WG2 & 5:

(highlights on cryo-modules)

Vittorio PARMA, AT-CRI

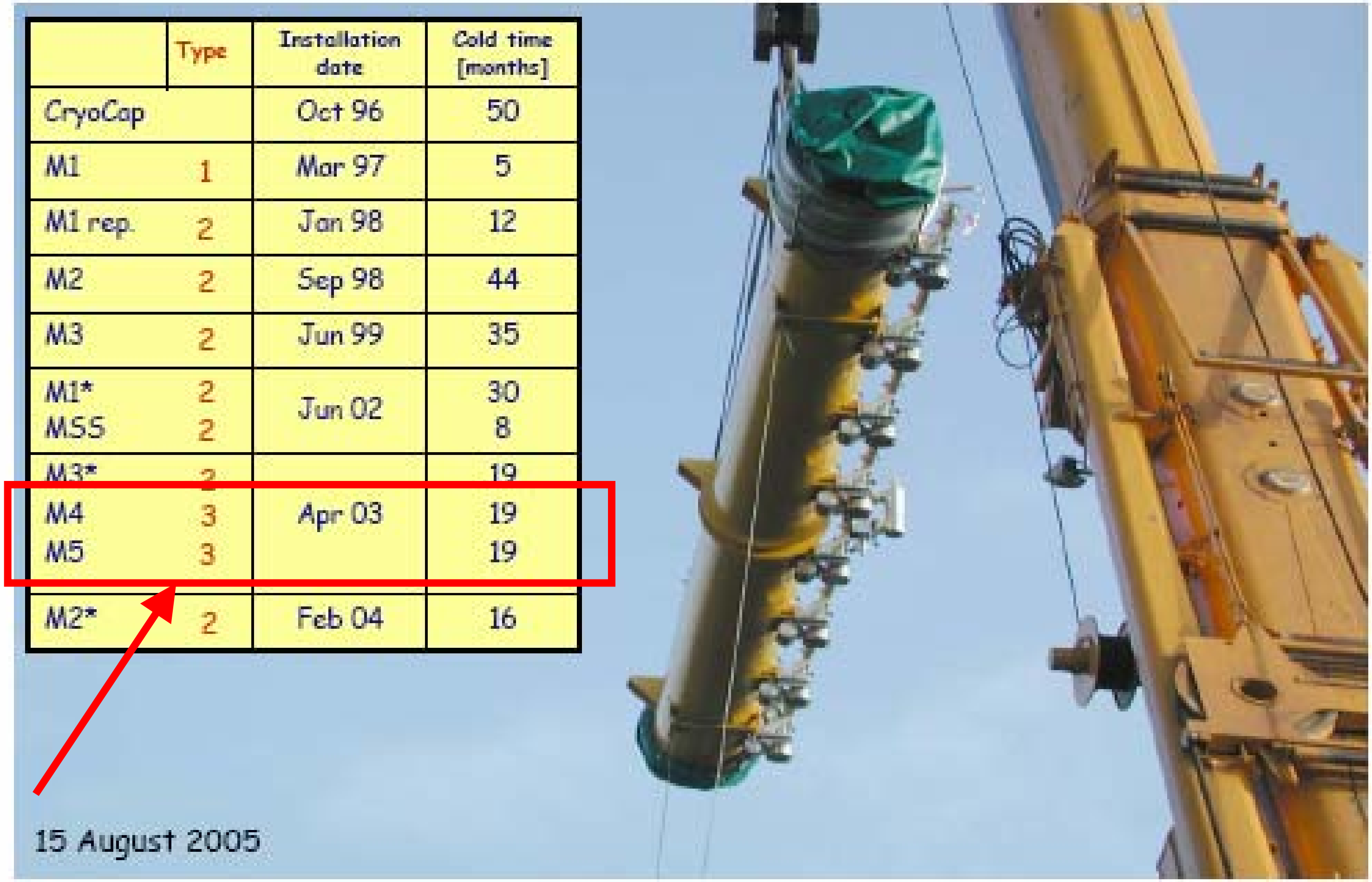
Cryo-module experience

- **TESLA & X-FEL at DESY**
  - Leading design/operation experience: ~ 10 years (ref. C.Pagani's talks)
  - 3 generations of cryostats (TTFI to III)
  - X-FEL: Industrial large-scale test for ILC
- **STF at KEK**:
  - Tesla-like (TTFIII) design
  - R&D cryostat → 2006

