Two-beam module review, 14-16 September 2009

Test modules: hardware, program, resources, schedule

G. Riddone, 16.09.2009

Thanks to K. Artoos, JP. Delahaye, C. Hauviller, C. Garion, H. Mainaud-Durand, M. Modena, R. Nousiainen, A. Samoshkin, L Soby, I. Syratchev

Content

- Objectives and motivation
- EuCARD – NCLinac – WP9.2
- Strategy
- Test module layout
- Resources (preliminary estimations)
- Conclusions

Recall of test stands in the pipeline

- Q4 mock-up (see Kurt talk)
- Girder mock-ups (see Helene talk)

- Test modules 0 and 1 (Eucard – NCLinac –WP9.2/9.3)

How to establish a short-medium term coherent test program with milestones before and after CDR

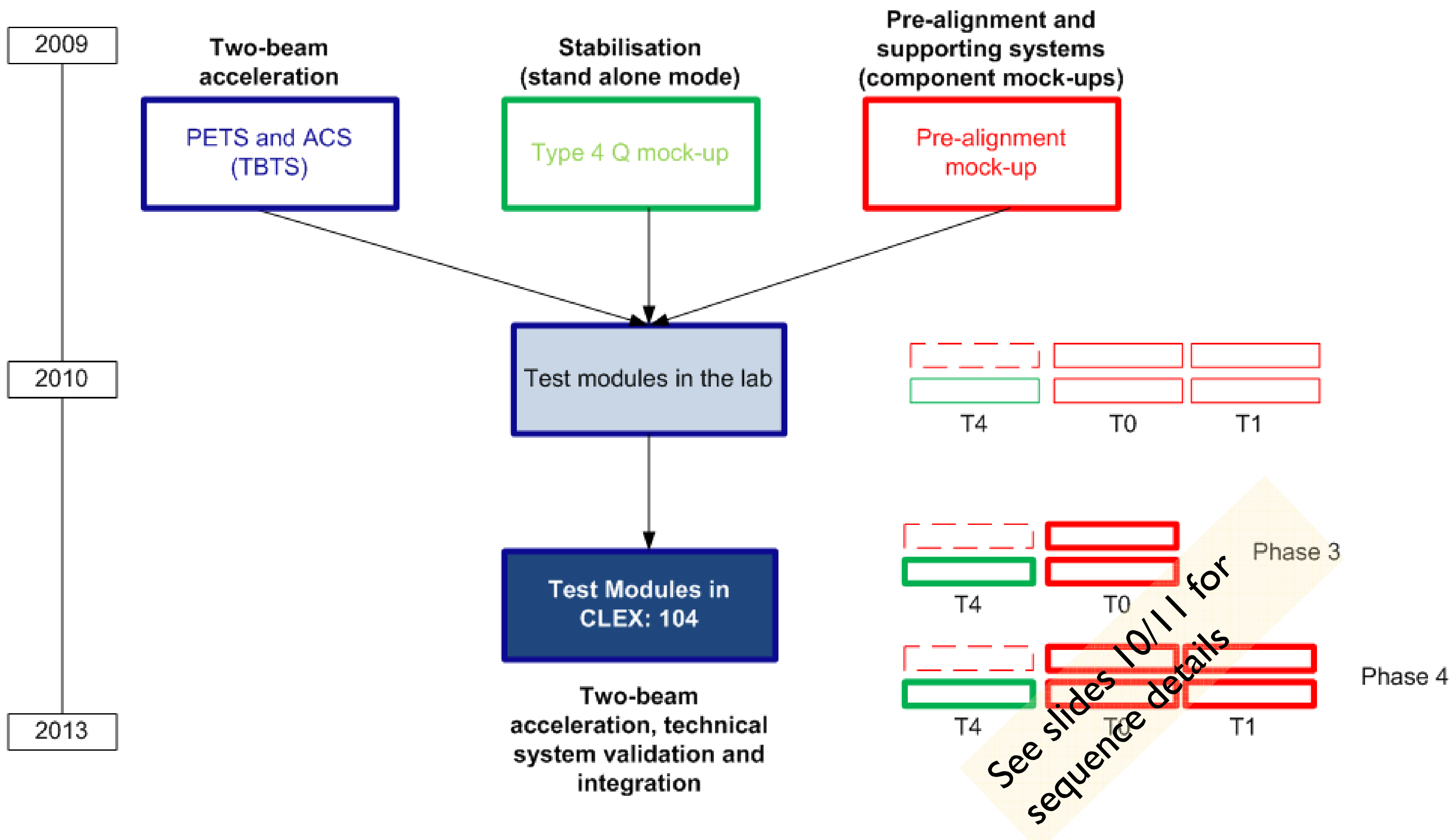
Objectives for CDR

- Address feasibility issues in an integrated approach
  - e.g. Stabilization-alignment-supporting systems
- Establish coherence between existing test set-up and future test modules in CLEX
- Prepare test modules for CLEX
  - if possible use components from stand-alone tests for test modules in CLEX

Question:

- what can be realistically done before CDR

Strategy for main linac two-beam module validation



Objectives of the test modules

From NCLinac kick-off meeting / march 2009

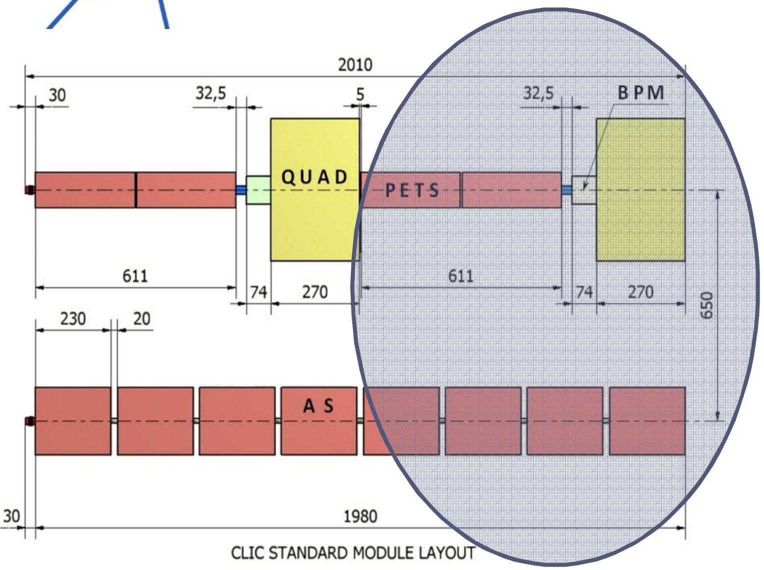
- Two-beam acceleration in a realistic environment
- Cost- and performance optimized accelerating structures and their integration in CLIC modules.
- Accelerating structure (ACS) alignment on girder using probe beam
- Wakefield monitor (WFM) performance in low and high power conditions (and after a breakdown)
- Cost- and performance optimized PETS (several option, e.g. mini-tank, on-off mechanism not integrated)
- 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

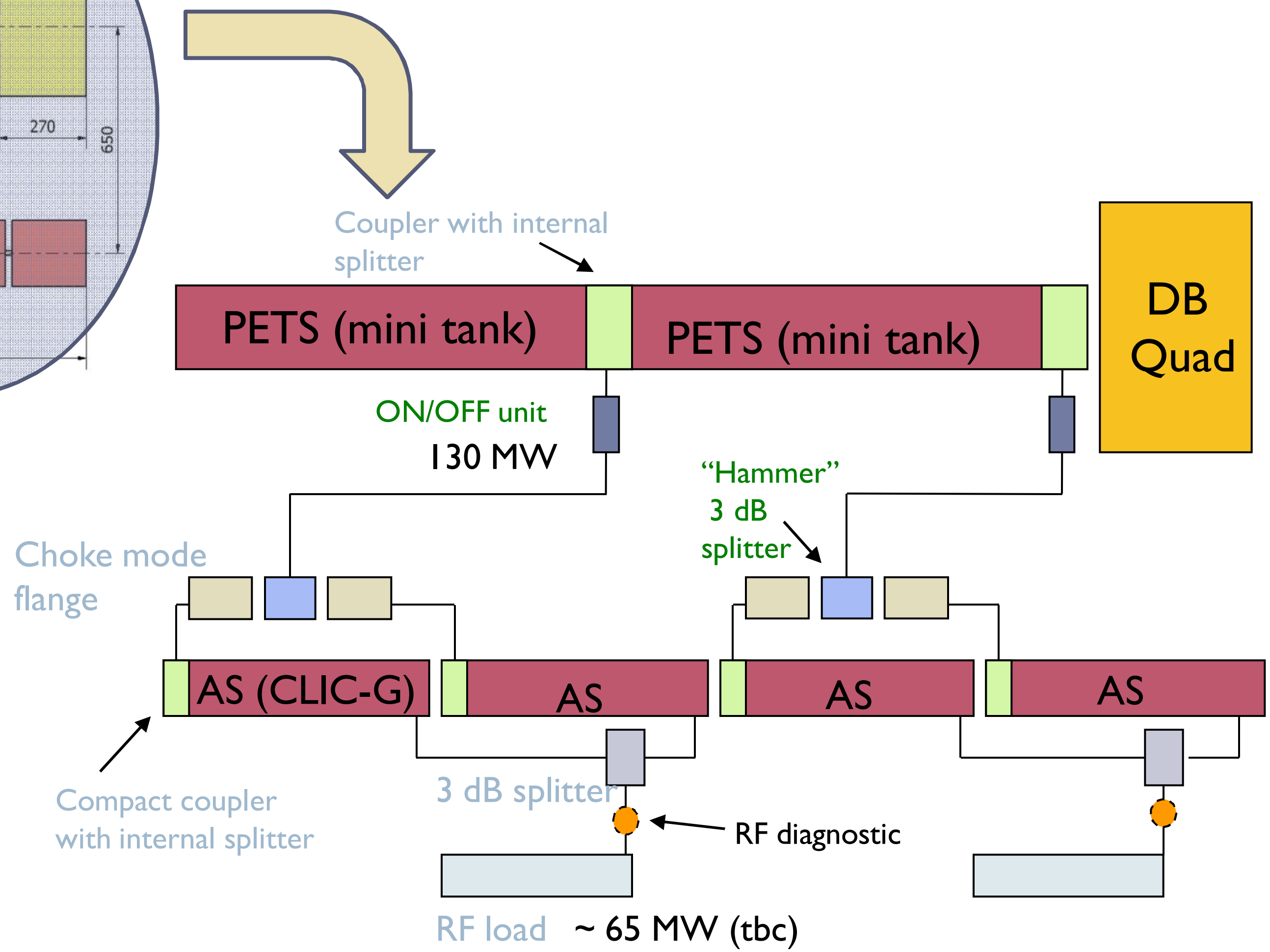
- Validation of assembly, transport, activation, maintenance etc.

