# Introduction to Test Module and FP7 HIP sub-task

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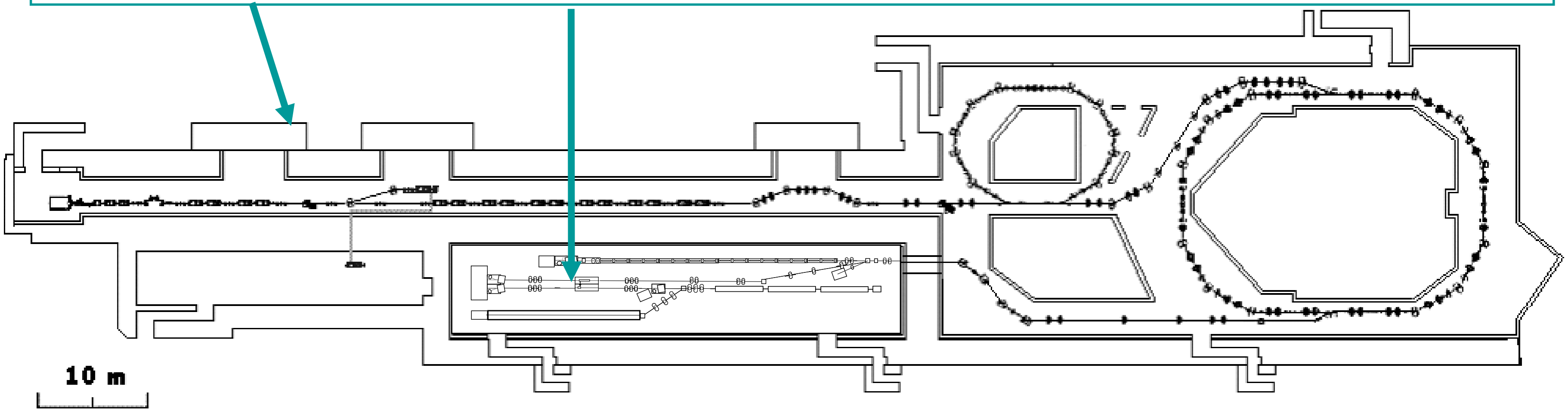
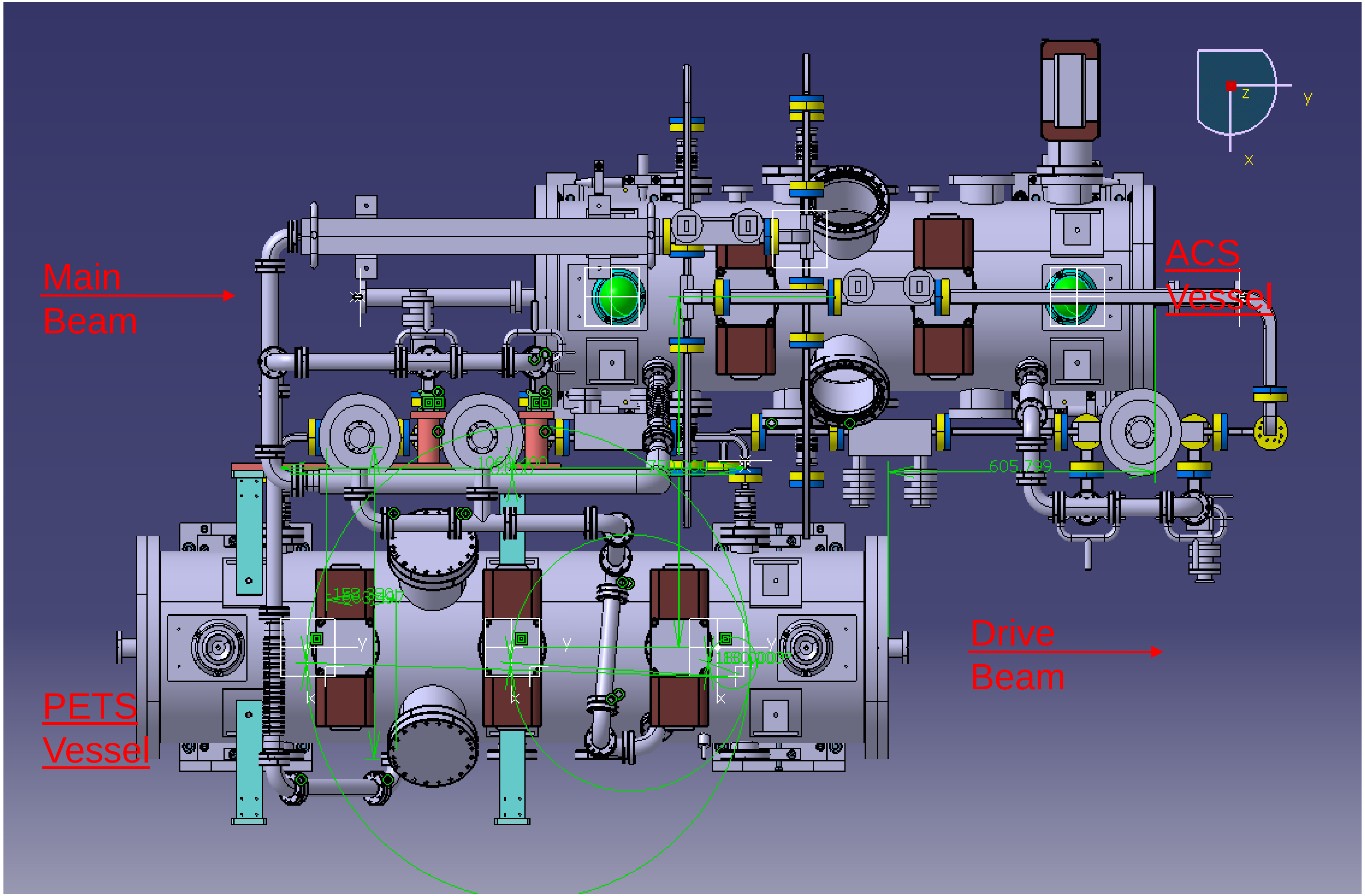
# Introduction

