E21 COMET Status Report

Makoto Yoshida Osaka Univ.
for the COMET Collaboration

9th J-PARC PAC meeting
16th Jan. 2010, KEK

Contents

- The COMET Collaboration
- R&D status
  - Muon beamline: SC solenoids
  - Calorimeter
  - Extinction monitor
  - Simulation
- Prospects

The COMET Collaboration

- Collaboration with the UK, the US, Canada, Russia and Japan
- New collaborators are about to join
  - University of Glasgow, UK
    - Silicon detectors for muon beamline (late arriving particle tagger)
  - BINP, Novosibirsk, Russia
    - Electron calorimeters
- Collaboration meeting
  - Jan. 20th, 21st, 2010 at KEK

The COMET Collaboration

51 people from 14 institutes (Jan. 2010)

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T. Numao

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Y.G. Cui, R. Palmer
Department of Physics, University of Houston, USA
E. Hungerford

Imperial College London, UK
A. Kurup, J. Pasternak, Y. Uchida, P. Dauncey, U. Egede, P. Dornan
University College London, UK
M. Wing, M. Lancaster, R. D'Arcy
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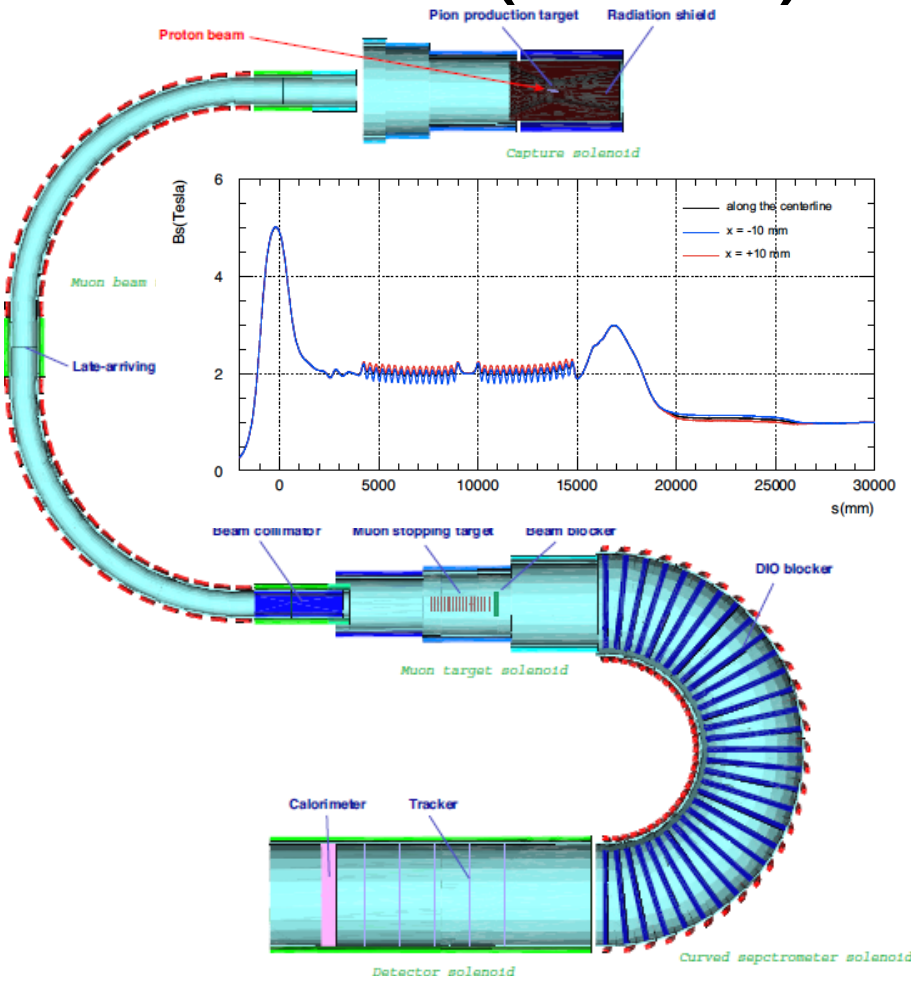
Department of Physics, Saitama University, Japan
M. Koike, J. Sato, M. Yamanaka
Department of Physics, Tohoku University, Japan
Y. Takubo,
High Energy Accelerator Research Organization (KEK), Japan
Y. Arimoto, Y. Igarashi, S. Ishimoto, S. Mihara, T. Nakamoto, H. Nishiguchi, T. Ogitsu, C. Omori, N. Saito, M. Tomizawa, A. Yamamoto, and K. Yoshimura

COMET Muon Beamline (CDR)

- Long SC magnet system from pion production to signal detection
- Pion Capture solenoid
  - Severe radiation from proton target
- Transport solenoid
  - Correction dipole filed
- Spectrometer solenoid
- Detector solenoid

