SCRF Test Facilities Toward the ILC

High Energy Accelerator Research Organization

(KEK)

Accelerator Lab

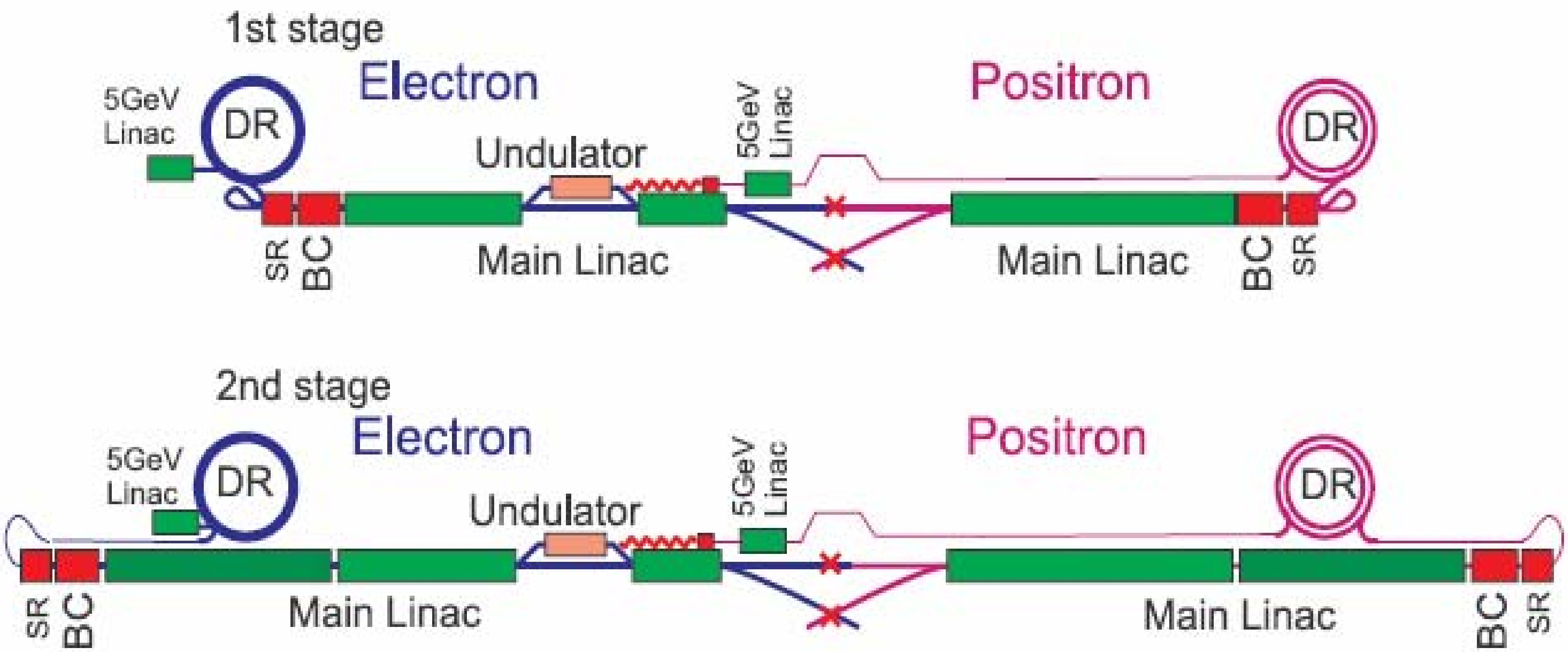
Kenji Saito

Outline

- ILC Baseline Parameters Related to SCRF
- Representative Test Facilities
  TTF(DESY), ILCTA(FNAL), STF(KEK)
- Expected outcome from these test Facility by the ILC TDR

ILC

The ILC is an electro/positron linear collider at 500 GeV center of mass in the first phase, 1 TeV in the second phase.



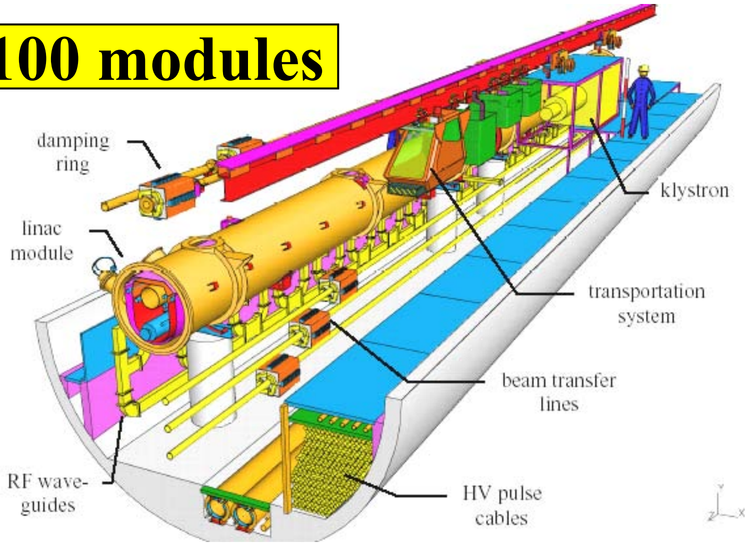
This machine is urgently required from high energy physicists for Higgs or Top quark physics.

The base technology

The core technology for the ILC is 1.3GHz superconducting RF cavity intensely developed in the TESLA collaboration, which was recommended for the ILC by the ITRP on 2004 August.
The cavities are installed in a long cryostat and cooled at 2k, and operated at gradient 31.5MV/m.

17000 cavities

2100 modules



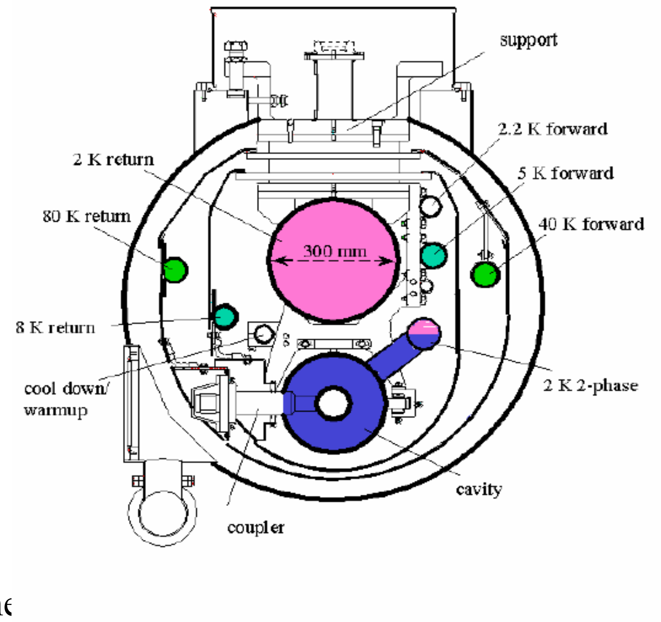


Figure 3.3.2: *Cross section of cryomodule.*

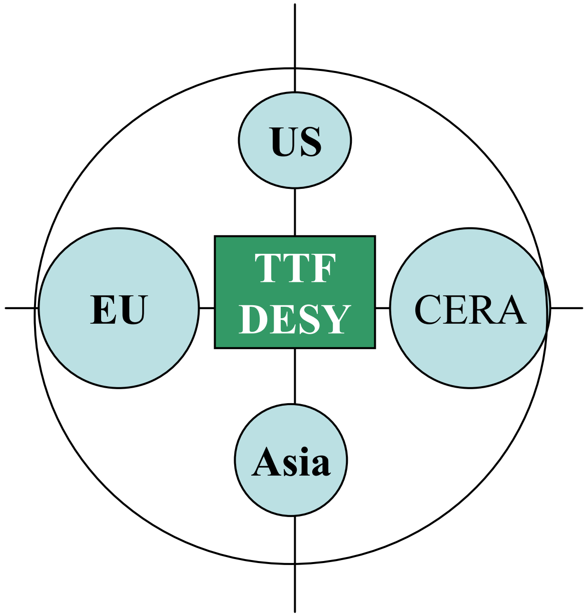
ILC Baseline Parameters related to SCRF

ILC parameters related to SCRF		BCD: Baseline	ACD: Alternative
Cavity Shape		TESLA	Low loss Reentrant
Acceptance Performance	Gradient [MV/m]	35	40
	Qo	0.80E10	0.80E10
Operation Performance	Gradient [MV/m]	31.5	36
	Qo	1.0E10	1.0E10
Cryomodule CM	Type	Type-IV	
	Number of cavity in one CM	8	8

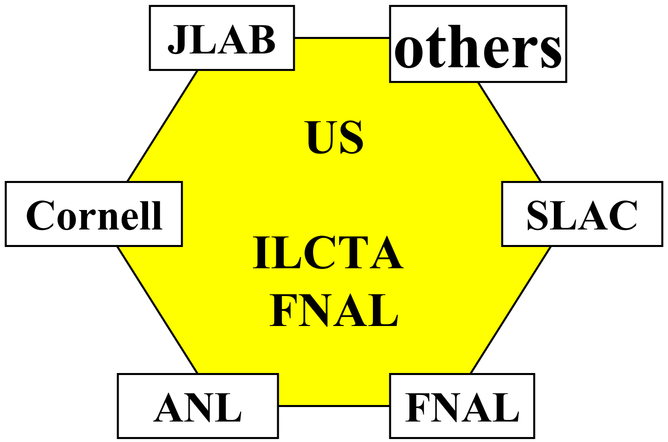
Repreventative SCRF Test Facilities
and
The activities

Represetative three SCRF test facility for ILC R&D

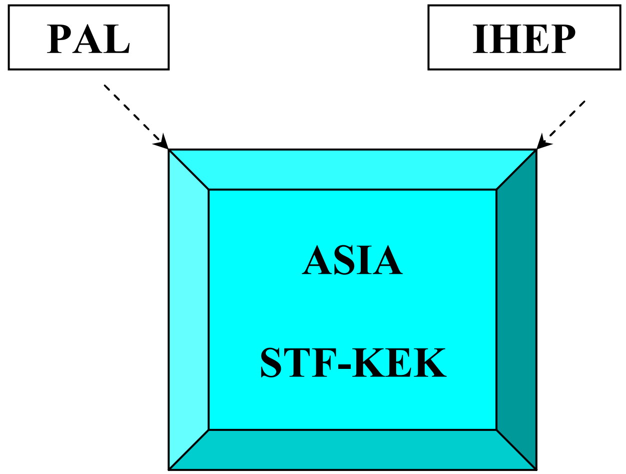
Formation



International collaboration since TESLA



US domestic collaboration

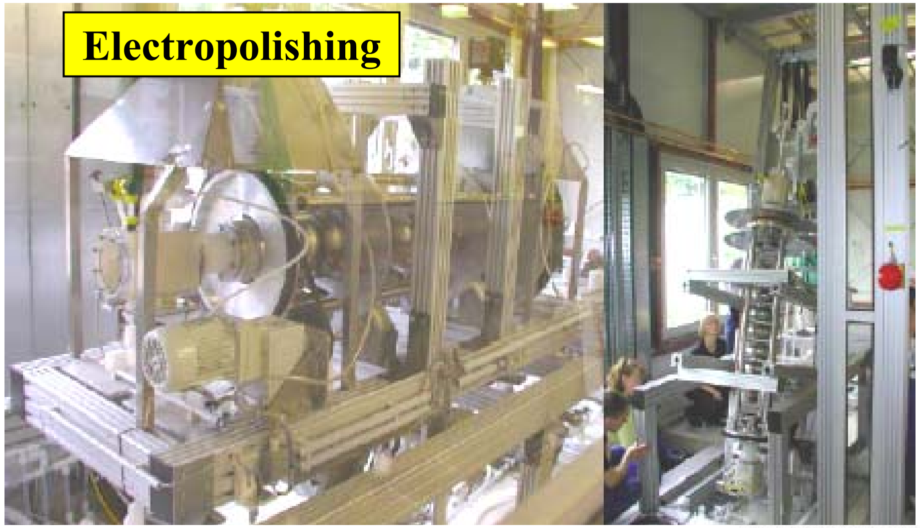


Asia Major Lab

TESLA Test Facility (TTF)
DESY

Preparation facility, Clean-room, Vertical test, Cavity string assembly, Cryomodule assembly, Cryomodlue test, Linac

TTF



String Assembly

The LC cold option

The assembly of an 8 cavity string

- is a standard procedure
- is done by technicians from the TESLA Collaboration
- is well documented using the cavity database as well as an Engineering Data Management System
- was the basis for two industrial studies.

