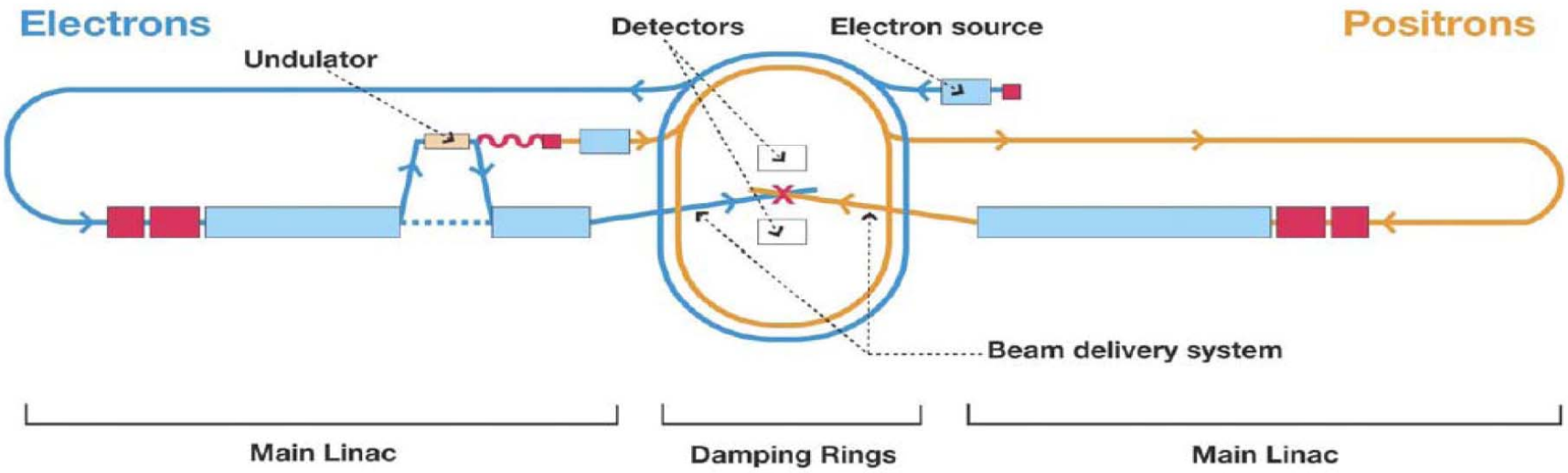
ILC – Superconducting Linear Collider

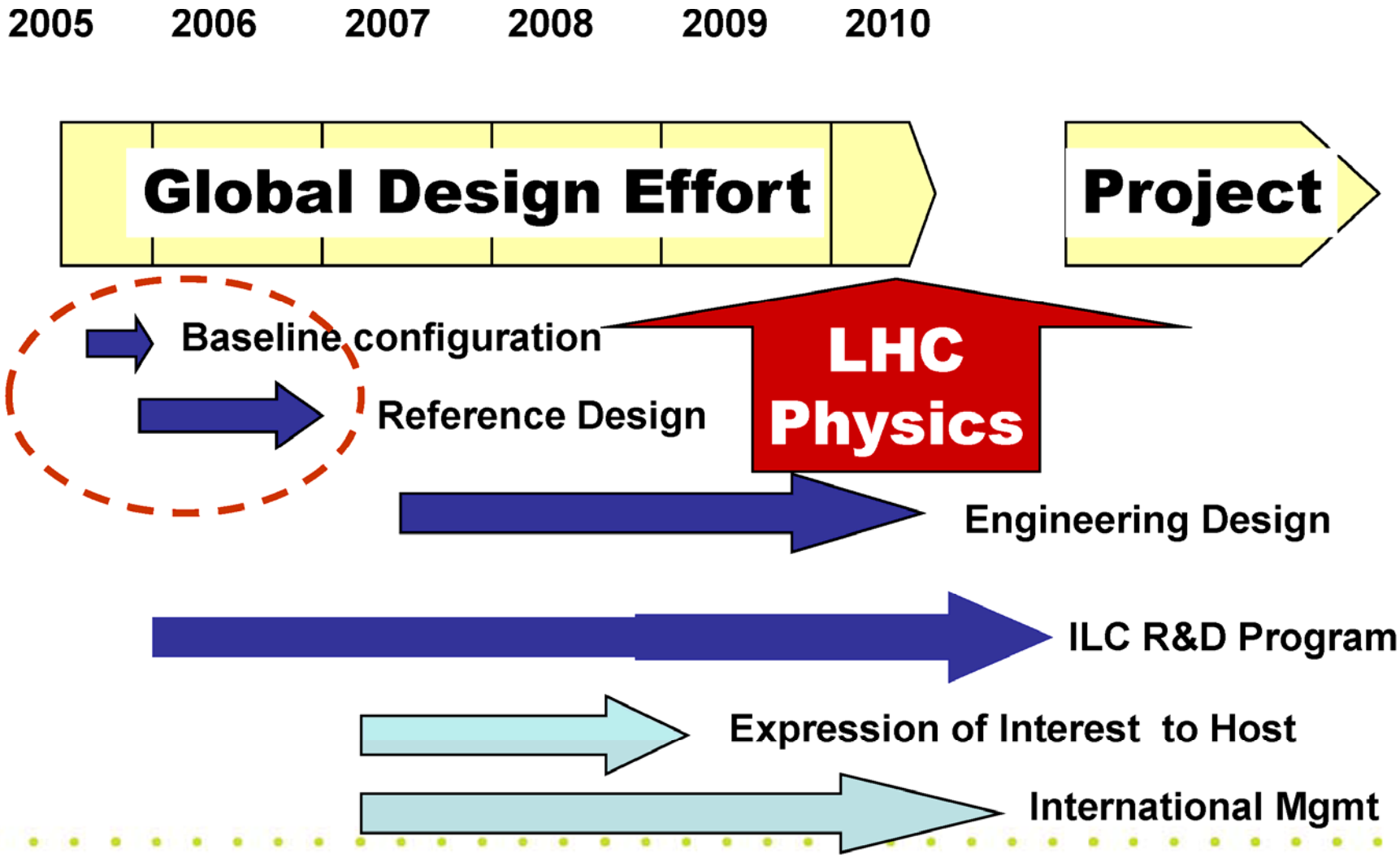
Marc Ross, Project Manager

GDE

Fermilab


Electrons
Undulator
Detectors
Electron source
Positrons
Beam delivery system
Main Linac
Damping Rings
Main Linac