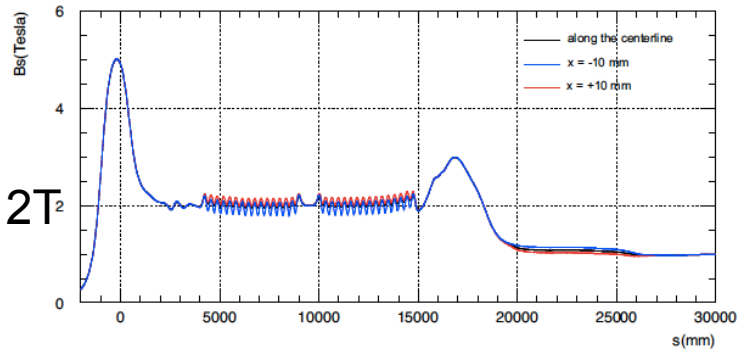


R&D progress since CDR

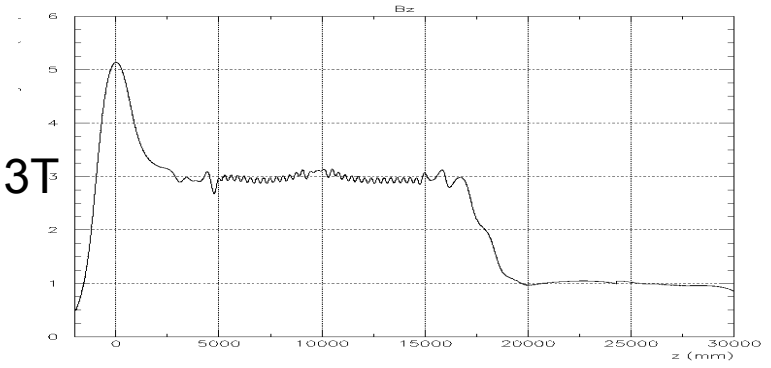
- Pion capture solenoid
  - Radiation study
  - Mu2e collaboration
- Transport solenoid
  - Field optimization
  - Quench study
- Spectrometer/Detector solenoid
  - Study on MgB2 SC wire
- Calorimeter
- Extinction monitor
- Software

Transport Solenoid

- Modify for better transport efficiency
  - larger bore or stronger field
- Stronger magnetic field 3T provides 1.4 times more stopping muons (without collimator).
  - Benefits to reduce bump before stopping target
- Will optimize muon stopping target and collimators



2T



3T

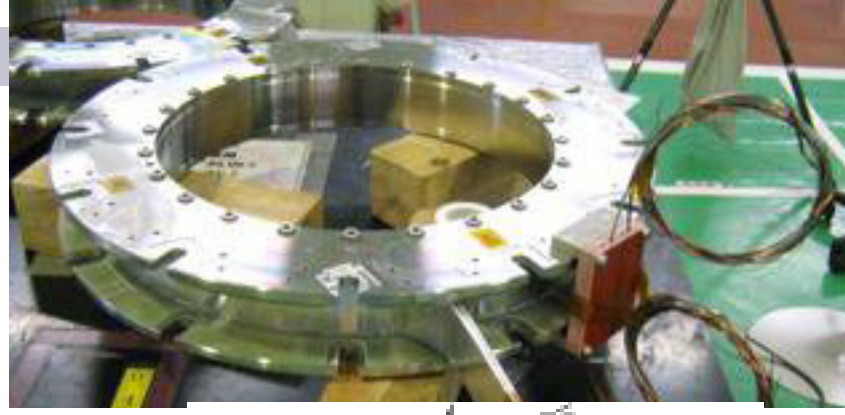
R&D on Transport Solenoid

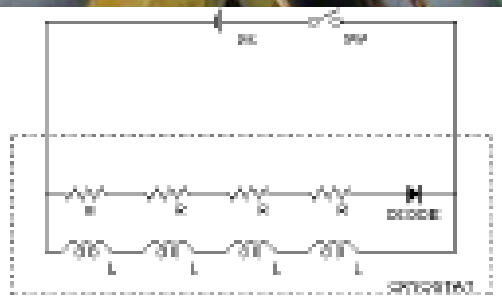
- Generate dipole field by surface winding dipole coils
- Prototyping of dipole SC coils in MUSIC at RCNP, Osaka Univ.

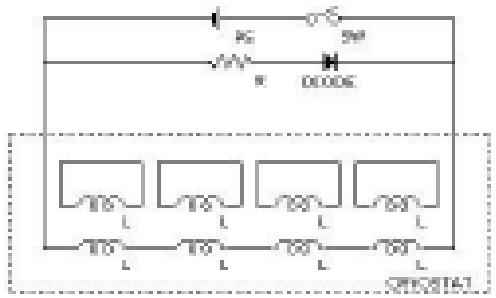
Dipole SC coils for MUSIC

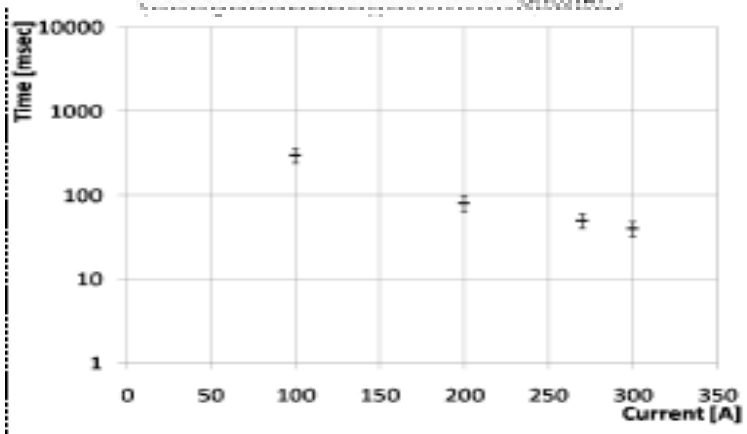
Quench Protection Study

- Long solenoids are segmented
- Quench propagation might be impeded
- Two types of quench back system are implemented on the coil mandrel, and tested by T. Adachi and Toshiba
  - Cu wire heater
  - Induction current in Al sheet ring
- Further investigation on heater type quench back can be done in MUSIC transport solenoids



