CLIC09 WORKSHOP
WG5 – Technical system

Module baseline for CDR and test program

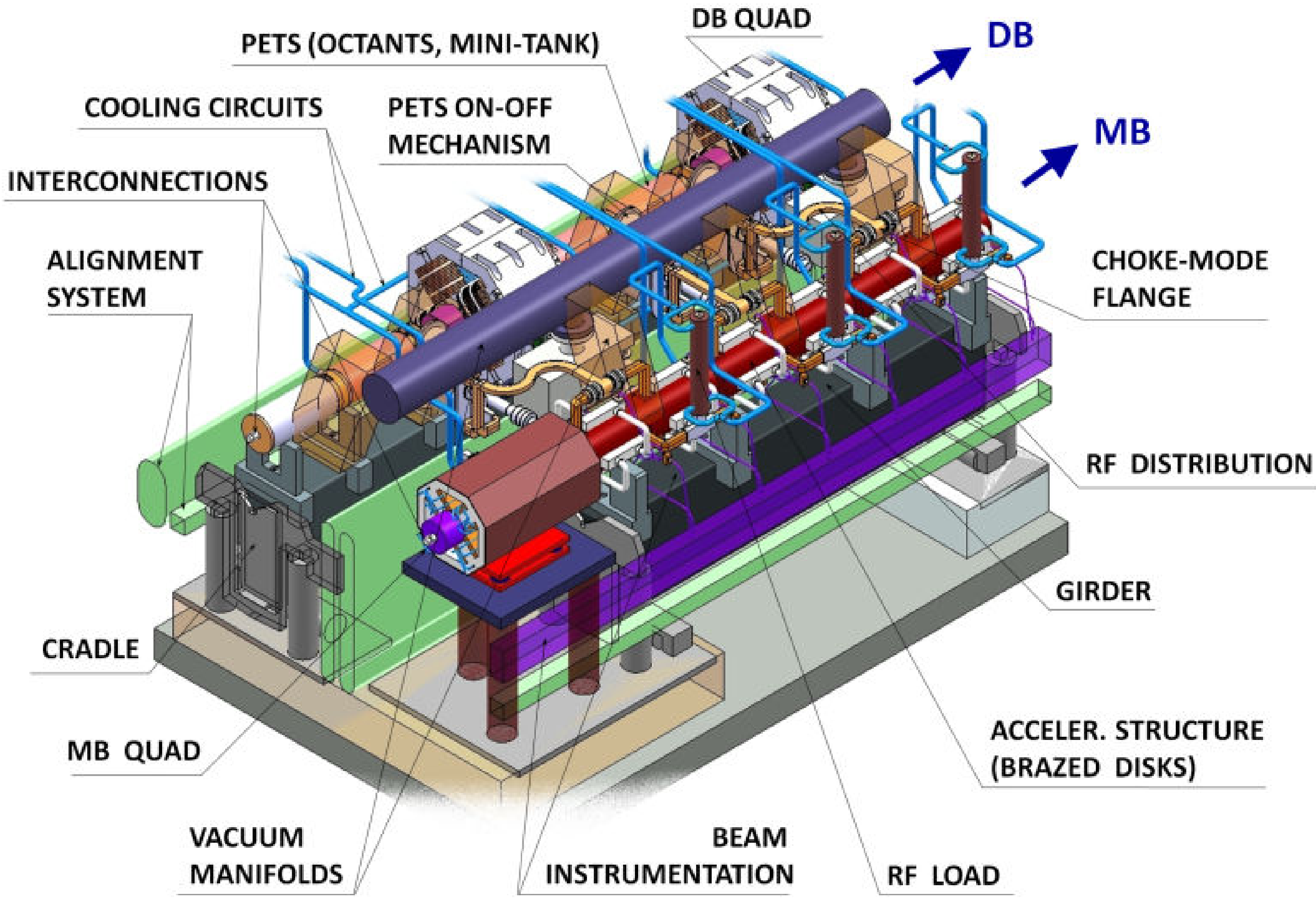
G. Riddone on behalf of the CLIC Module WG, 14.10.2009

Content

- Module design
  - baseline as validated in the module review on 15/16-09-2009
  - alternatives under study
- Test program
  - CLIC modules
  - CLEX modules

MODULE DESIGN:
BASELINE AND ALTERNATIVES

Module layout



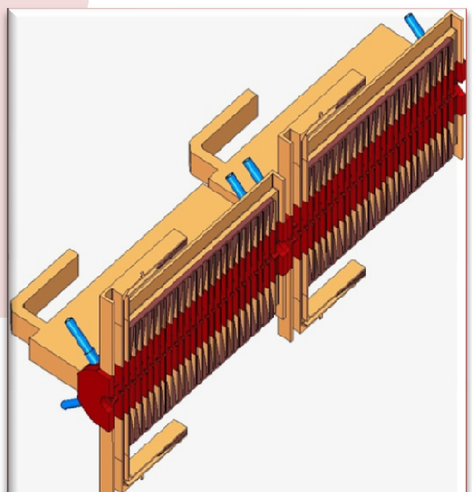
RF structures

- Accelerating structure: CLIC G, disks, waveguide damping sealed (100 mV/m, L = 230 mm, aperture ~ 5 mm)
- PETS, octants. mini-tank (6.5 MV/m, L=310 mm, aperture 23 mm)
- 1 PETS powering 2 accelerating structures

