Design: Current Test-Modules vs. CDR Modules

CLIC Module review 2015

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Jukka Väinölä, Helsinki Institute of Physics

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    - Support system
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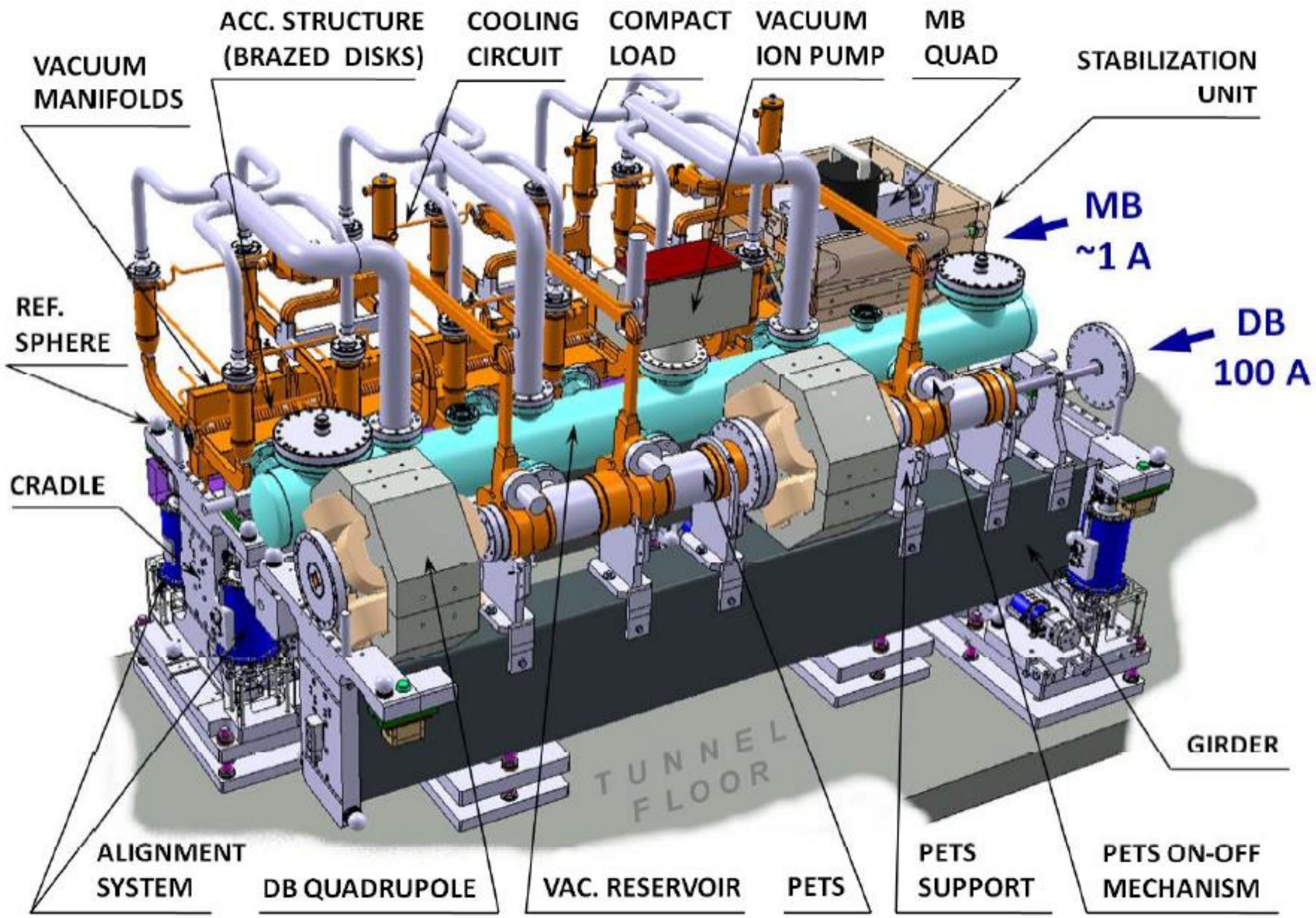
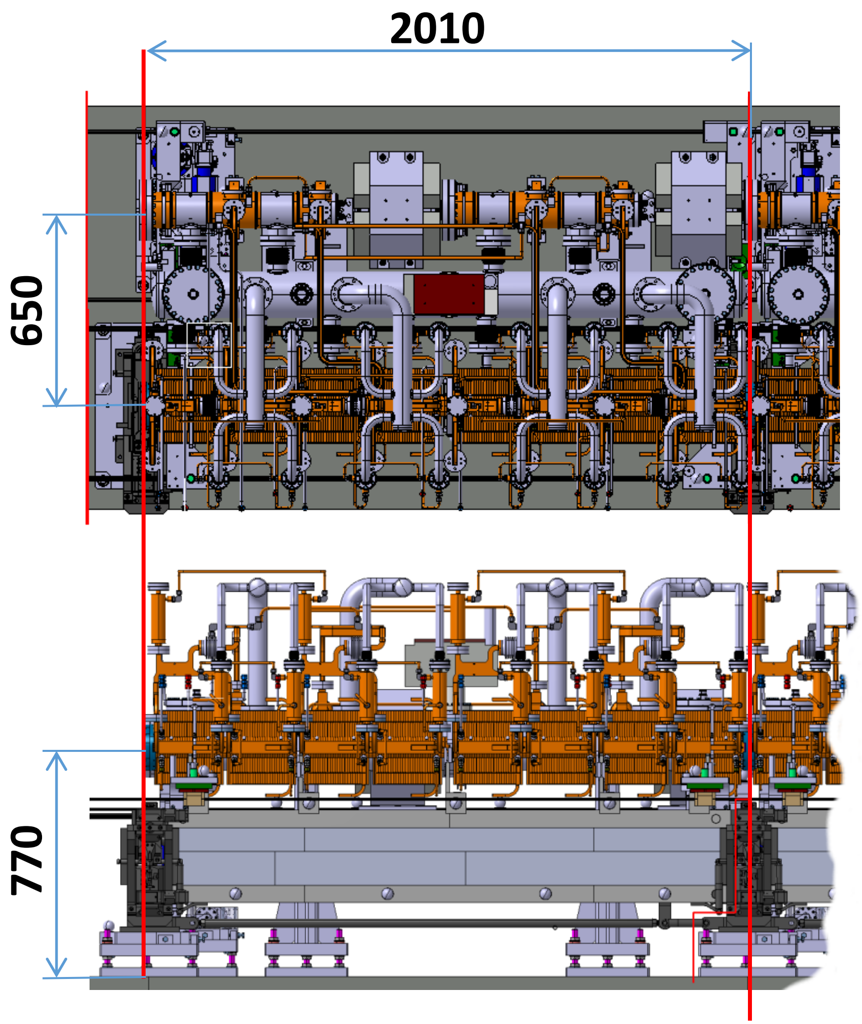
- Summary



Specifications CDR

TBM Type 0

Module Main Dimensions		
Length (RF components), mm	2010	
Inter beam distance, mm	650	
Beam height, mm	770	
RF Components	**T0**	**T1**
Number of AS	8	6
Number of PETS	4	3
Vacuum System		
Pressure	10^-9 mbar	
Magnets	**T0**	**T1**
Number of DBQs	2	2
Number of MBQs	0	1



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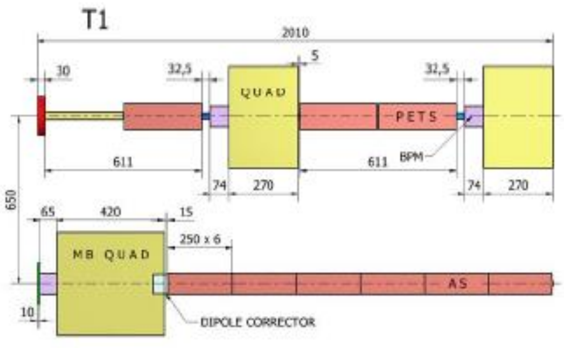
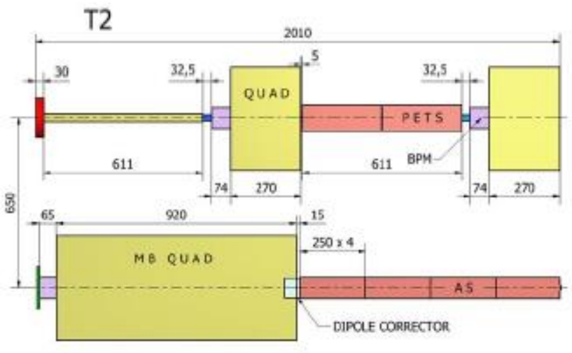
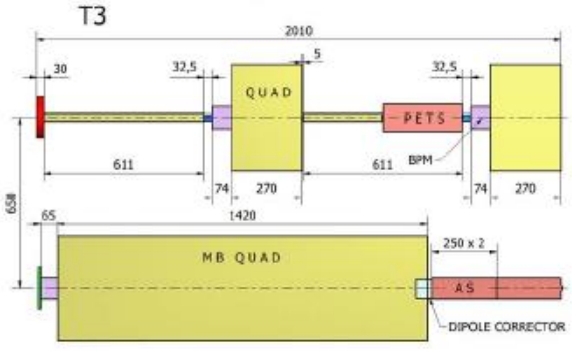
TBM main types



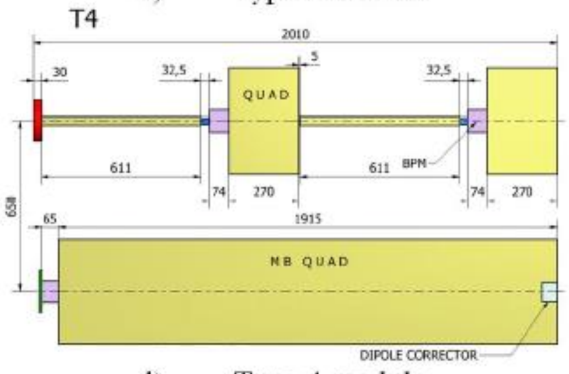
a) Type 1 module



b) Type 2 module



c) Type 3 module



d) Type 4 module

1 to 4 pairs of AS
replaced by
MB Quadrupoles

Type 1	3%
Type 2	12%
Type 3	9%
Type 4	3%

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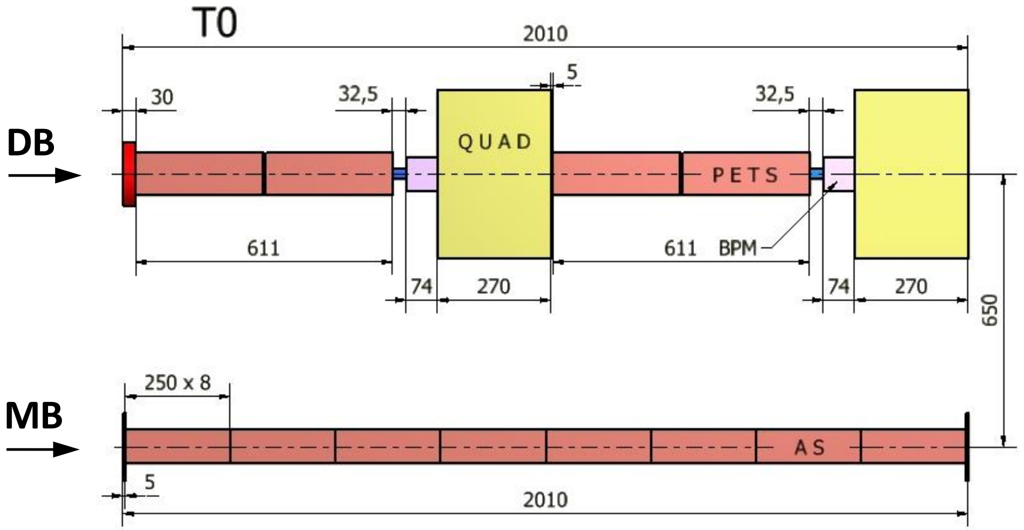
CLIC Module
Type 0
73 %

