- IPAC-10, Session for Industry –

Experience of Academia-Industry Collaboration on Accelerator Technologies and Projects in Asia

Akira Yamamoto
KEK

To be reported the IPAC-2010, Kyoto, May 26, 2010

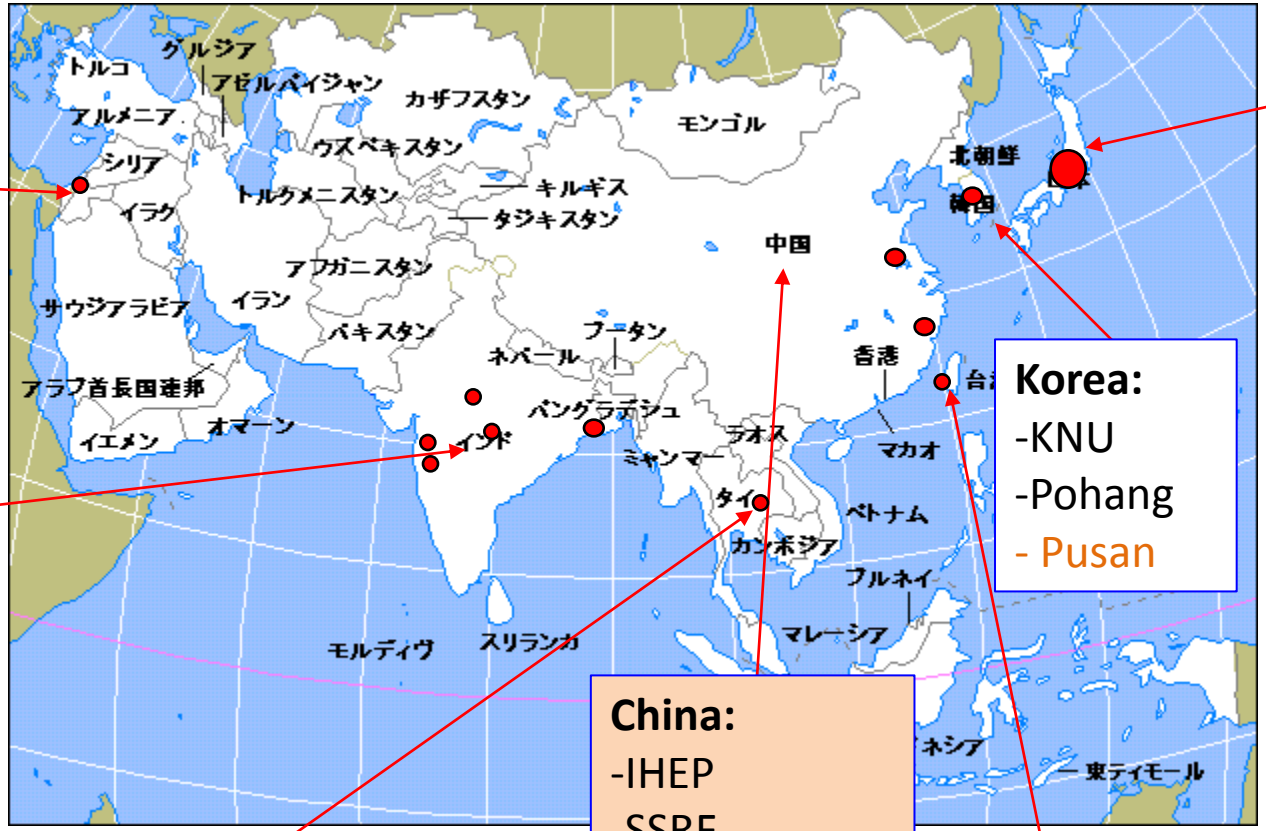
Outline

- Introduction
  - Overview of Accelerators for Research and Medial Applications in Asia
- Academia and Industry Collaborations
  - Status in China, Korea, India, and in Japan
- Advanced Accelerator Association, Japan
  - Cooperation among “Industry-Academia-Government” to promote science and technology
- Summary
  - Toward Asian Collaboration for future projects

Acknowledgments

- *Many thanks for the information provided by*
  - ***Jie Gao (IHEP, China),***
  - ***Chuangxian Tang (Tsinghua U., China)***
  - ***Kexin Liu (PKU, China)***
  - ***Eun-San Kim (KNU, Korea)***
  - ***Amit Roy (IAUC, India) ,***
  - ***Lyn Evans (CERN), and***
  - ***Other Many Collaborators***

Research and Medical (proton/Heavy-Ion) Particle Accelerators in Asia



Jordan:
- SESAME

India:
-IUAC
-RRCAT
-TIFR
-VECC
-BARC

Thailand:
- NSRC

China:
-IHEP
-SSRF
-山東省
-(北京)
-蘇州
-(上海)

Korea:
-KNU
-Pohang
- Pusan

Taiwan:
-NSRRC
-(Taiwan)

Japan:
***research**
-KEK,
-RIKEN
-Spring 8
-Universities
***Medical**
[proton]
-Tsukuba-U
-Nt'l Canc.C
-Shizuoka CC
-Truruga
-S. Tohoku
[Heavy Ion]
-NRIM
-Hyogo
-Gunma

Academia-Industry Collaboration in Particle Accelerators

	Research	Medical	Notes on Academia-industry Collaboration
China	IHEP, SSRF	山東、蘇州(Beijing, Shanghai)	In-house fabrication Collaboration Increasing
China-Taiwan	NSRRC	NSRRC	
Korea	Pohang/POSTECH PEFP, KNU and ..	Soel	Inevitable
India	IUAC, RRCAT, TIFR, VECC		In-house fabrication Some particular cases
Japan	KEK, RIKEN, Spring-8, Universities	NIRS Tsukuba, Nt'l CC, Shizuoka, Gunma,	Inevitable and close collaboration
Jordan	SESAME		
Thailand	NSRC		

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China: IHEP Contribution
FLASH/XFEL-Prototype Cryomodule

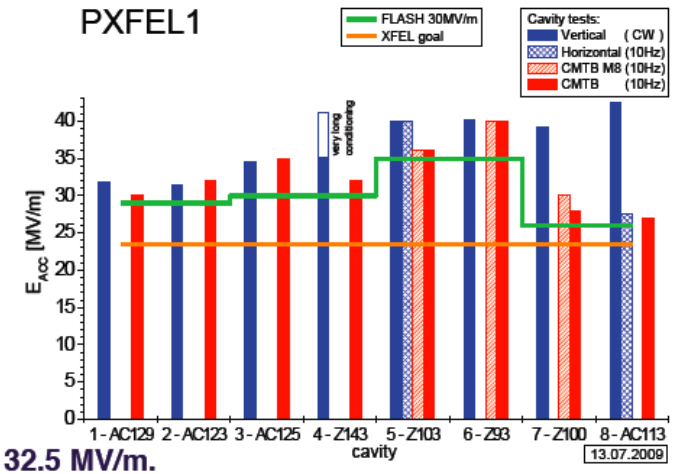
Cryomodule/Cryostat
Manufactured by
航天晨光股份有限公司
(**Airspace CHEN GUANG**
company limited) under
Supervision of **IHEP**
In cooperation with **INFN/LASA**

The European XFEL

European XFEL

PXFEL1 - The *Chinese* Module at CMTB

30



- The accelerator module PXFEL1 was conditioned and tested at the Cryo-Module Test Bench (CMTB).
- The average maximum gradient is **32.5 MV/m.**
- After string and module installation we have seen a **gradient reduction of only 5%.**
- PXFEL1 has been installed at FLASH and **can be operated** there with an average gradient of **30 MV/m.**
- The **XFEL waveguide dist**

Beam started already, April, 2010

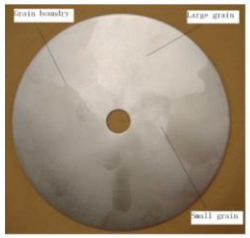
TTC Meeting, Fermilab, April 19/22, 2010
Hans Weise / DESY

Courtesy: Jie Gao (IHEP)

- Reported by H. Weise at TTC, FNAL, April 19, 2010.

