



Laboratoire d'Anecy-le-Vieux
de Physique des Particules



EuCARD NCLinac

9.3 Linac and FF Stabilisation

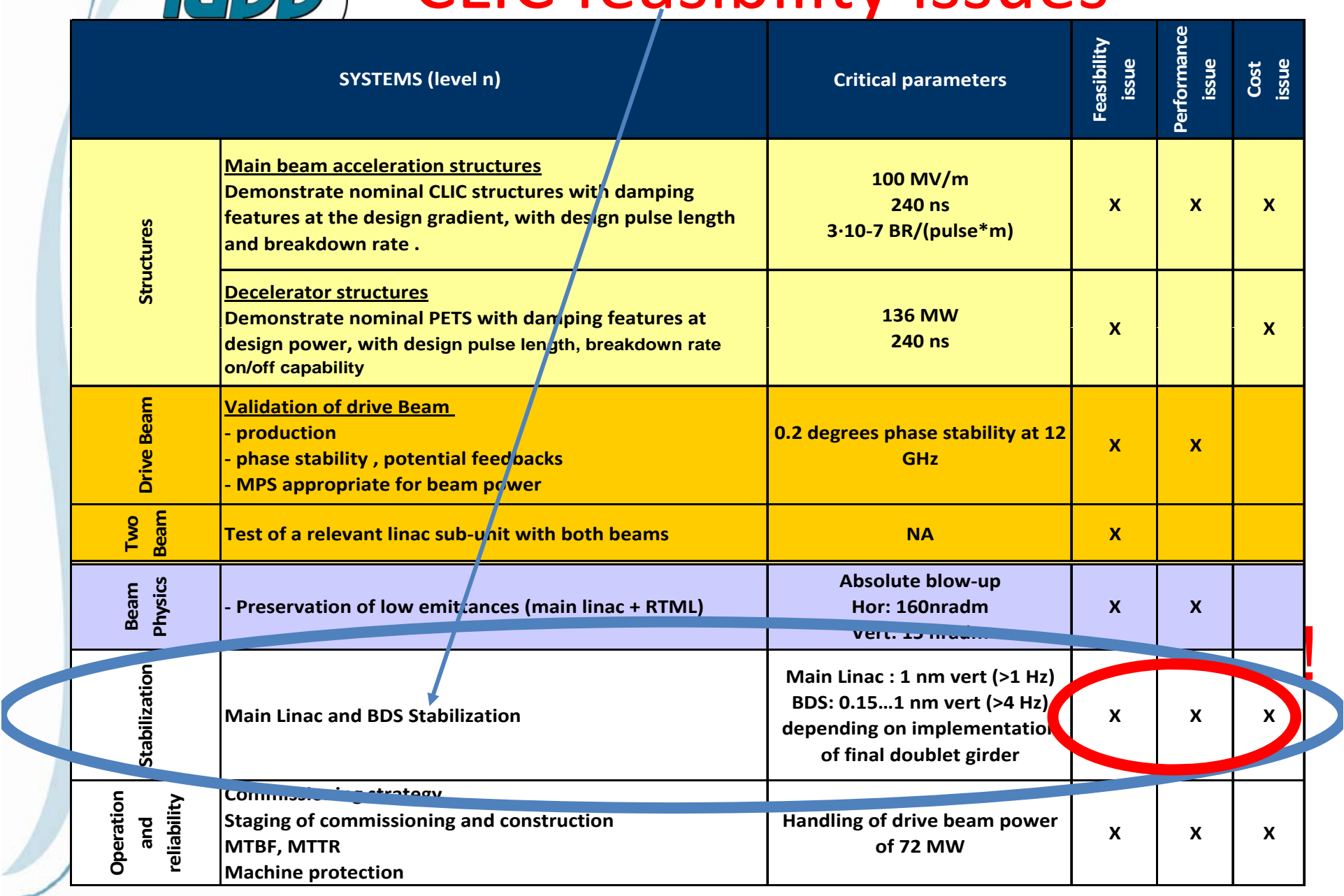
A.Jeremie





CLIC feasibility issues

SYSTEMS (level n)		Critical parameters	Feasibility issue	Performance issue	Cost issue
Structures	<u>Main beam acceleration structures</u> Demonstrate nominal CLIC structures with damping features at the design gradient, with design pulse length and breakdown rate .	100 MV/m 240 ns 3·10 ⁻⁷ BR/(pulse*m)	X	X	X
	<u>Decelerator structures</u> Demonstrate nominal PETS with damping features at design power, with design pulse length, breakdown rate on/off capability	136 MW 240 ns	X		X
Drive Beam	<u>Validation of drive Beam</u> - production - phase stability , potential feedbacks - MPS appropriate for beam power	0.2 degrees phase stability at 12 GHz	X	X	
Two Beam	Test of a relevant linac sub-unit with both beams	NA	X		
Beam Physics	- Preservation of low emittances (main linac + RTML)	Absolute blow-up Hor: 160nradm vert. 15 nradm	X	X	
Stabilization	Main Linac and BDS Stabilization	Main Linac : 1 nm vert (>1 Hz) BDS: 0.15...1 nm vert (>4 Hz) depending on implementation of final doublet girder	X	X	X
Operation and reliability	Commissioning strategy Staging of commissioning and construction MTBF, MTTR Machine protection	Handling of drive beam power of 72 MW	X	X	X



STRATEGY OF CLIC ALIGNMENT

- Mechanical pre-alignment



Within +/- 0.1 mm (1σ)

- Implementation of active pre-alignment



Girders and quadrupoles within $\pm 10 \mu\text{m}$ (3σ)

- Implementation of beam based alignment



Active positioning to the micron level

