Introduction: Joint GDE, ILC-HiGrade and JINR CFS Meeting

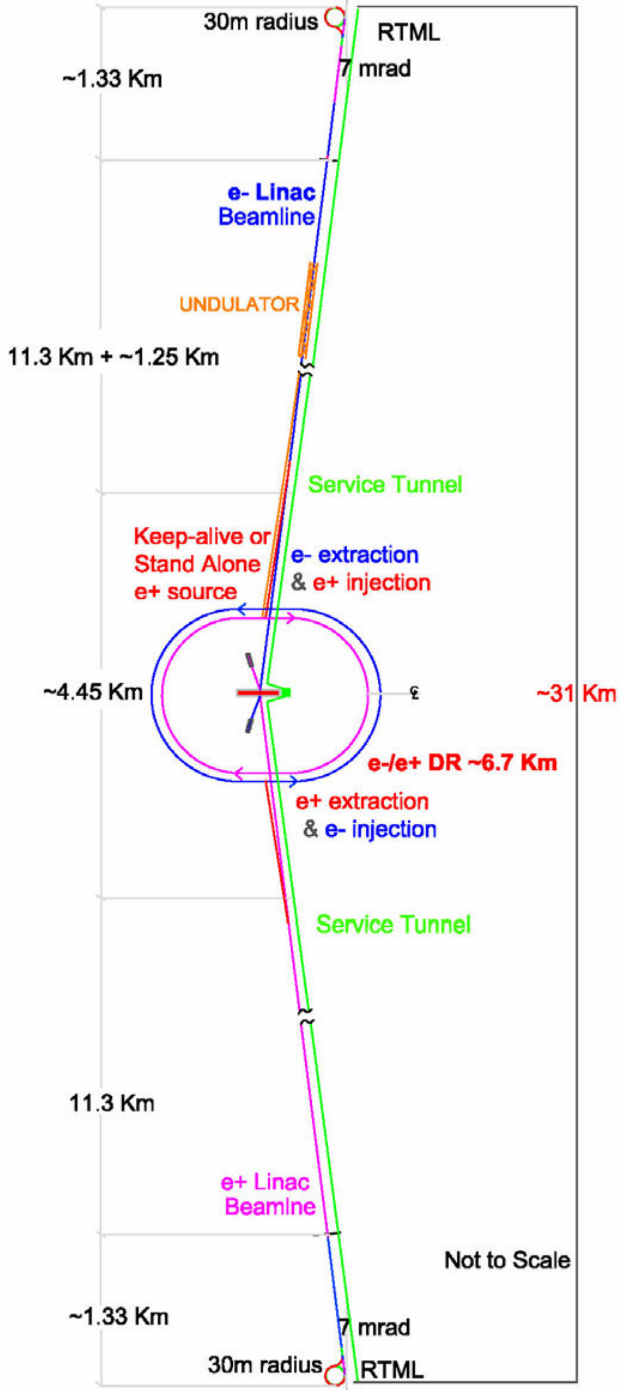
presented by Marc Ross - for the ILC Project Managers:

Marc Ross - (Fermilab),

Nick Walker - (DESY),

Akira Yamamoto – (KEK)

ILC-GDE / ОИЯИ-ГСПI, (DESY) 25-26.06.2009



Introduction

- ICFA statement (based on input from the community):
  - **the highest priority for a new machine for particle physics is a linear electron-positron collider with an initial energy of 500 GeV, extendible up to about 1 TeV, with a significant period of concurrent running with the LHC.**
- This is the International Linear Collider.

Physics:

- a continuous center-of-mass energy range between 200 and 500 GeV
- a peak luminosity of 2e34 and availability (75%) consistent with 500 fb-1 in the first four years
- > 80% electron polarization at the IP
- energy stability and precision < 0.1%
- option for 60% positron polarization
- options for e- e- and γγ collisions

ILC – Background:

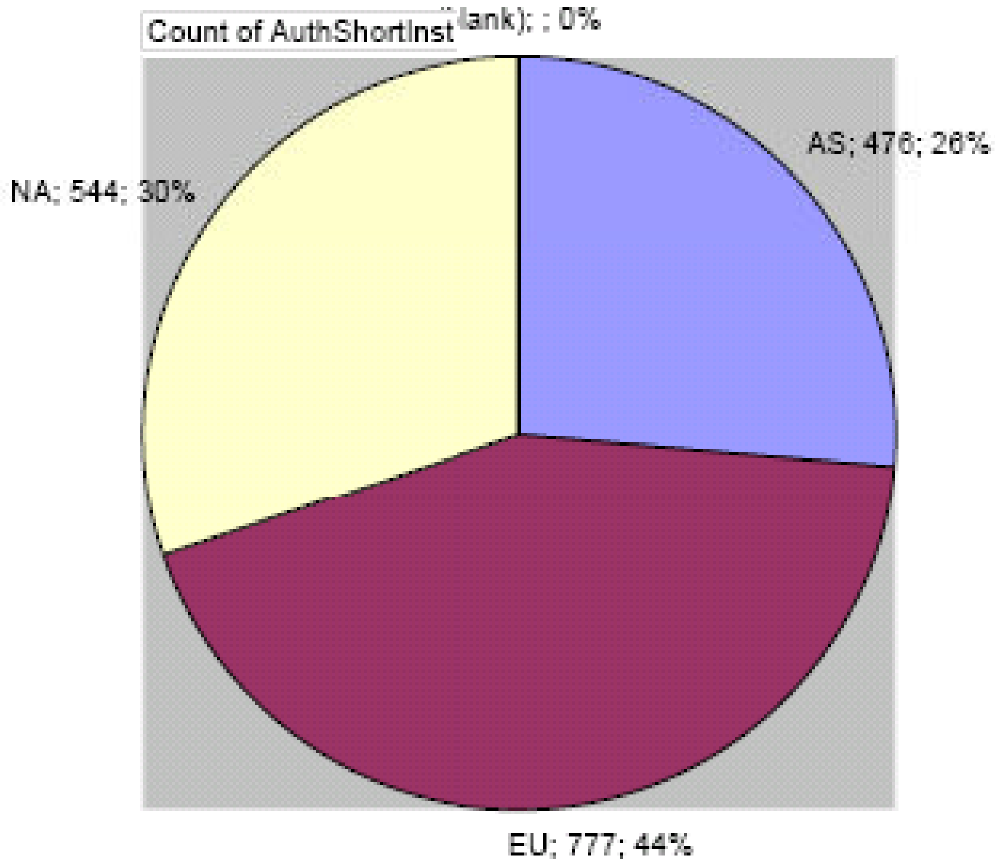
- traced back to:
  - **1965 article by Maury Tigner in *Nuovo Cimento* …**
  - **1972 meeting in Switzerland in which G. I. Budker…**
- e+/e- collider labs –
  - **where the linear collider was born:**
  - **BINP, SLAC, *KEK, Cornell, DESY*, …**
    - *where cold SRF linac technology started*
- Technology Reviewed (TRC);
- Recommendation made (ITRP):
  - **1995, 2002 and 2004**
  - ***0.5-1 TeV ILC: → Superconducting Linacs***

