## Participation of KEK ACCL people in commissioning and upgrade of LHC

#### Dec. 12, 2008 @ CERN-KEK Committee

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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:

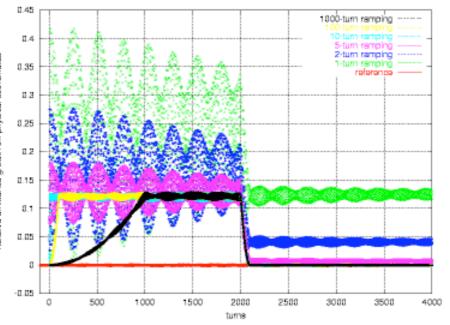
- X-band / CLIC (K.Yokoyama, et al)
- MAD-X (E. Forest)

## 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  $5\sim$ 10 turns.
    - Simulation model
      - Lattice:
      - Crab Cavity:
    - Crab Crossing Angle:
    - Particle Distribution:
    - Ramping Up:
    - Ramping Down:

V6.503 Collision 400MHz Local Crab @ ip4 285 µ rad @ ip5 Gaussian(Np = 10000) 1,2,5,10,100,1000 turns

100 turns(#2000  $\sim$  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

- 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)

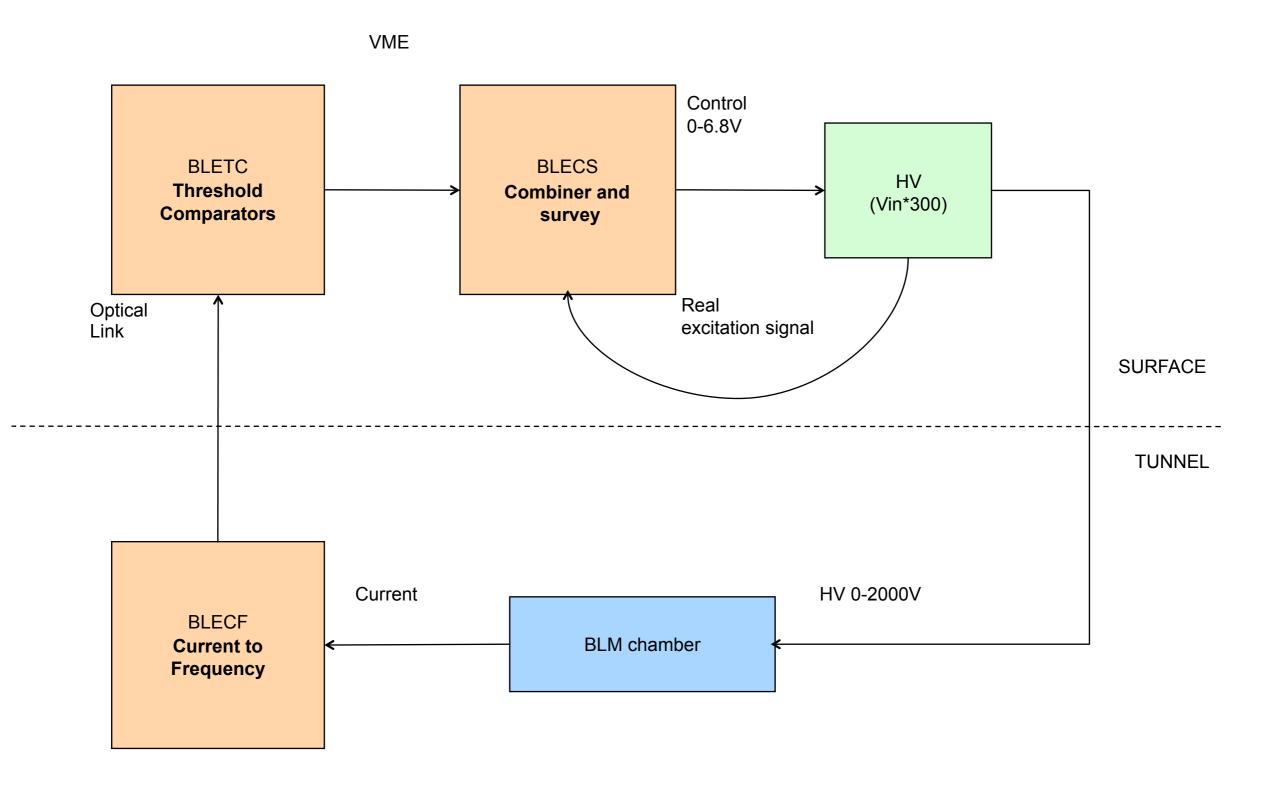
H. Ikeda

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#### 10 hours

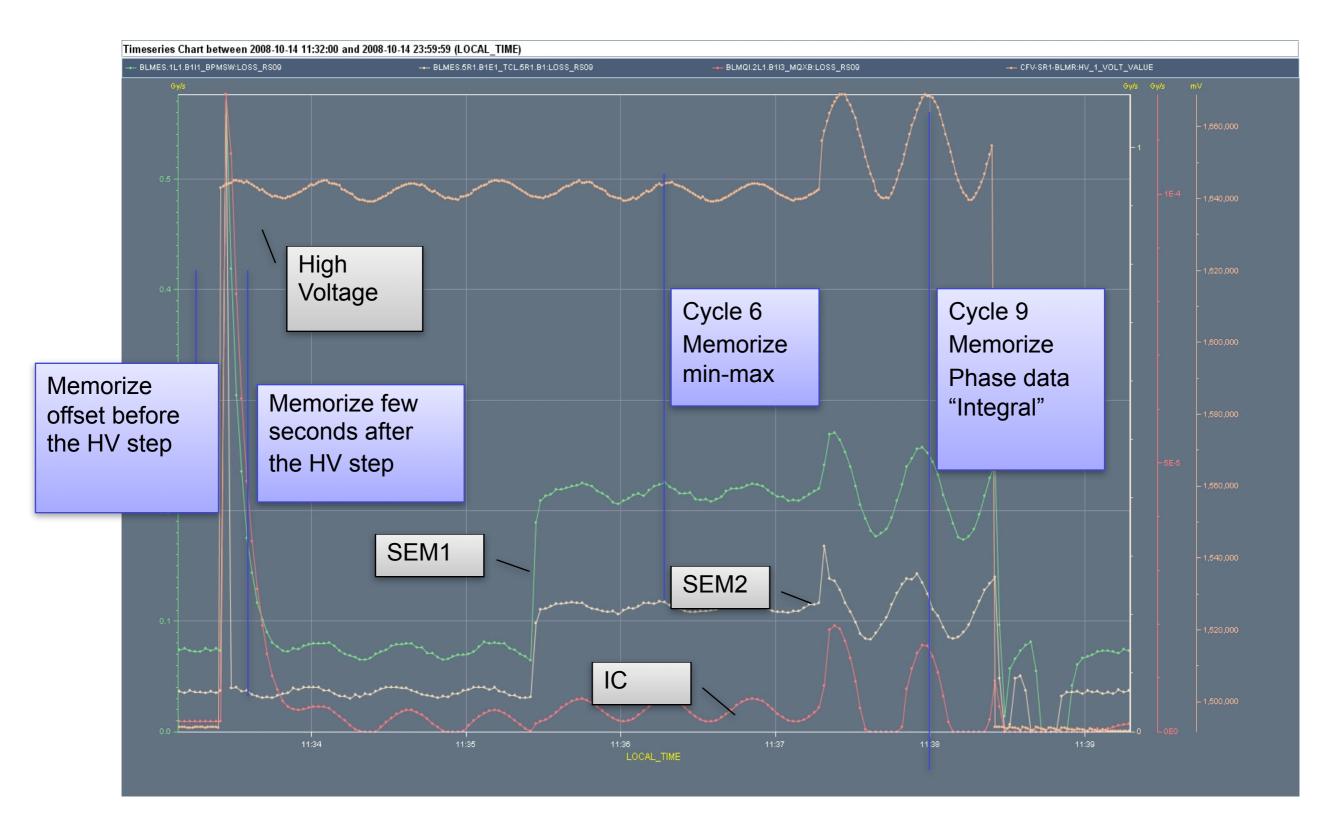
#### Setup of HV modulation test

H. Ikeda