Standard Module
(L = 2010 mm)
DB (100 A)
4 PETS, 2 Quads with BPM
Each PETS feeds 2 AS

MB (1 A)
8 acc. structures
MB filling factor: 91%



Two-beam module design and validation

CDR

Baseline solution of Two-beam module and its technical sub-systems defined in CDR:
RF components: AS, PETS, RF Network and RF Loads, Cooling, Vacuum system, MBQ, DBQ, Support system and Alignment

TBM Lab

Demonstration and validation of the two-beam module design:

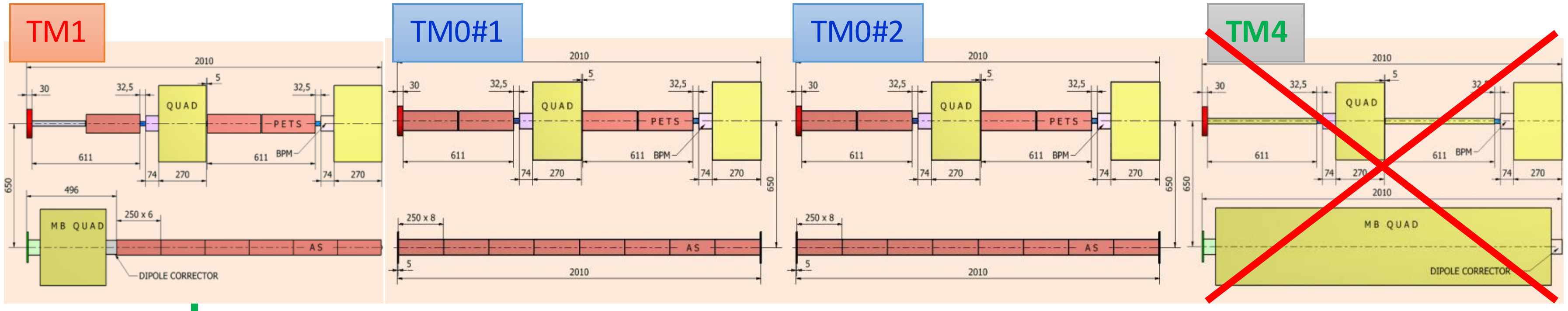
- the assembly and integration of all components and technical systems, such as RF, magnet, vacuum, alignment and stabilization in 2-m long two-beam module
- validation of the thermal and mechanical module behavior

TBM CLEX

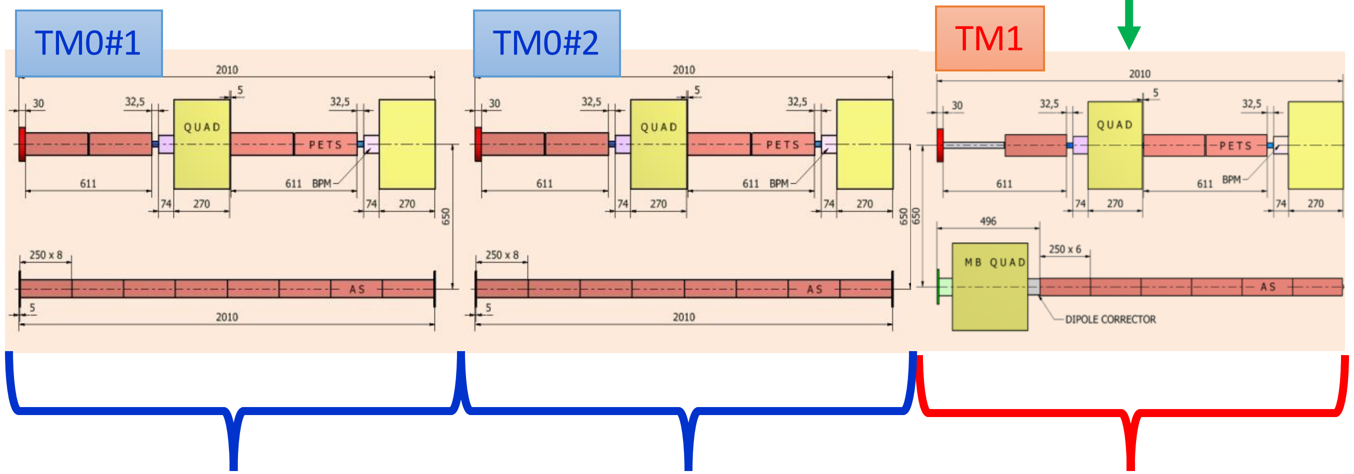
Demonstration of the two-beam acceleration with two-beam module