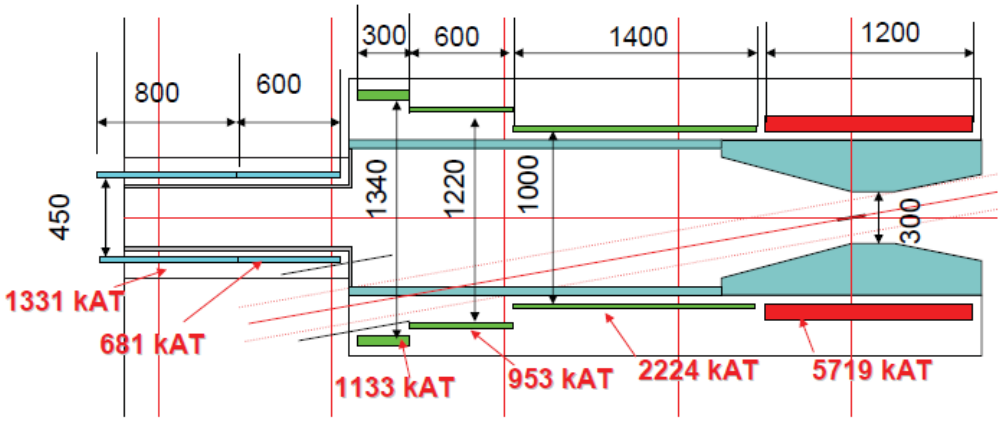


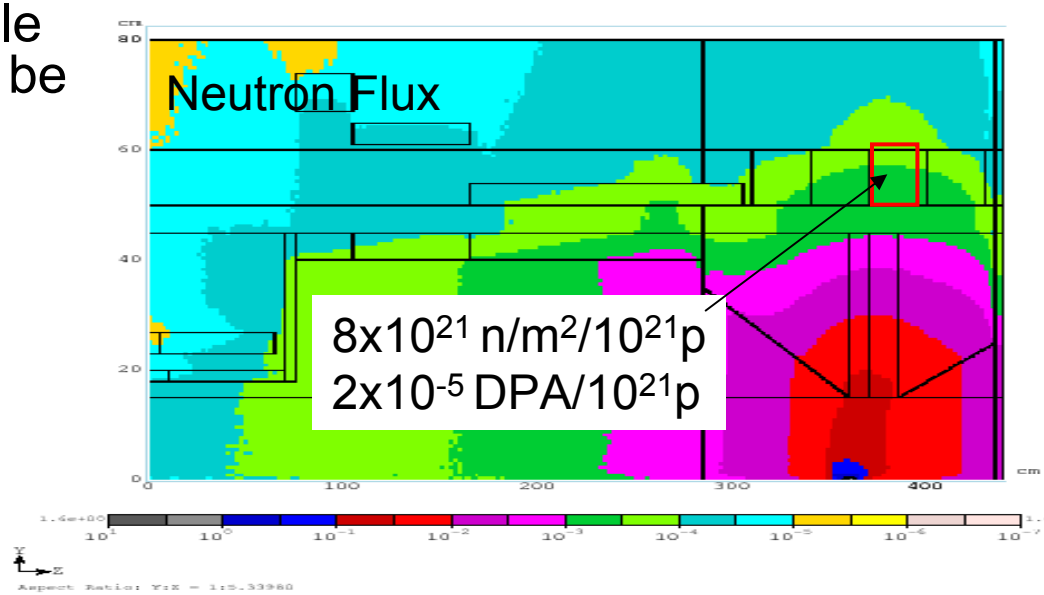




Radiation on Pion Capture Solenoid in CDR

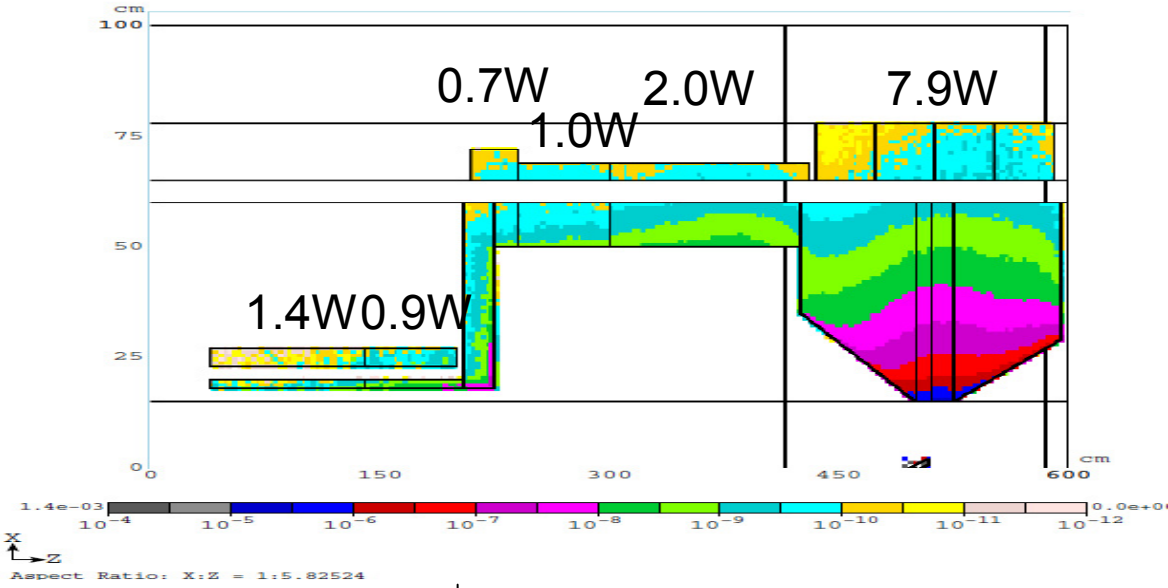
- Neutron irradiation can degrade conductivity of Al stabilizer
  - Neutron Flux:
    ~10^{22} n/m^2 for 10^{21}p
    - Same as ITER criteria
  - ~2x10^{-5} DPA for 10^{21}p
    - Conductor degradation
- Annealing with thermal cycle to room temperature might be necessary to recover degradation.
- Better to have margin
- Started to compare with another simulation code, PHITS