IHEP
SCRF Cavity Development

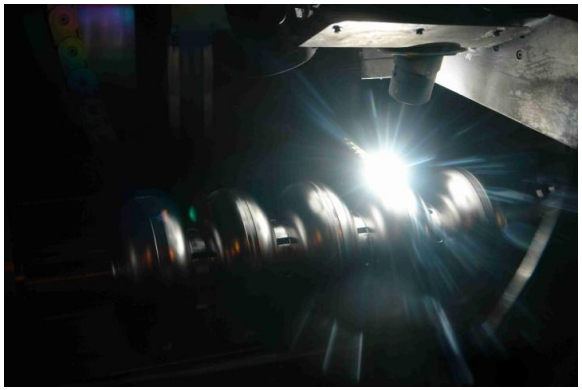
- SCRF cavity fabricated at IHEP in cooperation with 'Beijing Institute of Aviation Materials'



Courtesy: Jie Gao (IHEP)

Peking University
SCRF Cavity Development

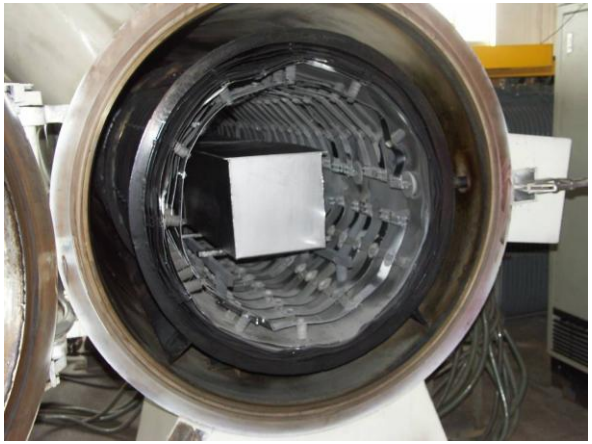
EBW: Cooperation with Harbin Institute of Technology



Courtesy: Kexin Liu（PKU)

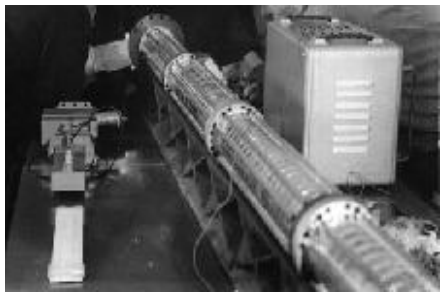
PKU, IHEP
Collaboration w/ Industry, on Nb Sheet

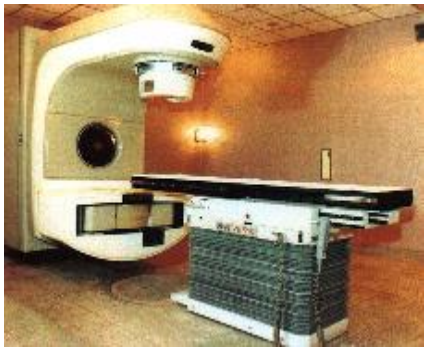
- Cooperation with Ningxia Orient Tantalum Industry to develop Nb material, high temperature annealing for cavities, to develop accelerator cavities in future.

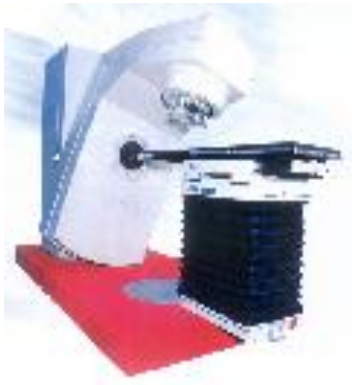


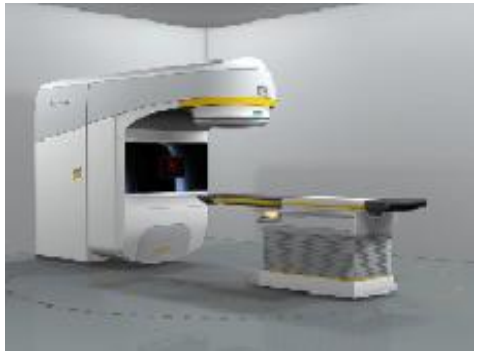
Tsinghua University

Low Energy Electron Linac Development as a Fabricator for Medical Applications









TW 10MeV Linac BJ-10

SW 6MeV Linac WDVE-6

SW 14MeV Medical Linac

SW 20MeV Linac with ES

Certesy: Chuanxian Tang (Tsinghua Univ.)

Korea: Pohang Acc. Lab/POSTECH
Pohang Light Source Upgrade

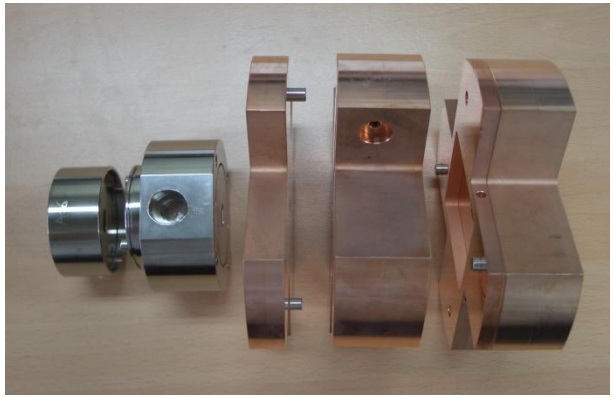
PLS Upgrade	PLS-1 →	PLS-2
Ring energy	2.5 GeV	3 GeV
Ring emittance	18.9 nm	5.7 nm
Number of ID	10	20
Linac energy	2.5 GeV	3 GeV

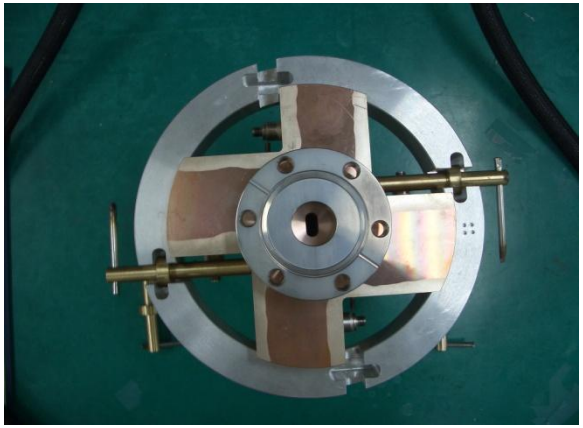
XFEL (Plan 2011-2015)

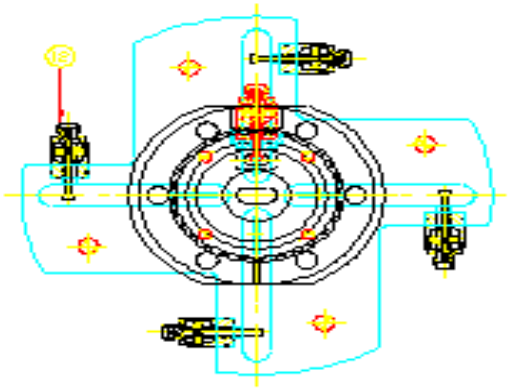
- 10 GeV S-band Linac (~ 550 m long)
- ~60 m undulator w/ gap of 5.3 mm