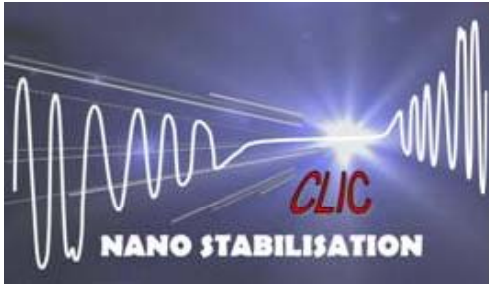
- Implementation of beam based feedbacks



Stability to the nanometer level

Main objective of task 9.3

- Address quadrupole stabilisation issues on CLIC
 - Main linac quadrupole stabilisation
 - Design, build and test for stabilisation a CLIC quadrupole module in an accelerator environment where a stability of 1 nm above one Hz is required.
 - Final Focus quadrupole stabilisation
 - Design, build and test for stabilisation a Final Focus test stand where a stability of 0.1 nm above a few Hz is required.



Fully integrated in the Active Stabilisation WG

An integrated approach: stabilization elements to be taken into account at the design phase of CLIC components, ground motion characterization, sensors, actuators, alignment compatibility with beam dynamics

- => stabilisation WG part of the CLIC Technical Committee:
CERN Claude Hauviller (and LAPP Andrea Jeremie as EuCARD task coordinator)
 - LAPP/CNRS: **A.Jeremie**, B.Bolzon, N.Geffroy, L.Brunetti, G.Deleglise, machine shop
 - CERN: **C. Hauviller**, K. Artoos, M. Guinchard, F.Lackner, D. Schulte, M.Modena
 - SYMME/Université de Savoie: **J.Lottin**, B.Caron, A.Badel, R.Lebreton
 - Oxford: **D.Urner**, P.Coe, M.Warden
 - Saclay: M.Fontaine
 - Some other groups interested
- already several common meetings in 2008-2009 and a task list

Teams involved

- Task Coordinator: A.Jeremie
- Oxford University/ JAI (John Adams Institute)
 - D. Urner and P. Burrows; Interferometry; Feedback; simulation
- LAPP/Annecy CNRS
 - A. Jeremie; stabilisation, feedback
- CERN
 - C. Hauviller; stabilisation
 - H. Mainaud-Durand; pre-alignment
 - M. Modena; magnets