Pief Panofsky and Gersh Budker

ILC R & D – Global effort

- ILC Reference Design (RD)
  - **based on R & D in support of: TESLA, SBLC, JLC/NLC, VLEPP, CLIC**
  - **strongly linked to TESLA Design; with work done by Russian institutions:**
    - BINP, Efremov, IHEP, INR, IRE-RAS, MEPhI, …
- RD Report authored by 325 institutions (including physics/detectors)
  - **9 Russian institutions including:**
    - BINP, Efremov, ITEP, JINR, Lebedev, and Universities
- EU-XFEL → a large scale demonstration
  - **~ 5 Russian institutions involved:**
    - BINP, Efremov, IHEP, INR, JINR

RDR Author List



- Asia 476
- Americas 544
- Europe 777

- TOTAL 1797

CLIC / ILC Joint Statements

27 October 2008

Purpose of these statements:

The CLIC and ILC Collaborations agree to work together, within the framework of the CLIC / ILC Collaboration, to outline comparative statements to be used in presenting their respective projects. The Collaboration members agree to limit statements made about each other's projects to specifically agreed upon statements such as those listed below:

- **Project design**

The CLIC and ILC projects both plan to release design documents in the coming years. The CLIC Conceptual Design Report is to be published in 2010. If the CLIC technology is demonstrated to be feasible, a CLIC Technical Design will then be launched for publication in a CLIC TDR by 2015. The ILC TDR will be published in 2012. The design reports are intended to summarize the R&D and project planning at that time and will serve as indicators of project readiness. Both TDRs are intended to be submitted to governments and associated funding agencies in order to seek project approval.

- **Test facilities and system tests**

The CLIC and ILC projects both have test facilities either in operation or under construction for the purpose of demonstrating the performance of key technical components or to allow system engineering and industrialization. For each project, R&D priorities and schedules have been defined and it is anticipated that milestones and progress will be reviewed and reported on by members of the community. The XFEL project, with the same technical basis as the ILC, although at a lower accelerating gradient, and 7% of the energy of one of the ILC linacs, is a large-scale system test and demonstration of the industrialization of the ILC linac technology. The CERN- based CTF3 project is a demonstration of the CLIC two beam technology, although at a lower beam power.

- **Technology maturity and risk**

The collaborations agree that the ILC technology is presently more mature and less risky than that of CLIC. There are plans to demonstrate, by 2010, the feasibility of CLIC technology and to reduce the associated risk in the future. The ILC collaboration will focus on consolidation of the technology for global mass-production. Both collaborations consider it essential to continue to develop both technologies for the foreseeable future.

- **Costing**

Project planners from the CLIC and ILC projects are developing common methodologies and tools with the intention of enabling the development of similarly-structured project planning and costing documents for each of the two projects. The two collaborations agree to make no public statements about the comparative cost numbers of the two machines until these project planning and costing documents are complete.