EUCARD – NCLinac - Task 9.2
Normal Conducting High Gradient Cavities

- **Sub-task 1:** Design, manufacture, and validate experimentally a **Power Extraction and Transfer Structure (PETS)** prototype to improve CTF3 ➔ **F. Toral/D. Carrillo - CIEMAT**
- **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. ➔**R. Jones/A. D'Elia - Un. of Manchester**
- **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. ➔ **K. Österberg - HIP(#1)**
- **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 ➔ **R. Ruber/V. Ziemann - UPPSALA**
- **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. ➔ **K. Österberg - HIP(#2)**

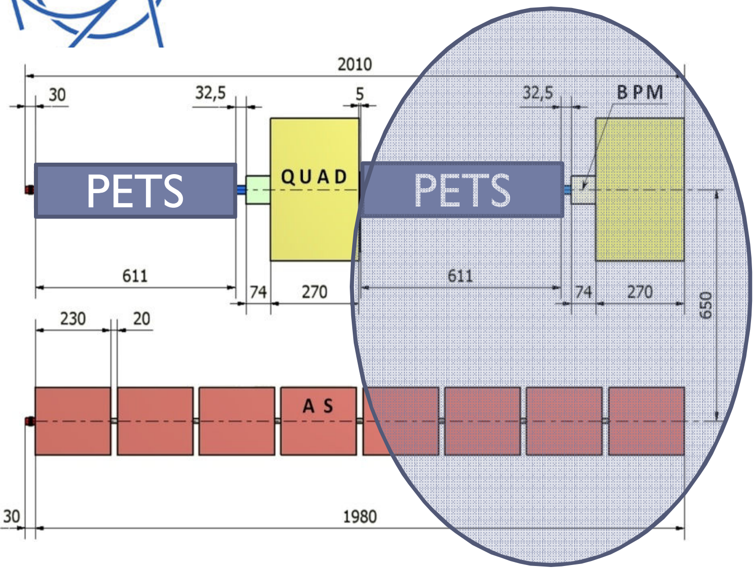
From CLIC module to test module





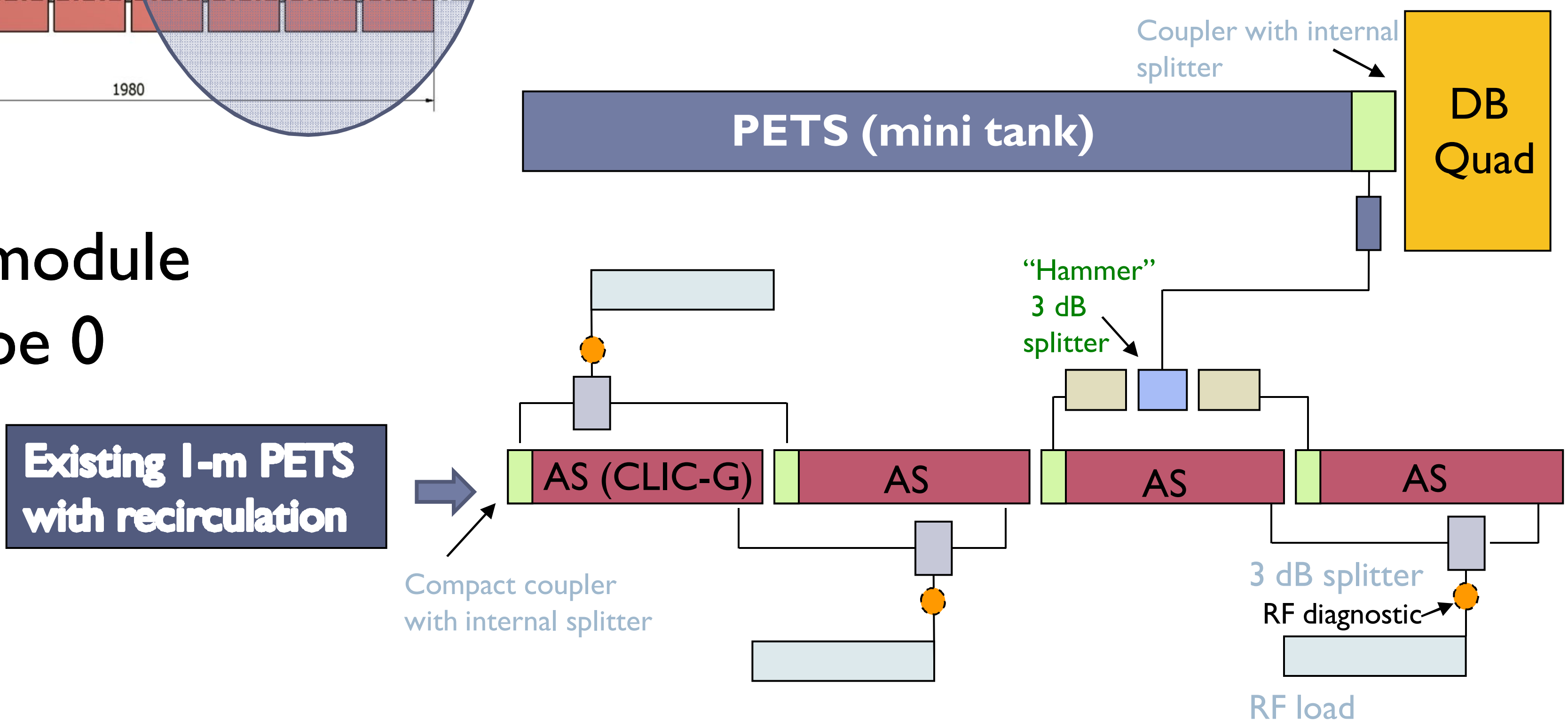
CLIC module type 0

From CLIC module to test module



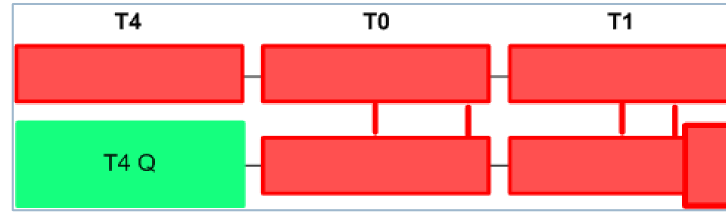
Parameters	CTF3	CLIC
Energy	0.150 GeV	2.4 GeV
Pulse length	1.2 μs	140 μs
Multiplication factor	2 x 4 = 8	2 x 3 x 4 = 24
Linac current	3.75 A	4.2 A
DB final current	30 A	100 A
RF frequency	3 GHz	1 GHz
Repetition rate	up to 5 Hz	50 Hz
Energy per beam pulse	0.7 kJ	1400 kJ
Average DB power	3.4 kW	70 MW