1 wake-field monitor per ac. structure

Water cooling

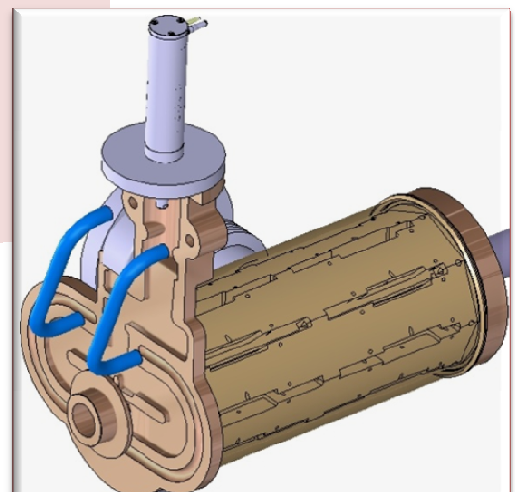
Vacuum manifold around each waveguide



PETS on-off

Water cooling for couplers only

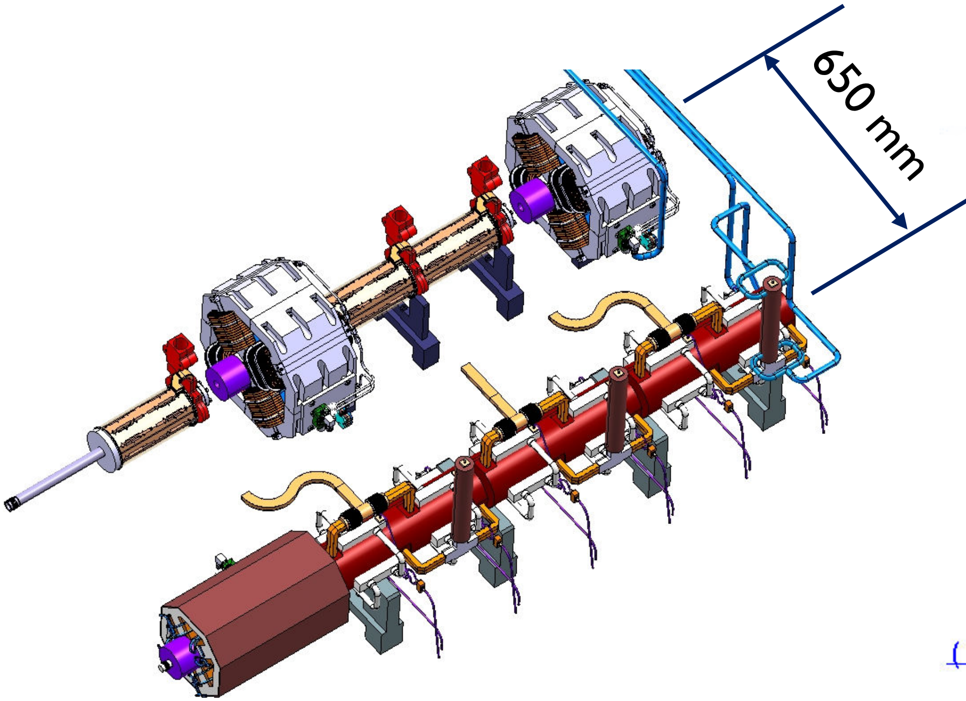
Mini-tank for octants

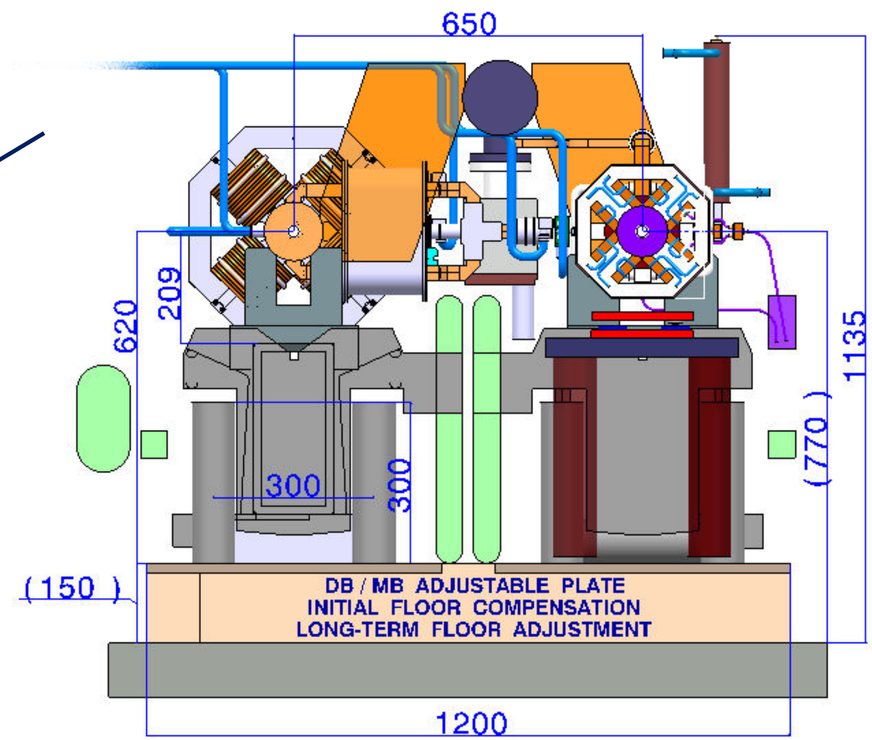


Beam height and interaxis

Beam interaxis: 650 mm ➔ same height for the two beams

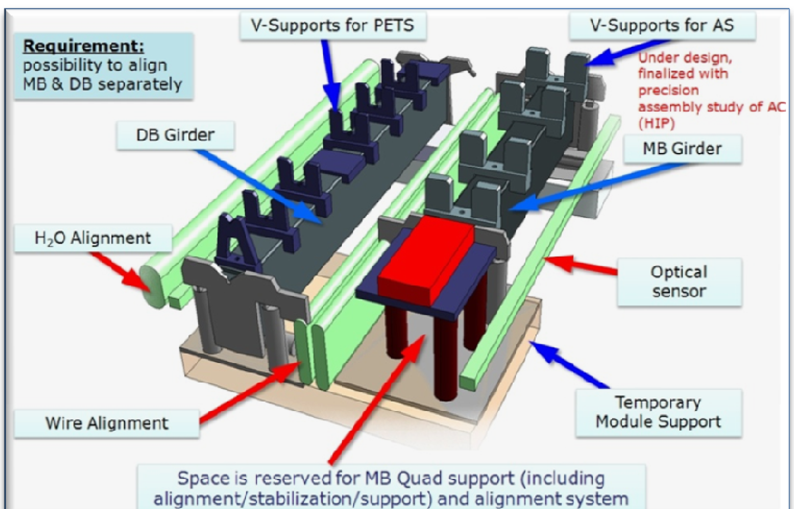
Beam height: 620 mm





Pre-alignment system/ girders

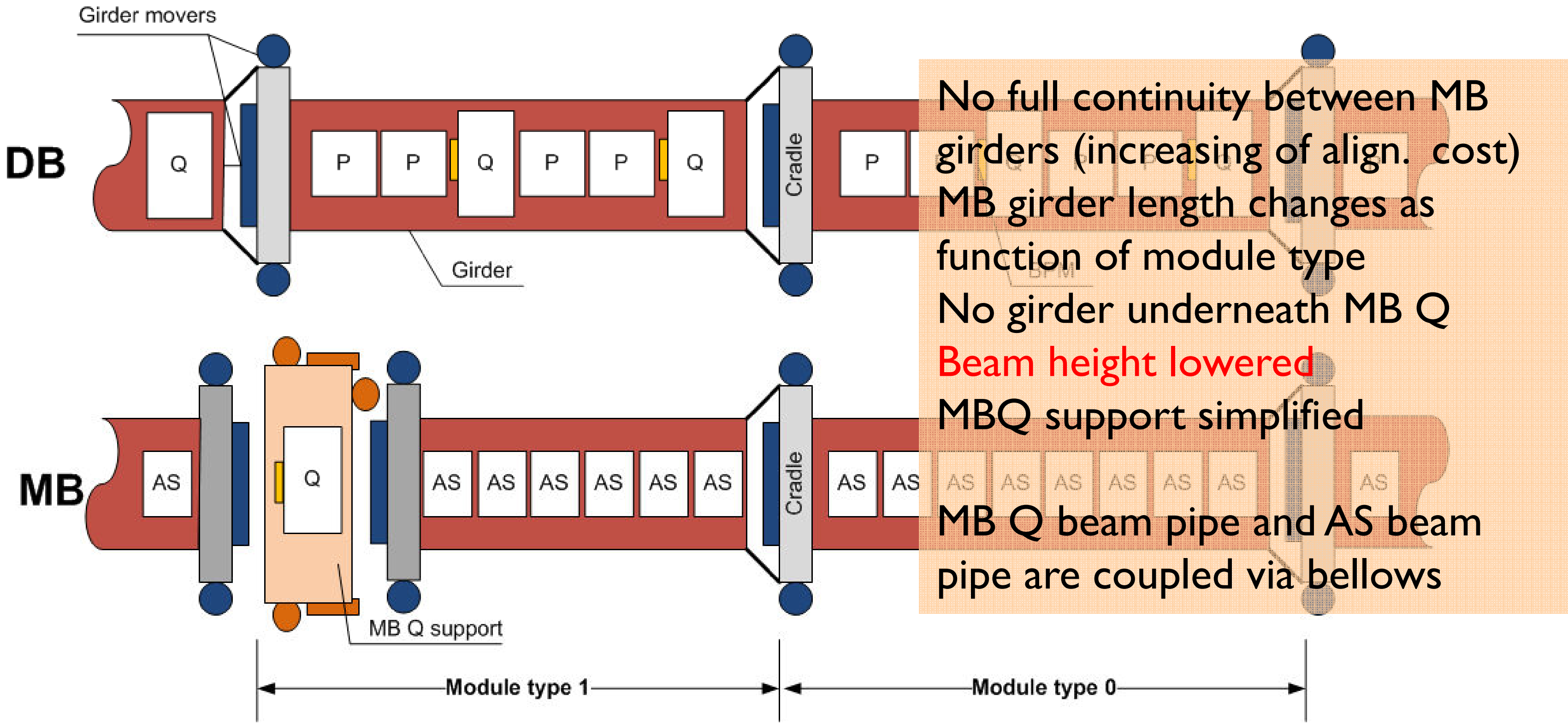
- Accelerating structures and PETS + DB Q on girders
- Girder end supports ➔ cradles mechanically attached to a girder and linked by rods to the adjacent one: **snake-system with articulation points adopted** (*DB: 100 A, MB: minimization of wakefields*, validation at 30 GHz in CTF2)
- Separate girders for main and drive beam ➔ possibility to align DB quadrupole separate from accelerating structures



Alternative under study: mono-girder
+ better stability, simplification for transport and installation
