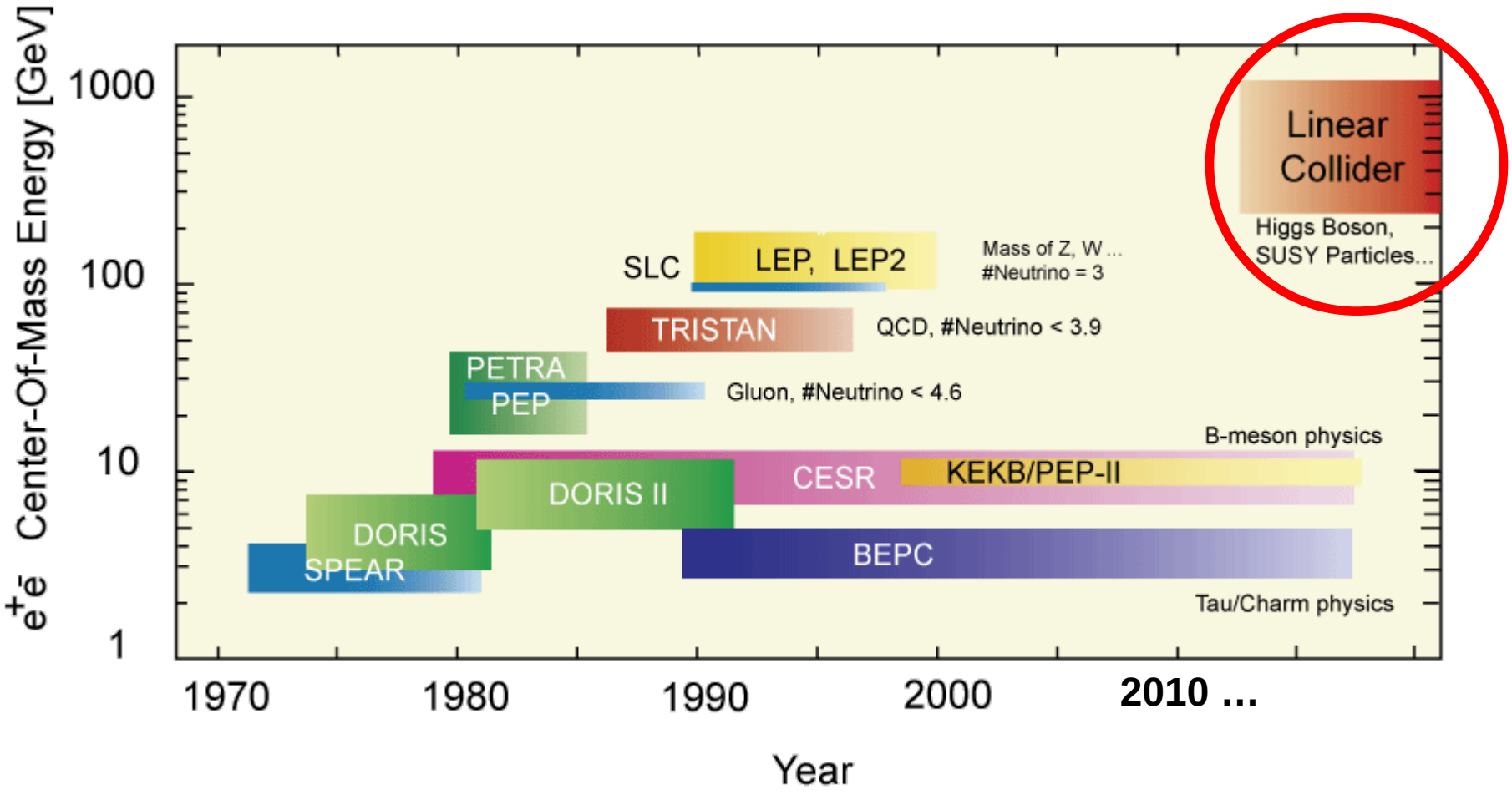
ILC Accelerators and Detectors

Nobu Toge (KEK)

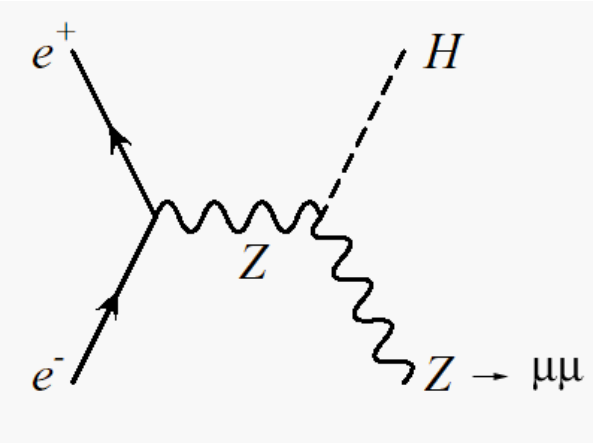
ILC as N'th Generation e+e- Collider

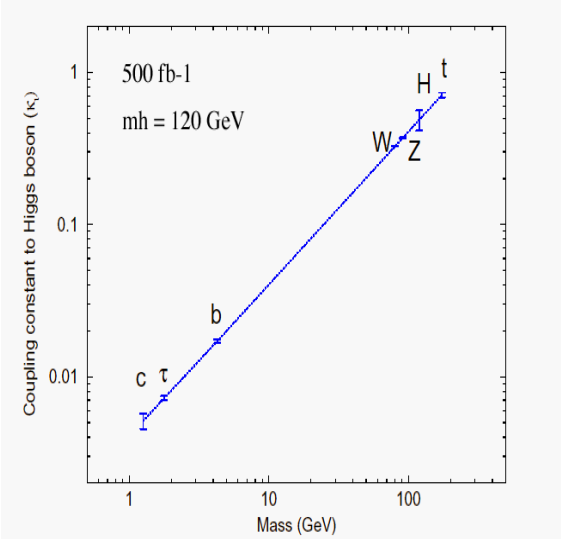


Physics at ILC

- **Higgs-strahlung**
  - Detection + Decays
  - Coupling
- **SUSY**
- **Top quark**
- **Signatures beyond SM**

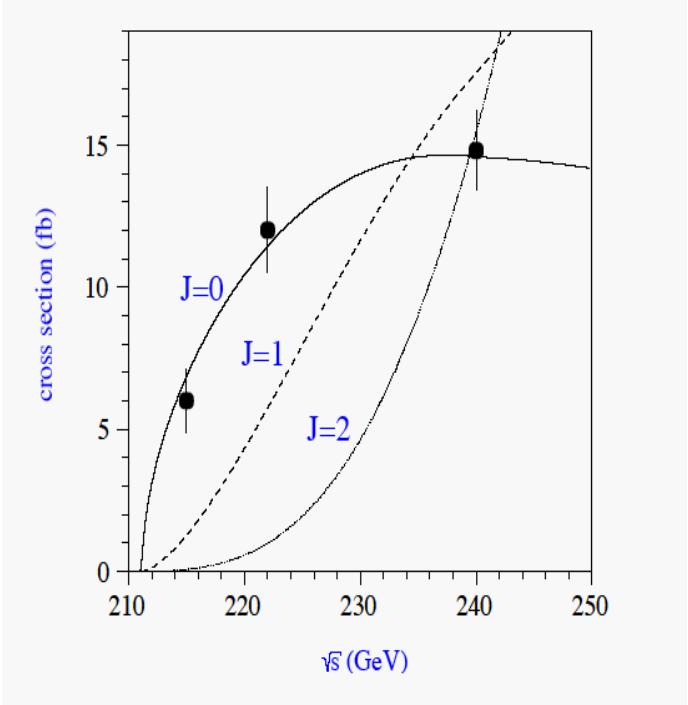
$$e^+e^- \rightarrow Zh,\ Z \rightarrow \mu\mu, ee$$





Physics at ILC

- **Higgs-strahlung**
  - Detection + Decays
  - Coupling
  - Properties
- **SUSY**

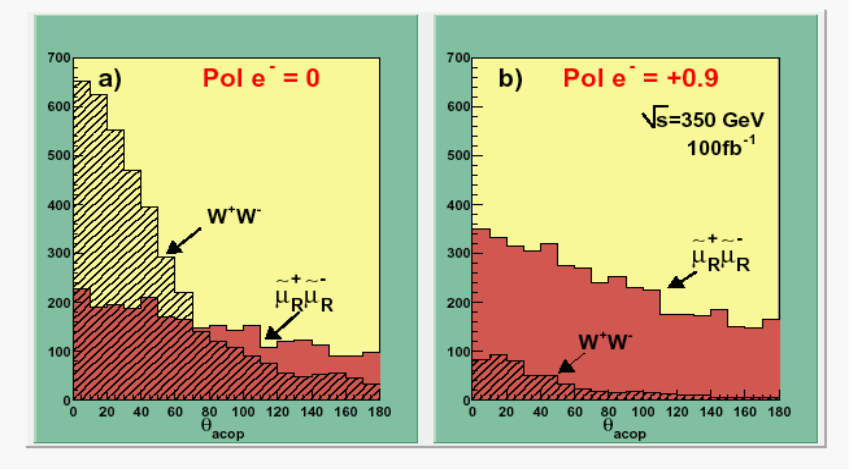


- **Top quark**
- **Signatures beyond SM**

Physics at ILC

- **Higgs-strahlung**
  - Detection + Decays
  - Coupling
  - Properties
- **SUSY**
  - Detection
  - Smuon mass, spin
  - Parameters
  - SUSY dark matter
- **Top quark**
- **Signatures beyond SM**

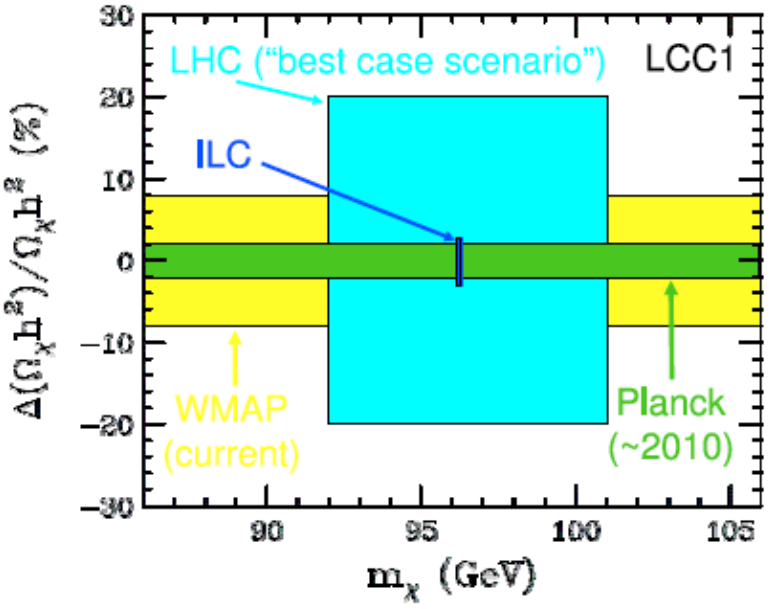
$$e^+e^- \to \tilde{\mu}_R^+\tilde{\mu}_R^-,\ \tilde{\mu}_R \to \mu\tilde{\chi}_1^0$$



- Signal : $\mu^+\mu^-$ and nothing. Plot acoplanarity of $e^+e^-\ \mu^+\mu^-$.
- Polarized e^- (R) can reduce $W^+\ W^-$ background.

Physics at ILC

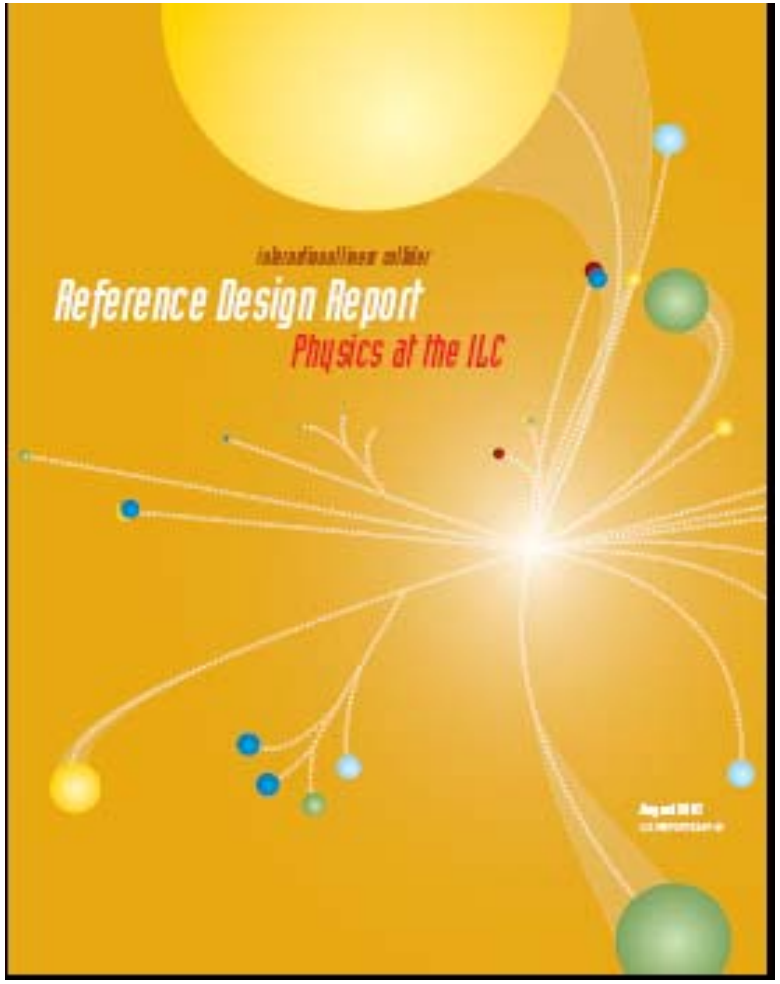
- **Higgs-strahlung**
  - Detection + Decays
  - Coupling
  - Properties
- **SUSY**
  - Detection
  - Smuon mass, spin
  - Parameters
  - SUSY dark matter
- **Top quark**
- **Signatures beyond SM**



Relic density estimation by LHC and ILC vs mass of LSP neutralino (scenario: (mSUGRA SPS1a)

Physics at ILC

- **Higgs-strahlung**
  - Detection + Decays
  - Coupling
  - Properties
- **SUSY**
  - Detection
  - Smuon mass, spin
  - Parameters
  - SUSY dark matter
- **Top quark**
  - Mass, width, decay mode
- **Signatures beyond SM**
  - If there are some

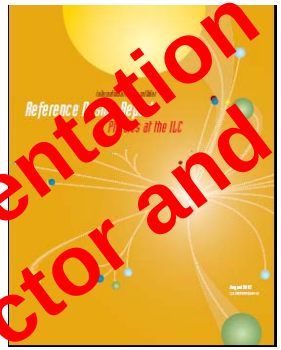


ILC Reference Design (Summer 2007)

- **As result of GDE work (2005-2007)**
- **4 volumes set**



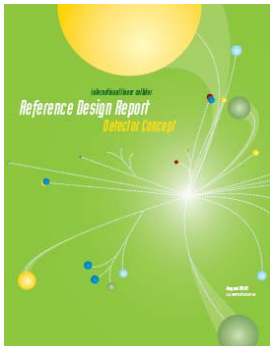
Executive Summary



Physics at the ILC



Accelerator



Detectors

Integrated Presentation for Physics, Detector and Accelerator

- **Available at:** http://www.linearcollider.org/cms/?pid=1000437

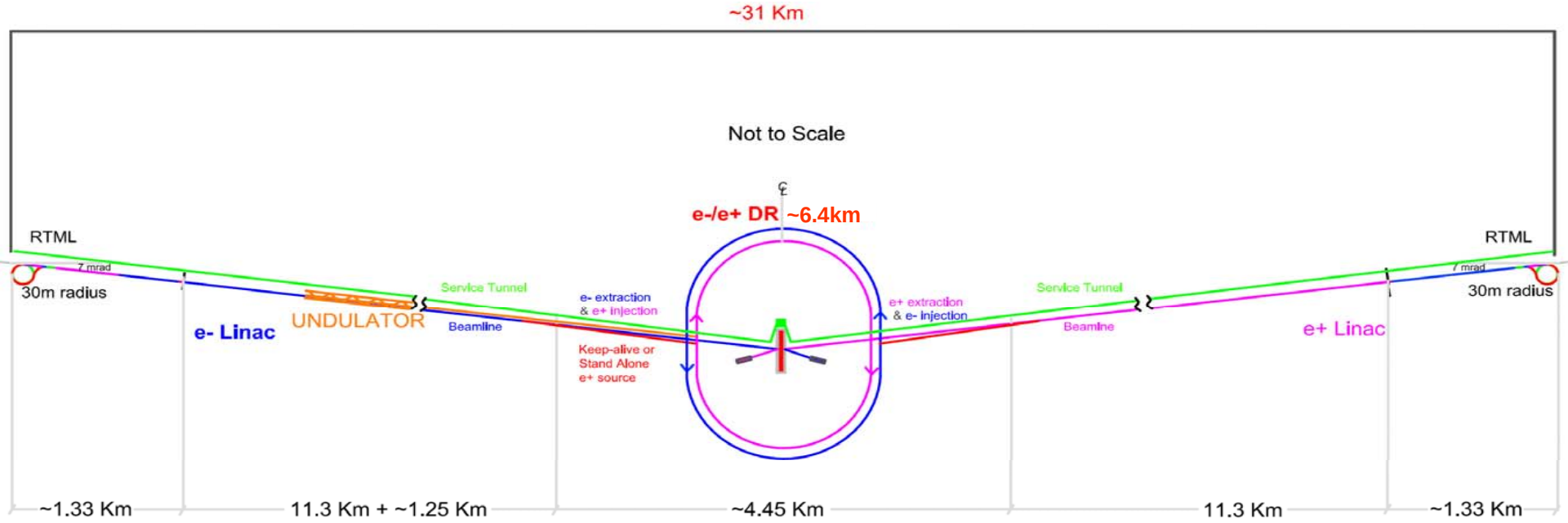
In this talk…

- I will bring you folks up to date on -
  - **Global efforts for ILC (International Linear Collider): Status and near-future plans.**
    - Accelerator - GDE (Global Design Effort)
    - Detector-related - RD (Research Director's Org.)

