GDE Status/Update

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GDE Meeting at Dubna

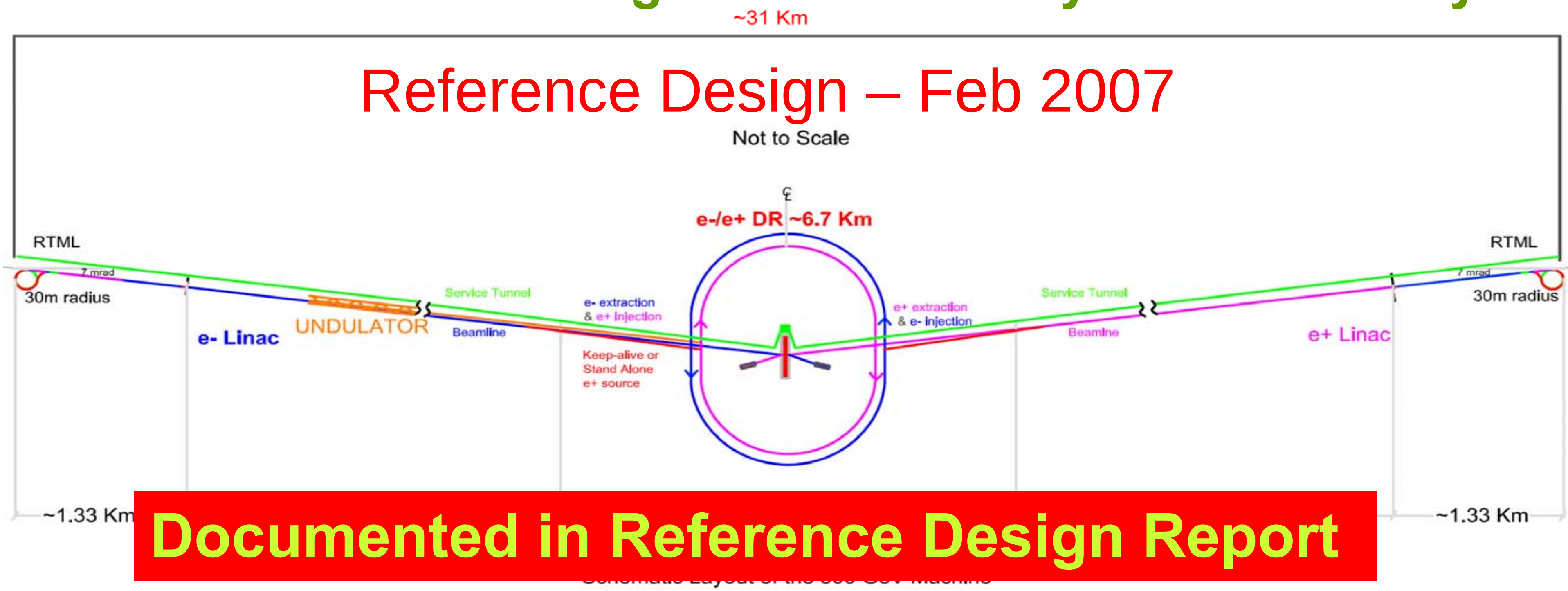
4-June-08

Outline

- General Remarks
  - **Updates on our plans and the global climate**
- Technical Design Phase
  - **Strategy for the next phase**
- Dubna GDE Meeting
  - **Technical Design Phase R&D Plan**
  - **Presentation of Dubna Site**
  - **Convention Facilities Approach --- Uniform Siting**

TDR Starting Point: ILC RDR

- **11km SC linacs operating at 31.5 MV/m for 500 GeV**
- **Centralized injector**
  - Circular damping rings for electrons and positrons
  - Undulator-based positron source
- **Single IR with 14 mrad crossing angle**
- **Dual tunnel configuration for safety and availability**



Documented in Reference Design Report

RDR Design & "Value" Costs

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

It is important to recognize this is a snapshot and the design will continue to evolve, due to results of the R&D, accelerator studies and 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

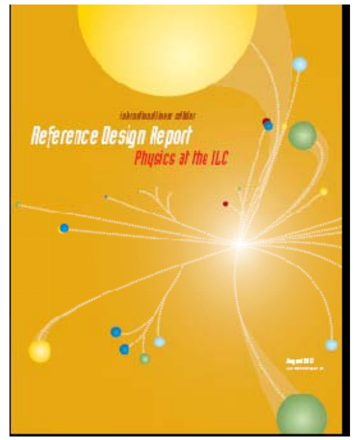
("explicit" labor = 24.0 M person-hrs @ 1,700 hrs/yr)

1 ILC Unit = $ 1 (2007)

ILC Reference Design

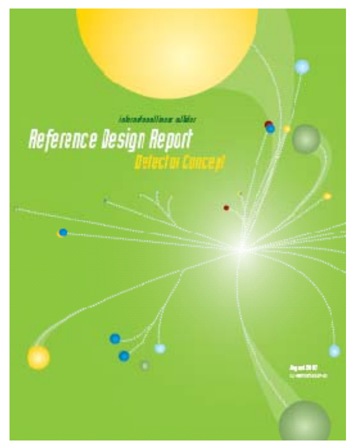
- **Reference Design Report (4 volumes)**

