Participation of KEK ACCL people in commissioning and upgrade of LHC

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KEK Accelerator Lab continues to send staffs to LHC.

- LHC accelerator commissioning + R&D for upgrade.
- Started with A. Morita (Sep. 2007 - Oct. 2008) and H. Ikeda (May 2008 -).
- In JFY 2009, 3 people will come, 4 - 6 months each.
- 4 people have applied to the nomination by KEK, then 3 were approved.
- Mainly for people who came after startup of KEKB.

LHC:

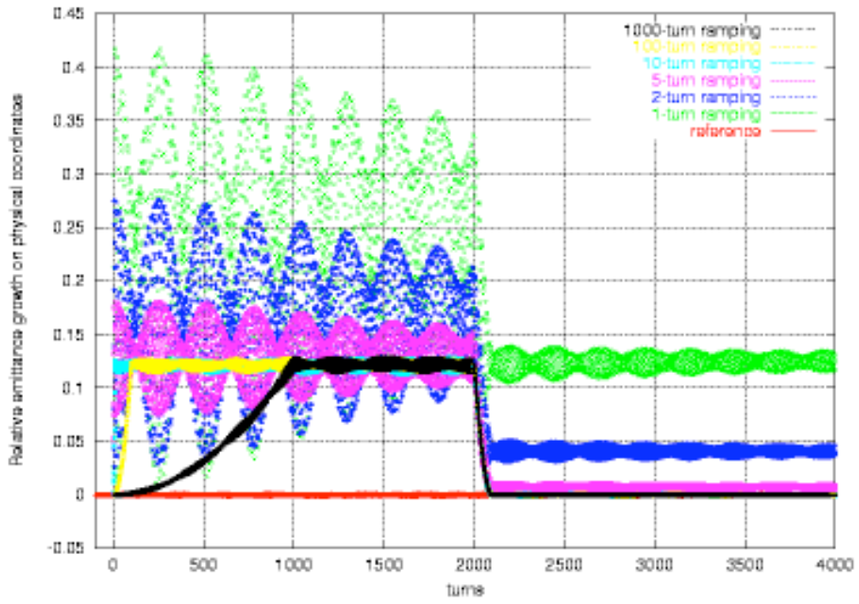
- Beam Optics / Dynamics (A. Morita)
- Beam Loss Monitors (H. Ikeda)
- Crab Cavity (Y. Morita, K. Nakanishi, et al)

Other projects:

- X-band / CLIC (K. Yokoyama, et al)
- MAD-X (E. Forest)

Beam Optics / Dynamics (A. Morita)

- IP Coupling/Dispersion/ β^* Knob for LHC
  - Calculation models are developed on SAD.
- Emittance Growth Simulation for LHC Crab Cavity Ramping Up
  - Threshold of emittance growth is between 5～10 turns.
    - Simulation model
      - Lattice: V6.503 Collision
      - Crab Cavity: 400MHz Local Crab @ ip4
      - Crab Crossing Angle: 285 μ rad @ ip5
      - Particle Distribution: Gaussian(Np = 10000)
      - Ramping Up: 1,2,5,10,100,1000 turns
      - Ramping Down: 100 turns(#2000 ～ 2100)



- KEKB Lattice Conversion from SAD to MAD-X
  - It turned out that it is impossible without extending MAD-X.
    - Missing features for KEKB lattice description
      - Tilted solenoid / Overlapping solenoid with multipoles
      - Edge focusing of dipole kicker
      - Quadrupole linear fringe
      - Sector bend with dipole kick(K0)

Beam Loss Monitors (H. Ikeda)

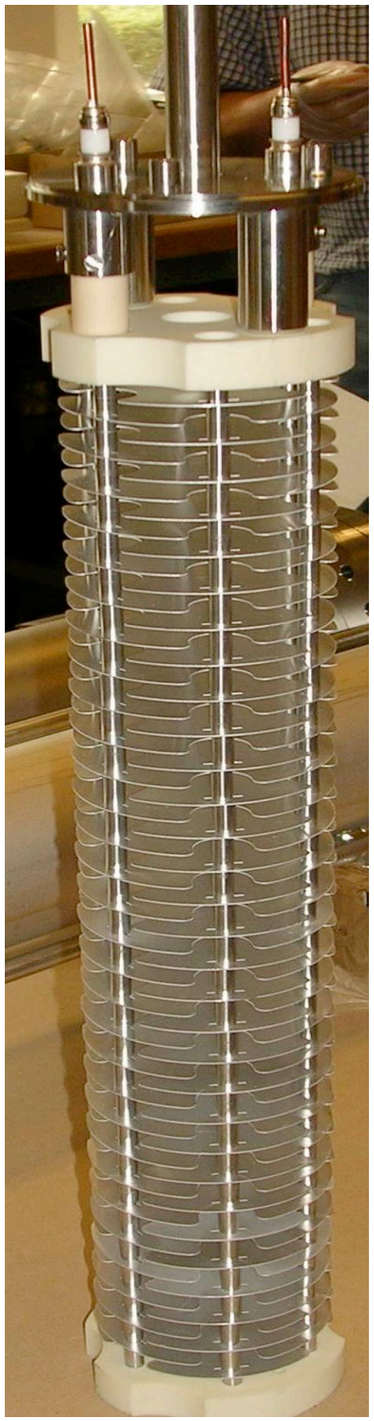
- Affiliation : AB/BI/BL
- Analysis of the testing the BLM system to verify the reliability of ensuring the protection functionality for the LHC.
  - Current to frequency converter (CFC) card status check
    →Bad Channels caused by ground loop are fixed.