- To put the conclusions first –
  - **There is a large, coordinated, global efforts on ILC,**
    - Aiming at developing a project proposal with integrated accelerator and detectors designs, together with
    - A project execution plan,
    - Which can be handed to governments.
    - In the form of a document completed in 2012.

Reference Design in Nutshells

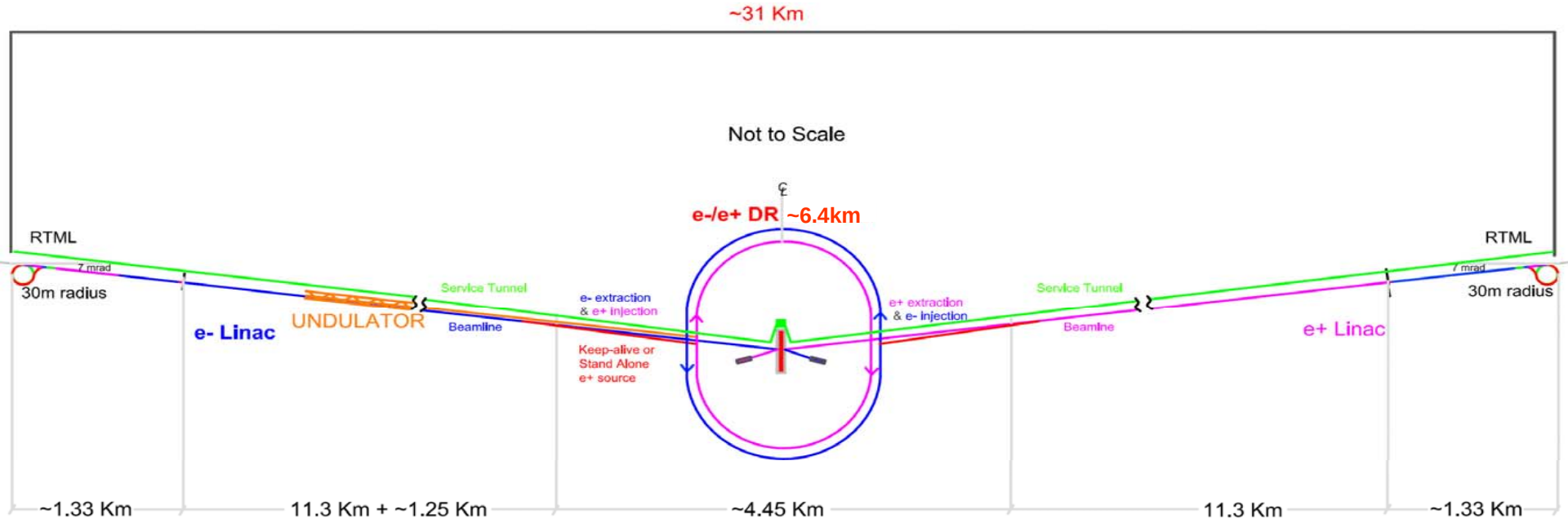
- ECM = 500GeV max within a site footprint of ~31km.
- Main Linacs: operating superconducting (SCRF) cavities at Eacc = 31.5MV/m (16000 units of 9-cell cavities → 2 x ~12km)
- Injectors: Polarized (P~80%) e- source with 2 damping rings (e- and e+) around interaction region.



Schematic Layout of the 500 GeV Machine

Reference Design in Nutshells

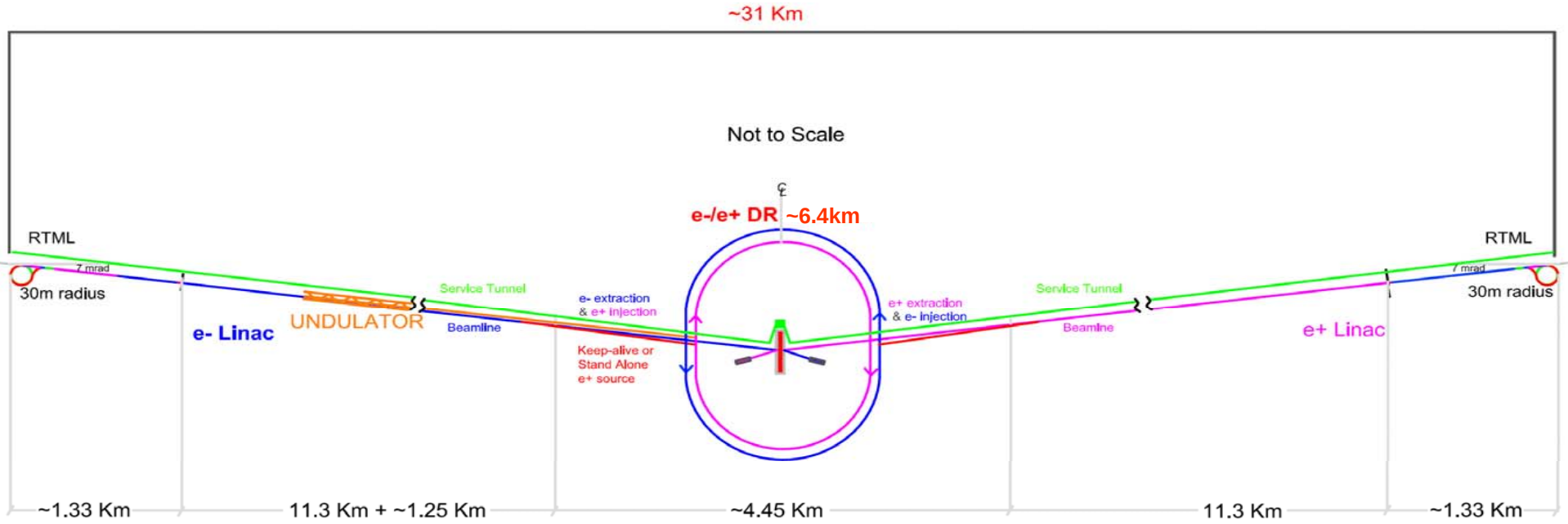
- Injectors (cont): Undulator-based (150m @ 150GeV) e+ source within e- main linac
- Interaction region: Single IR with 14mrad beam crossing
- Lumi = 2×10^{34} $cm^{-2}s^{-1}$, f_rep = 5Hz



Schematic Layout of the 500 GeV Machine

Reference Design in Nutshells

- Total tunnel length ~ 72.5 km
- Excavation 443km^3
- 13 x access shafts (or access routes)
- 92 x surface buildings, floor area ~ 52,700m^2



Schematic Layout of the 500 GeV Machine

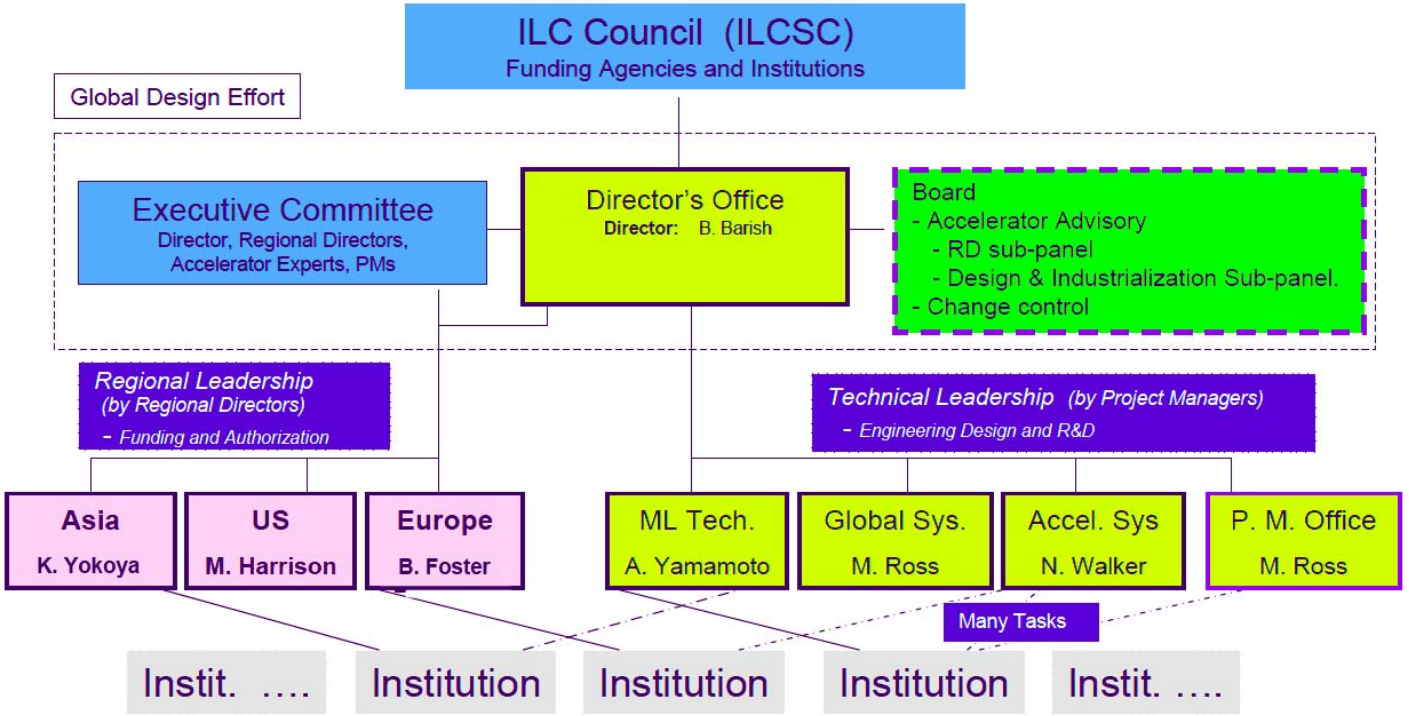
ILC Cryostats and Cavities for Main linacs

- 1 cryomodule contains 8 cavities + 1 magnet or 9 cavities (Eacc = 31.5MV/m on average, each having a length ~ 1m)



- Total ~1700 cryostats, ~16000 cavities.
- 3 cryostats to be driven by one 10MW L-band klystron
- Total 560 RF units in e+/e- main linacs

Accelerator: Mgmt Structure in GDE



- GDE Director = ICFA appointment
- Executive Committee (EC) assists GDE Director on Executive matters of GDE.
- Three leaders (Project Managers) under the Directoror to lead
  - **Accelerator Sys.**
  - **Superconducting RF**
  - **Instr. + Control, Conventional Facilities and Siting, Globals**
- And additional managerial groups

Global Efforts – Now what?

Technical Design Phase 1 -- till mid-2010

- Demo. “Technical Feasibility”
- High-priority, risk-mitigating R&D
- Value engineering (cost vs performance analysis) in selected areas.
- Re-baseline of the design as found appropriate and necessary.

Detector Design Phase 1 -- till mid-2010

- Validation of detector concepts, to examine as integral parts of accelerator TDP.
- Focus R&D on critical elements; MDI design details.
- Update of physics performance
- Start-up of technical design work

Technical Design Phase 2 -- till 2012

- Demo. “Technical Credibility”
- Refine the design
- Continued R&D
- Cost roll-up
- Development of a project implementation plan.

Detector Design Phase 2 -- till 2012

- Refine the design
- Continued R&D
- Cost roll-up.
- Development of a project implementation plan.
- Actions in response to LHC results

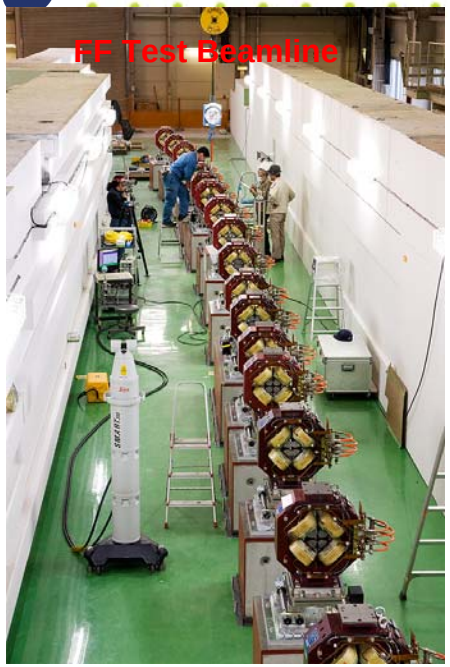
Intention is to produce a report which can be handed to governments for evaluation in ~2012.

ILC R&D Test Facilities Deliverables

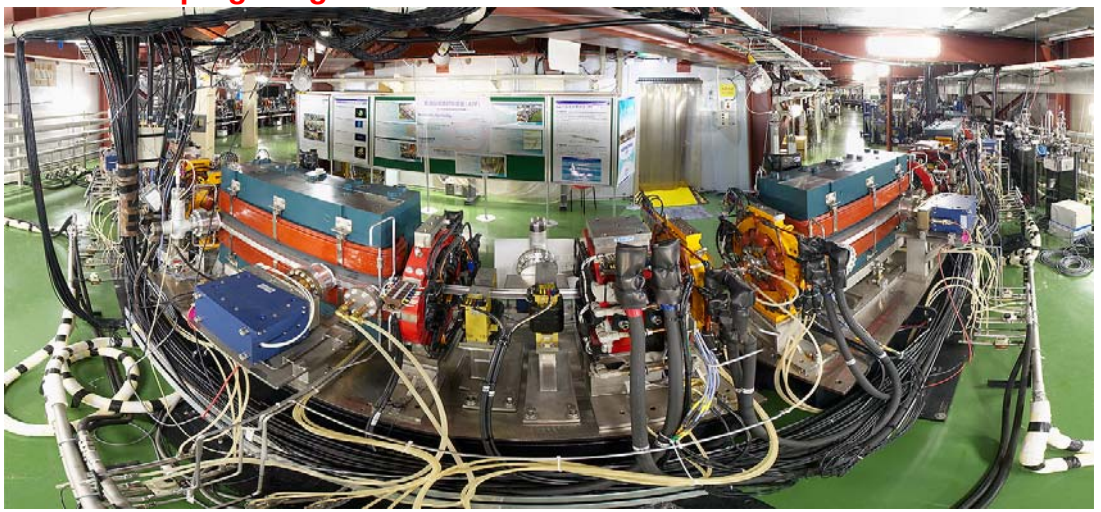
Test Facility	Deliverable	Date
Optics and stabilisation demonstrations:		
ATF	Generation of 1 pm-rad low emittance beam	2009
ATF-2	Demo. of compact Final Focus optics (design demagnification, resulting in a nominal 35 nm beam size at focal point).	2010
	Demo. of prototype SC and PM final doublet magnets	2012
	Stabilisation of 35 nm beam over various time scales.	2012
Linac high-gradient operation and system demonstrations:		
TTF/FLASH	Full 9 mA, 1 GeV, high-repetition rate operation	2009
STF & ILCTA-NML	Cavity-string test within one cryomodule (S1 and S1-global)	2010
	Cryomodule-string test with one RF Unit with beam (S2)	2012
Electron cloud mitigation studies:		
CESR-TA	Re-config. (re-build) of CESR as low-emittance e-cloud test facility. First meas. of e-cloud build-up using instrumented sections in dipoles and drifts sections (large emittance).	2008
	Achieve lower emittance beams. Meas. of e-cloud build up in wiggler chambers.	2009
	Characterisation of e-cloud build-up and instability thresholds as a func. of low vertical emittance ($\leq$20 pm)	2010