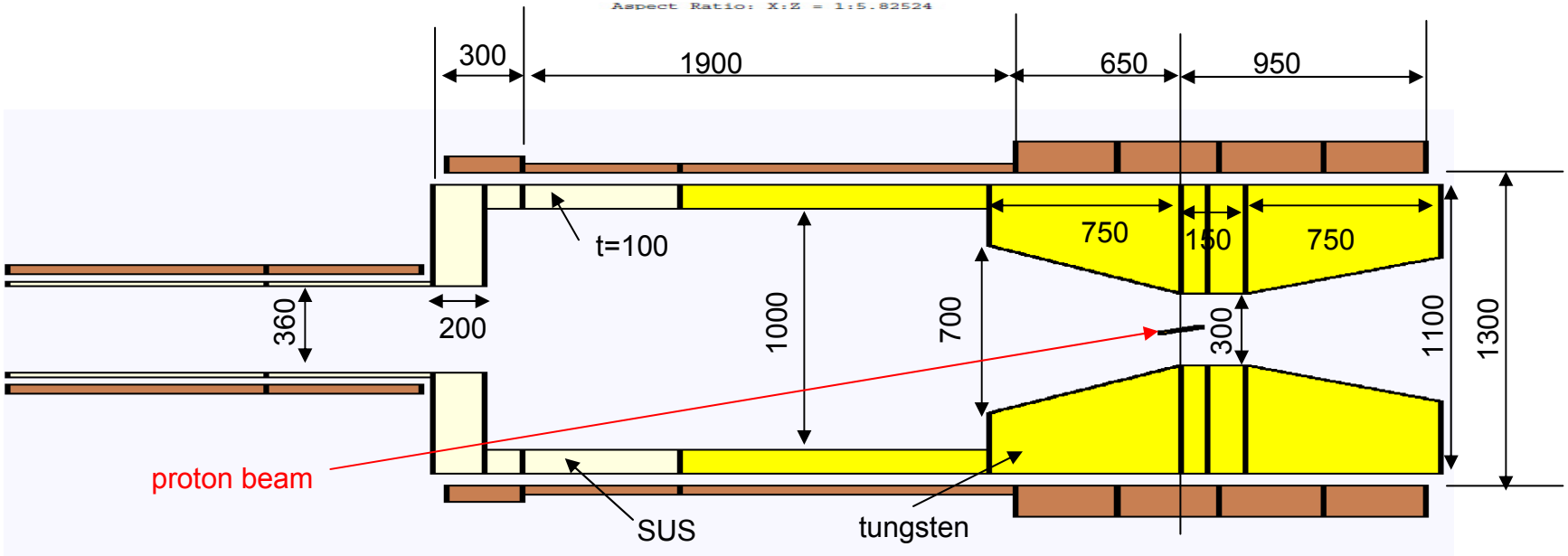




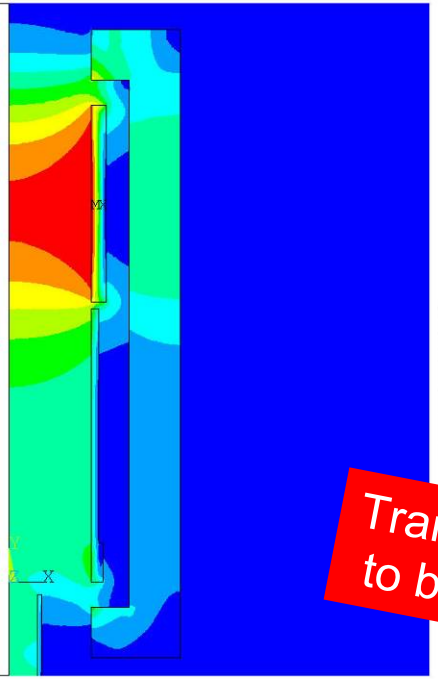
Capture Solenoid New Layout

- Enlarge coil diameter to 1300mm
- Thicker shielding by 150mm
- Simple mandrel
- 3×10^{-6} DPA/10^{21}p