- non-independent alignment MB and DB (is separate align. needed?)
- additional weight for movers (cam system, are we ready?)

Support for MBQ - BPM

- Separate support for MB Q and its BPM ➔ snake system interrupted at each MB quadrupole
- MB Q and BPM rigidly mechanically connected

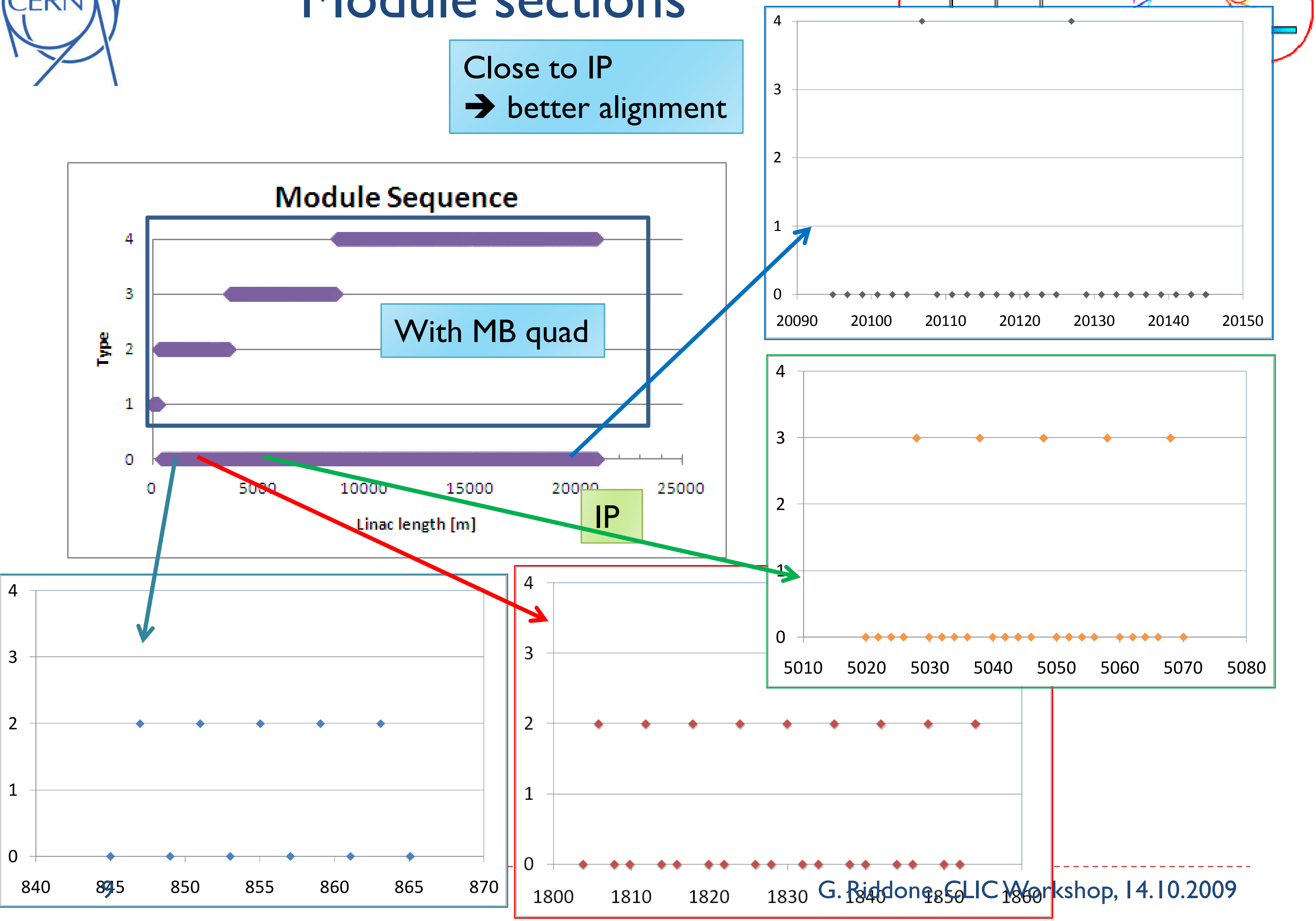


No full continuity between MB girders (increasing of align. cost)
MB girder length changes as function of module type
No girder underneath MB Q
Beam height lowered
MBQ support simplified

MB Q beam pipe and AS beam pipe are coupled via bellows

Module sections

Close to IP
➔ better alignment



Beam-Based Feedback

- Common actuators/devices for stabilization and beam-based feedback systems
  - extend dynamic range of stabilization actuators by 100 ! and make BBF corrections by displacing the MB quads.
    Fullscale = ± 5 um compared to ± 50 nm (several drawbacks)
- ***original configuration*** ➔ additional windings onto quad jokes in order to produce "a sort of dipole correction field"