We are ready to transfer this well known and complete procedure to industry.

ITRP Visit to DESY, 5th/6th April 2004

Module Assembly

TESLA

The LC cold option

The module assembly is a well defined and standard procedure.

- experience of 10 modules exists
- the latest generation (type III) will be used for series production (XFEL requires 120 modules)
- several cryogenic cycles as well as long time operation were studied
- the assembly problems occurred are well understood and cured

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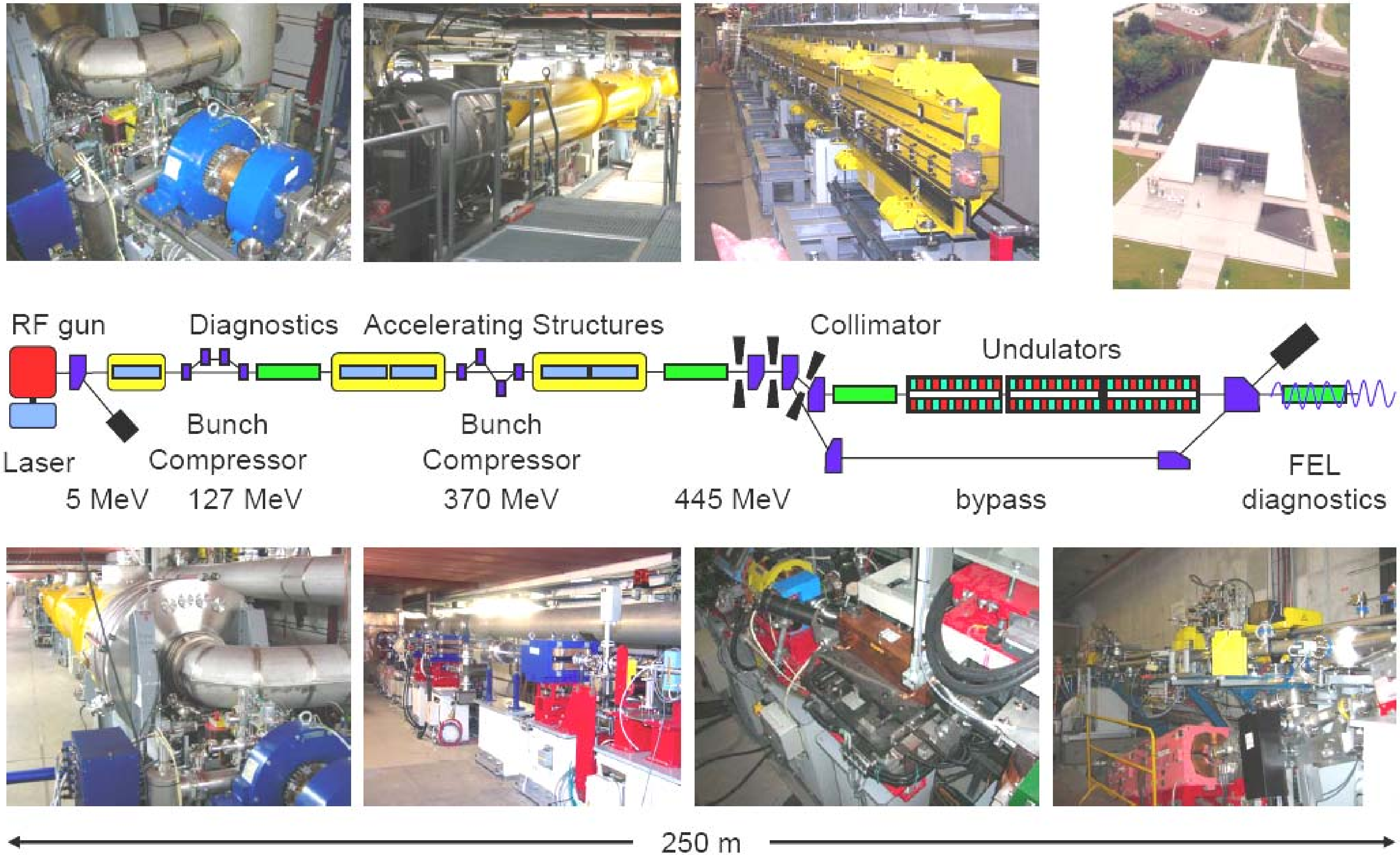
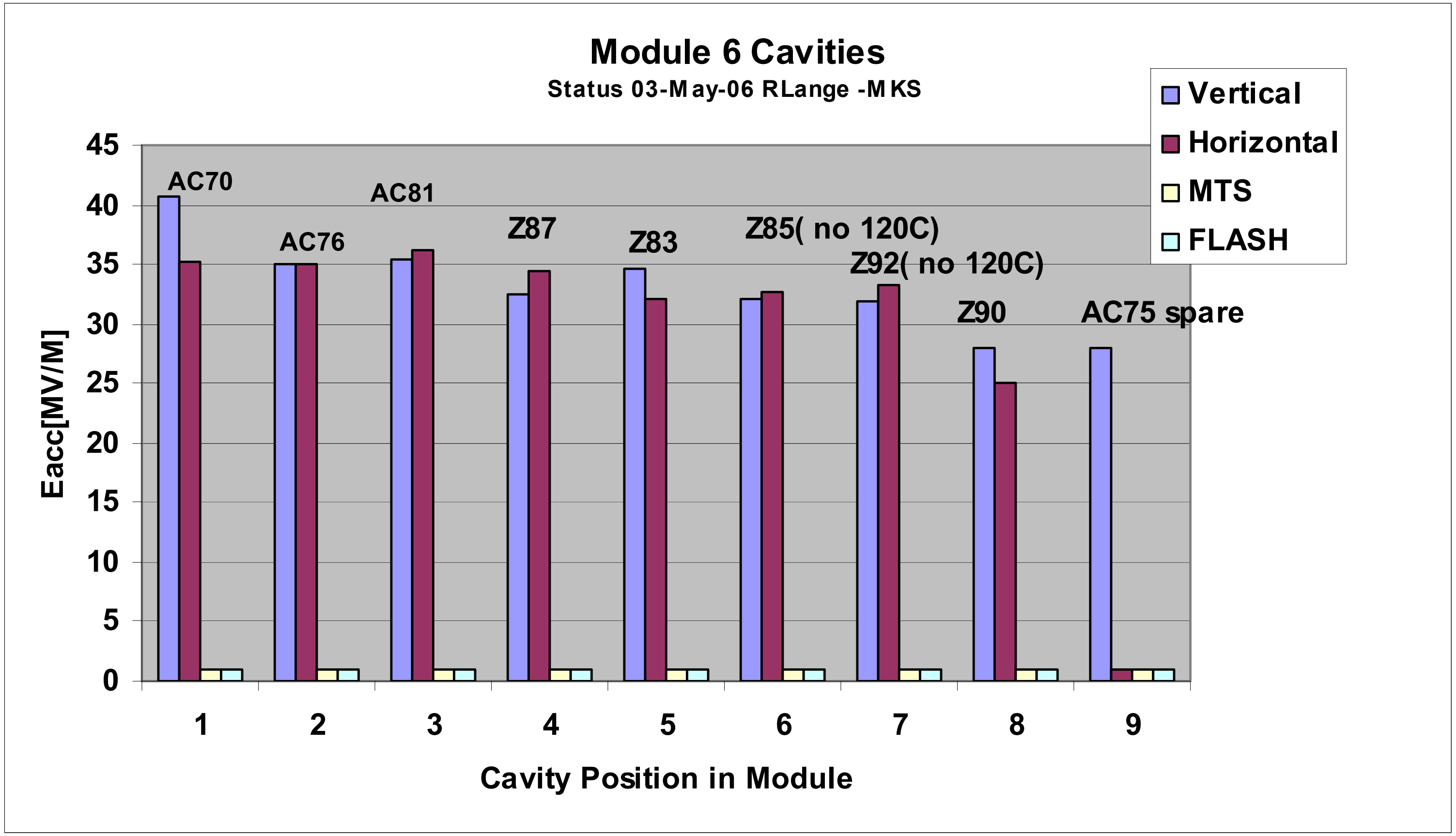
TTF LINAC: an unique VUV-FEL facility



35(31.5)MV/m Cryomodlue (2006)