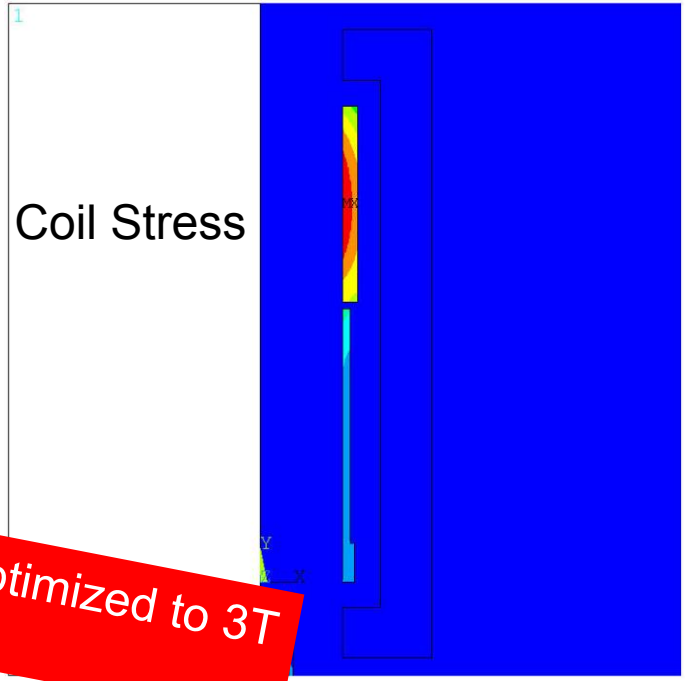




Field Map



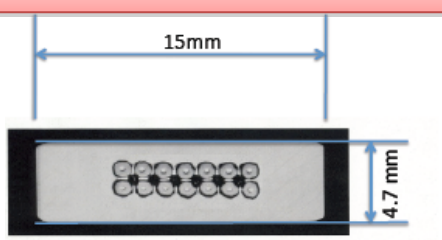
Coil Stress



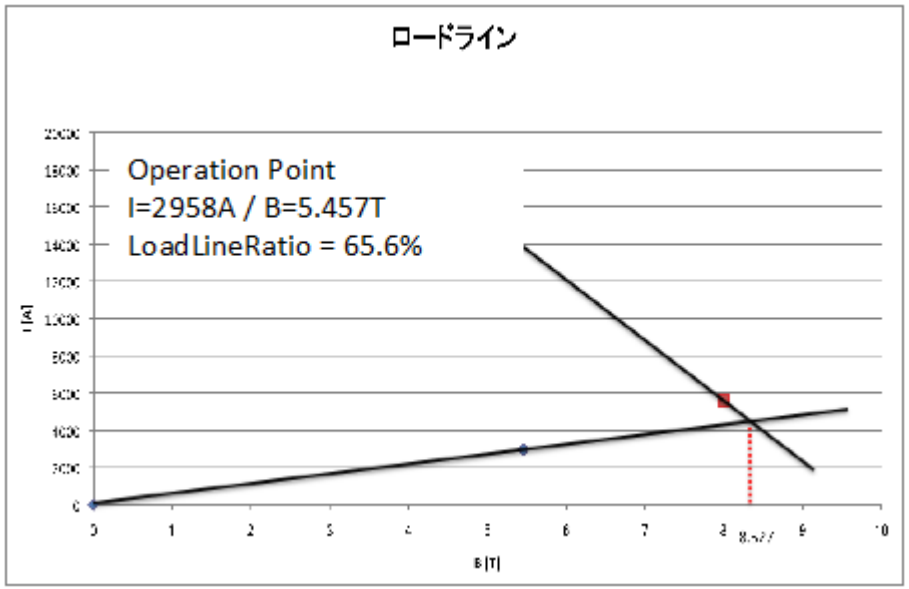
Transport not optimized to 3T
to be updated

R=650 mm
L=1550 mm
8 Layers
Current=2958 A
S-Energy=32.32 MJ
E/M=8.06 kJ/kg
Stress-eq=96 MPa
Mag-force=1.53 MN

New conductor development on going

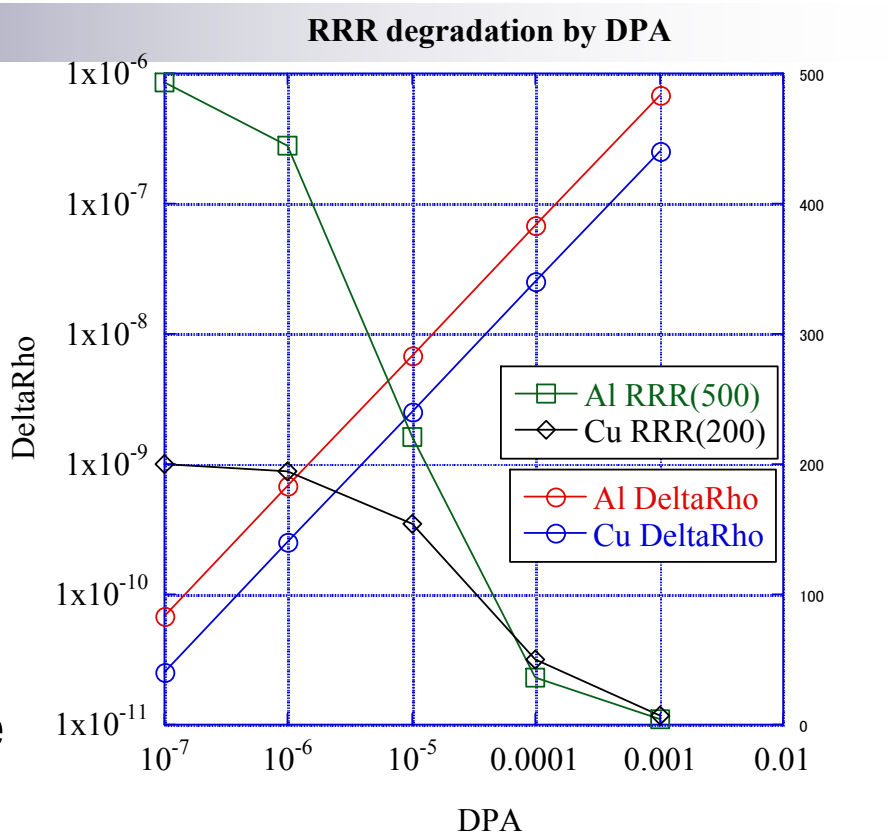


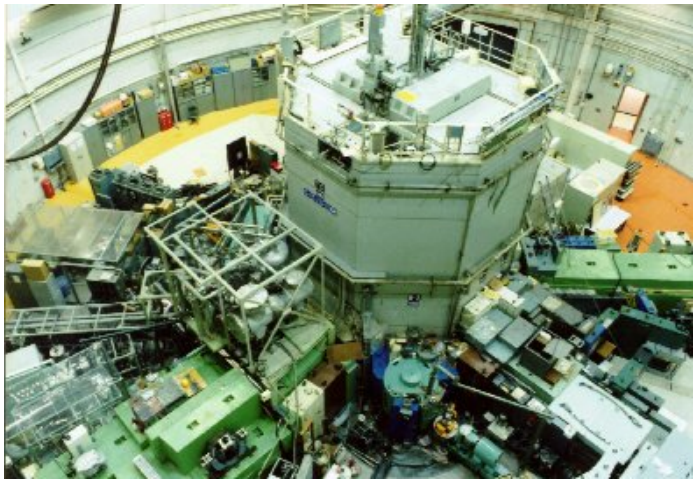
- Dimension 15mm*5mm
  - Including Insulation
  - 15*4.7 w/o ins.
- 14 strands (1.15mm dia)
- Al/Cu/SC ~ 7.3/0.9/1
- Yield Strength >200MPa



Neutron Irradiation Test

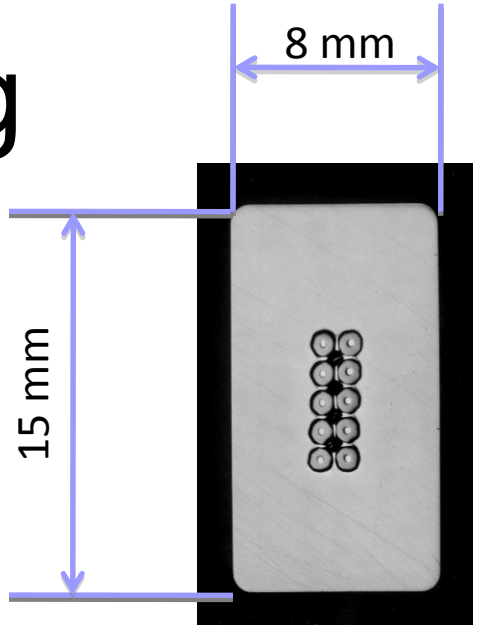
- Investigate conductor degradation by neutron irradiation
- Low temperature (>10K) irradiation facility is available at Kyoto Univ. Research Reactor.
  - 5MW
  - 10^{16} fast neutrons/cm^2/sec
- Plan in fall 2010.