The GDE Plan and Schedule



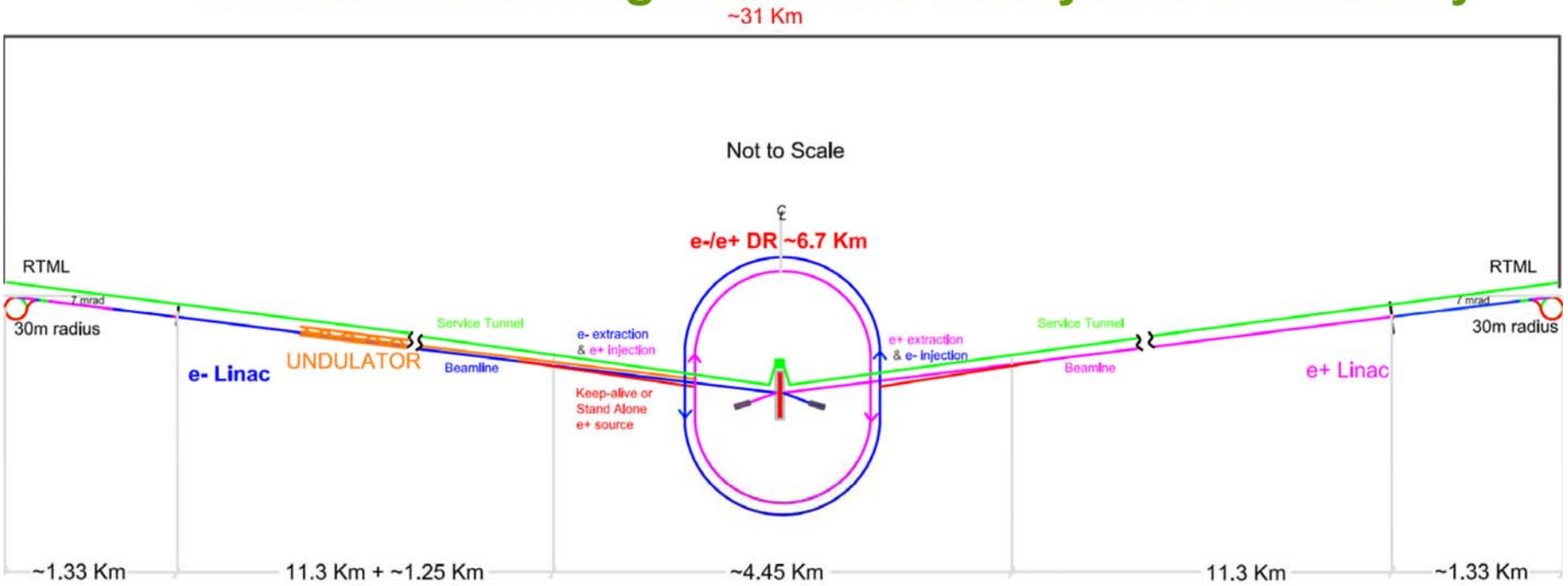
Parameters for the ILC

- E_{cm} adjustable from 200 – 500 GeV
- Luminosity → $\int L dt$ = 500 fb^{-1} in 4 years
- Ability to scan between 200 and 500 GeV
- Energy stability and precision below 0.1%
- Electron polarization of at least 80%

- The machine must be upgradeable to 1 TeV

RDR ILC Schematic

- **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**



RDR Design Parameters

Max. Center-of-mass energy	500	GeV
Peak Luminosity	~2×10^{34}	$1/cm^2 s$
Beam Current	9.0	mA
Repetition rate	5	Hz
Average accelerating gradient	31.5	MV/m
Beam pulse length	0.95	ms
Total Site Length	31	km
Total AC Power Consumption	~230	MW

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 extensively

- 3 day "internal review" in Dec
- ILCSC MAC review in Jan
- International cost review in Spring