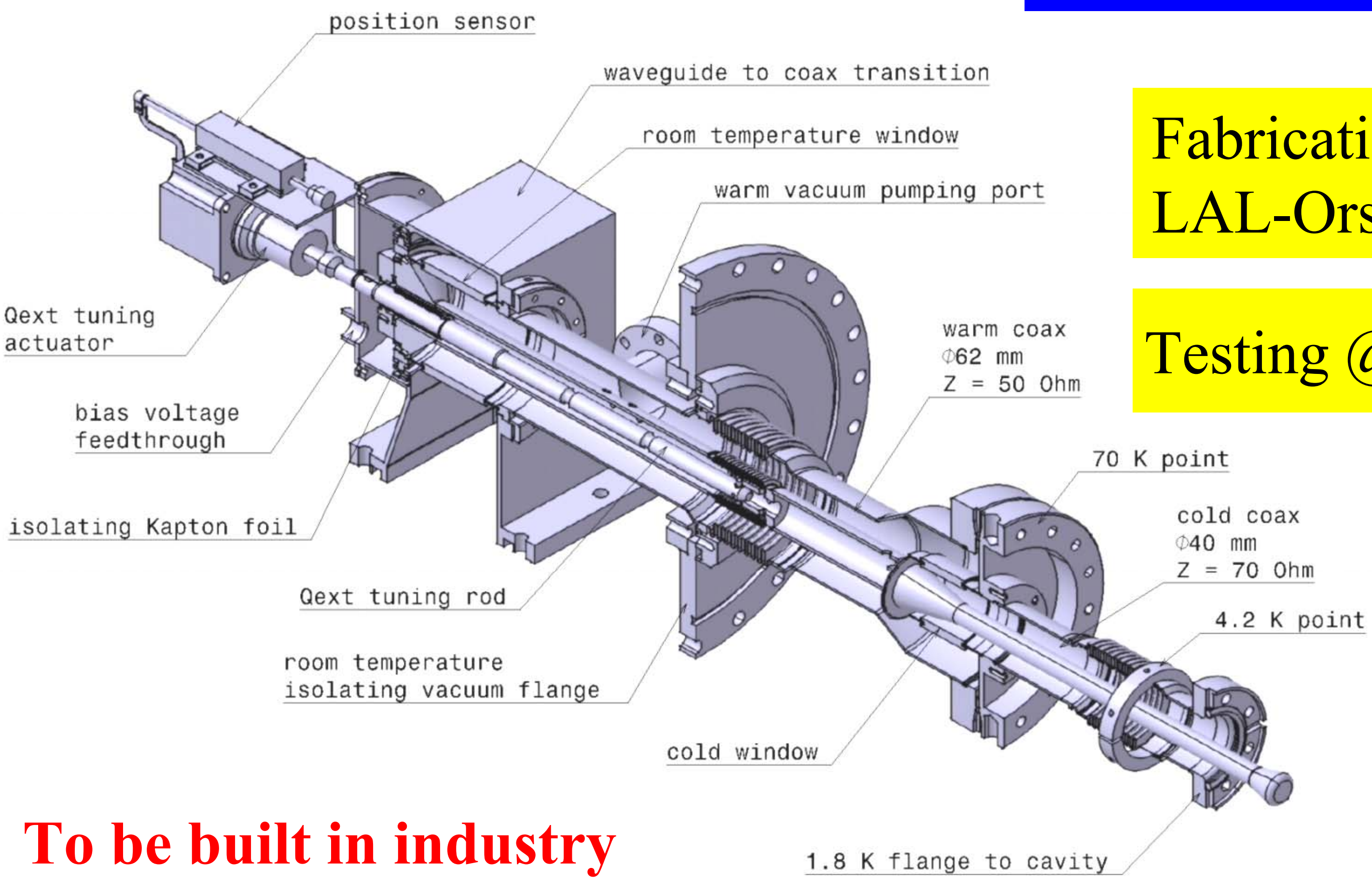


ITRP R1 issue (2004) : The feasibility demonstration of the TESLA energy upgrade to about 800GeV requires that a cryomodule be assembled and test at the design gradient of 35MV/m.

This issue is important with not only the gradient but also Piezo fast tuner.
High prioritized issues in the ILC!!

Recent Progress on ILC BCD Input coupler

X-FEL coupler



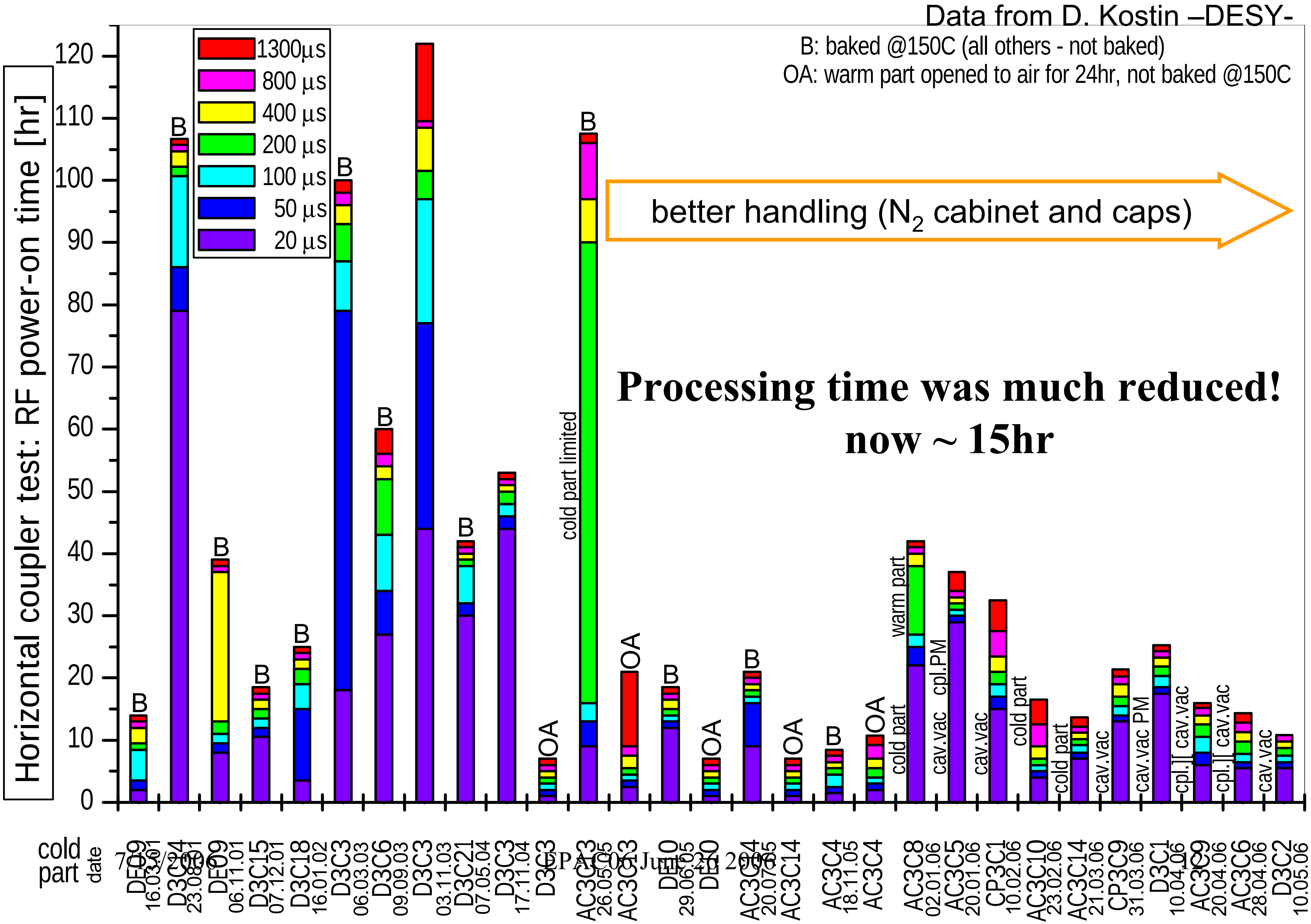
TTF-III; ILC BCD

Fabrication;
LAL-Orsay in France

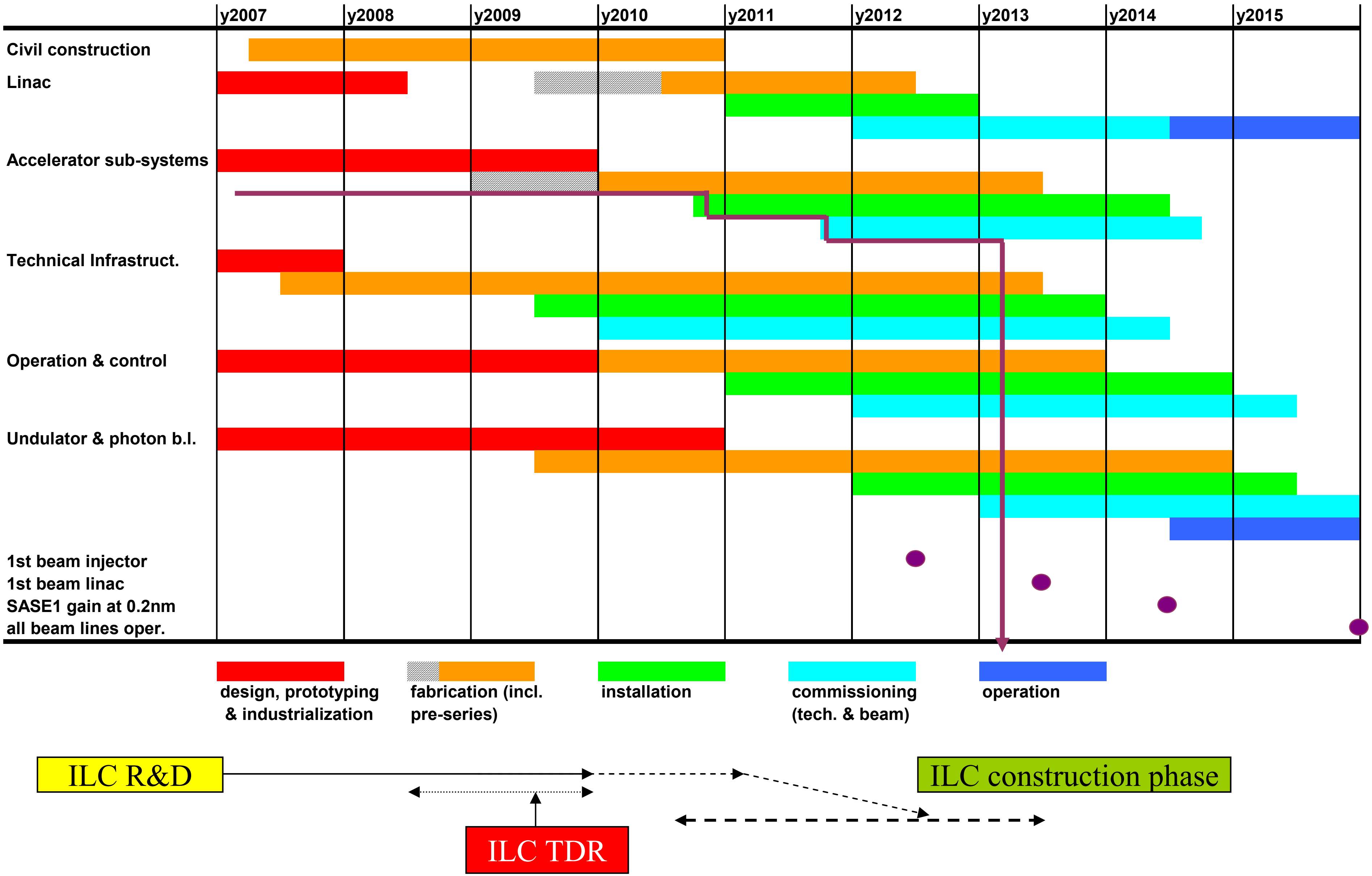
Testing @ FFT

To be built in industry and tested in 2006.