TBM Lab layout

T1-T0-T0-T4



New lab model design
T0#1, T0#2, T1

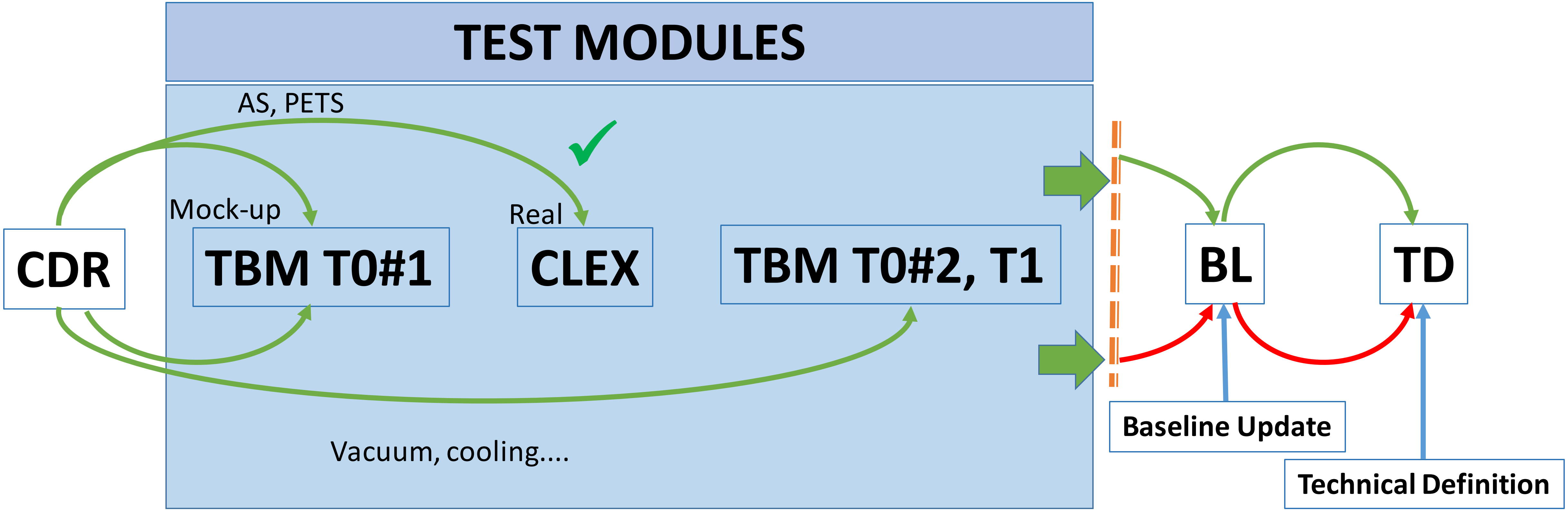


1) Under test

2) Under assembly and installation

3) Components under procurement and assembly

CDR and Test modules to Baseline Update and Technical Definition



RF SYSTEM

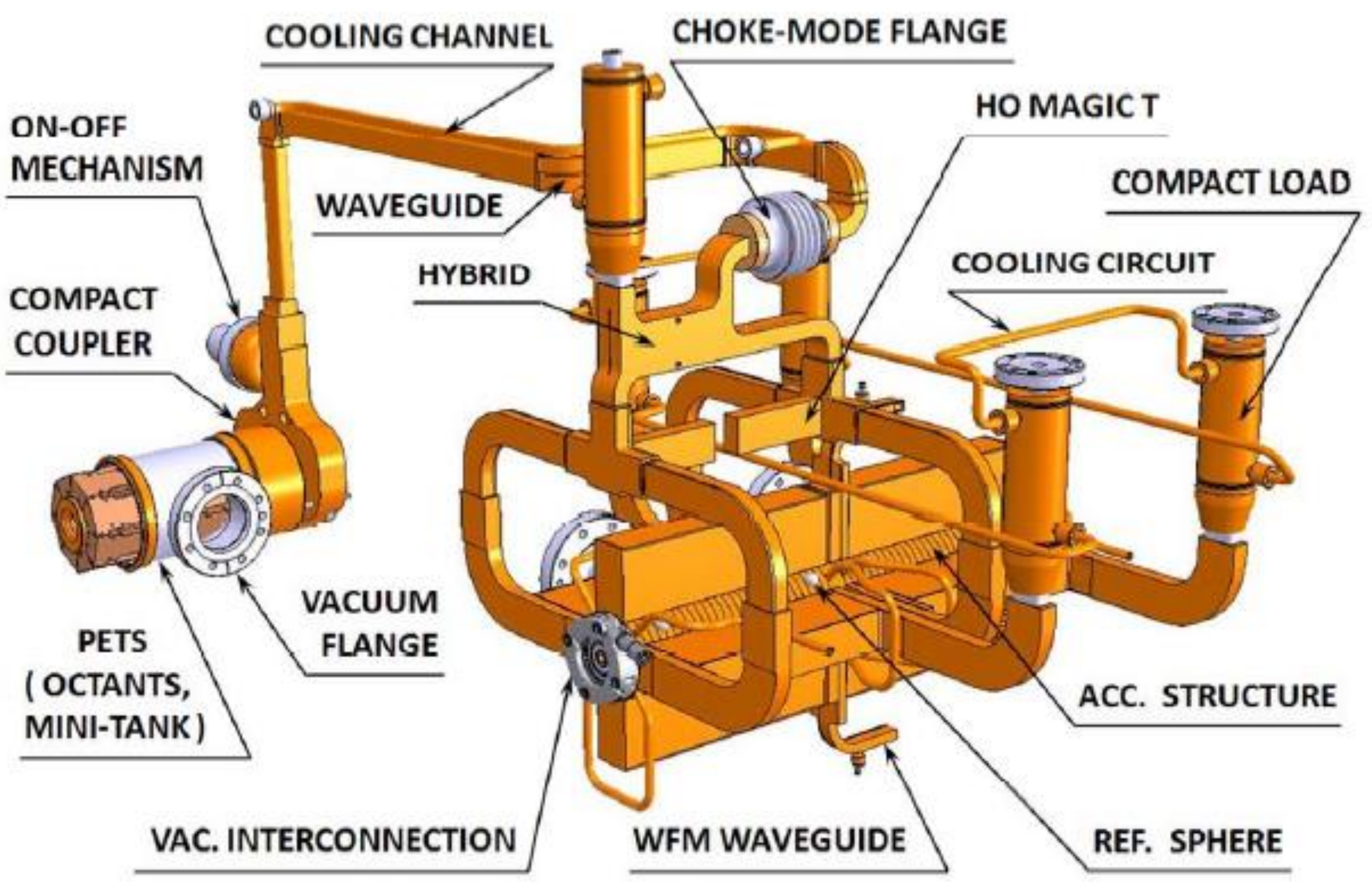
CDR

RF System

- PETS
- Accelerating Stuctures
- RF Network
- RF loads

Table 5.37: Main parameters of the RF structures

	Length [mm]	Aperture [Ø, mm]	Gradient [MV/m]	Power [MW]
PETS	308	23	6.5	136
AC	230	5	100	64



RF component specifications

Tolerances of the RF components and mock-ups

Real RF component	Mock-up
Accelerating structure disks	
Iris, shape tolerance, mm	
0.005	no iris (general ISO fH)
Flatness of extremity planes	
0.001	0.005
External diameter	
+-0.004	+-0.004
PETS, Octant, RF shape	
0.015	No octants (simplified), general ISO fH
RF network, splitters, hybrids, CMF	
0.02	0.1

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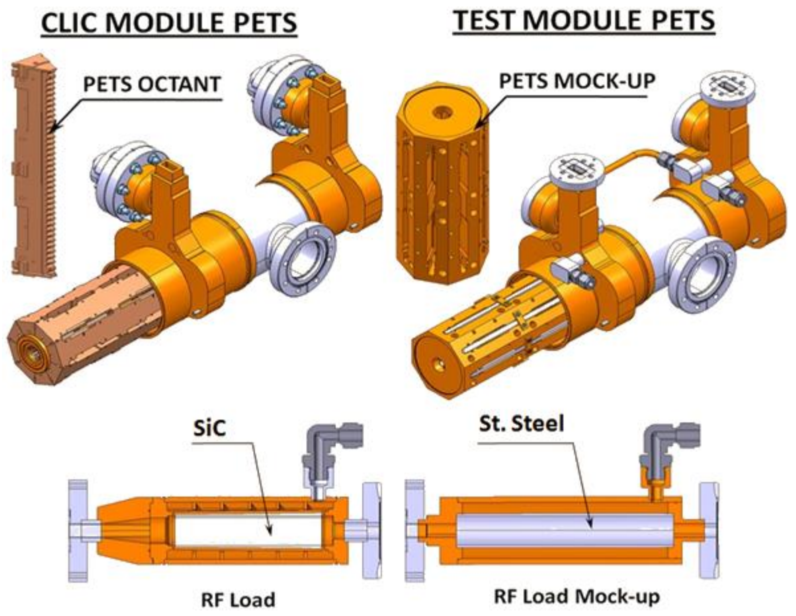
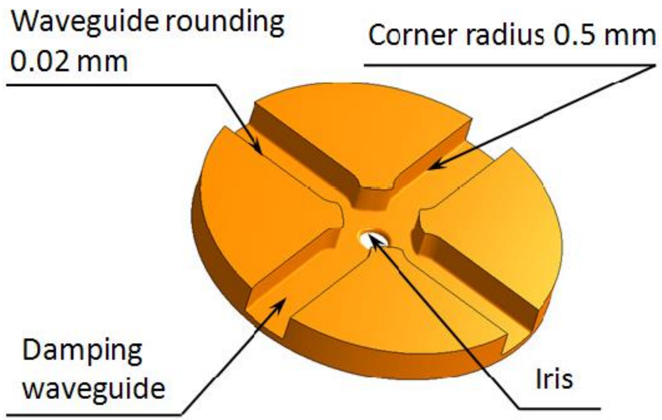
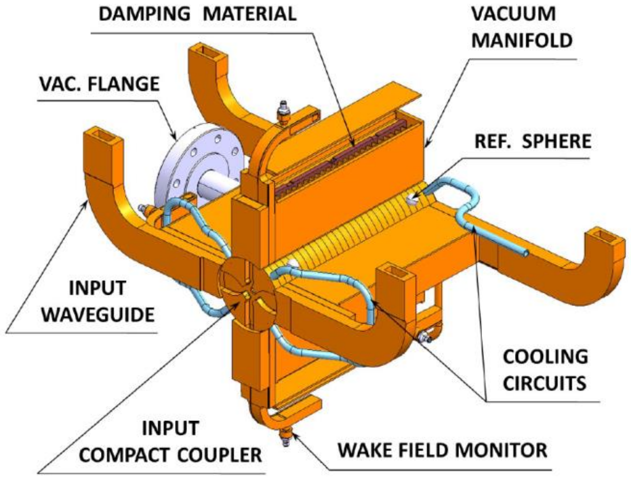
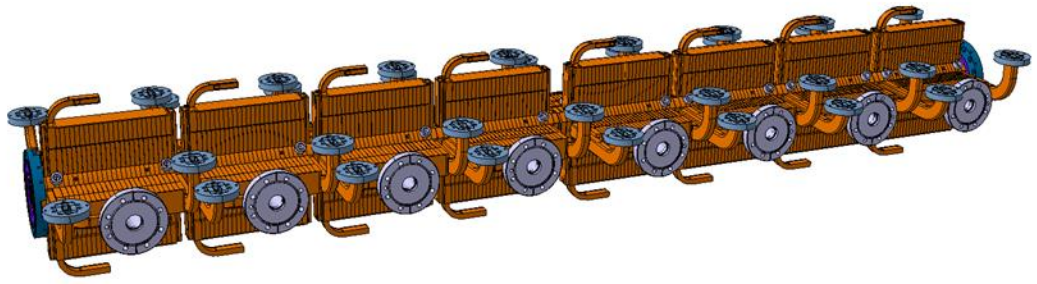


Accelerating Structures







LAB modules T0#1, T0#2

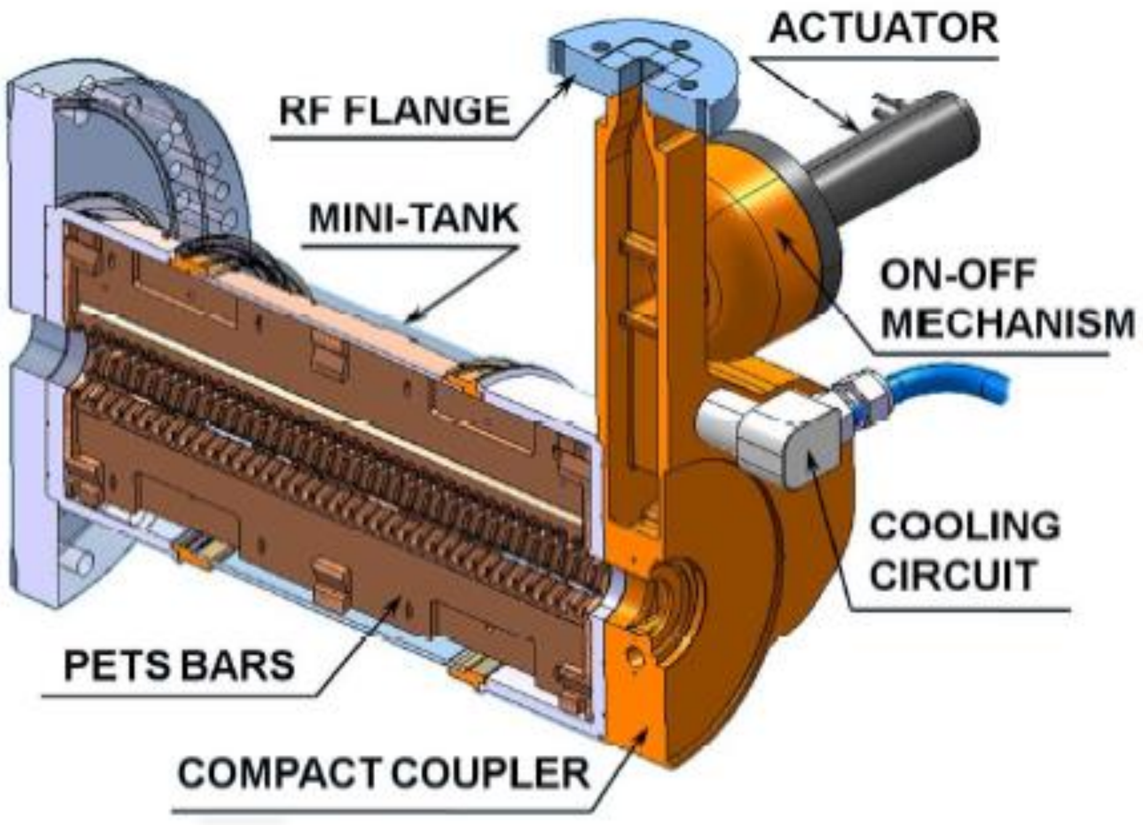
- AS based on mock-up disks
- Reduced cost due the simplified geometry:
  - no iris
  - intrenal surface area same than in real AS
- Mechanical interfaces as in real
- Heaters simulating the power dissipation

LAB module T1

- AS mock-ups based on bar structure
- No iris
- Mechanical interfaces as in real AS

CLEX
- real AS according to CDR specification

Power Extraction and Transfer Structure PETS



CDR:

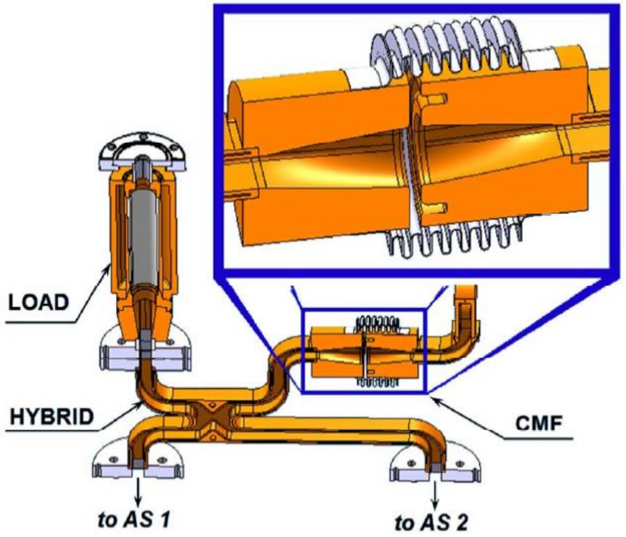
- PETS is comprised of eight octants separated by damping slots
- Shape accuracy of octant 15 μm
- Placed in minitank
- Including ON-OFF mechanism

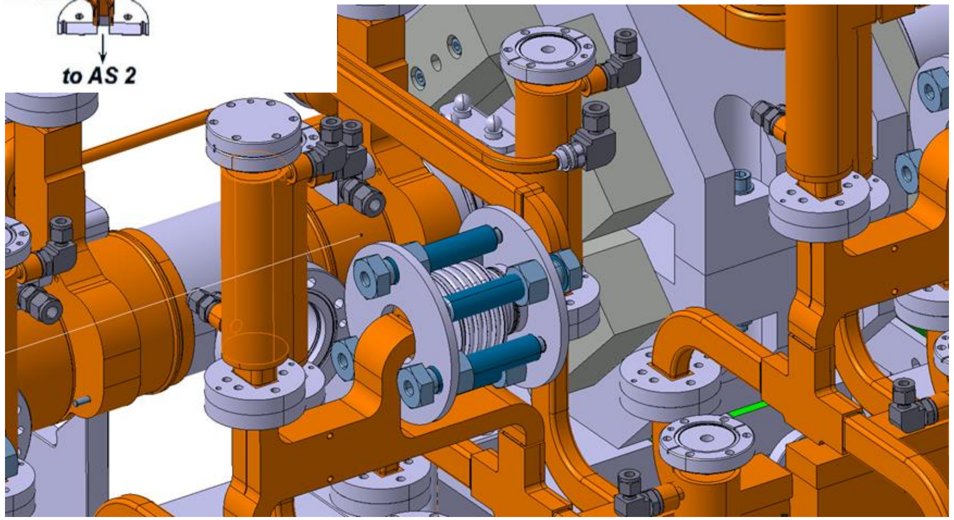
LAB modules mock-ups used

CLEX according to CDR

Mock-ups used in LAB Module T0 and T1. Real PETS according to CDR specification in CLEX.

RF Network





CDR

- Combining PETS to Accelereting structures
- Wavequide, hybrids and loads
- Chocke-mode flange allows allows moving and alligning two beams independently

RF network version 1 mock-up built to LAB T0#1 and to CLEX (real).
RF network version 2 for T0#2 ready. LAB T1 needs modification prior to installation.

RF Loads

CDR:

Compact loads and desing are presented in the CDR baseline desing

Two RF load per Accelerating stucture

Five loads per PETS

→RF load is the most common RF component

CLEX:

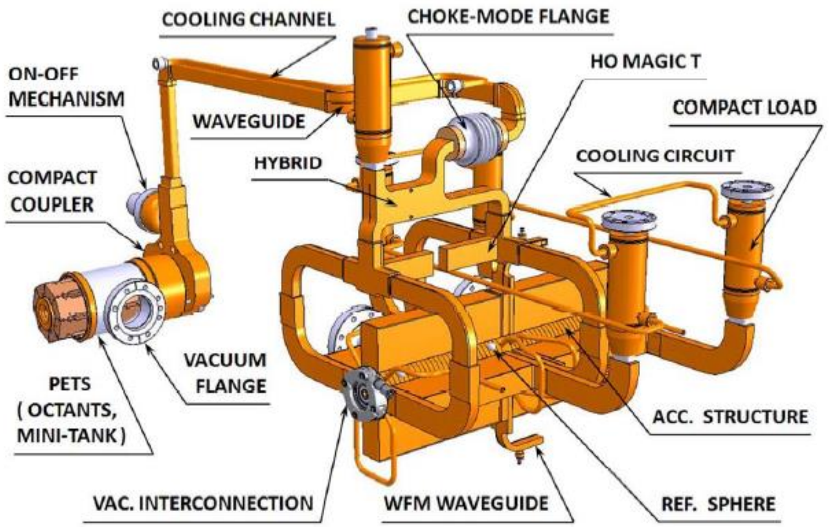
Loads used, but not compact loads

LAB modules:

Mock-up loads

No compact loads in any of the CLIC test modules

No tested design of compact loadsto be implemented to Baseline update



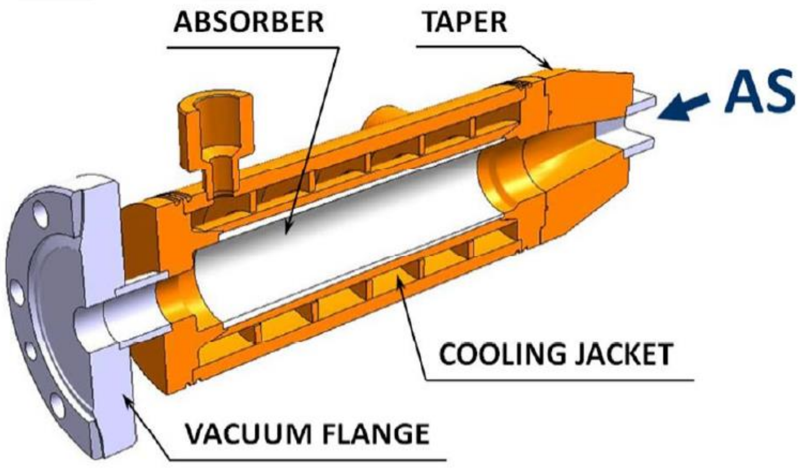
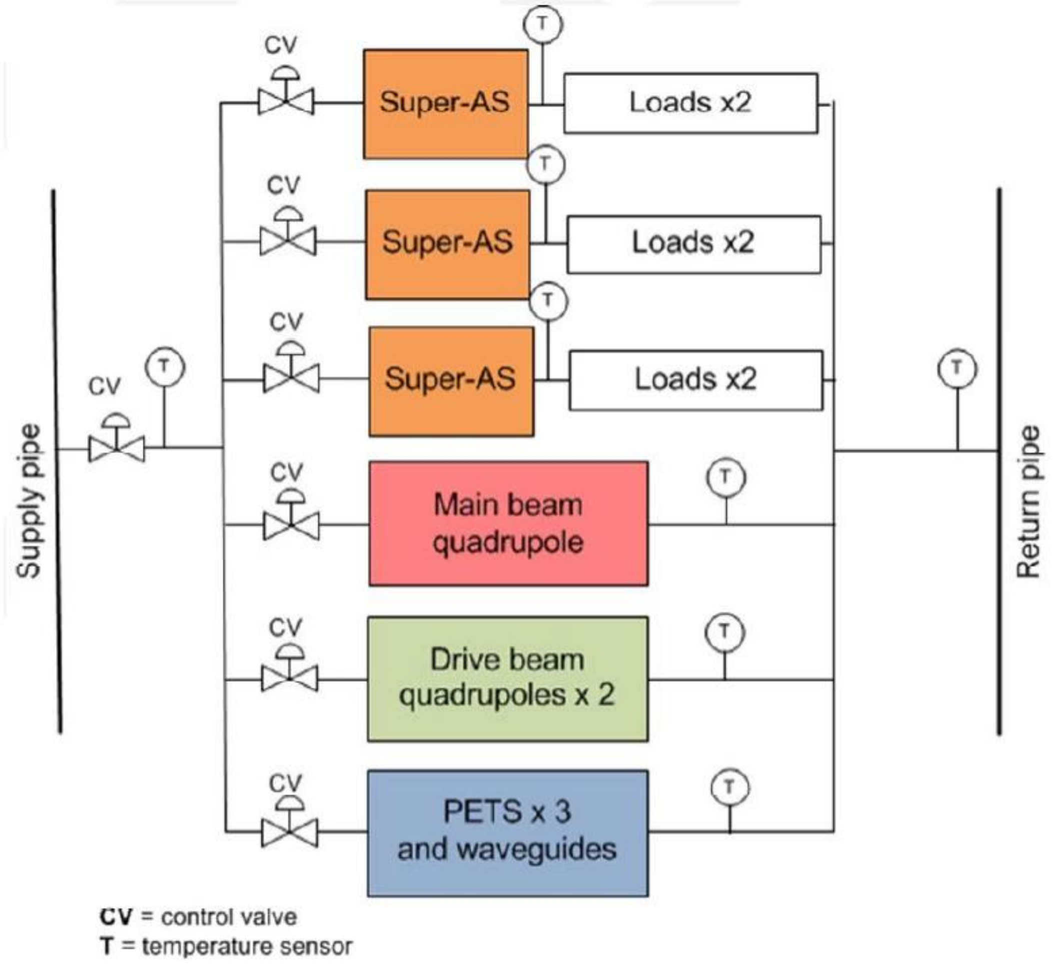


Fig. 5.143: Mechanical design of compact load

Cooling system

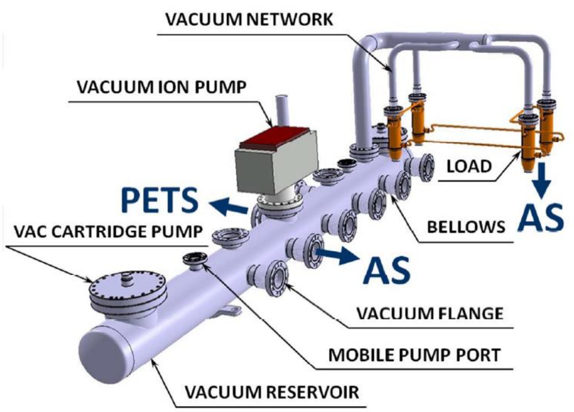


CDR:

- All module types require a different cooling layout, because of MBQ which comes in four different configurations.
- Requirements of vacuum, alignment, mechanical stability and vibrations especially in MB
- Cooling by water and airflow
- 65% water flow thru AS's

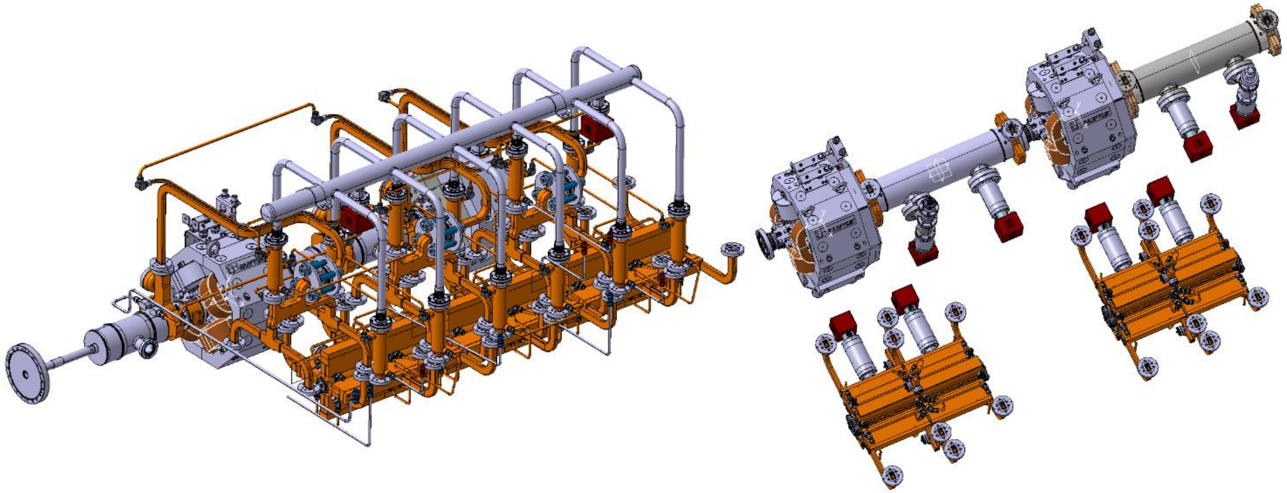
Airflow and watercooling in LAB environment, water cooling implemented to module T0#1, not to DBQ.
T0#2 including real DBQ with cooling. T1 MBQ with water cooling.
CLEX watercooling including DBQ.
Some technical design adn definition work still required for final technical specification.