- The CLIC test-module will be integrated in to the two-beam test stand of CTF3 where the drive and probe beams are available

CTF3 and the 2BTS (Two Beam Test Stand)



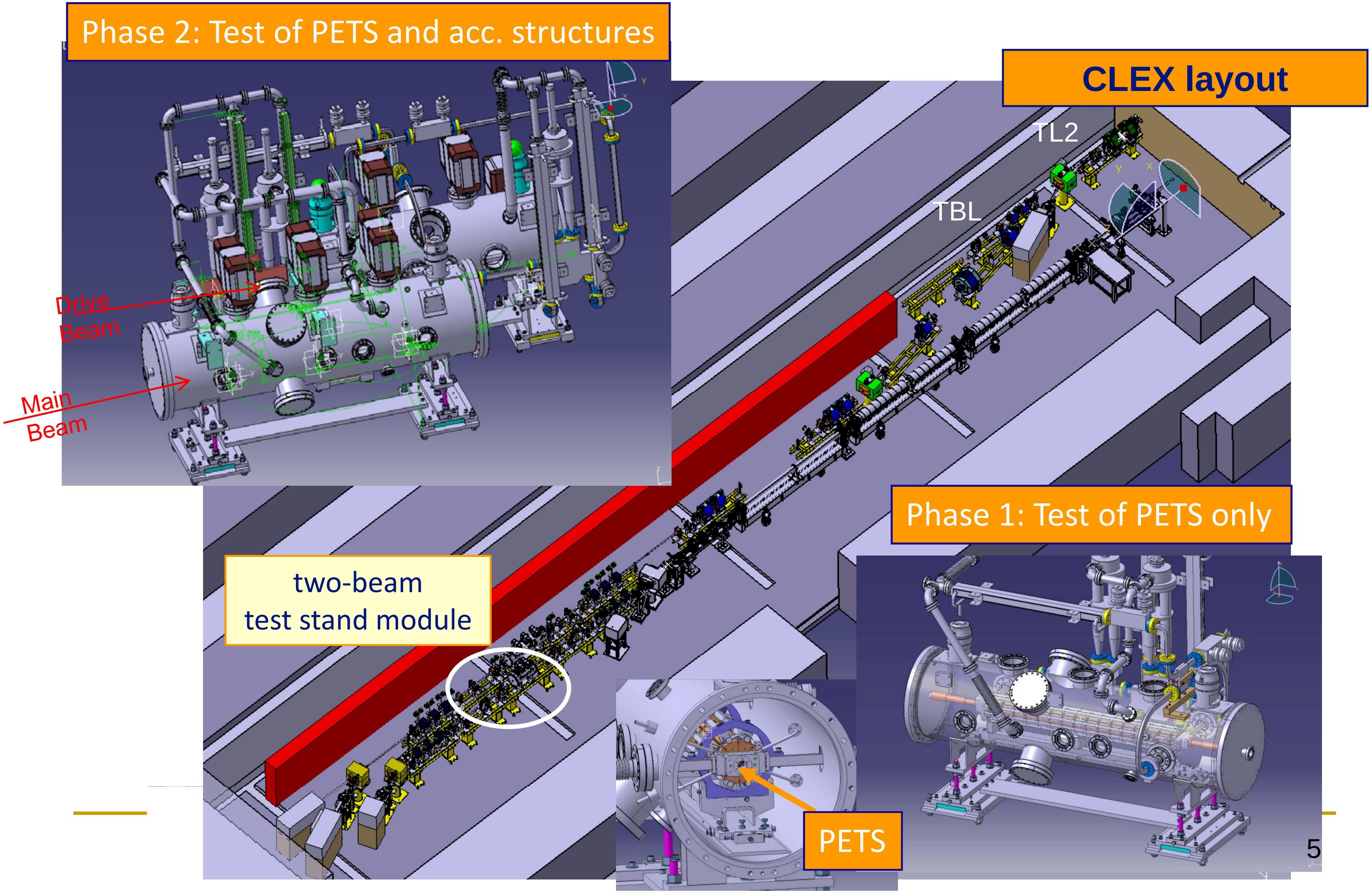
# TBTS



# Test program in CLEX

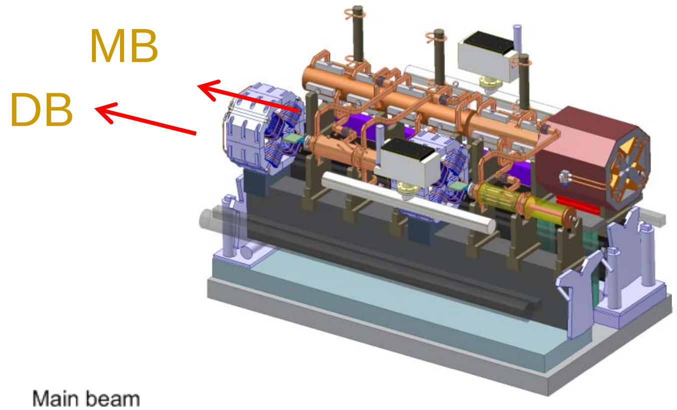
- Two-beam test stand
  - Phase 1: PETS only
  - Phase 2: PETS and accelerating structures
- Test Module (FP7 program)
  - Phase 1: accelerating structures only on main beam
  - Phase 2: accelerating structures + quadrapole on main beam

