CRAB for HL-LHC
KEK activity

2010DEC

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Requirements for LHC-Crab

- High crabbing voltage (2.5MV for global crabbing)
  - KEKB-Crab: 1.4MV
- Stable operation (low trip rate)
  - KEKB-HER-Crab：0.8 trip/day@1.4MV（not acceptable for LHC)
  - KEKB-LER-Crab：0.04 trip/day@0.9MV (acceptable trip rate for LHC?)
  - High field operation and stable operation are conflicting
- Invisible when no crabbing (not to disturb LHC operation)
  - KEKB was operated with crabs detuned

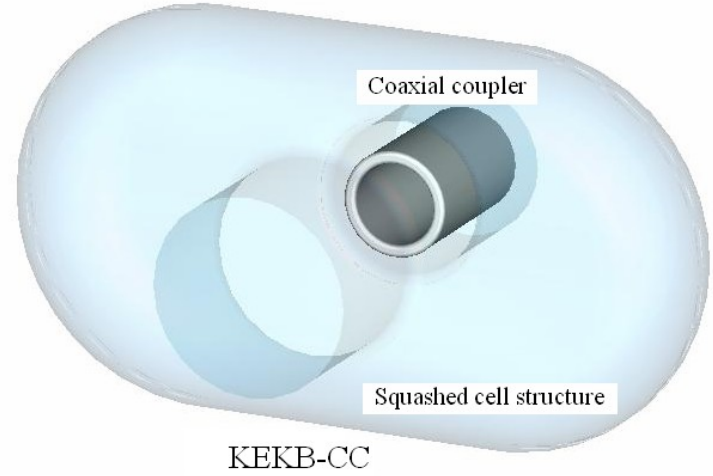
- LHC-Crab designs have more complicated structures than KEKB-Crab
- To develop the LHC-crab cavity
  - Need cavity R&D for high fields and low trip rate
    - Important to establish surface treatments for complicated structures
  - Need beam tests
    - To confirm reliability before installation

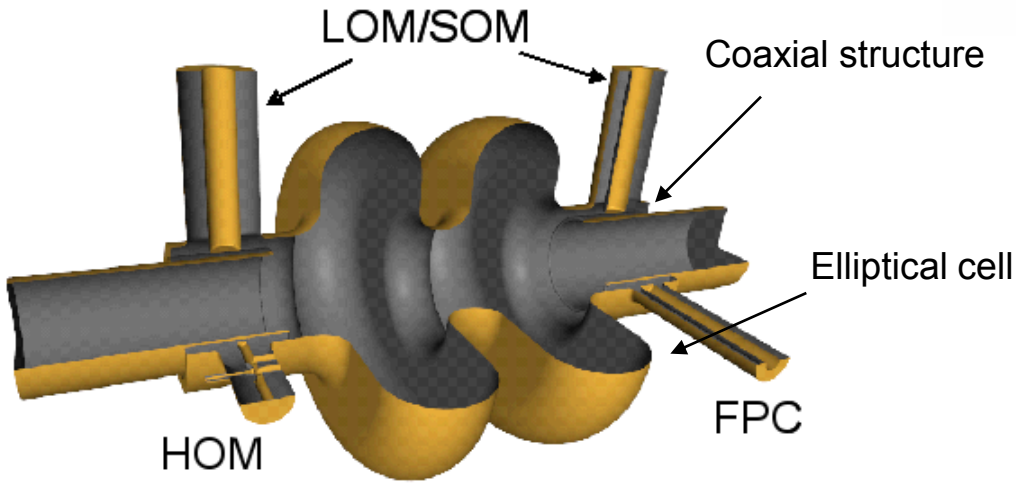
Baseline cavity for global crabbing

Needs for more complicated structures

Baseline cavity proposed by US-LARP

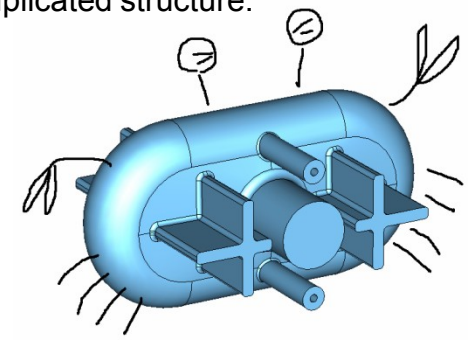
- The baseline design has similar properties like KEKB-Crab
  - Elliptical/squashed cross section
  - Coaxial coupler structure
- Different properties
  - Two-cell cavity
  - 800 MHz (KEKB-Crab: 509MHz)
  - More complicated LOM/SOM/HOM coupler





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

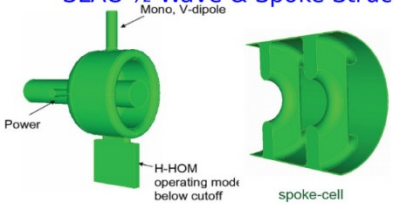
Crab cavity design for SuperKEKB (High current option) has much more complicated structure.