TTF III Coupler Processing Times in CHECHIA



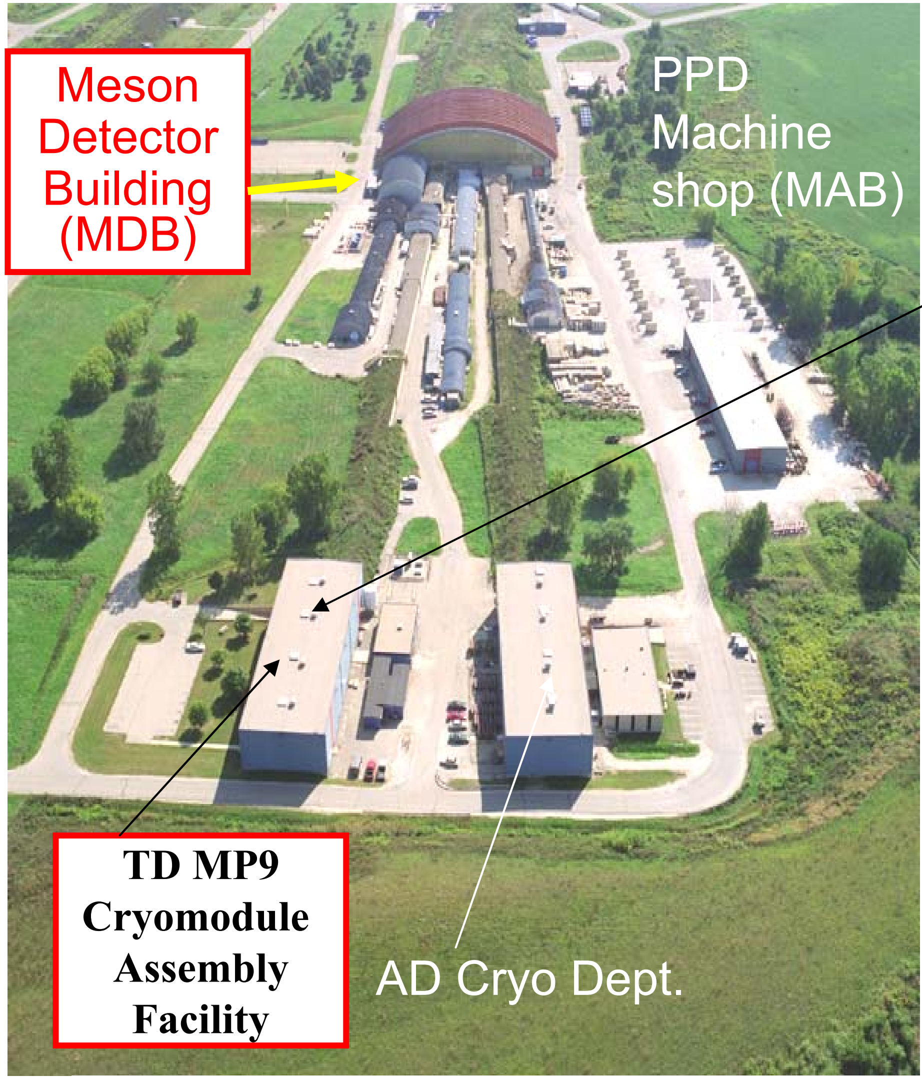
EURO XEFL Construction Schedule



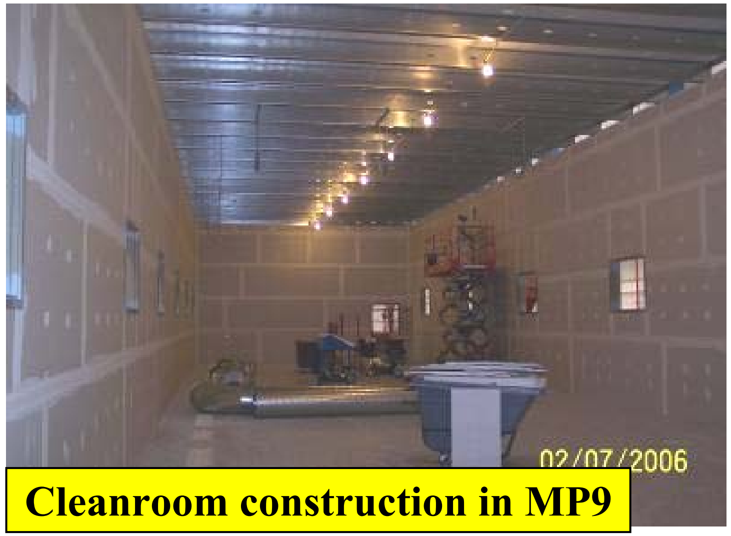
TTF activities and DESY accelerator manpower is going to the EURO XFEL project.
It might be difficult for their activity to couple the ILC R&D.

ILC Test Accelerator (ILCTA)
FNAL

ILC Test Accelerator (ILCTA) @ FNAL



Cleaned up MP9



Cleanroom construction in MP9

They are reforming the FNAL old building for the ILC activities.

Cryomodule Fabrication Plans for an RF Unit test at ILCTA

FNAL

Cryomodule 1

- Dressed Cavity Provided By DESY
- Cold Mass By DESY/INFN
- Cryomodule Assembled at Fermilab
- March 07

Cryomodule 2

- Standard Length Cavity Purchased By Fermilab
- BCP & VT At Cornell
- EP & VT At Jlab
- Dressed and HT At Fermilab
- Cold Mass From Zanon By Fermilab
- Dec 07

Cryomodule 3

- ILC Length Cavity Purchased By Fermilab (AES/Jlab)
- BCP & VT In USA
- EP & VT In USA
- Dressed New Design and HT At Fermilab
- Cold Mass Type-IV From US Company By Fermilab
- Mid 08

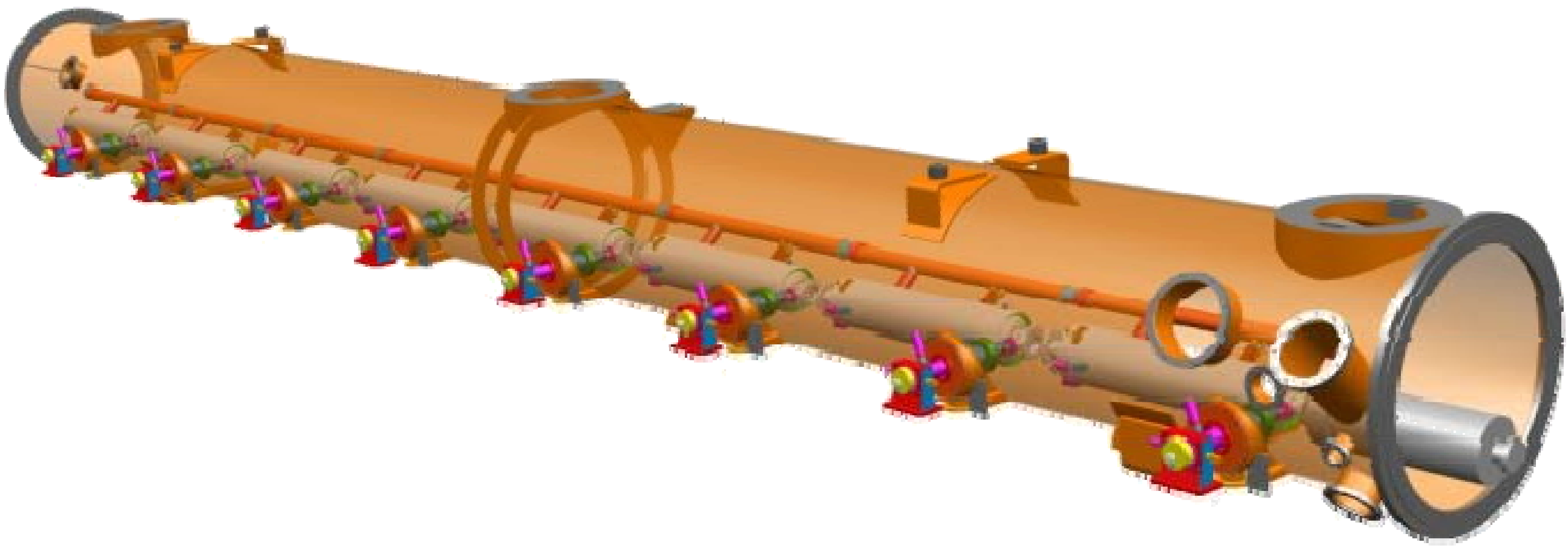
Cryomodule Assembly Fixtures

FNAL

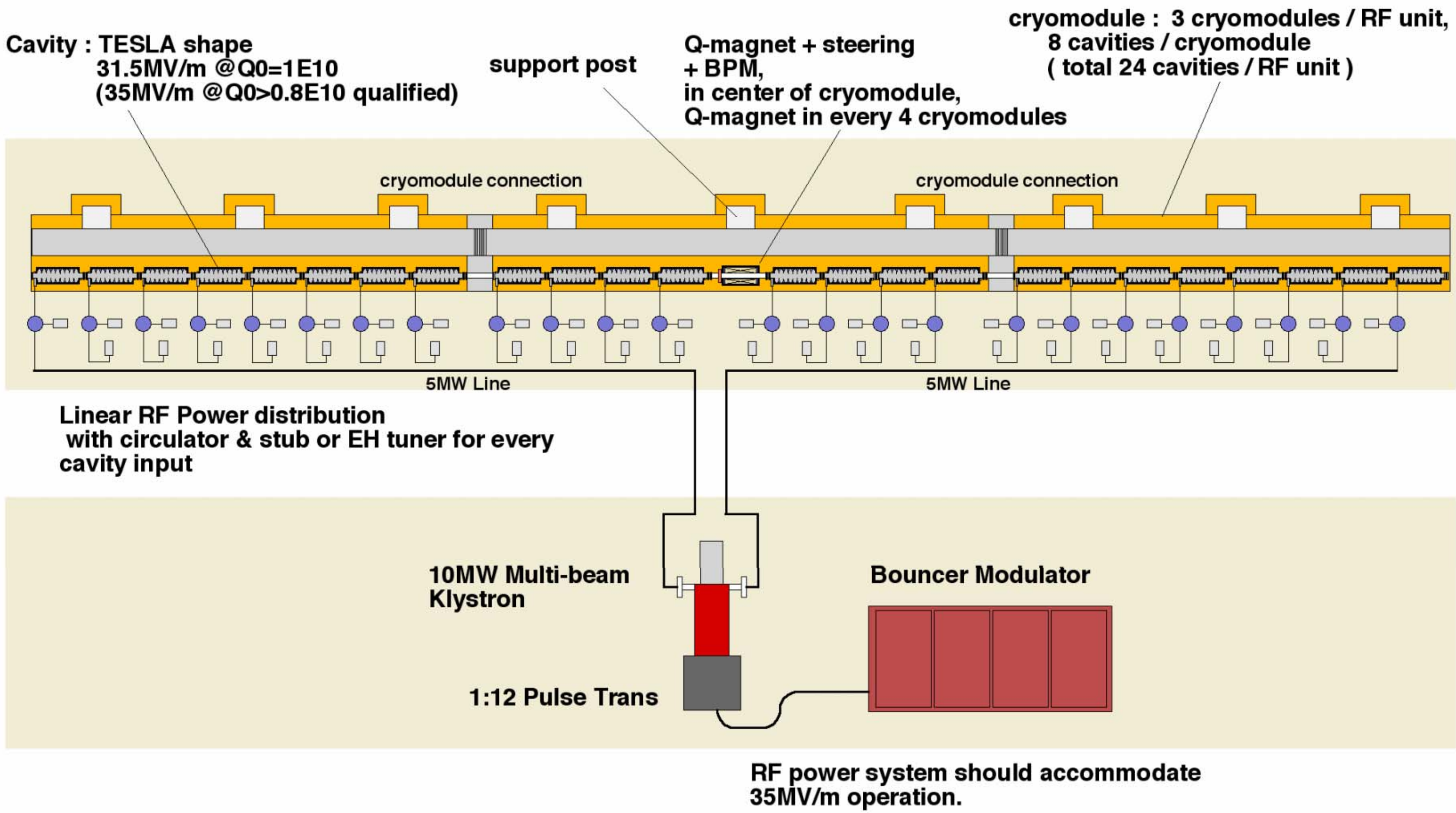
Cryomodule Design at FNAL

Fermilab

- Industrial fabrication and cost reduction of the ILC cryomodule are both crucial issues for a realistic ILC cost estimate
- In FY05 Fermilab started on converting drawings of the DESY/INFN design of the ILC cryomodule (Type-III+) to US standards for U.S. vendor fabrication and for cost reduction.
- Next goal is to design an improved ILC cryomodule (Type-IV).