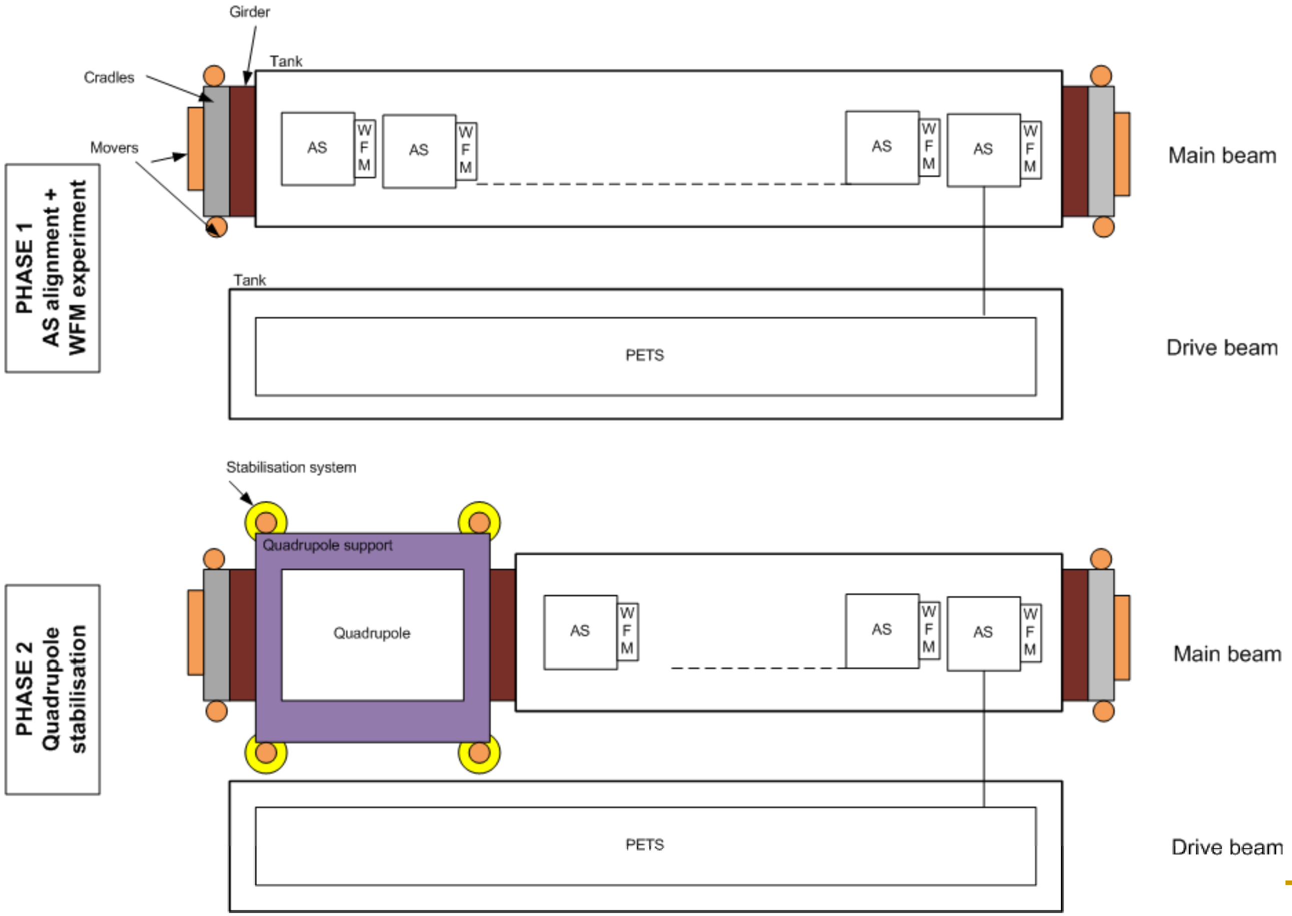
# Two-beam test stand



# Test module

Test module, as much as possible close to the final CLIC module




- CEA/France will participate in the design of acc. structures with wakefield monitor