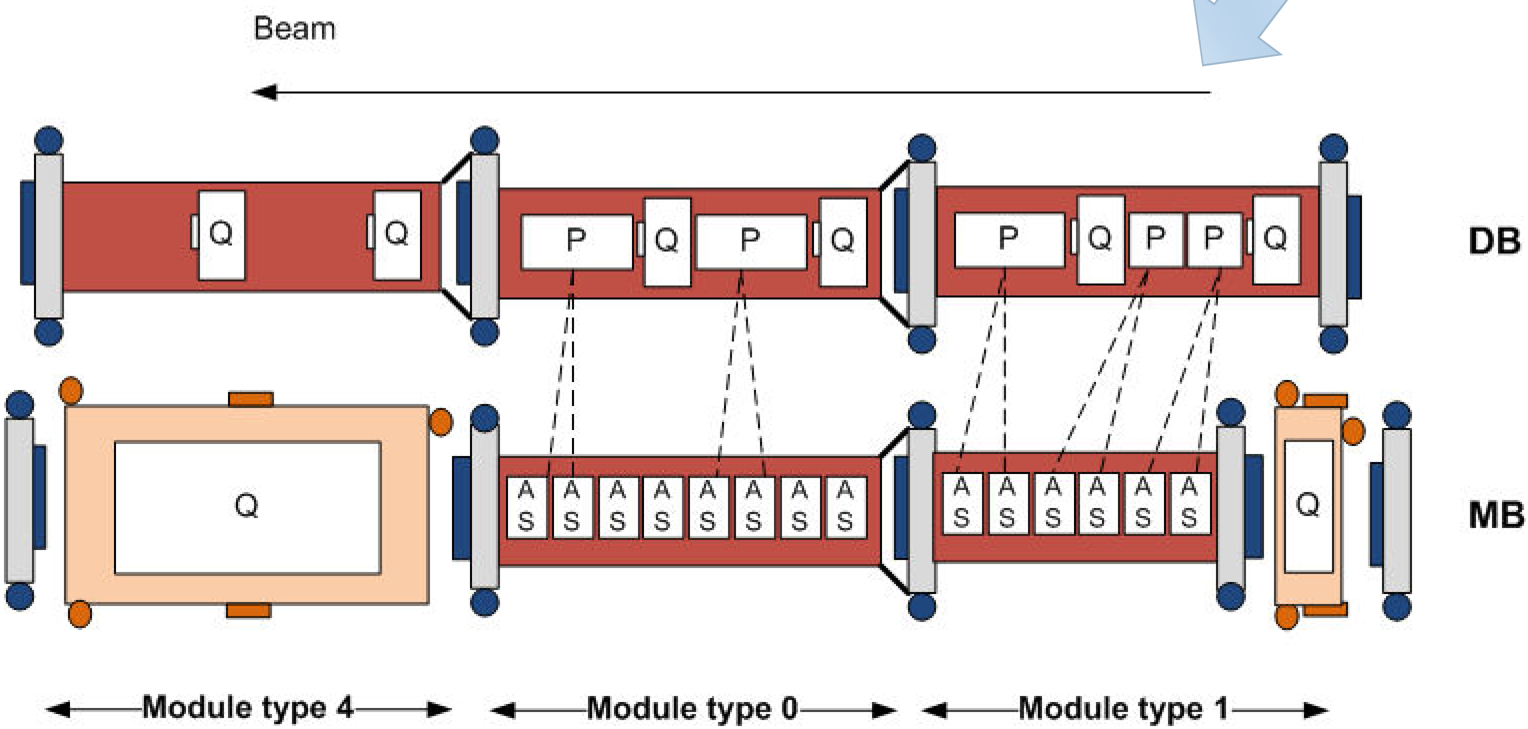
Test module
type 0