Construction of an ILC baseline RF unit in ILCTA



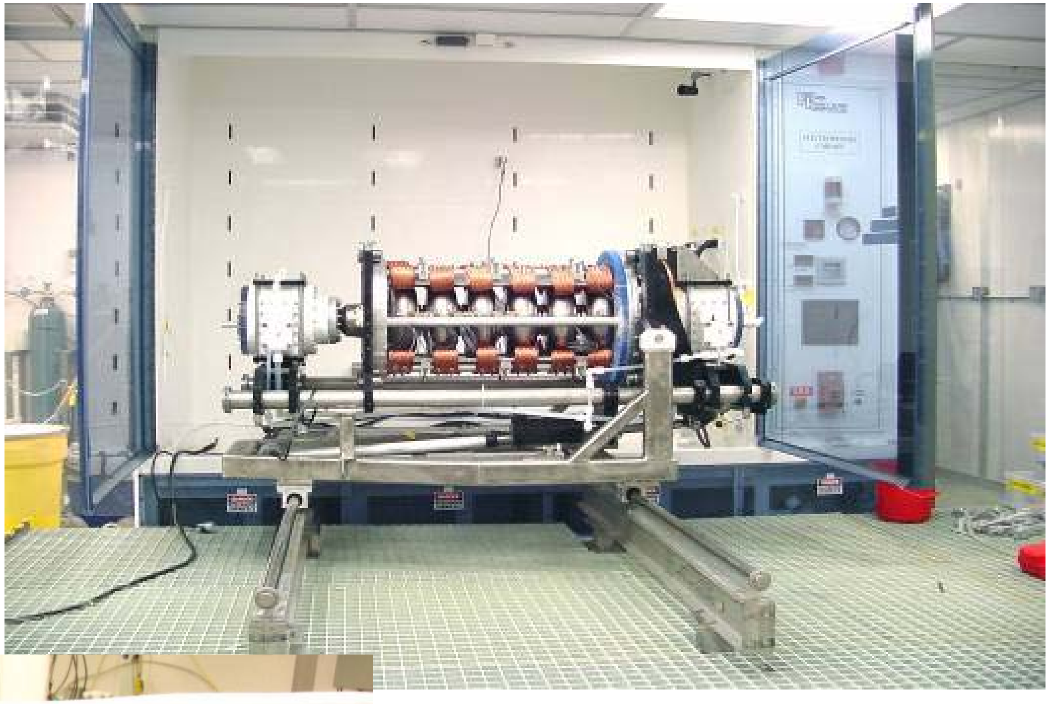
First ACCEL ILC Cavity at Cornell

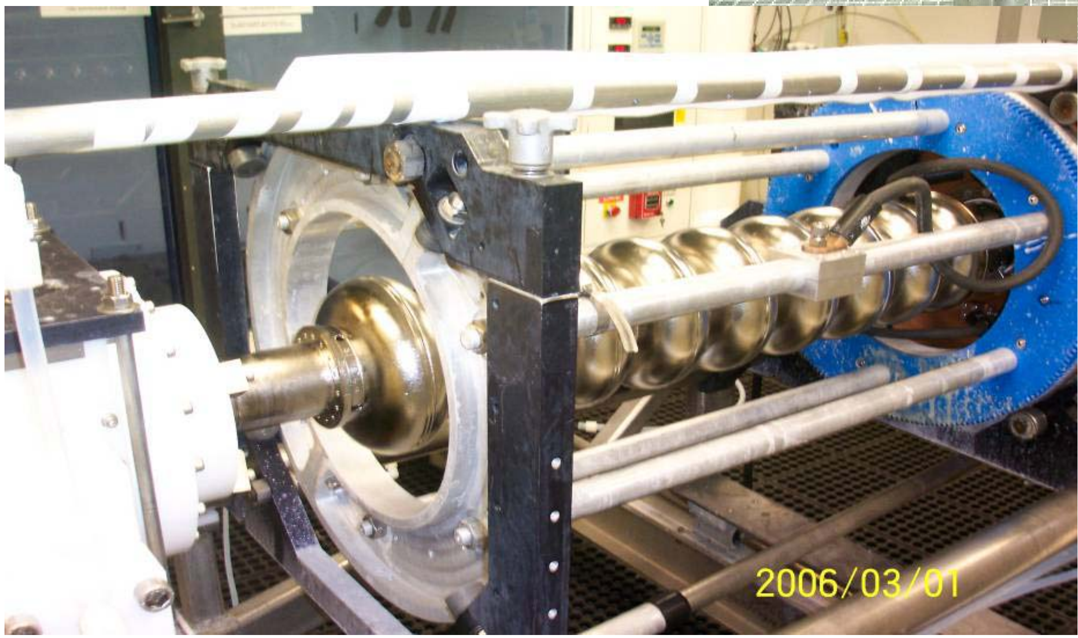
Cornell

New BCP system

New HPR system

Electropolishing Development in Jlab





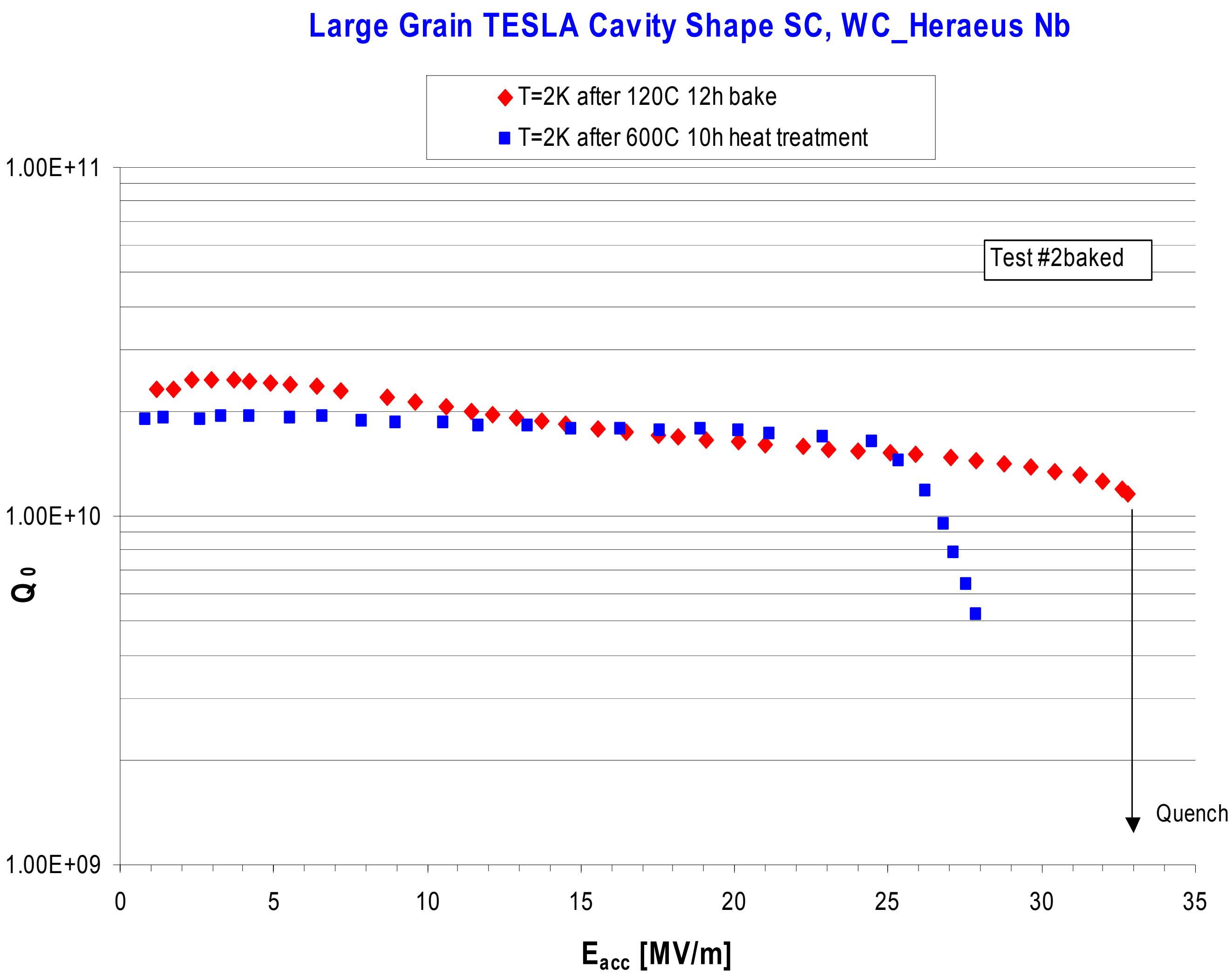
Jlab EP Cabinet

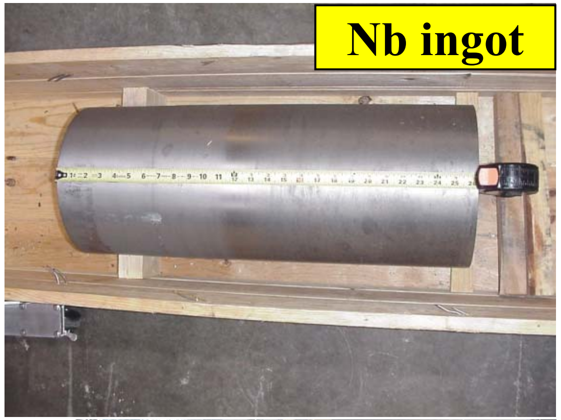
ILC Surface Processing Facility Development at ANL/FNAL

- The Joint ANL/FNAL Superconducting Surface Processing Facility (SCSPF), located at Argonne National Laboratory, is a major chemical processing facility capable of electropolishing and buffered chemical polishing a large quantity and variety of superconducting structures.
- This Facility is made up of two separate chemical processing rooms, with one room to be operated by FNAL and the other ANL.
- Adjoining the processing rooms is a shared ante-room that is class-1000 cleanroom certified. Opposing the processing room and adjoining the ante-room are two class-100 cleanrooms, with FNAL operating one room and the other ANL.