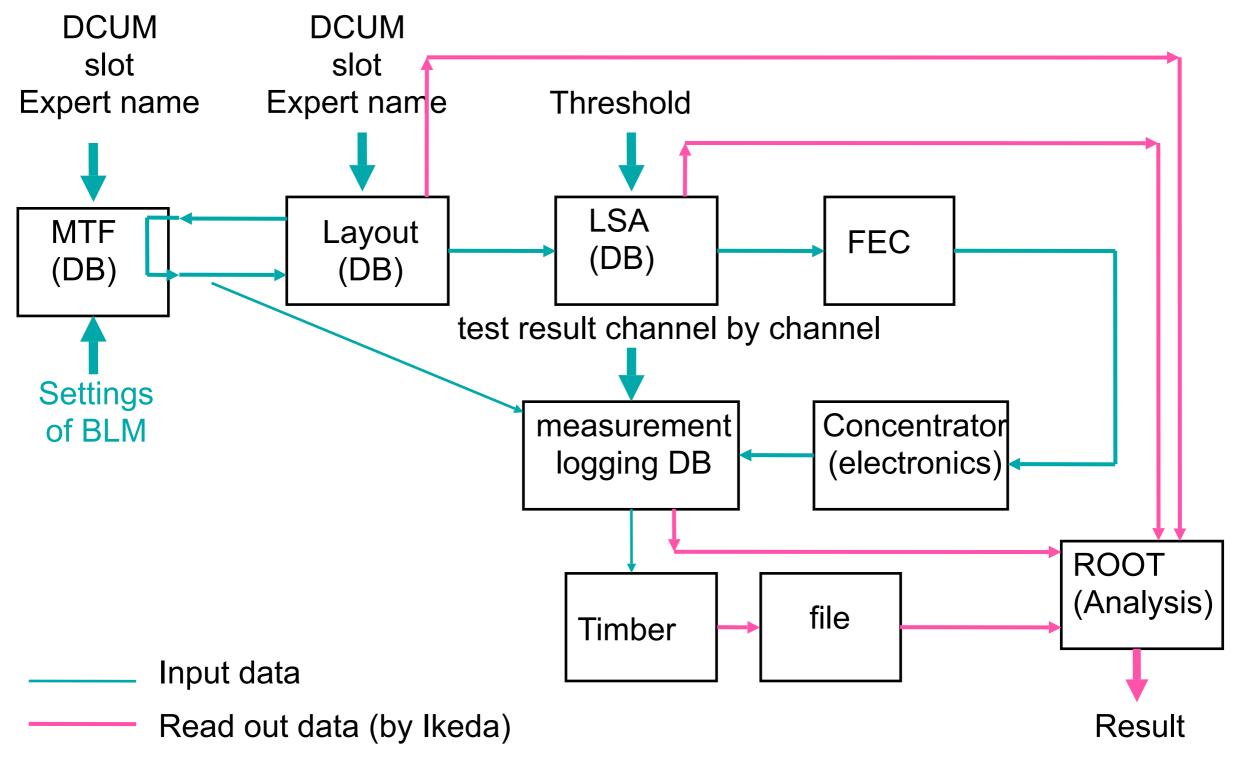
#### Result of HV modulation test

H. Ikeda



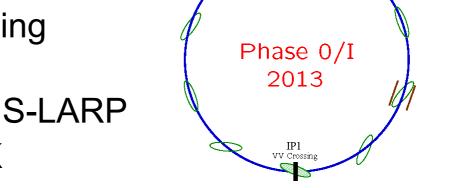
## Pick up the information of the BLM from several DB to check the test result and set the threshold.

H. Ikeda



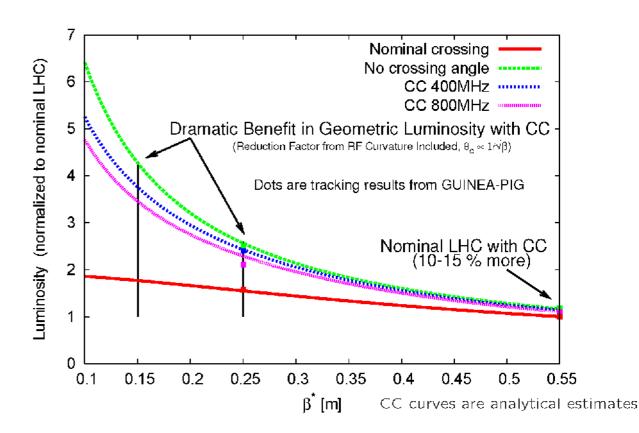
### LHC - Crab Cavity project as an international collaboration

- 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  $\beta^*$
  - Need compact crab cavities
  - KEK proposed a new type