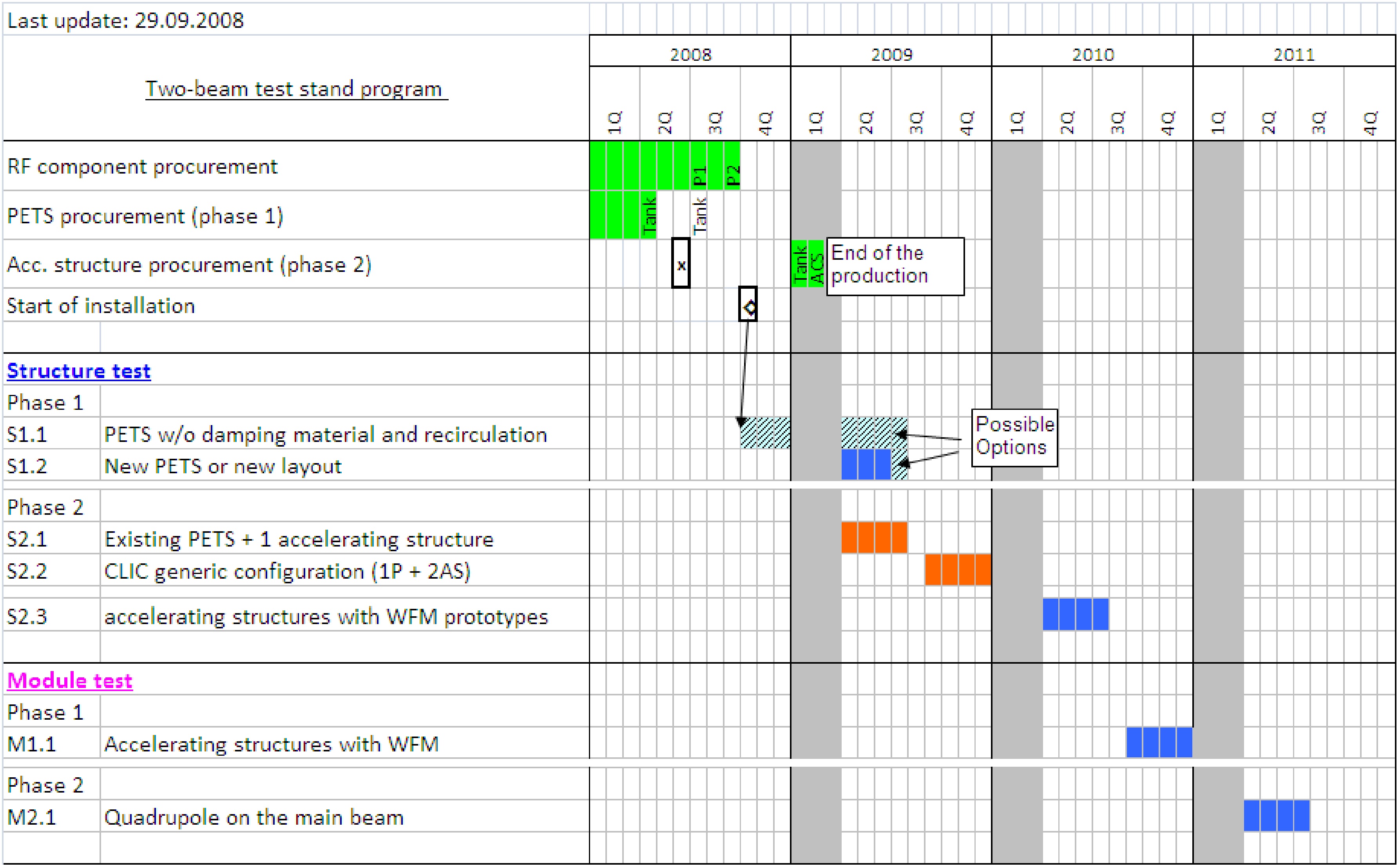
# Main objectives of the test module

- **Accelerating structure (ACS) alignment on girder using probe beam**
- **Wakefield monitor (WFM) performance in low and high power conditions (and after a breakdown)**

- Accelerating structure high-gradient performance
- PETS high-power performance
- RF network high-power performance
- Kick during breakdown
- Overall phase stability

- Alignment and stabilization systems in a dynamic accelerator environment
- RF network phase stability especially independent alignment of linacs
- Vacuum system performance especially dynamics with rf
- Cooling system, especially dynamics due to beam loss and power flow changes

- Practical issues like longer term operation, assembly, activation, maintenance etc.


Last update: 29.09.2008
Two-beam test stand program
2008
2009
2010
2011
1Q
2Q
3Q
4Q
RF component procurement
P1
P2
PETS procurement (phase 1)
Tank
Tank
Acc. structure procurement (phase 2)
Tank
ACS
End of the production
Start of installation
Structure test
Phase 1
S1.1
PETS w/o damping material and recirculation
S1.2
New PETS or new layout
Possible Options
Phase 2
S2.1
Existing PETS + 1 accelerating structure
S2.2
CLIC generic configuration (1P + 2AS)
S2.3
accelerating structures with WFM prototypes
Module test
Phase 1
M1.1
Accelerating structures with WFM
Phase 2
M2.1
Quadrupole on the main beam

# Introduction to Test Module and FP7 HIP sub-task

# FP7- task 2

- **<u>Task 2. Normal Conducting High Gradient Cavities</u>**
- The energy and luminosity design parameters for CLIC are 3 TeV and $6*10^{34}$ $cm^{-2}$ $s^{-1}$ respectively, and CLIC stands here synonymous for any future multi-TeV linear collider. These parameters result in extremely demanding requirements for the accelerating structures in terms of the accelerating gradient (100 MV/m or higher), high-power (of the order of 100 MW), tight mechanical tolerance (microns to tens of microns) and strong higher-order mode damping (complex geometries). A further level of difficulty is encountered when the challenges must be addressed simultaneously as is the case in the CLIC module.
- The CLIC Test Facility 3 (CTF3) has been constructed to address the above issues to demonstrate feasibility of a multi-TeV linear collider based on CLIC technology. This project seeks to complement ongoing efforts, which are addressing the individual requirements, by concentrating primarily on questions of the integration, i.e. to simultaneously satisfy requirements of highest possible gradient, power handling, tight mechanical tolerances and heavy HOM damping. In addition this project will enhance the expansion of the CLIC study from its origins as a CERN project to a truly international collaboration. Existing collaborations with SLAC and KEK will be built upon and included in this project.