EuCARD WP 9.3

- **Sub-task 1: CLIC quadrupole module.** Inertial **sensors will be tested** and evaluated for **accelerator environment** (magnetic field, radiation, electrical and acoustic noise from accelerator components). Study **vibration isolation** for the main beam quadrupole (principle, mock-up, feedback to be adapted to new boundary conditions) and build a test bench. Also study the design and construction of **main linac prototype magnet**. This activity aims to design and build a quadrupole mock-up that can serve as a model for the main linac quadrupole. **The model** will be used to **investigate the performance of the stabilisation equipment**
- aims at testing the **compatibility** (space, interferences, and complementarities) **between the repositioning system** (movers + associated sensors) **and the stabilization system** in the real environment of the two beam test stand.
- **Sub-task 2: Final Focus Test stand.** aims at exploring the potential to achieve 0.1 nm stability scale for the final doublet quadrupoles above a few Hz by working on the design, simulation, construction and installation of the support (final doublet mock-up, eigenmode analysis) and on the feedback design depending strongly on the final doublet support chosen. Contribute to the Development of optimized low-emittance beam transport and feedback for ILC and CLIC by completing an ILC prototype ATF2 intra-train and pulse-pulse Feedback and Final Focus system. In addition, they will study the simulation of the global luminosity performance of ILC and CLIC.

Deliverables & Milestones

Deliverable	Description/title	Nature	Delivery month
9.3.1	CLIC Quadrupole Module final report	R	M48
9.3.2	Final Focus Test Stand final report	R	M48

Milestone	Description/title	Nature	Delivery month	Comment
9.3.1	Characterization of noise/vibrations sources in an accelerator	O	M24	
9.3.2	Installation of interferometers at CTF3 Module	D	M24	
9.3.3	Installation of ATF2 final-focus alignment monitoring system	D	M6	
9.3.4	Installation of ILC prototype FB/FF at ATF2	O	M24	
9.3.5	Commissioning of CLIC quadrupole module	D	M30	Complete module with girder and accelerating structure
9.3.6	Quadruple mock-up manufactured and ready for installation	D	M30	

Warning!

- The next slides are a starting point of discussions in the Task.
- Some dates and numbers are final, some are under discussion and some are my suggestions but have not been discussed yet!
- They are not to be considered as final!

In red: Milestones from the Work Description

N°	Nom de la tâche	2009		2010		2011		2012		2013		2014					
		T1	T2	T3	T4	T1	T2	T3	T4	T1	T2	T3	T4	T1	T2	T3	T4
1	Linac and FF stabilisation	[Gantt bar: 2009 T1 to 2012 T4]															
2	CLIC quadrupole module	[Gantt bar: 2009 T1 to 2012 T4]															
3	feedback performance in accelerator tunnel	[Gantt bar: 2009 T1 to 2011 T4] LAPP/AJ															
4	inertial sensors in accelerator environment (magnetic field, radiation, CEM, acoustic noise)	[Gantt bar: 2009 T1 to 2011 T4] CERN/CH;LAPP/AJ															
5	support/vibration isolation (principle, mock-up, feedback, test-bench)	[Gantt bar: 2009 T1 to 2011 T4] CERN/CH;LAPP/AJ															
6	interferometric system: cross check and extend frequency range	[Gantt bar: 2009 T1 to 2011 T4] Oxford/DU															
7	magnet manufacturing methods + assembly methods	[Gantt bar: 2009 T1 to 2011 T4] CERN/MM															
8	magnet + stab.	[Gantt bar: 2009 T1 to 2011 T4] CERN/CH;CERN/MM;LAPP/AJ;															
9	compatibility of movers and stabilization in the environment of TB stand	[Gantt bar: 2009 T1 to 2011 T4] CERN/HMD															
10	9.3.1 Characterisation of noise sources in an accelerator	[Gantt bar: 2009 T1 to 2011 T4] CERN/CH;LAPP/AJ;Oxford/DU															
11	9.3.5 Commissioning of CLIC quad module (girder + accel. Structure)	[Gantt bar: 2009 T1 to 2011 T4] CERN/CH;LAPP/AJ;Oxford/DU;CER															
12	9.3.6 Quad Mock-up	[Gantt bar: 2009 T1 to 2011 T4] CERN/MM;CERN/CH;LAPP/AJ															
13	CLIC Module Report	01/04															
14	Final Focus Test stand	[Gantt bar: 2009 T1 to 2012 T4]															
15	support FF mock-up and eigenmode analysis	[Gantt bar: 2009 T1 to 2011 T4] LAPP/AJ;CERN/CH															
16	feedback design	[Gantt bar: 2009 T1 to 2011 T4] LAPP/AJ															
17	reduce costs	[Gantt bar: 2009 T1 to 2011 T4] CERN/CH;LAPP/AJ;Oxford/DU															
18	interferometer measure between magnet/girder and floor	[Gantt bar: 2009 T1 to 2011 T4] Oxford/DU															
19	interferometer installation : max resolution and correlate with sensors	[Gantt bar: 2009 T1 to 2011 T4] Oxford/DU															
20	beam optimisation	[Gantt bar: 2009 T1 to 2011 T4] Oxford/DU;Oxford/PB															
21	low emittance beam transport and feedback for ILC and CLIC	[Gantt bar: 2009 T1 to 2011 T4] Oxford/DU;Oxford/PB															
22	ATF2 intratrain and pulse-pulse feedback and FF system	[Gantt bar: 2009 T1 to 2011 T4] Oxford/DU;Oxford/PB															
23	simulation of global luminosity performance ILC and CLIC	[Gantt bar: 2009 T1 to 2011 T4] Oxford/DU;Oxford/PB															
24	9.3.2 Interferometer on CTF3	[Gantt bar: 2009 T1 to 2011 T4] Oxford/DU															
25	9.3.3 Installation of ATF2 FF alignment	[Gantt bar: 2009 T1 to 2011 T4] Oxford/DU															
26	9.3.4 ATF2 FB/FF	[Gantt bar: 2009 T1 to 2011 T4] Oxford/PB															
27	Final Focus report	01/04															

