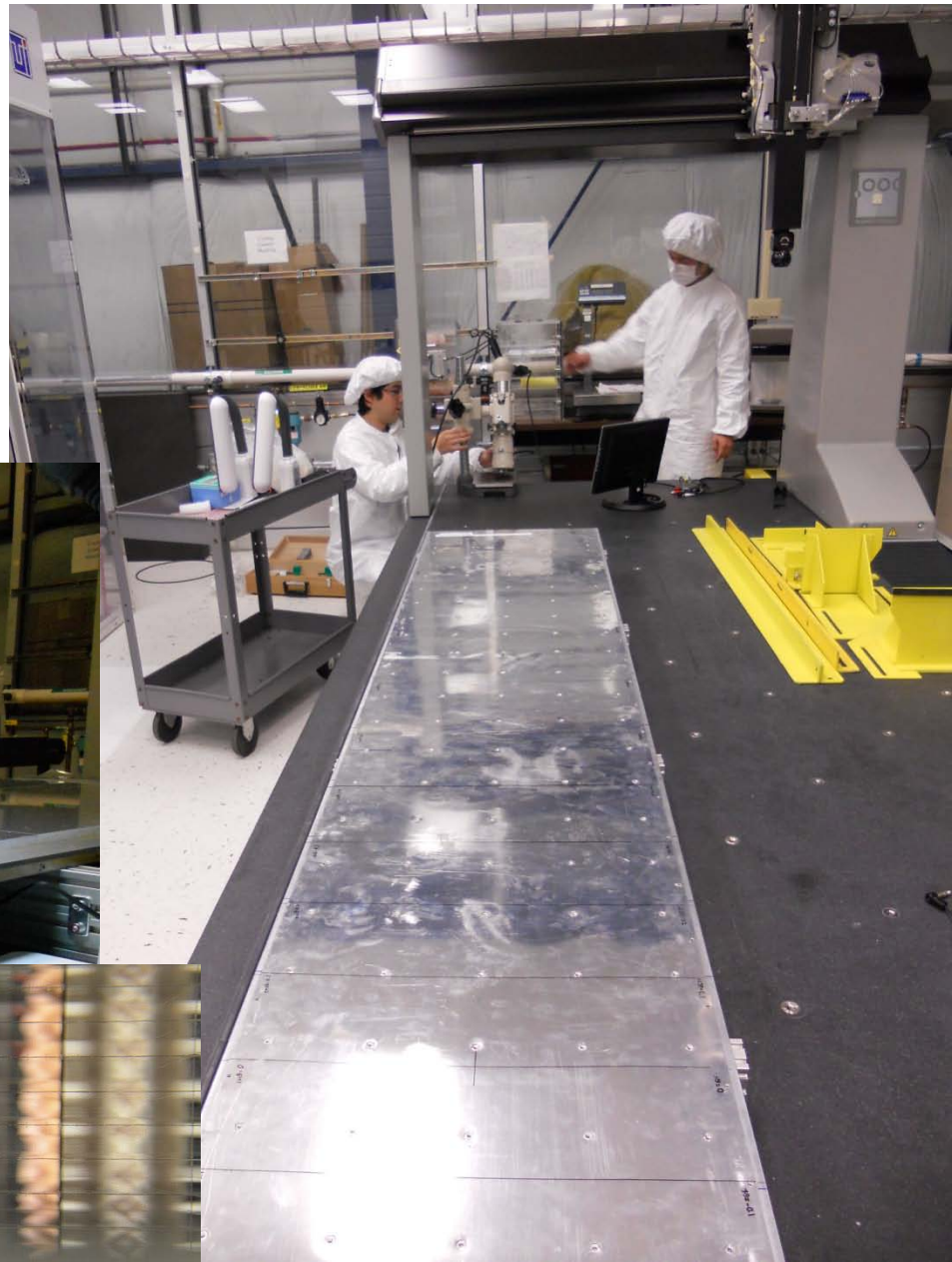


Performance and FEA simulations

Considering sag, natural modes (earthquake resistance), optimizing location of tracking/timing detectors, range-stack and/or Cherenkov detector

