LAB modules update

CLIC workshop 2016

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on behalf of the TBM team

20/01/2016

Overview

- Summary
- Configuration T0-T0-T1
- Component changes
- Testing Plan

Summary - Goals

Ambient temperature

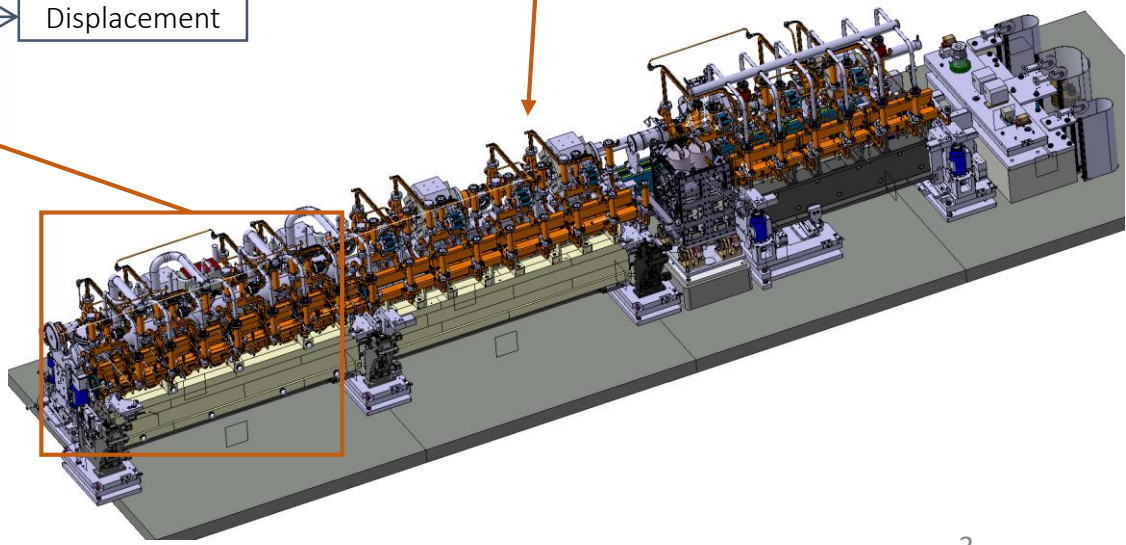
Air velocity

Thermal power

Water flow

Temperature

Displacement



Mock-up of a real module (2m) where we study:

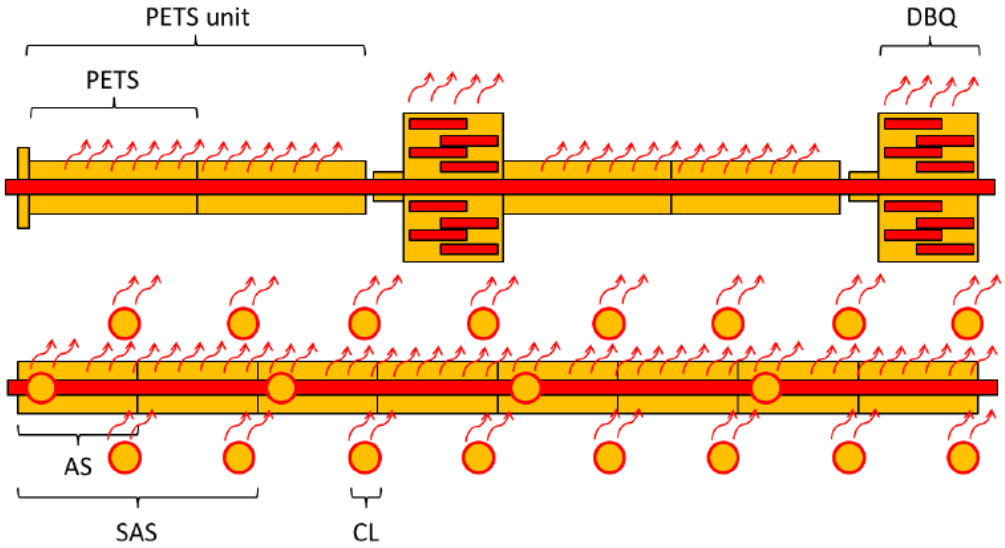
- Thermomechanical behaviour
- Interconnection of modules
- Assembling
- Prealignment
- Transportation