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

+

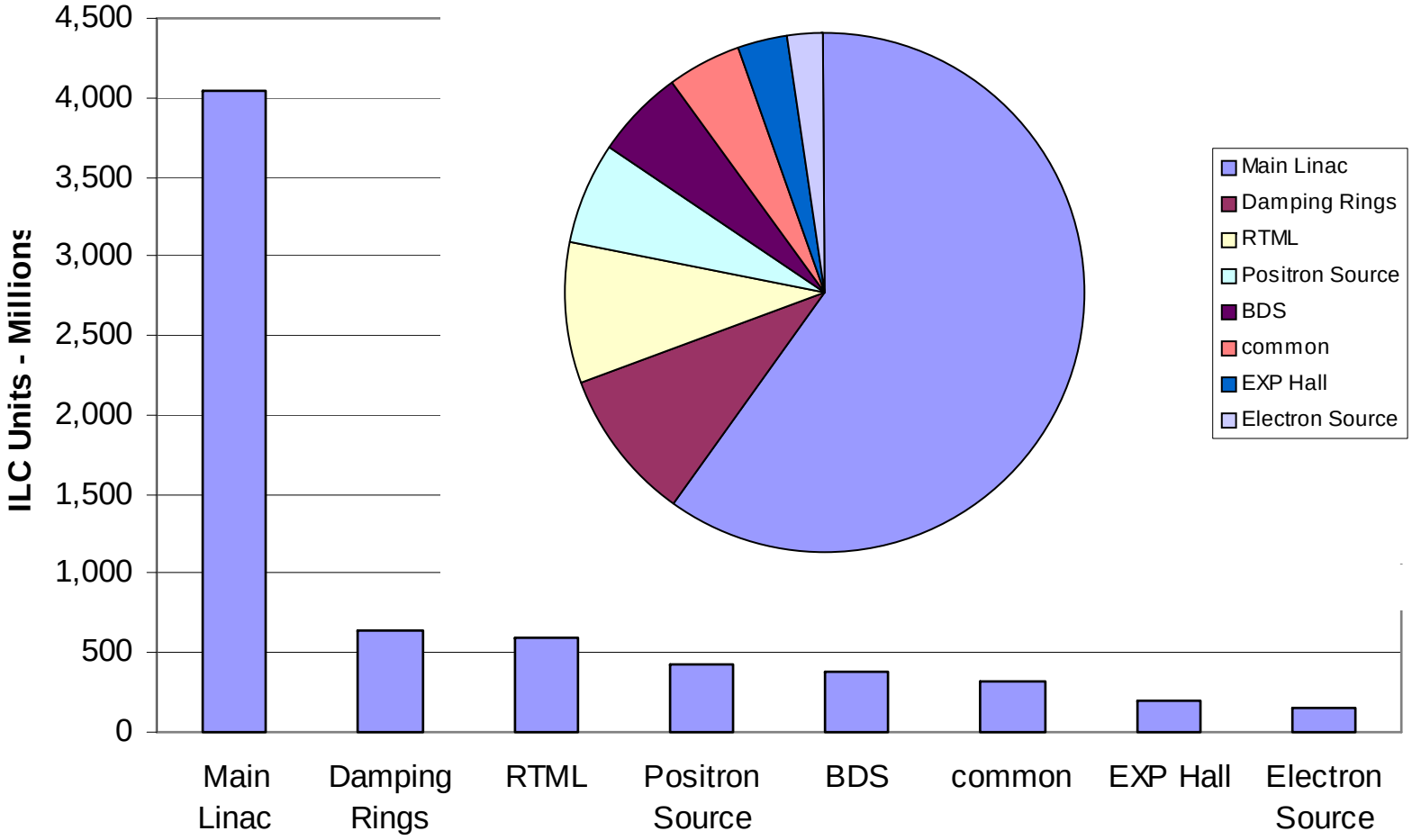
14.1 K person-years