Executive Summary



Physics at the ILC

Accelerator



Detectors

Next Steps: The GDE

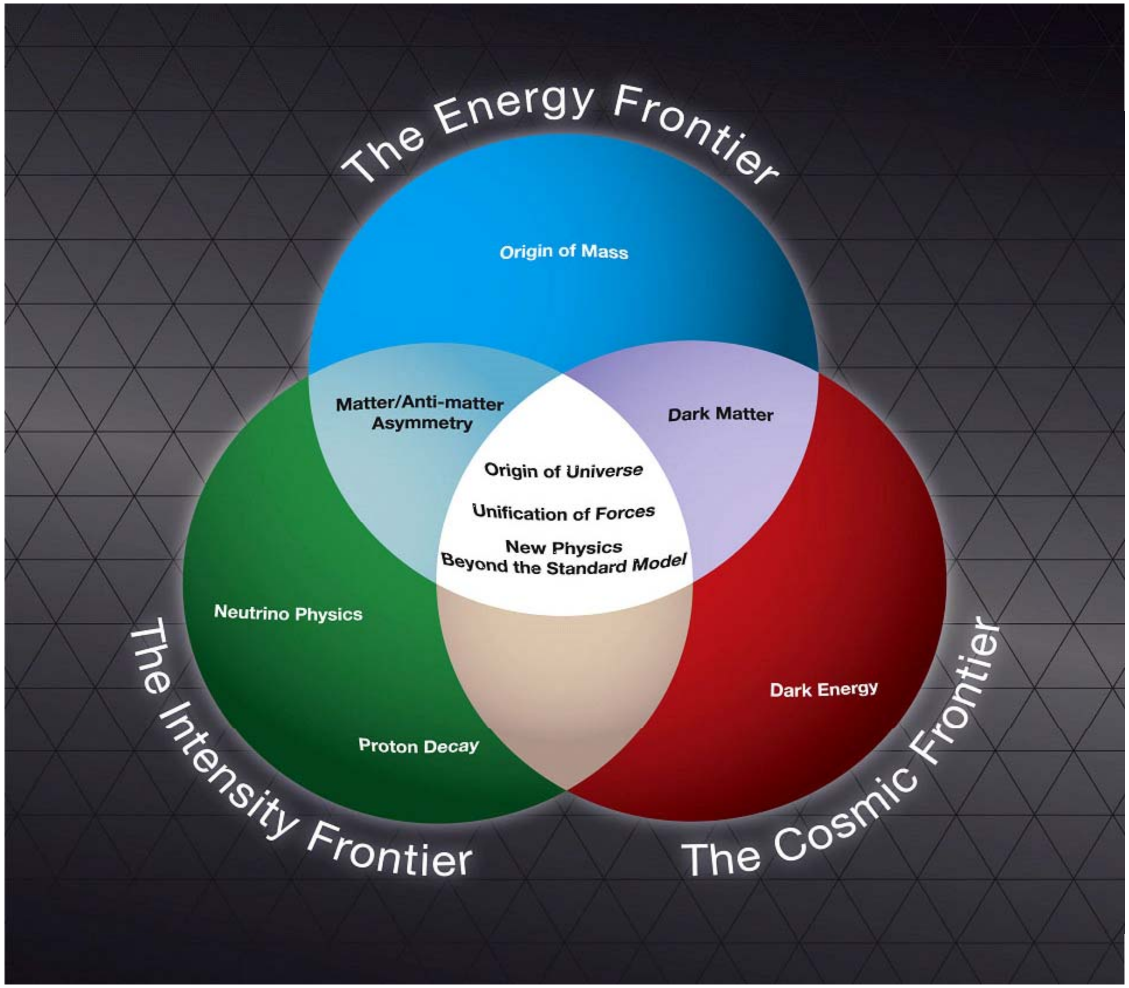
- **Build on Successes of GDE, RDR and DCR**
  - Be ready to make solid funding proposal compatible with the timescale for scientific results from LHC that could justify proposing a new accelerator construction project.
- **Plan**
  - Re-structured the GDE into a more traditional project management structure, using project tools.
  - Our primary program is to carry out a design and R&D program focussed on refining the RDR design through design studies and value engineering, as well as demonstrating key technologies .

Impacts of US / UK Funding Actions

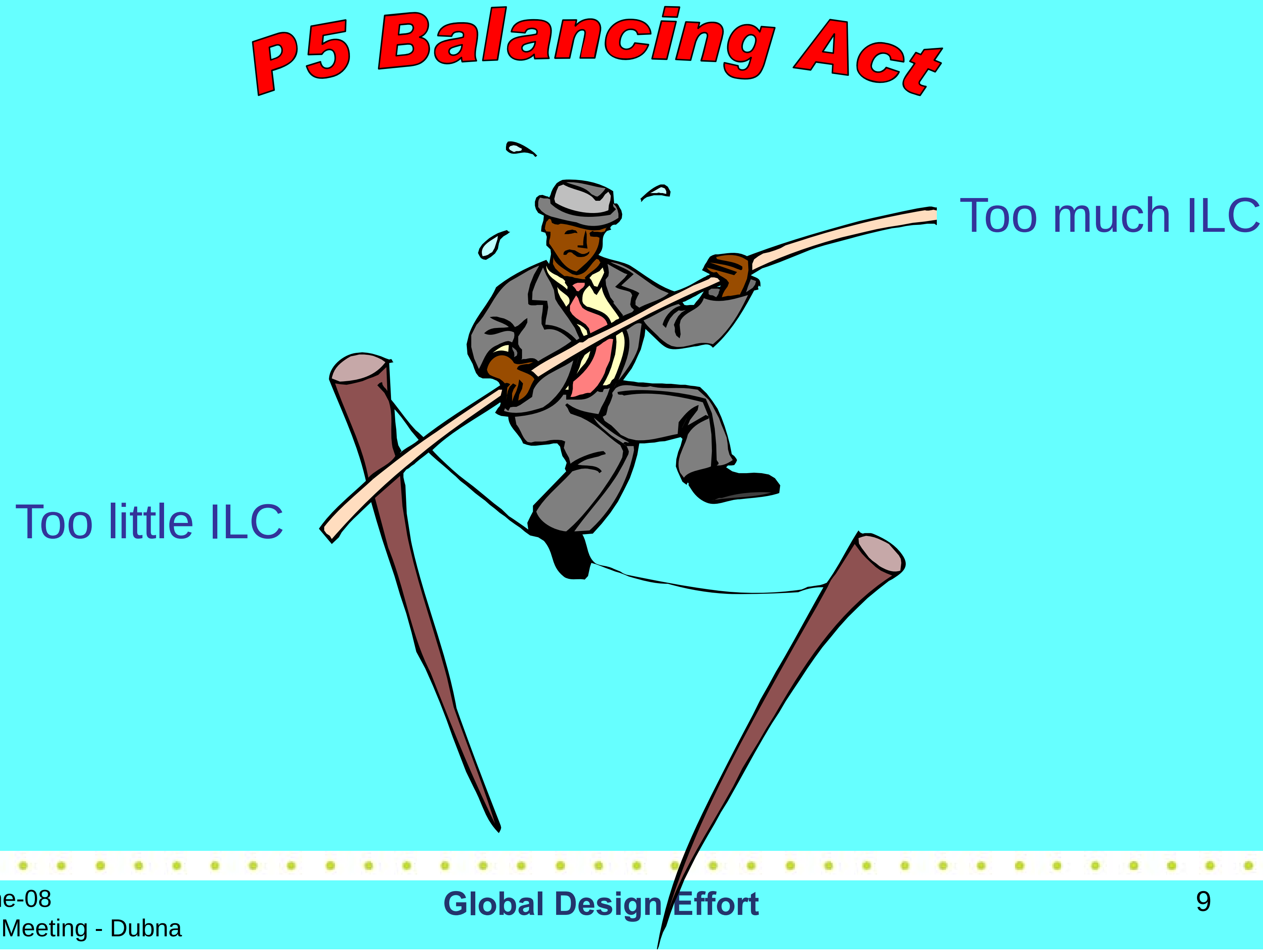
- UK ILC R&D Program
  - About 40 FTEs. Leadership roles in Damping Rings and Positron Source, as well as in the Beam Delivery System and Beam Dumps.
  - All of this program is generic accelerator R&D, some of which are continuing outside the specific ILC project, retaining some key personnel.
- US Program
  - ILC R&D reduced \$60M → \$15M for FY08. Planning a reduced level program for FY09 and beyond. US President's FY09 budget proposal is \$35M
  - Generic SCRF also terminated in FY08, but is proposed to be revived in FY09 to \$25M. and separated from ILC R&D.