Large grain niobium cavity R&D in Jlab





Large grain Nb sheet production can bring a cost down.
BCP could produce 35MV/m gradient and it brings further cost down.

Superconducting Test Facility STF (KEK)

Main goals of STF

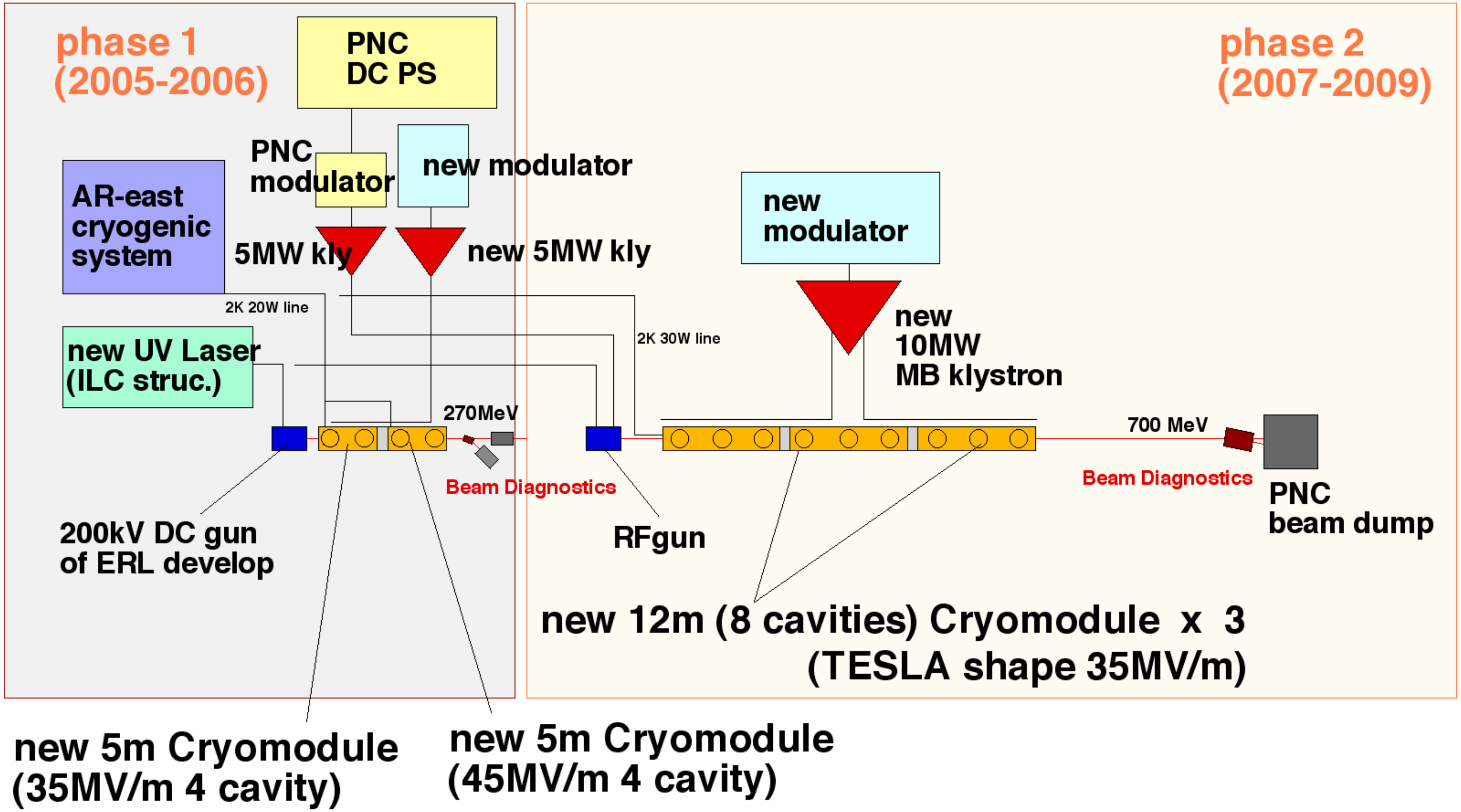
Phase 1 (2005 -2007),

Build up ILC SC-RF technology,
Establish 35MV/m cavity,
Establish 45MV/m cavity,
Build up SC-RF infrastructure.

Phase 2 (2007 - 2009),

Build ILC Main Linac RF unit, at least one unit
Achieve ILC BCD performance,
Operate the unit for long time,
Establish engineering design detail and basis of cost estimation.

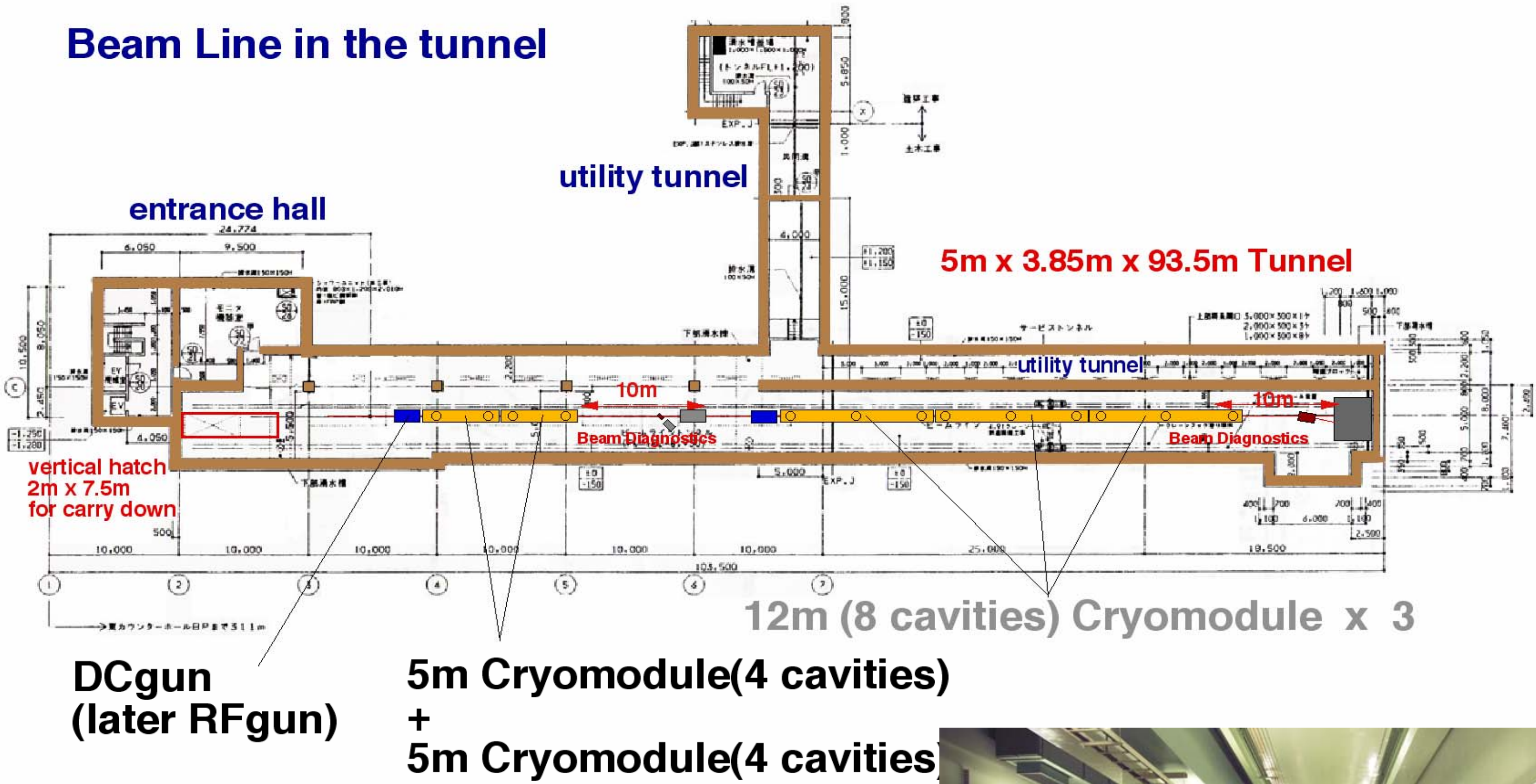
Plan of Superconducting RF Test Facility (STF)