CFC: 8 sections * 4 positions * 16 modules * 16 channels

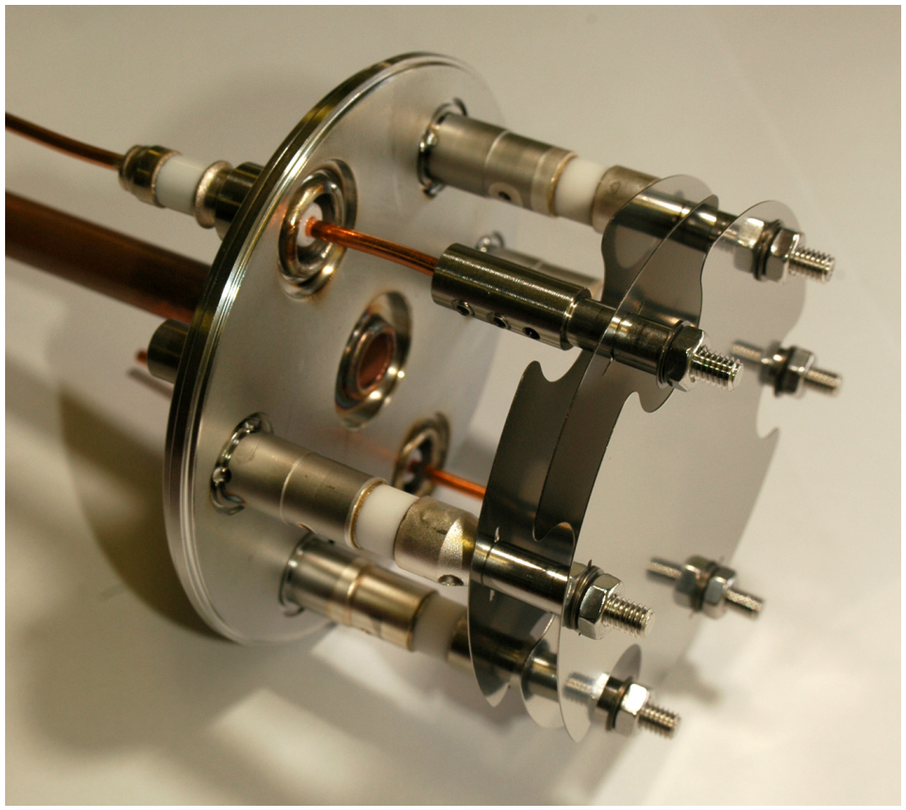
  - Analysis of High Voltage (HV) activation test and HV modulation test during operation : → threshold setting to reject bad channel which caused by aging and radiation damage on the electronics.
  - Check the consistency among the several DB and establish a reading scheme.