New U.S. HEP Long Range Strategy

P5 presentation to HEPAP 29-May-08



The Role of ILC in the Ten Year Plan



Lepton Colliders

- The international particle physics community has reached consensus that a full understanding of the physics of the Terascale will require a lepton collider as well as the LHC. The panel reiterates the importance of such a collider.
- In the next few years, results from the LHC will indicate the required energy for such a lepton collider.
- If the optimum initial energy proves to be at or below approximately 500 GeV, then the International Linear Collider is the most mature option with a construction start possible in the next decade.
  - **The cost and scale of a lepton collider mean that it would be an international project, with the cost shared by many nations.**
  - **International negotiations will determine the siting; the host will be assured of scientific leadership at the energy frontier.**
- A requirement for initial energy much higher than the ILC's 500 GeV will mean considering other collider technologies.
- Whatever the technology of a future lepton collider, and wherever it is located, the US should plan to play a major role.

Lepton Collider R&D Program

- For the next few years, the US should continue to participate in the international R&D program for the ILC to preserve the option of an important role for the US should the ILC be the choice of the international community. The US should also participate in coordinated R&D for the alternative accelerator technologies that a lepton collider of higher energy would require.
- The panel recommends for the near future a broad accelerator and detector R&D program for lepton colliders that includes continued R&D on ILC at roughly the proposed FY2009 level in support of the international effort. This will ensure a significant role for the US even if the ILC is built overseas. The panel also recommends R&D for alternative accelerator technologies, to permit an informed choice when the lepton collider energy is established.
- The panel also recommends an R&D program for detector technologies to support a major US role in preparing for physics at a lepton collider.

So, where do we stand?

- In the UK we have retained the key ingredients (e.g. intellectual leadership) in our efforts toward a linear collider.

- In the U.S., our budget should be restored at a level near the 2007 level and we can expect support at that level through technical design phase

- There is no long term commitments to a linear collider in either the U.S. or U.K. We will need both exciting validating **science** results from the LHC, and we will need a very successful TDP, cost reduction, a realistic siting plan, and an attractive project implementation plan

How we propose to move forward!

- General Theme: **RISK REDUCTION**
  - **We must re-examine our design and optimize for cost to performance.**
  - **This will require aggressive studies of the major cost drivers, reducing scope, staging, etc. This will be done openly and in full coordination with experimentalists.**
  - **We must develop our technical design such that major technical questions (gradient, electron cloud, etc) are positively resolved**
  - **We must develop the technical design in preparation of making a construction proposal (plug compatible designs, value engineered concepts, etc.**
  - **Finally, we must develop an attractive, realistic and flexible Project Implementation Plan**
- At this time, the central coordination of the GDE is even more essential, if we are to accomplish these goals
- A two stage Technical Design Phase (TDP-1 2010 and TDP-2 2012 is proposed. Draft submitted to ILSCS and circulated at this meeting. Finalize following Dubna and update ~ 6 months

Some Context for our Replan

- Building close collaboration with XFEL. It will provide all SCRF development, except high gradient and ILC scale mass production, including a full systems test in 2013, industrialization, etc.
- We plan to take advantage of alignments and synergies where they will exist with US generic SCRF program, Project X development, etc.
- Undertaking steps to integrate linear collider (ILC and CLIC) R&D efforts, where beneficial to both efforts (meeting on 8-Feb, 13-May). Examples – sources, beam delivery, conventional facilities, detectors, costing, …..