ATF and ATF2 @KEK

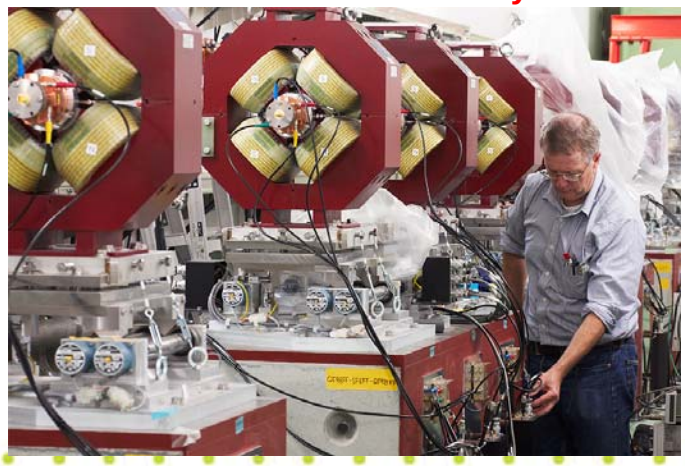
FF Test Beamline



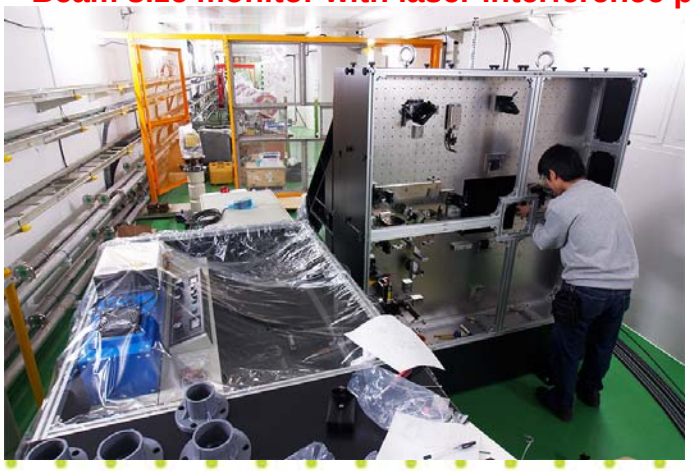
ATF Damping Ring



Check-out electronics for cavity BPMs



Beam size monitor with laser interference pattern

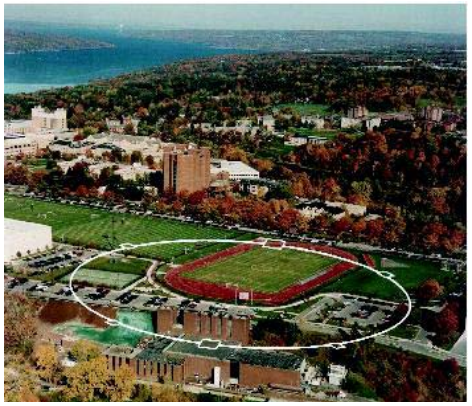


CesrTA @ Cornell

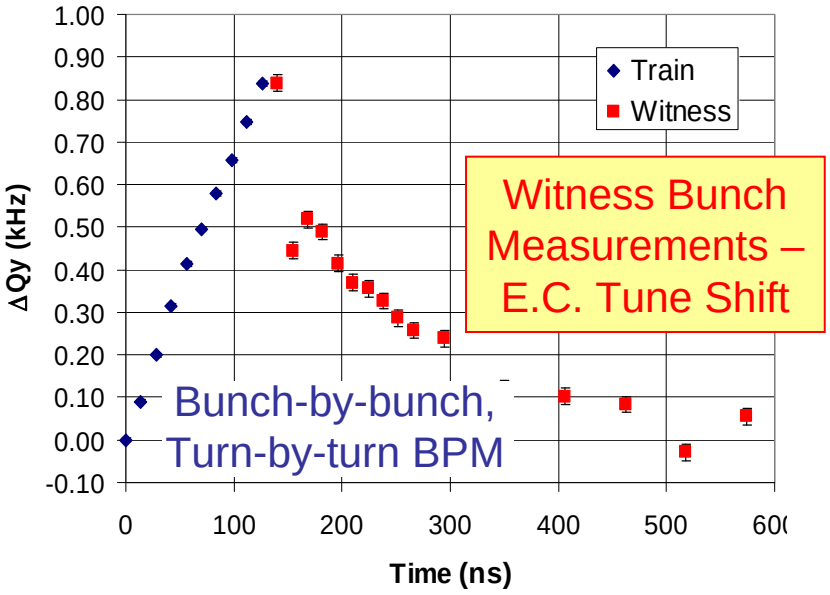
- "Electron Cloud" Issue at Positron Damping Rings (e+ DR)
  - **Synchrotron radiation → Inner wall of vacuum chamber → secondary electrons → "Electron cloud" → Beam instabilities / Emittance growth**
- CesrTA
  - **Can use positrons.**
  - **Vehecle for the ILCDR R&D on the timescale of the ILC TDP**
  - **Internat'l collaboration was formed, centered around Cornell.**
  - **Reconfiguration of CESR is in progress.**
- A series of beam experiments in 2008-2010.
  - **Growth of Electron Cloud and Mitigation Studies**
    - Probe bunch configurations similar to ILC DR
    - Conduct unique studies in high field damping wigglers
  - **Ultra Low Emittance Operation & Beam Dynamics Studies**
    - Validate correction algorithms
    - Measure and maintain ultra low emittance beams
    - Characterize sources of emittance growth in ultra low emittance beams
    - Probe species dependent effects
  - **Deliver design inputs for the ILC Technical Design Phase**

CesrTA @ Cornell - Program





0.75mA/bunch e+@1.9 GeV



Baseline Lattice

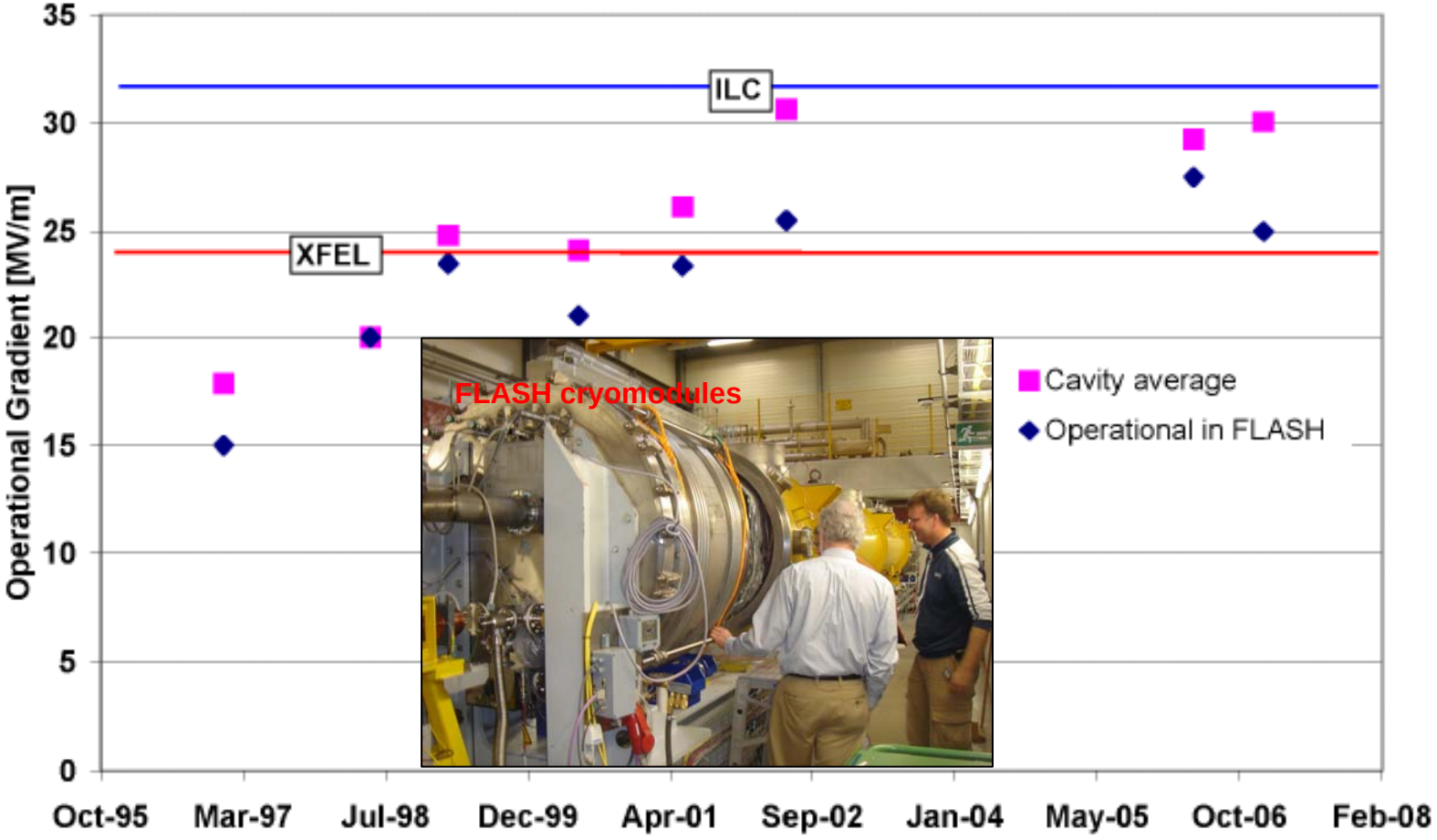
Parameter	Value
No. of Wigglers	12
Wiggler Field	2.1 T
Beam Energy	2.0 GeV*
$\Delta E/E$	8.6×10^{-4}
ε_v (geo) target	<20 pm
ε_h (geo)	2.3 nm
Damping Time	47 ms
Bunch Spacing	4 ns
Bunch Length	9 mm

*CESR operating range is 1.5-5.5 GeV

R&D on Superconducting RF System

Calender Year		2008	2009	2010	2011	2012
Technical Design	**TDP1**				**TDP-II**	
S0: Cavity Gradient (MV/m)	**30**	**35 (> 50%)**				**35 (>90%)**
KEK-STF-0.5a: 1 Tesla-like/LL						
KEK-STF1: 4 cavities						
S1-Global (AS-US-EU) 1 CM (4+2+2 cavities)			**CM (4_{AS}+2_{US}+2_{EU}) <31.5 MV/m>**			
S1(2) -ILC-NML-Fermilab CM1- 4 with beam			**CM2**	**CM3**	**CM4**	
S2:STF2/KEK: 1 RF-unit with beam			**Fabrication in industries**		**STF2 (3 CMs) Assemble & test**	

DESY Activities



Experiences being gained from FLASH and EuroXFEL construction are critical inputs for ILC:

SCRF tech; HW implementation in tunnels; multinat'l mgmnt

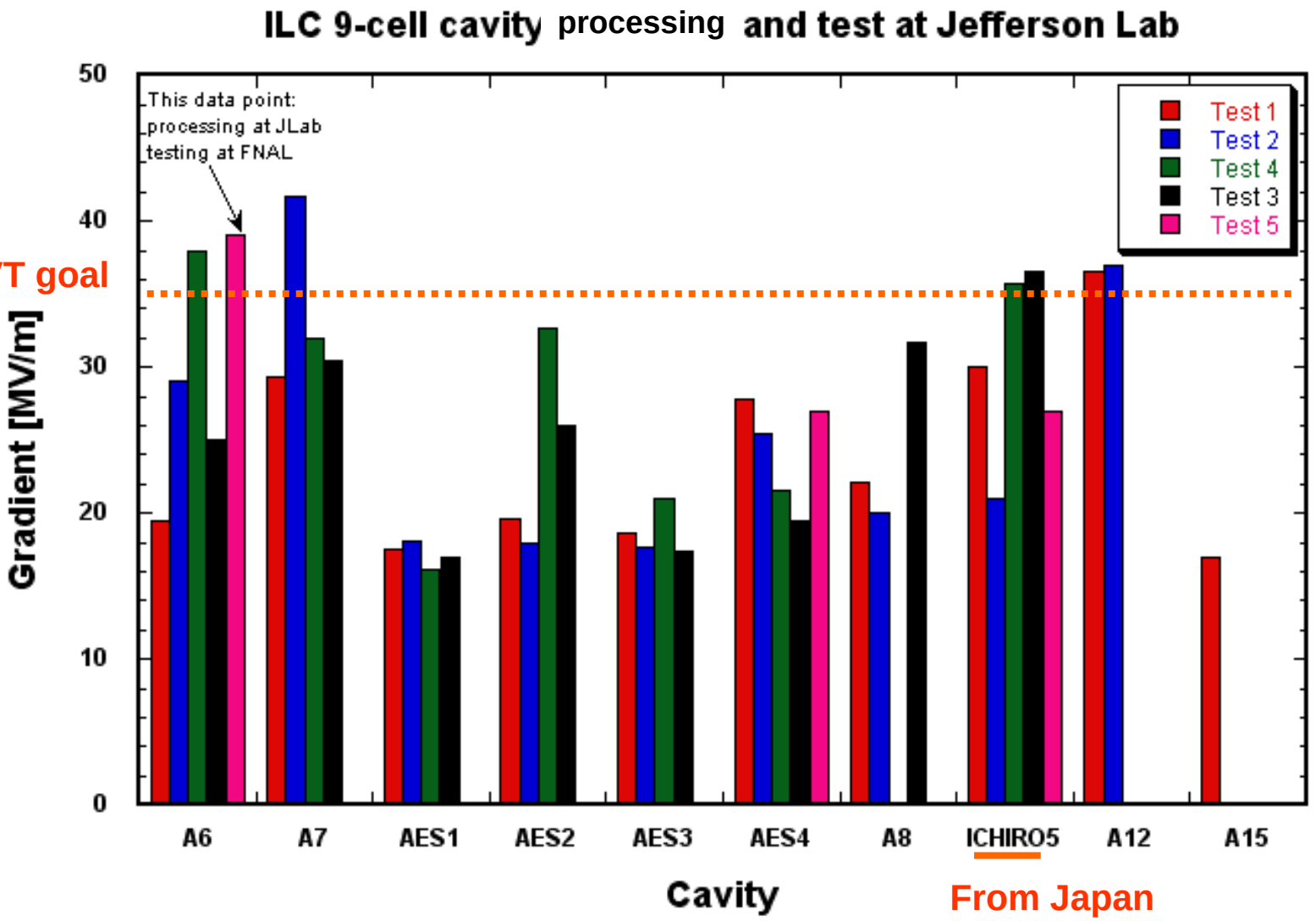
FNAL-ANL

New electro-polishing facility built at ANL





Data from Jefferson Lab
US Cavity Test Program (FNAL-Cornell-Jlab)

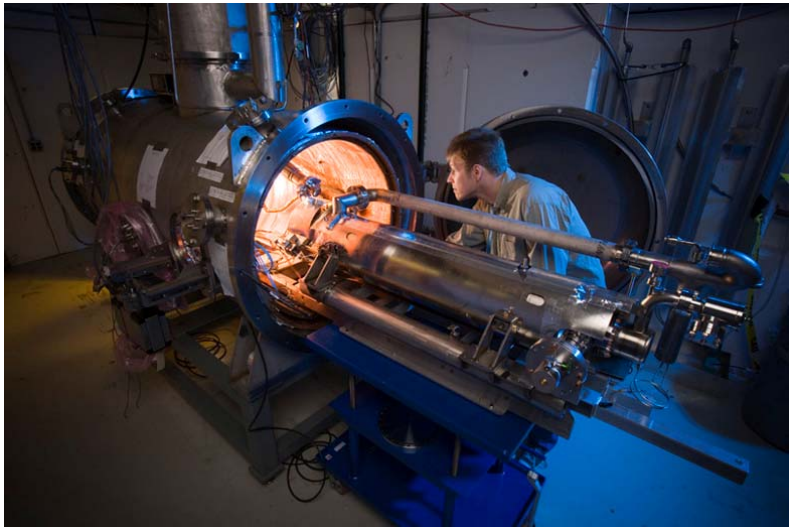


ILC Nominal VT goal

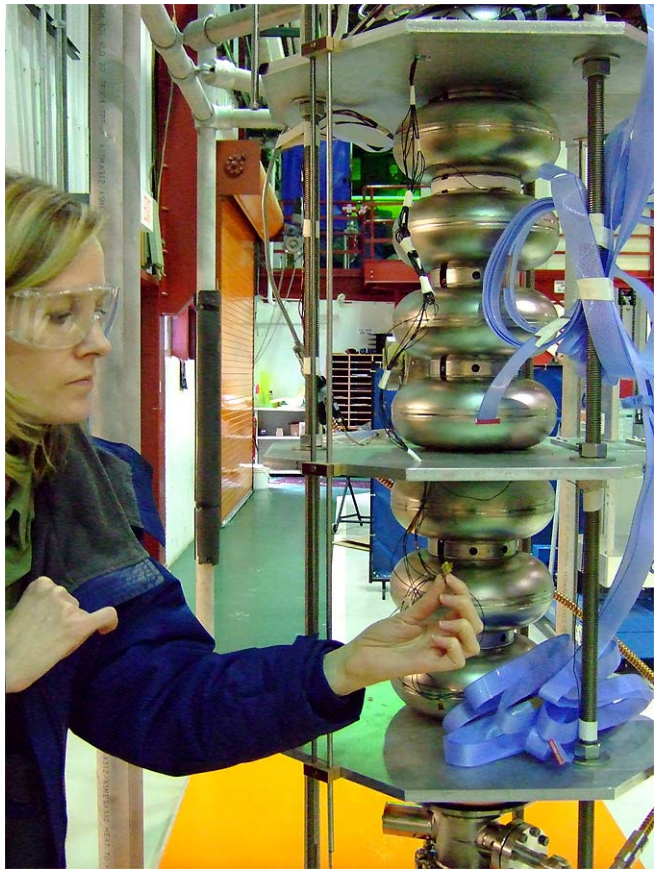
From Japan

ILCTA-NML @ FNAL

Horizontal test stand for cavities



9-cell cavity near vertical test stand



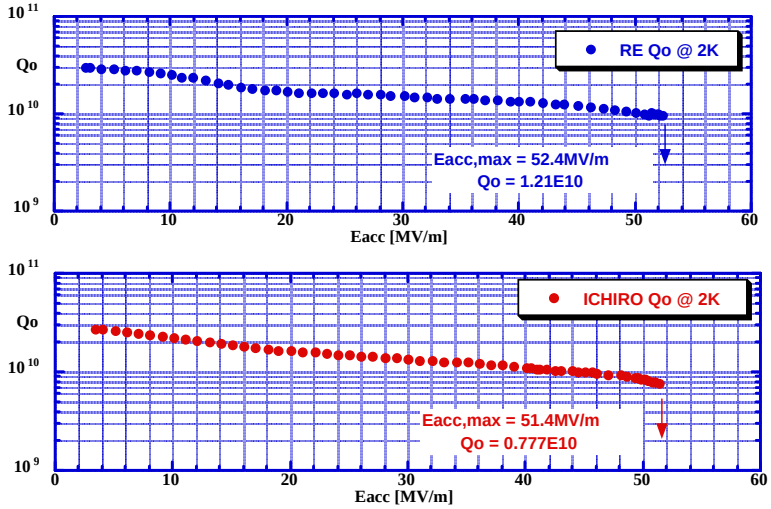
Cryomodule built at FNAL with DESY cooperation