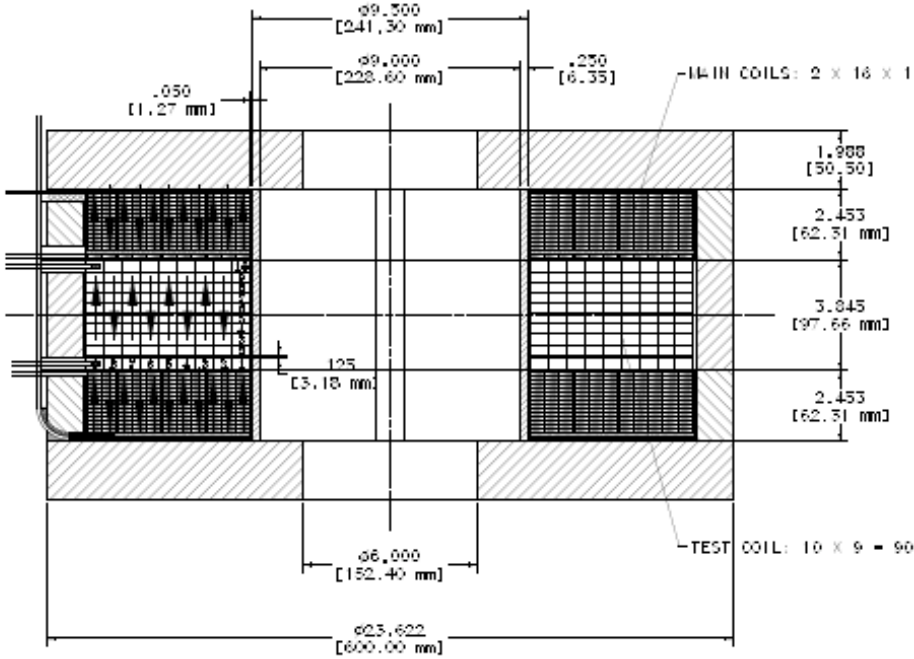




R&D with USJ Funding

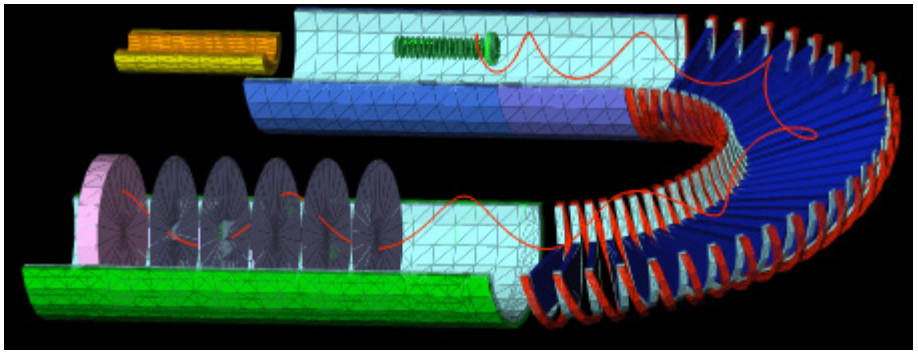
- Approved for JFY 2009
  - Try to adapt Al stabilized conductor for Mu2e for case study
  - Make small R&D coil to establish coil winding technology with Al stabilized conductor at FNAL
  - Use existing conductor = RIKEN SRC conductor

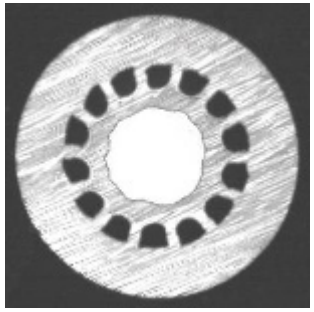


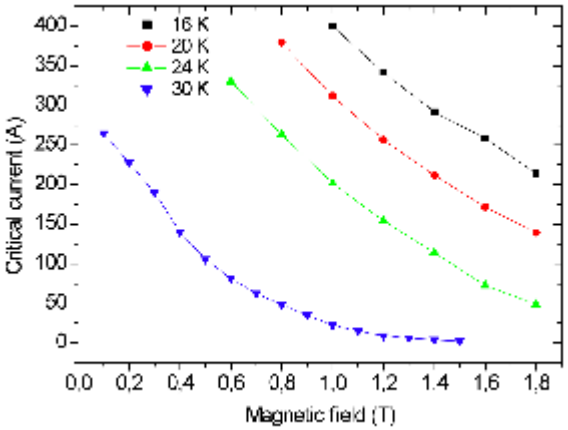


Spectrometer/Detector Solenoid

- Field 1T
- Possibility to use MgB_2 for better stability?
  - and eventual cost optimization?
- Some on going R&D with MgB2 Coil at KEK
  - Test Coil Fabricated by Company: soon to be tested
  - R&D coil winding at KEK: next March