CLIC/ILC Collaboration

- **Meetings at CERN in November when I visited CERN to give an ILC colloquium**
  - Meeting with the CLIC Extended Steering Committee, where I suggested we explore areas of joint work, where both stand to gain.
  - Meeting with R Aymar, who also endorses the general idea of increasing areas of joint work
- **Follow up meeting in February and May to organize and identify areas of joint interest**
- **Dubna meeting will involve joint ILC-CLIC site studies**

Initiating Joint Areas

- **Co-conveners of the CLIC-ILC working groups**
  - **Civil Engineering and Conventional Facilities (CFS):** Claude Hauviller/CERN, John Osborne/CERN, Vic Kuchler (FNAL)
  - **Beam Delivery Systems and Machine Detector Interface:** D.Schulte/CERN, Brett Parker (BNL), Andrei Seryi (SLAC),, Emmanuel Tsesmelis/CERN
  - **Detectors:** L.Linssen/CERN, Francois Richard/LAL, Dieter.Schlatter/CERN, Sakue Yamada/KEK
  - **Cost & Schedule:** John Carwardine (ANL), Katy Foraz/CERN, Peter Garbincius (FNAL), Tetsuo Shidara (KEK), Sylvain Weisz/CERN
  - **Beam Dynamics:** A.Latina/FNAL), Kiyoshi Kubo (KEK), D.Schulte/CERN, Nick Walker (DESY)

Essential Elements of TDP

- Draft Document
  - *"ILC Research and Development Plan for the Technical Design Phase"* **Release 2 June 2008**

- Key Supporting R&D Program (priorities)
  - **High Gradient R&D - globally coordinated program to demonstrate gradient for TDR by 2010 with 50%yield**
  - **Electron Cloud Mitigation – Electron Cloud tests at Cornell to establish mitigation and verify one damping ring is sufficient.**
  - **Final Beam Optics – Tests at ATF-2 at KEK**

TD Phase 1

- Timescale: Interim report mid 2010
- Major theme: High-priority risk-mitigating R&D
  - **Superconducting RF linac technology – technical demonstration of gradient and quantifying the scope for potential cost reduction**
  - **Produce a new baseline for the conceptual machine design, in preparation for more detailed technical design work in TD Phase 2.**
  - **The re-baseline will take place after careful consideration and review of the results of the TD Phase 1 studies and the status of the critical R&D.**

TD Phase 2

- Timescale: Produce report mid-2012
- **First goal:** New baseline design
  - **Detailed technical design studies**
  - **Updated VALUE estimate and schedule.**
  - **Remaining critical R&D and technology demonstration**
- **Second Goal:** Develop a Project Implementation Plan.

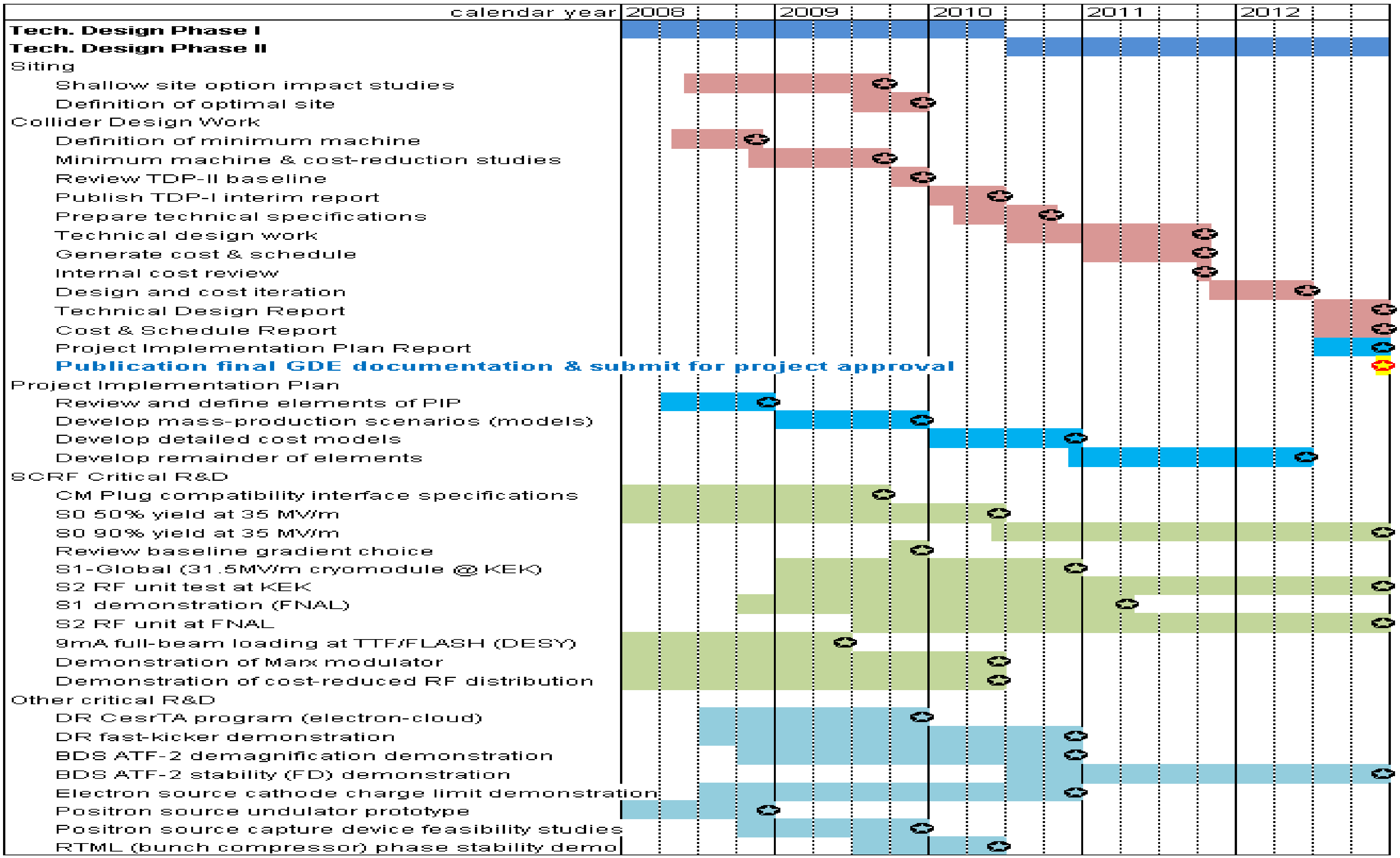
ILC R&D Major Test Facilites

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-SLAC ESA	Machine – Detector Interface	SLAC	2006	SLAC