Barry C. Barish
ILC-GDE Director

J-P. Delahaye
CLIC Study Leader

CLIC / ILC Collaboration

- Working Groups with joint leadership

- Accelerator Tech Areas
- Physics / Detectors
- Costing

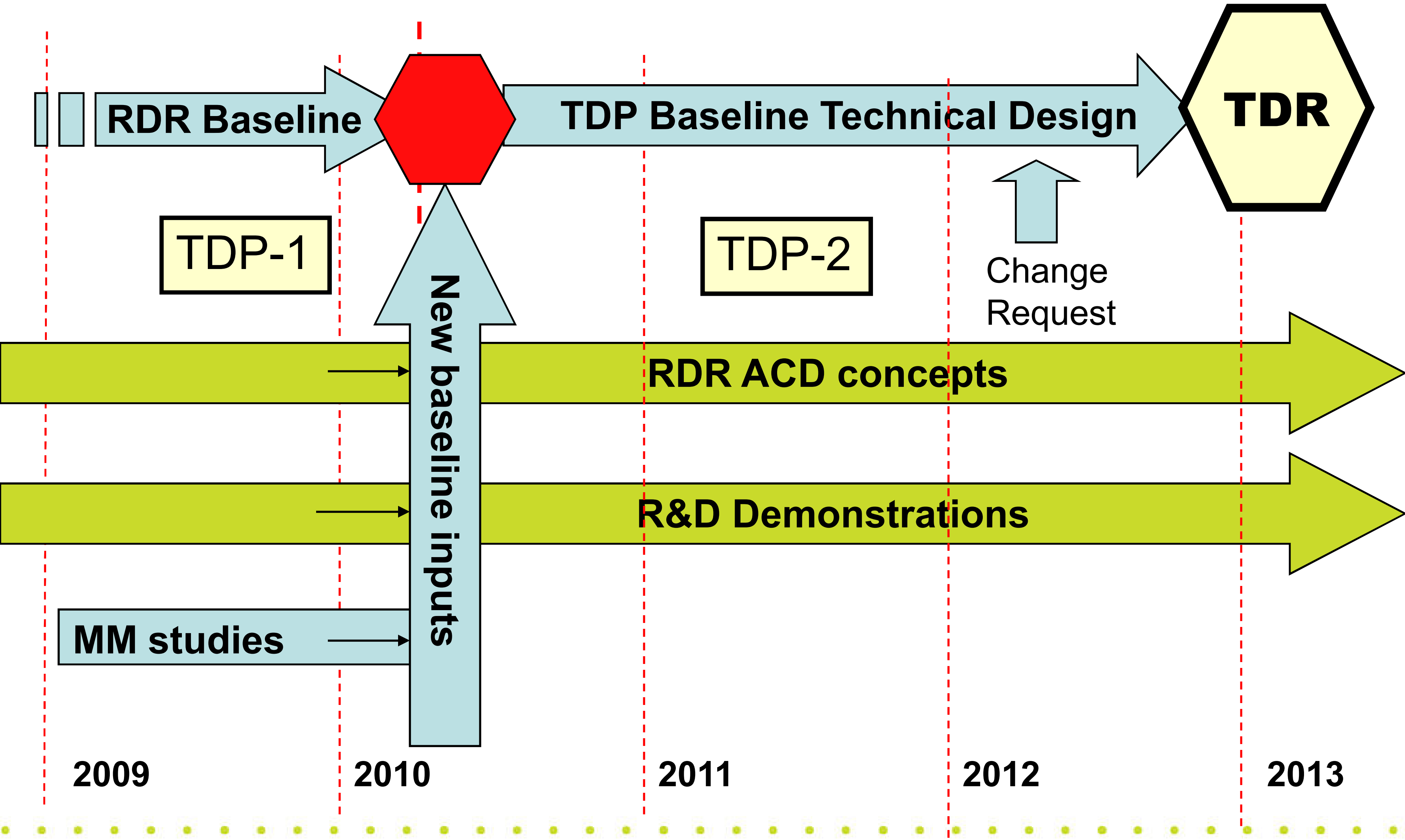
- First progress reported last fall

LOI Follow-on: Study extrapolation to multi-TeV

Collaboration Working Groups

	CLIC	ILC
Physics & Detectors	L.Linssen, D.Schlatter	F.Richard, S.Yamada
Beam Delivery System (BDS) & Machine Detector Interface (MDI)	D.Schulte, R.Tomas Garcia E.Tsesmelis	B.Parker, A.Seryi
Civil Engineering & Conventional Facilities	C.Hauviller, J.Osborne.	J.Osborne, V.Kuchler
Positron Generation (new 11/08)	L.Rinolfi	J.Clarke
Damping Rings (new 11/08)	Y.Papaphilipou	M.Palmer
Beam Dynamics	D.Schulte	A.Latina, K.Kubo, N.Walker
Cost & Schedule	H.Braun, K.Foraz, P. LeBrun	J.Carwardine, P.Garbincius, T.Shidara

Technical Design Phase and Beyond



ILC - Technical

16,088 SC Cavities: 9 cell, 1.3 GHz

1848 CryoModules: 2/3 containing 9 cavities,
1/3 with 8 cavities + Quad/Correctors/BPM

613 RF Units: 10 MW klystron, modulator, RF distribution

72.5 km tunnels ~ 100-150 meters underground

13 major shafts $\geq$ 9 meter diameter

443 K cu. m. underground excavation: caverns, alcoves, halls

10 Cryogenic plants, 20 KW @ 4.5° K each
plus smaller cryo plants for e-/e+ (1 each), DR (2), BDS (1)

92 surface "buildings", 52.7 K sq. meters = 567 K sq-ft total

240 M Watts connected power, 345 MW installed capacity

13,200 magnets – 18% superconducting

Priorities for ILC

- (value estimate metrics:)
- Cost risk
  - Linac: 60%
    - main linac and its conventional
  - CFS: 38%
    - all conventional
  - Linac + CFS: 79%
    - main linac and all conventional
- Technical risk (e.g.):
  - SCRF “process”
  - damping ring, esp electron cloud instability
- Planning

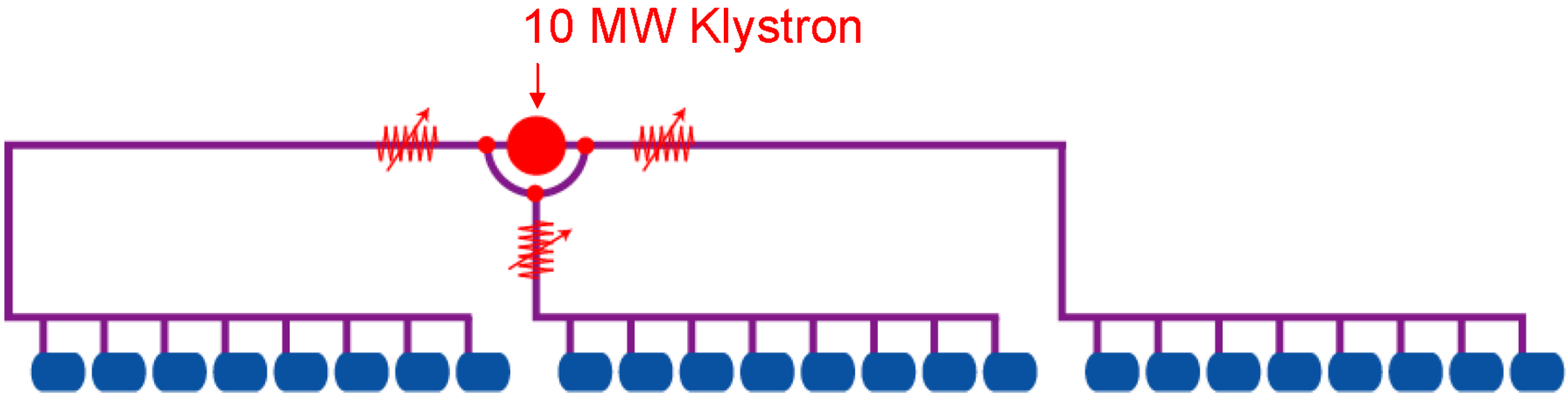
- What are the issues?

cost of going to the energy frontier: beam power

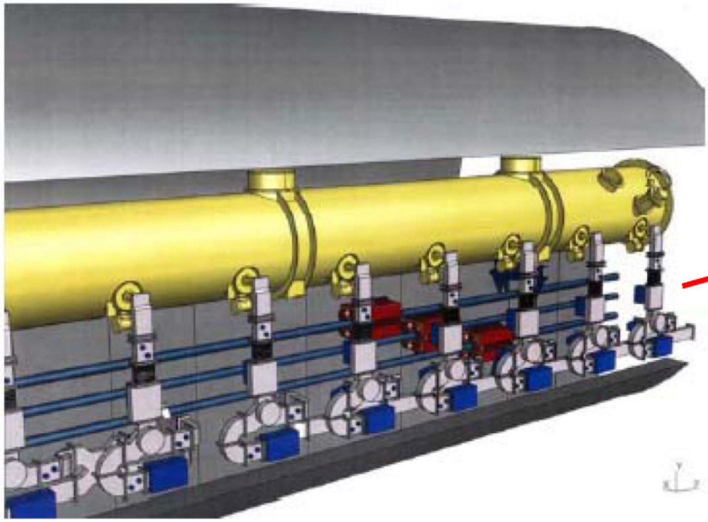
RDR civil "footprint"