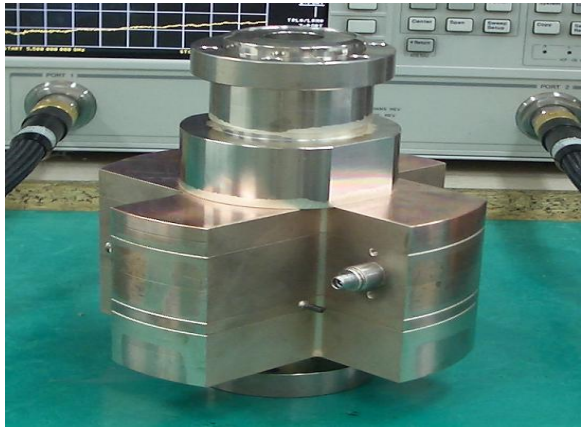
Courtesy: Eun-San Kim

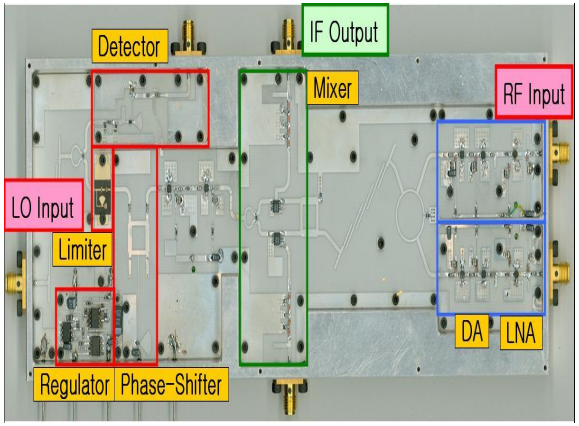
KNU
beam diagnostics with industry

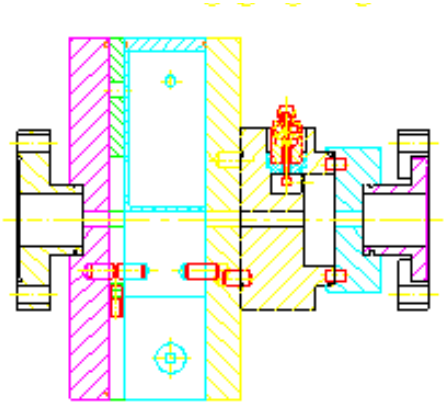








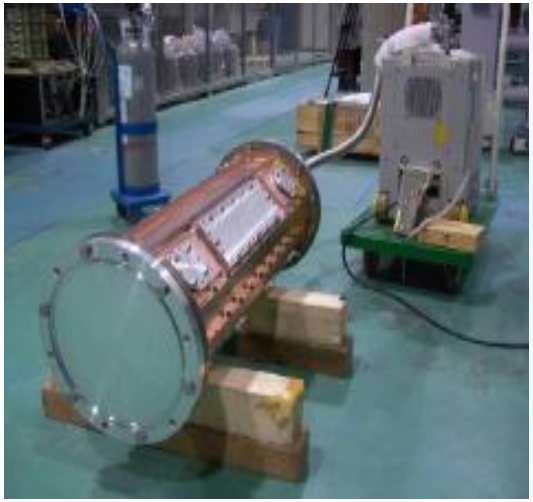




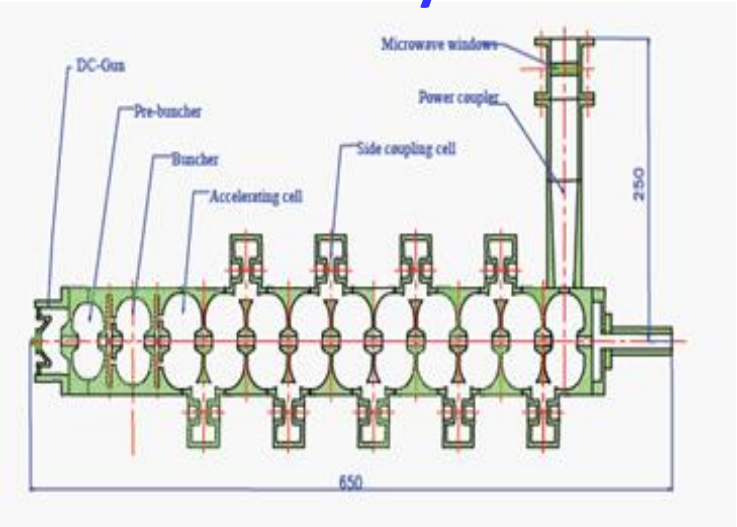
Several Industrial Manufacturing at Korea

DTL

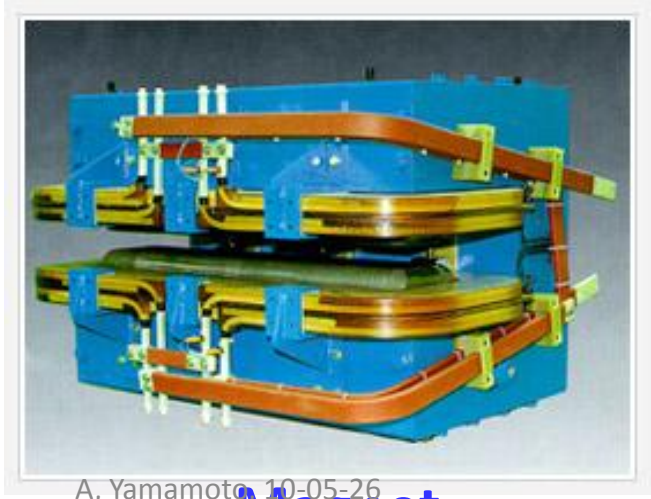
RFQ



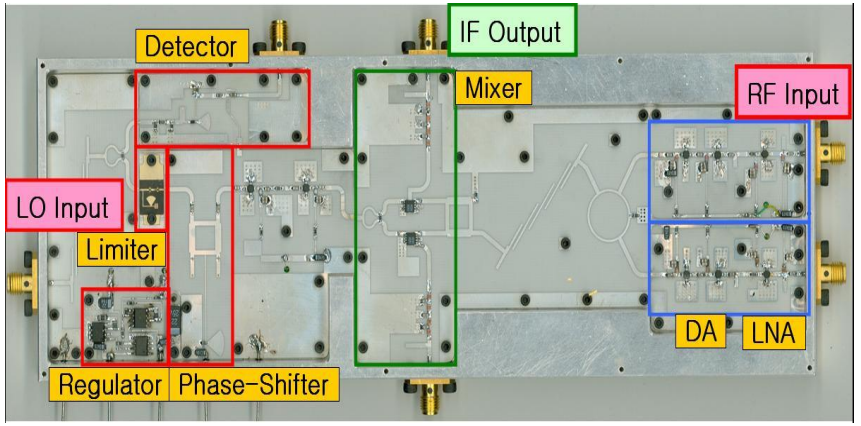
S-band RF system



Magnet



Beam diagnostics

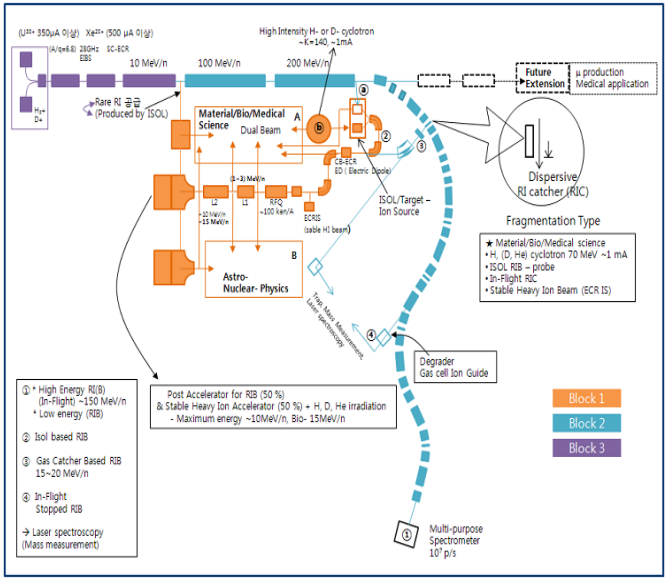


Heavy-ion Accelerators (Plan)