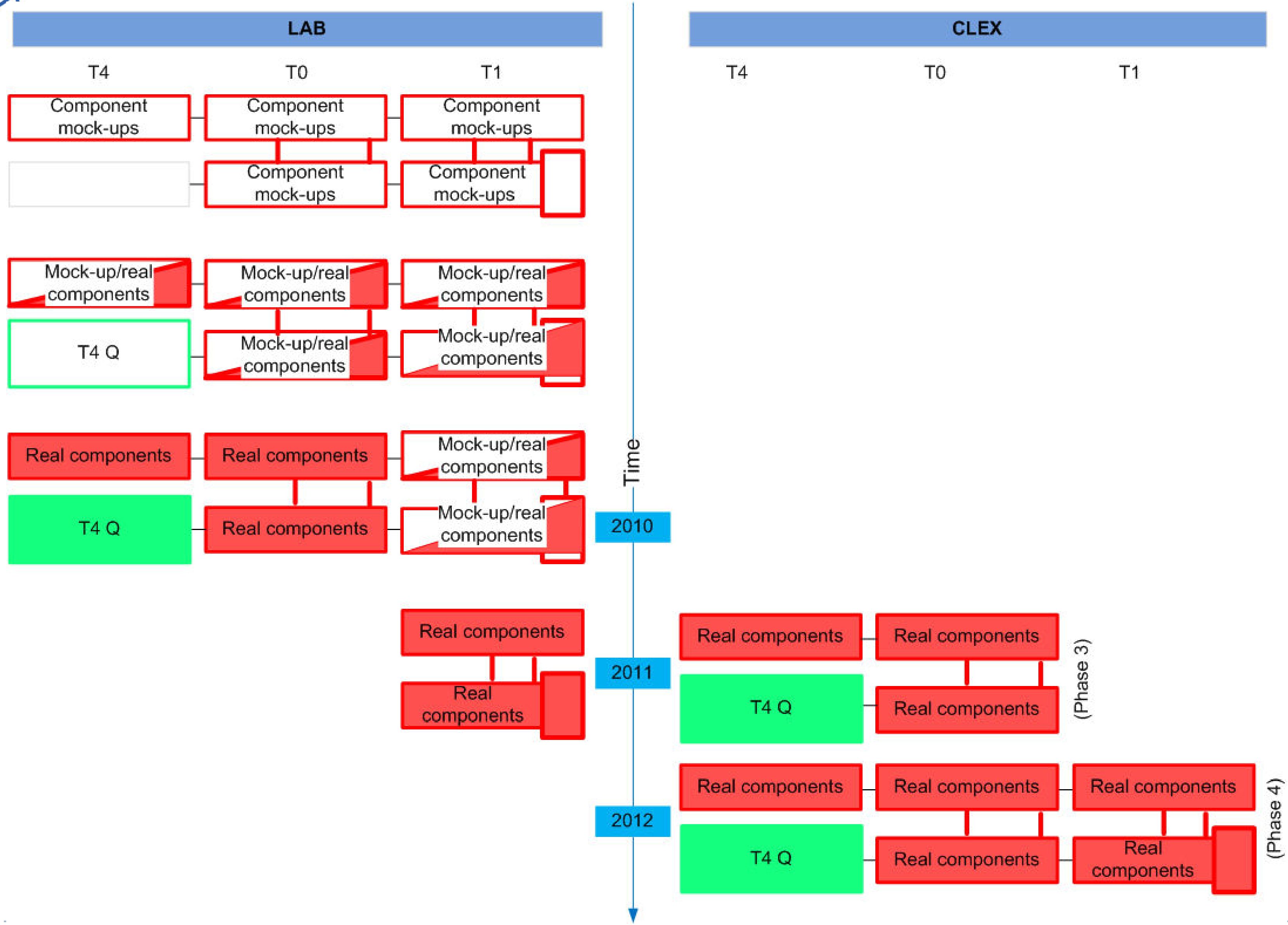
Test Modules 104 (final configuration)