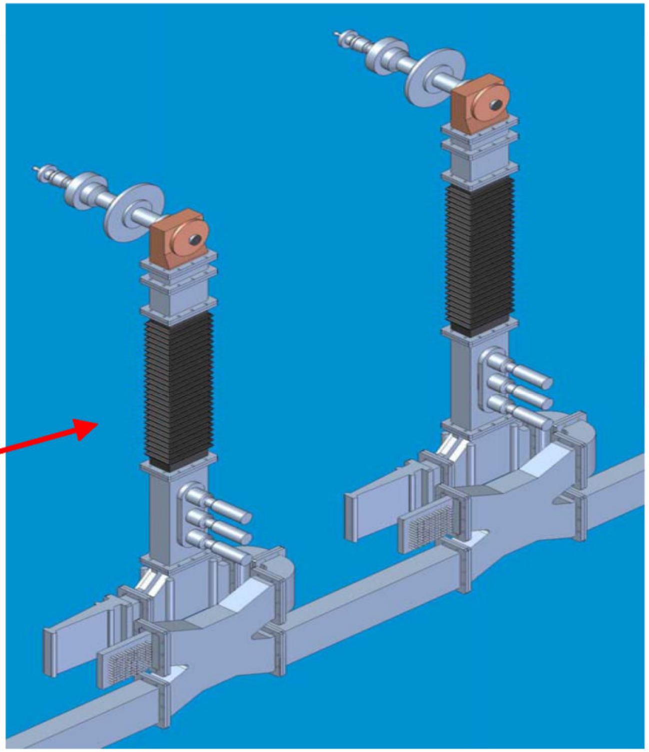
- 72.5 km tunnels ~ 100-150 meters underground
  - 93% overhead v/v actual tunnel needed for 'beam pipe'
  - Tevatron/MI? … ~0.
  - LEP/LHC ? 5%? PEP 5%
- 13 major shafts > 9 meter diameter
  - 1.6 km of large shafts
  - roughly ½ of LHC/LEP
- 443 K cu. m. underground excavation: caverns, alcoves, halls
  - 77 m cube
- 10 Cryogenic plants, 20 KW @ 4.5o K each
- plus smaller cryo plants for e-/e+ (1 each), DR (2), BDS (1)
- 92 surface "buildings" (for Americas' site), 52.7 K sq. meters
- 230 M Watts connected power, 345 MW installed capacity