Vacuum network



CDR:

- unbaked system
- lower than 10^{-7} – 10^{-8} mbar
- Design based on vacuum tank

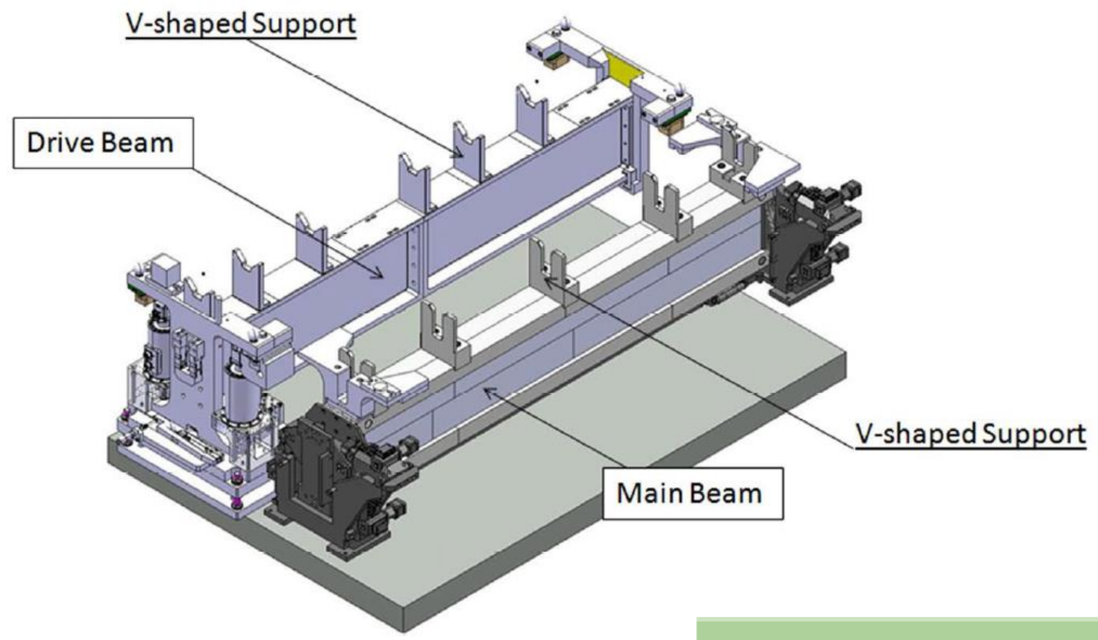


TEST MODULES:

- T0#1: based on vacuum tank
- CLEX: minipumps on PETS and SAS
- T0#2: minipumps
- T1: based on minipumps, under design

Technical design work still needed for final design, decission and Baseline update.

Support system



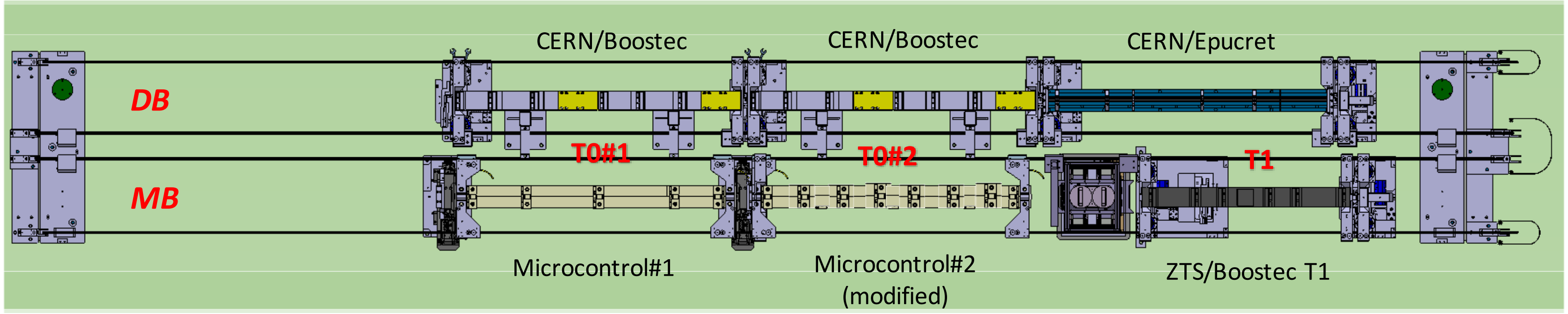
CDR:

- Mechanically connected girders
- V-supports, brazed or glued
- Stiffness higher than two-beam modules
- Baseline materials SiC and Epucret minaral cast
- 2 baseline configurations for girders

TEST MODULES: Boostec, Microcontrol #1&#2, Epucret

Table 5.40: Girder technical requirements

Parameter	Requirement
Modulus of elasticity	≥ 400 GPa
Mass per girder (universal)	≤ 240 kg
Maximum vertical deformation in loaded condition	$10\,\mu$m
Maximum lateral deformation in loaded condition	$10\,\mu$m
Maximum weight on top of the girder (distributed)	400 kg/m

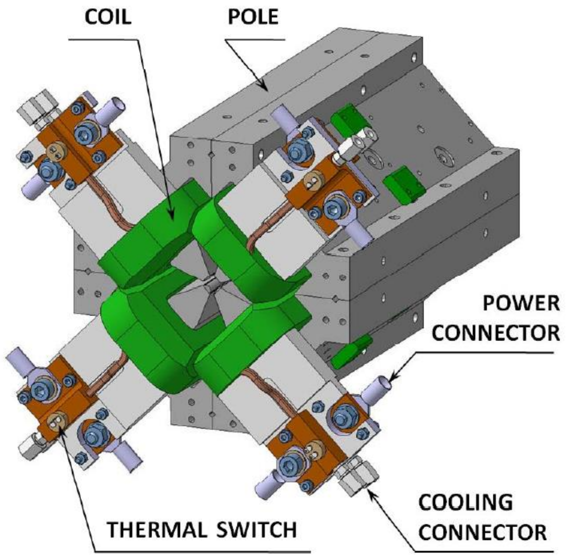


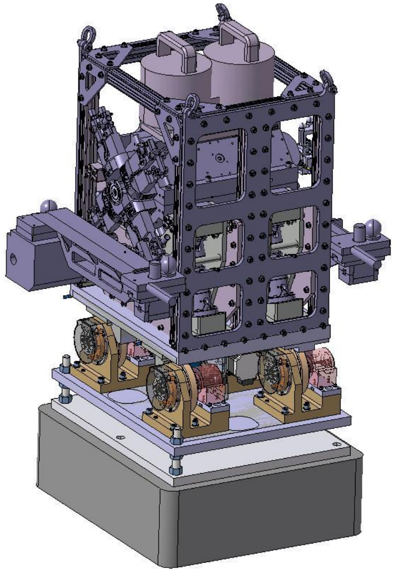
A. Vamvakas

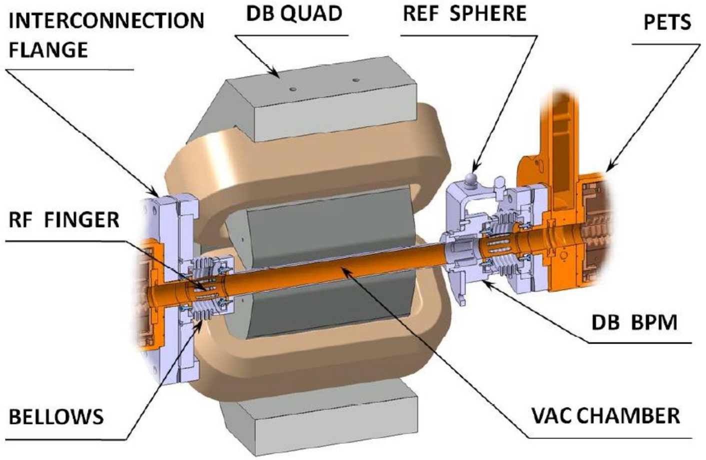
Several configurations used in LAB modules and CLEX. New adjustable V-support designed.

For baseline update final selection of supporting system needs to be done requiring some technical design work.