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





From mock-up to test modules



Test module configurations in CLEX

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

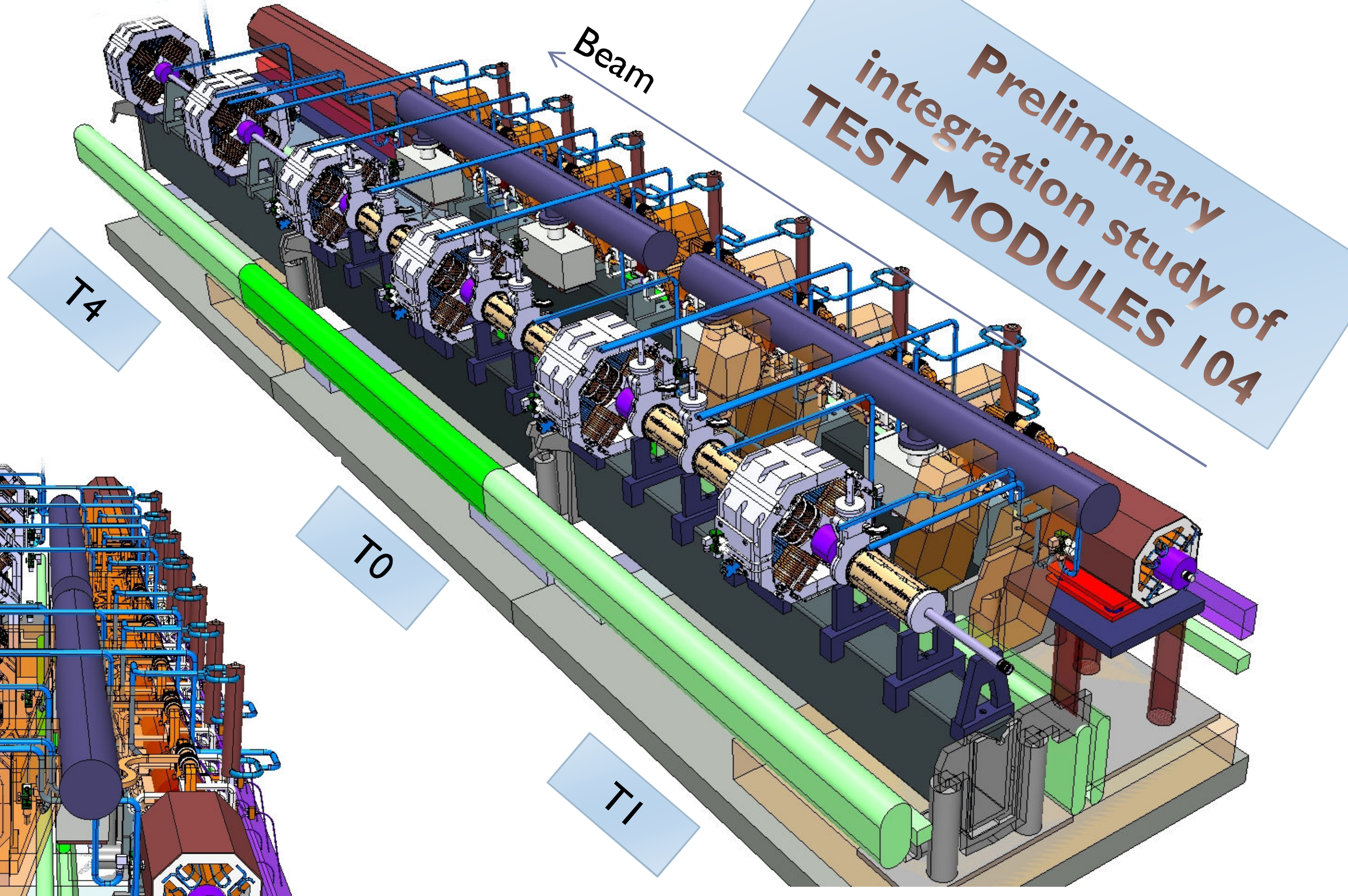
Phase 4, Conf. 4.1

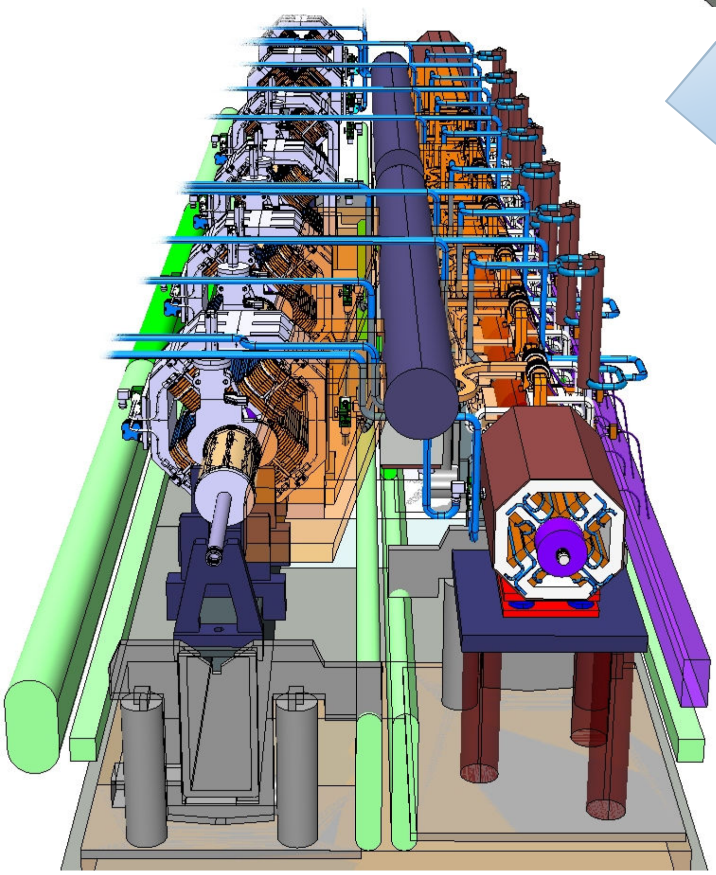
No modifications on the test module type 0 HW
Addition of a module type 1
Increase of current from 19.2 A to 22 A