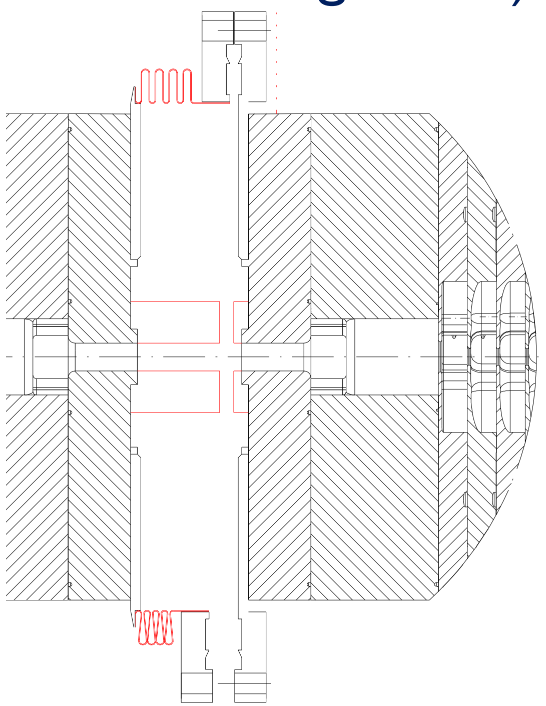
- MB quad: solid yoke, not possible to insert correct coils (bandwidth problems)

- ***New proposed configuration***: use electromagnetic correction coils for RT trajectory correction: 1 cm long 0.1 - 0.4 T magnet at each MB quad (feasibility under evaluation)

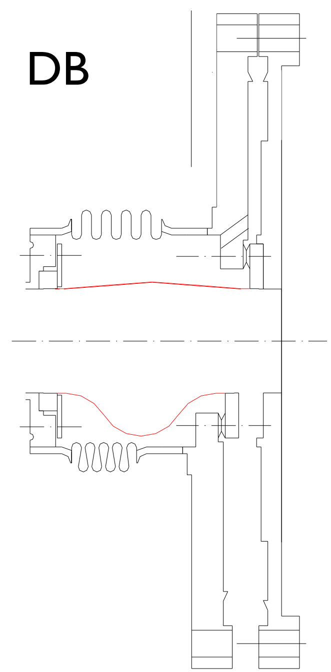
Interconnections

- MB: gap is accepted (damping is needed for the long range wake)
- DB: electrical continuity is required (100 A)
- MB-DB: choke mode flanges (flexibility needed during thermal transient and alignment)

MB



DB



Others

- Vacuum design based on 10^{-8} mbar requirement
- Cooling
  - Water cooling for RF structures and quadrupoles
  - Air cooling for quadrupole cables (powering strategy)
- Instrumentation
  - BPM: 1 per Q
  - WFM: 1 per ac. structure

TEST PROGRAM

Motivation for Test Modules

One of the feasibility issues is the two beam accelerating (two beam module is part of the program)

- Address feasibility issues in an integrated approach
  - e.g. RF structures, stabilization-alignment-supporting systems
- Establish coherence between existing test set-up up to future test modules in CLEX
- Validate technical systems (tests in the labs) - if possible use components from stand-alone tests for test modules in CLEX
- Validate two-beam acceleration scheme (tests in CLEX with beam)

Test modules

TEST MODULES

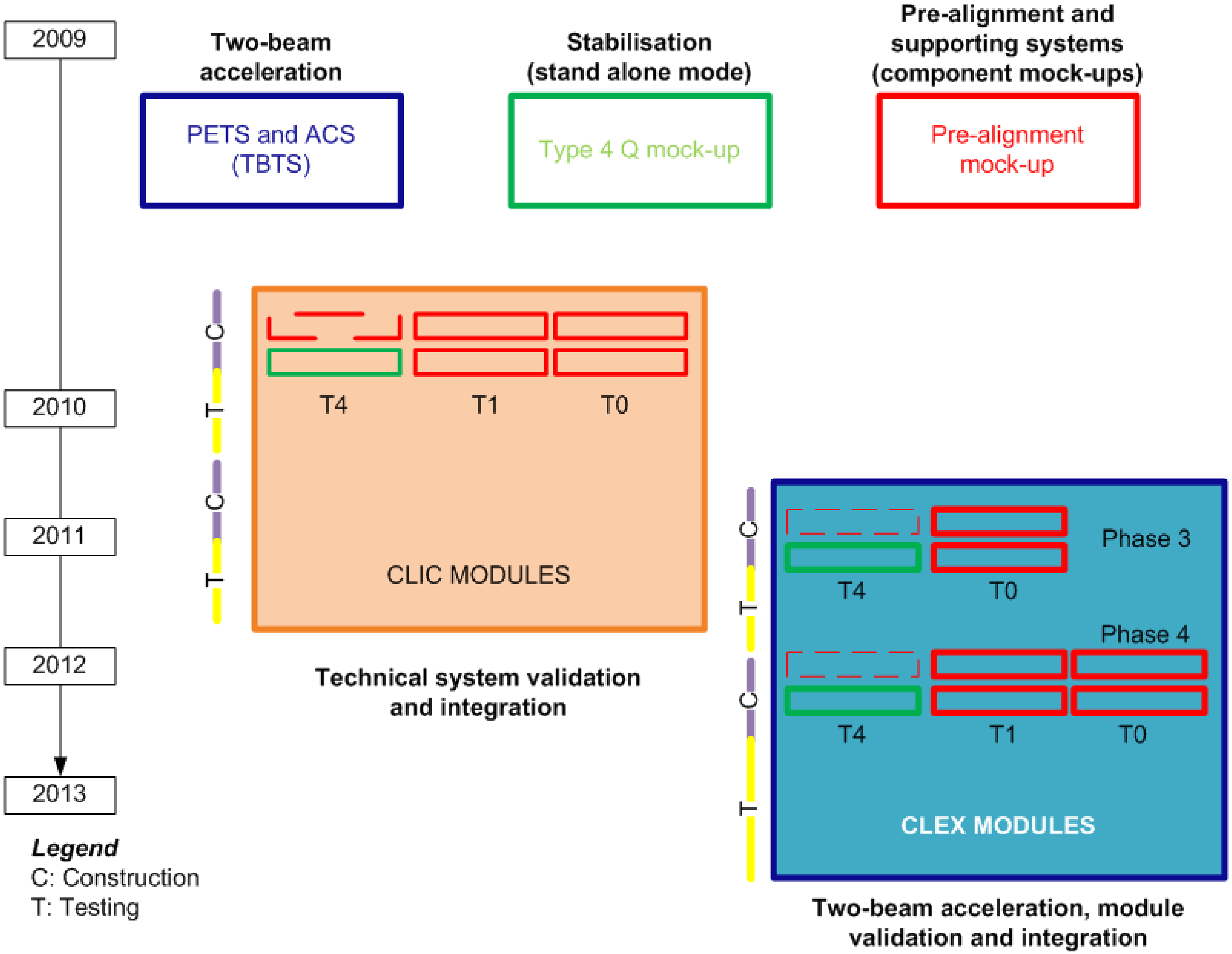
one project with two parallel lines

CLIC modules
(as much as possible close to CLIC modules)