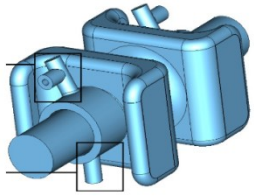
Local crab crossing needs compact crab cavities

Because available space is tight.

SLAC ½ Wave & Spoke Structures

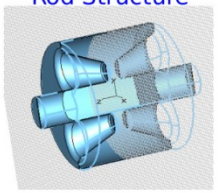


FNAL Mushroom Cavity

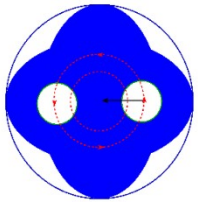


KEK has long history for superconducting cavities.
We made and operated crab cavities for the first time.
Let's study fabrication and surface treatment methods for compact crab cavities.
Let's establish those methods for luminosity increase of LHC.

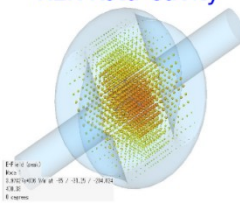
EUCard,UK-JLAb Rod Structure



BNL TM010, BP Offset



KEK Kota Cavity



TEM-type Delayen and Wang

There are many cavity designs for compact crabs, however…
Can we fabricate such a complicated structure?
How can we polish cavity inner surface?

Outline of LHC-Crab R&D

Study for fabrication
Forming of a model cavity
Electron beam welding

↓

Study for surface treatments
Electro-polishing
Heat treatment
High pressure rinsing
etc.

↓

Cold performance test

Feedback (→ Study for surface treatments)

Surface treatments for KEKB-SCC and KEKB-Crab

KEKB-SCC

Developed for stable operation @1.5MV

- Degreasing
- Pre-EP,EP Ⅰ (80~100μm)
- Heat treatment (700℃ x 90min)
- EP Ⅱ (10~15μm)
- Pure water shower rinsing (4 bar)
  Ozonized ultra pure water rinsing
  Ultra-sonic rinsing with ultra pure water
- Assembling and baking (120~150℃) VT

KEKB-Crab

Developed for high crabbing voltage ~1.4MV

- Barrel polishing (~100μm)
- Pre-EP, EP Ⅰ (~100μm)
- HPR
- Heat treatment (700℃ x 3h)
- EP Ⅱ (~5μm)
- HPR (80 bar, 45min)
- HPR after assembling for VT
- Baking before ~100℃VT

Combining above two methods may be a suitable surface treatments for high field and stable operation?

S. Mitsunobu

New electro-polishing system for KEKB-SCC

- 横型回転方式，連続回転方式

Horizontal and rotating system for electro-polishing developed for TRISTAN superconducting cavities.