STF @ KEK

Single-cell cavities that recorded Eacc > 50MV/m





Horiz. Cryostat with 4 units of 9-cell cavities



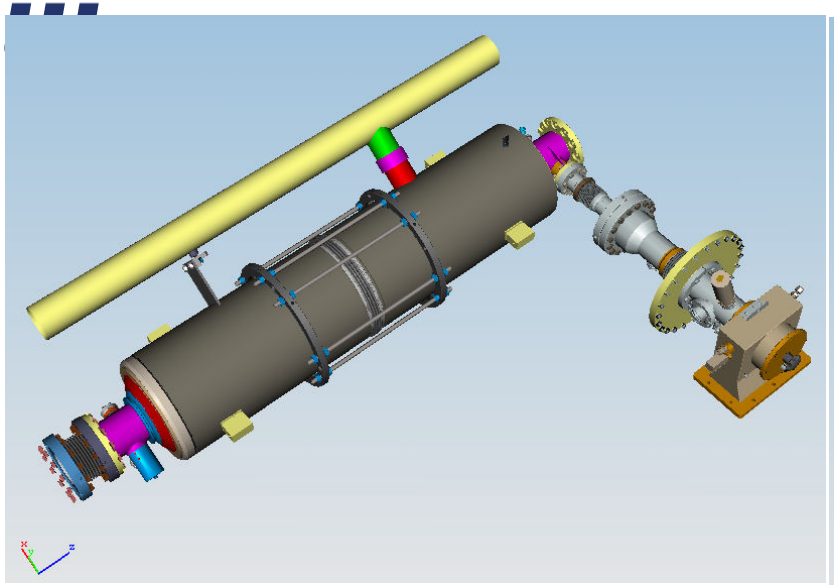
ILC High-Gradient Cavity R&D

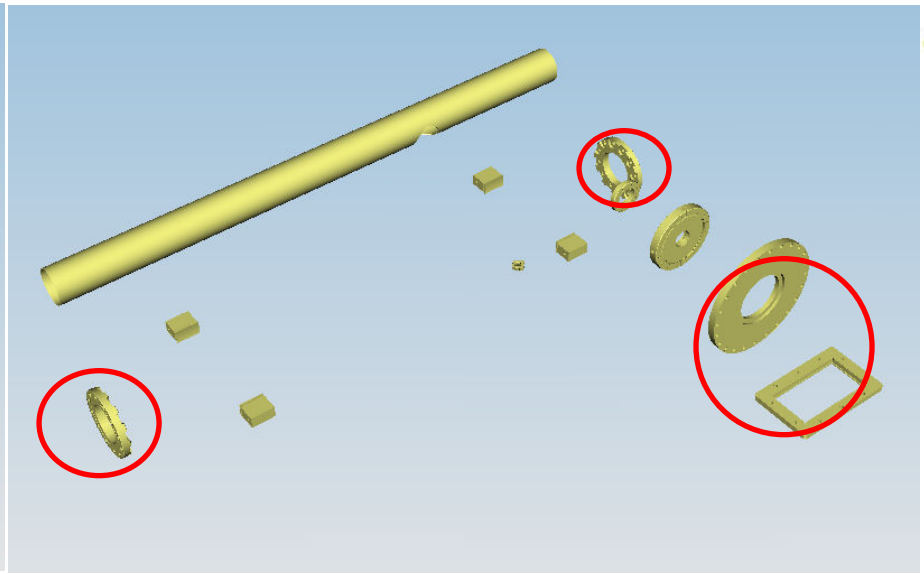
- A certain number of 9-cell cavities started satisfying ILC performance spec in vertical testing.
- Basic infrastructure has been built up and put in place for cavity manufacturing and testing, at US and Asian labs, besides Europeans.
- “Reference procedure” for cavity fab. and tests has been formulated:
  - **For repeated studies.**
  - **For identifying issues and varying practices across the world**
- New (or renewed) diagnostic techniques and studies are put into lab test cycles.

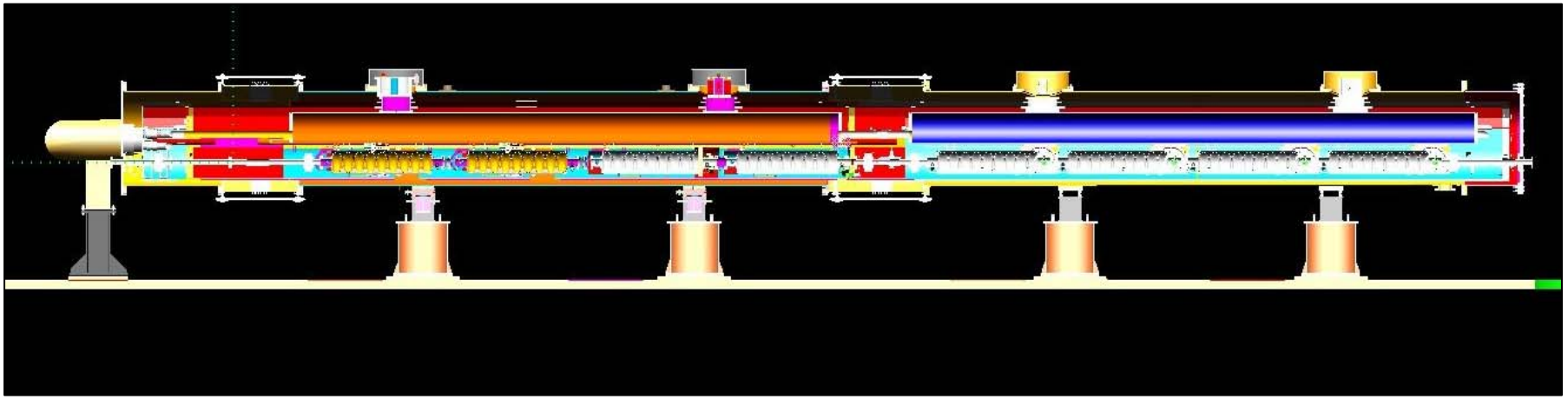




Plug Compatible Assembly

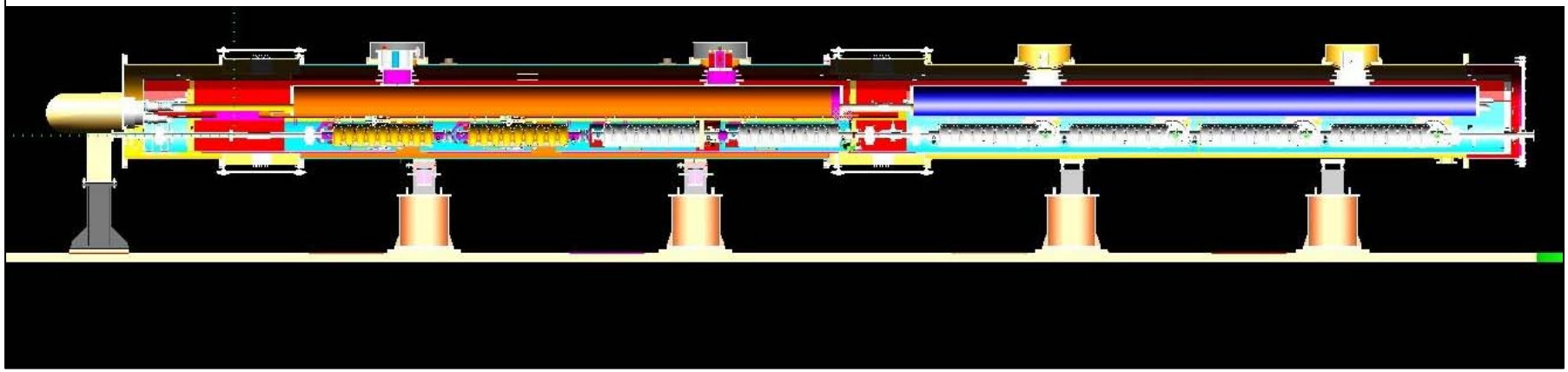






Plug Compatible Assembly

- String assembly + test via international collaboration under planning.
- 2 cavities from Europe, 2 cavities from Americas 4 cavities from Asia, to be assembled into
- A cryomodule based on a European design.
- An exercise of learning “global component plug compatibility” in 2009-2010.



Conventional Facilities and Siting

- **Cost reduction / Value engineering**
  - **CF/S accounts for approx 1/3 of the total construction cost in RDR.**
  - **Surveys on selected set of topics are being relaunched**
    - re-strategize the cooling systems design for RF/controls;
    - revisit the 1-tunnel vs 2-tunnel,
    - And others
- **Site issues – Our mission is to prepare the best possible information to potential hosts, NOT to make a statement of preferred site(s) one way or others. So, we conduct -**
  - **More specific studies on "deep-tunnel" cases, which have been examined with RDR (one "sample" sites from each of the three regions).**
  - **Survey of "shallow-tunnel" cases (a study case offered by the Dubna Group).**
  - **Attain additional understanding and options for cost saving opportunities.**
  - **Collaboration with the CLIC group.**

ILC-CLIC Cooperation

- **Anticipation of the new energy frontier to open with LHC, which**
  - **Would motivate a complementary lepton collider,**
  - **With varying technological backbone but with fairly common technical issues also,**
  - **That lead us to cooperatively optimize the developments of lepton colliders.**
- **Formation of several ILC-CLIC working groups**
  - **Civil engineering and conventional facilities.**
  - **Beam delivery systems and machine-detector interface.**
  - **Cost and schedule.**
  - **Beam dynamics.**
  - **Physics and detectors.**
- **Meeting in May, 2008**
  - **Conveners have been identified for each WG.**
  - **First, learning on activities + issues of both sides; Then, hopefully launch joint subsystem design development in some selected areas.**

For Details of TDP Plans



ILC Research and Development Plan for the Technical Design Phase

Release 2

June 2008

ILC Global Design Effort

Director: Barry Barish

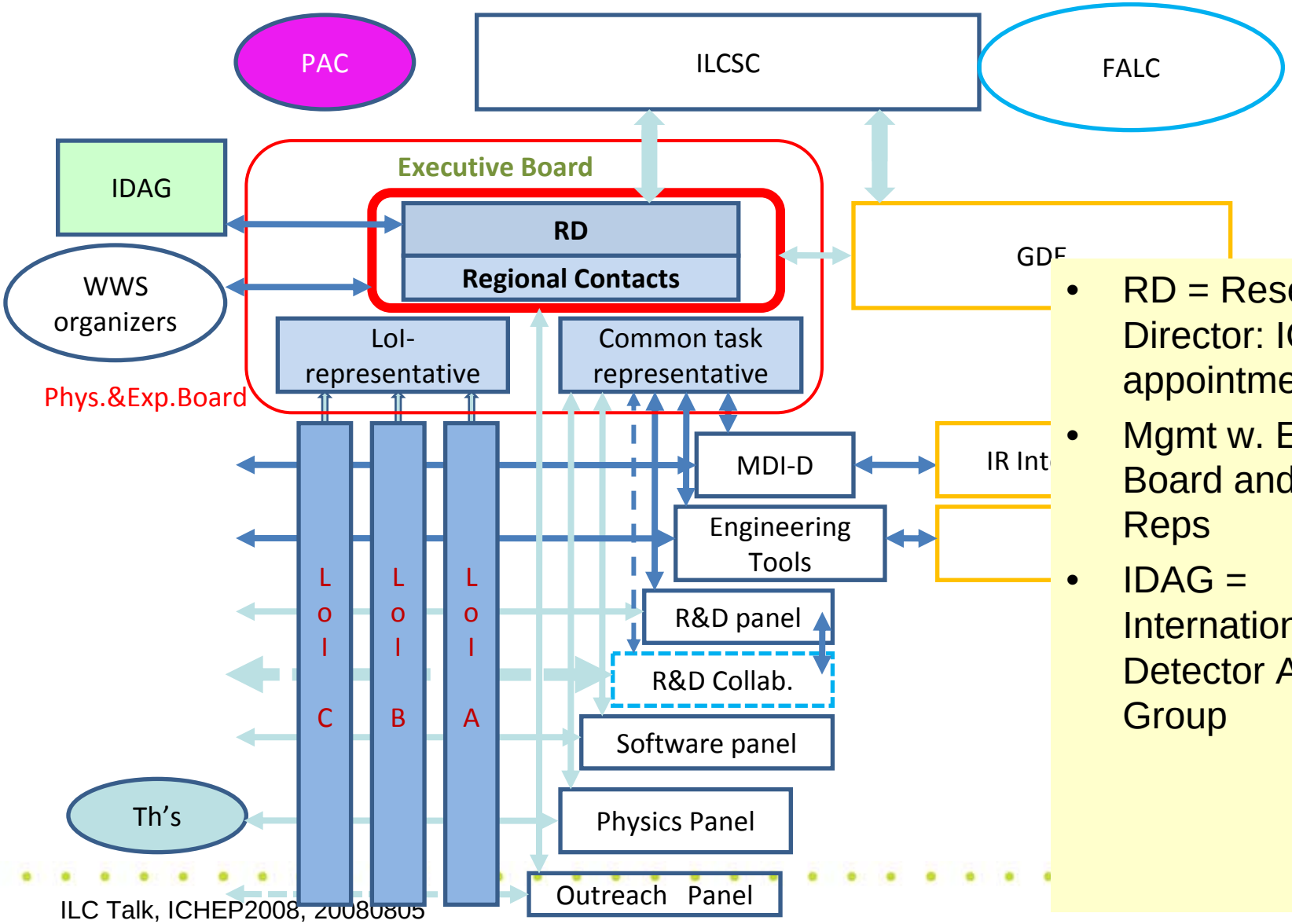
Prepared by the Technical Design Phase Project Management

Project Managers: Marc Ross, Nick Walker, Akira Yamamoto

- Available from: http://ilc-edmsdirect.desy.de/ilc-edmsdirect/file.jsp?edmsid=D0000000*813385