Projet : EuCARDNCLinacStab Date : Jeu 26/03/09	Tâche [] Jalon	Fractionnement [] Récapitulative	Avancement [] Récapitulatif du projet	Tâches externes [] Jalons externes	Échéance
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Interferometry

Activity	Sub-Activity	Expected completion date
MB Linac	Complete CSM Measure motion between magnet and floor Compare with seismic sensors	January 2010
	Connect several CSM Simulation, develop right tools	July 2011
FF	Full frequency stabilized laser system	January 2011
ATF2	Install vacuum system	June 2009
	Full system with laser	September 2009

Beam

Activity	Sub-activity	Expected completion date
FF	beam optimisation	April 2010
	low emittance beam transport and feedback for ILC and CLIC	April 2010
	ATF2 intratrain and pulse-pulse feedback and FF system	April 2010
	simulation of global luminosity performance ILC and CLIC	January 2011

Stabilisation LAPP

Activity	Sub-Activity	Expected completion date
MB Linac	feedback performance in accelerator tunnel	April 2012
	study different damping devices	September 2009
	study adapted feedback loop	December 2010
	test actuators	April 2010
	Stabilisation mock-up	December 2010
	inertial sensors in accelerator environment (magnetic field, radiation, CEM, acoustic noise) Assess new sensors	September 2009
	support/vibration isolation Mechanical simulations and measurements on quad mock-up	December 2010
	Step-by-step update of components in FE model	December 2012
FF	support FF mock-up and eigenmode analysis	December 2012
	feedback design	December 2012

Stabilisation CERN

Sub-activity	Expected completion date
inertial sensors in accelerator environment (magnetic field, radiation, CEM, acoustic noise)	January 2011
support/vibration isolation (principle, mock-up, feedback, test-bench)	July 2011
magnet + stab.	December 2011
Reduce costs	January 2011

MB Magnet

ACTIVITY	<i>Expected Completion date</i>
Electromagnetic Design	3 March 2009 (DONE)
Procurement 5 poles	WEEK37 (11 Sept 2009)
Procurement 5 coils	WEEK 39 (25 Sept 2009)
Assembly of magnet	WEEK 43 (23 Oct 2009)
Commissioning and 1 st vibration Test	WEEK 47 (20 Nov 2009)
Availability for further stabilization studies	WEEK 48 (23 Nov 2009)