CLEX test modules
(Eucard – NCLinac – WP9.2/9.3) (to be adapted to test infrastructures)

We have to establish a test program with clear milestones before and after CDR

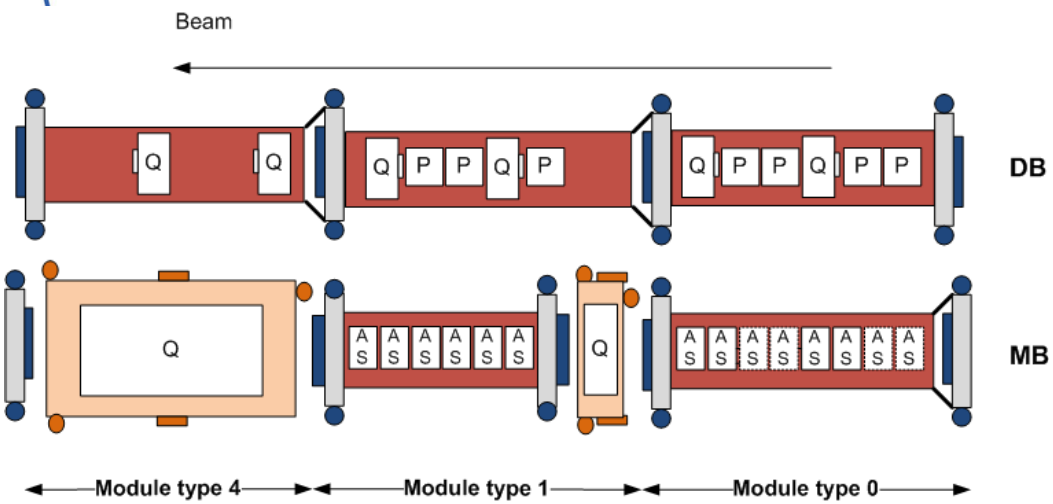
Strategy for main linac two-beam module validation



Objectives of the CLIC modules

- Integration of all technical systems (dummy RF structures and quadrupoles can be used – real dead weight and interfaces to other systems)
- Full metrology
- Pre-alignment of MB and DB, including fiducialisation
- Interconnections validation under different simulated thermal loads
- Stabilisation of main beam quad in the module environment
- Vibration study of all systems and identification of vibration sources
- Measurement of resonant frequencies
- Heating in several thermal cycles. Measurements of thermal transient e.g. how long it takes to achieve a new equilibrium state.
- Transport of the module and verification of alignment

CLIC modules (LAB)



The test module types 0-1-4 are representative of all module types

Phase 1

- Pre-alignment validation with dummy elements
- Interconnections - pumping (static conditions)
- Repositioning
- Measurements of resonant frequencies

Phase 2

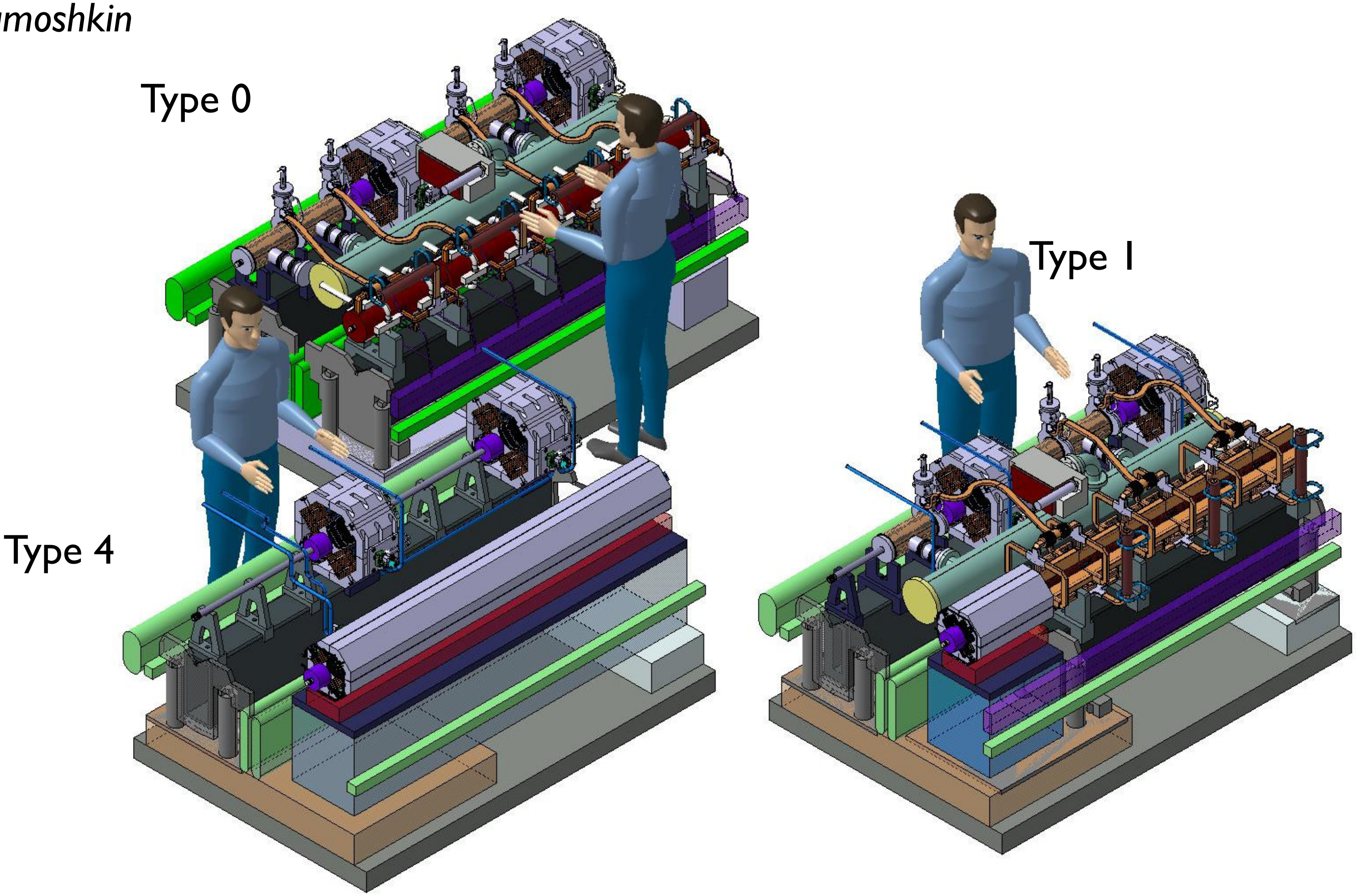
- Transport and thermal cycles
- Measurements of resonant frequencies

Phase 3

- Stabilization (Q) and pre-alignment compatibility
- Vibration study of all system and vibration sources