Industry collaboration expected

Research (Nuclear Physics)

- Rare Isotope Accelerator
- 200MeV/n SCRF linac + In-Flight
- 200 MeV proton cyclotron + ISOL
- Beam current: U : 2pμA
- 2010 -2015 (CDR stage at present)

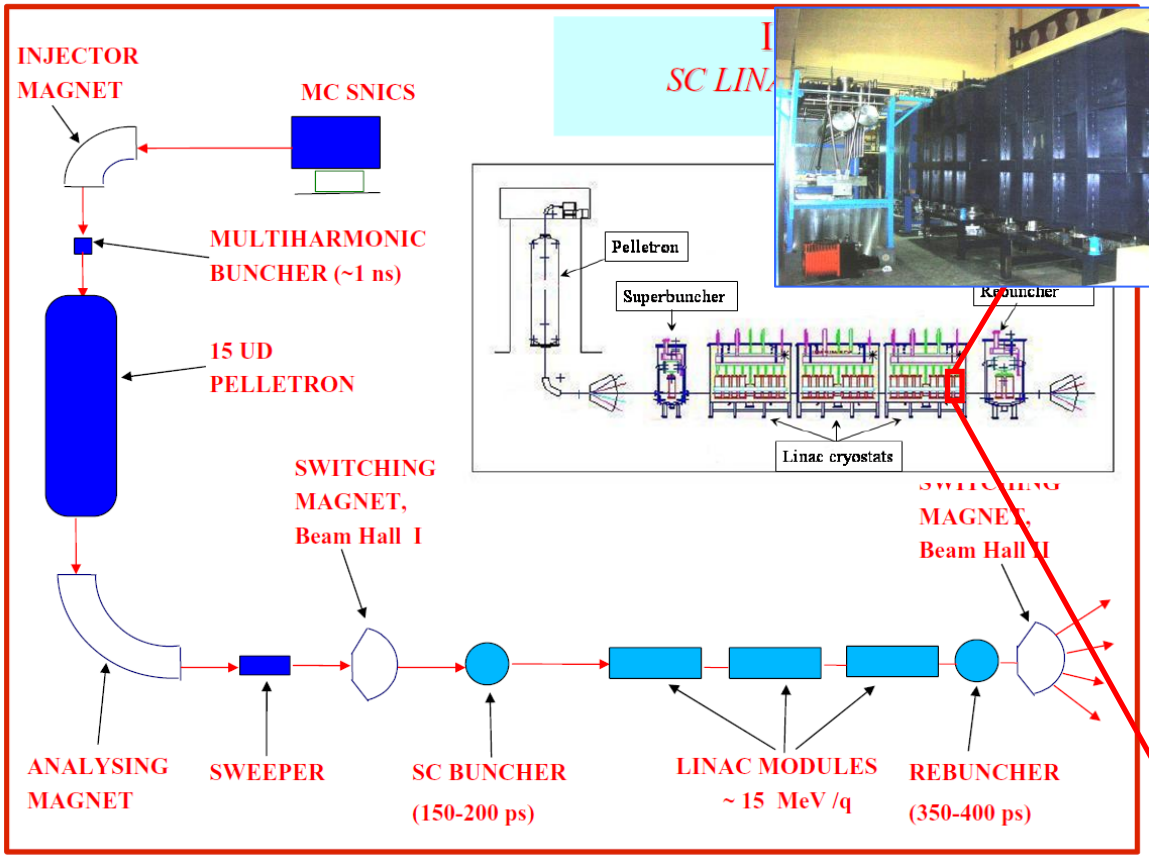


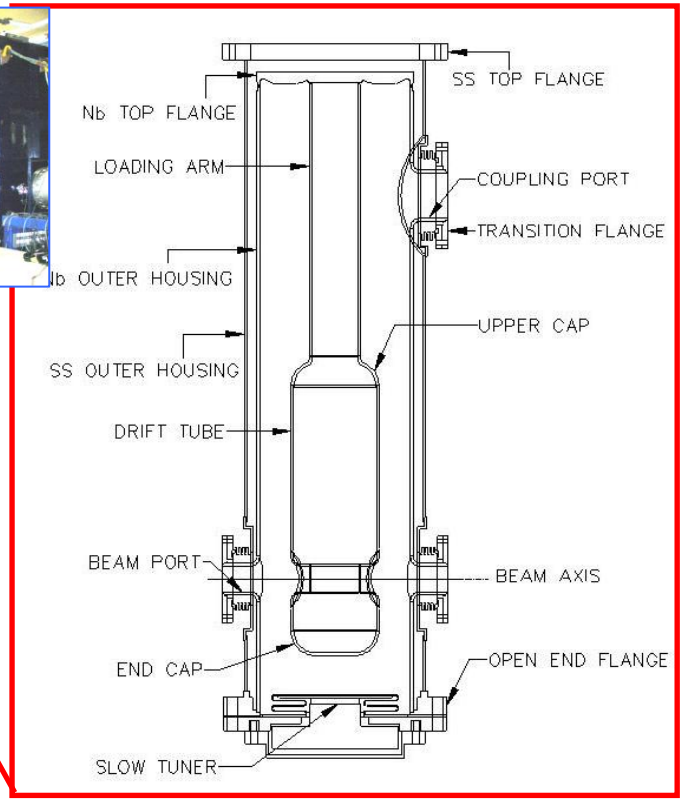
Medical Application

- Carbon beam : 400 MeV/n
- Consists of Linac and Synchrotron
- Period : 2010 – 2015
- Location : Pusan

India: IUAC

SCRF Cavity In-house Effort: QWRs for Linac





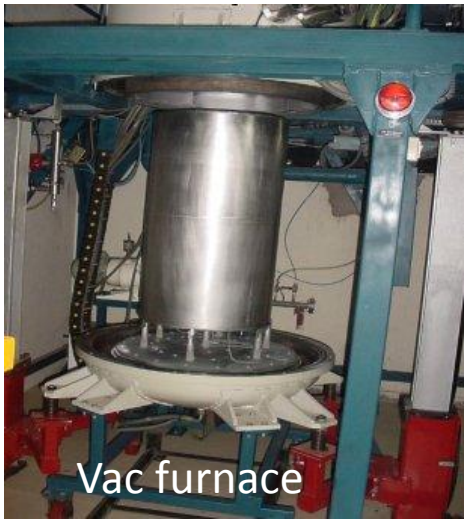
Nb Quarter Wave Resonator.

12 QWRs + 15 Slow Tuners were ready by Aug./Sept. 2009.
3 QWRs to be ready by June 2010.

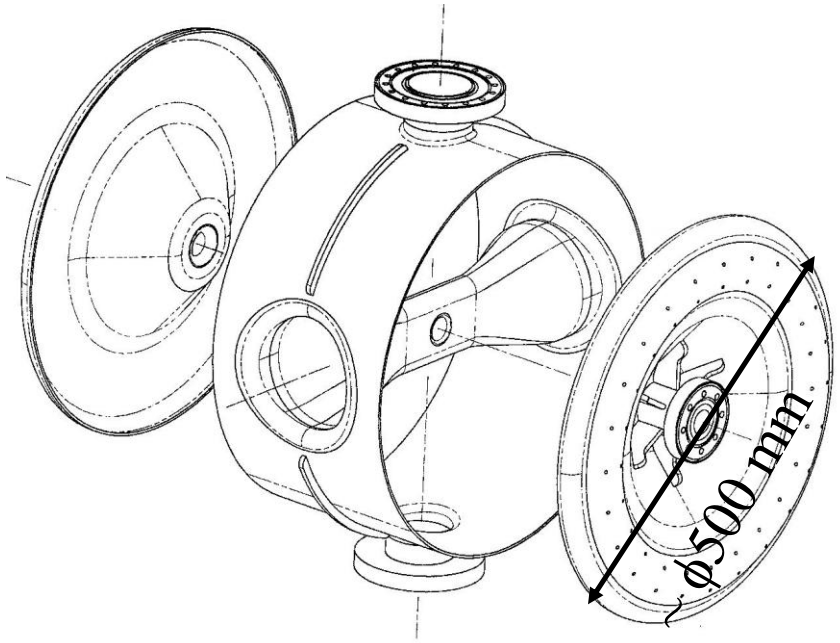
Courtesy: Amit Roy (IUAC)

