ILC EDR Kick-off Meeting

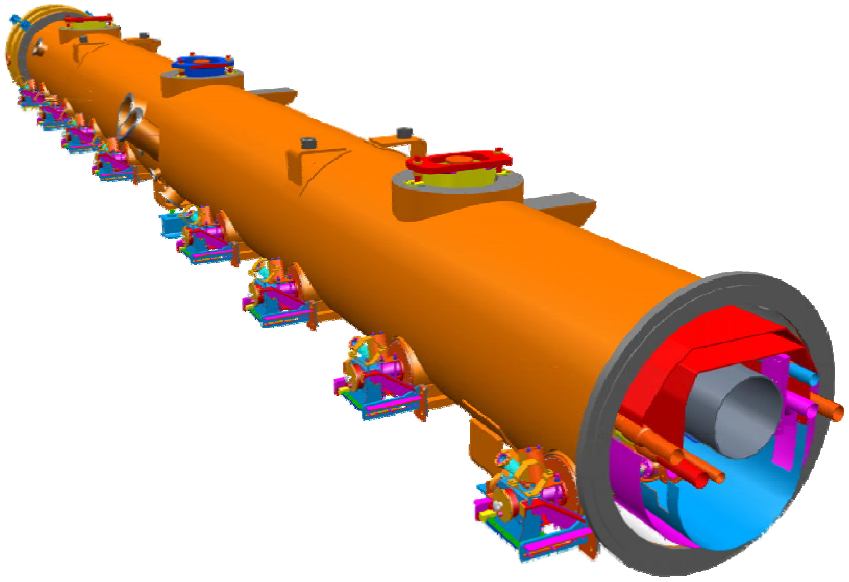
DESY, 19-21 September 2007

ILC and XFEL Cryomodules

Carlo Pagani
University of Milano
INFN Milano-LASA & GDE

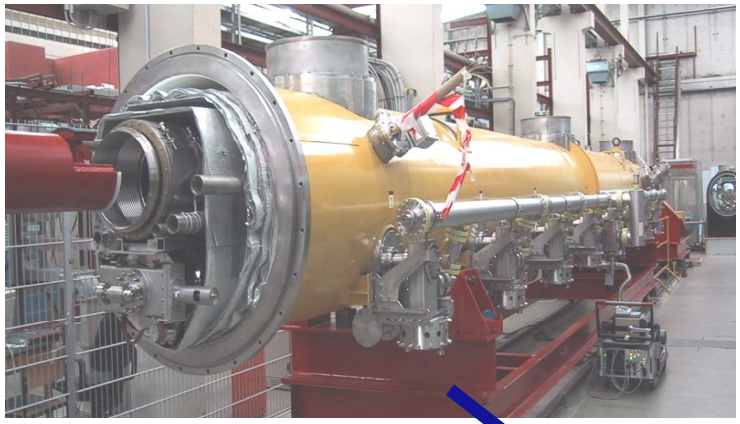
Cryomodules

TESLA cryomodule

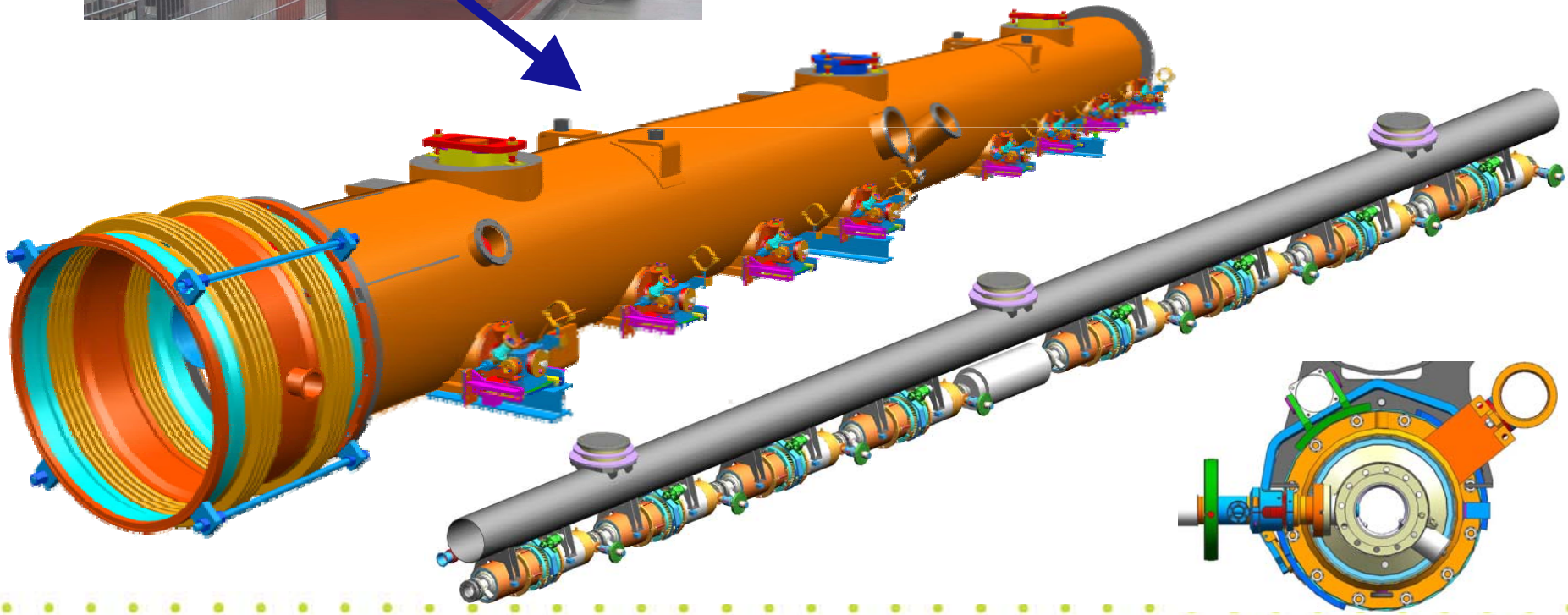


4th generation prototype ILC cryomodule

From Type 3 to the ILC Cryomodule



- International collaborative Effort in the three regions
- Design changes are towards nailing down slot length of components
  - Costing should be straight-forward from TTF (and possibly XFEL) experience