V3.0 Hitoshi Hayano, 12/02/2005

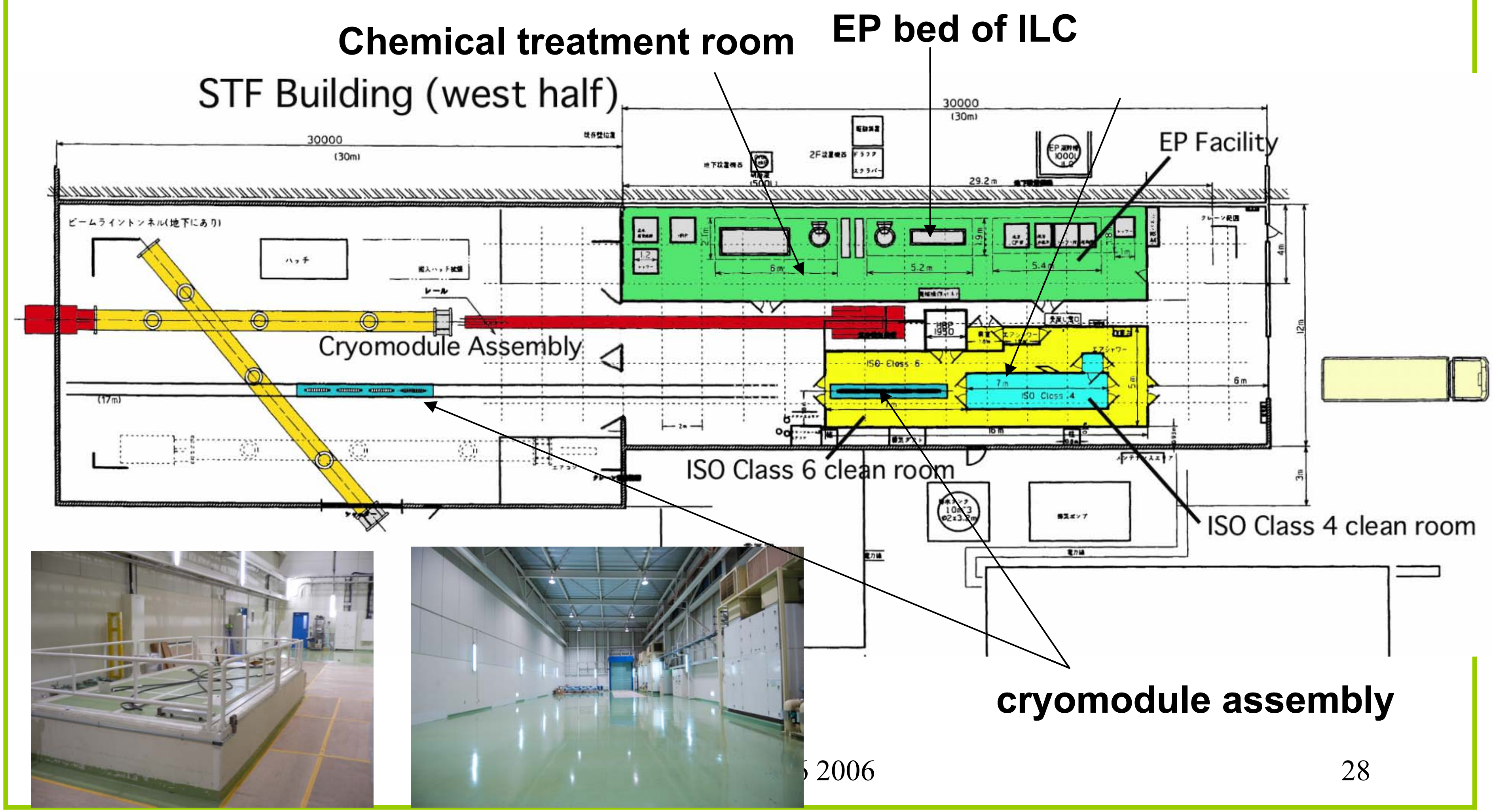
STF underground tunnel plane view

Beam Line in the tunnel

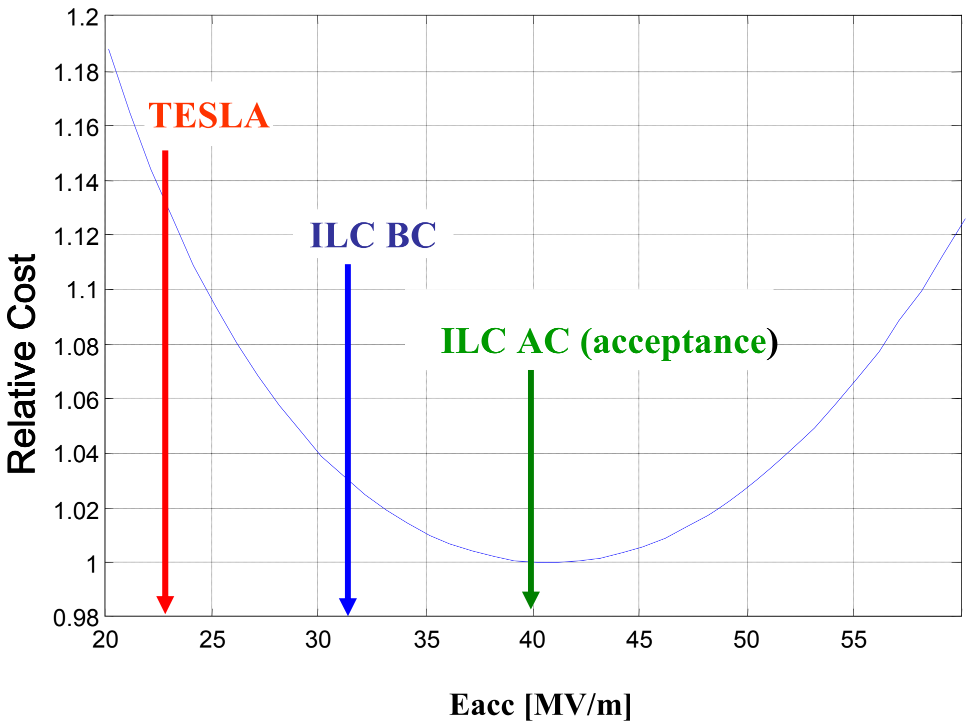


STF Infrastructure

EP: new EP(Electro chemical Polishing) facility to be built by March 2007.
Clean room: new clean room installation in March 2006.



High gradient cavity R&D program with LL shape



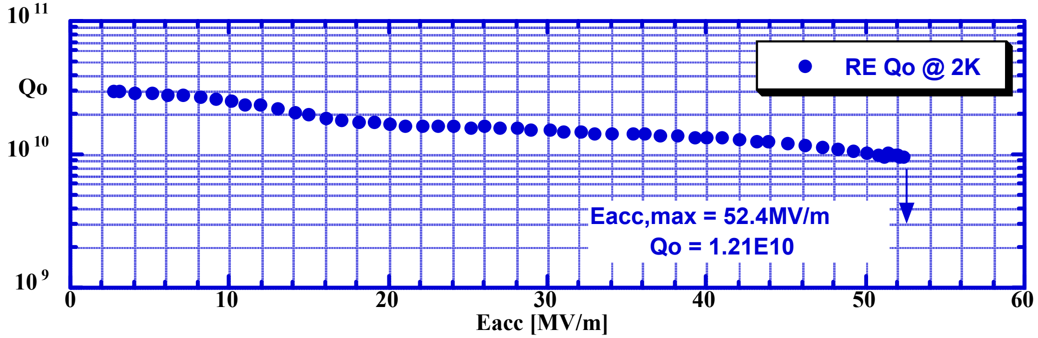
By C.Adolphsen

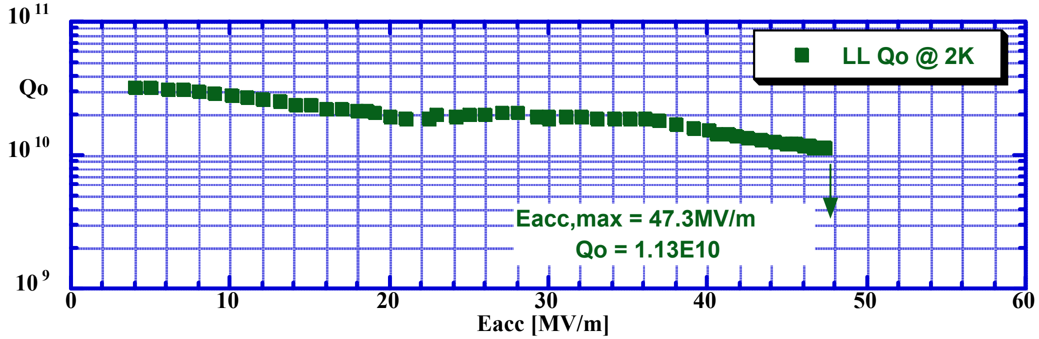
One % cost reduction corresponds to ~ 60 US M$ with ILC project.
A few % is a large cost reduction!

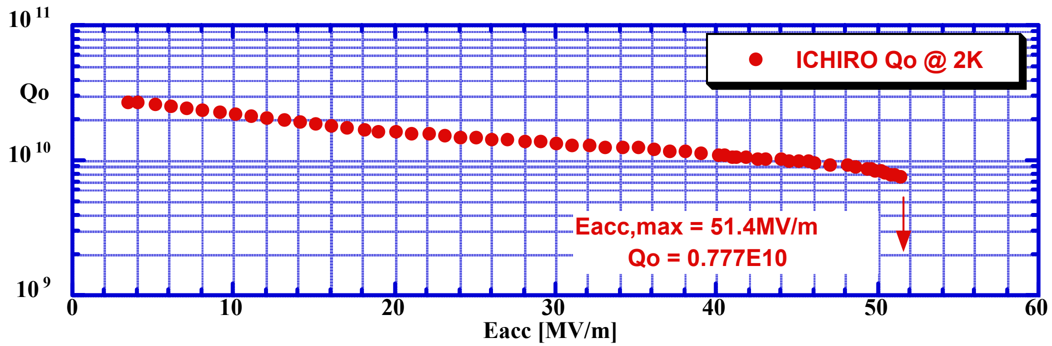
New cavity shape like LL could push up the gradient ~50MV/m.
ILC 1st workshop 2004 @ KEK (by K.Saito)