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

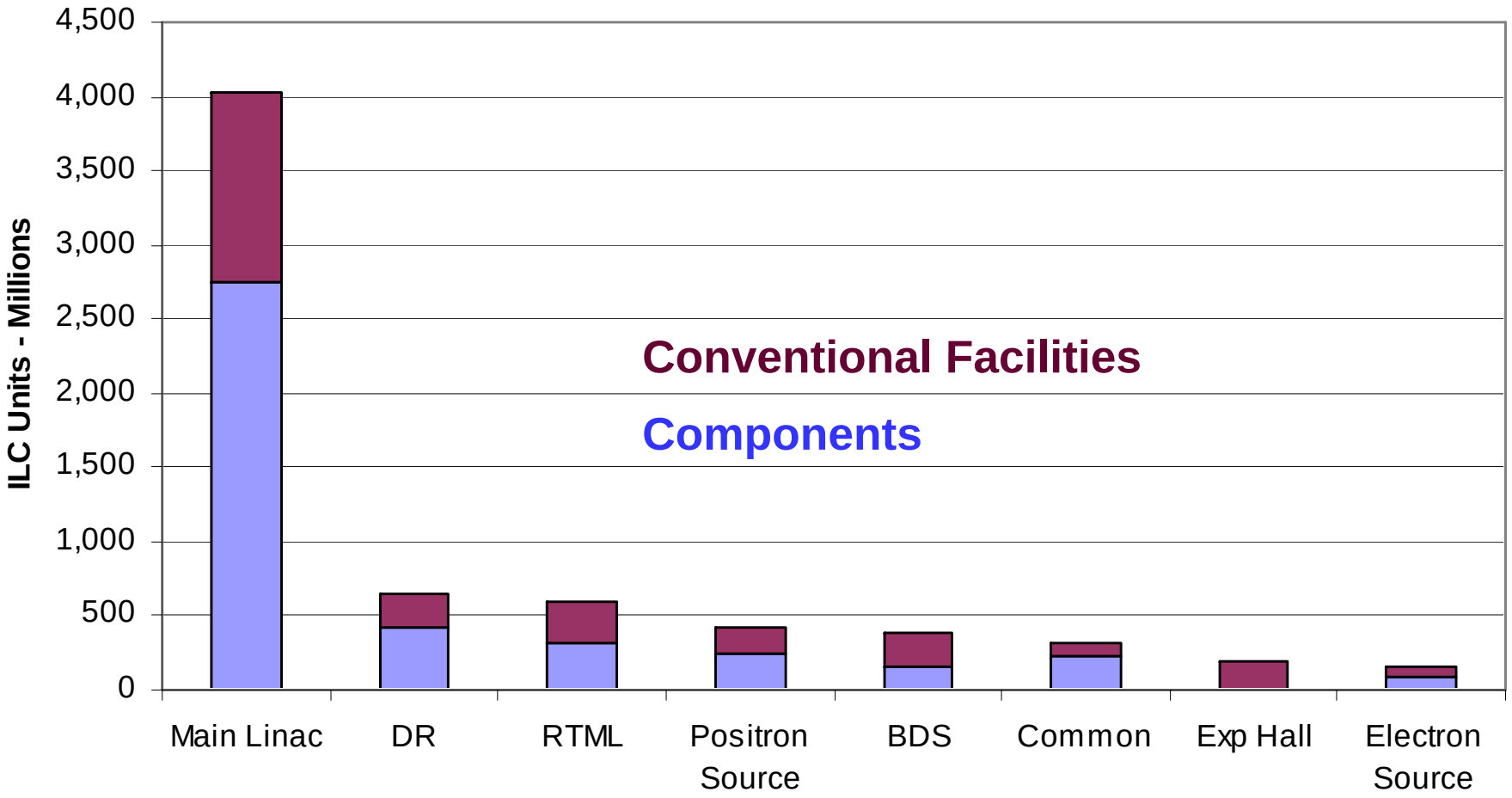
1 ILC Unit = $ 1 (2007)