Magnet system







MBQ

- replacing 1 to 4 pairs of accelerating structures
- 4 types of MBQ
- Individual cooling, sabilization and alignment

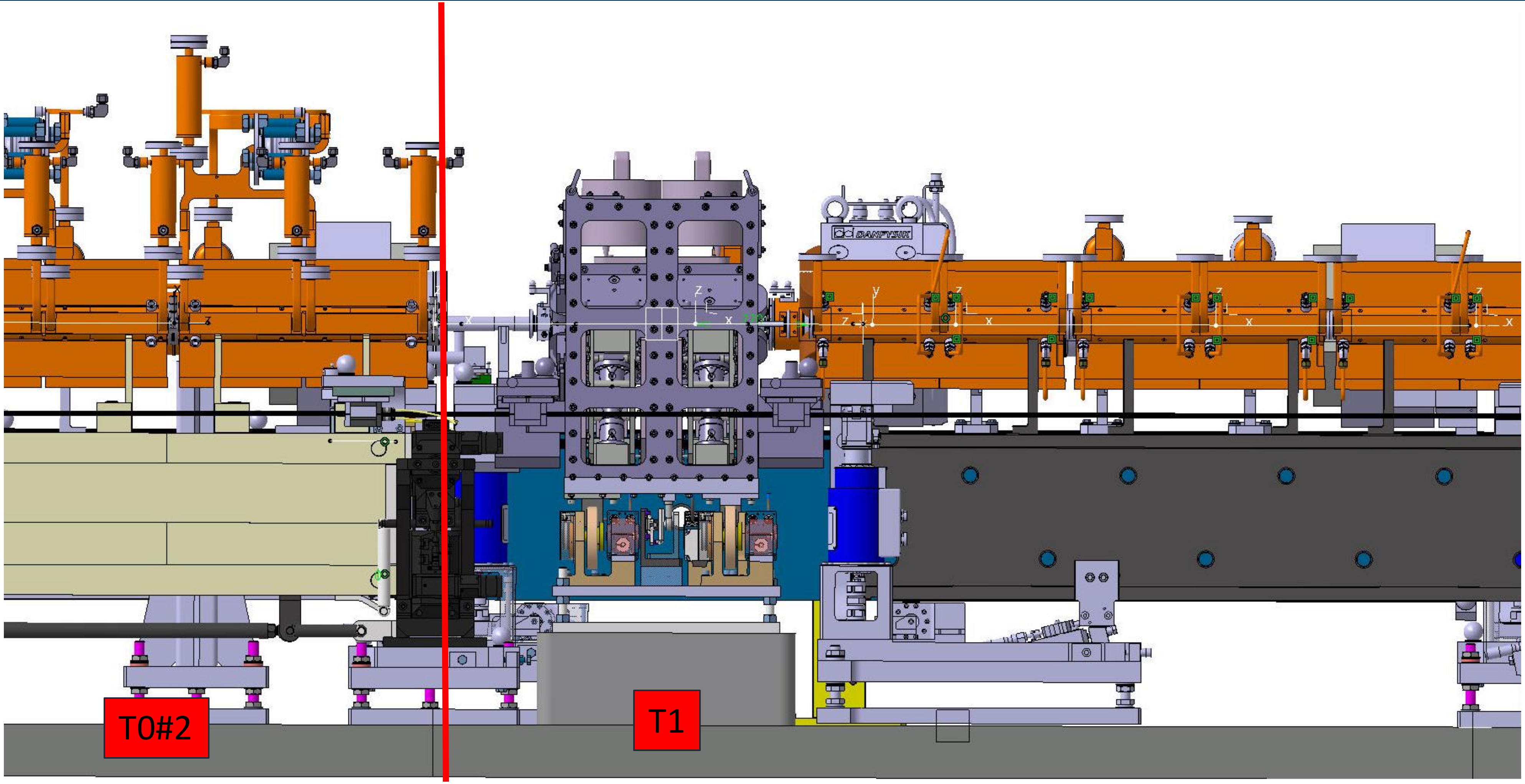
Quadrupole type	Magnetic length [mm]	Quantity
Type-1	350	308
Type-2	850	1276
Type-3	1350	964
Type-4	1850	1472

DBQ

- 2 magnets per module
- Size constant
- cooling
- 41400 in total

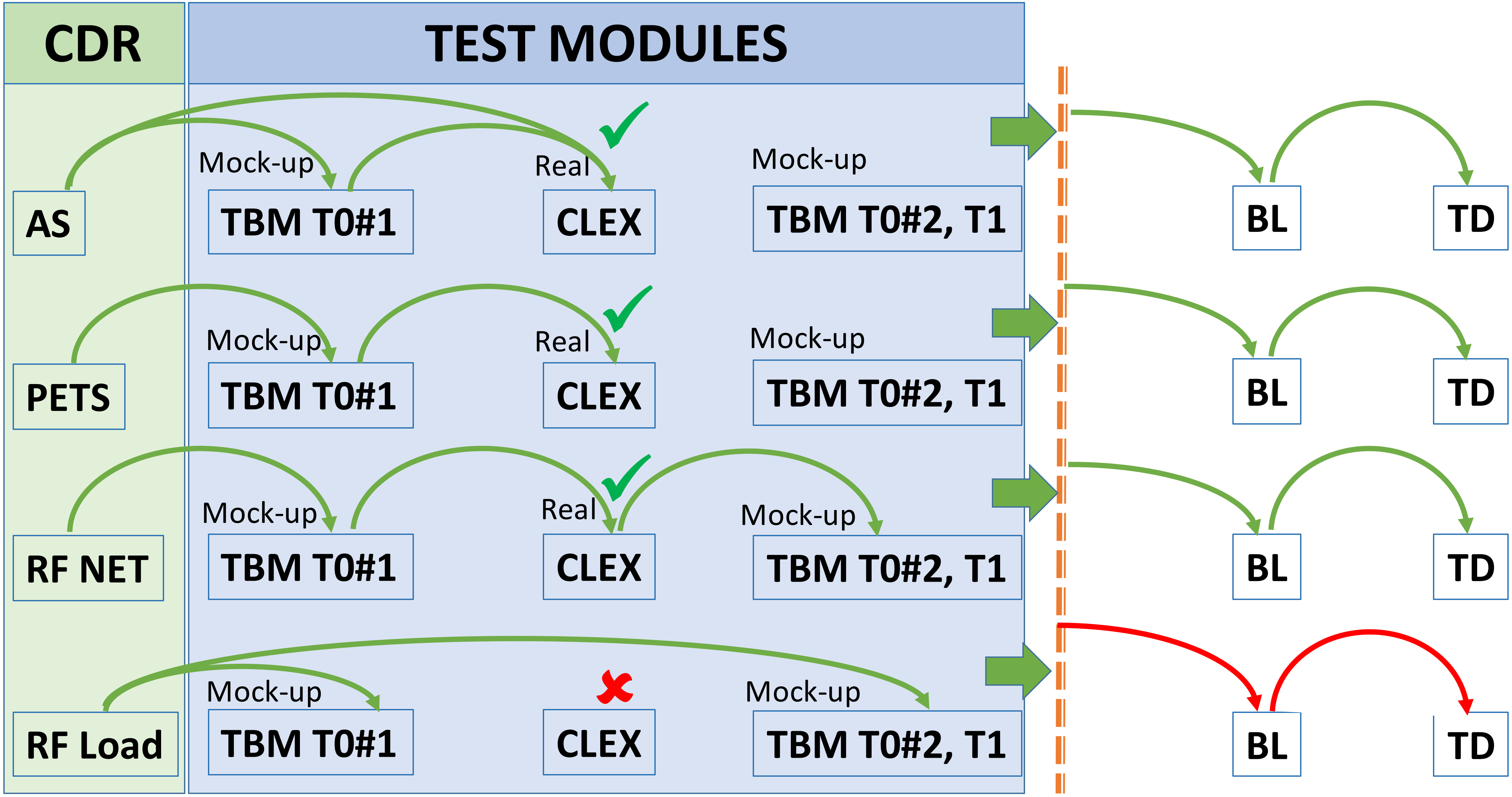
MBQ type 1 to be installed to LAB module T1, not the final design.
DBQ mock-ups installed to LAB T0#1, real DBQ's with cooling implemented to CLEX. Real DBQ's to be installed to T0#2 and T1.

MBQ-T0 interface

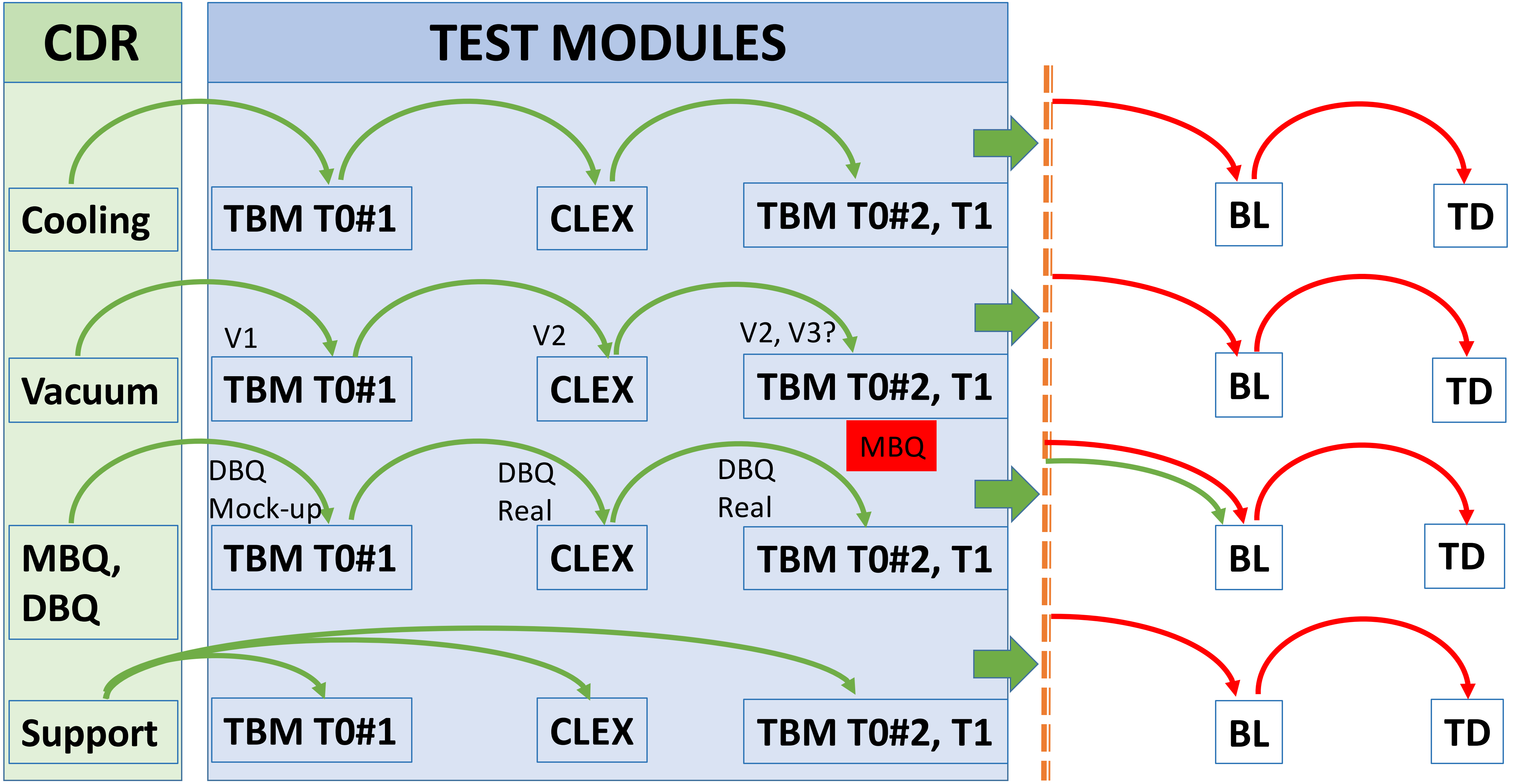


MBQ type 1 will be installed to LAB module T1. Prototype design with measuring devices doesn't fit to envelope due to adjacent module T0#2 with Boostec support system. LAB module configuration needs fore modified.
Baseline update interconnection T0-MBQ (T1) to Boostec type support. No mechanical desing exists yet.