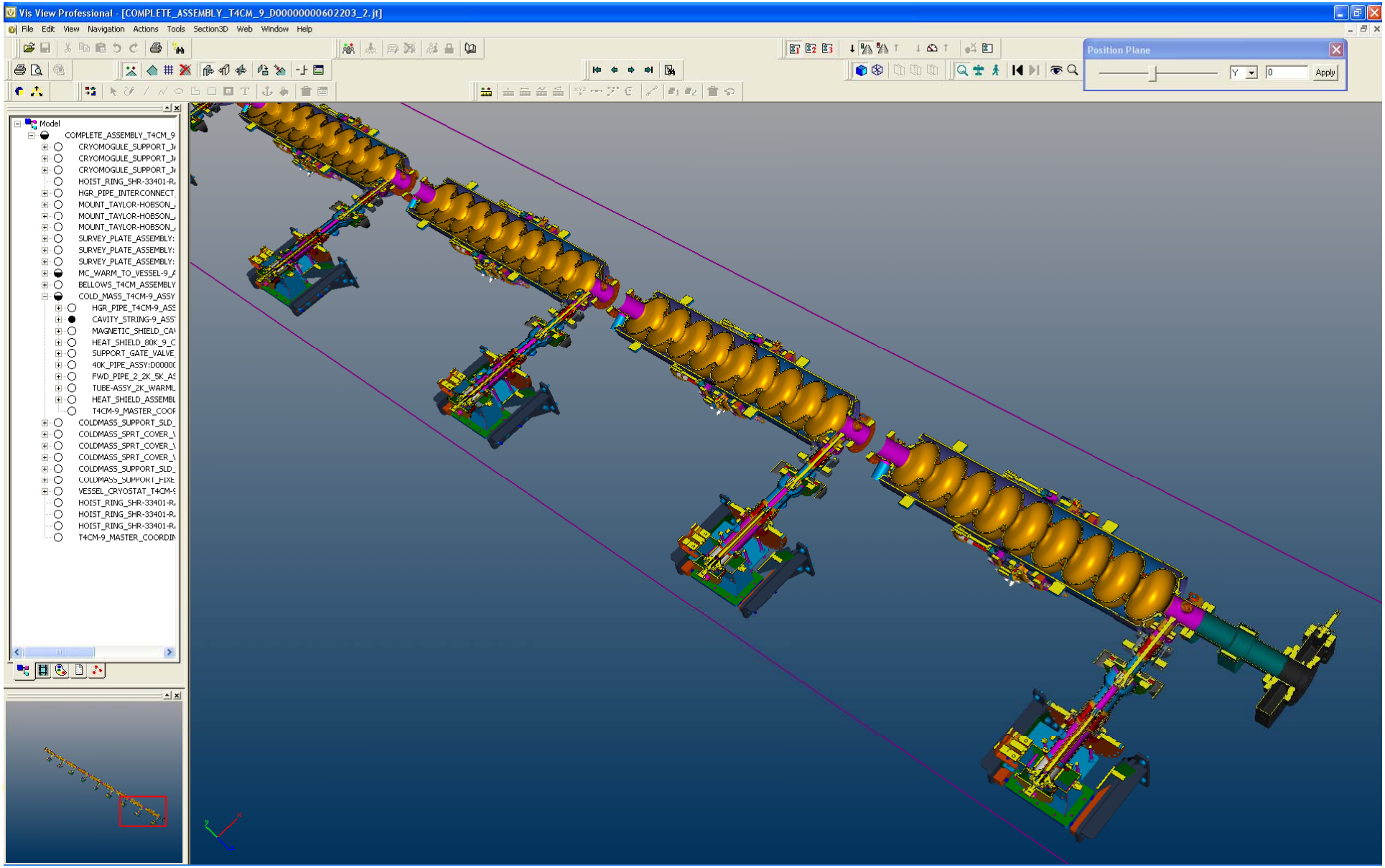


The Main Linac

Subdivision	Length (m)	Number
Cavities (9 cells + ends)	1.326	14,560
Cryomodule (9 cavities or 8 cavities + quad)	12.652	1,680
RF unit (3 cryomodules)	37.956	560
Cryo-string of 4 RF units (3 RF units)	154.3 (116.4)	71 (6)
Cryogenic unit with 10 to 16 strings	1,546 to 2,472	10
Electron (positron) linac	10,917 (10,770)	1 (1)

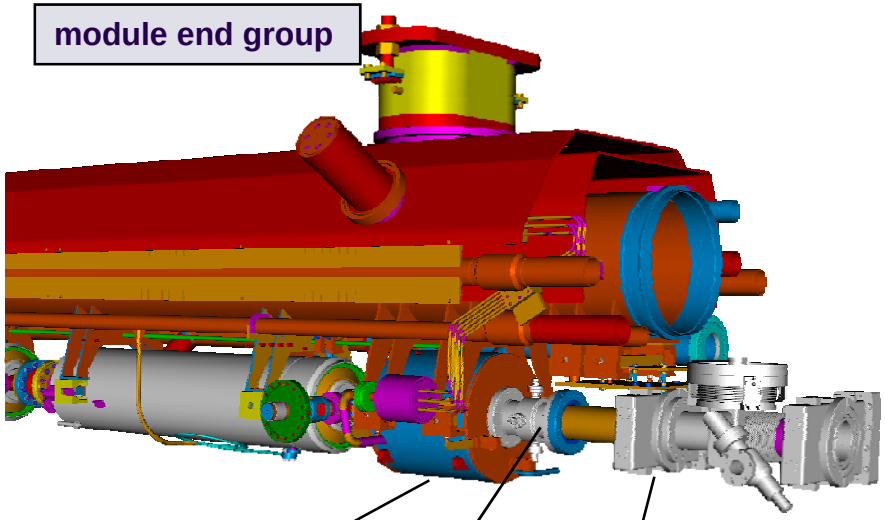
- Costs have been estimated regionally and can be compared.
  - **Understanding differences require detail comparisons – industrial experience, differences in design or technical specifications, labor rates, assumptions regarding quantity discounts, etc.**