Year	Activity
2009	-Design & Procurement “solid” quad (long) for stabilization studies -“Lamination versus solid” tests
2010	-Procurement “laminated” quad (long) for stabilization studies -Investigation of permanent magnet option
2011	-Design & Procurement quad (short) for Phase 4 -Further manufacturing test (Series Production Oriented)

Pre-alignment

- compatibility of movers and stabilization in the environment of TB stand
- 9.3.5 Commissioning of CLIC quad module (girder + accel. Structure)
- Completion date during commissioning of complete CLIC MB module

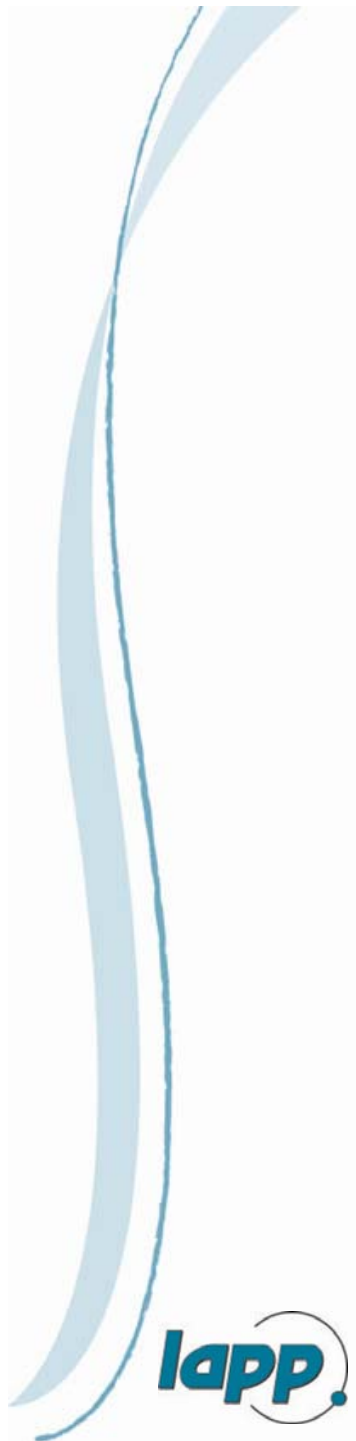
Tentative spending profile

The spending profile is still under preparation

Coordinator	year 1 material (2009-2010)	year 1 personnel (2009-2010)	year 2 material (2010-2011)	year 2 personnel (2010-2011)	year 3 material (2011-2012)	year 3 personnel (2011-2012)	year 4 material (2012-2013)	year 4 personnel (2012-2013)	Total material
D.Urner/P.Burrows	20000	18	20000	23	7000	8	0	4	47000
A.Jeremie	5000	10	13000	14	5000	14	5000	12	28000
C.Hauviller	4000	9	3000	10	1300	10	0	10	8300
M.Modena	24882	4,5	16588	4	16530	3,5	0	0	58000
H.Mainaud-Durand	12188	1	12187	1	9750	2	4875	2	39000
Total	66070	42,5	64775	52	39580	37,5	9875	28	180300