Principle proof of the 50MV/m in 2005

KEK

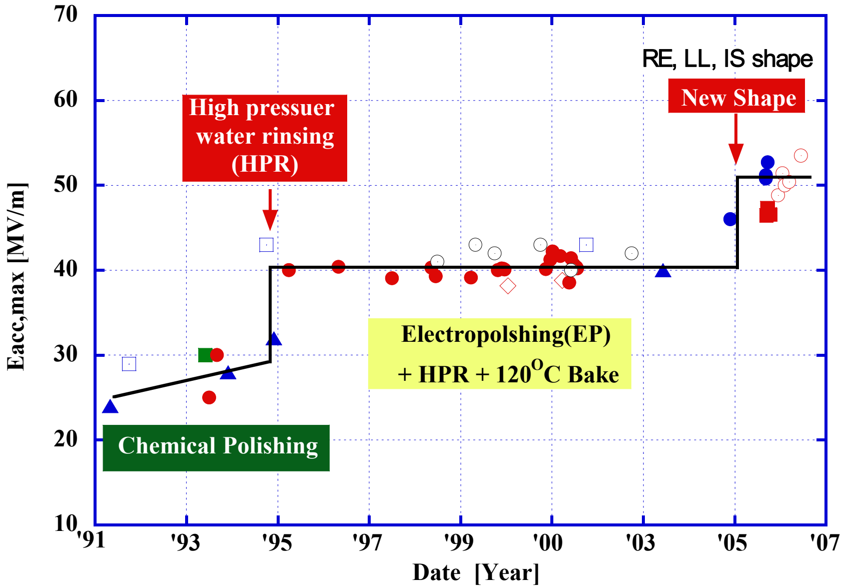




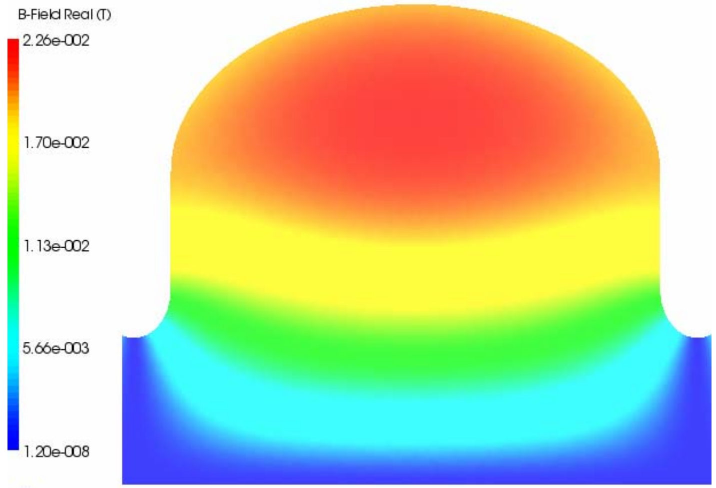


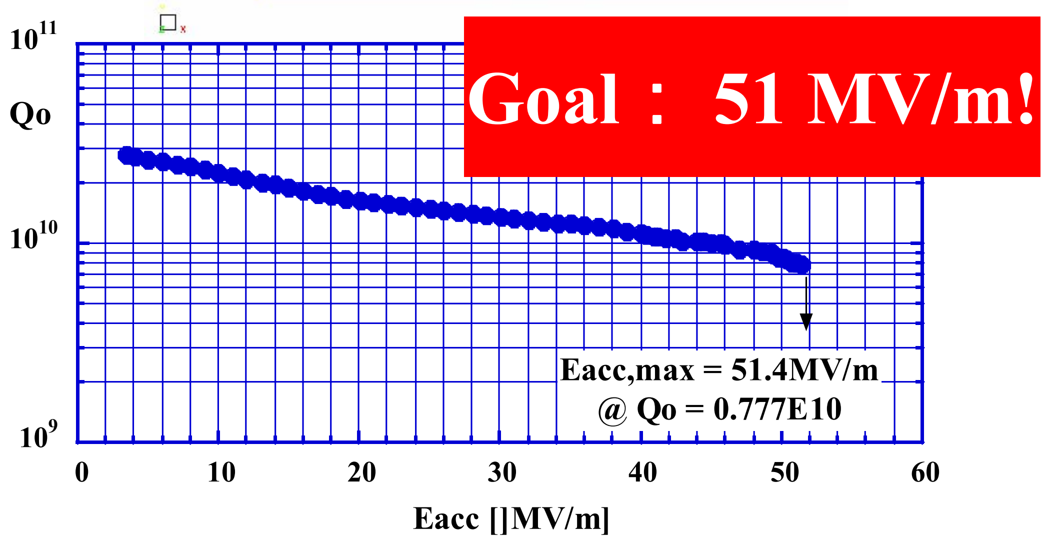
Re-entrant

Low-Loss

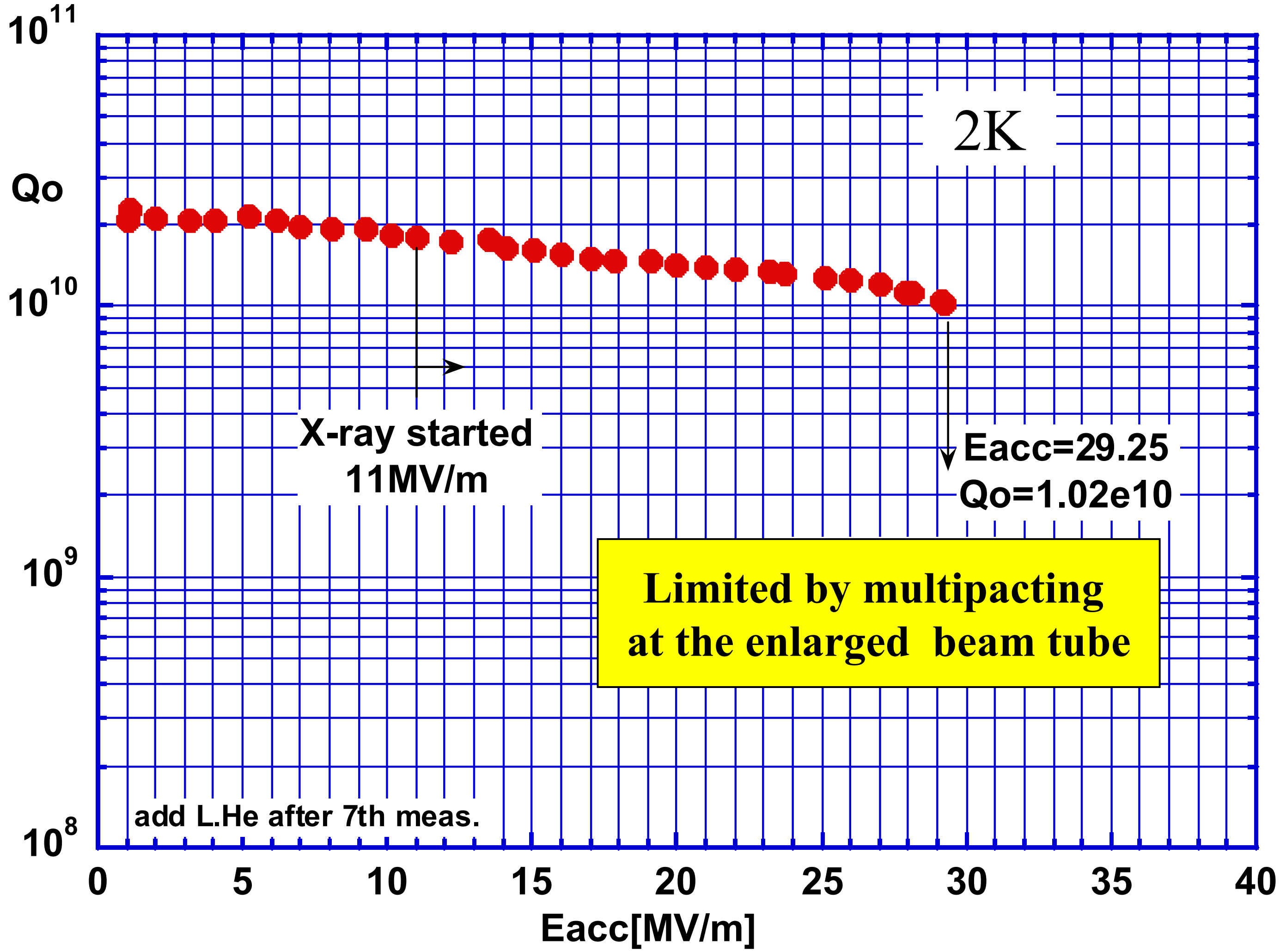


ICHIRO Cavity program in KEK for ILC





Latest result of the ICHIRO#0



35MV/m STF Baseline Cavity Program

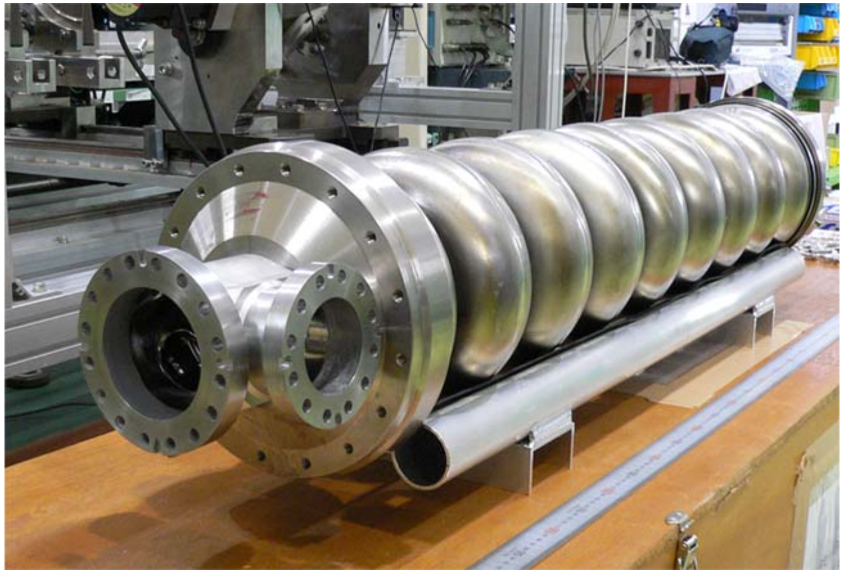
(by Mitsubishi Heavy Industry)

Dumbbell & end group

Ti Jacket end plates

End cell & end group

Baseline cavity No.1:
Setting to CBP(Centrifugal Barrel Polishing).



Baseline cavity No.1:
After CBP and 1st EP(Electro-chemical Polishing).

Excepted outcome from those activities by the ILC TDR (2008-2009)

Summary of the SCRF Test facility

		TTF (DESY)	ILCAT (FNAL)	STF (KEK)
Acceptance test (Vertical test)	**EP facility**	**OK**	**07 @ ILCAT(ANL)**	**Mar 07 @ STF**
			OK (Jlab)	**OK @ KEK/NP**
	HPR	**OK**	**07 @ ILCAT(ANL)**	**Aug 06 @ STF**
			OK (Jlab, Cornell)	**OK @ NP and KEK**
	Cavity Assembly	**OK**	**07 @ ILCTA**	**07 @ STF**
			OK (Jlab, Cornell)	**OK ARE2nd EH (KEK)**
	VT System	**OK**	**07 @ ILCTA**	**End 07 @ STF**
			OK (Jlab, Cornell)	**OK ARE2ndEH (KEK)**
Cryomodule Assembly	**String Assembly**	**OK**	**End 06 @ ILCTA**	**Aug 06 @ STF (4 cavities)** **Upgraded 07 @ STF (8 cavities)**
	Horizontal test	**OK**	**07 @ ILCAT**	**Under discussion**
	CM Assembly	**OK**	**Dec. 07 @ ILCTA**	**Sep 06 @ STF (4 cavities)**
Cryomodule Test	**OK**		**09 @ ILCTA**	**NO Plan**
Test Linac	**OK**		**09 @ ILCT**	**Dec 2006**
Beam Test	**OK**		**09 @ ILCT**	**Mar 07 (STF-I)** **2008 (STF-II)**
Cryomodule	**M6 May 06 (Type-III)** **M7 Sep 06 (Type-II)** **M8 Jan07 (Type-III+)** **M9 Begin 07 (Type-III+, for FNAL)**		**#1 Mar. 07(TTF-III+)** **#2 Dec. 07(TTF-VI)** **#3 Middle 08(ILC type)**	**#1 Sept. 06 (for STF-I)** **#2 09 (ILC type for STF-II)**

Expected outcomes from three representative SCRF Test Facilities

	Issue	Needed Facility	Where and When
1) Gradient	35MV/m Qo = 0.8E10, >90% yield	VT	STF(07-08) ILCTA(07-09)
	31.5/35MV/ operation	LINAC	TTF(06-07) STF(07-09) ILCTA(08-09)
2)Preparation Recipe	>90% Yield	VT	TTF(06-07) STF(06-07)
3) Tuner	Piezo fast tuner,	LINAC	TTF(06-07) STF(07-09) ILCTA(07-09)
4) Input coupler	Processing time, Cost	Test stand/LINAC	TTF(06-07) STF(06-09) ILCTA(08-09)
5) Large grain Nb	Cost , BCP reliability @ 35MV/m	VT	ILCTA(07-09) FFT (07-08)
6) 10MW Klystron	horizontal, 10MW reliability	LINAC	TTF(07-08) STF(08-09) ILCTA(08-09)
7) Industrialization	Transfer SRF tech. to companies		TTF(06-08) STF(07-) ILCTA(07-)

Summary

- After the ICFA decision 2004 August, TTF in EURO, ILCTA in US, and STF in Asia are in under or in construction stage for the ILC R&D.
- TTF will demonstrate the 31.5 MV/m operation in this year2006, which is important for not gradient but also fast tuner in the ILC.
- EURO XFEL project will come to production phase in 2007, the ILC R&D in TTF would be reduced but still contributes to the cryomodule study and industrialization for the ILC.
- US is forming the ILCTA in FNAL, where the cryomodule activities will really start in 2007 and install an ILC one RF unit at least until 2009.
- Other US laboratories are making unique contributions to the ILC R&D, e,g. EP development or Large grain cavity in Jlab.
- KEK will complete STF-I by 2007 and STF-II by 2009.
- STF will make an unique contribution for the high gradient cavity.
- Major issues on SCRF will be solved using these facilities by the TDR.