Tunnel function: RF power



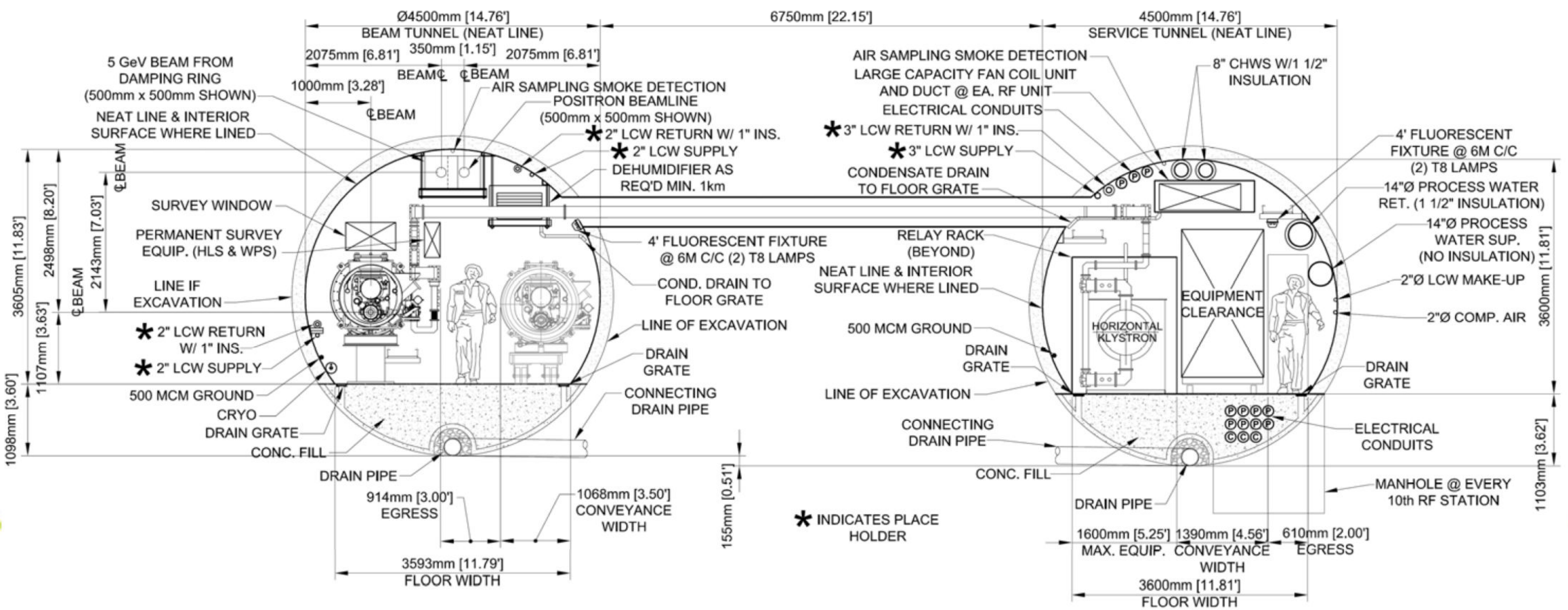
Two of ~ 16,000 Feeds



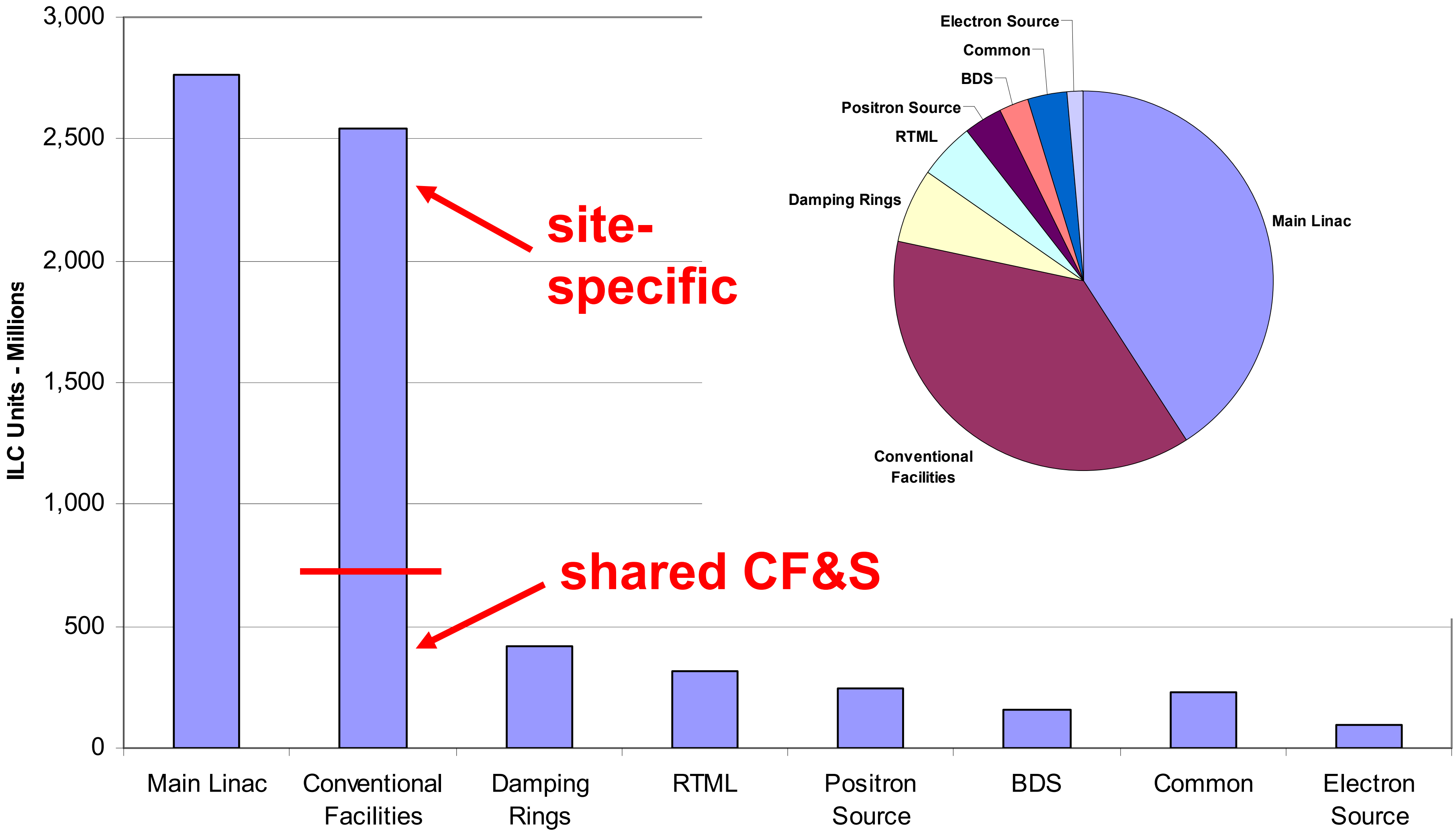


Main Linac Tunnels

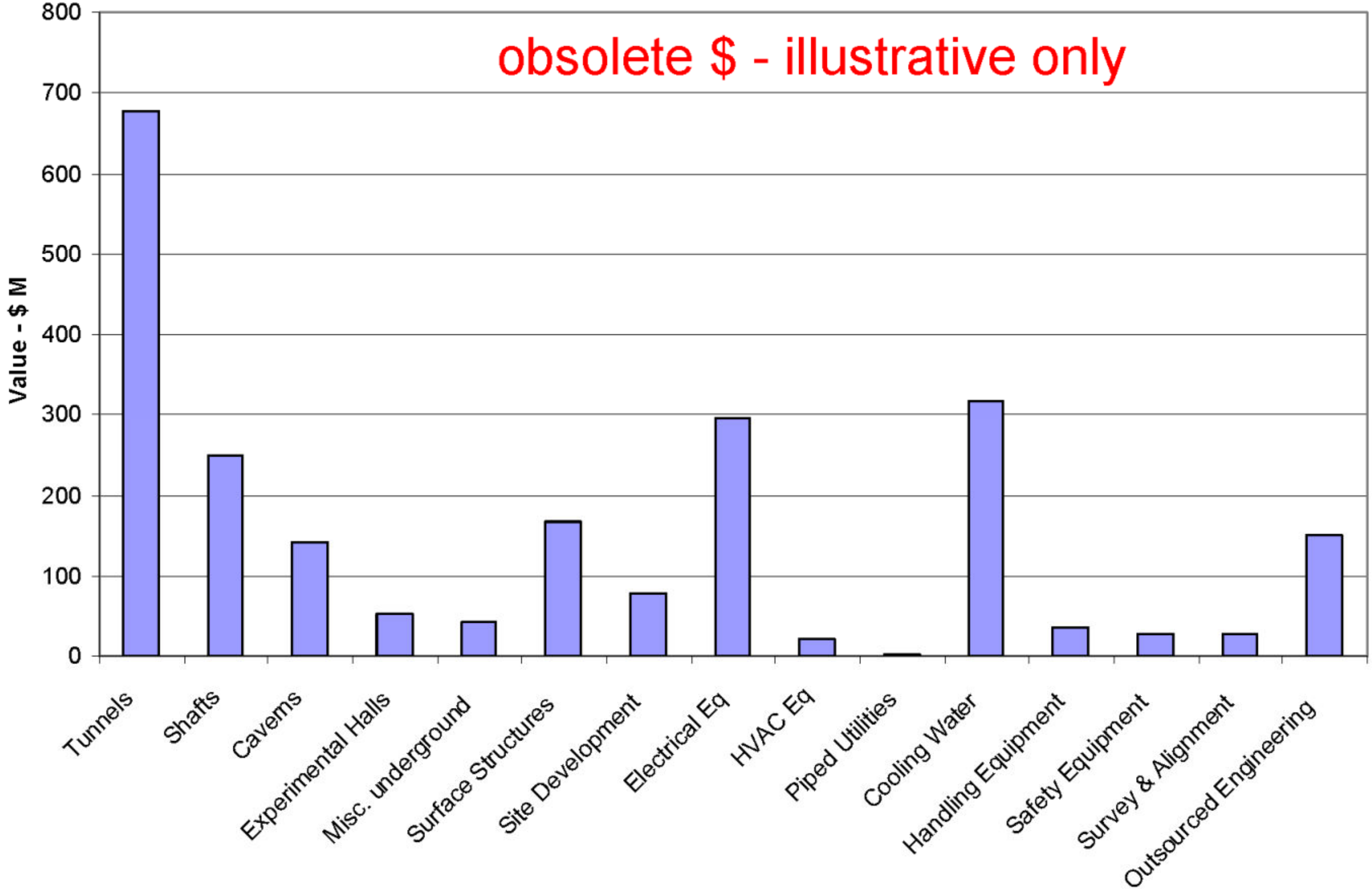
- Design based on two 4.5m tunnels
  - **Active components in service tunnel for access**
  - **Includes return lines for BC and sources**
  - **Sized to allow for passage during installation**
  - **Personnel cross-over every 500 meters**