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	Demonstration of compact Final Focus optics (design demagnification, resulting in a nominal 35 nm beam size at focal point).	2010
	Demonstration 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-configuration (re-build) of CESR as low-emittance e-cloud test facility. First measurements of e-cloud build-up using instrumented sections in dipoles and drifts sections (large emittance).	2008
	Achieve lower emittance beams. Measurements of e-cloud build up in wiggler chambers.	2009
	Characterisation of e-cloud build-up and instability thresholds as a function of low vertical emittance (≤20 pm)	2010

TD Phase 1 & 2 Schedules



TD 1 Phase Resources – SCRF Facilities

FTE-Years

Region	Country	Cavities	Cryomodule	HLRF	Cryogenics	ML Integ.	**total FTE-Years**
Americas	**Canada**	18					**18**
	USA	73	24	68	5	14	**183**
Asia	**China**	12	8	8	4	1	**33**
	India	24	12				**36**
	Japan	45	6	11	4	5	**72**
	Korea	13		5			**18**
Europe	**EU (CERN)**				1	4	**5**
	France	94					**94**
	Germany	51	10	7	7	9	**83**
	Italy	38	8		1	1	**48**
	Poland						
	Russia	2	20				**22**
	Spain		3				**3**
	Sweden						
	Switzerland						
	UK						
		370	**90**	**99**	**21**	**34**	**615**

total M&S

Region	Country	Cavities	Cryomodule	HLRF	Cryogenics	ML Integ.	**total M&S**	
Americas	**Canada**	1050					**1050**	k$
	USA	9169	3960	5909	134	362	**19535**	k$
Asia	**China**	10000	10000	10000	5000	1000	**36000**	kRMB
	India	1560	900				**2460**	k$
	Japan	2225	462	452	180	1119	**4438**	M JY
	Korea	1500		245			**1745**	M KRW
Europe	**EU (CERN)**					129	**129**	kEUR
	France	10058					**10058**	kEUR
	Germany	1705	361			23.5	**2089**	kEUR
	Italy	1182	160				**1342**	kEUR
	Poland							kEUR
	Russia	20					**20**	k$
	Spain		9				**9**	kEUR
	Sweden							kEUR
	Switzerland							kEUR
	UK							kGBP

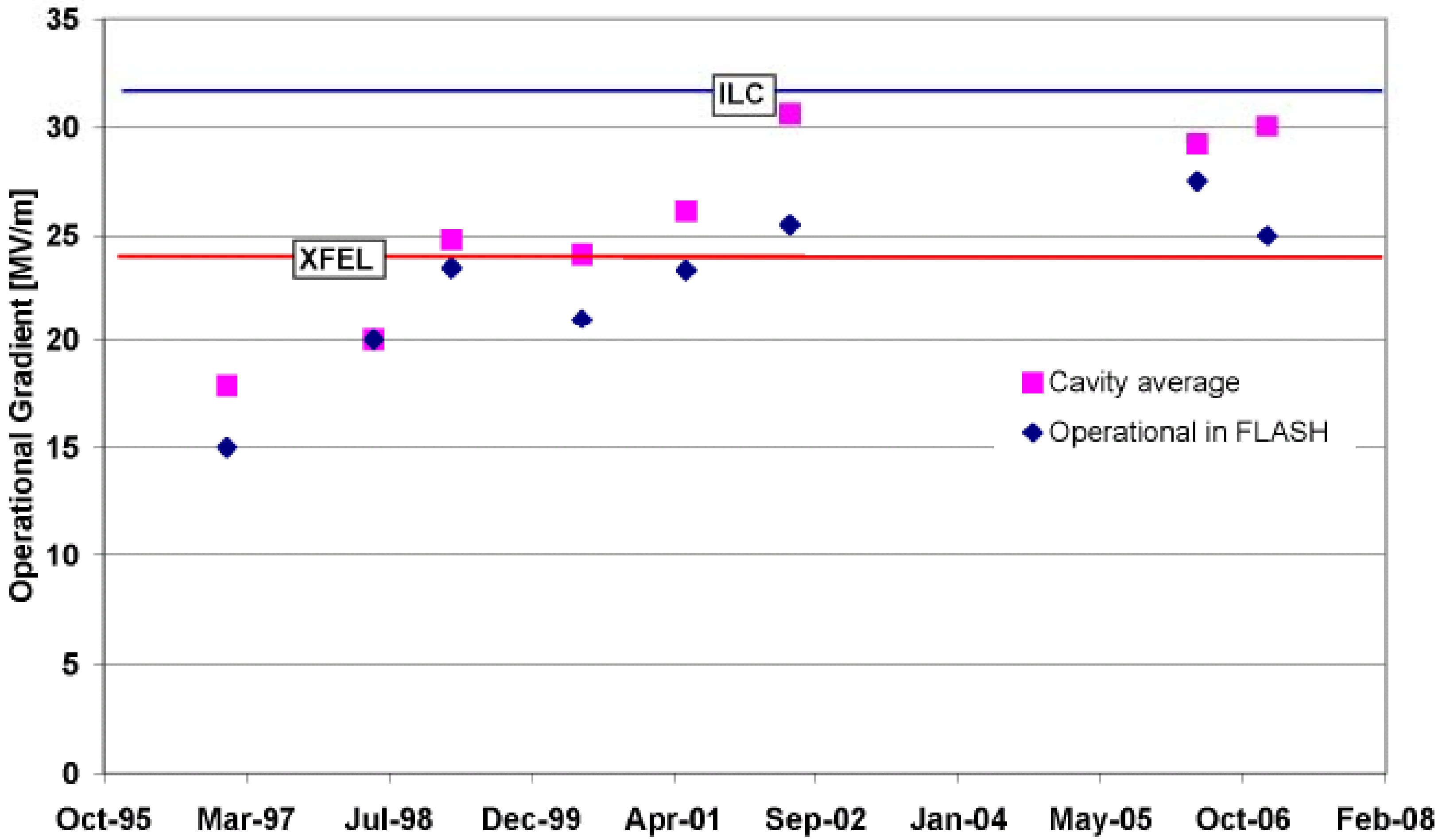
TD 1 Phase Resources – Conv Facilities

		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**								

DESY Cryomodule Performance



Development of flexible RF distribution systems will allow higher gradient operation, approaching E_max