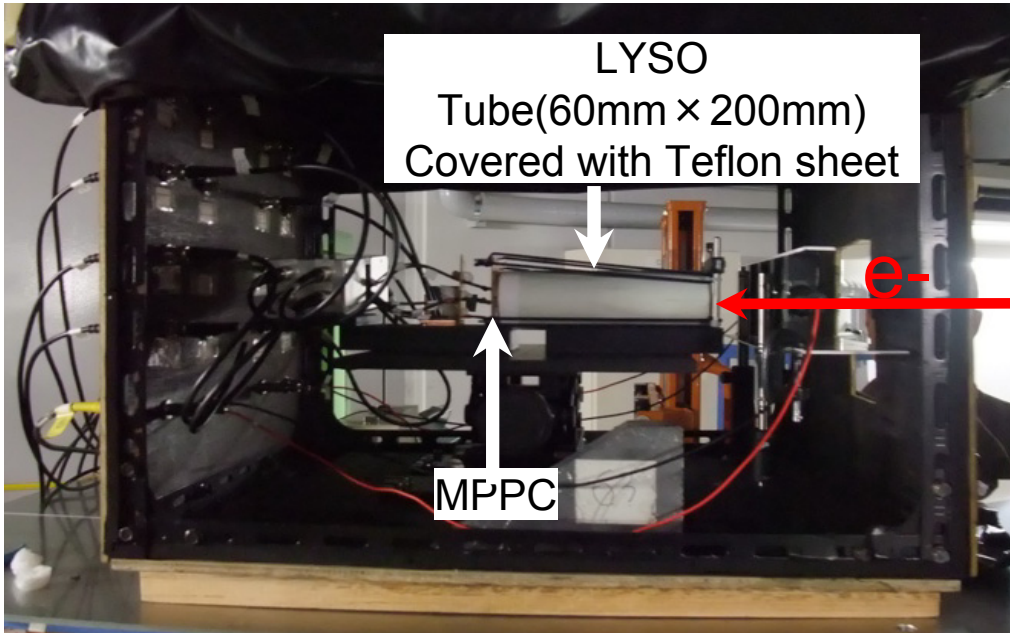


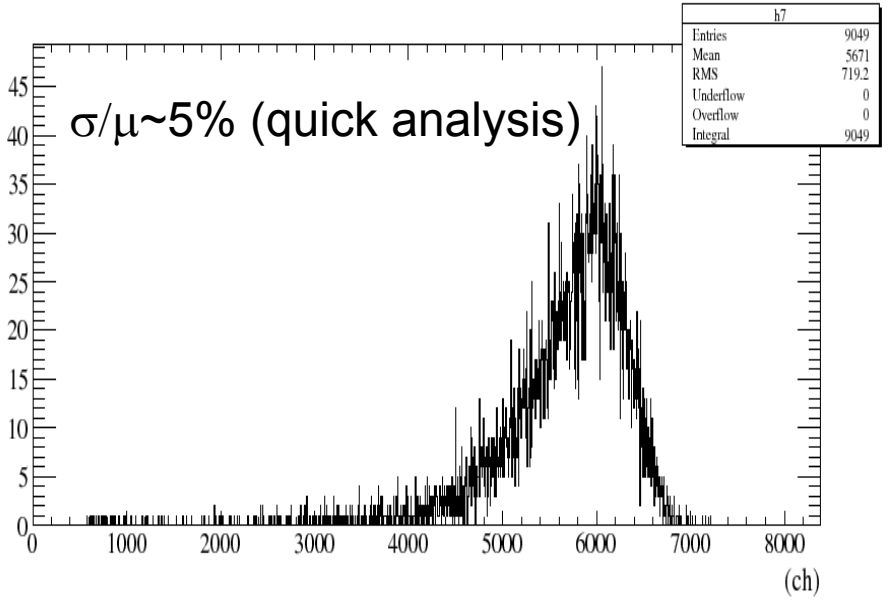


Conductor used for the test coil

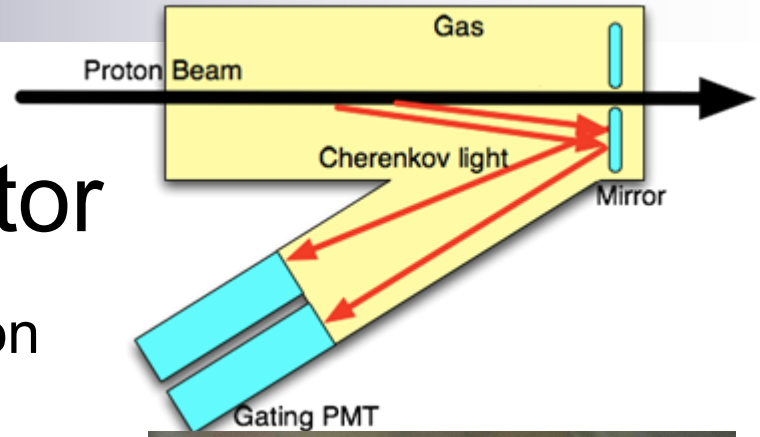
Calorimeter R&D

- LYSO crystal was exposed to electron beam at Tohoku Univ., Dec. 2009.
- Successful data taking with MPPC readout.
- Detailed analysis underway