RF System from CDR to Baseline and Technical Desing



Module from CDR to Baseline and Technical Desing



Summary

- RF structures (AS, PETS) according to the spesification realised in CLEX, Mock-ups in LAB modules. RF network some evolution between different versions
- RF loads: no real compact loads tested in any of the modules

- Cooling system: cooling system is individual for each module and environment, current versions ”plumber desing”. Some design work needed for Baseline update.
- Vacuum system: Different vacuum system designs in T0#1 and T0#2. T1 still under design work. Based on the results from different test modules decissions for final system design has to be maken.
- Support system: In CDR 2 alternative materials are defined for girders. Several support system solutions are used in test modules. Final decission and possibly additional desing work is needed prior the final baseline design.
- Magnet system:

  - DBQ, mock.ups installed to T0#1, real magnets with cooling in CLEX, T0#2 and to T1. Cooling system desing under work, when ready to be implemented to Baseline update.

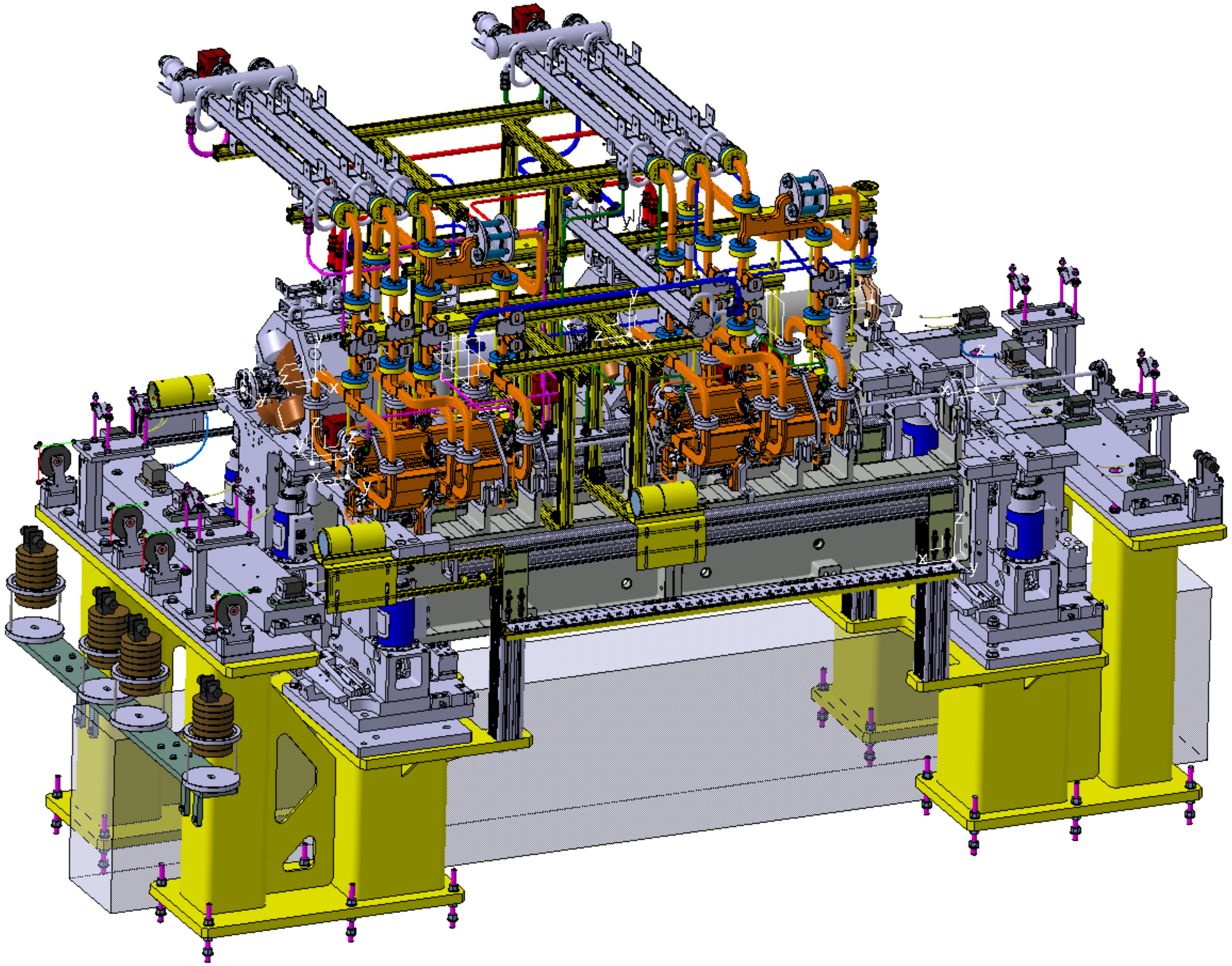
  - MBQ: No MBQ in T0 (LAB or CLEX). First MBQ to be implemented to LAB T1, but this will be an old design. MBQ will be instrumented for alignment studies, therefore not respecting the envelope reserved in CDR for T1 layout design -> LAB module design modified.

  New stabilisation design under work.

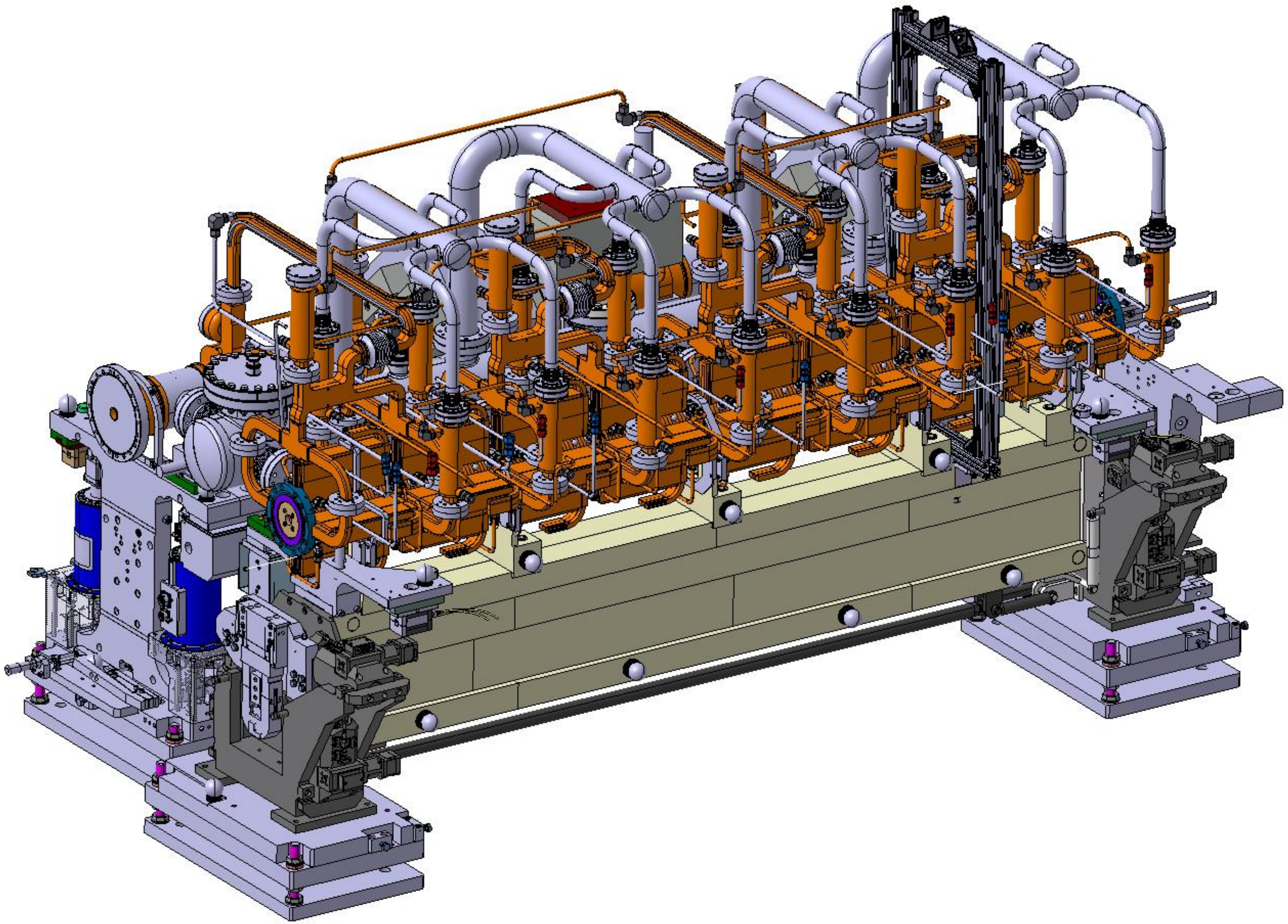
  - Depending on the selected support system used in adjacent module the envelope and interface between adjacent module and MBQ needs to be redesigned.