Summary - 2015

- One module successfully installed
- Testing completed, both steady state and transient conditions
- FEA simulator validated
- Several issues have been addressed, many components updated
- Procurement and new installation began

Previous setup

- One TBM, type 0
- Components mock-ups
- Heaters simulate heat dissipation

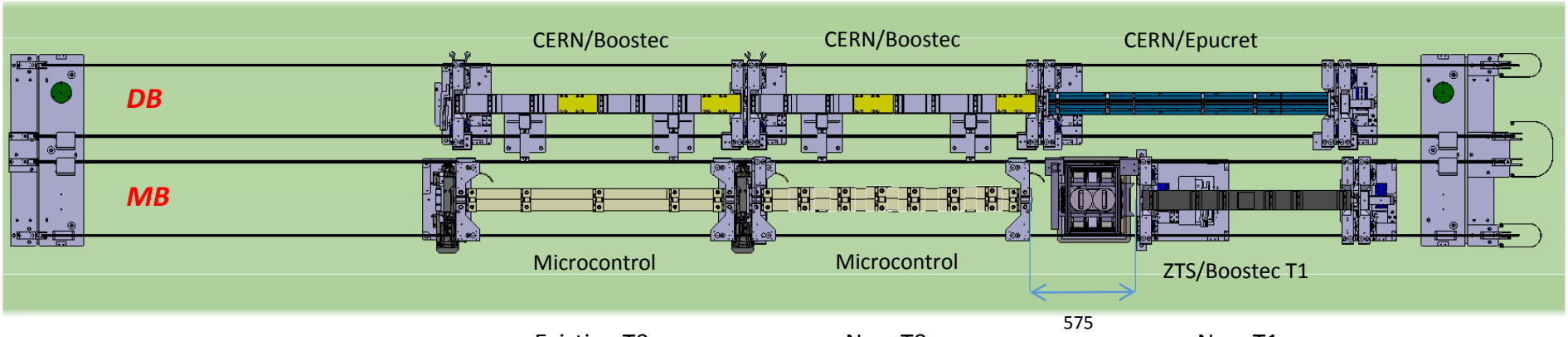


Limitations:

- DBQ mock-ups without cooling
- Single heaters through beam lines – Poor testing range
- No UHV tests possible due to leaks
- Central vacuum mechanically couples the two beamlines

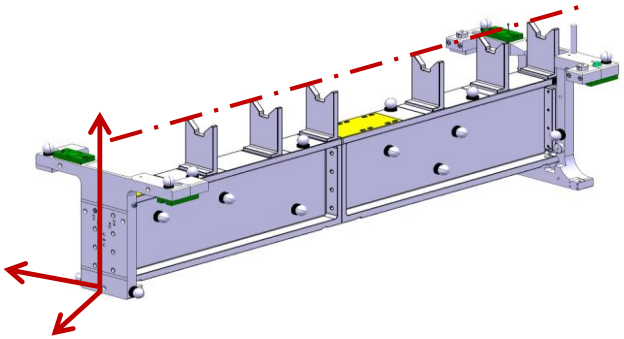
New configuration

- Addition of 2 modules
- 3-module string
- Configuration T0-T0-T1
- Variety of supporting systems
- Great flexibility for testing

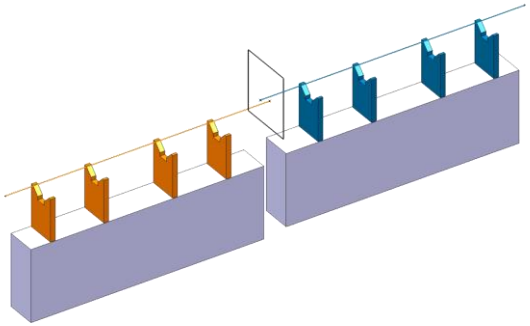


Supporting system

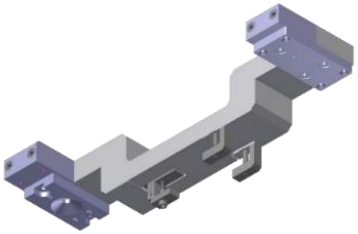
- Fiducialisation of the girders
  - Linking fixed targets to beam line