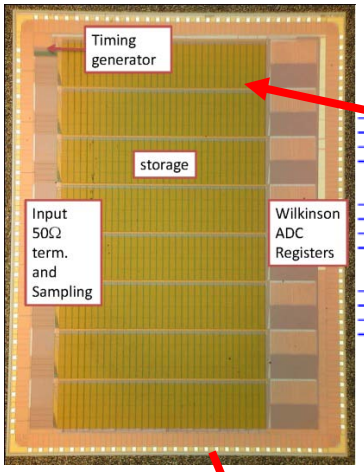
Beam test options

- FNAL off-line
- LEPS, SLAC, DESY…
- Cost, shipping issues



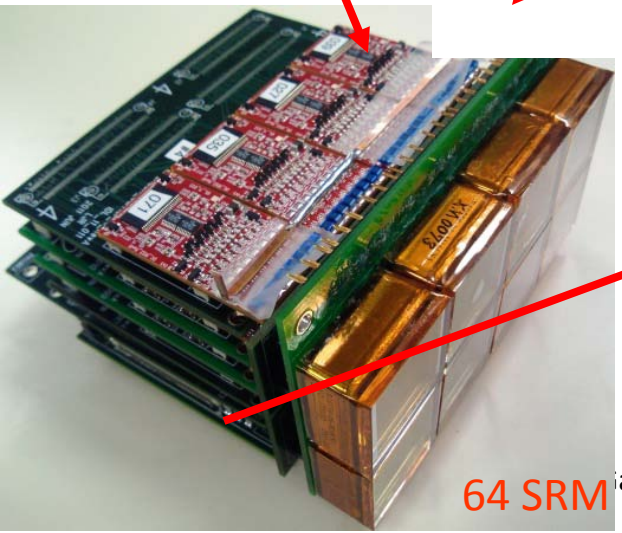
TOP Readout Architecture

Waveform sampling ASIC

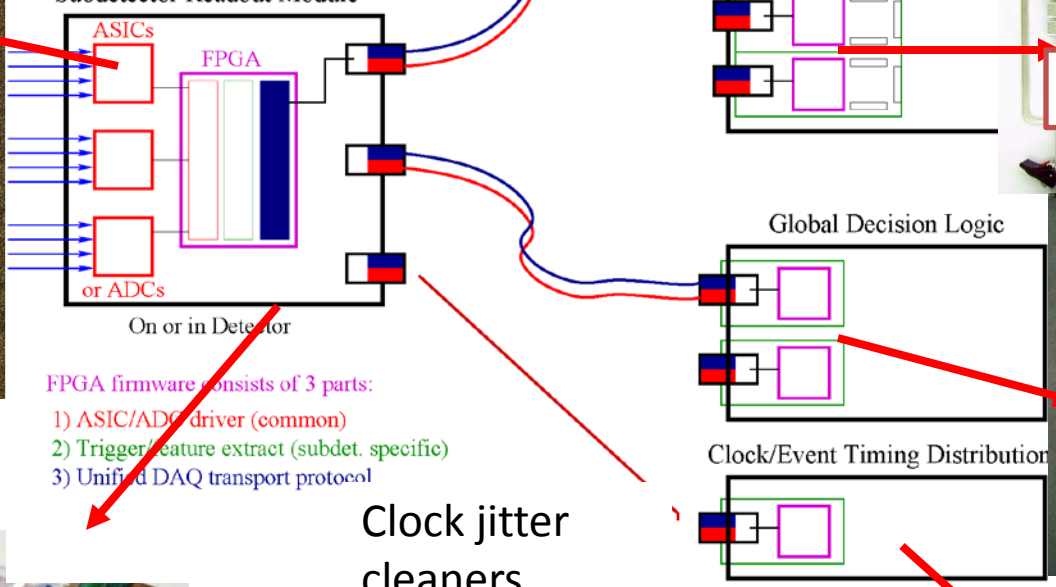


8k channels

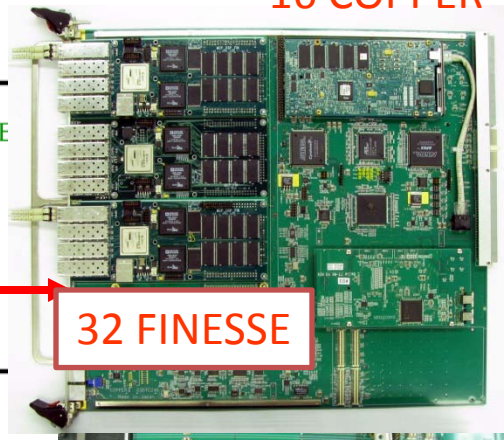
1k 8-ch. ASICs



64 SRM



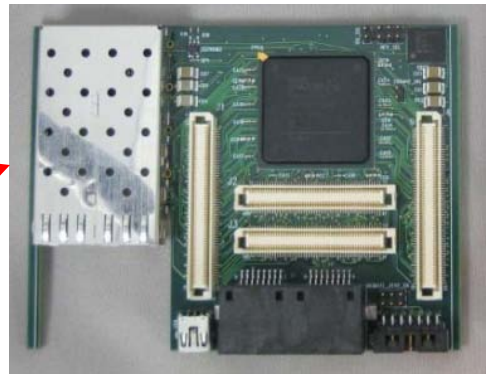
16 COPPER



32 FINESSE

9 TRGmod

Clock jitter cleaners



FTSW clock, trigger, programming

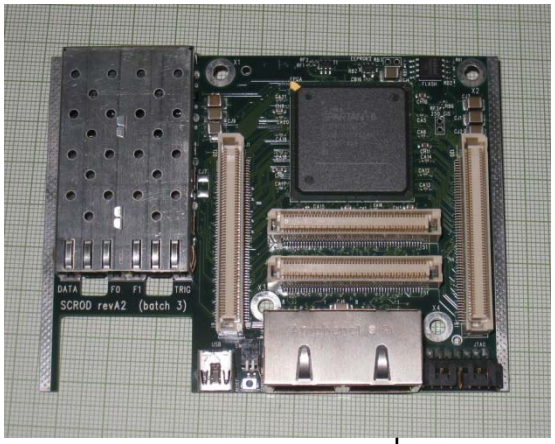
16 FTSW

Lessons Learned (first proto readout)

1. Sample pointer dephasing fix → IRS3B ASIC
2. Timebase servo-loop
    1. Firmware needs to be re-written
    2. Possible hardware change (phase detector)
3. SCROD v2 (“final” form factor)
4. Better thermal management (85C redline ops)
5. HV divider redesign; packaging SL-10 into module by HPK/Nagoya
6. Demonstrate DSP (real time) data reduction
7. In-situ (on demand) calibration