Value – CF&S + AS (non-CF&S)



Conventional Facilities (US site)



Rdr power parameters / water

Fermilab

- power / water handling scheme is an indicator of design maturity
- Beam power at IP → 10.8 + 10.8 MW
  - 15 % efficient
  - 10% cooling overhead (100W to remove heat from 1 KW load)
- Good performance figures – but more to do
  - TESLA design (2001): ~ 80 MW lower for same luminosity

TABLE 4.3-1
Estimated Nominal Power Loads (MW) for 500 GeV Centre-of-Mass Operation

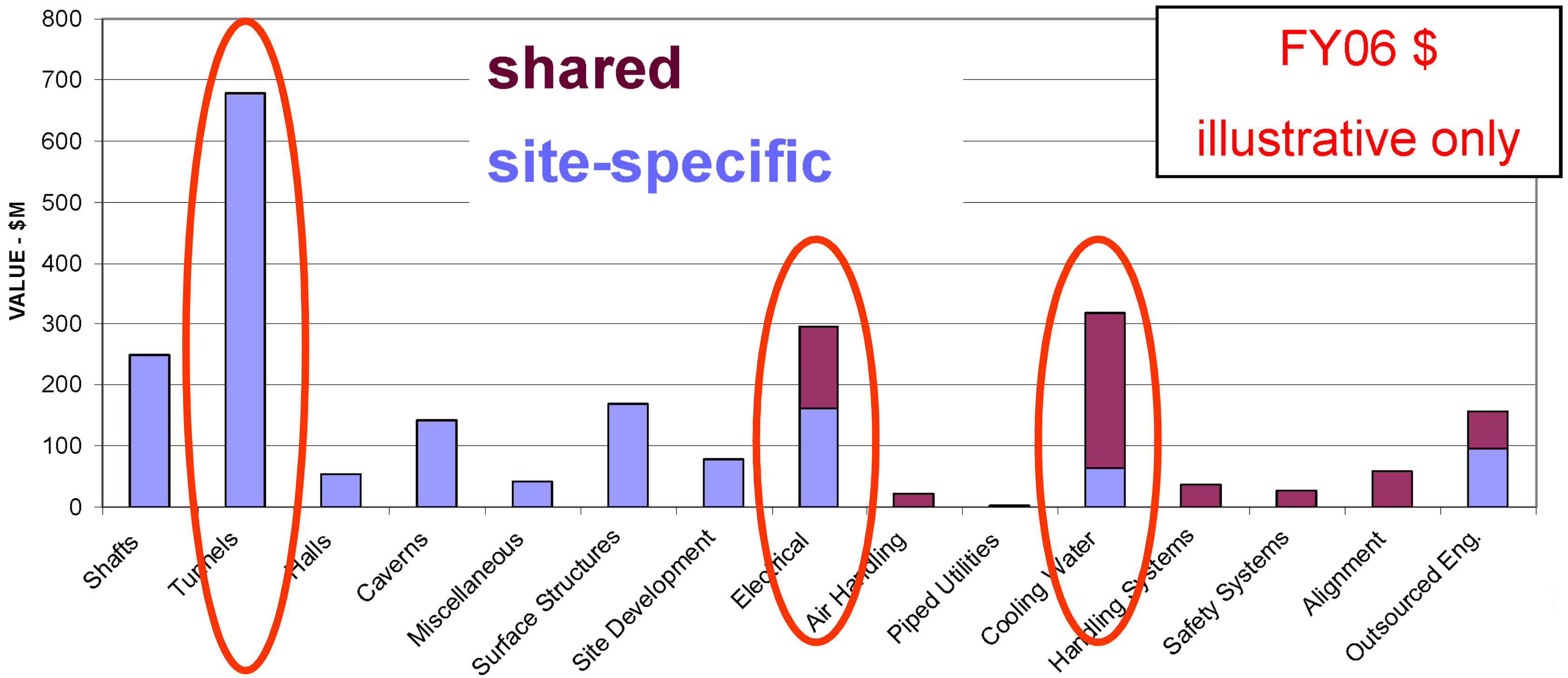
AREA SYSTEM	RF	CONV	NC MAGNETS	WATER SYSTEMS	CRYO	EMER	TOTAL (by area)
SOURCES e-	1.05	1.19	0.57	1.27	0.46	0.06	4.59
SOURCES e+	4.11	7.32	6.52	1.27	0.46	0.21	19.89
DR	14.0	1.71	6.78	0.66	1.76	0.23	25.15
RTML	7.14	3.78	2.84	1.34	0.0	0.15	15.24
MAIN LINAC	75.72	13.54	1.41	9.86	33.0	0.4	134.84
BDS	0.0	1.11	18.48	3.51	0.33	0.20	23.63
DUMPS	0.0	3.83	0.0	0.0	0.0	0.12	3.95
TOTAL (by system)	102.0	32.5	36.6	17.9	36.9	1.4	227.3