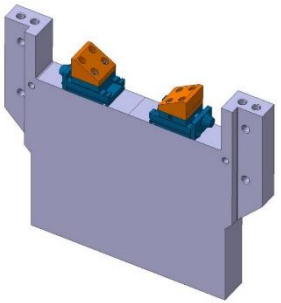
- Adjustable articulation point
  - Fixing possible discontinuities between adjacent girders



- Improvement of WPS support
  - WPS original interface was losing link over time
  - New design, based on flexural joints

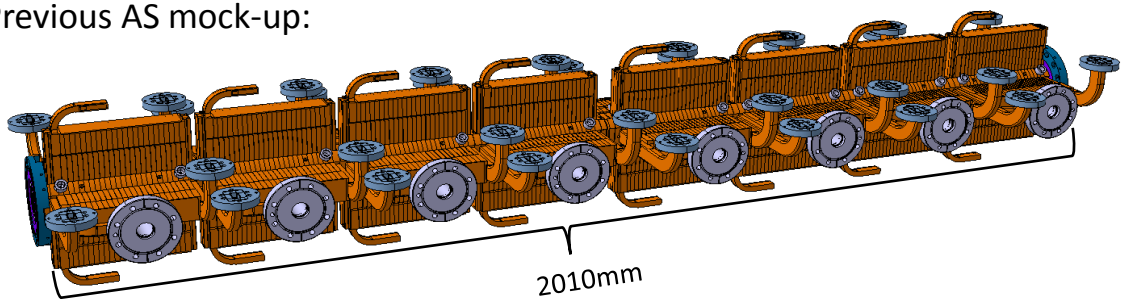


- Adjustable V-supports
  - Relaxing girder tolerances
  - Better pre-alignment
  - Under development



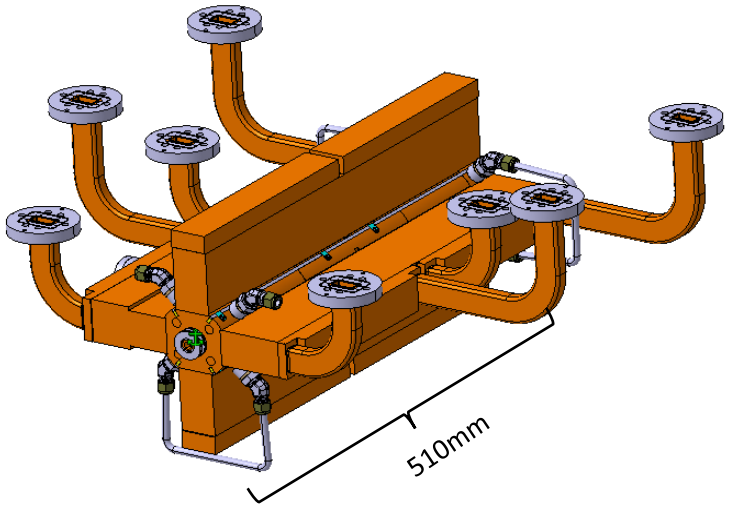
Structures

Previous AS mock-up:

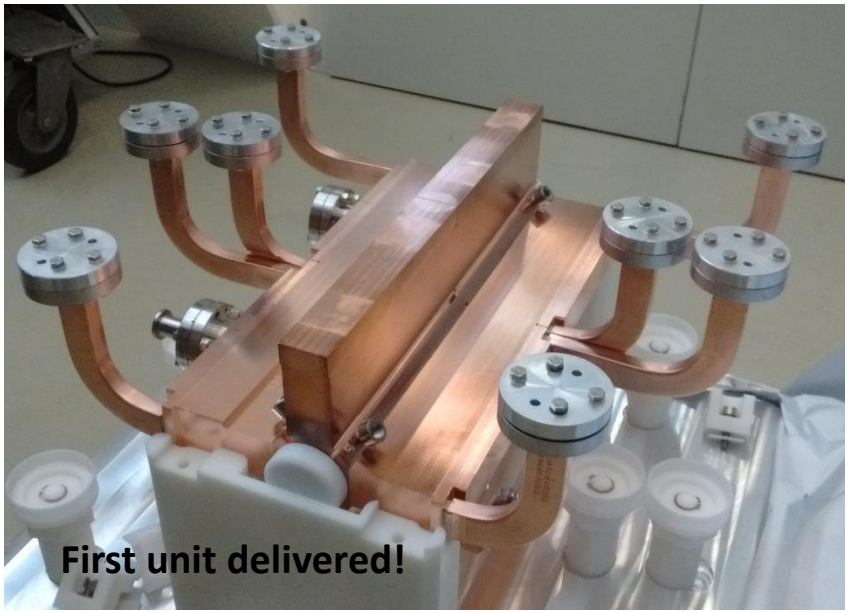


New AS mock-up:

- Simplified single piece core
- Damping material included
- Independent heaters on the outer side
- Possibility of simultaneous vacuum and thermal loading
- Integrated cooling for both AS



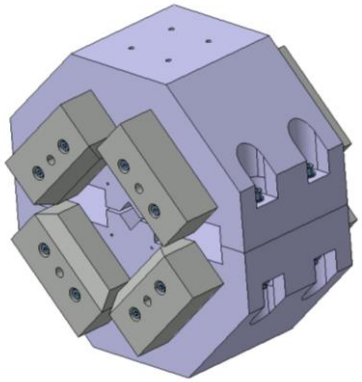
- 6 units in Industry (first time)
- 1 unit in CERN

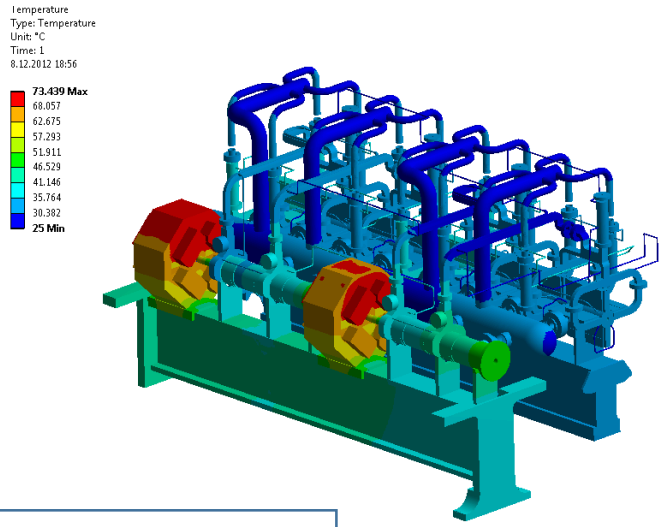


DB Quads

Current mock-ups

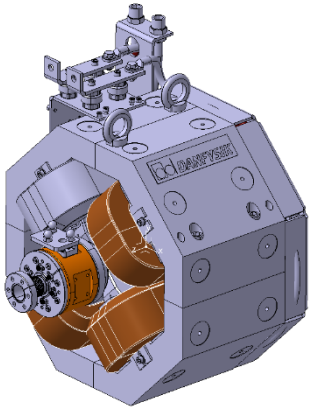
- No coils
- Heated by electrical heaters
- No cooling
- Distorted thermal results – too much heat to the girder