ILC Value – by Area Systems

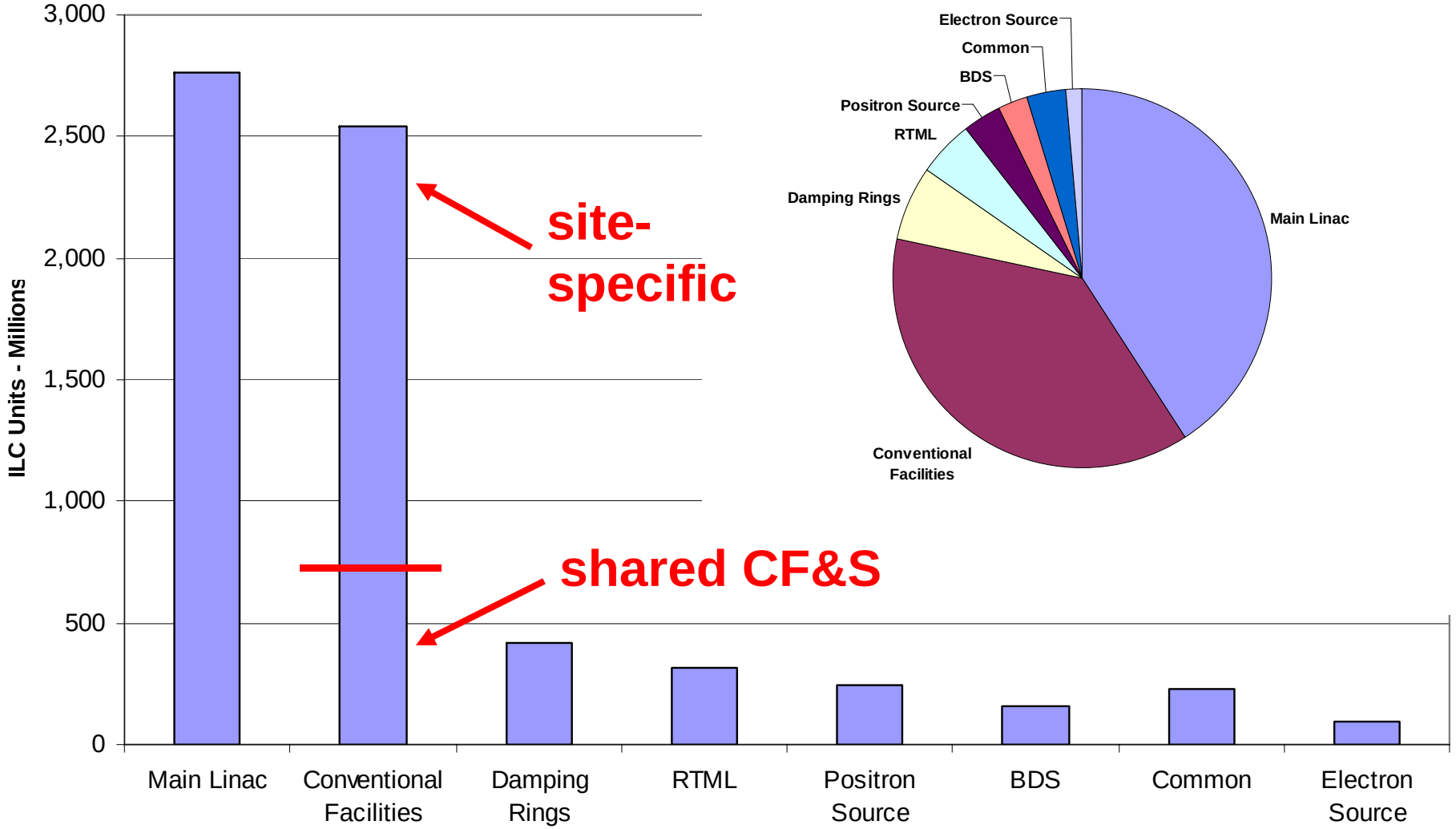
- **includes CF&S in each AS total**



ILC Value – by Area Systems



Value – CF&S + AS (non-CF&S)



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

Rdr power parameters / water

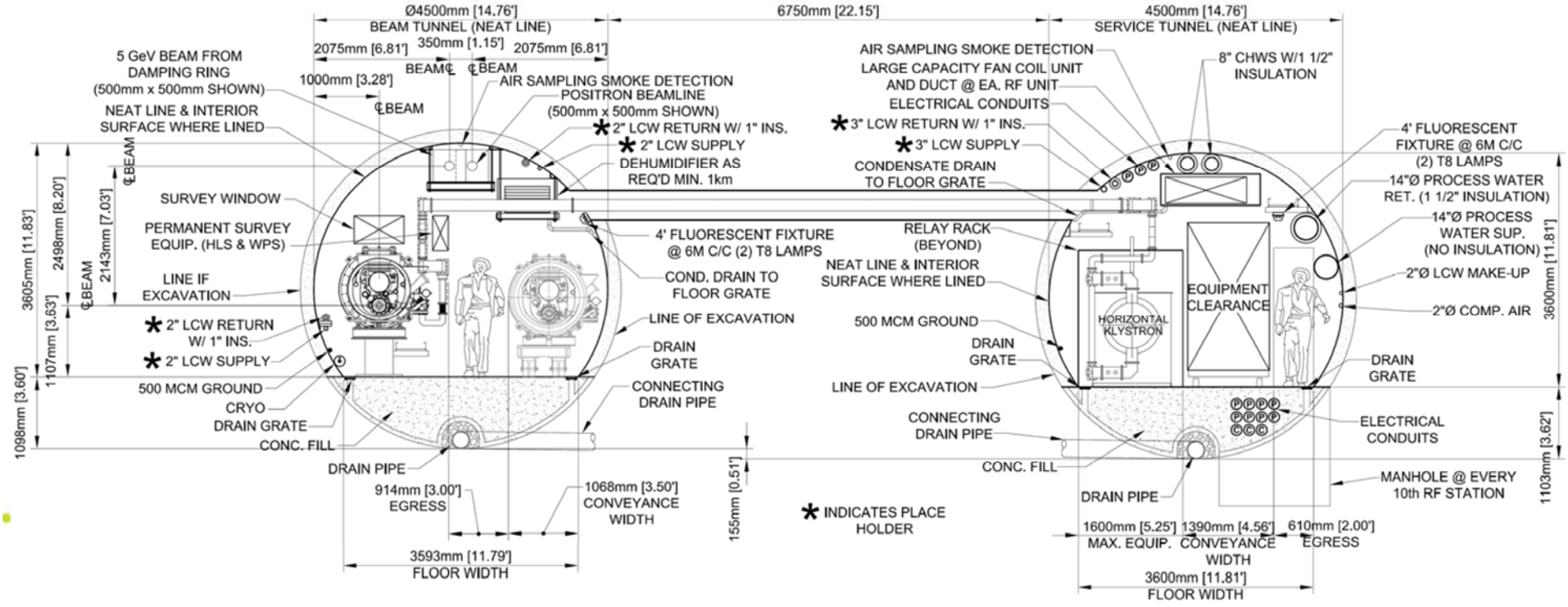
- power / water handling scheme is an indicator of design maturity
- Beam power at IP → 10.8 + 10.8 MW
  - **15 % efficient**
  - **10% cooling overhead (100W to remove heat from 1 KW load)**
- Good performance figures – but more to do
  - **TESLA design (2001): ~ 80 MW lower for same luminosity**