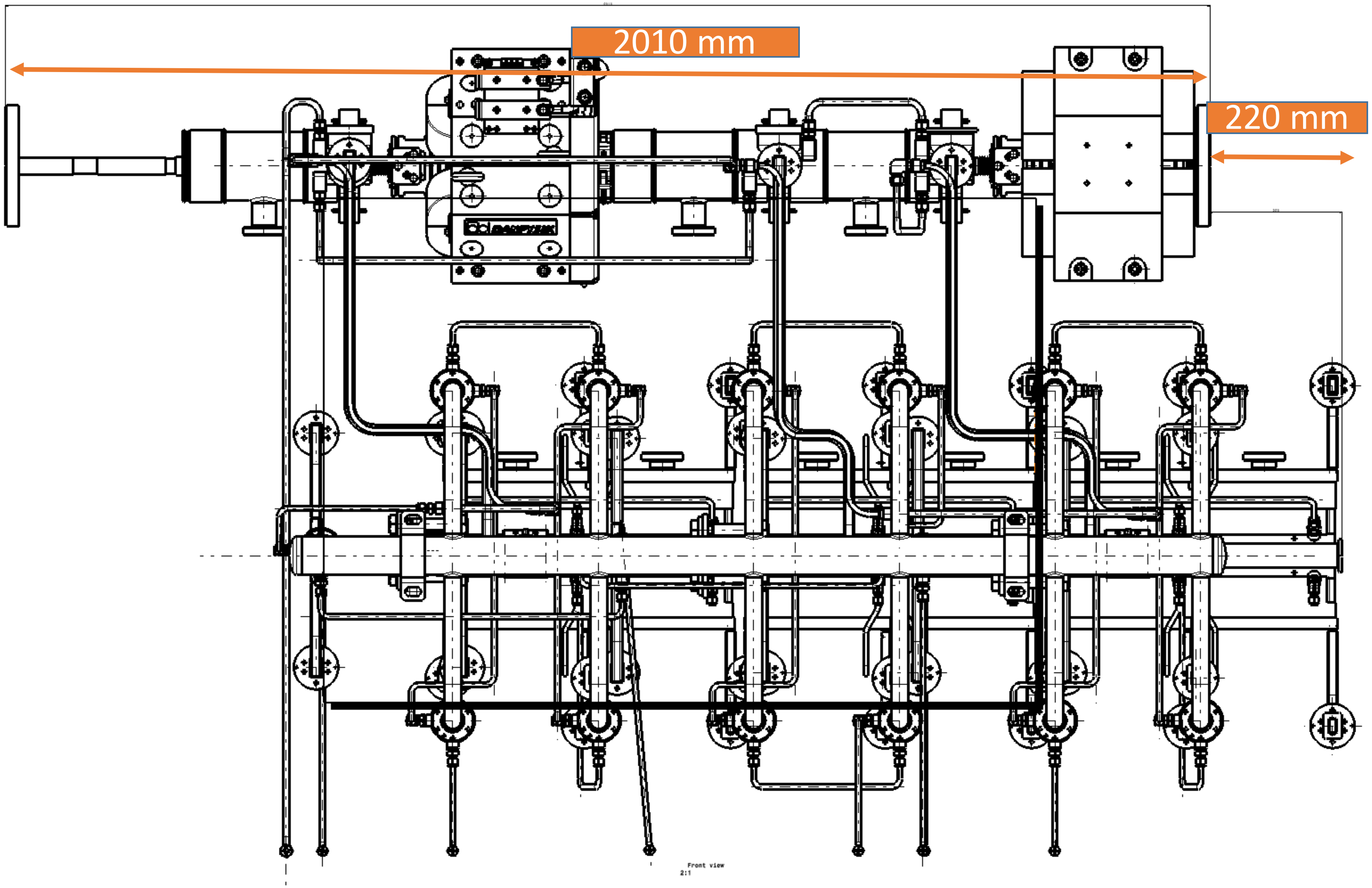
Implementation plan will be presented by Alex after lunch

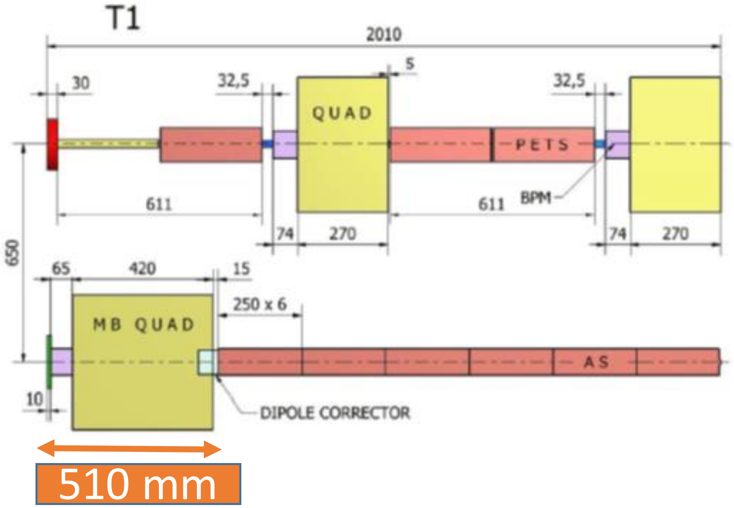
CLEX module



TBM T0#1 CAD




2010 mm
220 mm


T1
2010
30
32,5
5
32,5
QUAD
PETS
611
611
BPM
74
270
74
270
650
65
420
15
250 x 6
MB QUAD
AS
10
DIPOLE CORRECTOR
510 mm

In order to accomodate all needed configurations five types of modules are needed. Type-0 modules contain only accelerating structures in the Main Beam line (see Fig. 5.136) whereas Type-1 to Type-4 modules have Main Beam Quadrupoles (MBQs) of variable length, replacing 2, 4, 6 or 8 accelerating structures correspondingly (see Fig. 5.137).

The module components are mounted on alignment girders. The module length is determined mainly by considerations about the mechanical and thermal stability of the overall system. Presently a value of 2010 is chosen. Drive Beam linac simulations show that the Drive Beam Quadrupole spacing must be about 1 m with a quadrupole length of about 270 mm to produce sufficient strength. The remaining space is available for two PETS and the BPM. A length of 30 mm has been reserved for inter-girder connections. A few modules with only Main Beam and Drive Beam quadrupoles are needed where each Drive Beam is fed into and out of a Drive Beam linac sector.

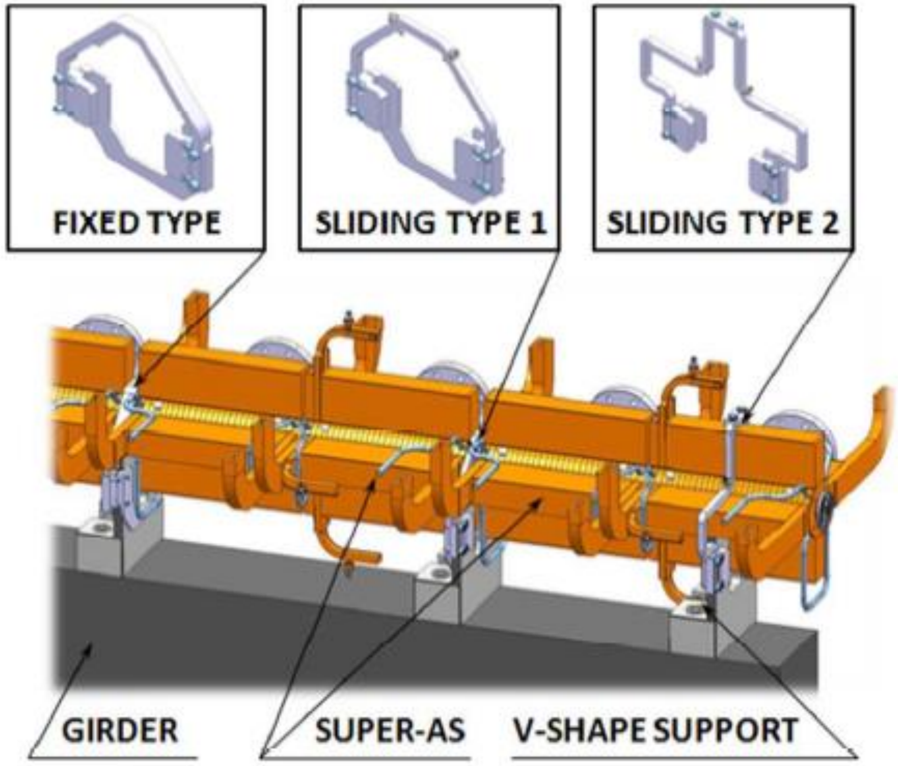
Module design and integration requirements

SYSTEM	REQUIREMENTS
RF	AS/PETS shape tolerance ± 2.5/ ±7.5 µm AS/PETS Assembly ± 15/ ± 25 µm
INSTRUMENTATION	BPM resolution: MB - 50 nm, DB – 2 µm, temporal - 10 ns (MB & DB),
SUPPORTING	Max. vertical & lateral deformation of the girders in loaded condition 10 µm
COOLING	~400 W per AS, ~ 7.5 kW per modules
MAGNET & POWERING	DB: 81.2-8.12 T/m, current density: 4.8 A/mm2, MB: 200 T/m
PRE-ALIGNMENT & STABILIZATION	active pre-alignment ± 14 µm at 1σ, beam axis included in a cylinder of radius 10 µm MB Q stabilization 1 nm > 1 Hz (vertical)
VACUUM	10^{-9} mbar
ASSEMBLY, TRANSPORT, INSTALLATION	same transverse interconnection plane for DB & MB

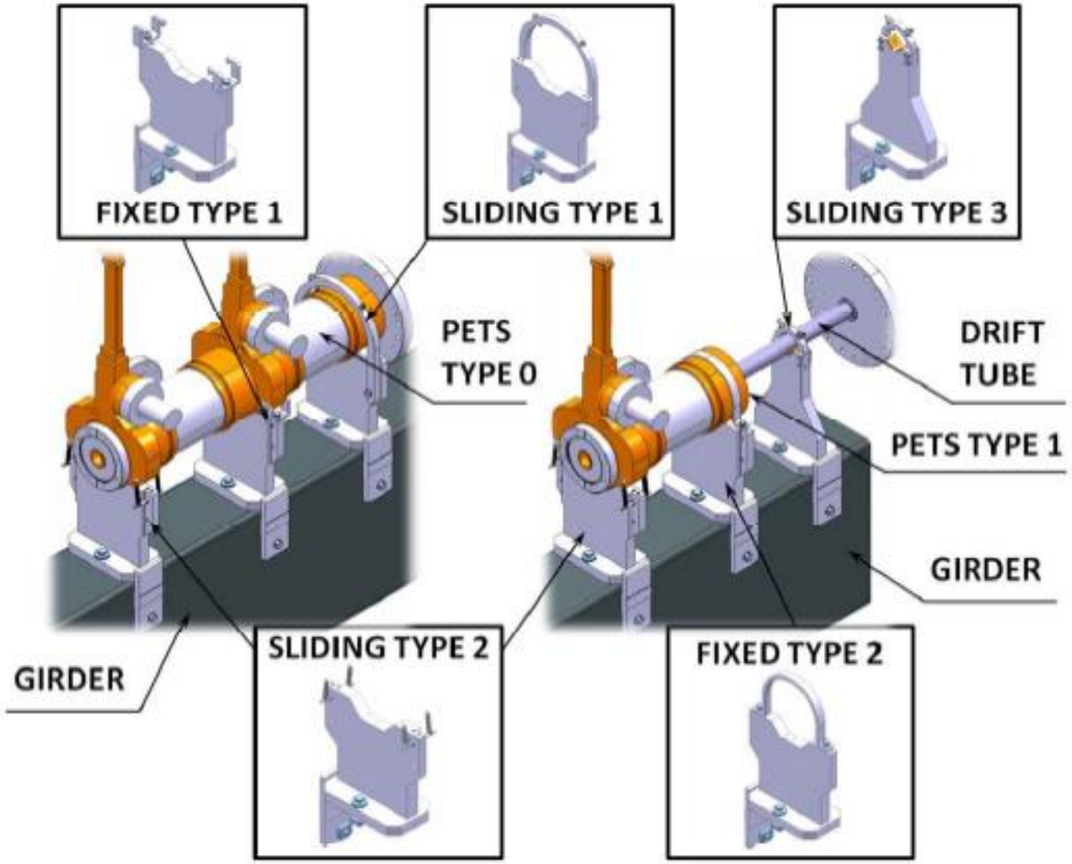
D. Gudgov

Baseline solutions defined for each technical system in the CDR

In CDR, Lab module T0#1, support



a) main beam



b) drive beam