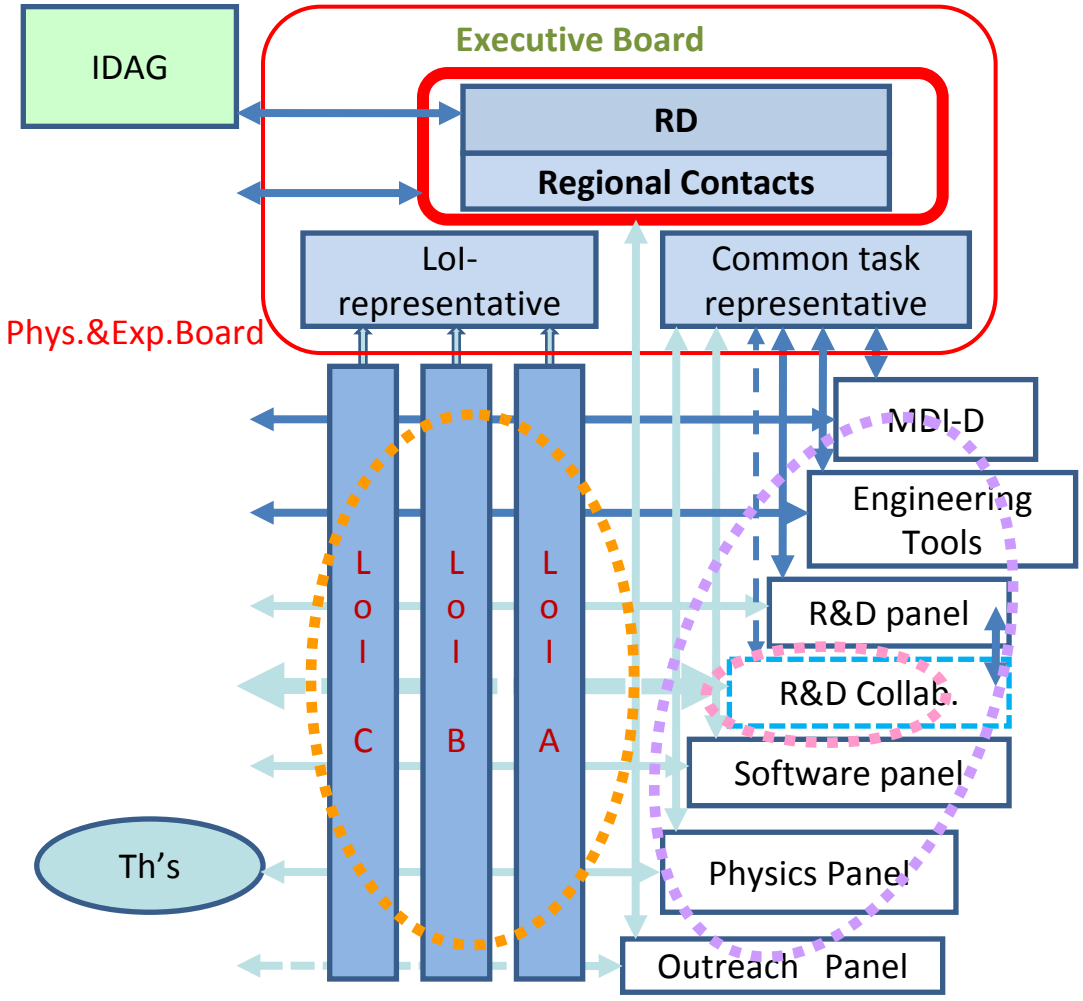
- First Official Release
- Released in GDE meeting at Dubna
- Next review and release: December 08

Detector: Mgmt Structure under RD



- RD = Research Director: ICFA appointment
- Mgmt w. Exec Board and Group Reps
- IDAG = International Detector Advisory Group

Detector Concepts / Common Task Groups



- Detector concepts
  - **Ways of integrating detector technologies into optimized detector facility designs, and then into part of a bigger ILC facility.**
- Common task groups
  - **Ways of facilitating development and refinement of "common" tools / tasks.**
- R&D Collabs
  - **Collabs on specific subsystem technologies**

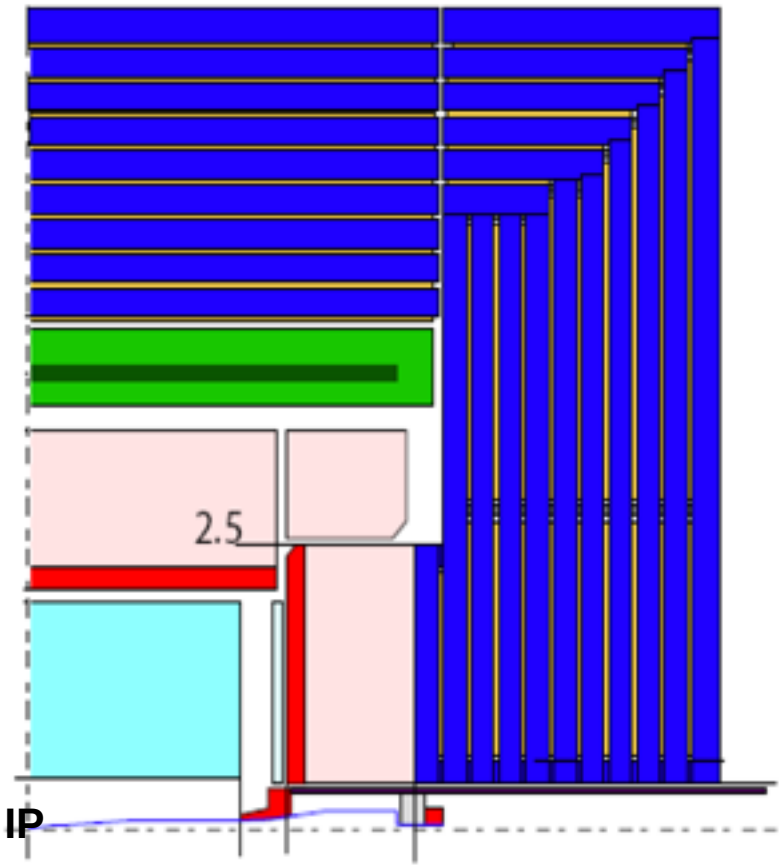
Detector Concepts

- Three sets of ***Expressions of Interest*** (EOIs) have been submitted in March 2008.
  - **SiD**
  - **ILD**
  - **4th Concept**
- ***Letters of Intent*** (LOIs) are due by March 2009. LOIs will then be validated by the newly-formed International Detector Advisory Group (IDAG, Chair: M.Davier) under RD, before proceeding in sync with the rest of GDE TDP.
  - **validation = ascertain whether the proposed detector can do the required physics; NOT acceptance of an experiment for construction of ILC.**
- Notes:
  - **Collab program on detectors between ILC and CLIC also.**

Two-Phased Development of Detector Concepts (in sync with GDE)

- Detector Design Phase I (till 2010)
  - **Focus R&D on critical elements**
  - **Completed validated detector specifications, then initiate technical design work**
  - **Update physics performance specs**
  - **Detailed MDI studies**
- Detector Design Phase 2 (till 2012)
  - **Respond to LHC results with appropriate actions**
  - **Confirmation of physics performance**
  - **Complete the technical design of detectors to incorporate in the ILC proposal**
- Matrix-like structure of Common task groups
  - **for the three concepts to cooperate among themselves**
- and with Detector R&D collaboration

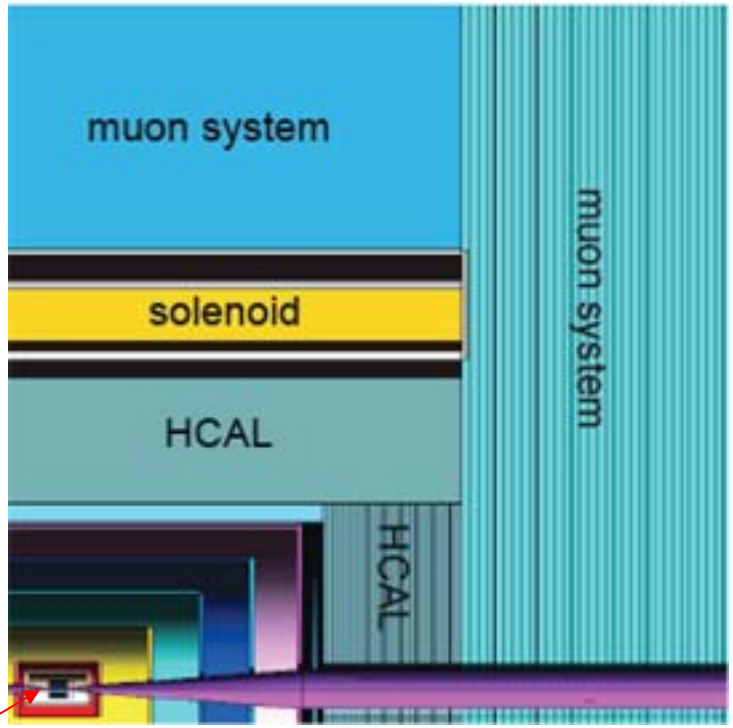
Detector Concepts - ILD



- LDC + GLD
- 169 inst's (28 countries)
- VTX + SI + TPC + CAL + SC Mag (3~4T) + Muon
- PFA
- Versatile detector with high precision, high reliability

OD ~ 14.4m, L ~ 15m total

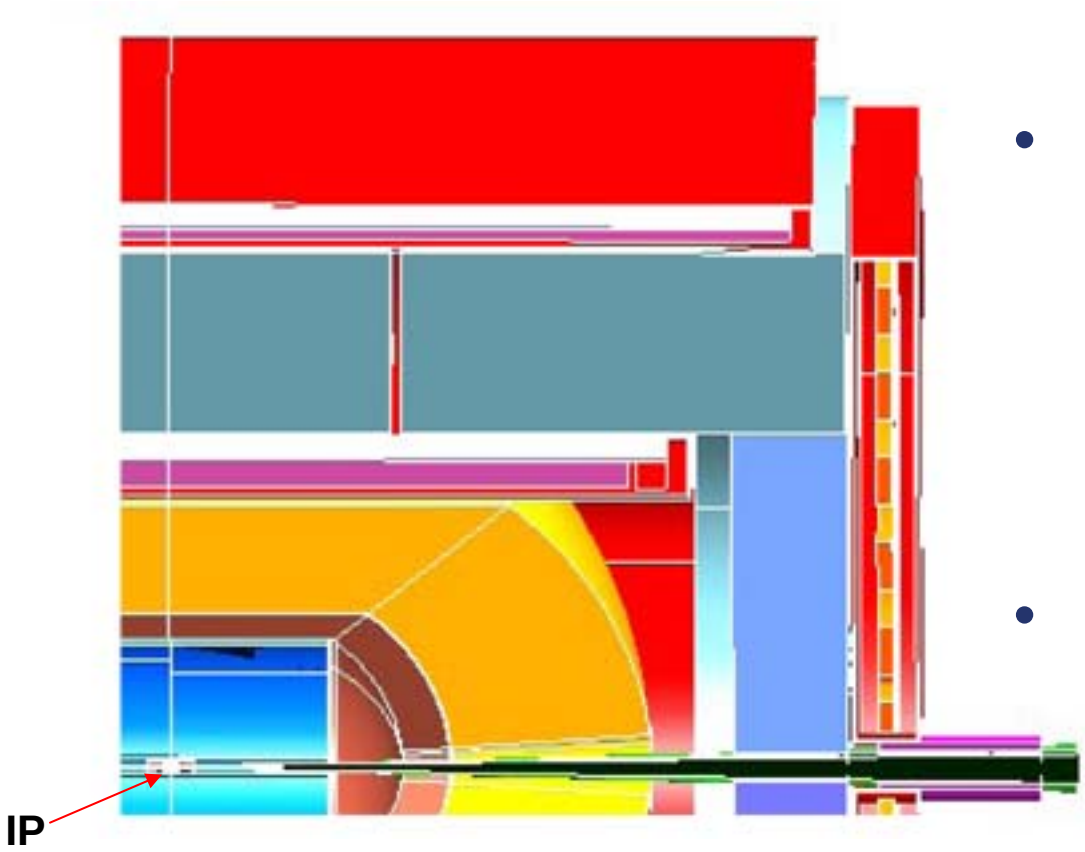
Detector Concepts - SiD



OD ~ 12 m, L ~ 12 m total

- 49 inst's (8 countries)
- VTX + Si-based tracker + Si/W ECAL + HCAL + SC Mag (~5T) + Muon
- Active use of Si technology
- PFA
- Versatile, compact detector with high precision, high reliability

Detector Concepts – 4th



OD ~ 12 .8 m, L ~ 15.4 m total

- 17 inst's (10 countries)
- VTX + Cluster-counting tracker (low-mass) + CAL with dual-readout + Iron-free dual-solenoid (~1.6T/3T) + CluCou muon tracker
- General-purpose detector with a very innovative approach to calorimetry, tracking and field configuration.

Global Efforts Onward for ILC – A Big Picture

Technical Design Phase 1 -- till mid-2010

- Demo. "Technical feasibility"
- igh-priority risk-mitigating R&D
- Value engineering (cost vs performance analysis) in selected areas.
- Re-baseline of the design as found appropriate and necessary.

Detector Design Phase 1 -- till mid-2010

- Validation of detector concepts, to examine as integral parts of accelerator TDP.
- Focus R&D on critical elements; MDI design details.
- Update of physics performance
- Start-up of technical design work

Technical Design Phase 2 -- till 2012

- Demo. "Technical credibility"
- Refine the design
- Continued R&D
- Cost roll-up
- Development of a project implementation plan.

Detector Design Phase 2 -- till 2012

- Refine the design
- Continued R&D
- Cost roll-up.
- Development of a project implementation plan.
- Actions in response to LHC results

Intention is to produce a report which can be handed to governments for evaluation in ~2012.

Conclusions (1)

- There is a large, coordinated, global effort on ILC,
  - **Aiming at developing a project proposal with integrated accelerator and detectors designs, together with**
  - **A project execution plan,**
  - **Which can be handed to governments.**
  - **In the form of a document to be completed in 2012.**
- For this, a renewed set of, coordinated, multi-prong, yet focused actions are being launched
  - **Design evaluations, value engineering.**
  - **R&D on critical issues.**
  - **Expanded collaboration in selected areas.**
  - **Collaborative efforts between the detector R&D front under the Research Director and the accelerator under GDE.**
- Check out the following URI for regular updates
  - **http://www.linearcollider.org**

Conclusions (2)

- Support the R&D, Support Design Effort
  - **Because they will support you.**

- Thanks are due to those who gave me their materials and help in preparing this talk:
  - **B.Barish, S.Yamada, M.Ross, A.Yamamoto, J.-P.Delahaye, M.Palmer, R.Geng, E.Elsen, A.Wolski, J.Brau, H.Yamamoto, J.Hauptmanm, T.Benhke, H.Weerts, and all within/around ILC GDE and Detector/Physics Groups.**

Backup Slides

RDR Design & "Value" Costs

The reference design was "frozen" as of 1-Dec-06 for the purpose of producing the RDR, including costs.

Note: this is a snapshot and the design will continue to evolve, with inputs such as, results of the R&D, accelerator studies, value engineering

The value costs have already been reviewed twice

- **3 day "internal review" in Dec**
- **ILCSC MAC review in Jan**

Σ Value = 6.62 B ILC Units

Summary

RDR "Value" Costs

Total Value Cost (FY07)

4.80 B ILC Units Shared

+

1.82 B Units Site Specific

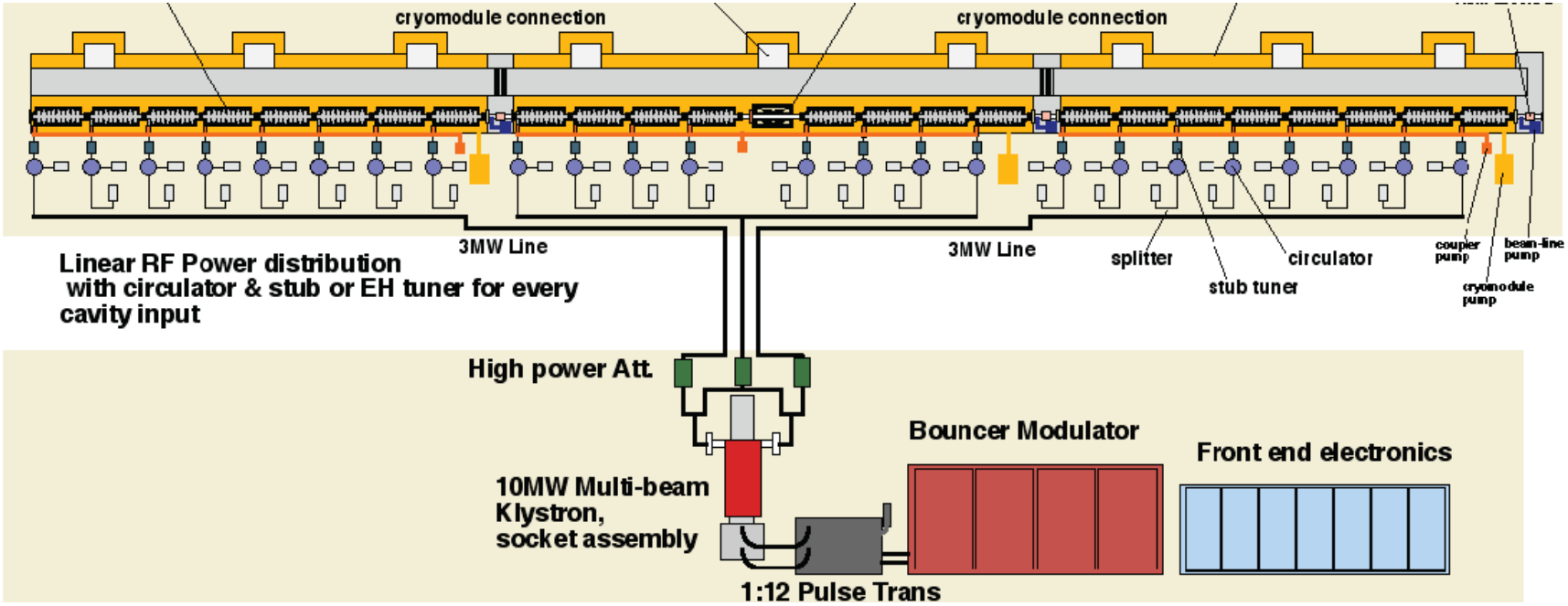
+

14.1 K person-years

("explicit" labor = 24.0 M person-hrs @ 1,700 hrs/yr)