IUAC In-House Cavity Facility

12 QWR fabricated



Collaborations – IUAC & Fermi Lab



Single Spoke Resonator – SSR1 (niobium portion) for Project-X at Fermi National Accelerator Laboratory, USA. $\beta = 0.22$, f = 325 MHz

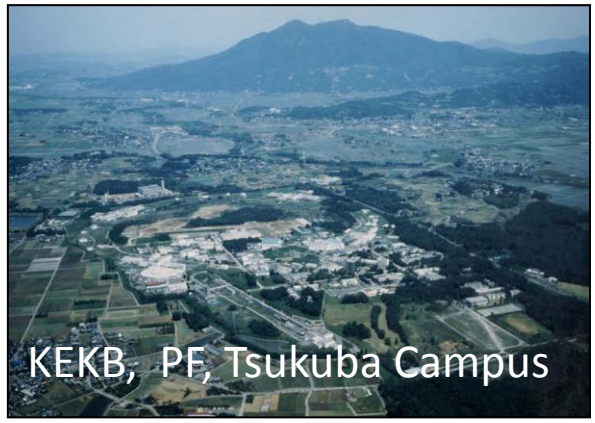
IUAC is presently fabricating two Single Spoke Resonators.

Collaboration – RRCAT & IUAC with Fermilab

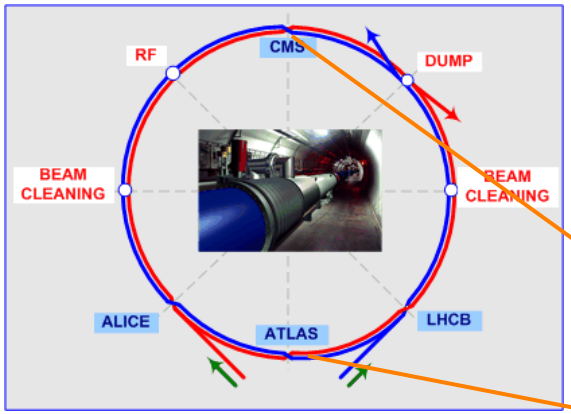
- RRCAT, Indore & IUAC in collaboration have fabricated two Tesla-type Single Cell Cavities with niobium.
- The plan is to eventually build a complete 9-Cell Cavity.
- All the tooling for the fabrication has been built at RRCAT. Several fixtures have been built in consultation with IUAC.
- IUAC facilities (EBW, SPL etc.) have been used for the fabrication.
- Presently the Cavities are at **Fermi Lab** for further processing and cold testing.
  - One of the Cavities has been electropolished & rinsed (HPR) at ANL and undrgone cold test. Achieved 21 MV/m on first cooling.

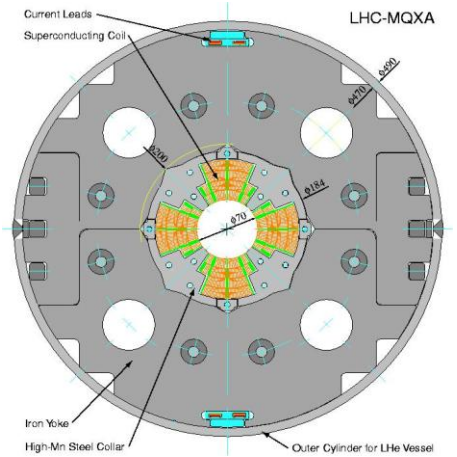
1.3 GHz Tesla-type Niobium Single Cell Cavity