- **SMTF at FNAL** (under DOE funding)
  - Tesla-like (TTFIII) design
  - Very aggressive effort from FNAL for industrialisation:
    - Important infrastructure under construction (assy halls, clean rooms, cryo test bench…)
    - Cavity industrialisation effort
  - 2 ILC cryo-modules planned for 2006-2007
  - New generation cryo-module (Type IV) will be developed

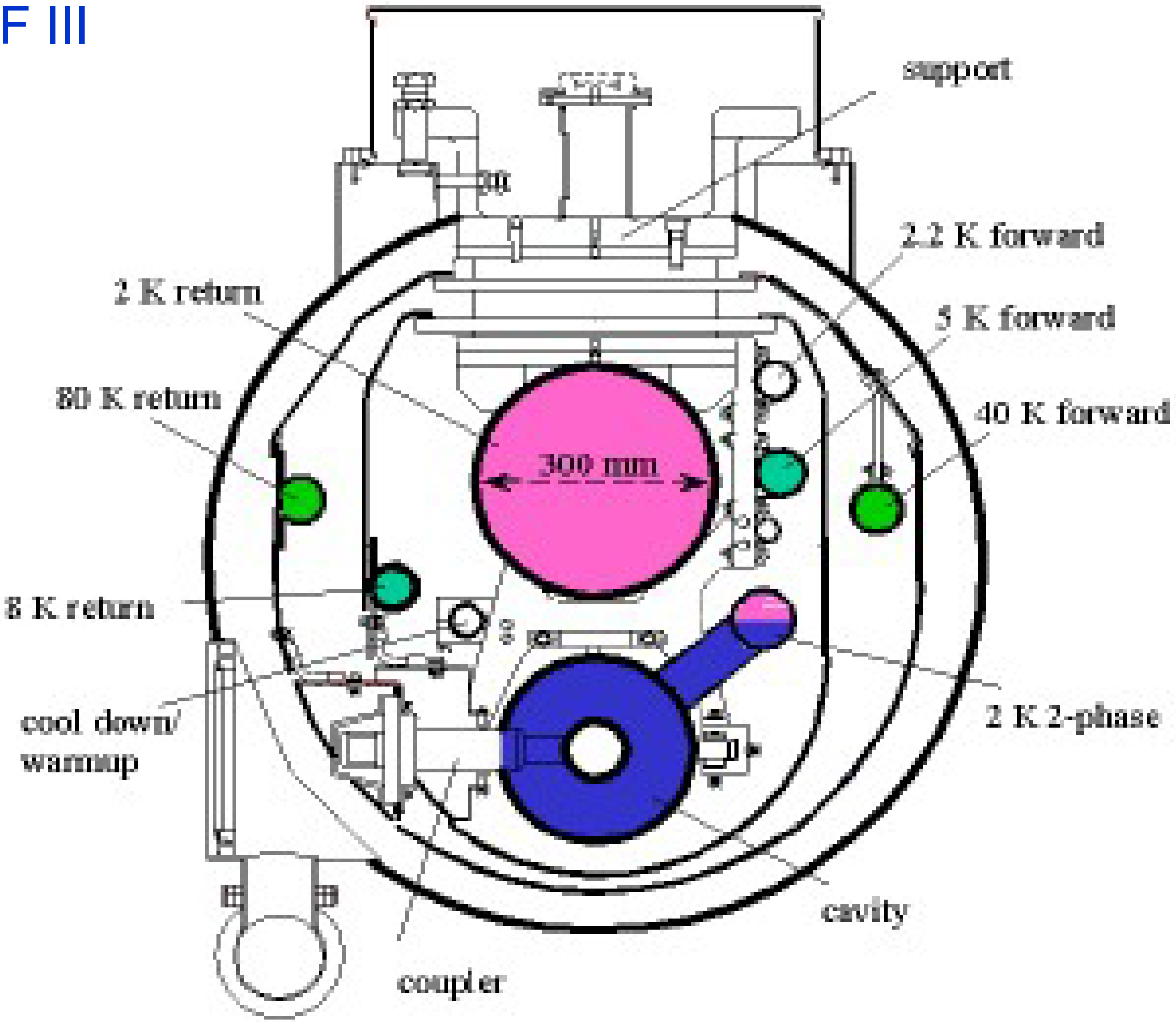
TESLA experience

Large Operation Experience in TTF

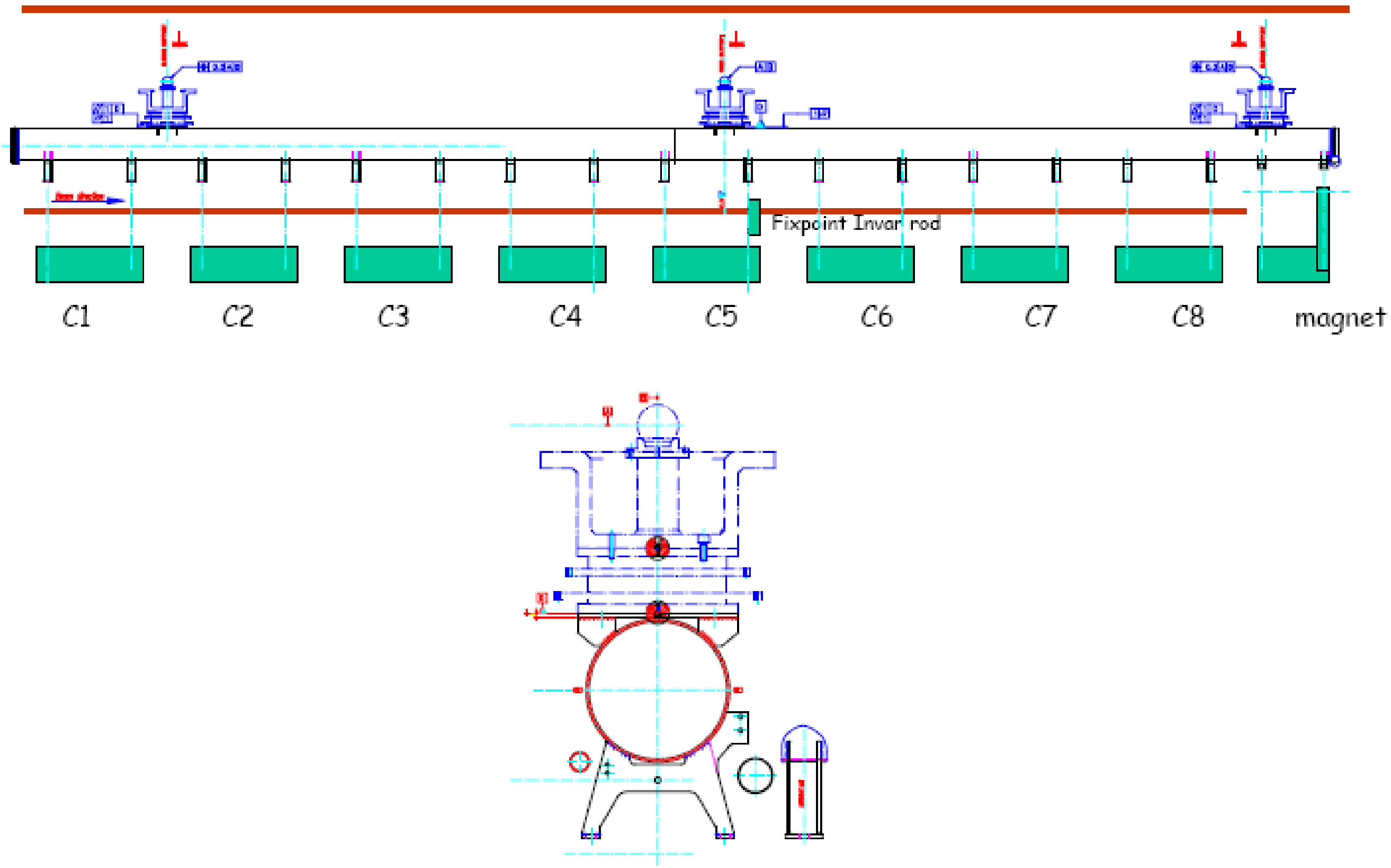


	Type	Installation date	Cold time [months]
CryoCap		Oct 96	50
M1	1	Mar 97	5
M1 rep.	2	Jan 98	12
M2	2	Sep 98	44
M3	2	Jun 99	35
M1*	2	Jun 02	30
MSS	2		8
M3*	2	Apr 03	19
M4	3		19
M5	3		19
M2*	2	Feb 04	16