Conventional Facilities

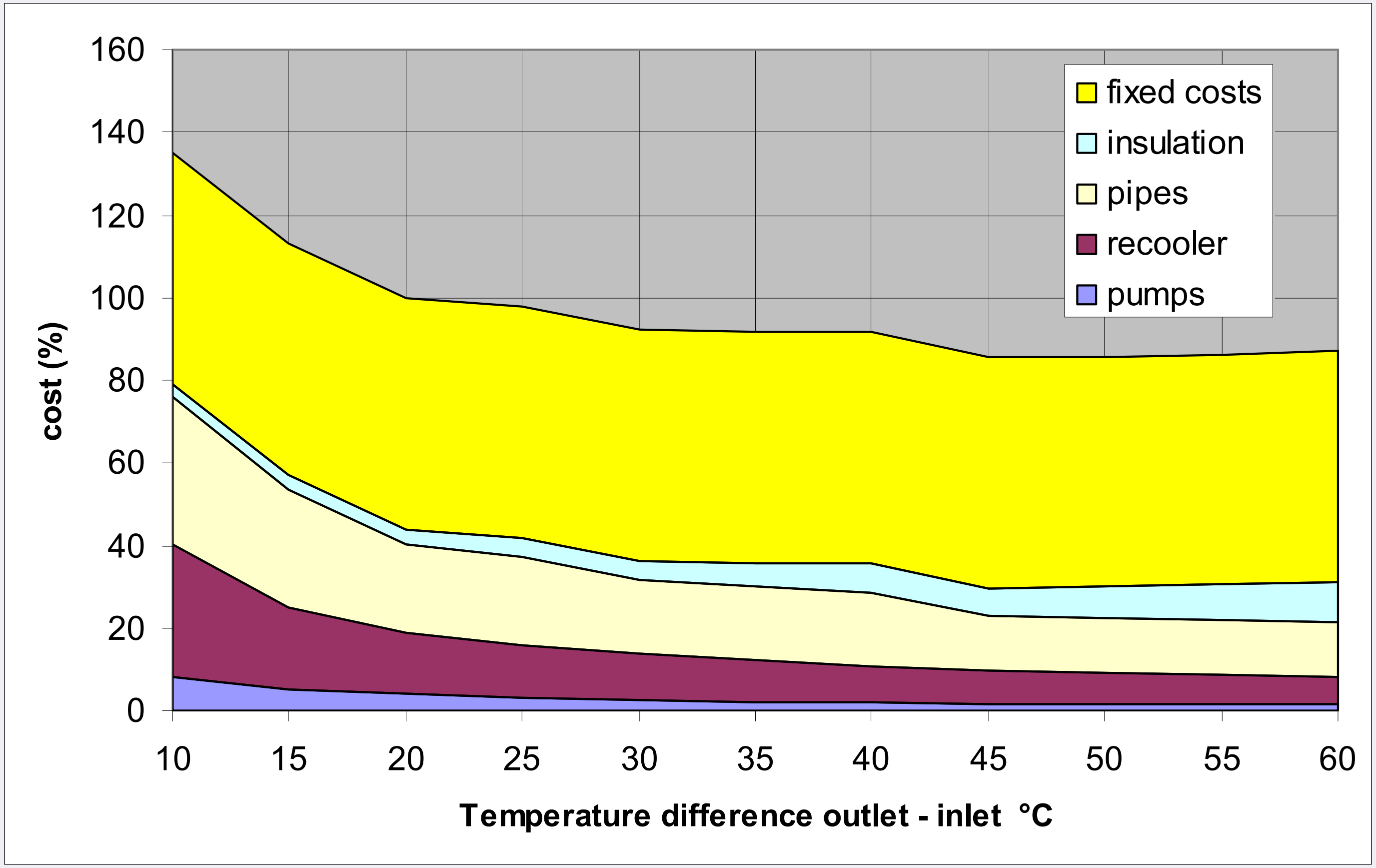
Regional Comparisons :

Quote 2007$ – Escalate 2006$ by 10.6% U.S (Turner); 2-3 % other regions

ASIA	TOTAL COST=	$2,247,562	CIVIL ONLY=	$1,377,765	Yen to US $	0.0085714
AMERICA	TOTAL COST=	$2,540,439	CIVIL ONLY=	$1,648,052	Euro to US $	1.2
EUROPE	TOTAL COST=	$2,493,066	CIVIL ONLY=	$1,608,407	Euro to Yen	140
					US to Yen	116.7



Cost cutting by increasing the temperature difference



Fixed costs:
chillers, pressed air, water treatment, auxiliary pipes, etc

recooler:
constant temperature difference for the heat flow at the cold side (e.g. the air temperature)

insulation:
always the same heat flow

The outlet temperature should be less than 70°C:

Otherwise the water will be to hot for some equipments

Klystron RF Power S

- S. Kazakov, A. Larionov, V. Teriaev, BINP, Branch of Institute of Nuclear Physics, Russia, et. al
  - **Russian Design team; fabricated in Japan**

- 1 TOSHIBA E3736 at DESY
  - 10.4MW, 1.5ms, 10Hz, 66%
  - 750h, ~80% at full power
  - will be used at the modulator test stand in Zeuthen

- Most successful 10 MW multi-beam klystron → BASELINE

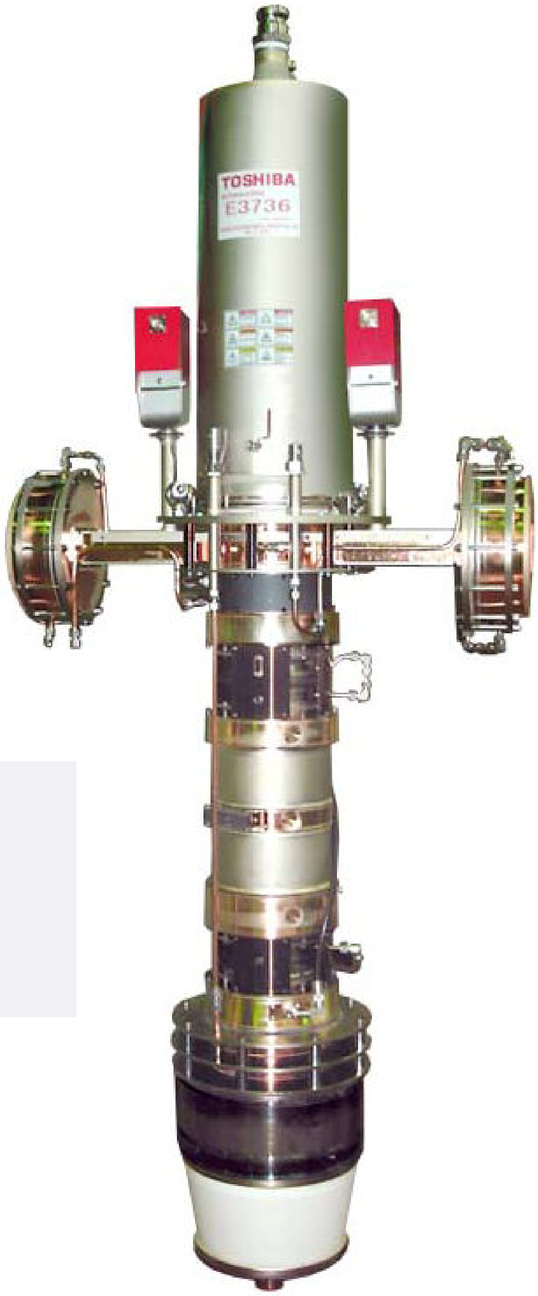
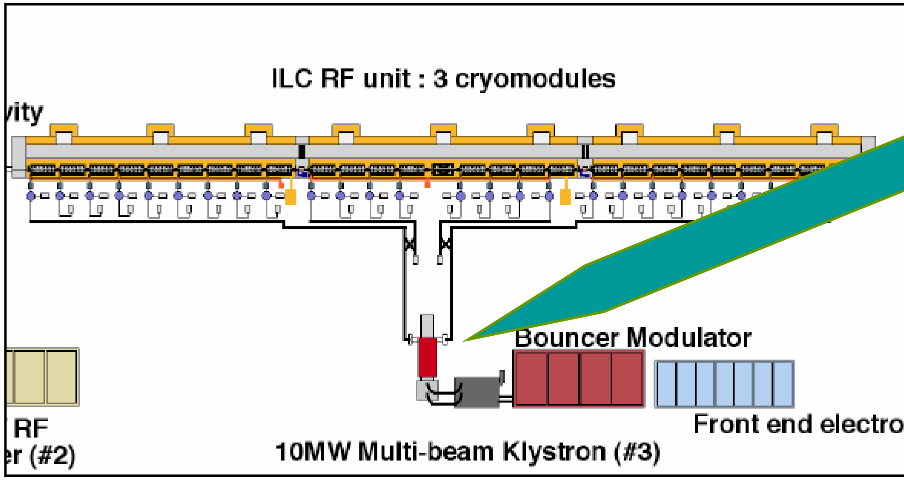
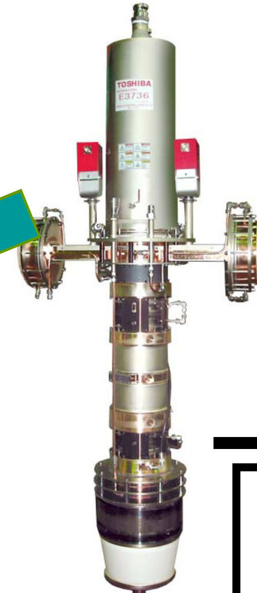