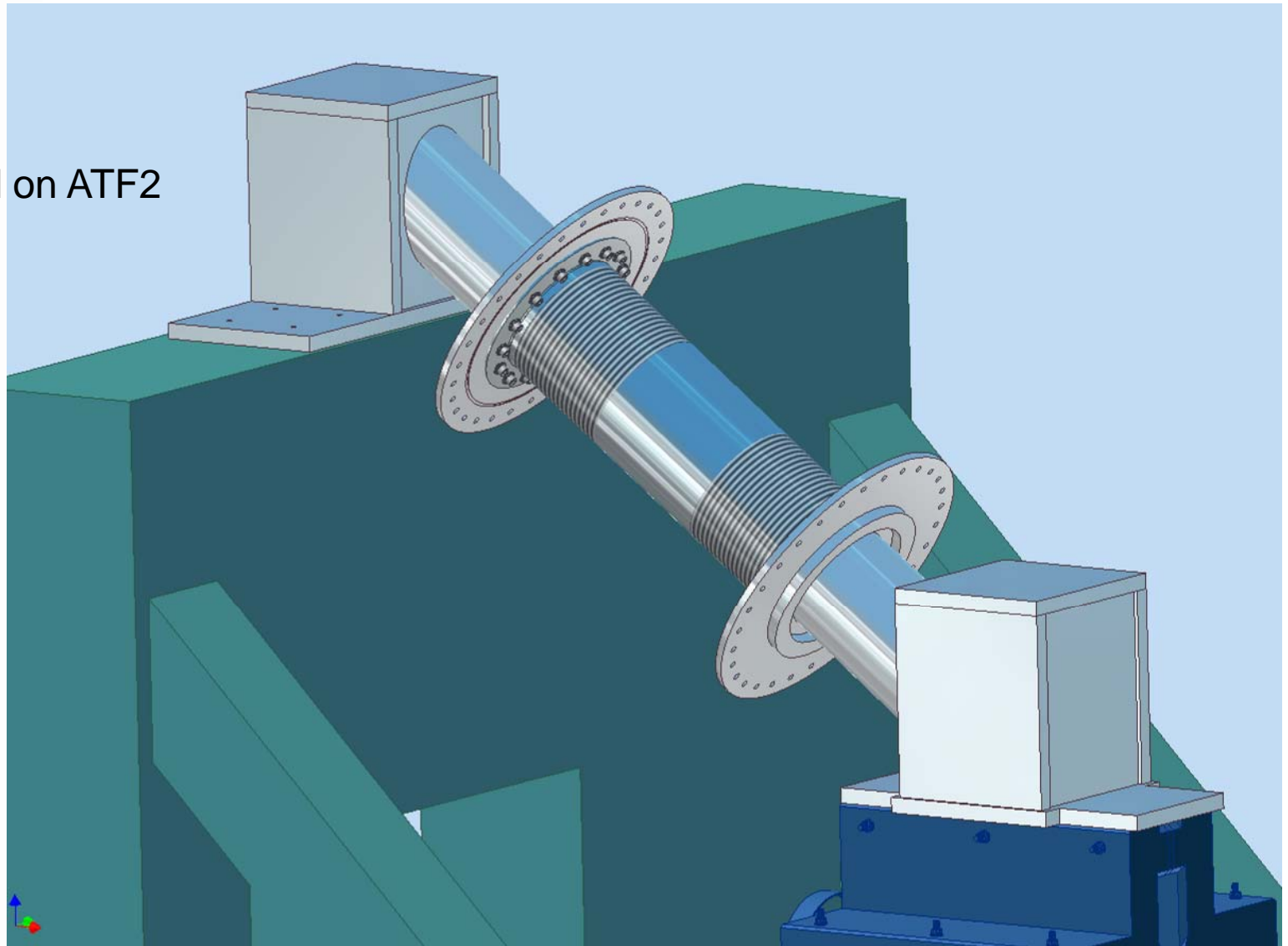
The lines in yellow are my suggestion and have not been discussed with the sub-task coordinator