Phase 4, Conf. 4.2

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

A. Samoshkin

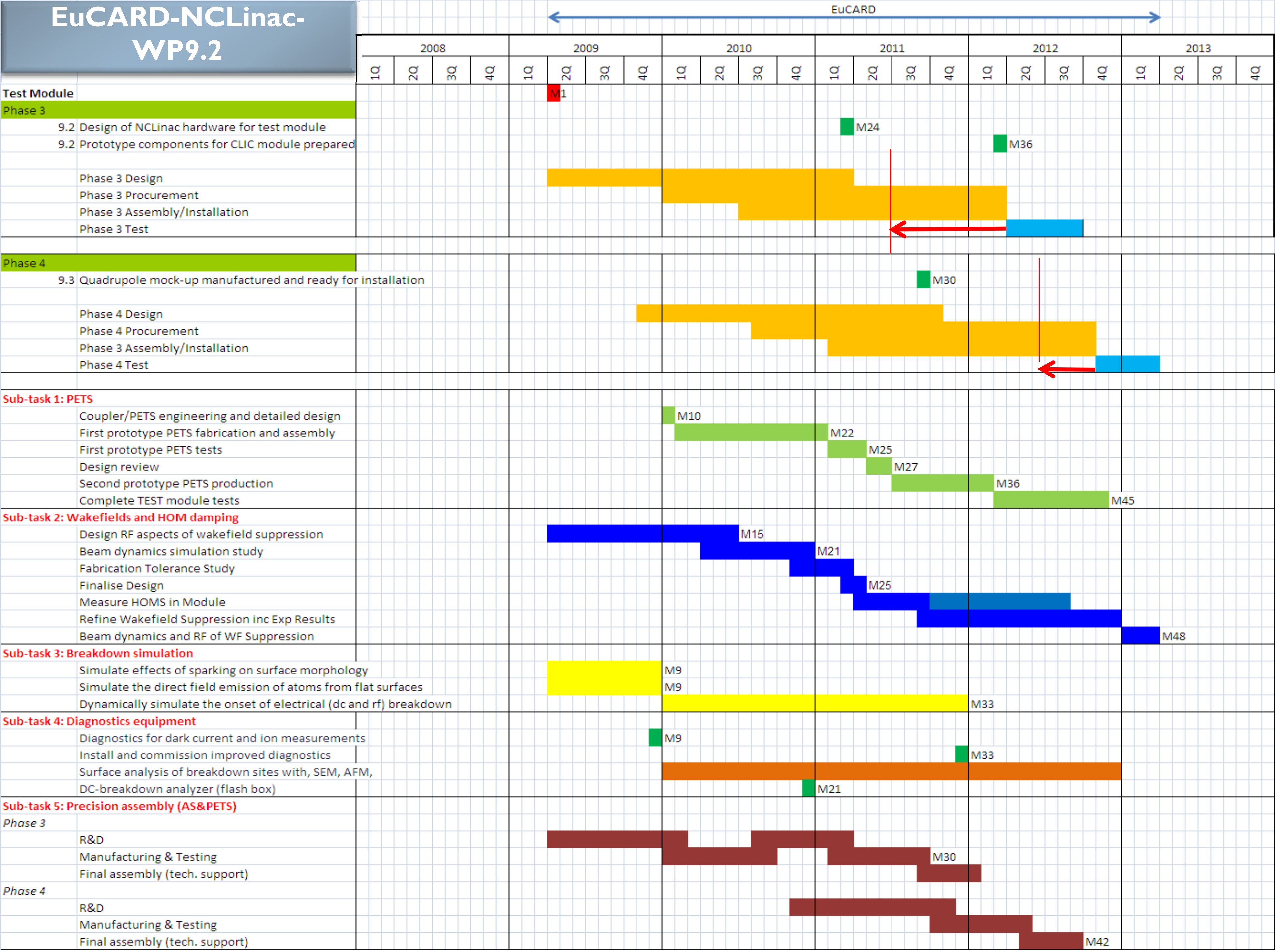

Preliminary
integration study of
TEST MODULES 104
Beam
T4
T0
T1



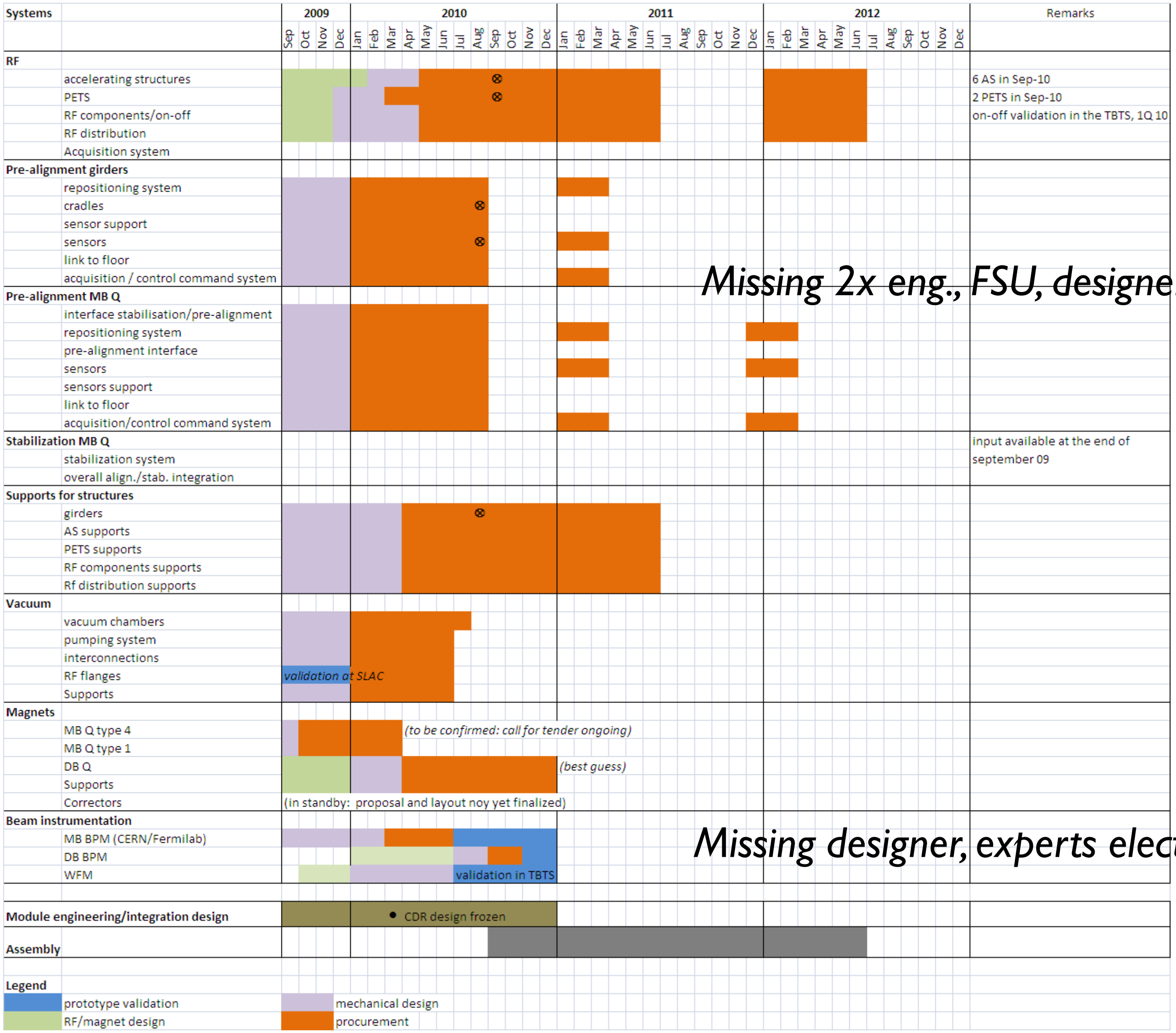
Inventory of main components

Conf.	Existing PETS	Double-length PETS	CLIC PETS	CLIC structures/ WFM	DB Q/ DB BPM	MB Q/ MB BPM
3.1	1	2	0	8	4	1 (T1)
3.3	1	2	0	8	4	1 (T1)
4.1	1	4	0	14	6	2 (T1-T4)
4.2	1	3	2	14	6	2 (T1-T4)
TOTAL	**1**	**4**	**2**	**16**	**6**	**2**

EuCARD-NCLinac-WP9.2



104 TM Schedule (aggressive)



Missing 2x eng., FSU, designer

Missing designer, experts electronics for WFM

Material cost estimate (preliminary)

(in brackets person which supplied the input)	quantity			quantity total	Material cost / unit	Material cost/module		
Systems	T0	T1	T4		[CHF]	[CHF]		
RF (G. Riddone)						*(TBC)*	2 080 000	
accelerating structures, incl. cooling	8	6	0	14	110 000	1 540 000		
PETS., incl. mini-tanks	2	4	0	6	60 000	360 000		
Loads with DC	4	3	0	7	10 000	70 000		
ON-OFF system	2	4	0	6	7 500	45 000		
RF distribution	2	4	0	6	7 500	45 000		
acquisition system				1	20 000	20 000		
Pre-alignment girders (H. Mainaud-Durand)							505 000	
actuators	6	20	11	37	10 000	370 000		
cradles	2	5	2	9	3 000	27 000		
sensor support	2	5	2	9	1 000	9 000		
sensors	4	10	4	18	4 000	72 000		
link to floor	2	5	2	9	3 000	27 000		
acquisition system				0		0		
Pre-alignment MB Q (H. Mainaud-Durand)							252 000	