# FP7- task 2

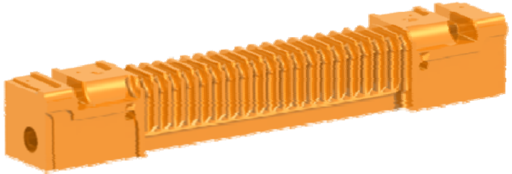
- **Sub-task 1:** Design, manufacture, and validate experimentally a Power Extraction and Transfer Structure (PETS) prototype to improve CTF3.
- **Sub-task 2:** Explore influence of alignment errors on wake fields, elaborate and demonstrate appropriate High Order Mode (HOM) damping in the presence of alignment errors.
- **Sub-task 3:** Breakdown simulation: Develop and use atomistic simulations of atom migration enhanced by the electric field or by bombarding particles, understand what kind of roughening mechanisms lead to the onset of RF breakdown in high gradient accelerating structures.
- **Sub-task 4:** Design and build equipment to diagnose the electrons, ions and light emanating from the breakdown event both in the CTF3 Two-Beam Test-Stand at CERN and inside a scanning electron microscope in UU to analyze the surface science relevant to RF-breakdown.
- **Sub-task 5:** Precise assembly: Develop a strategy of assembly for the CLIC accelerating and power extraction structures satisfying the few to 10 micrometer precision requirement of positioning both radial and longitudinal taking into account dynamical effects present during accelerator operation.

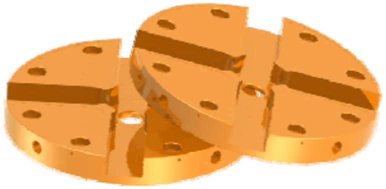
• Helsinki Institute of Physics is currently sponsoring the mechanical engineering for CLIC (for example with the acc. structures)

# Accelerating structures

Two main basic structure types

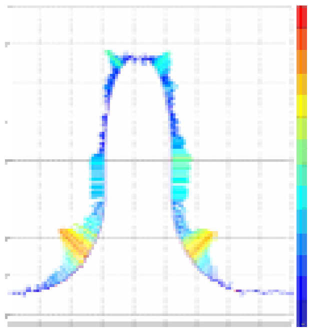
- Quadrant
- Disk





Alignment and assembly

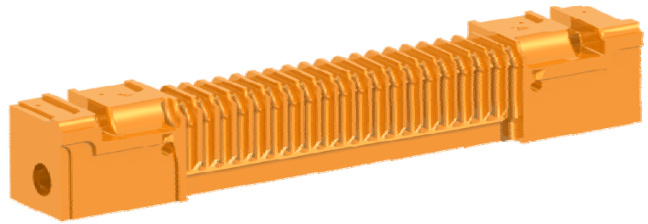
Manufacturing and design issues concerning micron level accuracies