Some pictures



Interferometry

Planned on ATF2



Different MB mock-ups for stabilisation studies: CERN and Annecy

- Stabilisation table

Develop the isolation system; stabilise 420mm magnet mock-up

⇒ In Annecy

⇒ Table built; start measurements soon

- MB quadrupole mock-up

Measure magnet vibration and develop best magnet support

⇒ At CERN/ quiet place

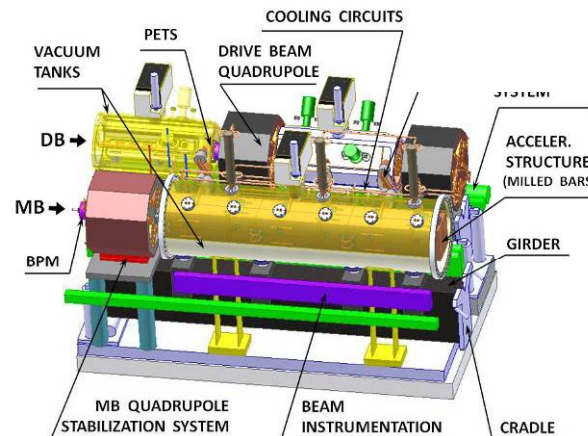
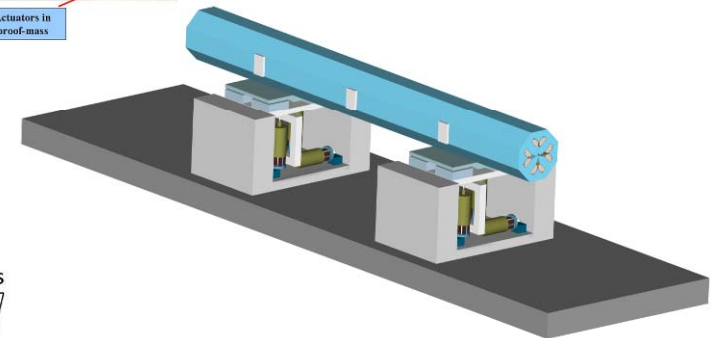
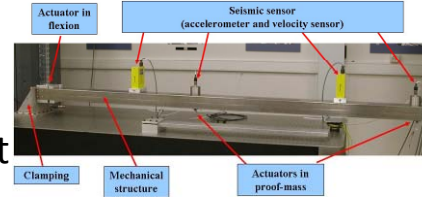
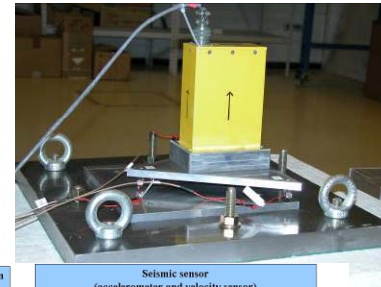
⇒ Under design; within a year with magnet mock-up