interface stabilisation/pre-alignment		1	1	2		0		
pre-alignment system		5	5	10	20 000	200 000		
pre-alignment interface		3	4	7	4 000	28 000		
link to floor		4	4	8	3 000	24 000		
acquisition system				0		0		
Stabilization MB Q (K. Artoos)							0	
stabilization system				0		0		
overall stab/pre-align integration				0		0		
				0		0		
Supports for structures (R. Nousiainen,G. Riddone)							131 000	
girders	2	2	1	5	15 000	75 000		
AS supports	8	6		14	2 000	28 000		
DB Q supports				0		0		
PETS supports	2	3		5	2 000	10 000		
RF components supports	4	3		7	1 500	10 500		
Rf distribution supports	2	3		5	1 500	7 500		
Vacuum (C. Garion)							196 850	
vacuum chambers	0	1	4		55 600	55 600		
pumping system	2	3	2		105 500	105 500		
interconnections	16	16	16		20 850	20 850		
RF flanges /bellows					11 900	11 900		
Supports					3 000	3 000		
Magnets (M. Modena)							280 000	
MB Q Type 4			1	1	90 000	90 000	power supplies missing	
MB Q Type 1		1		1	32 000	32 000		
DB Q	2	2	2	6	25 000	150 000		
Correctors				0				
Cooling circuits	2	3	3	8	1 000	8 000		
Beam instrumentation (L. Soby)							320 000	
MB BPM		1	1	2	10 000	20 000		
DB BPM	2	2	2	6	10 000	60 000		
WFM	8	8	8	24	*10 000*	240 000		
							50 000	
Infrastructure/Assembly					50 000	50 000		
			TOTAL MATERIAL COST			3 814 850		

Conclusions

- Important to show a solid case for CDR
- Important to freeze the design by Q1 2010
- Needed Green light for 104 TM
- Missing resources are urgent