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

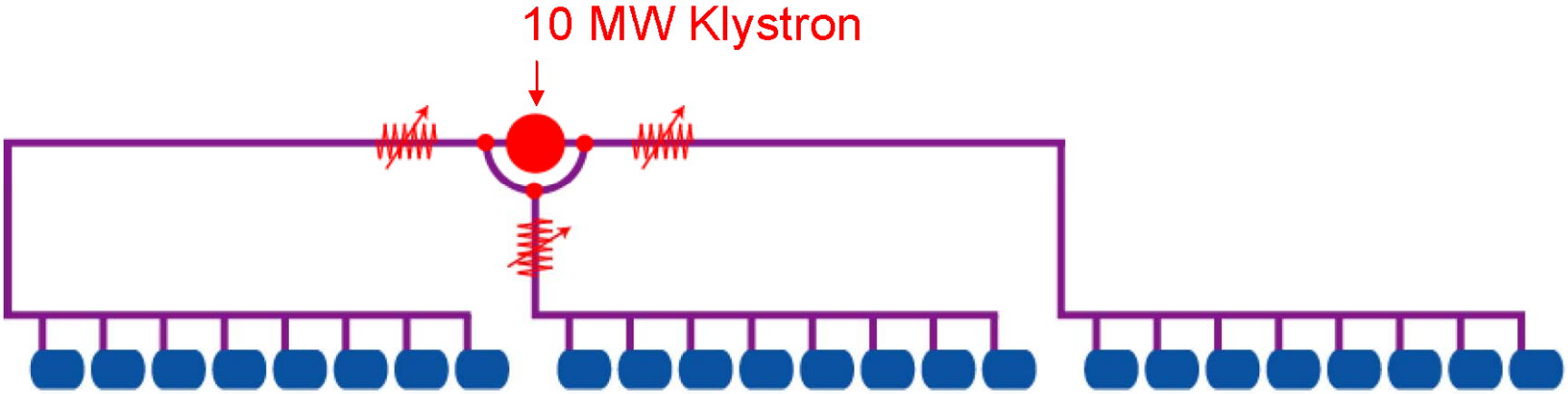
AREA SYSTEM	RF	CONV	NC MAGNETS	WATER SYSTEMS	CRYO	EMER	TOTAL (by area)
SOURCES e-	1.05	1.19	0.57	1.27	0.46	0.06	4.59
SOURCES e+	4.11	7.32	6.52	1.27	0.46	0.21	19.89
DR	14.0	1.71	6.78	0.66	1.76	0.23	25.15
RTML	7.14	3.78	2.84	1.34	0.0	0.15	15.24
MAIN LINAC	75.72	13.54	1.41	9.86	33.0	0.4	134.84
BDS	0.0	1.11	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