014 CLIC modules

A. Samoshkin



Objectives of the test modules

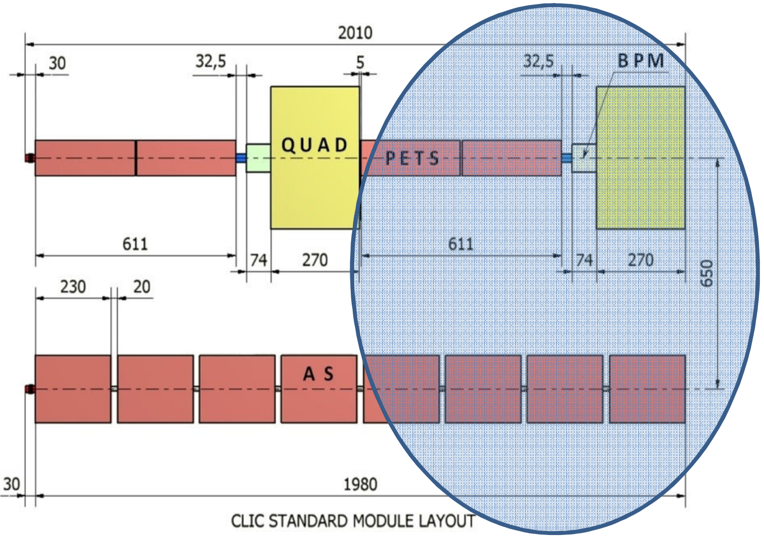
- Two-beam acceleration in a realistic environment
- Cost- and performance optimized structures and their integration in CLIC modules.
- Accelerating structure (ACS) alignment on girder using probe beam
- Wakefield monitor (WFM) performance in low and high power conditions (and after a breakdown)
- Investigation of the breakdown effect on the beam

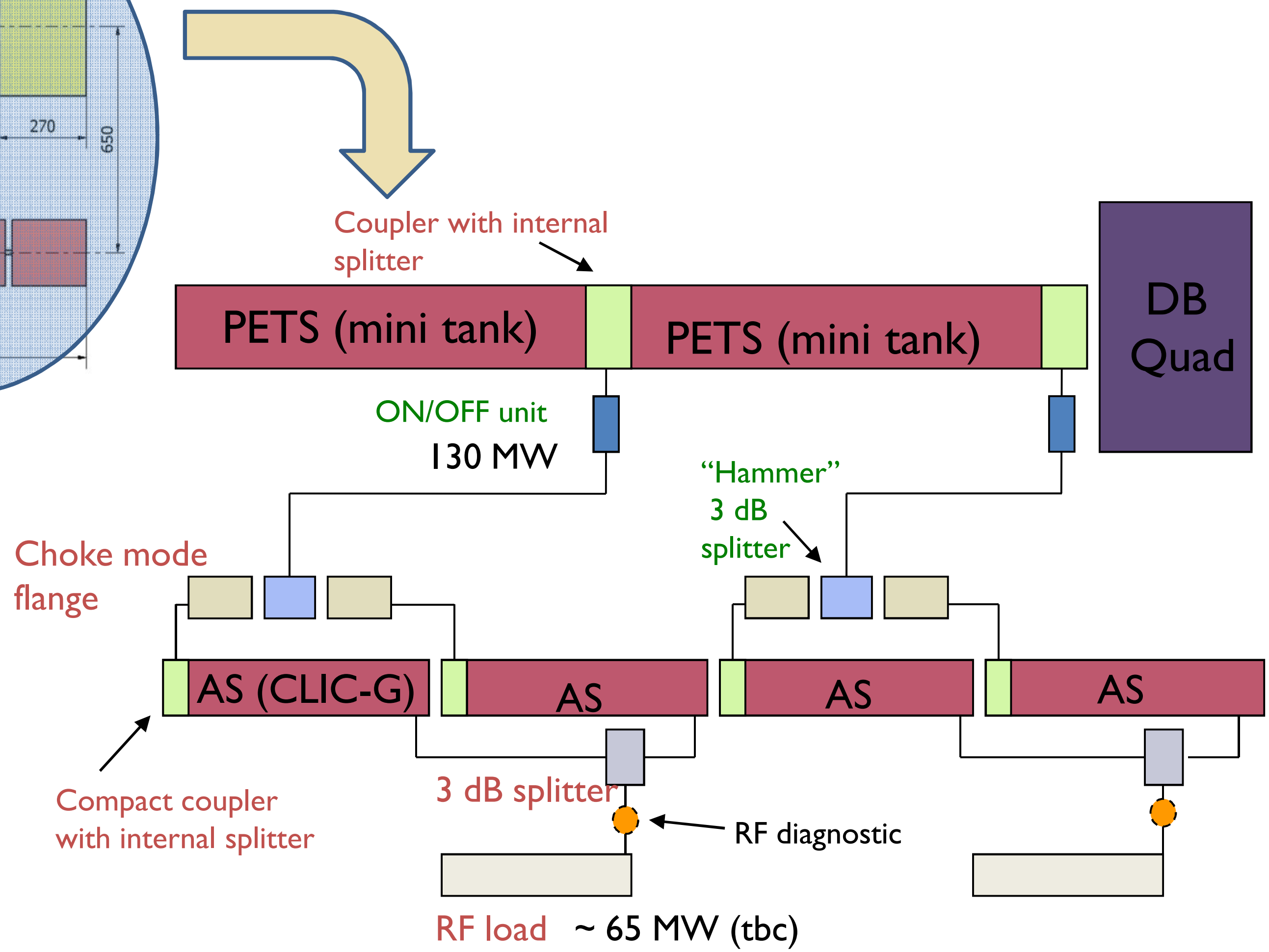
- Alignment and stabilization systems in a dynamic accelerator environment
- RF network phase stability especially independent alignment of linacs
- Vacuum system performance especially dynamics with rf
- Cooling system especially dynamics due to beam loss and power flow changes

- Integration of all different sub-systems: , i.e. to simultaneously satisfy requirements of highest possible gradient, power handling, tight mechanical tolerances and heavy HOM damping

- Validation of assembly, transport, activation, maintenance etc.