LHC - BLM

H. Ikeda

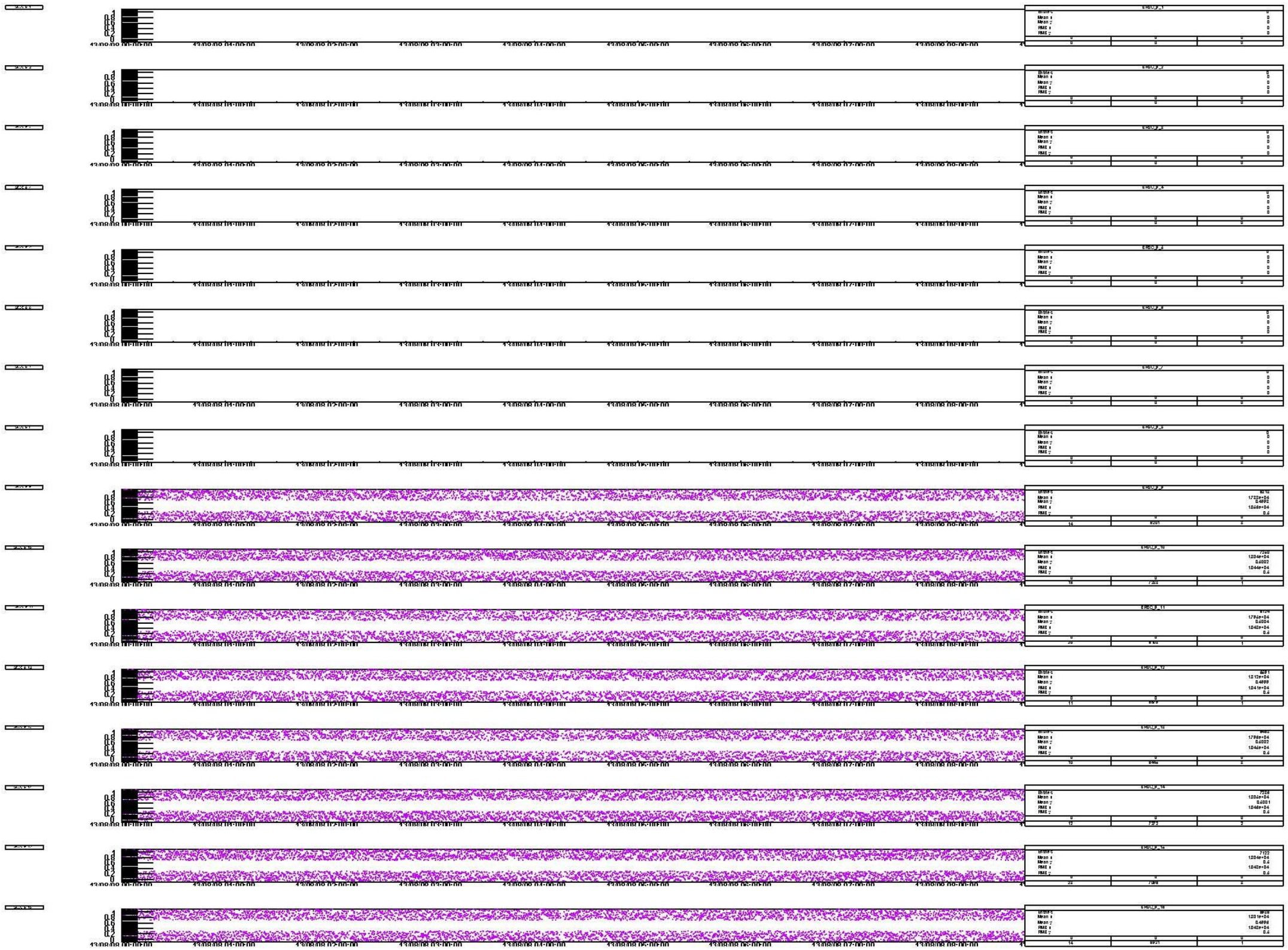


- 3643 Ionization chambers (IC)
- 303 Secondary emission monitors (SEM)
- 25 VME Crates in 8 racks per LHC octant.
- Signal cables for 3m up to 600m length
- Stainless steal cylinder
- Parallel electrodes distance 0.5 cm
- Diameter 8.9 cm
- Voltage 1.5 kV
- Low pass filter at the HV input
- **Signal Ratio: IC/SEM = 60000**



An example of frequently changing the status of CFC card (Analysis with ROOT by Ikeda)