From the ILC Cryomodule drawings

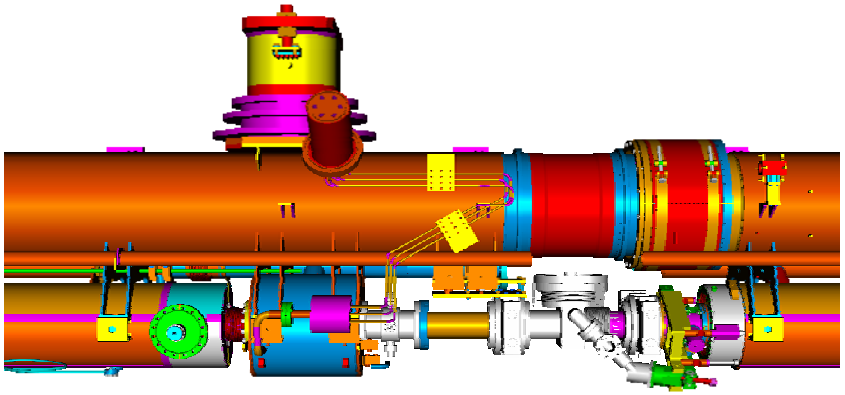


XFEL Accelerator Cryomodule

module end group



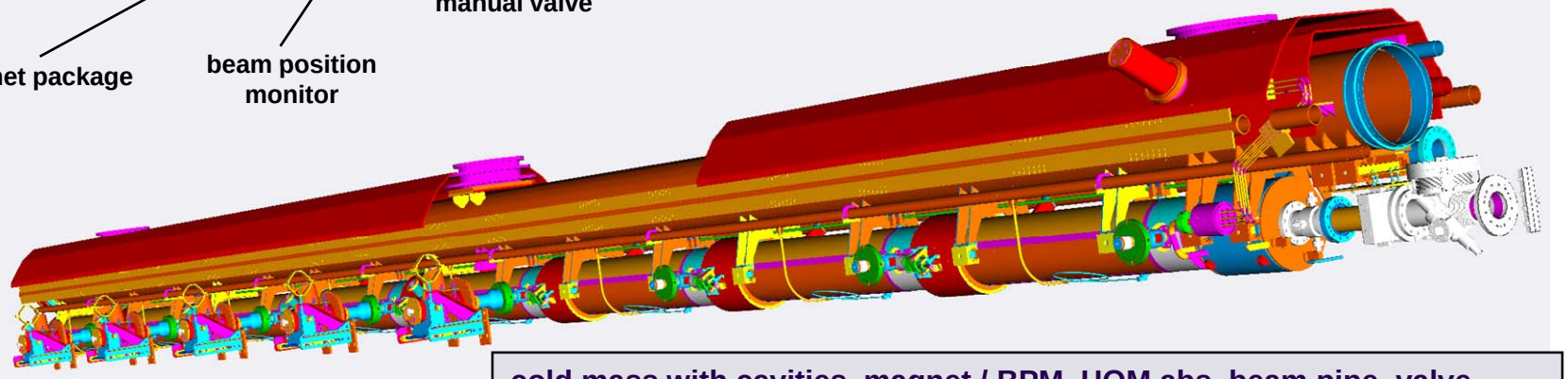
module to module connection