SCRF Major Goals

High-gradient cavity performance at 35 MV/m according to the specified chemical process with a yield of 50% in TDP1, and with a production yield of 90% in TDP2	2010 2012
Nominal Cryomodule design to be optimized: - plug-compatible design including tune-ability and maintainability - thermal balance and cryogenics operation - beam dynamics (addressing issues such as orientation and alignment)	2009
Cavity-string performance in one cryomodule with the average gradient 31.5 MV based on a global effort (S1 and S1-global)	2010
An ILC accelerator unit, consisting of three cryomodules powered by one RF unit, with achieving the average gradient 31.5 MV/m (S2)	2012

Global R&D Plan

Consensus in SCRF-TA

Calender Year		2008	2009	2010	2011	2012
EDR	**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**	

Cavity Gradient

- TD Phase goals for gradient R & D are:
  - **Achieve 35 MV/m in 9-cell cavity in vertical dewar tests with a sufficient yield**
  - **Preparation process and vertical test yield for 35 MV/m at *Q*0 = 10^{10} should be greater than 50% for a sufficiently large number (greater than 100) of preparation and test cycles by the beginning of CY 2010 (TDP1) and 90 % by CY 2012 (TDP2).**
  - **(includes 20% re-processing fraction)**

- Perform a series of inter-laboratory cavity exchanges and re-test sequences in order to cross-check and compare infrastructure performance
  - **Deliver a gradient recommendation to the TD Project in time to allow the development of a consistent linac design. This should be before the beginning of CY 2012.**

SCRF Global Cavity Program

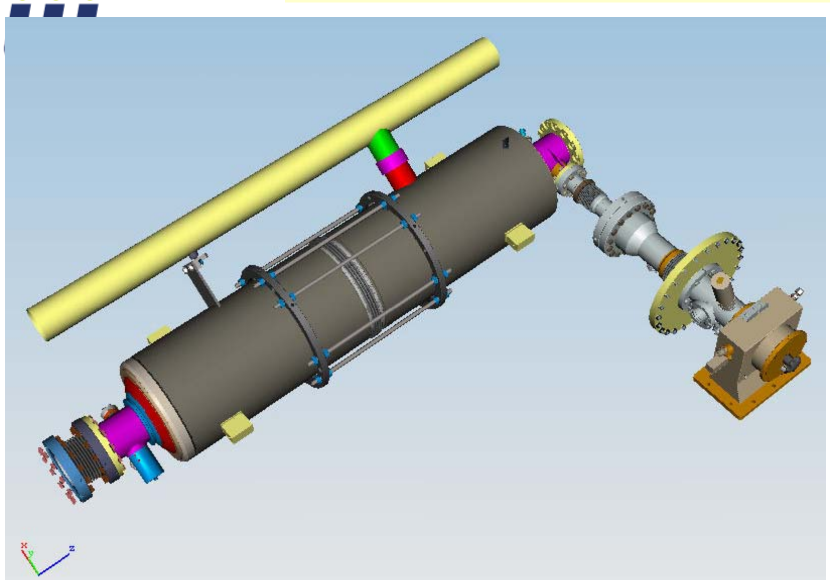
Americas	US FY06 (actual)	US FY07 (actual)	US FY08	US FY09	US FY10	TDP-1 Totals*	US FY11	US FY12
Cavity orders	22	12		10	10	**52**	10	10
Total 'process and test' cycles		40	5	45	30	**113**	30	30
Asia	**JFY06 (actual)**	**JFY07 (actual)**	**JFY08**	**JFY09**	**JFY10**		**JFY11**	**JFY12**
Cavity orders	8	7	8	25	15	**44**	39	39
Total 'process and test' cycles		21	40	75	45	**147**	117	117
Europe	**CY06 (actual)**	**CY07 (actual)**	**CY08**	**CY09**	**CY10**		**CY11**	**CY12**
Cavity orders	60**	8		834*		**8**		
Total 'process and test' cycles		14	18	26	30	**73**	380	406
Global totals								
Global totals - cavity fabrication	90	27	8	869	25	103	49	49
Global totals - cavity tests		75	65	135	175	333	501	501

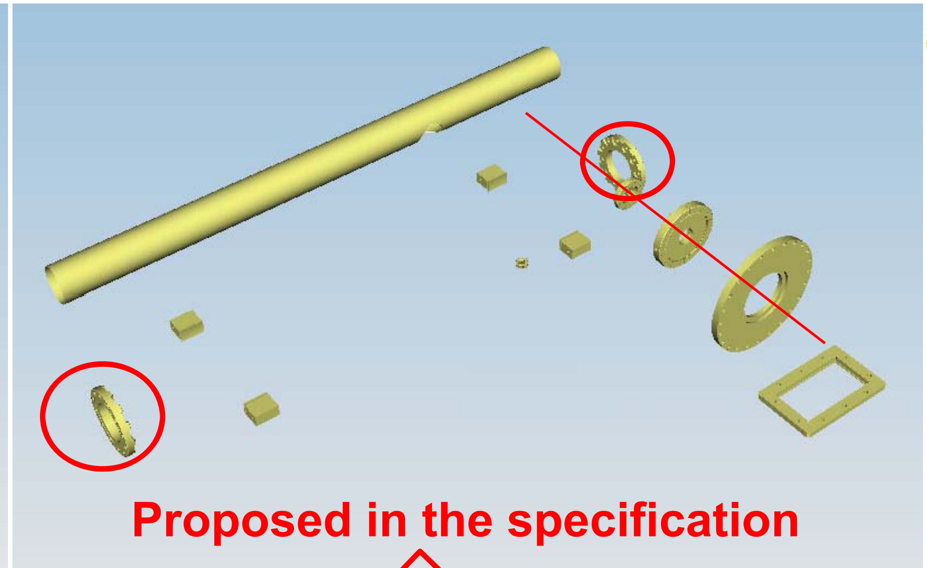
Cryomodule Design: Plug Compatible

- TDP 2: RF Unit ≡ 3 each cryomodules
- R&D Priority – High
  - Primary ILC 'High-Tech' component;
  - GDE development and construction plan must account for regional & institutional ambitions
- 6 basic components:
  - Cryostat, internal supports and cryogen plumbing:
  - and 4 interchangeable internal sub-assemblies