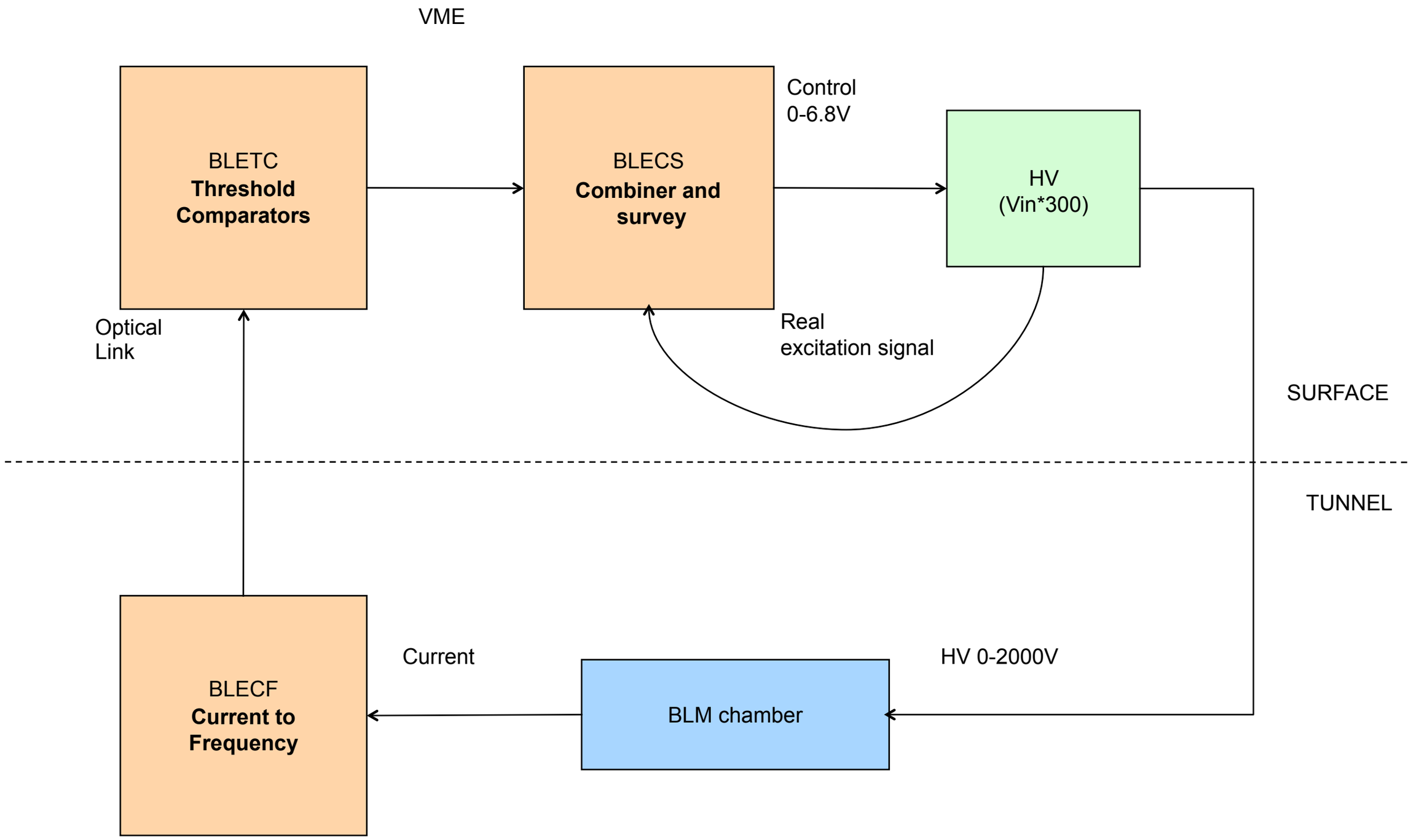
H. Ikeda



10 hours

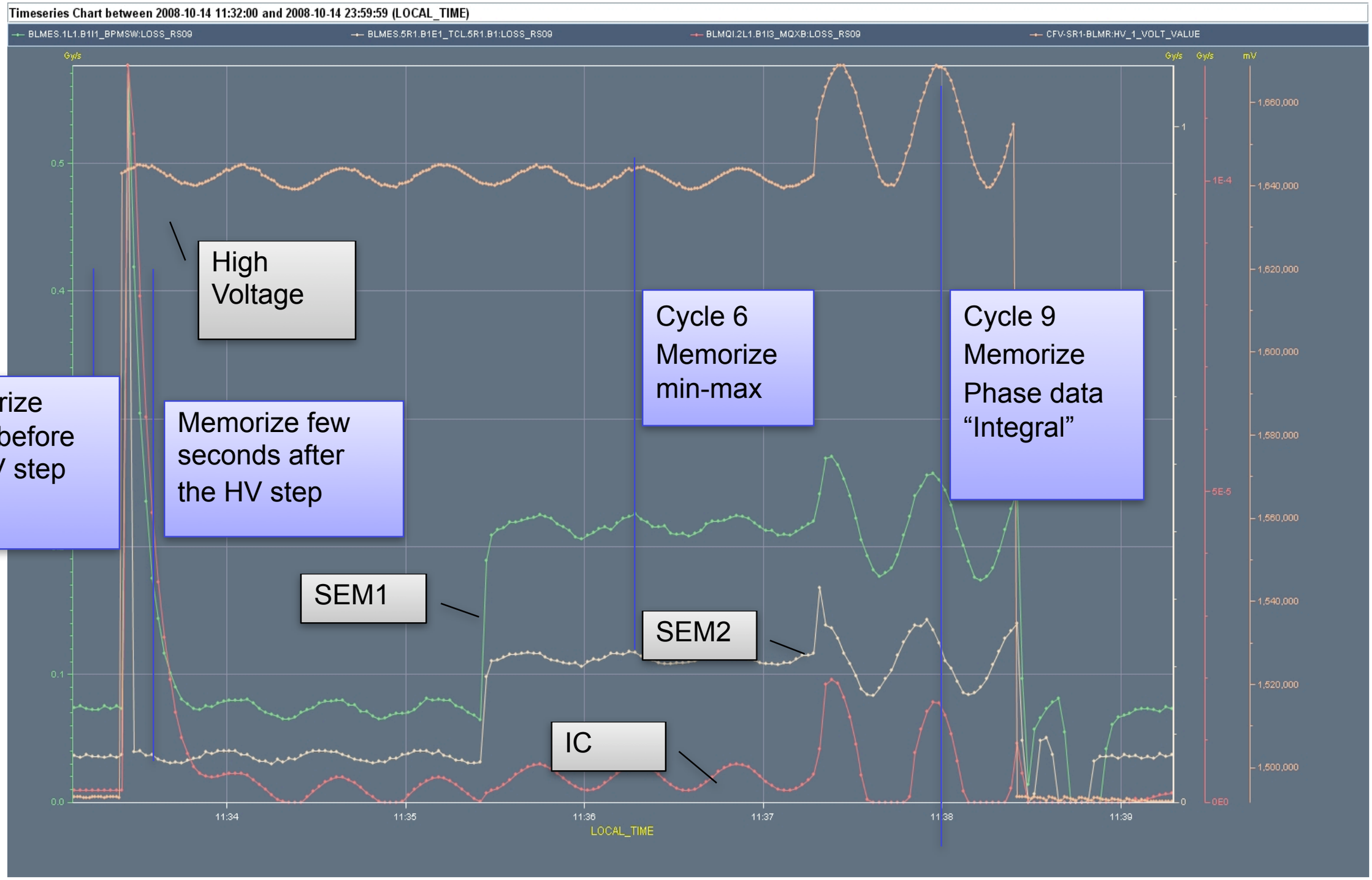
Setup of HV modulation test

H. Ikeda