magnet package

beam position monitor

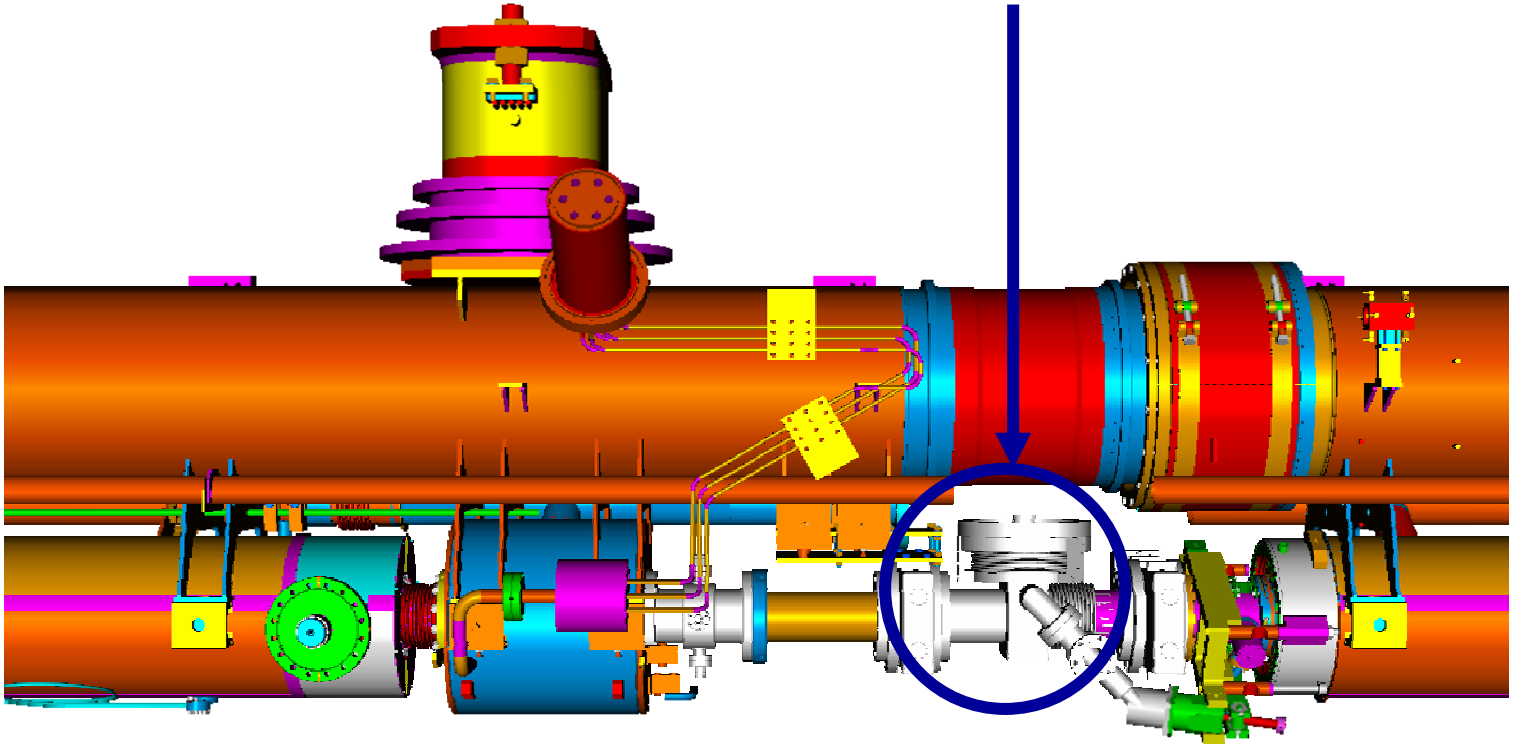
manual valve



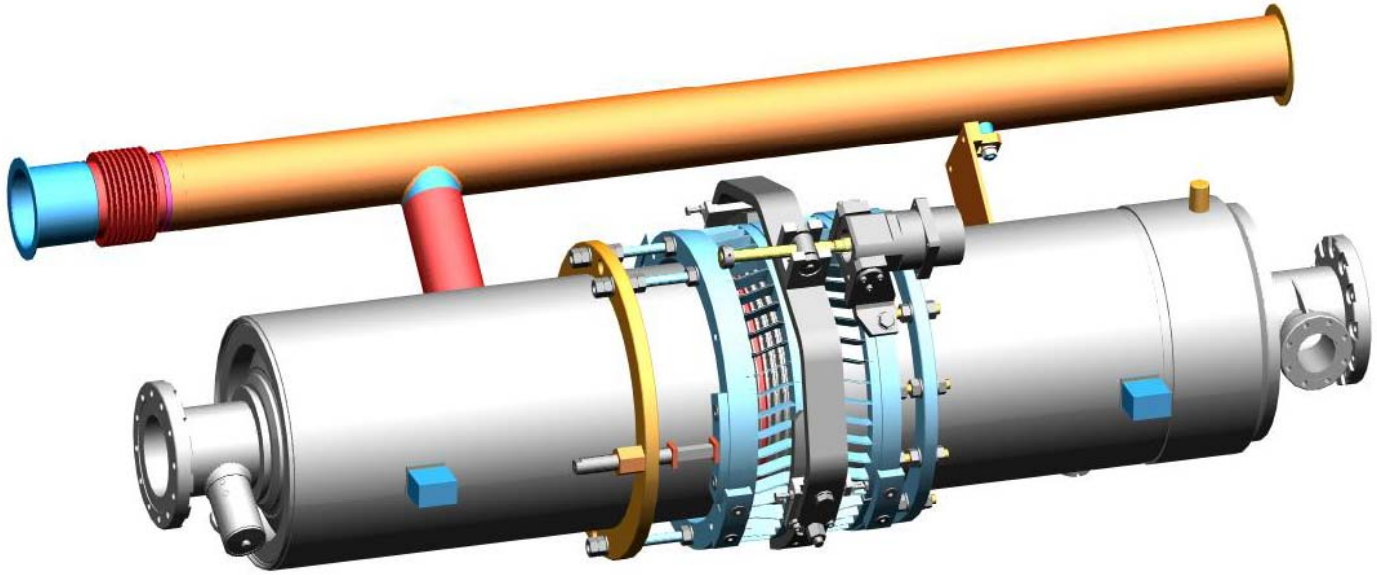
cold mass with cavities, magnet / BPM, HOM abs. beam pipe, valve