Japan: KEK, RIKEN, Spring-8, HIMAC and others…



CERN-LHC Inner Triplet
CERN, Fermilab KEK, Industry Collaboration

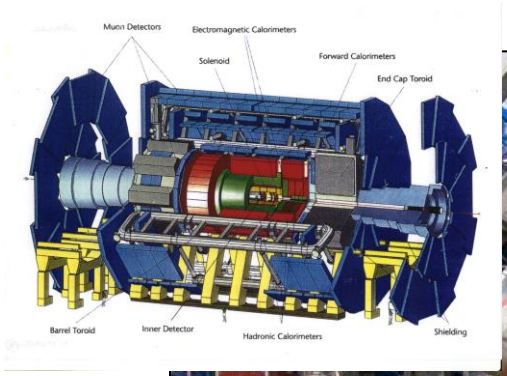


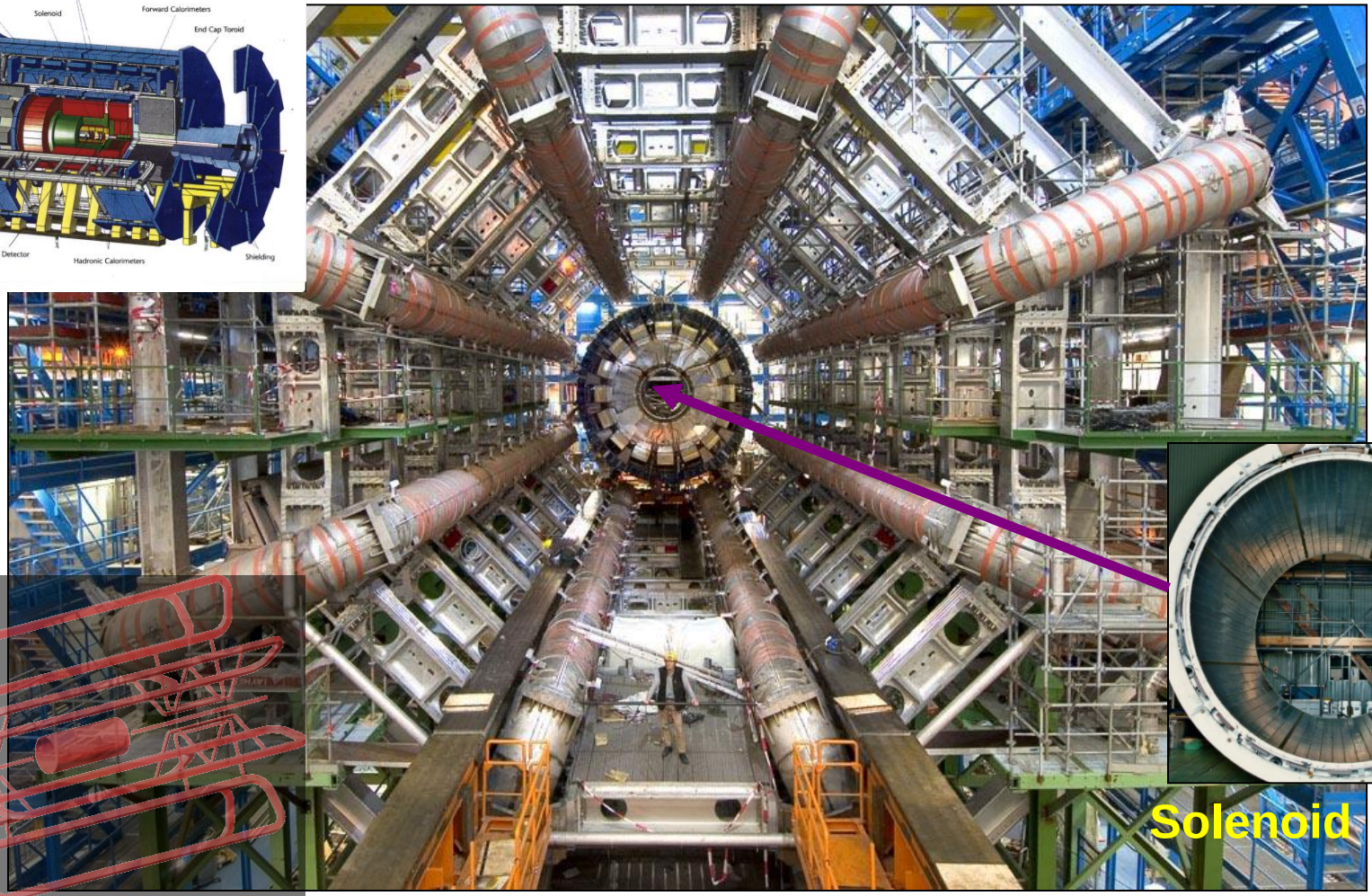


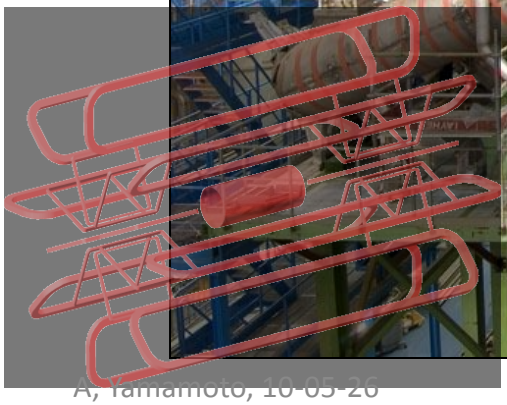
CERN, FERMILAB, & KEK Collaboration with Cooperation with Japanese Industries

ATLAS Superconducting Solenoid

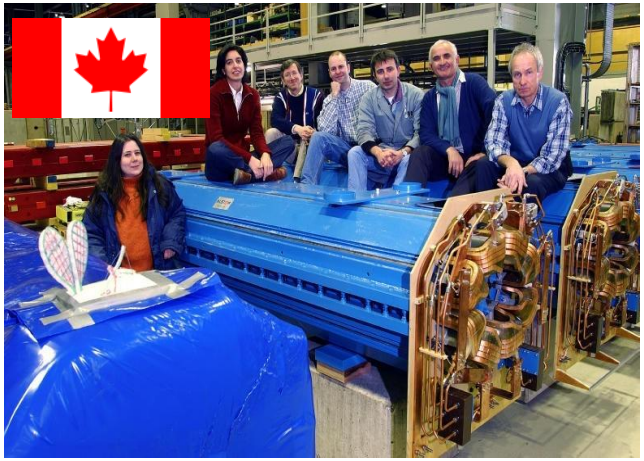
CERN-KEK collaboration with Japanese Industries

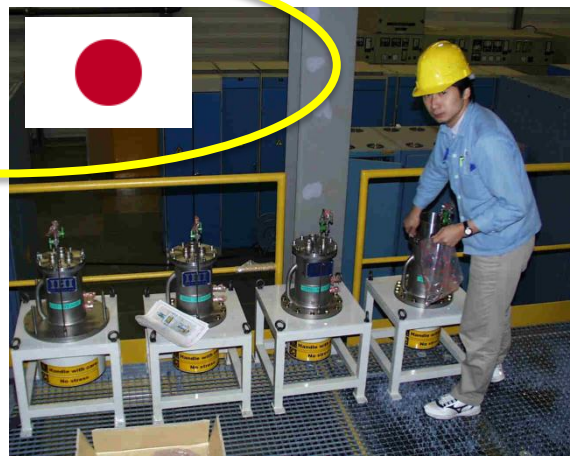


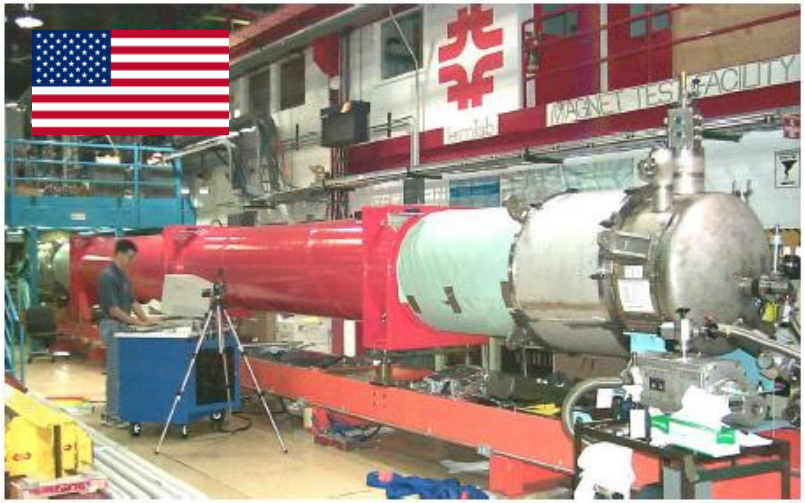




Contribution from Asia for LHC
as part of global collaboration







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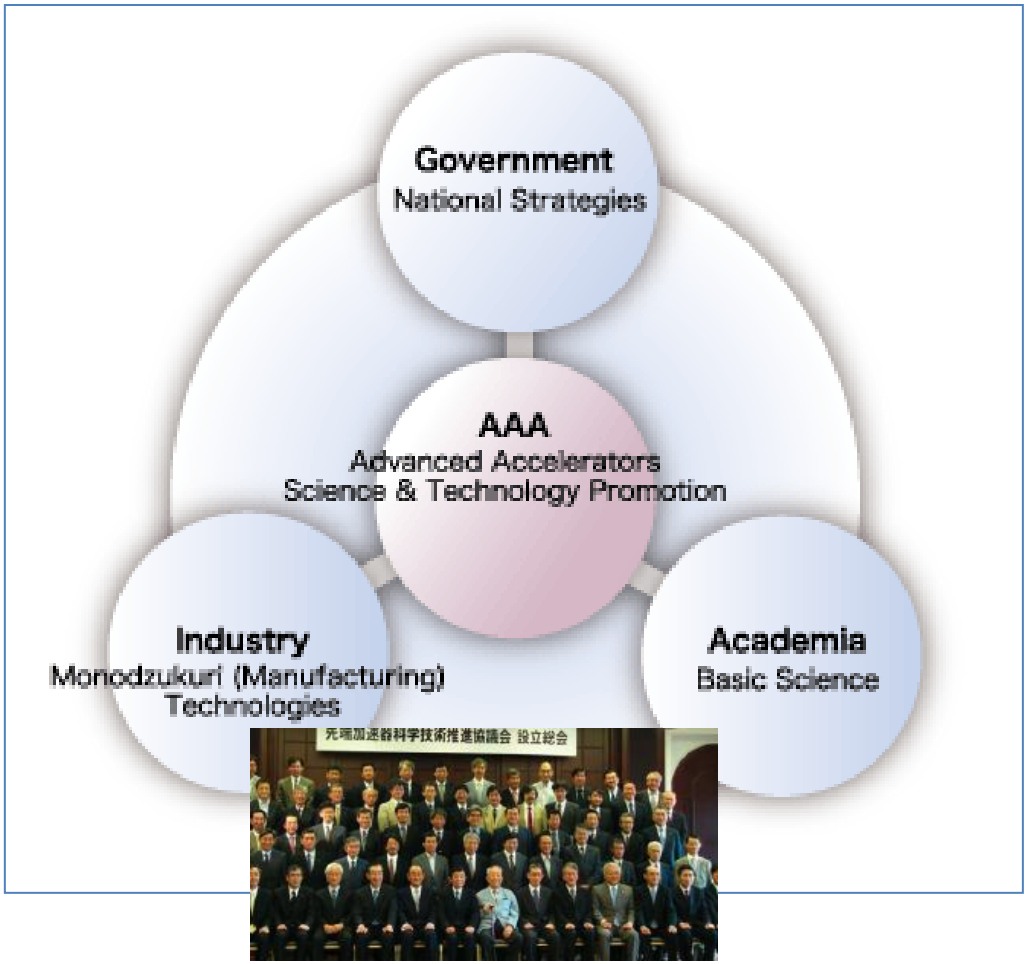
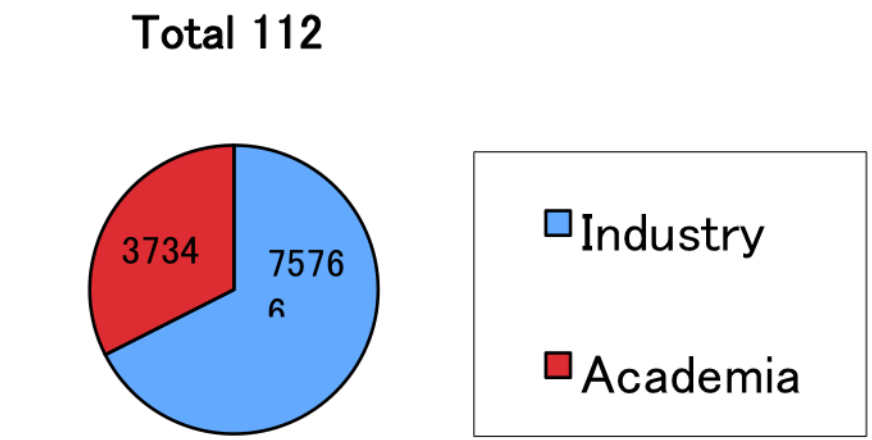
AAA: Advance Accelerator Association established, Japan, in 2008