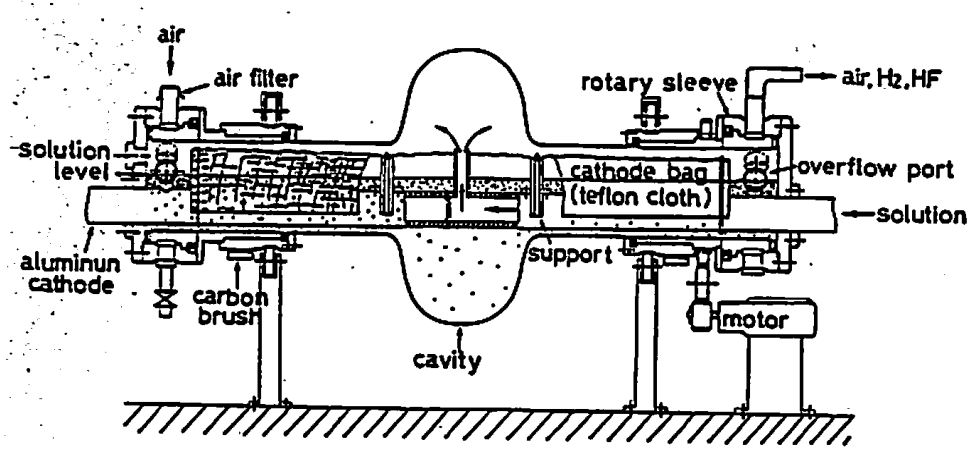
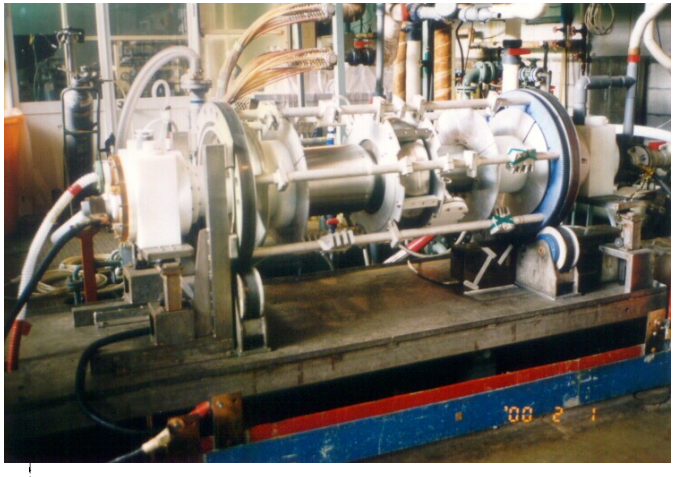
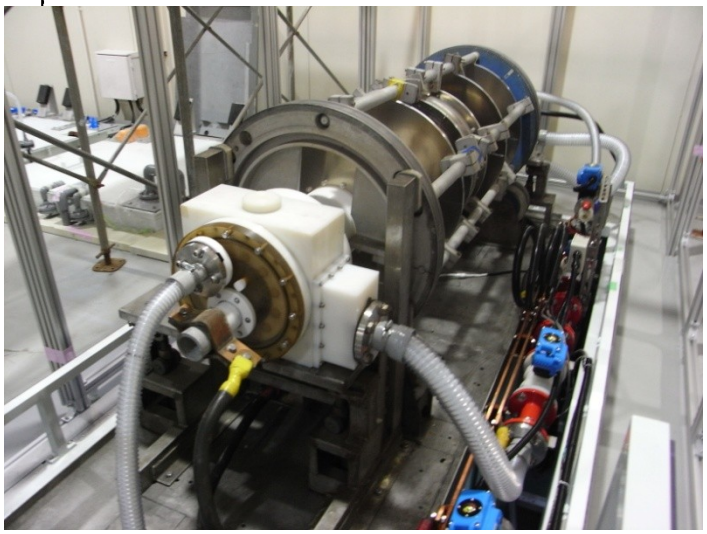


Fig.23
Horizontal rotational EP method for single cell cavities.

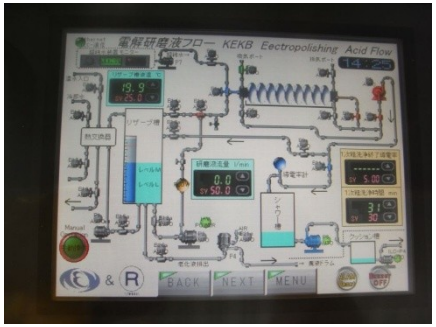
Old EP system at Nomura Plating Co.



Rotating equipment and EP bed were transferred to new EP facility at KEK.



New features
Automatic controlling system
Tight sealing for HF acid



Control panel

S. Mitsunobu

New EP facility for KEKB-SCC

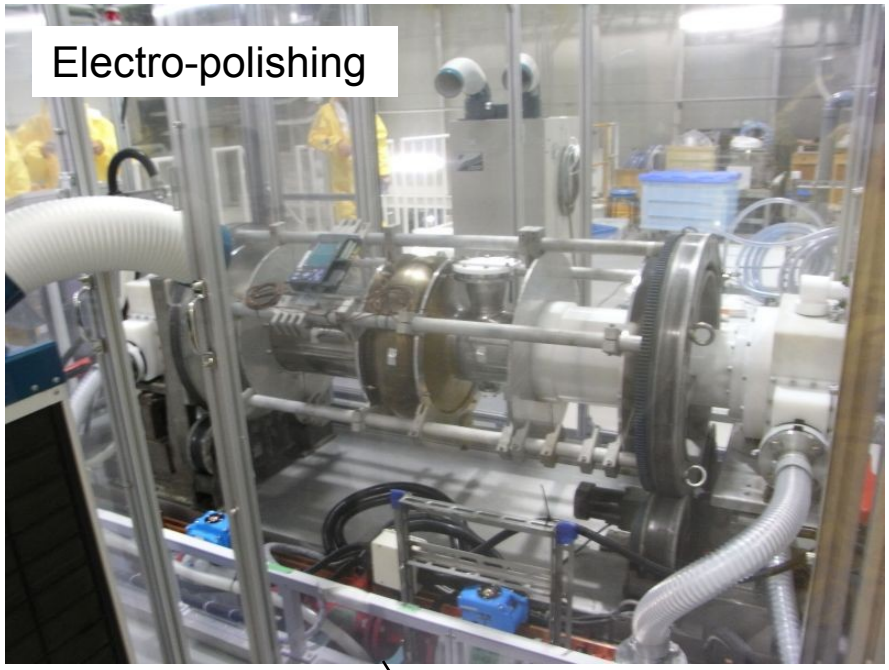
New EP equipment for SCC on 2nd Floor

Acid gas cleaning system

New 500 L reservoir for HF/H_2SO_4 solution

Ultra-sonic bath and shower tank

1st EP for a test cavity



- Electrolyte solution: HF(45%):H_2SO_4(96%)=1:9
- Acid temperature: 20~30 ℃
- Cathode voltage: -20~-30 V
- Current density: 30~50 mA (EPI>EPII)
- Acid flow rate: 40L/min

EP bed is moving to hold the cavity vertically.