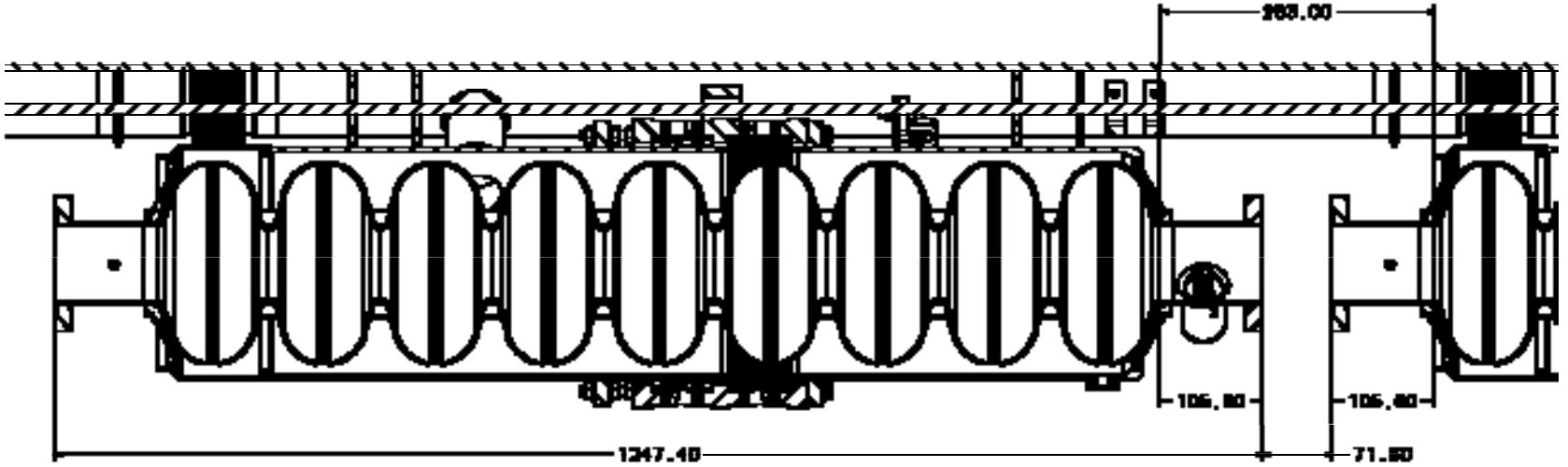
HF HOM Coupler for the XFEL

In the XFEL the HOM Couplers for frequencies above cut-off are placed at each module interconnection. The power extracted from the beam is dissipated at the 40-70 K level.



Actual ILC Baseline Cavity





Present XFEL/ILC Differences

- Cavity distance and Quadrupole length:
  - Just "2 parameters" in the 3 D model
- Quadrupole position:
  - In the XFEL is maintained because of the required effort.
- Number of cavities per module:
  - XFEL maintains 8, ILC has 9+8+9 in one cryounit
  - ILC numbers could be reviewed if beneficial ?
- Cavity ancillaries:
  - Couplers: same baseline
  - Tuner: 2 alternatives on baseline. It could easily converge
  - Magnetic shield: tuner dependent
- Module ancillaries:
  - vacuum, beam pipe HOM, BPM, diagnostics: they could converge easily at least in term of interfaces.

TDR Industrial Study, Nov. 2000

Production of 2,500, 12 m long, Cold Masses - All costs in €

Total Cost for 2500 Cryostats [EURO]			
Description		Prefabrication Activities	Tooling
MATERIAL	49,807,521	50,739,921	
CRYO-SUPPORTS		3,566,780	77,469
VACUUM VESSEL		37,296,258	1,510,636
GHeRP		15,790,670	511,292
SHIELDS 4,5°K		9,677,111	165,266
SHIELDS 70°K		9,677,111	165,266
CRYO PIPES		2,218,505	72,304
COLD-MASS		4,389,884	92,962
Total	**49,807,521**	**133,356,240**	**2,595,196**

Description		Cost
Management	5% activities	9,287,948
Untermediate transports	0,5% prefabb.	666,781
Final Transports	1 lorry for 2 sists	1,613,928