TTF III


support
2.2 K forward
2 K return
5 K forward
80 K return
40 K forward
300 mm
8 K return
cool down/
warmup
2 K 2-phase
cavity
coupler

Helium GRP, Posts & Invar Rod



Main features underlined

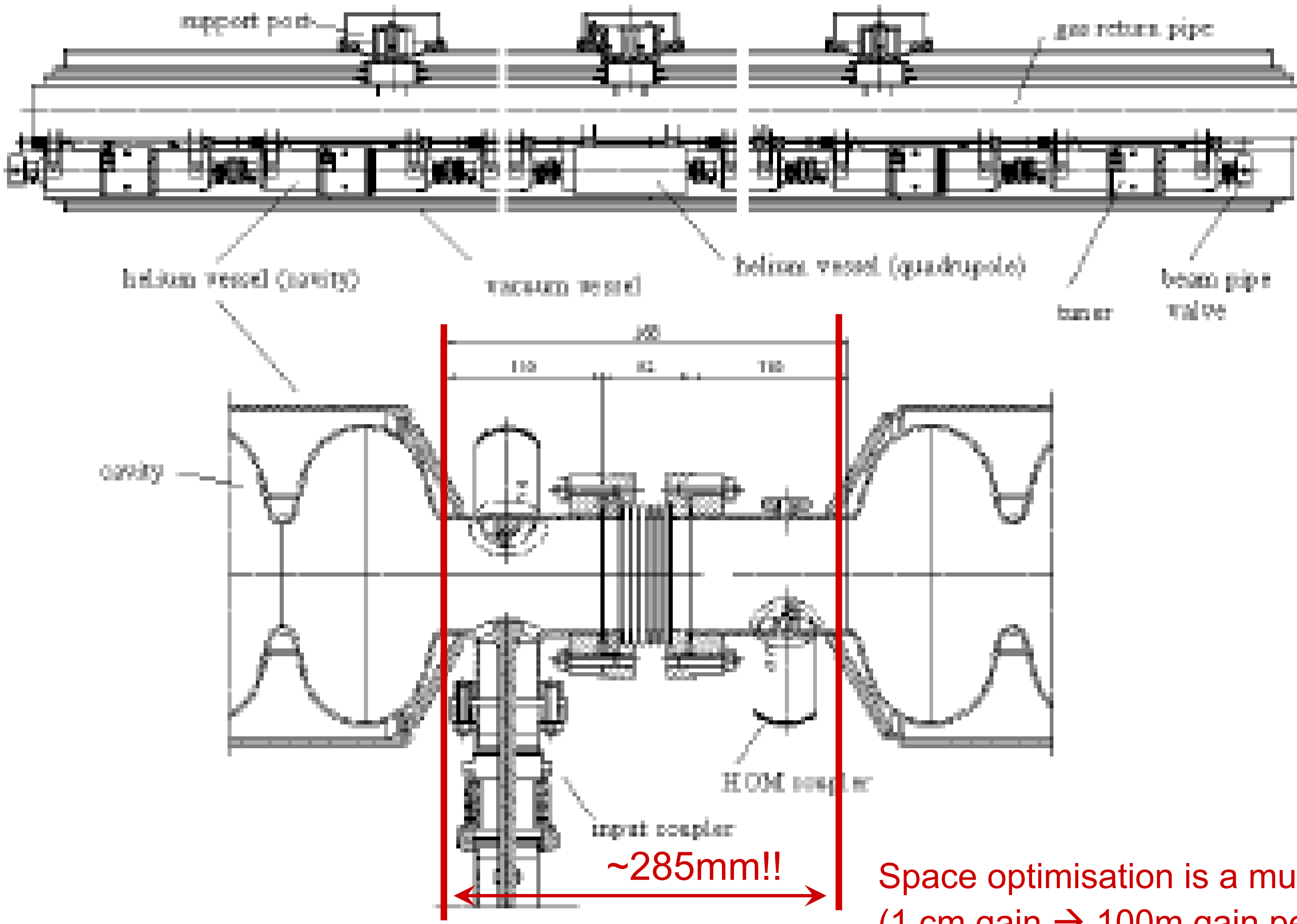
- **TTF III is a confirmed concept → BCD**
  - Low static heat loads
  - Simple & effective solutions (GRP as backbone, shields…)
  - Relaxed tolerance for industrial cost-effectiveness
  - Alignment requirements satisfied (± 300 μm)
  - Real estate gradient to be improved (components optimisation)
- **“To do list” from TTFIII to ILC:**
  - Review layout
    - Quads/BPM at center with movers for vertical adjustment
    - Review pipe sizes/positions (new cryo needs from higher gradients)
    - Consider/include movers for module centering according to HOM data
  - Review sub-components:
    - Materials, welds,
    - components engineering and optimisation
    - MLI system
    - …
  - Reduce inter-cavity space for improved real-estate gradient
  - QA and QC to be addressed (to increase MTBF)