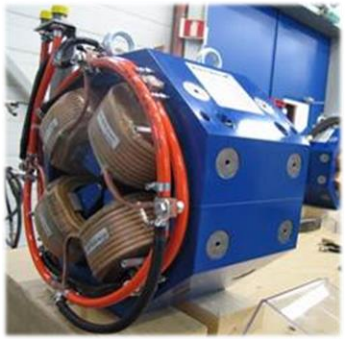




Real DBQs

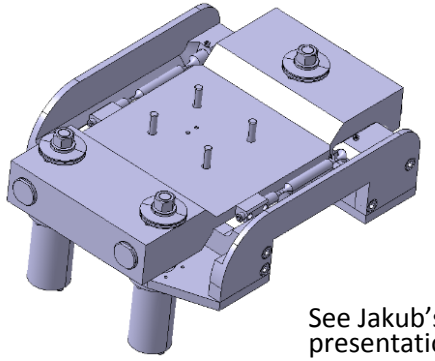
- Water cooled
- Real heat dissipation





Adjustable supports

- Big success in CLEX
- Option for motorisation

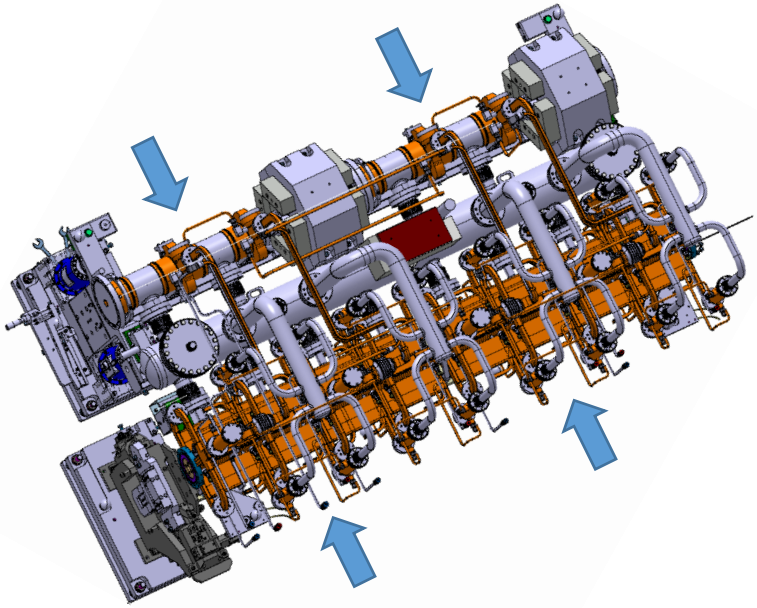


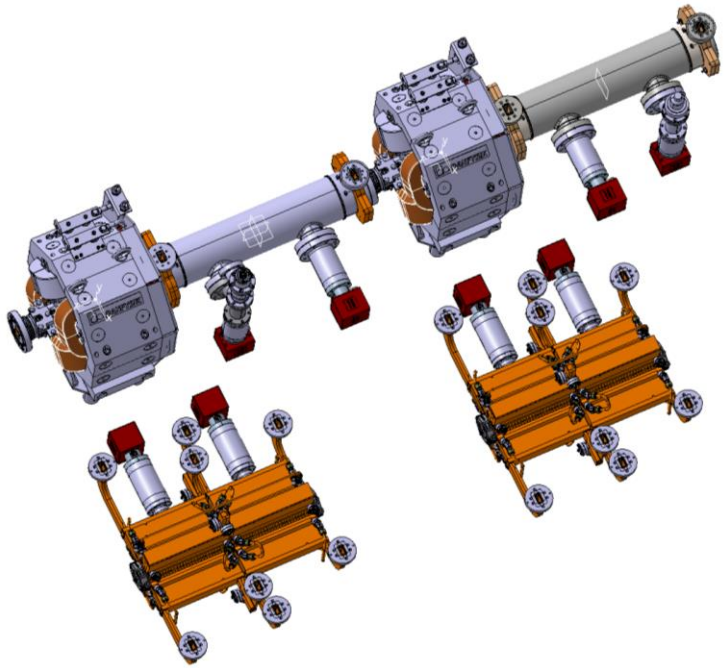
See Jakub's presentation

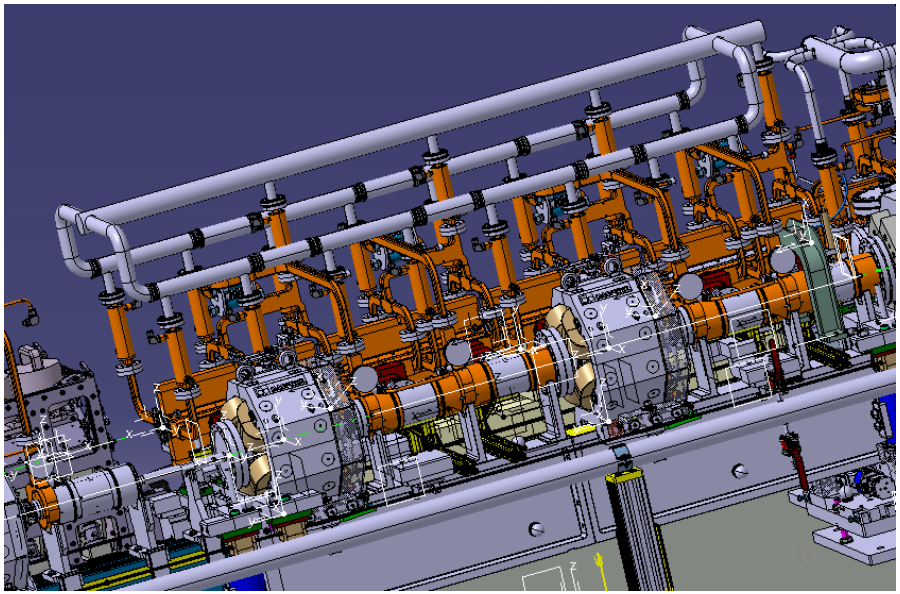
Vacuum System

Decoupling of the two girders:

- Mini pumps on PETS and SAS
- Independent vacuum tank for MB
- Tested in CLEX
- Designed to cancel vacuum forces







Testing capabilities

- Vacuum tests
- Vacuum + thermal
- Independent SAS breakdown study
- Module interconnection, including MB quad
- Accurate DBQ thermal behaviour
- More relevant alignment experiments on module string

Testing objectives

Pre-alignment

- Fiducialisation
- Installation
- Alignment

Observation

Behaviour under operating conditions

Action

- Translate to real CLIC
- Feedback to design
- Control algorithms

Experimental program

Pre-alignment

Test	Description
Fiducialization of components and supports for T0#2 and T1	• Adjustment and test of new V-shaped supports • Installation of fiducials and sensors interfaces • Magnetic measurements for DBQ
Alignment of components on their supports	• Measurements and adjustments • Preparation of the 2 standard DBQ supports : assembly & validation • Preparation of the 2 non-standard DBQ supports : design, assembly & validation
Alignment of girders	
Installation of sensors	• Calibration & test • Validation in situ • Installation of cables & acquisition system • Analysis of data
Active algorithm	• Implementation • Validation

Experimental program

Observation

Test	What we do	What we learn
Articulation point	• Shocks, loads, constraints • T°	• Investigate stability over time
Thermo-mechanical test without vacuum	• Nominal operation mode • Transients	• Comparative assessment T0-1, T0-2 • Study T1 • Modules interconnection • Comparative assessment of cradle sensors • MB-DB dependence
Vacuum tests	Apply vacuum	• Displacement of girders • Roll • Displacement of cradles
Thermo-mechanical test under vacuum	• Vacuum • Nominal operation mode • Transients	• Steady-state and time constants under vacuum • Modules interconnection • MB-DB dependence
Failure modes	• SAS breakdown • PETS breakdown	• Temperature and displacement during breakdown • Maximum acceptable duration for breakdown
Vibration tests	Add accelerometers	• Sources of vibration • Dangerous eigen-frequencies