Electrolyte solution is extracted while the cavity was vertically held.

S. Mitsunobu

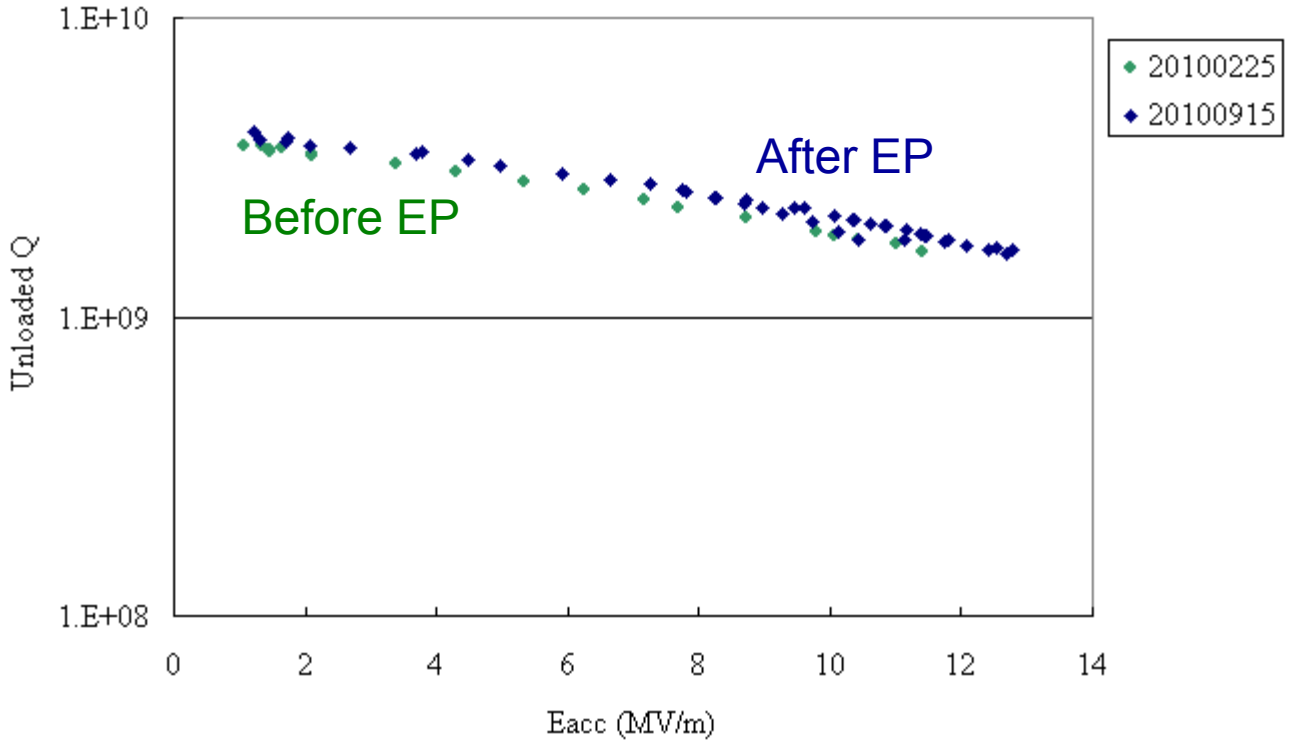

4 bar shower rinsing with pure water


O_3 rinsing


Ultra-sonic rinsing in a hot water bath

Vertical test

Eacc＝13MV/m was achieved after EP（@KEK)
Test cavity was successfully electro-polished with new EP system



Summary

- Needs for
  - more complicated structures
  - High field operation
  - Stable operation
- Needs for study to establish surface preparation methods
- Our new EP facility is ready !
  - Three KEKB-SCC type cavities (for TAIWAN light source project) will be electro-polished next year
  - LHC-Crab can also be electro-polished with minor modifications
- We are going to study surface preparation with O_3Rinsing+HPR after EPII
- If we succeed, we can apply our preparation method to KEKB-SCC and HCL-Crab

Reel cavity

- To move the acceleration mode frequency higher is one of solutions to reduce the Rsh.
- The big difference between the frequency of crabbing and accelerating mode arrow simple waveguide HOM