1 ILC Unit = $ 1 (2007)

One RF unit of ILC main linac



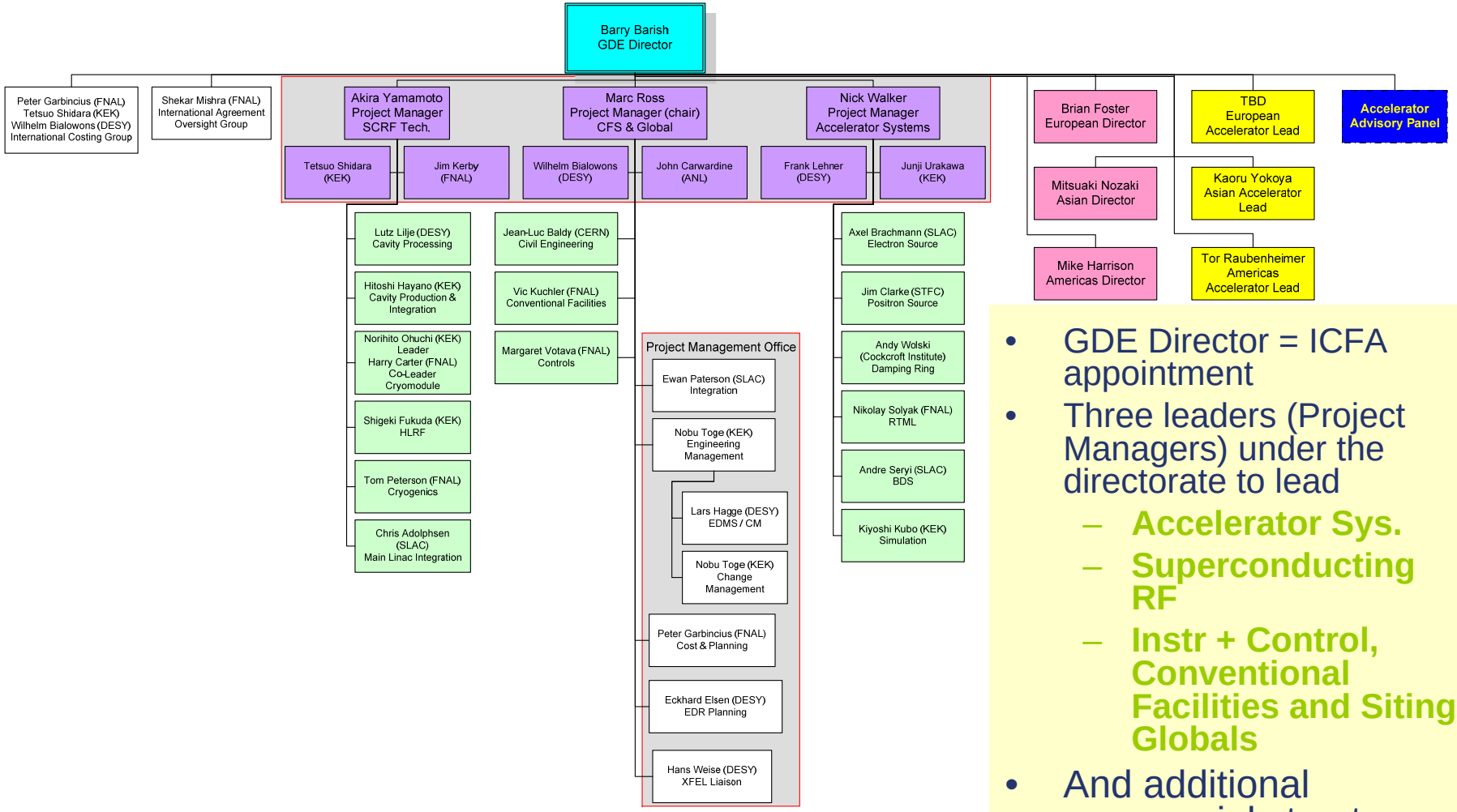
- Current baseline configuration of a unit RF system
  - **3 units of cryomodules**
  - **10MW multibeam klystron driven by a bouncer modulator (work under way to replace it with a Marx generator-type modulator)**
- Total 560 RF units in main linacs (e+ and e-)

ILC R&D Major Test Facilities

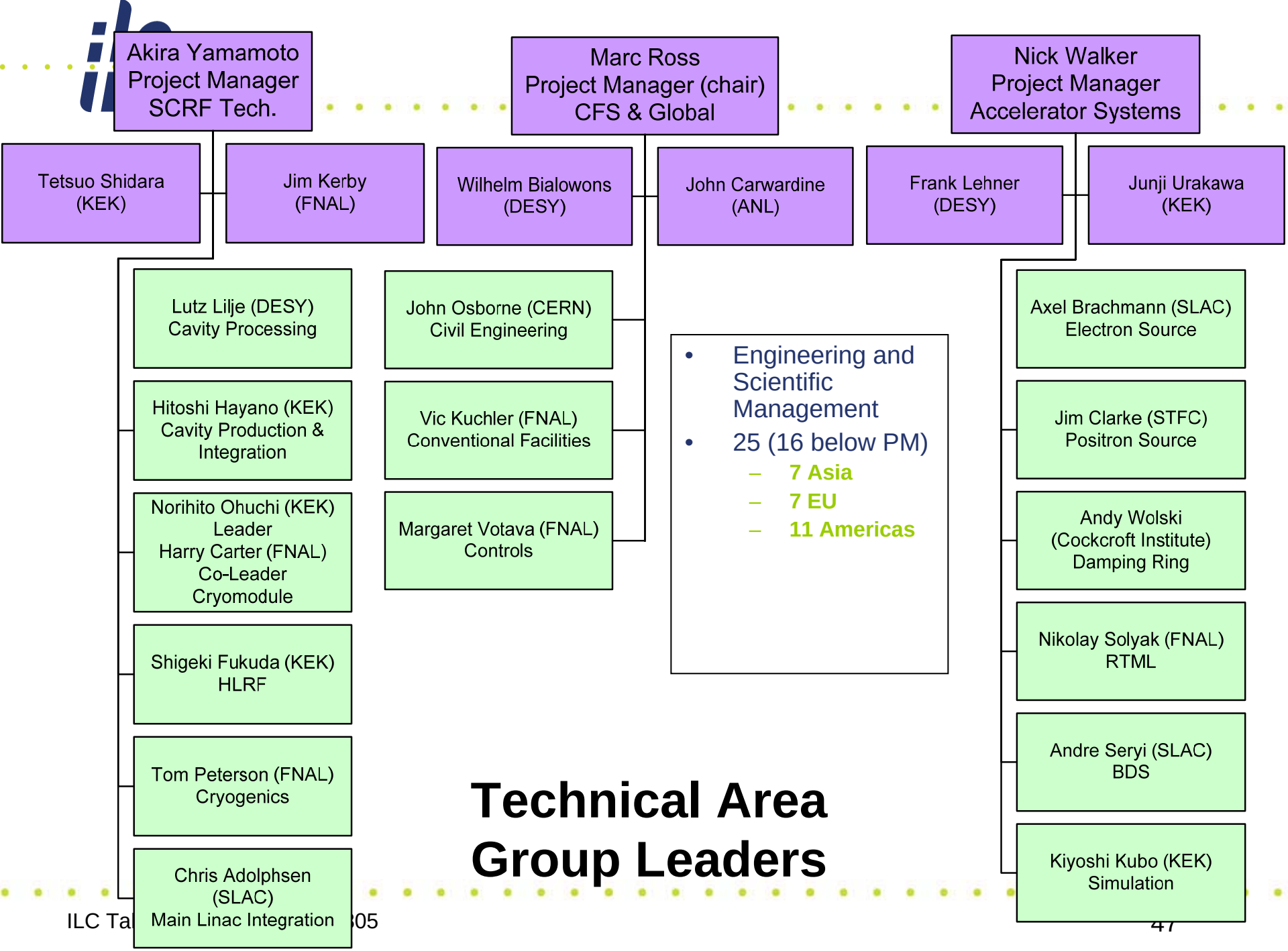
Test Facility	*Acronym*	*Purpose*	*Host Lab*	*Operation start*	*Organized through:*
Accelerator Test Facility	**ATF**	Damping Ring	KEK	1997	ATF Collaboration
Cornell Test Accelerator	**CESR-TA**	Damping Ring	Cornell	2008	Cornell
Superconducting RF Test Facility	**STF**	Main linac	KEK	2008	KEK
TESLA Test Facility/ Free Electron Laser Hamburg	**TTF FLASH**	Main linac	DESY	1997	TESLA Collaboration, DESY
ILC Test Accelerator	**ILCTA-NML**	Main Linac	FNAL	2009	Fermilab
Beam Delivery Test Facility	**ATF-2**	Beam Delivery	KEK	2008	ATF Collaboration
End Station A (program terminated 2008)	**ILC-SLACESA**	Machine – Detector Interface	SLAC	2006	SLAC

Accelerator: Mgmt Structure in GDE

GDE ILC Technical Design Phase



- GDE Director = ICFA appointment
- Three leaders (Project Managers) under the directorate to lead
  - **Accelerator Sys.**
  - **Superconducting RF**
  - **Instr + Control, Conventional Facilities and Siting, Globals**
- And additional managerial structure



Technical Area Group Leaders

SCRF Project Management Structure

(March, 4, 2008, still to be updated)

Regional/Intsitutional Effort:
- Director-US: Mike Harrison
- Director-EU: B. Foster
- Director-AS: M. Nozaki

Technical Effort (ML (SCRF) Technology):
- Project Manager: A. Yamamoto
- Associate Managers: T. Shidara, J. Kerby,

* Group leader, ** Co-leader

Regions	Institute	Institute Leaders	Cavity (Process) L. Lilje*	Cavity (Prod./Int.) H. Hayano*	Cryomodule N. Ohuchi* -H. Carter**	Cryogenics T. Peterson*	HLRF S. Fukuda*	ML Integr. C. Adolphsen
US	Cornell Fermilab SLAC ANL J-lab	H.Padamsee R. Kephart T.Raubenhaimer W. Funk	H.Padamsee M. Shekhar	C.Adolphsen	M. Champion	T.Peterson	R. Larsen	C. Adolphsen
EU	DESY CERN Saclay Olsay INFN Spain	R.Brinkman J. Delahaye O. Napoly G. Wormser C. Pagani	L.Lilje TBD	L. Lilje TBD S. Pratt C. Pagani	Parma F. P.	Tavian		
AS	KEK Korea Inst. IHEP Indian Inst.	K.Yokoya	Hayano, Noguchi, Saito TBD	Hayano TBD	Tsuchiya/ Ohuchi TBD	Hosoyama/ Nakai TBD	S. Fukuda TBD	Hayano/Ohuchi TBD

How We Work Together?

Regional Effort and Project Management

- ***Project Managers** are responsible for*
  - Leading the world-wide technical development effort
    - efficiently and effectively
  - Setting technical direction and executing the project toward realization of the ILC
    - Day-to-day project execution and communication
- ***Regional Directors and Institutional Leaders** are responsible for*
  - Promoting, funding and authorizing the cooperation programs.
    - Formality to start institutional activities, and periodical oversiting the technical progress,

10

Basic Parameters

Properties of Materials												
Material	Z	A	Radiation length		Density		Electrical resistivity (at 0deg C)	Thermal conductivity	Coef of thermal expansion	Specific heat	Young's modulus	Poisson ratio
			g/cm	cm	g/cm (g/l for gas)		nano Ohm. M	W/m/K	micron / m / K	J / mol / K	GPa	
H2 gas	1	1.00794	61.28	731000	0.0838	[0.0899]						
H2 liq	1	1.00794	61.28	866	0.0708							
He	2	4.002602	94.32	756	0.1249	[0.1786]						
C	6	12.011	42.7	18.8	2.265							
N2	7	14.00674	37.99	47.1	0.8073	[1.25]						
O2	8	15.9994	34.24	30	1.141	[1.428]						
Al	13	26.98154	24.01	8.9	2.7		26.5	237	23.1	24.2	70	0.35
Si	14	28.0855	21.82	9.36	2.33							
Ar	18	39.948	19.55	14	1.396	[1.782]						
Ti	22	47.867	16.17	3.56	4.54		420	21.9	8.6	25.06	116	0.32
Fe	26	55.845	13.84	1.76	7.87		96.1	80.4	11.8	25.1	211	0.29
Cu	29	63.546	12.86	1.43	8.96		16.78	401	16.5	24.44	110-128	
Nb	41	92.90638			8.57		152	53.7	7.3	24.6	105	0.4
In	49	114.813			7.31		83.7	81.8	32.1	26.74		
Sn	50	118.71	8.82	1.21	7.31		115	66.8	22	27.112	50	0.36
W	74	183.84	6.76	0.35	19.3		52.8	173	4.5	24.27	411	0.28
Pt	78	195.08	6.54	0.305	21.45		105	71.6	8.8	25.86	168	0.38
Pb	82	207.2	6.37	0.56	11.35		208	35.3	28.9	26.65	16	0.44

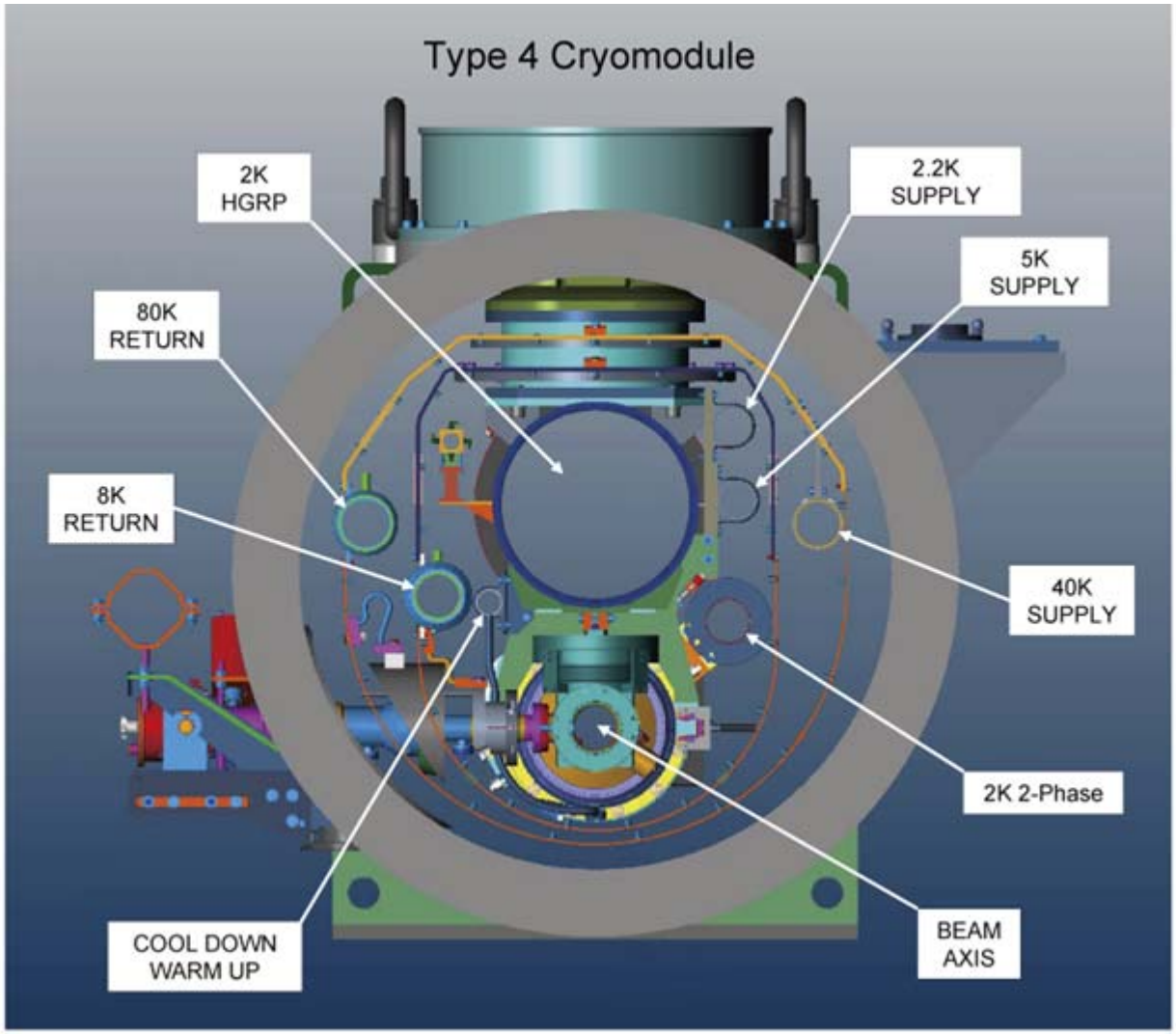
ILC Global Parameters

Global accelerator parameters for 500GeV cms (RDR Table 2.1-1)			
Parameter	**Value**	**Units**	
Center of mass energy	500	GeV	
Peak luminosity	2.00E+34	cm-2s-1	
Availability	75	%	
Repetition rate	5	Hz	
Duty cycle	0.5	%	
Main linacs			
Average accelerating gradient in cavities	31.5	MV/m	
Length of each main linac	11	km	
beam pulse length	1	ms	$I_{ave} = eN / t_b$
average beam current in pulse	9	mA	
Damping Rings			
Beam energy	5	GeV	
Circumference	6.70	km	
Length of Beam Delivery Section (2 beams)	4.5	km	
Total site length	31	km	
Total site power consumption	230	MW	
Total installed power	300	MW	