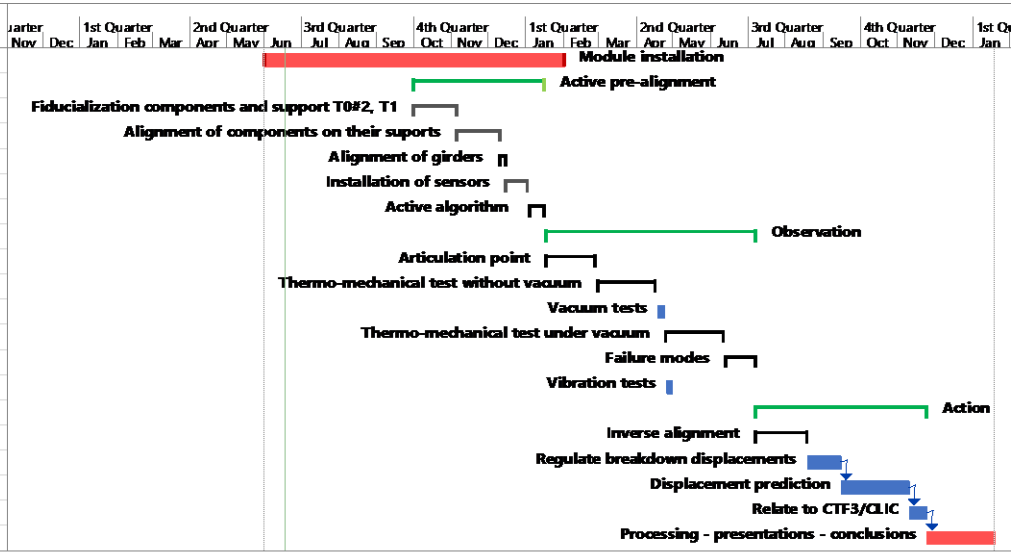
Experimental program

Action

Test	Description
Inverse alignment	Pre-align in negative displacements and test if under nominal operation the components align at correct zero position
Regulate breakdown displacements	• Time constant depends on water flow • Develop control algorithm to regulate water flow towards minimization of displacement
Displacement prediction	• Can we predict displacement from temperature using a simple mathematical model? • Development of real-time displacement diagnostic • Comparison with simulator • How many temperature inputs do we need?
CTF3/CLIC	Relate module to CTF3 • CLEX • Dogleg

Planning

ID	Task Mode	Task Name	Duration	Start	Finish
1		Module installation	176 days	Mon 01/06/15	Sun 31/01/16
2		Active pre-alignment	77 days	Thu 01/10/15	Fri 15/01/16
3		Fiducialization components and support T0#2, T1	25 days	Thu 01/10/15	Wed 04/11/15
7		Alignment of components on their suports	26 days	Thu 05/11/15	Thu 10/12/15
11		Alignment of girders	2 days	Fri 11/12/15	Mon 14/12/15
13		Installation of sensors	14 days	Tue 15/12/15	Fri 01/01/16
18		Active algorithm	10 days	Mon 04/01/16	Fri 15/01/16
20		Observation	123 days	Mon 18/01/16	Wed 06/07/16
21		Articulation point	30 days	Mon 18/01/16	Fri 26/02/16
24		Thermo-mechanical test without vacuum	35 days	Mon 29/02/16	Fri 15/04/16
32		Vacuum tests	5 days	Mon 18/04/16	Fri 22/04/16
33		Thermo-mechanical test under vacuum	35 days	Mon 25/04/16	Fri 10/06/16
41		Failure modes	18 days	Mon 13/06/16	Wed 06/07/16
47		Vibration tests	5 days	Mon 25/04/16	Fri 29/04/16
48		Action	100 days	Thu 07/07/16	Wed 23/11/16
49		Inverse alignment	30 days	Thu 07/07/16	Wed 17/08/16
51		Regulate breakdown displacements	20 days	Thu 18/08/16	Wed 14/09/16
52		Displacement prediction	40 days	Thu 15/09/16	Wed 09/11/16
53		Relate to CTF3/CLIC	10 days	Thu 10/11/16	Wed 23/11/16
54		Processing - presentations - conclusions	40 days	Thu 24/11/16	Wed 18/01/17



- Projected finish date: end of 2016
- Installation already started, combined with alignment tests

Summary

- T0-T0-T1 configuration
- More relevant components design
- Great testing flexibility
- Projected finish by the end of the year

- Final goal: feedback to next generation module design

Thank you!!