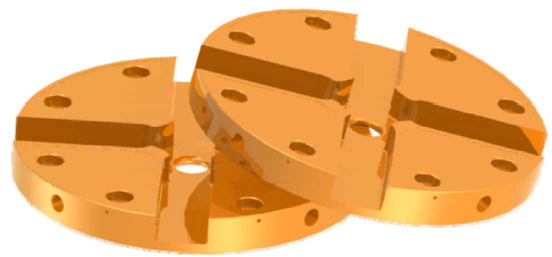
# Accelerating Structures

Two main basic structure types

- Quadrant
  - Problematic assembly
  - Uncertain behavior

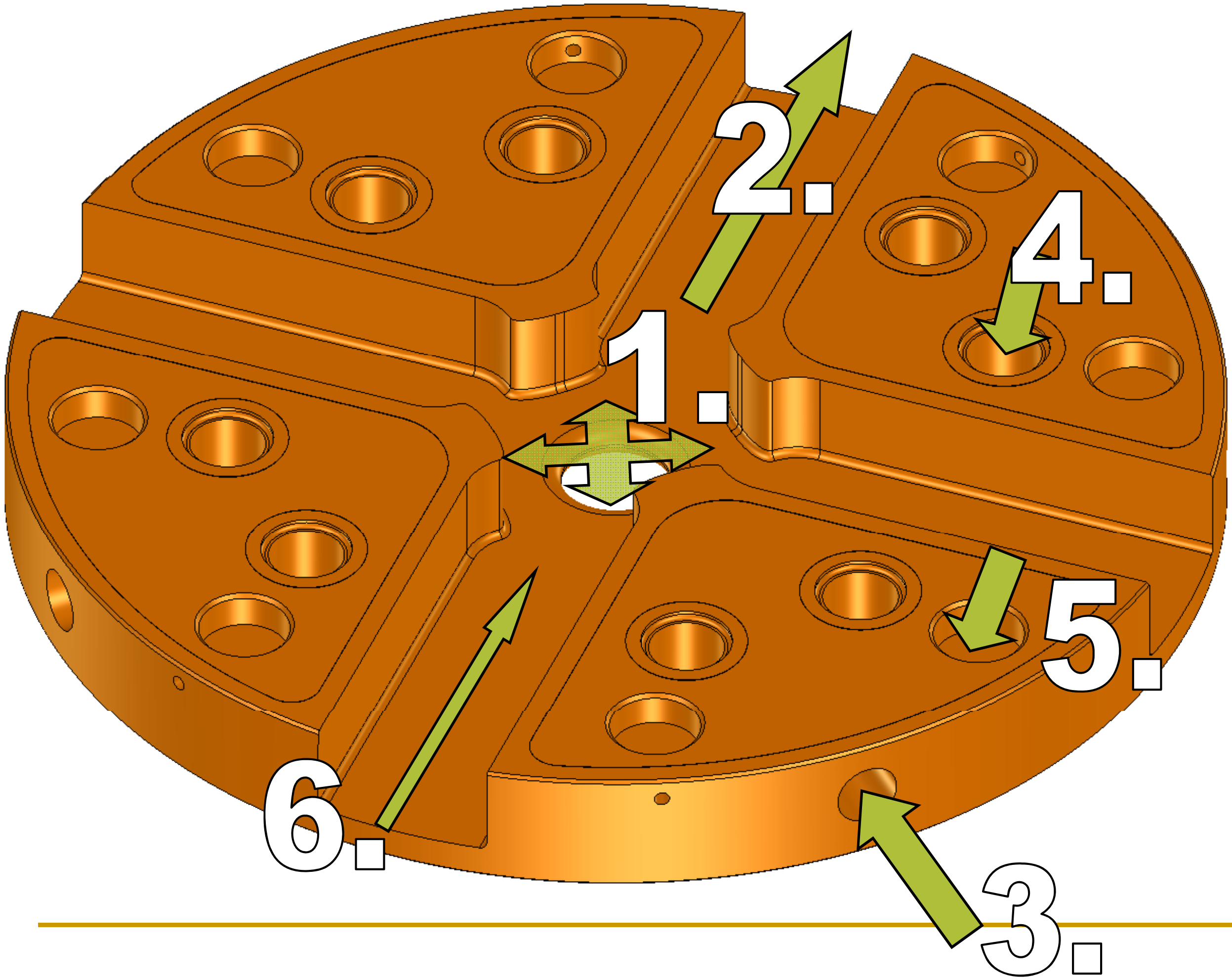


- Disk
  - Higher manufacturing accuracy
  - More parts
  - Better behavior



- The disk structures have been chosen for the feasibility study

# Disk – Main Features



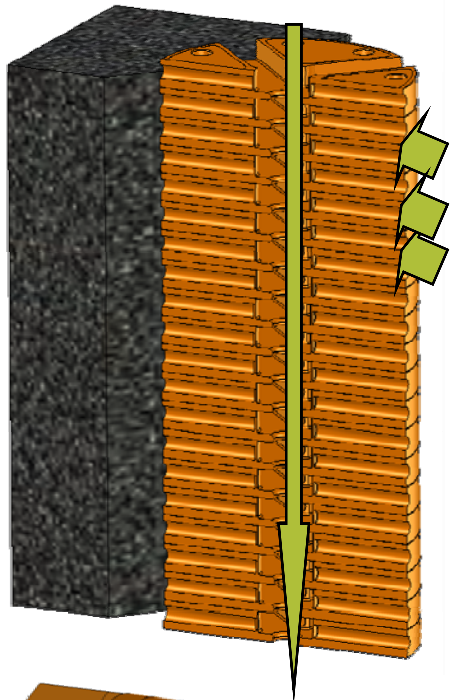

1. Main geometry
2. Waveguides (or not)
3. Tuning
4. Cooling
5. Features for brazing
6. Damping material (diameter dependent)