ILC Beam Parameters

Beam and IP Parameters for 500GeV cms (RDR Table 2.1-2)					
Parameter	**Symbol/Units**	**Nominal**	**Low N**	**Large Y**	**Low P**
Center of mass energy	E_cm (GeV)	500	500	500	500
Repetition rate	f_rep (Hz)	5	5	5	5
Number of particles per bunch	N (1E10)	2.07	1.06	2.07	2.04
Number of bunches per pulse	n_b	2625	5120	2625	1320
Bunch interval in the main linac	t_b (ns)	369.23	189.23	369.23	480.00
in units of RF buckets		480	246	480	624
Main linac RF	GHz	1.3	1.3	1.3	1.3
Average beam current in pulse	I_ave (mA)	9	9	9	6.8
Normalized emittance at IP	γεx (mm.mrad)	10	10	10	10
	γεy (mm.mrad)	0.04	0.03	0.08	0.036
Beta function at IP	βx* (mm)	20	11	11	11
	βy* (mm)	0.4	0.2	0.6	0.2
RMS beam size at IP	σx* (nm)	639	474	474	474
	σy* (nm)	5.7	3.5	9.9	3.8
RMS bunch length	σz* (microns)	300	200	500	200
Disruption parameter	Dx	0.17	0.10	0.50	0.20
	Dy	18.75	14.13	24.04	24.70
Beamstrahlung parameter	Υave	0.048	0.05	0.038	0.097
Energy loss by BS	δBS	0.024	0.017	0.027	0.055
Number of BS photons	nγ	1.32	0.91	1.77	1.72
Luminosity enhancement factor	HD	1.71	1.48	2.18	1.64
Geometric luminosity	Lgeo (1E34/cm2/s)	1.2	1.35	0.94	1.21
Luminosity	L (1E34/cm2/s)	2	2	2	2
Bunch train length	n_b x t_b (micro.s)	969	969	969	633
Total beam power per linac per pulse	P_beam (MW)	10.9	10.9	10.9	5.4

Cross section of a cryomodule



TD 1 Phase Resources – SCRF Facilities

		FTE-Years						total M&S						
		Cavities	Cryomodule	HLRF	Cryogenics	ML Integ.	total FTE-Years	Cavities	Cryomodule	HLRF	Cryogenics	ML Integ.	total M&S	
Americas	**Canada**	18					**18**	1050					**1050**	k$
	USA	73	24	68	5	14	**183**	9169	3960	5909	134	362	**19535**	k$
Asia	**China**	12	8	8	4	1	**33**	10000	10000	10000	5000	1000	**36000**	kRMB
	India	24	12				**36**	1560	900				**2460**	k$
	Japan	45	6	11	4	5	**72**	2225	462	452	180	1119	**4438**	M JY
	Korea	13		5			**18**	1500		245			**1745**	M KRW
Europe	**EU (CERN)**				1	4	**5**					129	**129**	kEUR
	France	94					**94**	10058					**10058**	kEUR
	Germany	51	10	7	7	9	**83**	1705	361			23.5	**2089**	kEUR
	Italy	38	8		1	1	**48**	1182	160				**1342**	kEUR
	Poland													kEUR
	Russia	2	20				**22**	20					**20**	k$
	Spain		3				**3**		9				**9**	kEUR
	Sweden													kEUR
	Switzerland													kEUR
	UK													kGBP
		370	**90**	**99**	**21**	**34**	**615**							

TD 1 Phase Resources – Conv Facilities

		FTE-Years			total M&S			
		CFS	Controls	total FTE-years	CFS	Controls	total M&S	
Americas	Canada							k$
	USA	12	18	**30**	1397	1098	**2495**	k$
Asia	China		8	**8**		1000	**1000**	kRMB
	India							k$
	Japan	3	5	**8**				M JY
	Korea	1	1	**2**	40		**40**	M KRW
Europe	EU (CERN)	2					**0**	kEUR
	France		18	**18**		307	**307**	kEUR
	Germany	3	14	**17**		63	**63**	kEUR
	Italy		4	**4**		80	**80**	kEUR
	Poland		20	**20**		248	**248**	kEUR
	Russia	2		**2**	40		**40**	k$
	Spain							kEUR
	Sweden							kEUR
	Switzerland		3	**3**		90	**90**	kEUR
	UK							kGBP
	(mixed)		11	**11**		95	**95**	kEUR
		23	**102**	**112**				

TD 1 Phase Resources – Tech Accelerator Facilities

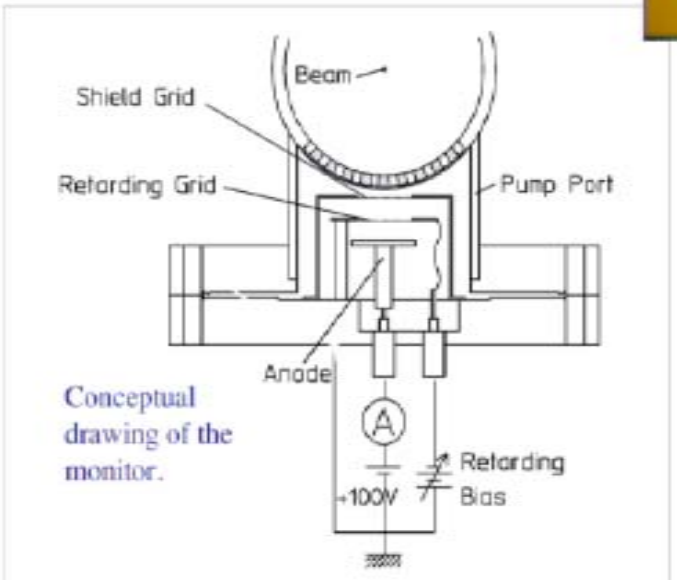
		FTE-Years							total M&S							
		Elec. Source	Posi. Source	Damping Rings	RTML	Beam Delivery	Simulations	**total FTE-years**	Elec. Source	Posi. Source	Damping Rings	RTML	Beam Delivery	Simulations	**total M&S**	
Americas	**Canada**			5				**5**			20				**20**	k$
	USA	11	8	28	1	48	16	**113**	617	144	7174	3	3847	190	**11975**	k$
Asia	**China**			12	4	20	2	**38**		500	5000	100	200	100	**5900**	kRMB
	India															k$
	Japan	2	7	16		23	4	**52**			722		375		**1097**	M JY
	Korea			2	2	4	3	**12**			26	26	201	26	**279**	M KRW
Europe	**EU (CERN)**			2		1	4	**7**			7		2.3	8.6	**18**	kEUR
	France		11		5	12		**27**		390			6		**396**	kEUR
	Germany		22	3		4	4	**33**		32	7		36	14	**88**	kEUR
	Italy			17				**17**			300				**300**	kEUR
	Poland															kEUR
	Russia															k$
	Spain					2		**2**								kEUR
	Sweden				2	2		**3**								kEUR
	Switzerland															kEUR
	UK		10	11		85		**106**		35	62		1537		**1634**	kGBP
		13	**57**	**97**	**14**	**201**	**33**	**415**								

Measurement of Electron Cloud (Kanazawa)

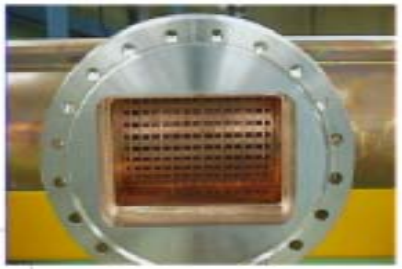
- RFA (Retarding Field Analyzer) type electron detectors with Faraday cup or MCP or multi-strip anode are installed to KEKB LER.

Electron Monitors (1)

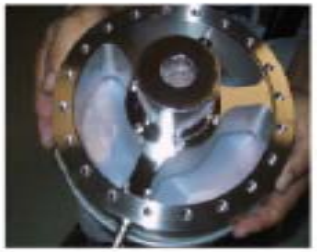
Retarding field analyzer type electron monitors are set at pump ports of KEKB LER.



Conceptual drawing of the monitor.



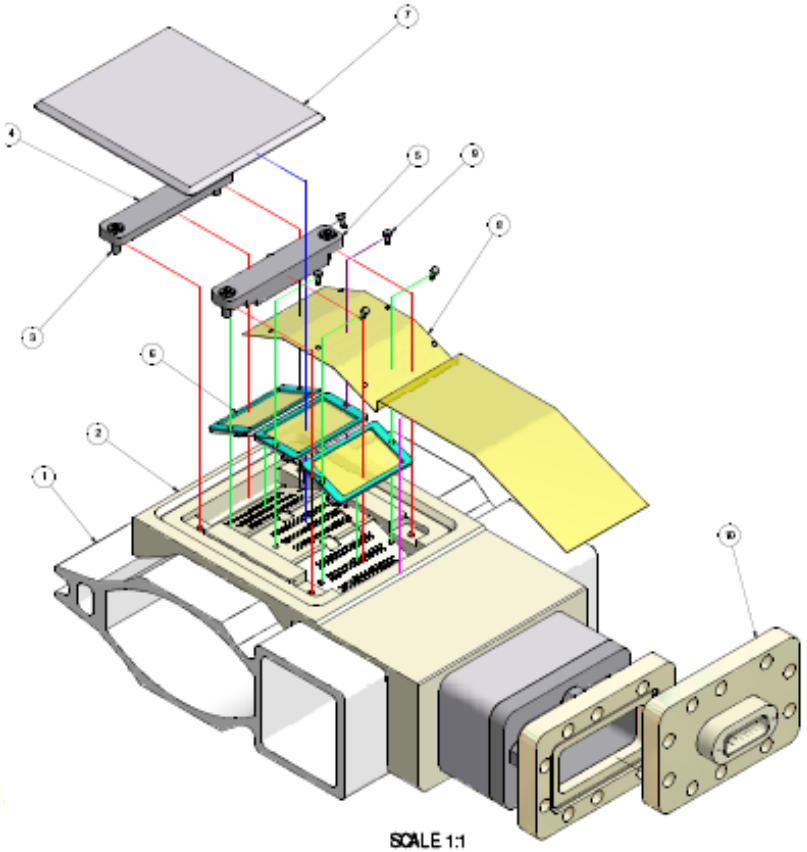
Pump port of KEKB LER



Electron Monitor (Modified Type)

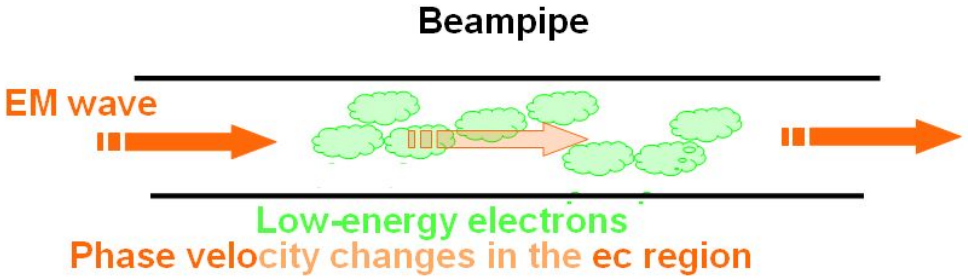
Measurement (Greenwald)

- Comparison between Cornell-type thin RFA and APS-type
  - **Almost consistent each other**
- Newly developed RFA for CESR-TA
  - **Dipole Chamber RFA**

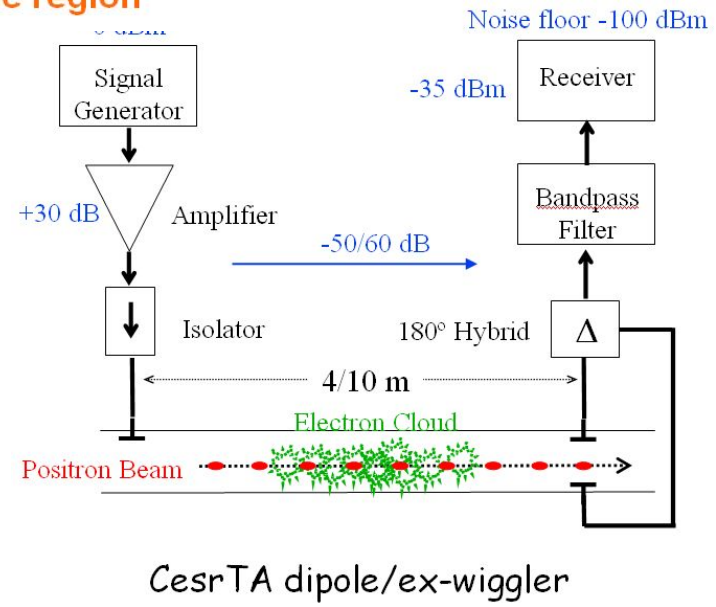


Measurement (Santis)

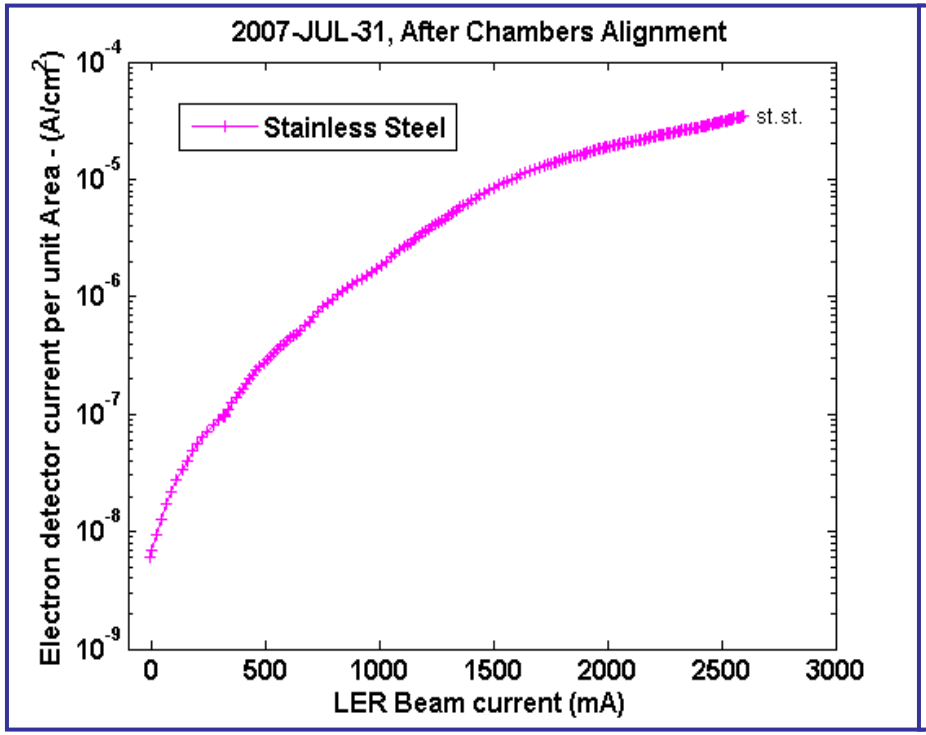
- Electron density can be estimated by measuring the phase shift of transmitting microwave

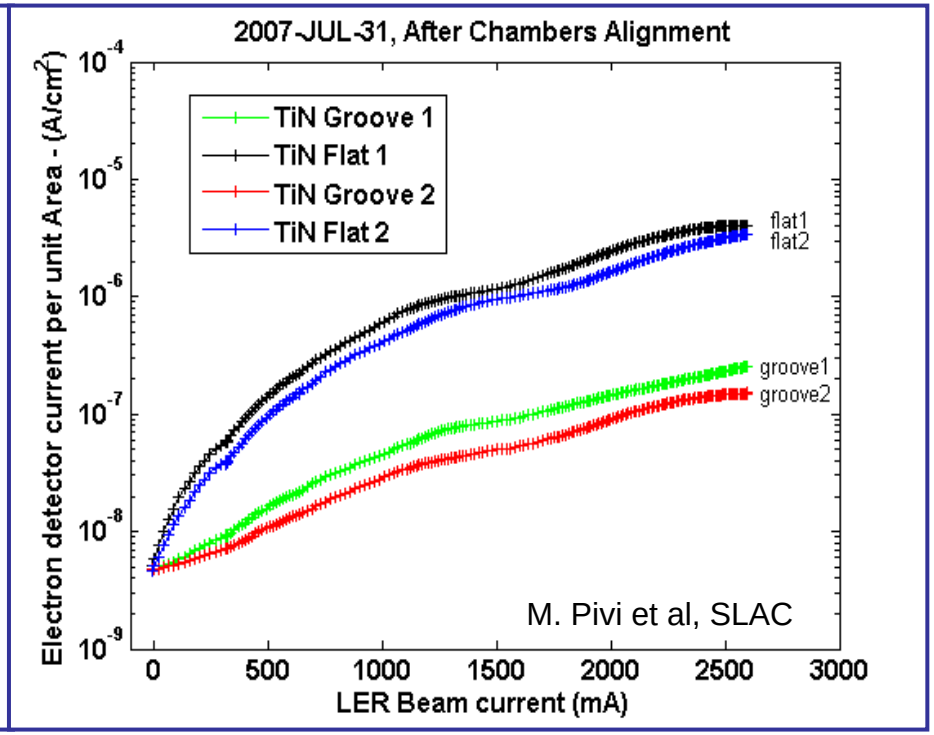


- Instruments were set up for CESR-TA, following PEP-II



ECLOUD2 – Grooved Chambers Performance: M. Pivi





Electron cloud signal in stainless steel chamber.