Gran total	**197,327,614**

TDR Industrial Study, Nov. 2000

Production of 2,500, 12 m long, Cold Masses - All costs in €

Total Cost for 2500 Cryostats [EURO]					Cost/Cryoostat
Description	**Materials**	**Fabrication**	**Tooling**	**Total**	
CONSUMABLES	2,743,677			2,743,677	1,097
CRYO-SUPPORTS	4,680,802	8,604,172	77,469	13,362,442	5,345
VACUUM VESSEL	15,726,527	63,618,000	1,510,636	80,855,164	32,342
GHeRP	12,113,998	33,250,883	511,292	45,876,174	18,350
SHIELDS 4,5°K	5,196,910	10,481,009	165,266	15,843,185	6,337
SHIELDS 70°K	5,196,910	10,481,009	165,266	15,843,185	6,337
CRYO PIPES	4,148,696	2,531,284	72,304	6,752,284	2,701
COLD-MASS Pre-assemby		4,389,884	92,962	4,482,846	1,793
Total	**49,807,521**	**133,356,240**	**2,595,196**	**185,758,957**	**74,304**

Description		Cost	
Managment	5% attivities	9,287,948	3,715
Intermediate Transport	0,5% prefabb.	666,781	267
Final Trasports	1 lorry for 2 systs	1,613,928	646
Gran total		**197,327,614**	**78,931**

General Comments

- The study is complete and well done. **But, year 2000 costs**
- Costs are consistent with the logarithmic extrapolation law.
- Minor (few per cent) cost reduction is expected using long modules.
  - Less cryo-supports and pipes.
  - Higher machining cost because of size.
  - Equal pre-assembling cost.
- A small margin exists through a further production optimization.
- Cost distribution is homogeneous: no expensive components.

ILC extrapolation to 2007 cost has been confirmed

- Material cost increase from the market prices
- Labor cost increase from official tables

XFEL extrapolation valid but penalized by the smaller quantity

Cryomodule Assembly Studies - 1

ACCEL

ACCEL Cryomodule Assembly Study I

S. Bauer, B. Griep, M. Pekeler, H. Vogel, J. Zeutschel
ACCEL Instruments GmbH
Friedrich-Ebert-Str. 1
51429 Bergisch Gladbach

TTC meeting at FNAL, April 23-26, 2007

TTC meeting at FNAL, April 23-26, 2007

Cryomodule Assembly Studies - 1

BILFINGER BERGER Power Services

BABCOCK NOELL

Industry Study on the Series Production of XFEL Cryomodules

C.Boffo, W. Gärtner, S. Sattler, G. Sikler, U.-M. Tai

Cryomodule Transportation Study

- Very complete and detailed study performed by Babcock Noell / DESY on Complete Module transportation issues
- Critical points have been detected
- Reasonable cures have been proposed that look sufficient for a save transportation

- Next steps are:
  - careful reviewing of the document delivered
  - definition of a set of tests required for qualification
  - final qualification tests on a module prototype

Final Considerations - 1

- The present XFEL cryomodule is very close to the present ILC baseline design. Both are derived by the TTF Type III.
- A part from few parametric details (cavity distance and quadrupole length), the 2 modules could be set almost identical, or at lest compatible (consistent interfaces)
- A possible joint effort to reinforce convergence, if agreed upon by the two Project Managements, would have a number of unequivocal benefits, mainly for the ILC:
  - **Maintain a strong links between the two projects**
  - **Have XFEL as a large size ILC prototype**
  - **ILC cost saving by sharing the XFEL invaluable experience on**
    - industrialization and consequent cost saving
    - managing QA and QC with industry
    - effective cavity gradient and yield
    - reliability issues of major components
    - ……

About the XFEL Status

- External contributions for the Phase I formally promised
- The project, as European Project, started on June 5th 2007
- The XFEL ISC is acting as XFEL Council
- New major Countries are still subscribing and Phase II from the beginning looks possible.
- As the substantial part of the in-kind contributions from Italy and France, INFN and CEA look interested to jointly support DESY on the SC linac construction
- LAL Orsay confirmed its interest on Couplers
- Next Monday at the "XFEL In-Kind Review Board" a preliminary document, jointly prepared, will be presented by DESY with a possible distribution of tasks and responsibilities on the major machine components
- All agreement are expected to be signed, and shares distributed by the end of 2007.