IP5

HH Crossin



Y. Morita

IP5

Local Crossing

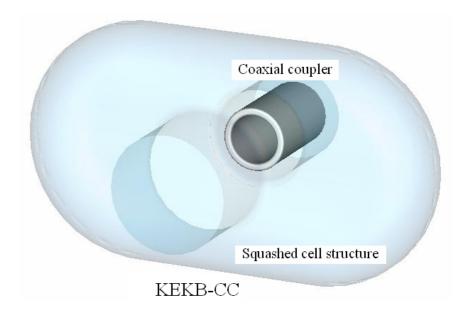
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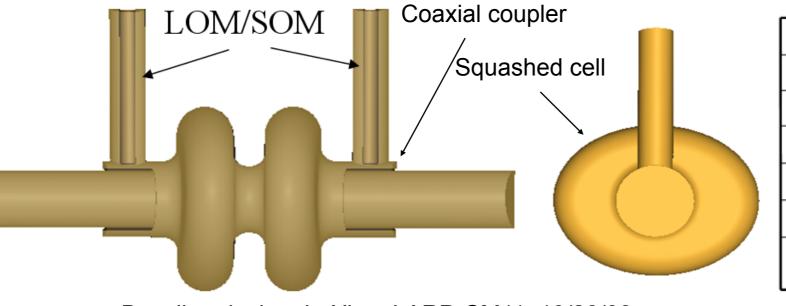
#### Y. Morita

## 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





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

Frequency	800MHz
(R/Q)_T	117ohm/cavity
Deflecting Voltage V <sub>T</sub>	2.5MV
Deflecting Gradient Ekick	6.67MV/m
Epeak	24.72MV/m
Bpeak	82.75mT
Mode separation (OptSOM)	89MHz

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Y. Morita
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## Conceivable contributions from KEK for the LHC Crab Cavity

- 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?

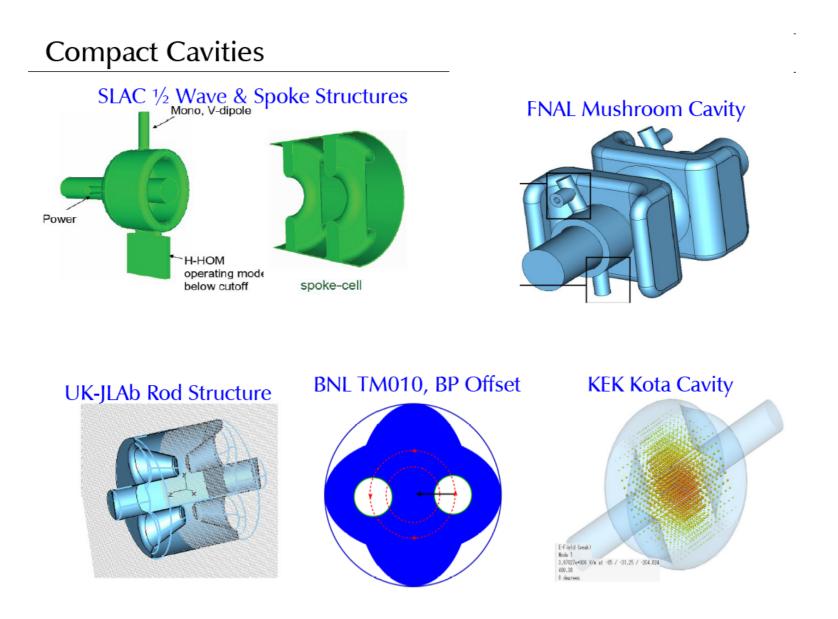
There are several key technologies for fablilcation, already experienced at KEK.

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

### Compact Crab Cavities for Phase 2

Y. Morita

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



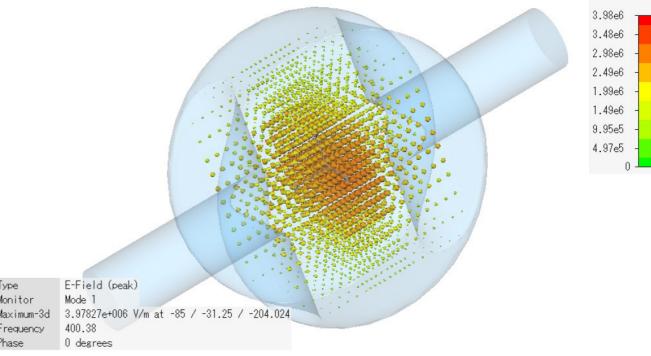
Rama Calaga, LARP-CM11, 10/28/08

### A New Design for Compact CC

#### K. Nakanishi / Y. Morita

V/m

- 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

• 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