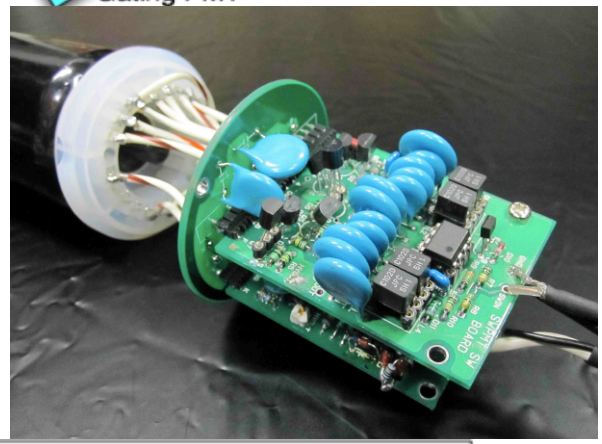


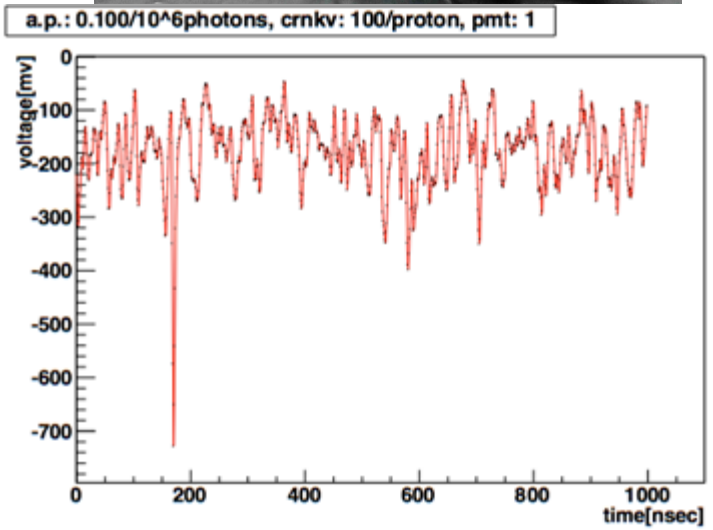


Proton Extinction Monitor



- We are developing proton extinction monitor
  - Detect single proton contaminating between proton pulses
  - Monitor extinction of 10^{-9}
- Photon detectors need to be gated to avoid damage by proton main pulse
- Gating circuit has been worked successfully
  - with 2-inch PMT(R329-02, 9954B)
  - Cutoff ratio ~10^{-6}
- After-pulses in PMT create dummy photon signals in signal time window
  - Add optical switch to reduce main pulse by 1/100
  - or try MPPC

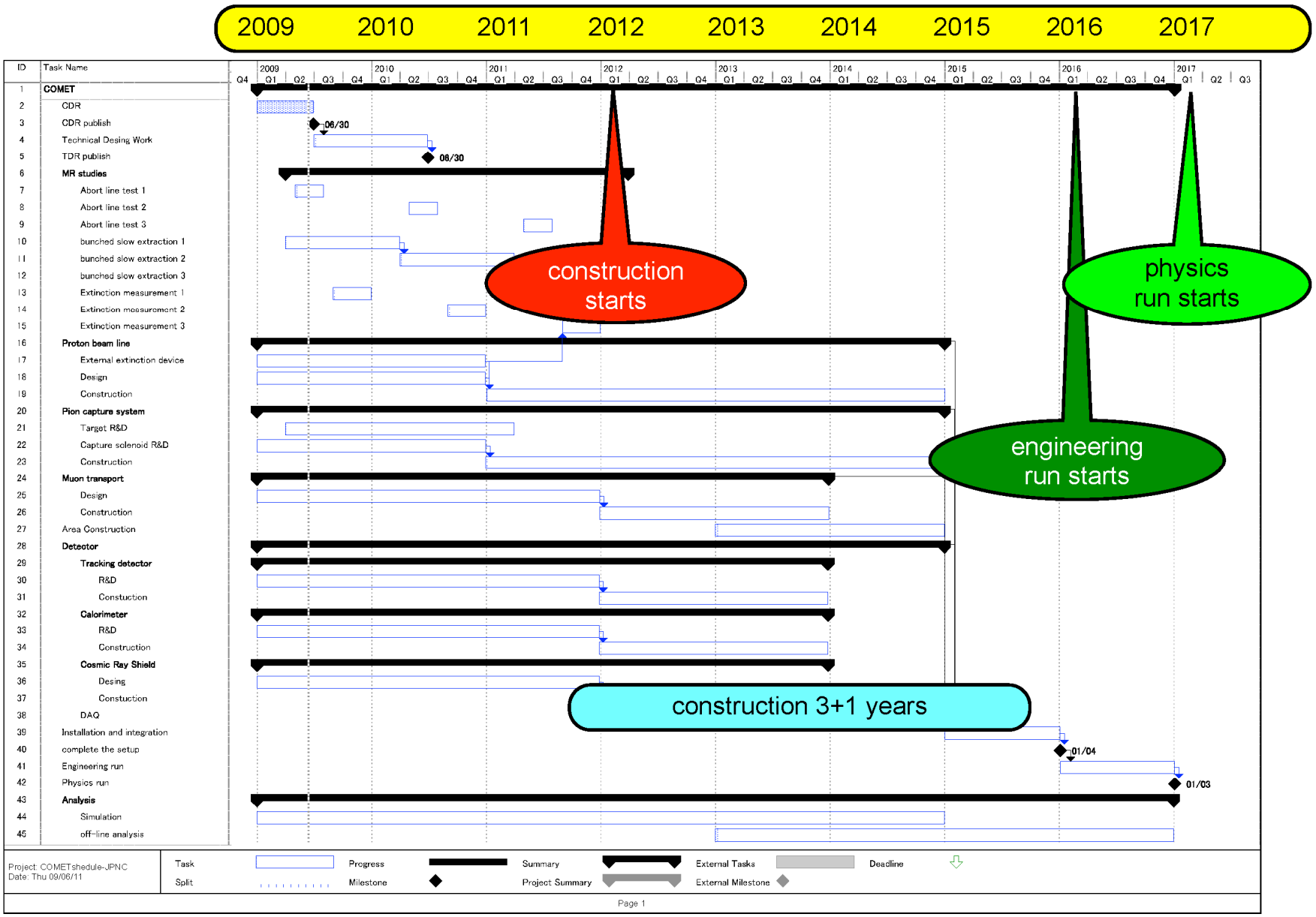




Simulation Studies

- We use two simulation tools so far
  - G4Beamline for muon beam transport
  - Geant4 based simulation for spectrometer and detectors
- Short term plan to integrate the functionality of the G4beamline simulation into the Geant4 based simulation.
- Longer term plan to develop a simulation and analysis framework that includes detailed (hit-level) simulation of detectors.
- Ongoing tasks:
  - Stopping target optimization
  - Study use of a detector system to identify late arriving particles
  - Alternative tracker technology
- Regular EVO meetings held to coordinate the activities in Japan and the UK

Timeline (presented at the previous PAC meeting)



Prospects

- R&D works underway towards the TDR
  - Refinement of pion capture solenoid design
    - Neutron irradiation on the pion capture solenoid
  - Quench protection
  - Field optimization
  - Calorimeter
  - Extinction monitor
  - Simulation studies
- Reevaluation of the superconducting solenoid coil design and costs
  - Superconducting solenoid conceptual design by companies has been started
- Reevaluate of the COMET Schedule
  - We have to keep the schedule to be competitive to Mu2e
    - Mu2e has passed CD0 process in Nov. 2009