- MB test module

Test the integration of all systems

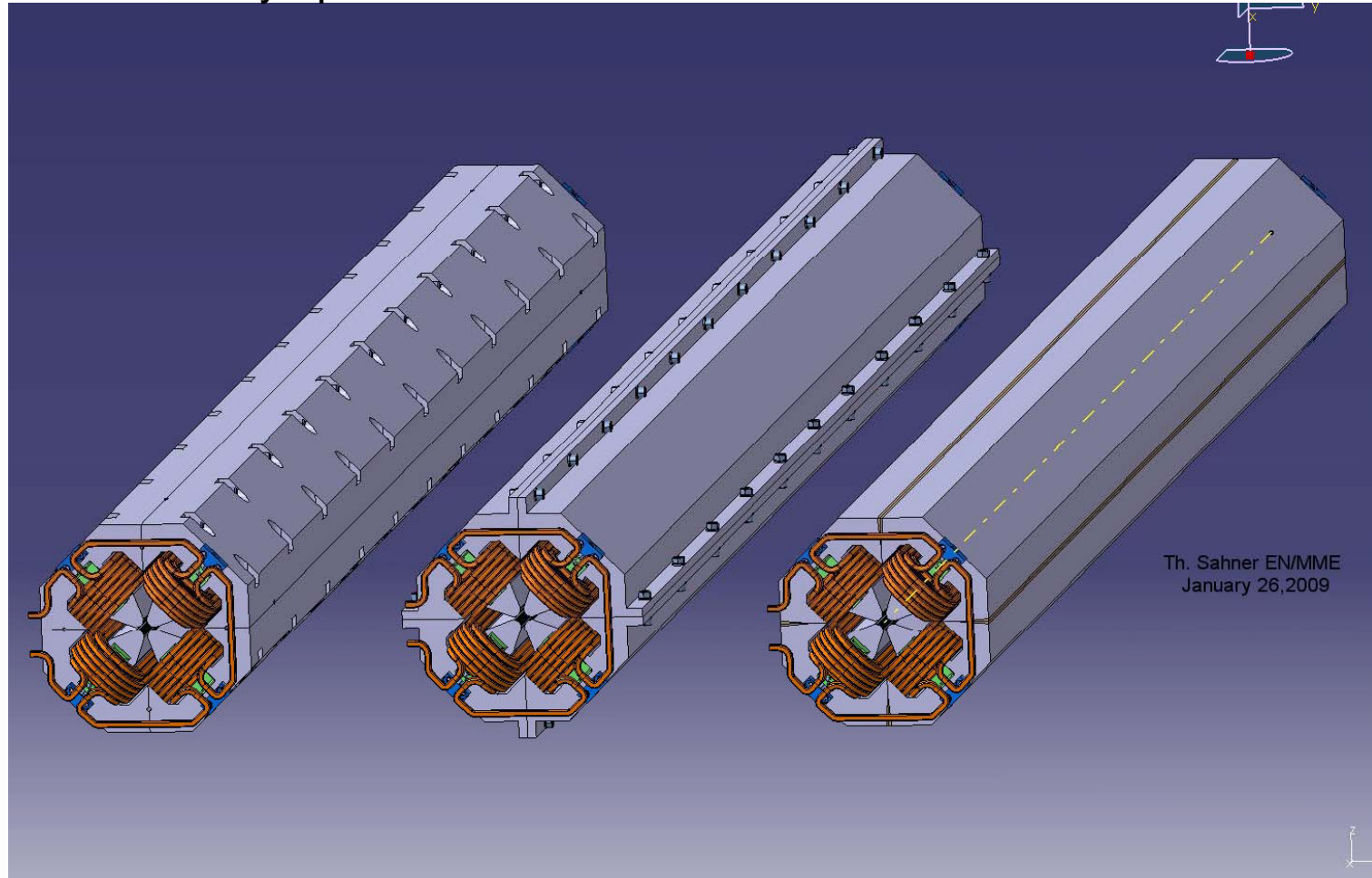
⇒ At CERN/ in CTF3 environment

⇒ Under design



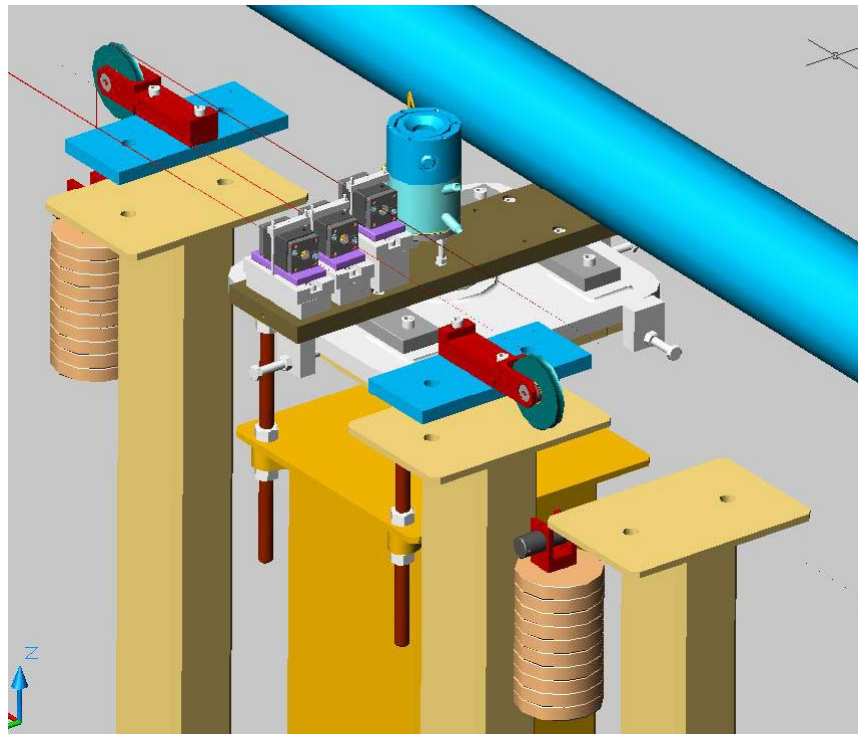
Magnet

Different assembly options



Th. Sahner EN/MME
January 26, 2009

Pre-alignment



Choice of sensors and tests

Conclusions

- Active group already started meeting while waiting for the EU acceptance
- Task list refinement underway
- Mock-ups being defined for the EuCARD work
- Starting (just about!) to put together the organisational tools
- Ready, set...go!