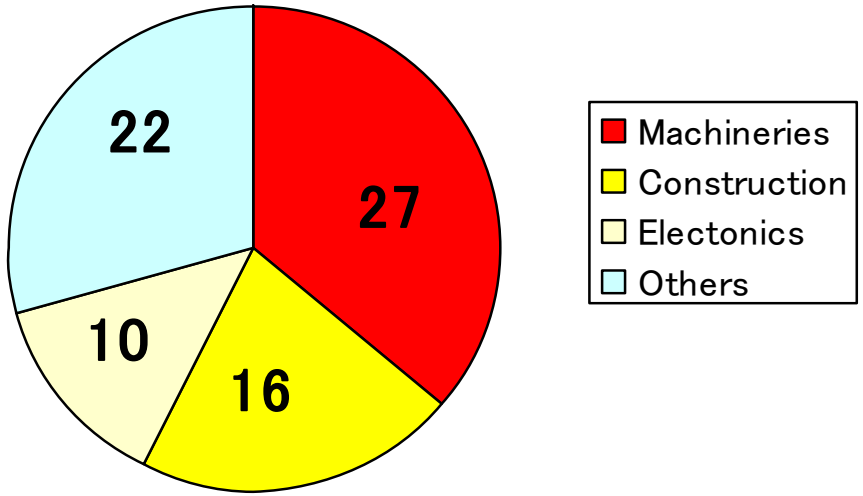
- In collaboration of
  - Industries
  - Government, and
  - Academia

- ***Thanks*** *for previous effort by "Linear Collider Forum, Japan"*
  - as a preliminary step, in collaboration between
    - Industries, and
    - Academia
  - *Special acknowledgment for Mr. N. Ozaki (Chairing this session)*



AAA Member as of April, 2010





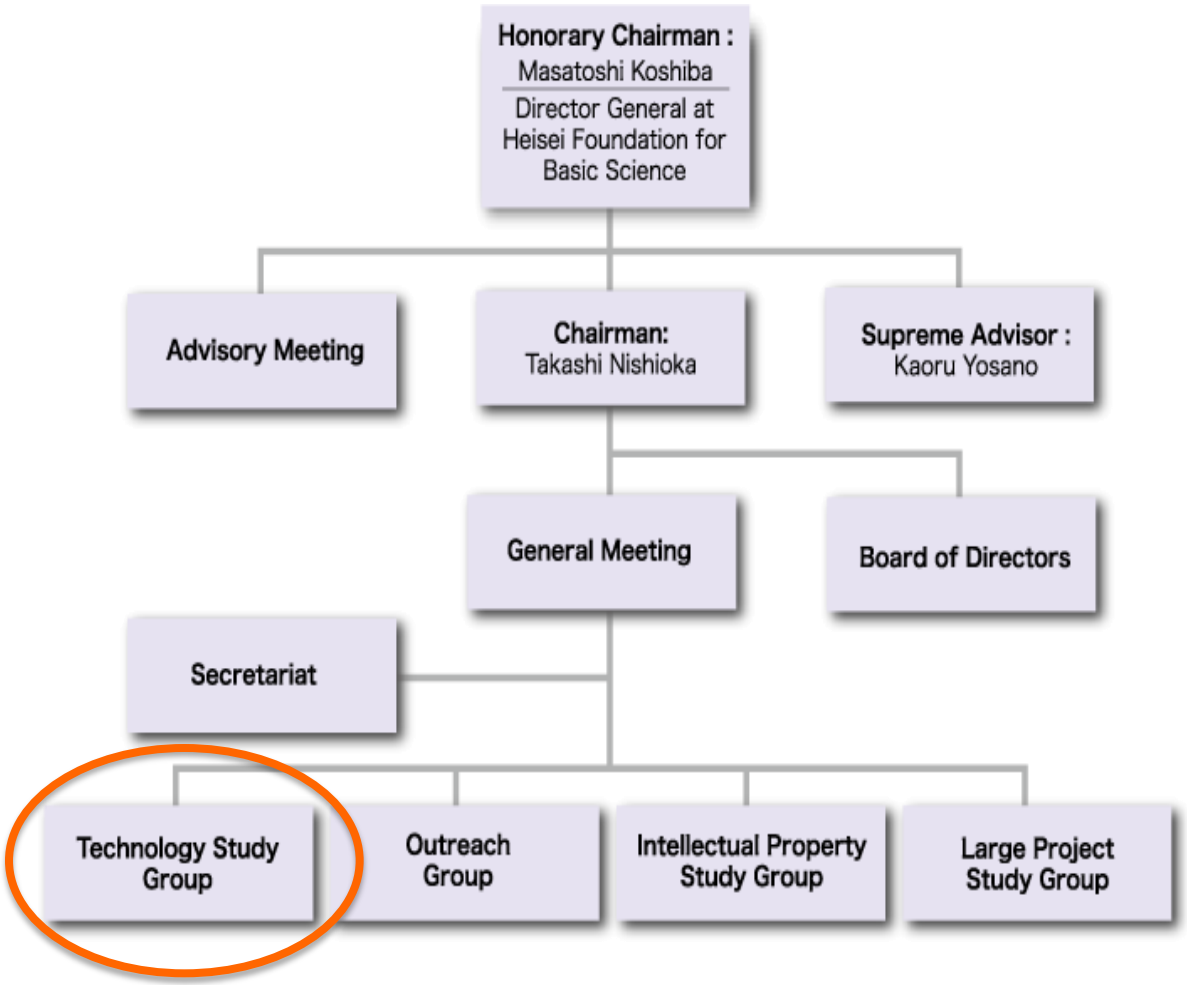
【 Academia 】
KEK
RIKEN
JAEA
Tokyo University
Tohoku University
Kyoto University, and
Others

【 Industries 】
M H I
Toshiba Co.
Hitachi Ltd
Mitsubishi Electric Co
KASHIMA Co
IBM Japan , KYOCERA
TEPCO, and
Others

AAA motivated to

- Promote science and technology with joint effort with **Industries-Government-Academia cooperation**,
- Seek for and **create industrial applications** of advanced accelerator technologies, in such fields of
  - Advanced material, biotechnology, medical use, and various innovative applications

Organization and Activities



Group Activities:

- Technologies
- Outreach
- Intellectual Properties
- Large Projects

Technology Group Activities

Organization

- Steering in cooperation of academic organization and industries
  - Composed with KEK and Industries

Activities:

- Lectures/Seminar Series
- Working groups:
  - Superconducting Accelerator Technology
  - Conventional Facilities