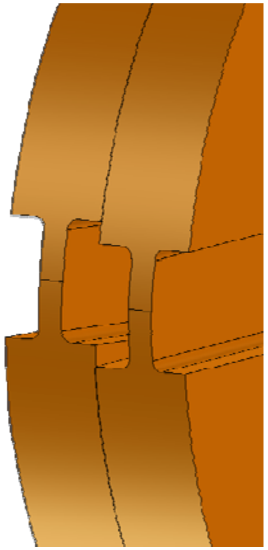
# Manufacturing a Disk

- Tolerances regarding the shape and alignment of the disk require accuracy of ± 1…5 µm
- Manufacturing by turning
  - ± 1 µm is realistic
  - inside and outside diameters have a high relative precision
  - can be used as a reference for assembly and alignment
  - waveguides require some extra work (requires milling)

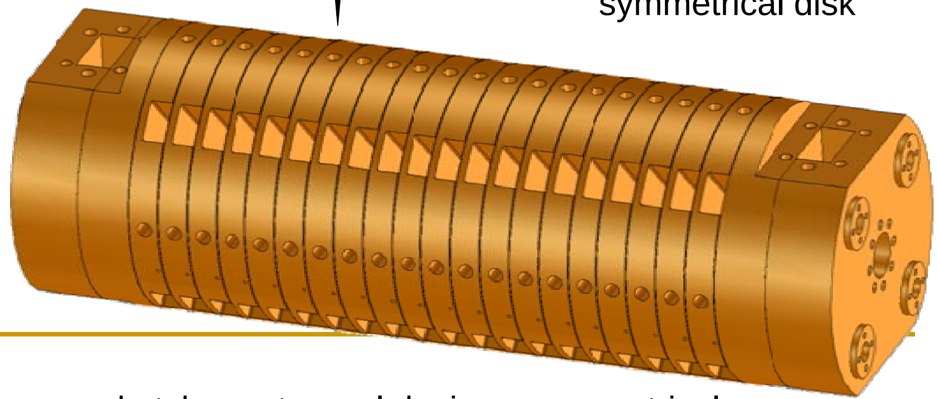
# Disk Alignment & Assembly

- Vertical V-block assembly to avoid “bookshelf”-effect
- Using the turned surface as reference
- Brazing material is inserted between the disks during assembly
- After brazing the connection features are machined (waveguides, cooling)
- Cooling connections brazed





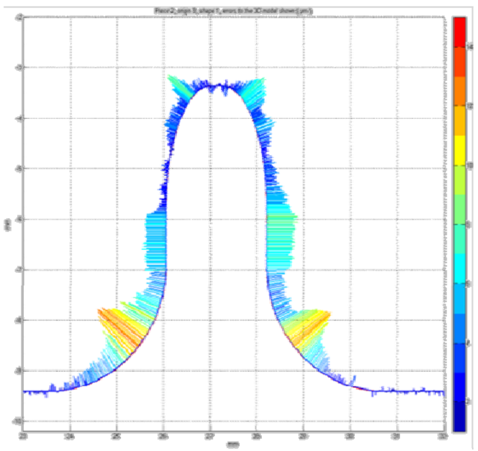
Problem with symmetrical disk



sketch – not a real design, asymmetrical

# Machining compensation

- Ongoing test
- Test structure manufactured by milling
- Aim is to improve the shape accuracy by compensating the shape of the tool



# Future work

- Confirmation what needs to be tested in the test module
- Issues concerning TBTS
  - Confirmation of results
  - Needed improvements
- Finding and solving problems

# Future work

- Solving the mechanical design problems concerning tuning
- Optimizing the disk design
- Testing the assembly accuracy concerning rotational errors
- Selecting the possible manufacturing strategies and manufacturing larger series of components

Thank you.