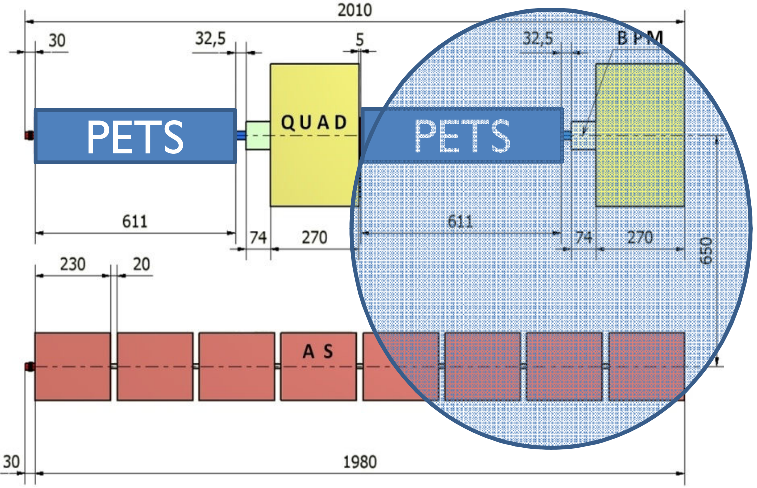
From CLIC module to CLEX module





CLIC module type 0

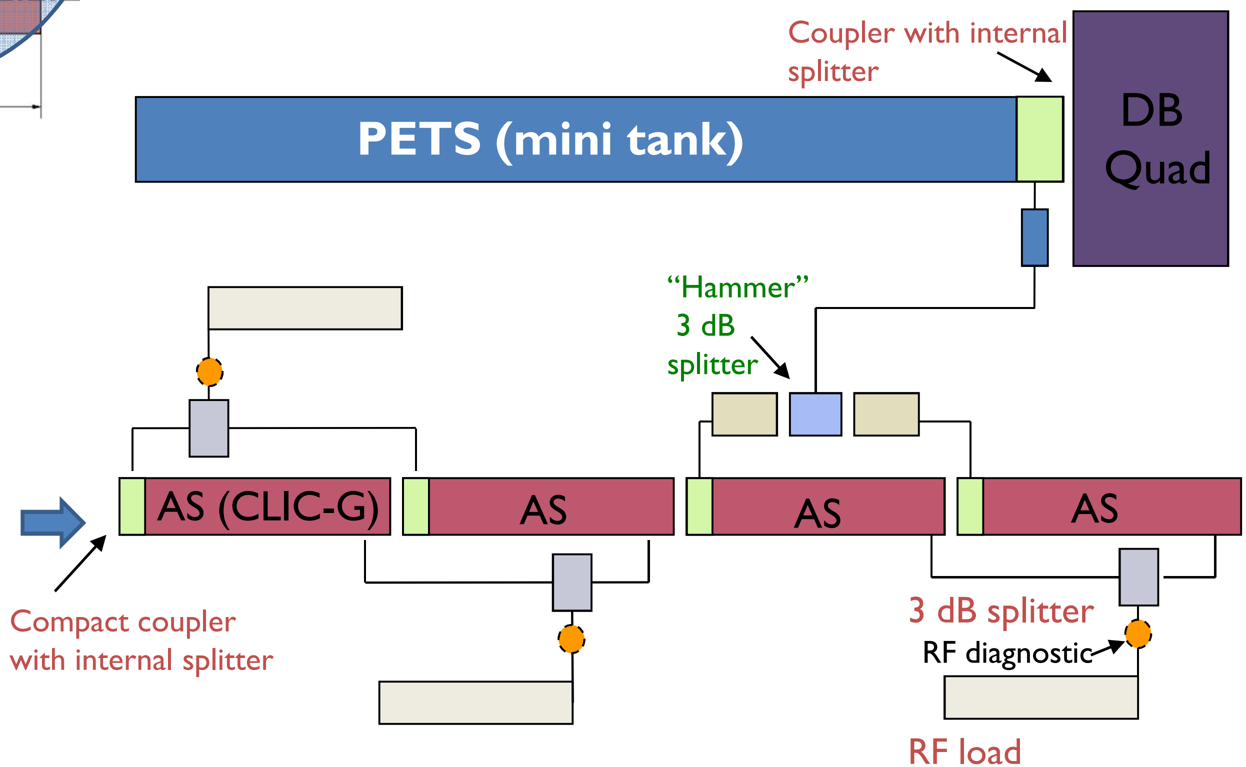
From CLIC module to CLEX module



Parameters	CTF3	CLIC
Energy	0.150 GeV	2.4 GeV
Pulse length	1.2 μs	140 μs
Multiplication factor	2 x 4 = 8	2 x 3 x 4 = 24
Linac current	3.75 A	4.2 A
DB final current	30 A	100 A
RF frequency	3 GHz	1 GHz
Repetition rate	up to 5 Hz	50 Hz
Energy per beam pulse	0.7 kJ	1400 kJ
Average DB power	3.4 kW	70 MW

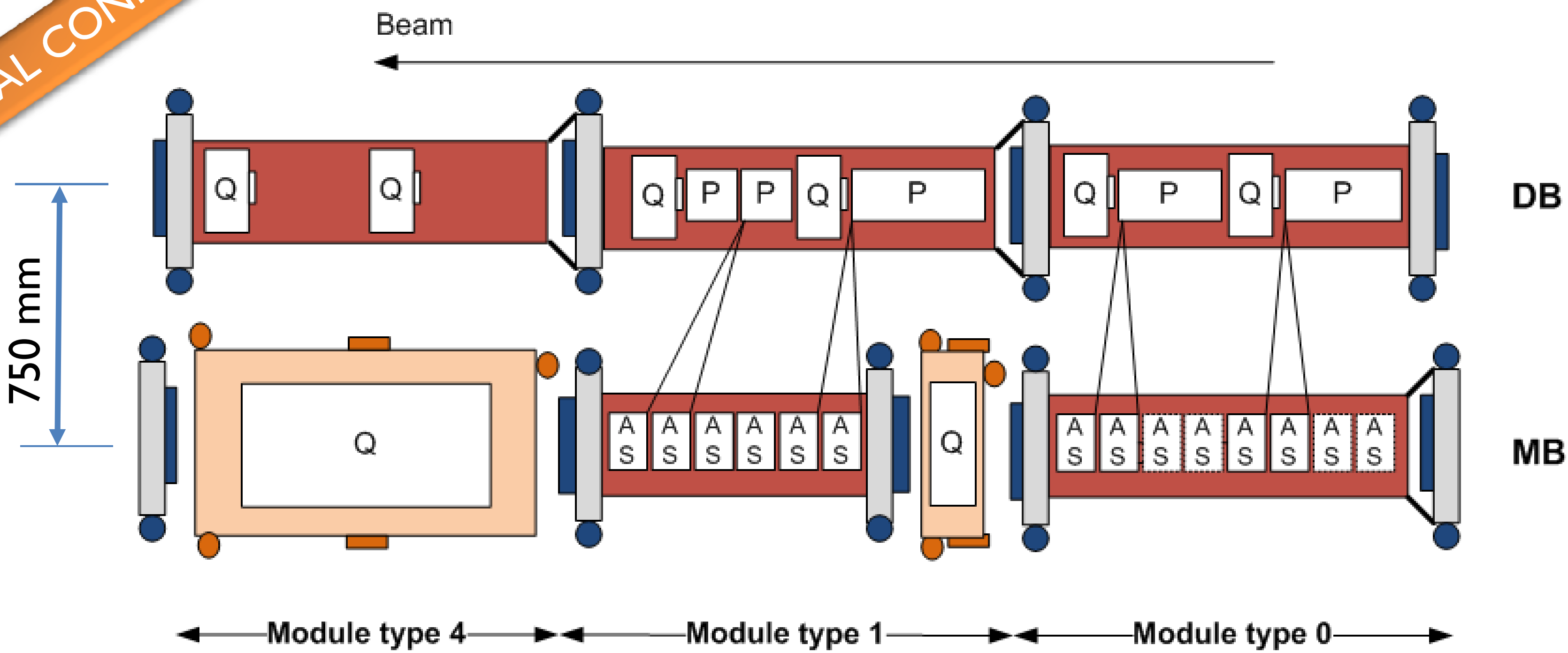
CLEX module type 0

Existing 1-m PETS with recirculation



FINAL CONFIGURATION

CLEX module



All AS are with WFM

16 accelerating structures
5 PETS

Phase 3: Modules 0 and 4
Phase 4: Module 1
- 4.1: double length PETS
- 4.2: two CLIC PETS replacing 1 double length PETS