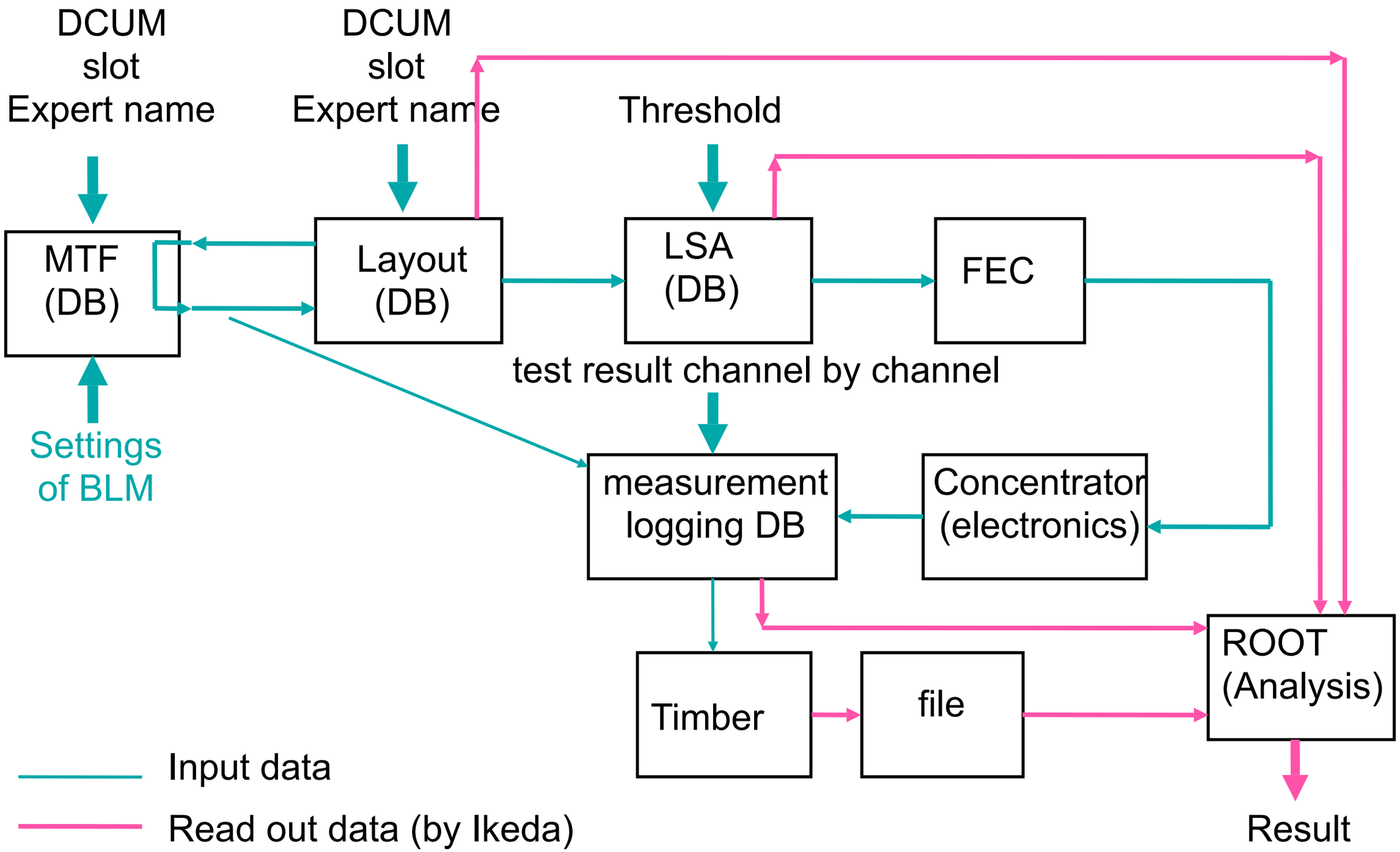
Result of HV modulation test

H. Ikeda



Pick up the information of the BLM from several DB to check the test result and set the threshold.