Lectures and Seminars in every moth

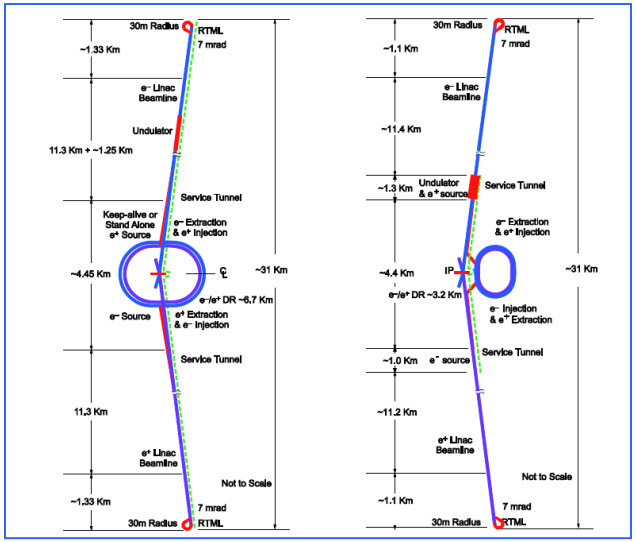
#	Dates	Focusing	Themes
1	2008-08-29	Basic	**Introduction for Advance Accelerator**
2	08-09-16	Basic	**Status of SC Accelerator Technology and Prospect**
3	08-10-08	Basic	**Accelerator and Conventional Facility Technology**
4	08-10-29	Basic	**Superconducting RF Cavity Technology**
5	08-11-12	Basic	**High-Legel RF Technology**
6	08-12-19	Appl.	**Adv. Accelerator and Synchrotron Radiation Science**
7	09-01-14	Basic	**Adv. Accelerator and Cryogenic Engineering**
8	09-02-18	Appl.	**Adv. Accelerator and Neutron Science**
9	09-03-18	Basic	**Adv. Accelerator and Control/Instrumentation**
10	09-05-13	Appl.	**Industrial technology and application supporting A. Acc.**
11	09-07-27	Basic	**General activity reports**
12	09-10-28	Appl.	**Adv. Accelerator and Medical Application**
13	10-02-10	Appl.	**Adv. Accelerator and Laser Science and Application**
14	10-04-15	Project	**ILC R&D Progress and Prospects**

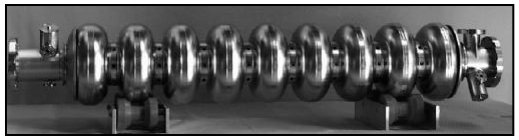
As a core study theme:

ILC: SCRF-ML Technology

RDR Parameters	Value
C.M. Energy	500 GeV
Peak luminosity	$2x10^{34}$ $cm^{-2}s^{-1}$
Beam Rep. rate	5 Hz
Pulse time duration	1 ms
Average beam current	9 mA (in pulse)
Av. field gradient	**31.5 MV/m**
# 9-cell cavity	**14,560**
# cryomodule	**1,680**
# RF units	**560**

RDR → SB2009





Global Plan for SCRF R&D

Year	07	2008	2009	2010	2011	2012
Phase	TDP-1			TDP-2		
Cavity Gradient in v. test to reach 35 MV/m	→ Yield 50%			→ Yield 90%		
Cavity-string to reach 31.5 MV/m, with one-cryomodule		Global effort for string assembly and test (DESY, FNAL, INFN, KEK)				
System Test with beam acceleration			FLASH (DESY) , NML (FNAL) STF2 (KEK, test start in 2013)			
Preparation for Industrialization				Production Technology R&D		

Superconducting Accelerator Technology WG:

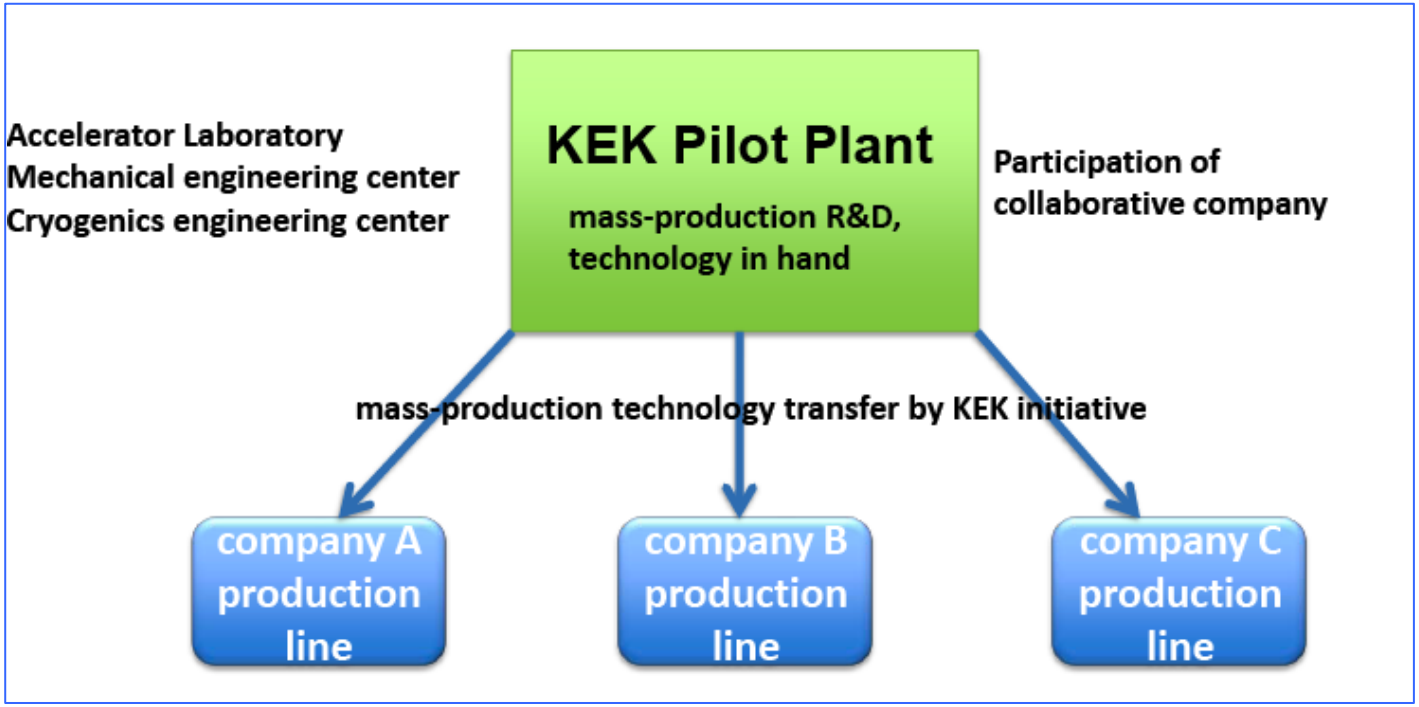
Studying Industrialization and the R&D model

WG	#	Dates	Subjects
SC	WG1	09-04-08	Nb material, Surface cleaning
SC	WG2	09-06-04	Ceramics Electron Beam Welding
SC	WG3	09-09-10	Cavity fabrication
SC	WG4	10-01-14	Cavity surface polishing
SC	WG5	10-5-20	Cavity fabrication: pressing and blanking

Outlook from SC Acc. Tech. WG (recmmendation):
Industrialization study: Cavity Fabrication R&D Facility

Industrialization of Cavity Fabrication

R&D Facility to be established



- Based on a recommendation given by AAA in cooperation of industry - academia

Summary

- Industry-Academia Collaboration critically important to open a door to realize future, energy/power frontier particle accelerators
- We may need to:
  - First, Create new industrial applications including medical, power, material, biotechnology, transportation, and various application, the
  - Then, Realize a true 'International Particle Accelerator Collaboration' ----- IPAC !