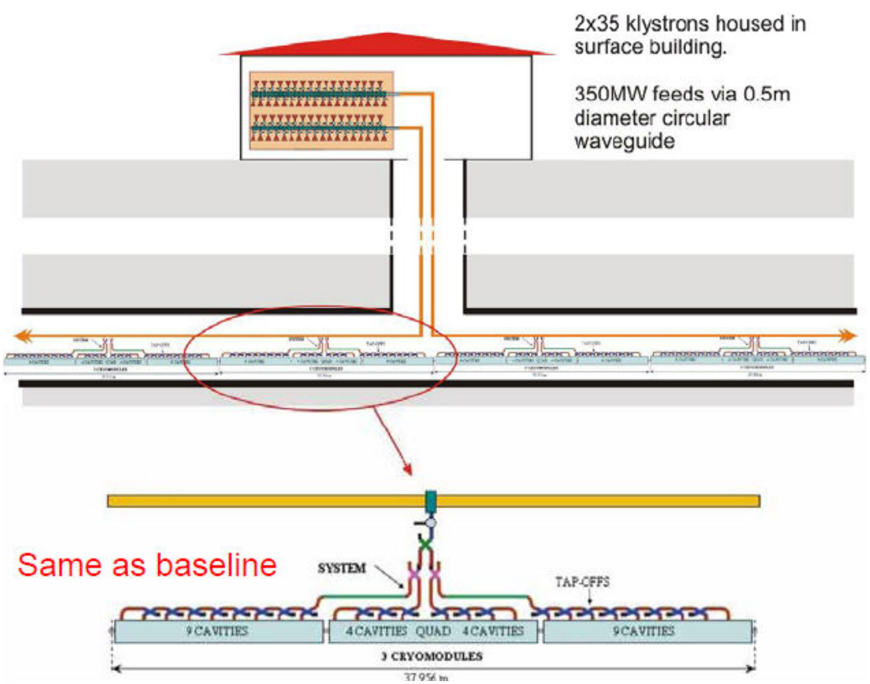
Figure 9: The E3736 KL





Basis:
2 tunnels

Cost Reduced RF Concepts



Surface Klystron Cluster (Adolphsen, Nantista, SLAC; Kazakov, KEK)

Both options aimed at single-tunnel solutions

Also: Distributed RF Source Concept (Fukuda, KEK; Kazakov, KEK)

CFS Value Engineering

The purpose of Dubna 06.2008 workshop

- The Dubna shallow site:
  - **subsurface ‘communication building’ cost 1/10 bored tunnel**
  - **RDR WBS input from GSPI (ГСПИ)**
- Next step:
  - **Joint Development of Dubna site:**
    - To be discussed and reported
  - **How to take best advantage of special features…**

Civil works: RDR strategy

- ‘Sample sites’ – key aspect
  - **Allow detailed design development**
- Sample sites restricted to deep rock sites
  - **Only very preliminary investigation of shallow sites**
- Deep sites are less affected by surface conditions
- Surface details make understanding of shallow site more complex
  - **More complex, but also more accessible**
  - **Promise of substantially reduced cost**

Role of JINR – GSPI Study:

- The most advanced shallow site study underway
  - **All other site studies involve deep rock**
  - **A kind of 'neutral' process**
- Comparison between deep and shallow sites will indicate substantial cost savings
  - **By evaluating a specific shallow sample site we are able make effective comparisons**
  - **Allows us to prioritize and define further studies**

Goal for ILC-GDE / JINR-GSPI meeting

- Review GSPI Preliminary Report
- Discuss geo-technical aspects of TALDOM area
- Summarize in a jointly authored report
  - **Sponsored by:**
  - **ILC – GDE**
  - **JINR**
  - **GSPI**
  - **EC ‘ILC Hi-Grade’ FP7 programme**
  - **DESY**

Summary

- Shallow site studies are *very important* for the ILC – GDE Conventional Facilities Technical Design Phase
  - **Cost.**
  - **Comparison and evaluation will lead to cost savings and design improvements**
- JINR – GSPI is the *most extensive* shallow site study undertaken in support of the ILC – GDE Reference Design
  - **No other specific shallow site study is presently planned**

Summary

- Site studies will facilitate the site selection process
- JINR effort is unique and will prove very useful in this complex task
  - **Preparation of joint report comes at a critical time: 2009 will see a recommendation to update the GDE Reference Design**
- *On behalf of the ILC Project Managers, We thank you very much and strongly encourage further collaborative efforts*