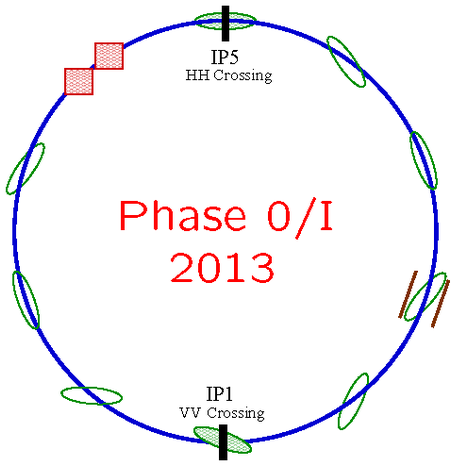
H. Ikeda

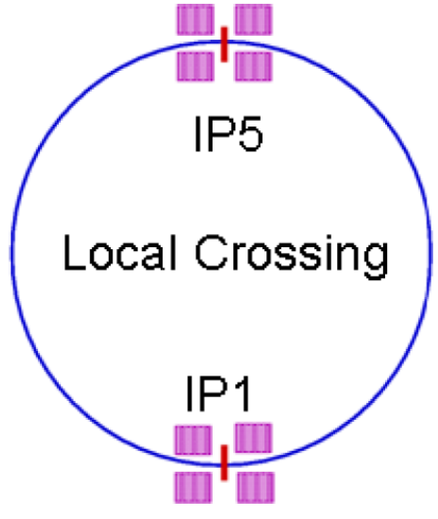


LHC - Crab Cavity project as an international collaboration

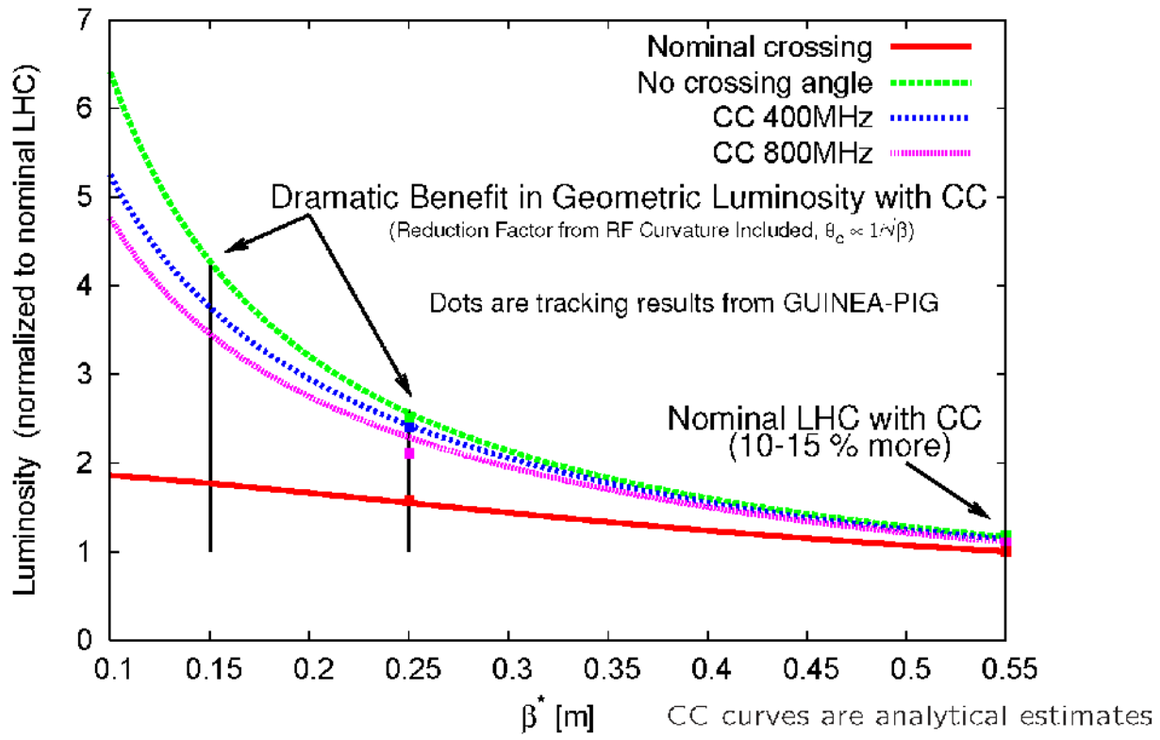
Y. Morita

- Phase 0/I
  - Global crab scheme
  - Feasibility study of the crab crossing
    - LUMI increase ~10%
  - Crab cavity: baseline design by US-LARP
  - Fabrication and cold test: at KEK
    - not yet funded
  - High power tests and beam tests: ?





- Phase II
  - Local crab scheme
  - Increase LUMI by a factor of two
    - With small β*
  - Need compact crab cavities
  - KEK proposed a new type