→ Lots of engineering and industrialisation

From Type III to ILC

- Take TTF Type III as reference conceptual design
- Introduce layout modifications required to fit ILC requirements:
  - Quadrupole/BPM package at the center (symmetry and stability)
  - Review pipe sizes/positions according to gradient and cryo-distribution
  - Consider/include movers (warm) at the center post for x,y quadrupole beam based alignment
  - Consider/include movers to optimize the module centering according to HOM data
  - Review suspension system (post, etc.) for stability and transport
- Review all the subcomponent design for production cost and MTBF
  - Materials, welds, subcomponent engineering, LMI blankets, feed-through, diagnostics and cables, etc.
  - Module assembly issues
- Reduce the waste space between cavities for real estate gradient
  - Flange interconnection, tuners, etc.
- Define all the QC and QA steps required to assure MTBF

Inter-cavity space



Space optimisation is a must!
(1 cm gain → 100m gain per linac)

Figure 3.2.10: *Longitudinal view of a cryomodule.*

Potential “to do list” on
Cryo-module topics where our (AT-CRI) competence could be useful

- **Thermal budget estimate/management** (input for cryogenics, already started with AT-ACR)
  - Review of Tesla heat load tables for ILC parameters
  - Integrate other sources of heat in-leaks (ex.quadrupoles, dark current, etc.)
  - Understand uncertainty and tendency to change

- **Design of thermal shielding**:
  - Structural thermal shield (cryo-lines positioning accuracy, required stiffness for bellows stability)
  - Active/passive 5 K shield vs. capital cost
  - Choice of type of MLI system (materials, blankets…), experimental assessment of performance with an LHC-type solution? (on TTF or other ILC cryo-module)
  - Industrialisation of assembly of MLI (mounting, fixations…)

- **Cryo-modules design/integration** of TTF III towards a **reference design (2006)**:
  - Overall cross-section space management (new pipe sizes, positions of cryo-lines, Th.shelds shapes, MLI…)
  - Length of cryo-modules (towards a max no.of cavities/cryomodule)
  - Integration management of cryo-module sub-systems (cavities, couplers, HOM couplers/absorbers…)
  - Study ACD solutions dictated by new cryogenic layouts (separate distribution line?)

Potential "to do list" on Cryo-module topics where our (AT-CRI) competence could be useful (cont.d)

- **Cavity-to-cavity interconnection** optimisation **for improved "real estate" gradient**:
  - Inter-Cavity bellows optimal design ("1 cm gain = 100m gain"!!)
  - Cryo-Module Interconnection bellows optimal design
  - Cryomodule interconnections assembly/welding (LHC experience)

- **Composite Supports:**
  - Towards a specific design for ILC (TTF uses FNAL design)
  - Cost-effective industrial solutions (LHC experience)

- **Materials and technical choices:**
  - Titanium helium vessel and bellows
  - Ti-to-St.st. transitions
  - Joining techniques: welding Ti/Ni
  - …