CLEX modules - configurations

Phase 3, Conf. 3.1

Nominal power and pulse length for 1 PETS and 2 AS
Recirculation
12 A and 240 ns

Phase 3, Conf. 3.3

No modifications on the test module type 0 HW
No Recirculation
Current increase from 12 A to 19.2 A
Pulse length reduced from 240 ns to 140 ns

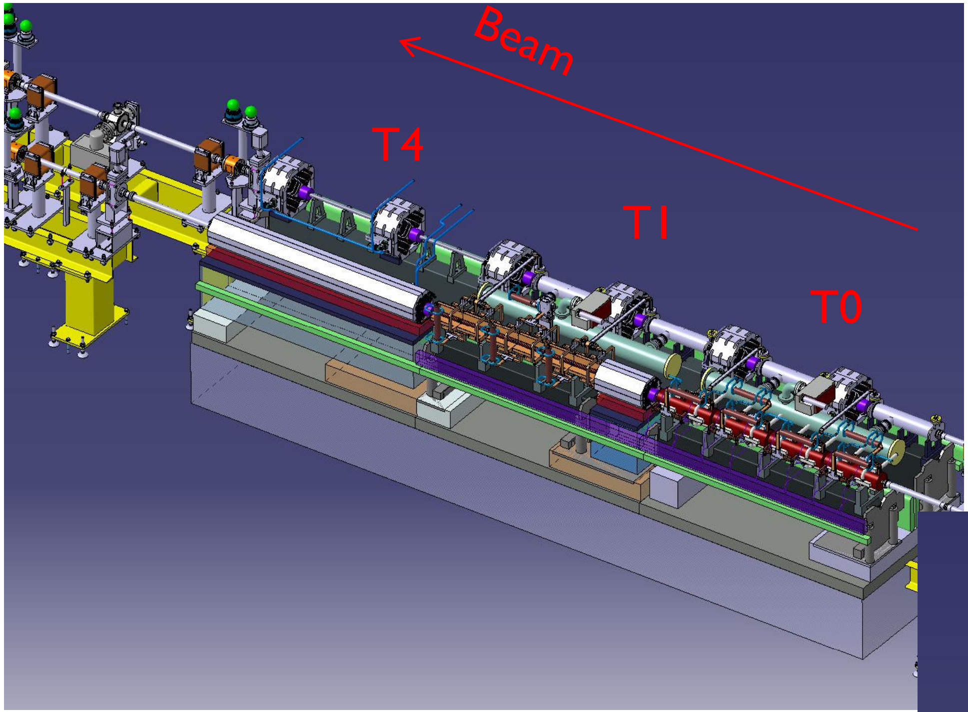
Phase 4, Conf. 4.1

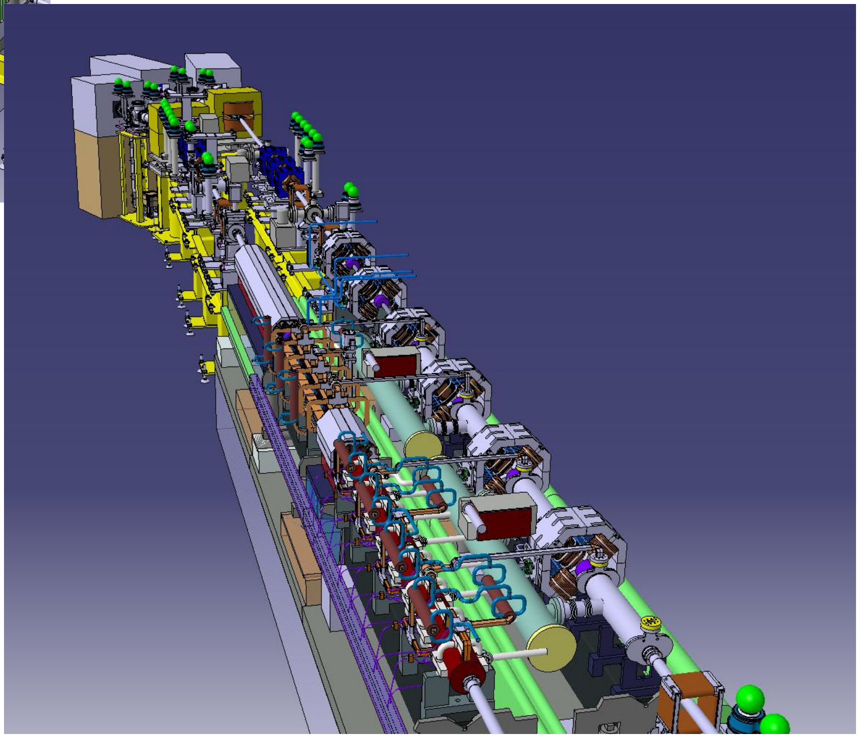
No modifications on the test module type 0 HW
Addition of a module type 1
Increase of current from 19.2 A to 22 A

Phase 4, Conf. 4.2

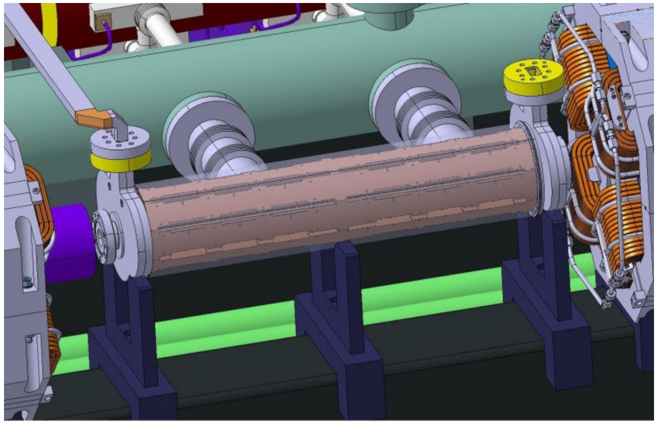
Modification on the test module type 1 HW (2 CLIC PETS)
Needed klystrons and PC

A. Solodko





Double-length PETS



CONCLUSIONS

- Baseline defined for CDR
  - In parallel study of alternatives (e.g. cam system)
- Design has to be frozen by 1Q 2010 – a lot of work and limited resources: needed close collaboration with all technical experts
- Test module project with two parallel lines:
  - in the lab (from 2010)
  - in CLEX (from 2011) [also part of EuCARD – WP9.2 (G. Riddone /WP9.3 (A. Jeremie))