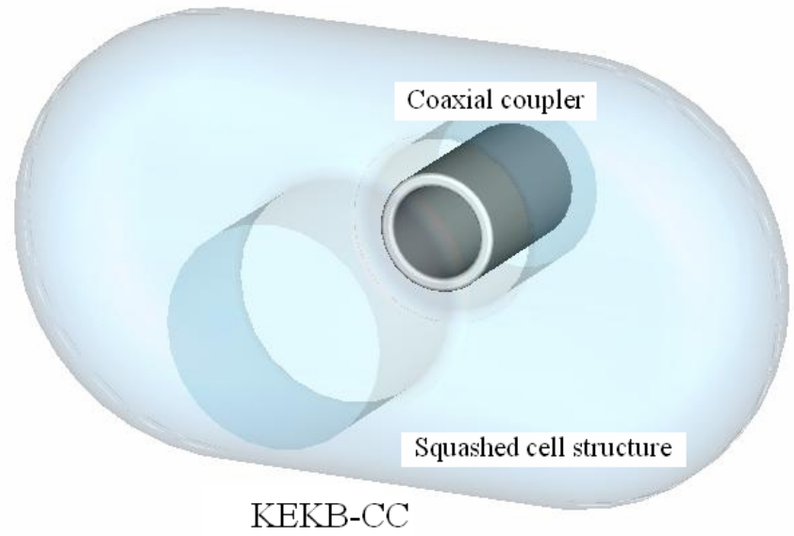


Y. Morita

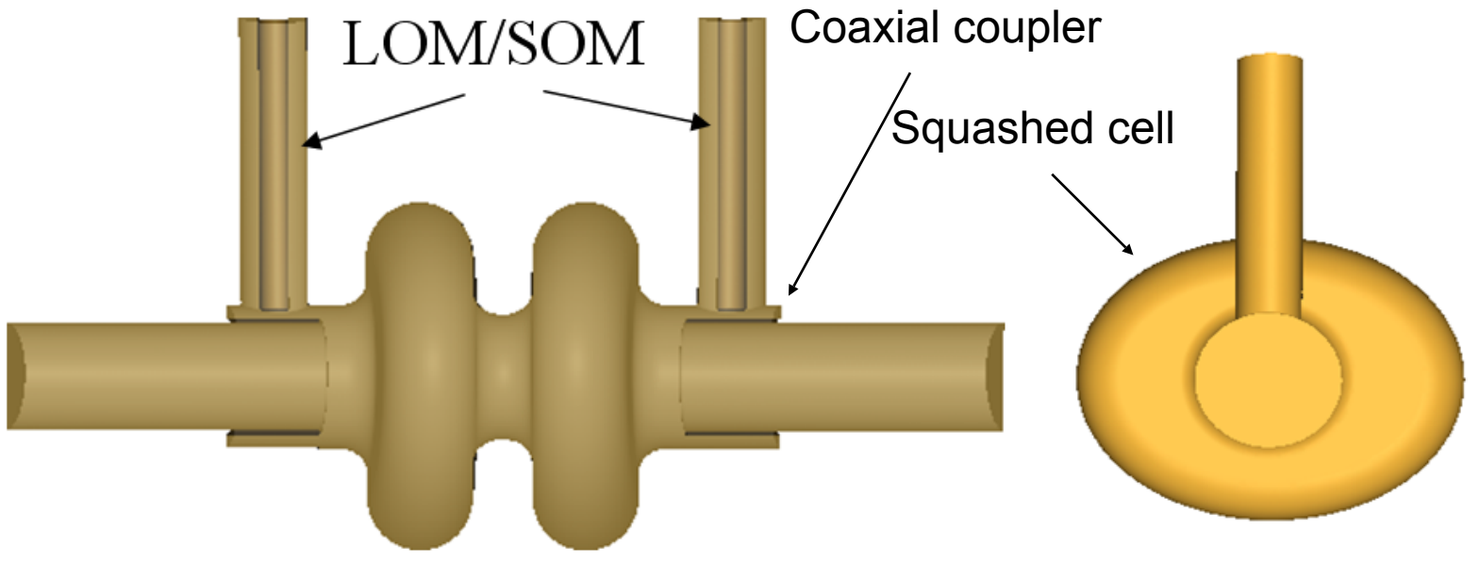
Baseline cavity for phase 0/I

Recently US-LARP proposed a baseline cavity

- The baseline design has similar properties like KEKB-CC
  - Elliptical/squashed cross section
  - Coaxial coupler
- Different properties
  - Two-cell cavity
  - 800 MHz (KEKB-CC: 509MHz)
  - More complicated LOM/SOM/HOM coupler



KEKB-CC



Baseline design, L. Xiao, LARP-CM11, 10/28/08

Frequency	800MHz
(R/Q)_T	117ohm/cavity
Deflecting Voltage V_T	2.5MV
Deflecting Gradient Ekick	6.67MV/m
Epeak	24.72MV/m
Bpeak	82.75mT
Mode separation (Opt.-SOM)	89MHz

Y. Morita

Conceivable contributions from KEK for the LHC Crab Cavity

Not yet funded !!

- Fabrication of prototype CC at KEKB
  - Based on the experiences for KEKB-CC fabrication
  - Cavity design: US-LARP baseline design
  - Fabrication of cavity cell
  - Surface treatments (Heat treatment, EP, High pressure rinsing)
  - Vertical cold test at KEK
  - Fabrication of cryomodule: FNAL/KEK/CERN collaboration
  - Human resources?

There are several key technologies for fablilcation, already experienced at KEK.

Hydroforming of the squashed cavity cell and electron beam welding
Surface treatments (especially electro-polishing)
Barrel polishing, Heat treatment, High pressure water rinsing, etc.

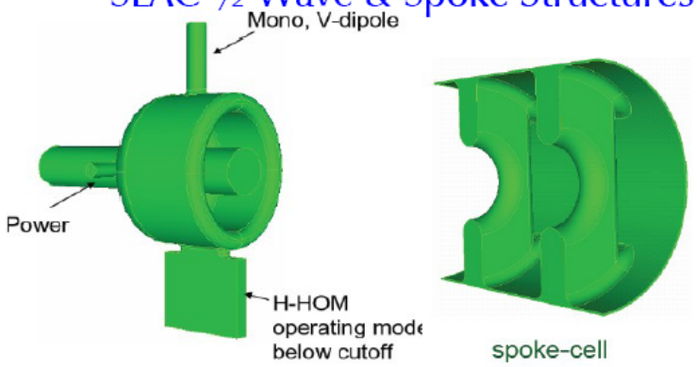
Y. Morita

Compact Crab Cavities for Phase 2

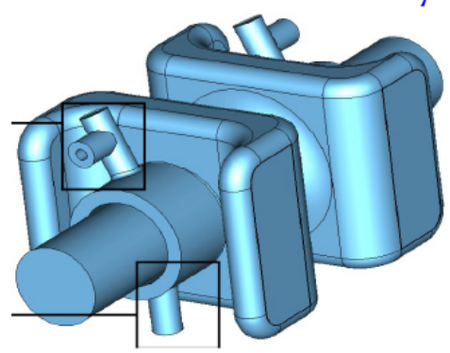
- Compact CC is attractive for the future local crab scheme
- There are many interesting designs (US-LARP, UK-EUCARD, KEK)