• Cavity + cryogen tank + tuner	64% CM cost
• Power input coupler	12%
• Quad	4%
• BPM	2%
– (Cryostat & plumbing/supports	19%)

Plug Compatible Assembly





Helium Vessel Body		KEK-STF-BL	KEK-STF-LL	FNAL-T4CM	DESY-XFEL
Helium Jacket	Material	Ti	SUS	Ti	Ti
	Slot length, mm	1337	1337	1326.7	(1382:Type3)
	Distance between beam pipe flanges, m	1258.6	1254.5	1247.4	1283.4
	Distance between bellows flanges, mm	78.4	85.2	80.49 (cold)	
	Outer diameter, mm	242	236	240	240
Beam Pipe Flange	Material	NbTi	Ti	NbTi	NbTi
	Outer diameter, mm	130	140	140	140
	Inner diameter, mm	84	80	82.8	82.8
	Thickness, mm	14	17.5	17.5	17.5
	PCD, bolts	ϕ115, 16-ϕ9	ϕ120, 16-ϕ9	12, M8 SS studs	12, M8 SS studs
	Sealing	Helicoflex	M-O seal	Al Hex Seals	Hexagonal Al ring
	Distances between the connection				
	surface and input coupler axis	62, -1196.6	58.1, -1213.9	60.6, -1186.8	60.6, -1222.8

32

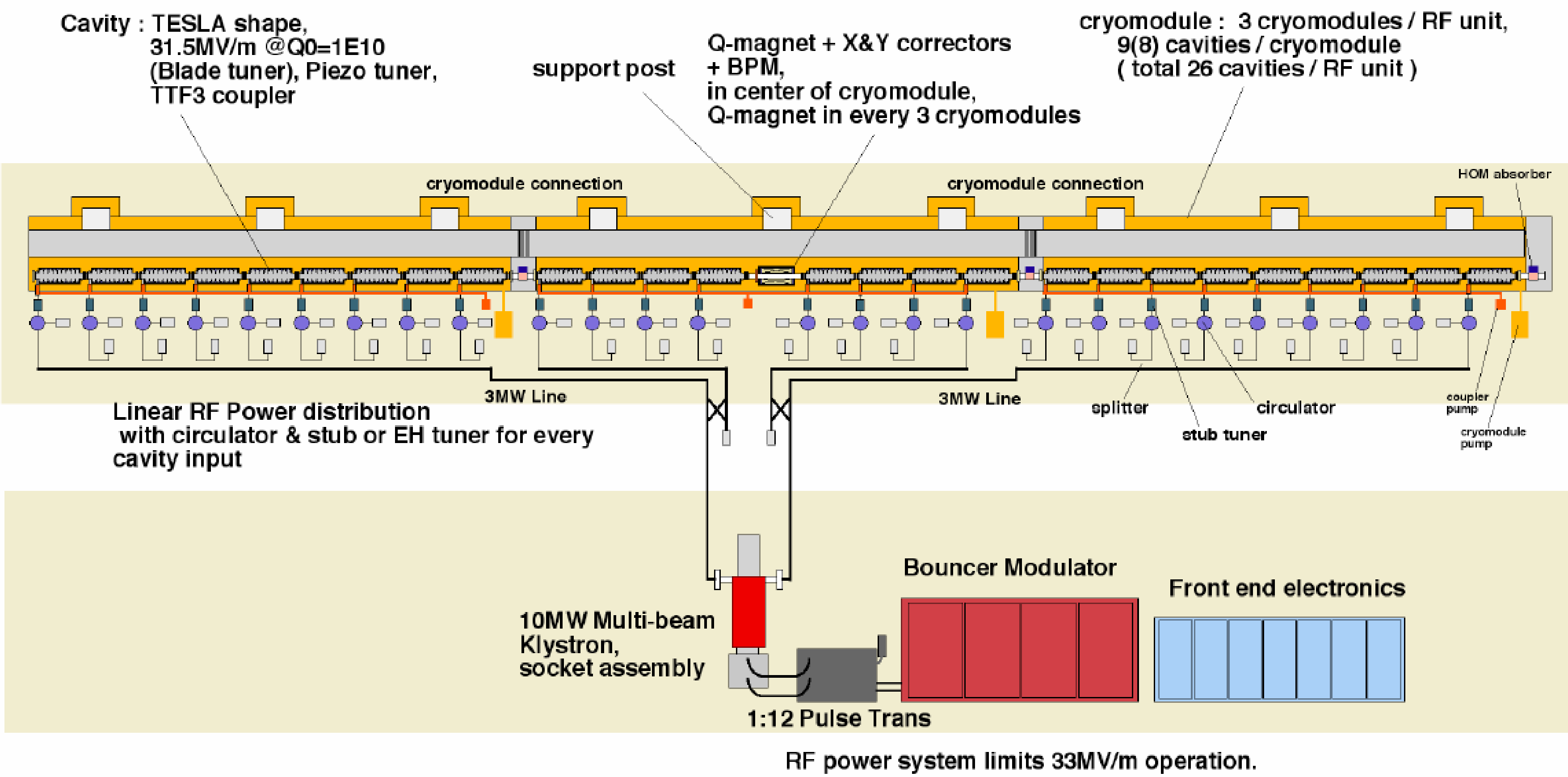
TDP 2 - 2012

- RF unit test – 3 CM + beam (KEK)
- Complete the technical design and R&D needed for project proposal (exceptions*)
  - **Documented design**
  - **Complete and reliable cost roll up**
- Project plan developed by consensus
  - **Cryomodule Global Manufacturing Scenario**
  - **Siting Plan or Process**