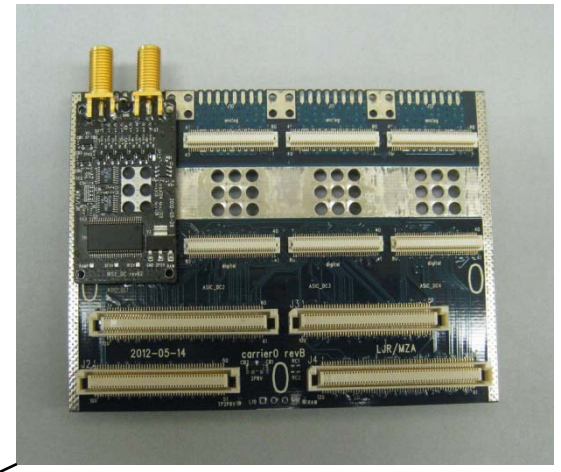
2nd generation “board stack” status

new PCB designs



SCROD revA2

IRS2_DC revB2

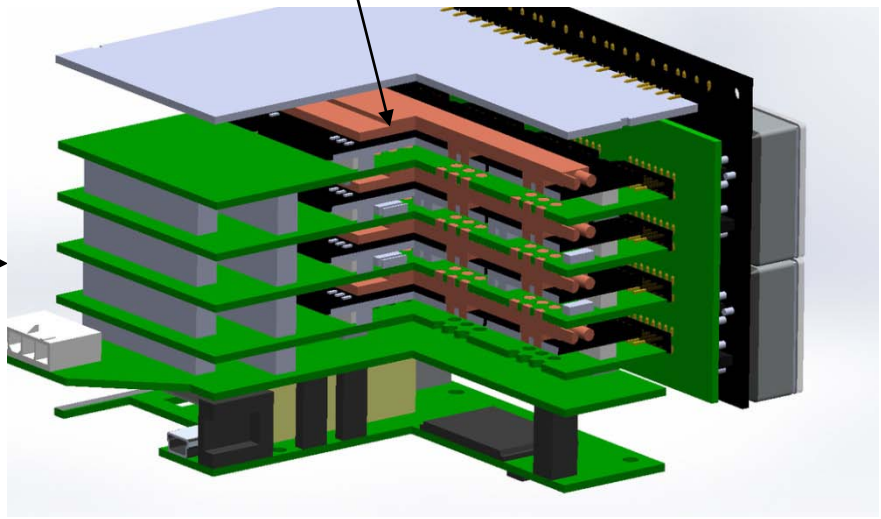


carrier0 revB

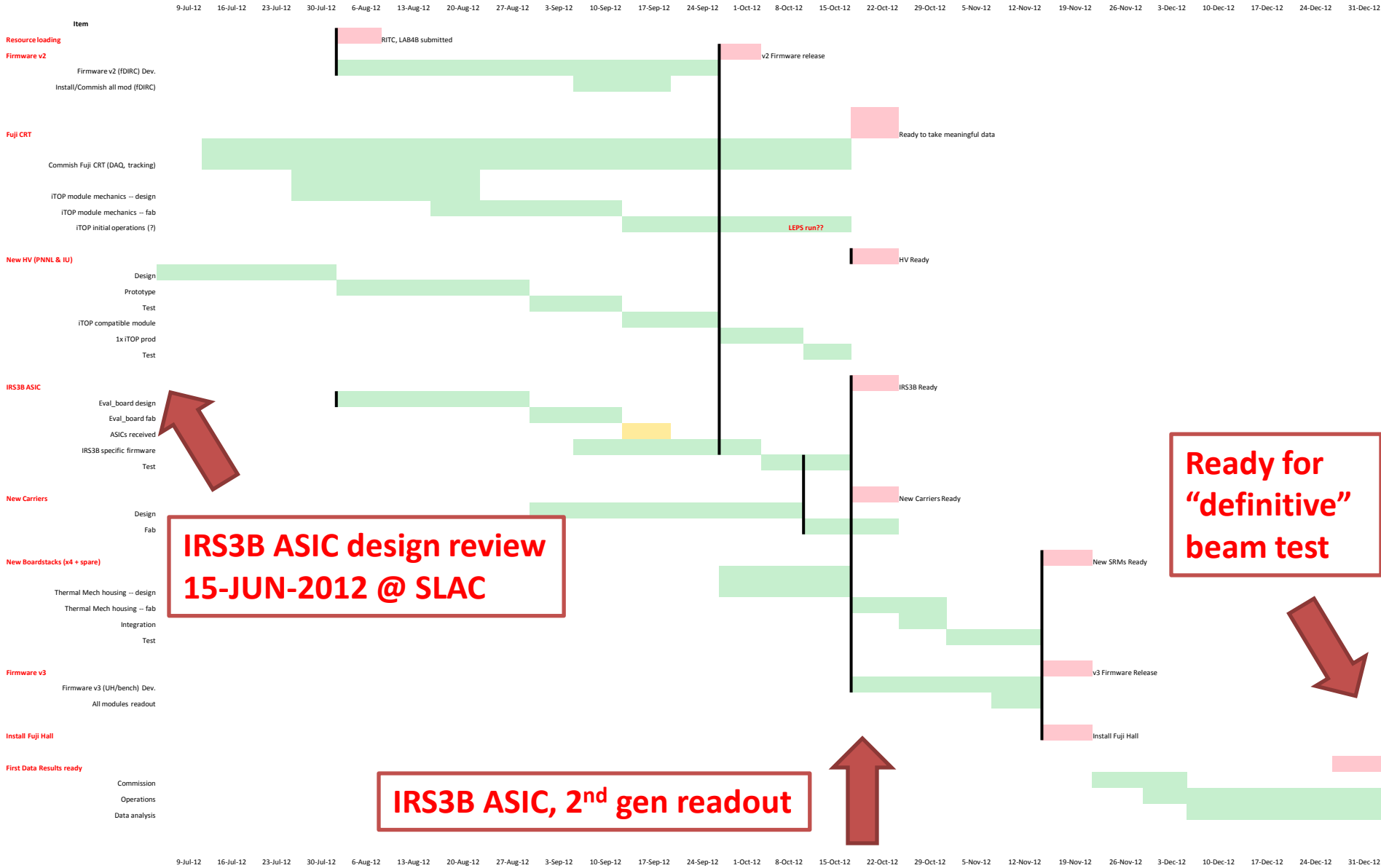
bench testing

still too hot!

new heatsink concept



TOP Readout Electronics Schedule



Readout Summary

- IRS3B “pre-production prototype” ASIC in fab, due back 10-SEP
- Next generation control firmware in development (fDIRC CRT)
- Redesign, fab of next generation board stack
  - Improved HV, cooling
  - Feedback control, in-situ calibration
  - Evaluate amplifier options
- Experience with pre-production prototypes by end of 2012
- Production in 2013-2014

Current TOP Strategy

2012 Oct — Nov — Dec — 2013 Jan — Feb — Mar — Apr

Temp. CRT ⟶ Full CRT

"Airway"

If IRS3B ready

FNAL quartz + IRS3B 2 layer @ LEPS

FNAL or new quartz + IRS3B 2 layer @ LEPS or Somewhere (SLAC, CERN,…

* 1st quartz delivery & tests

FNAL quartz + CFD 1 layer @ LEPS

if IRS3B not ready

FNAL quartz + CFD 2 layer @ LEPS

"Jeep way"

Verification of LEPS beam (multiple scattering ?)

CD-3B ?

CD-3B ?

- Beam availability:
  - LEPS: 2012 Oct/beg, 2013 Jan/beg, Apr/beg
  - Need check SLAC, FNAL, CERN, + others

DOE Readiness Summary

- Software, MCP-PMTs, Assy/clean-room, bar box covered separately (next)
- We have clear homework we must complete before we will be ready for review
- Key items to demonstrate
  - Confirm performance with final optics
  - Robustness of performance
  - Demonstrate Belle II readout compatible electronics
- Cosmic ray and Test Beam Campaign
- Passing CD3-b is crucial to keep on schedule