Compact Cavities

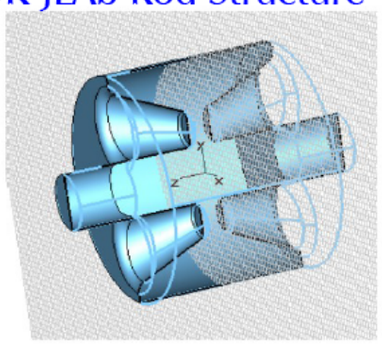
SLAC ½ Wave & Spoke Structures



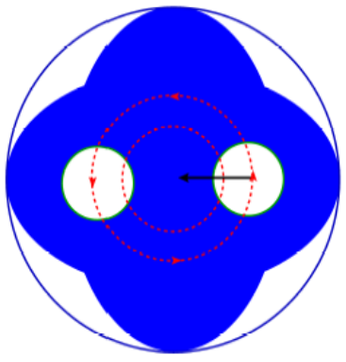
FNAL Mushroom Cavity



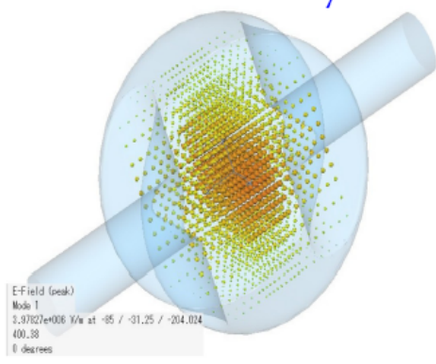
UK-JLAb Rod Structure



BNL TM010, BP Offset



KEK Kota Cavity

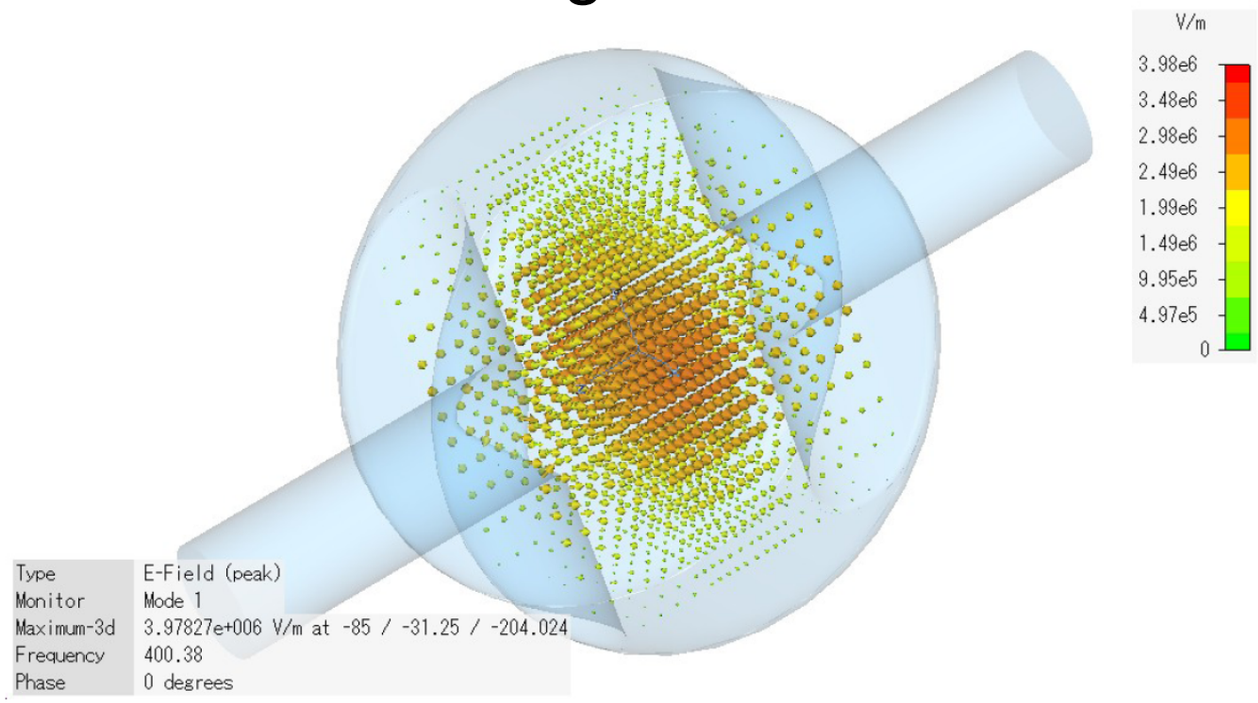


Rama Calaga, LARP-CM11, 10/28/08

A New Design for Compact CC

K. Nakanishi / Y. Morita

- We proposed a new design, “KOTA” cavity:
  - Use the lowest order mode (TM010) of a pill box cavity to kick the beam.
    - No need to damp LOM
  - Electric fields kick the beam to make crabbing.
  - But magnetic fields kick back (in a pill box cavity).
  - Then a nose cone structure will shield the magnetic fields on the beam passage.



Beam Study of Crab Cavity at KEK

Y. Morita

- Dear all,
  As you probably already know I will be in KEK from the 8th to the 18th of December. The main purpose of my visit is to attend the ATF2 collaboration meeting. However I will have some days to understand the KEK crab cavity problematics (weekend and more). R. Tomas

- Test 1:Controlled RF noise
  - Until blow-up due to beam-beam
  - Variation with beam current

- Test 2: Ramp-up of Crab Cavity with beam: skipped this time.

- Test 3: Longitudinally kicked beam with crab cavities
  - Qs sidebands in the transverse spectrum