Electron cloud signal in two smooth (flat) TiN-chambers and two grooved TiN-chambers installed in PEP-II.

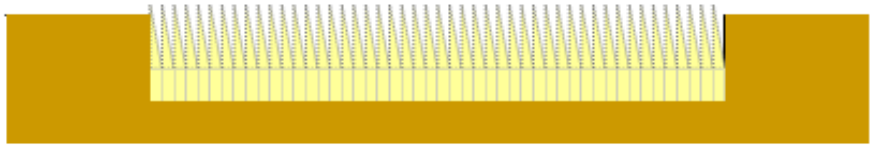
Mitigation tests in Cesr TA: M. Palmer, Cornell

(M. Pivi)

Cornell University
Laboratory for Elementary-Particle Physics

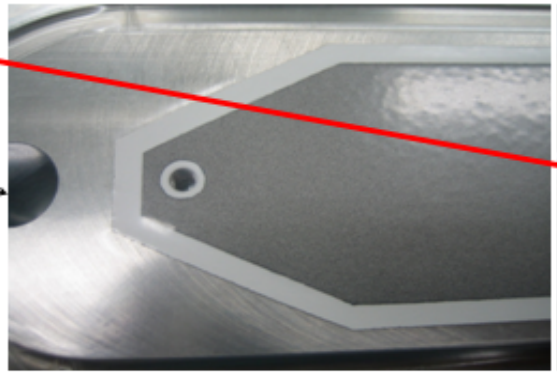
Mitigation Techniques

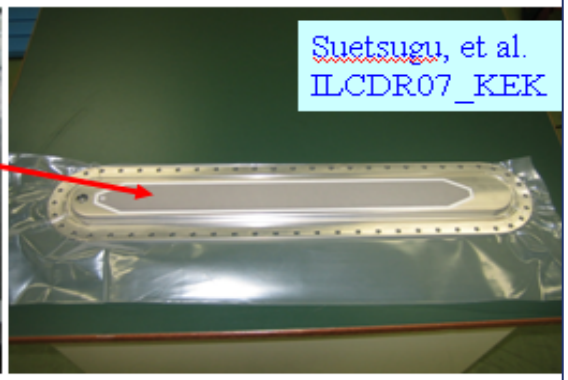
- Wiggler extrusion split into top/bottom halves ⇨ provides exposed vacuum chamber surface for modifications
  - Possibility of adding grooved surface
  - Tungsten Electrode (hot spray) on alumina – see talk by Suetsugu



Propose to pursue this option next

For feed-through Looking at options for low impact feedthroughs





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Recommendation for mitigation as input for DR design: Discussion All

(M. Pivi)

DR element	% ring	Antechamber	Coating	Additional Mitigation	Remarks
DRIFT in STRAIGHT	33	No	NEG	Solenoid	Groove if necessary
DRIFT in ARC	56	Downstream of BEND only	NEG	Solenoid	Groove if necessary
BEND	7	Yes	TiN	Grooves and Electrodes	
WIGG	3	Yes	TiN	Electrodes and Grooves	
QUAD	1	Downstream BEND / WIGG	TiN	Grooves and Electrodes	

Preliminary table to be completed as input for Technical Design Phase. Goal is to turn all Red colors to Green in the next two years.

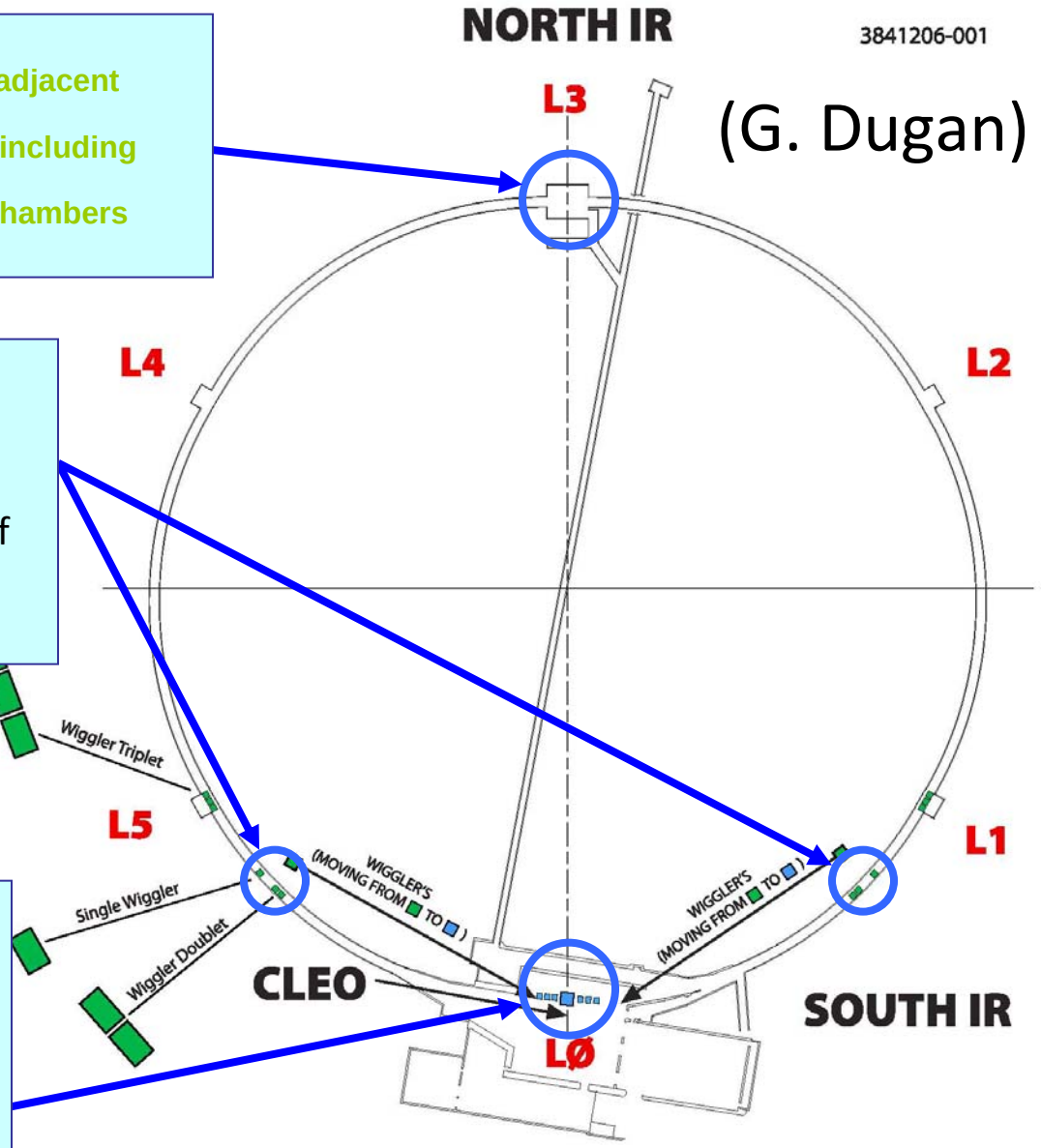
Other mitigations under development! (ex: Carbon coating CERN)

CESR EC experimental areas

- L3 Straight Experimental area
  - **Instrument large bore quadrupoles and adjacent drifts**
  - **Install of PEP-II experimental hardware (including chicane) in early 2009**
  - **Provide location for installation of test chambers**

- Arc experimental areas
  - Instrument dipoles and adjacent drifts
  - Provide locations for installation of test chambers, in drifts where wigglers were removed.

- L0 Wiggler Experimental area
  - All wigglers in zero dispersion regions for low emittance
  - Instrumented wiggler straight and adjacent sections



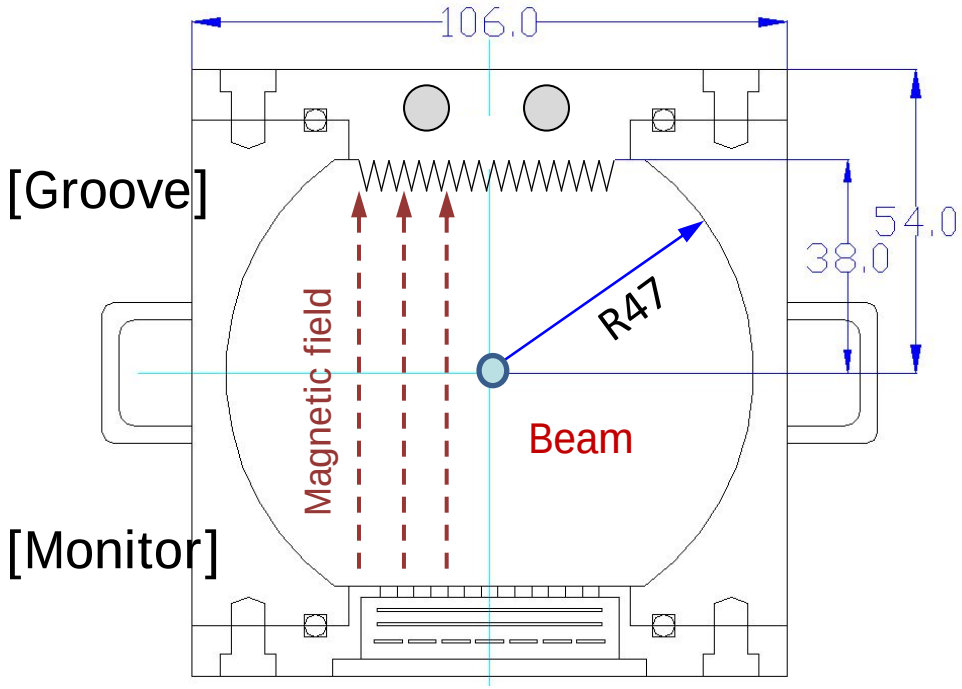
(G. Dugan)

Experimental Plan at KEKB Positron Ring
Grooved Surface, and Clearing Electrode Ver.2

Y. Suetsugu, H. Fukuma, KEK
M. Pivi and W. Lanfa, SLAC

- Use the same location (G. Dugan)

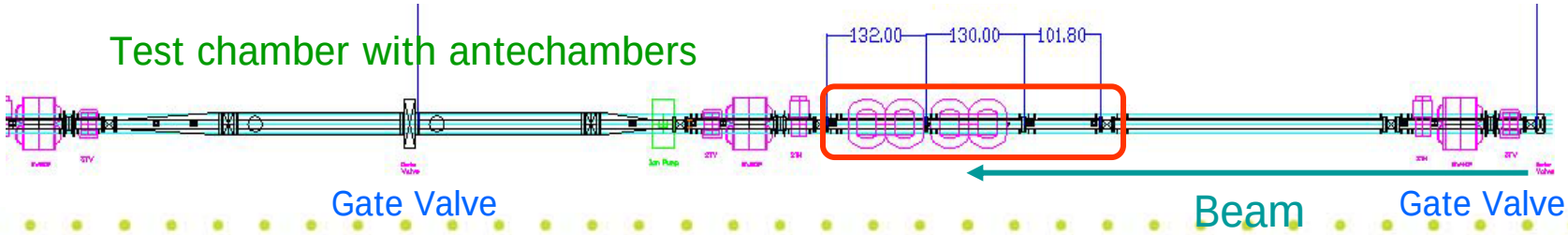
Experimental Setup



Wiggler magnets
B = 0.75 T



Test chamber with antechambers



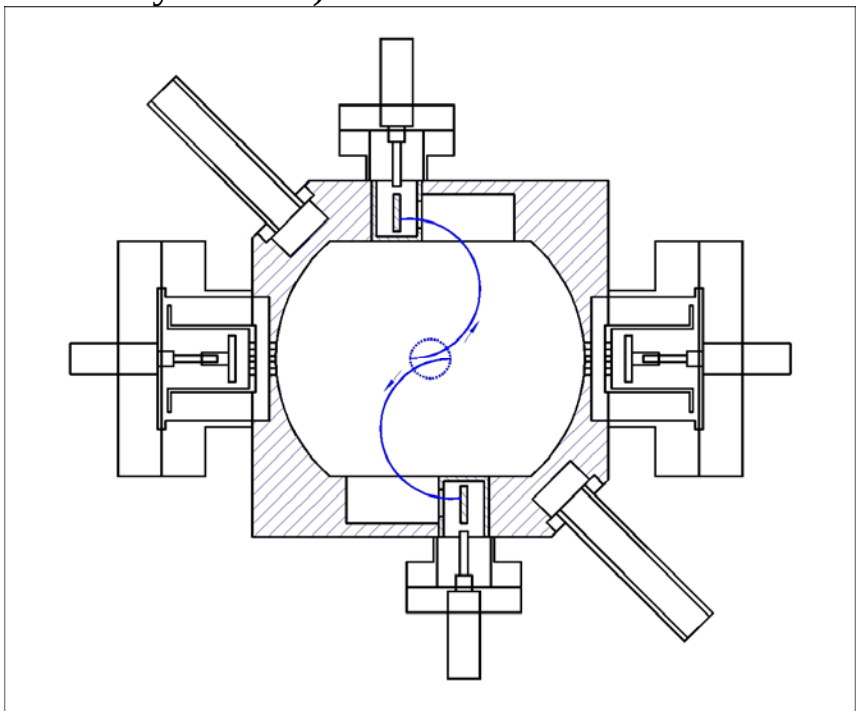
Plan of measuring cloud density in the solenoid field and in the quadrupole field

K. Kanazawa (KEK)

(G. Dugan)

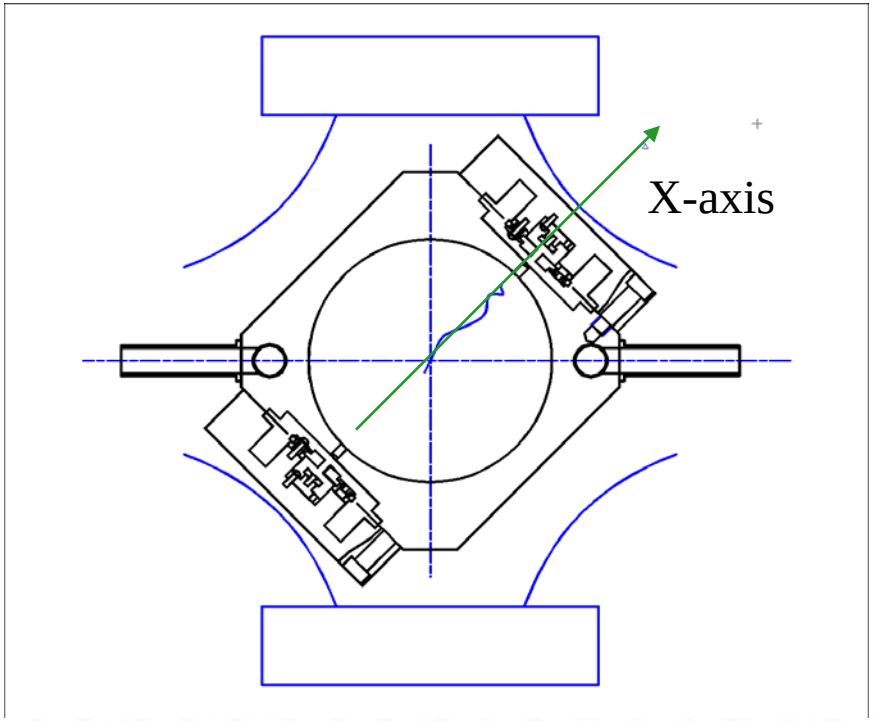
SOLENOID

• Given a solenoid field and the position of detection, the energy of measured electrons is automatically selected (=the volume is automatically defined).



QUADRUPOLE

Electrons accelerated by a bunch along X-axis reach the detector.



Responding to LHC

- Systematic studies needed
  - **When are we likely to know what from LHC?**
    - Possible LHC discovery scenarios
  - **For each scenario**
    - What physics modes to study at ILC
    - What kind of machine to build
    - What kind of detector to build
    - Priorities and timescale
  - **Cost and political realities to be included**
- Rethinking of the machine parameter will be needed.
  - **Energy (250 GeV, 360 GeV, 500 GeV, 800 GeV…)**
  - **Luminosity**
  - **Upgrade path**
- Accelerator and physics/detector community should have close and intensive discussions
  - **Cost and politics**
  - **GDE + the RD structure (we need name)**