Main Linac Tunnels

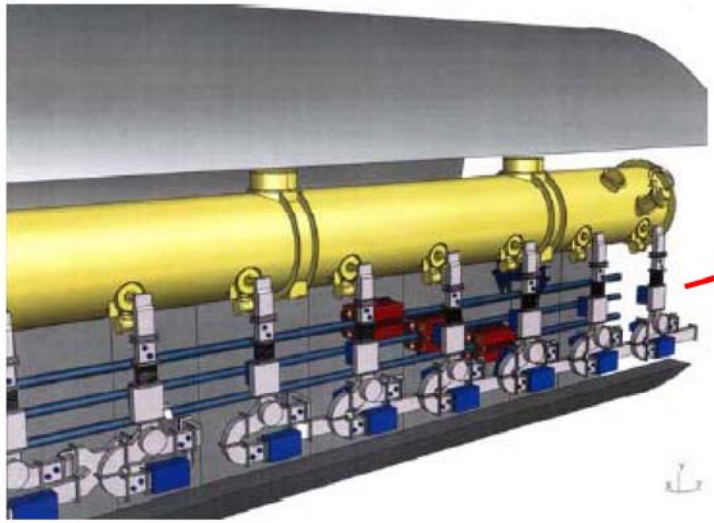
- Design based on two 4.5m tunnels
  - **Active components in service tunnel for access**
  - **Includes return lines for BC and sources**
  - **Sized to allow for passage during installation**
  - **Personnel cross-over every 500 meters**

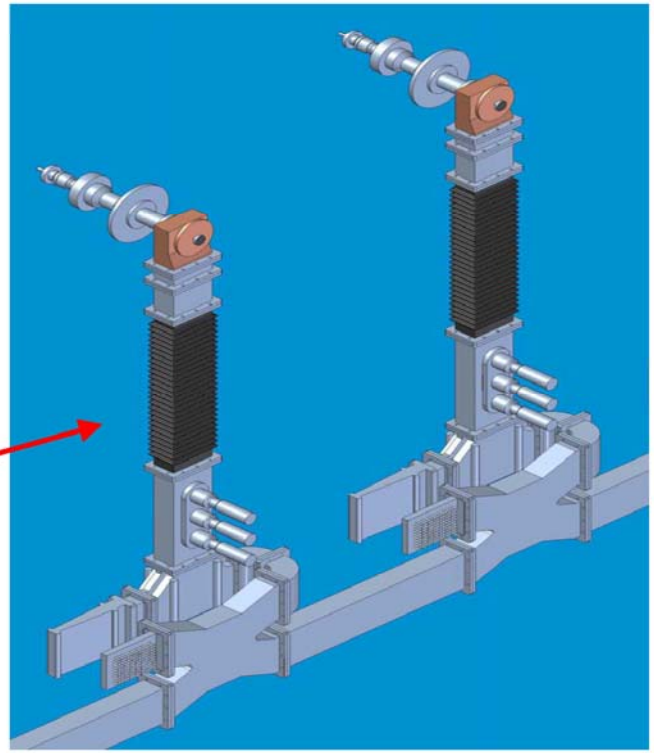


Tunnel function: RF power



Two of ~ 16,000 Feeds





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
AMERICA	TOTAL COST=	$2,540,439	CIVIL ONLY=	$1,648,052
EUROPE	TOTAL COST=	$2,493,066	CIVIL ONLY=	$1,608,407

Yen to US $	0.0085714
Euro to US $	1.2
Euro to Yen	140
US to Yen	116.7

SCRF linac – basic building block

Figure 1.2-1: A TESLA nine-cell 1.3 GHz superconducting niobium cavity.

- ~ 70 parts electron-beam welded at high vacuum
  - **mostly stamped 3mm thick sheet metal**
- pure niobium and niobium/titanium alloy
  - **niobium cost similar to silver**
- weight ~ 70 lbs
- 6 flanges