Cryomodule Testing Plan

- Development of CM unified design;
  - fabrication in at least two labs – provides a test facility
  - Project X plans to adopt this design
- R&D goal:
  - A cryomodule (of any type) with operational MV/m gradient 31.5MV/m
- Testing to be completed: TDP2:
  - KEK /STF – full beam test RF unit in 2012; CM testing from 2009
  - Fermilab – NML – CM testing from 2009

ILC Main Linac RF unit



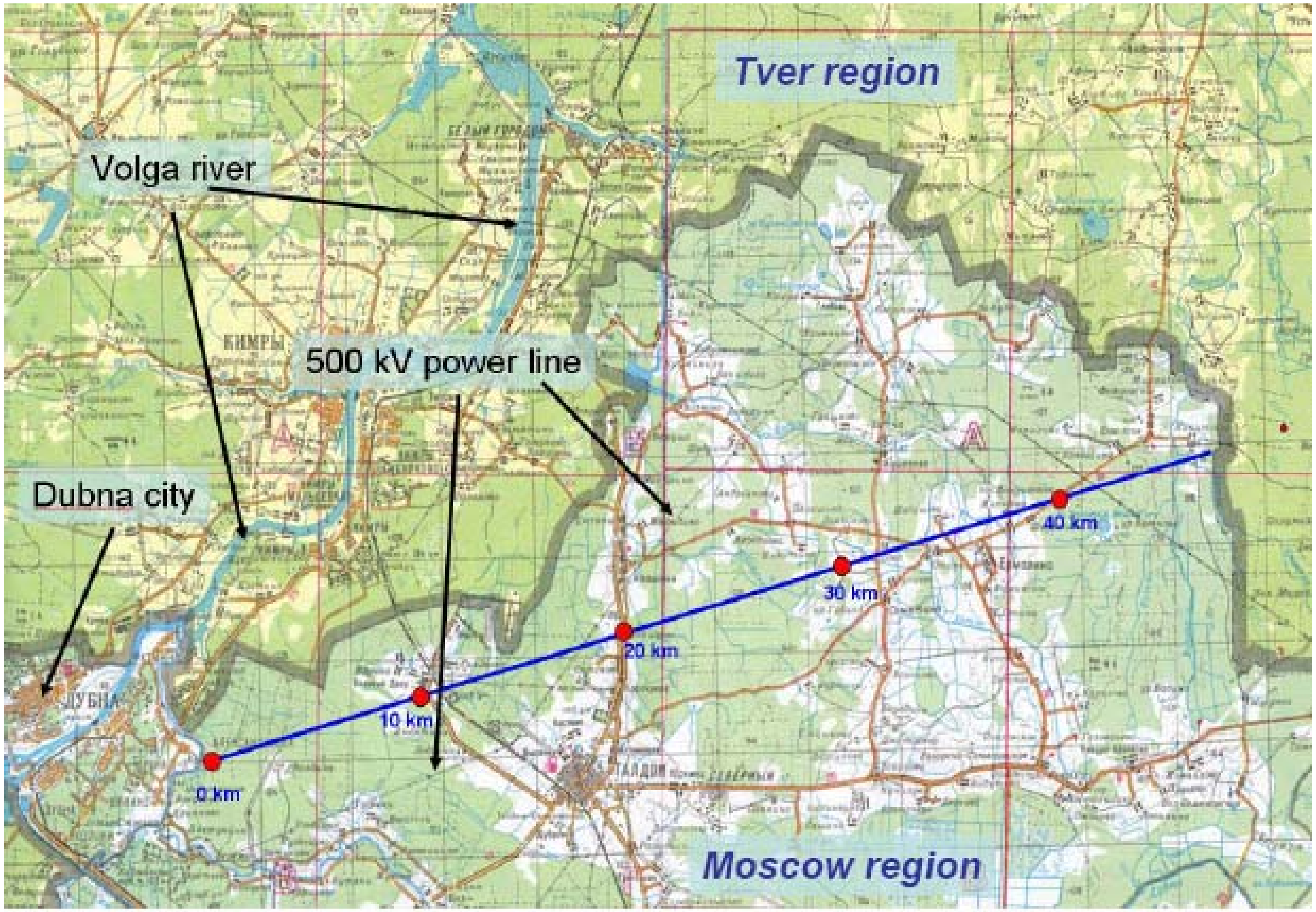
RDR configuration

Conventional Facilities Plan

- RDR based on "sample sites"
  - Accounts for about 1/3 of costs
  - Much specific information, but not cost minimized
- TD Phase proposed to produce "uniform" site study
  - Work together on siting to apply "value engineering" to minimize costs
  - Investigate shallow sites, single tunnel, etc.
  - Define uniform site
- Develop Siting strategy
  - Desired features, requirements, cost and other information for potential hosts
  - What is asked from hosts?

Russian Site

- Unique shallow site – thick loam layer near the surface.



Uniform Design Approach

- Examine CFS Requirements for ILC Reference Design
- Develop Models for Cost Scaling to Various Alternative Sites and CFS Configurations, in Particular Shallow Sites and Single-Tunnel Options
- Examine the Conventional Facilities of the Machines with Particular Attention to the Cost Drivers (Process Cooling Water etc.), and Understand the Impact with Respect to the Choice of Site Configuration
- Evaluate Alternative Layouts to minimize cost and to understand the cost/ performance trade-offs
- **Special Strategy Session – tomorrow morning and closing talk by J Dorfan**

Conclusions

- **We have presented the elements of the GDE plan for the next phase, which we call the Technical Design Phase.**
  - **A two stage ILC Technical Design Phase (TDP I 2010 and TDP II 2012 is proposed)**
- **Overall Goals: Cost reduction, technical design and implementation plan on the time scale of LHC results**
-
- *SCIENCE remains the key to ultimate success.*