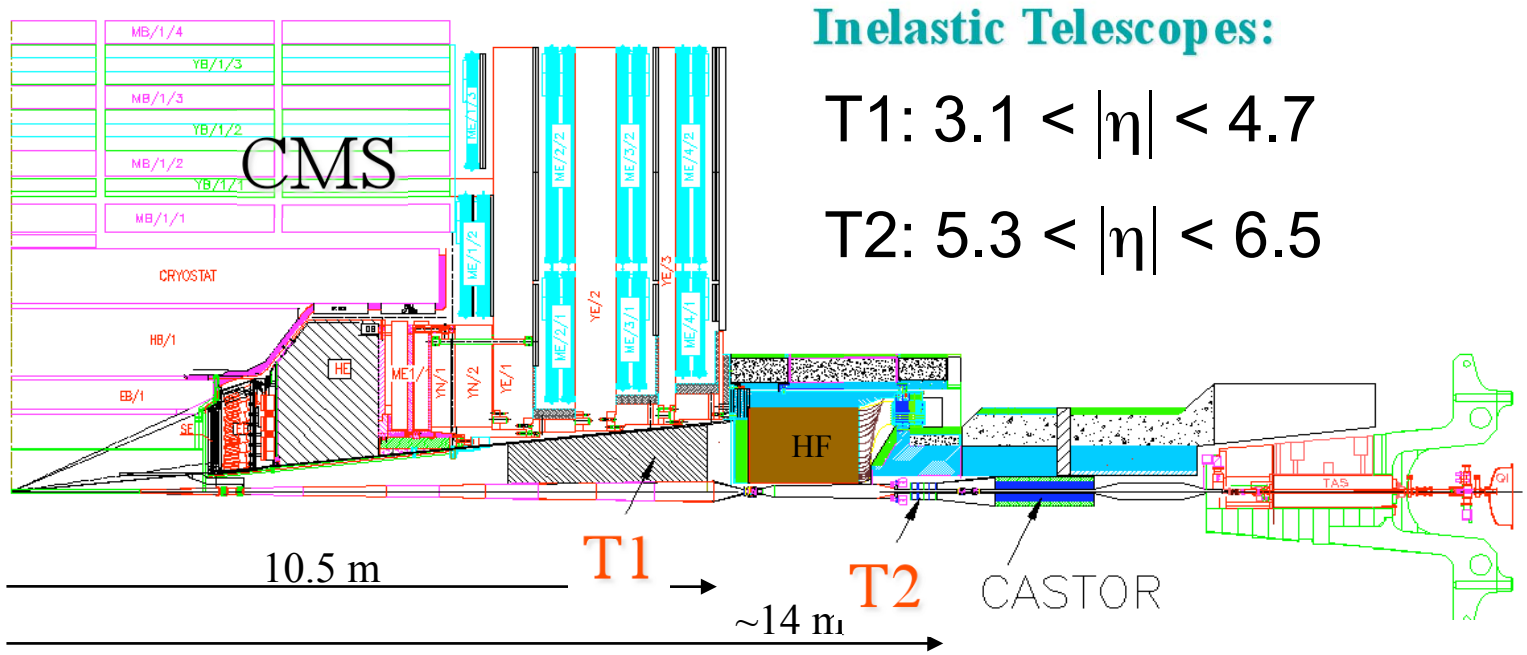
Status of the TOTEM Experiment

CERN-RRB-2009-059

- The Roman Pots
- The T1 Telescope
- The T2 Telescope
- Electronics
- DAQ
- Software
- Early Physics
- Summary

The TOTEM Experiment

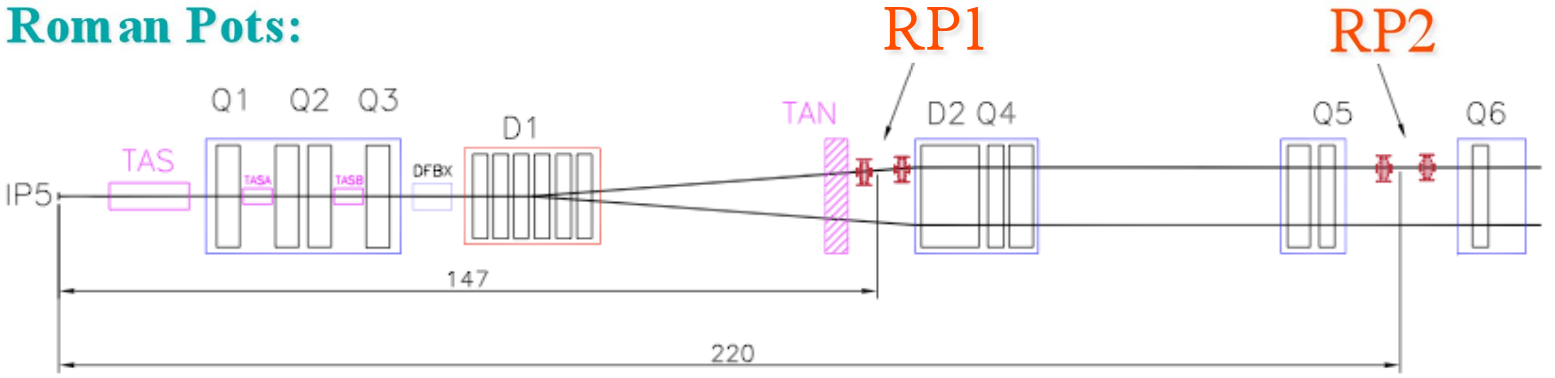


Inelastic Telescopes:

T1: $3.1 < |\eta| < 4.7$

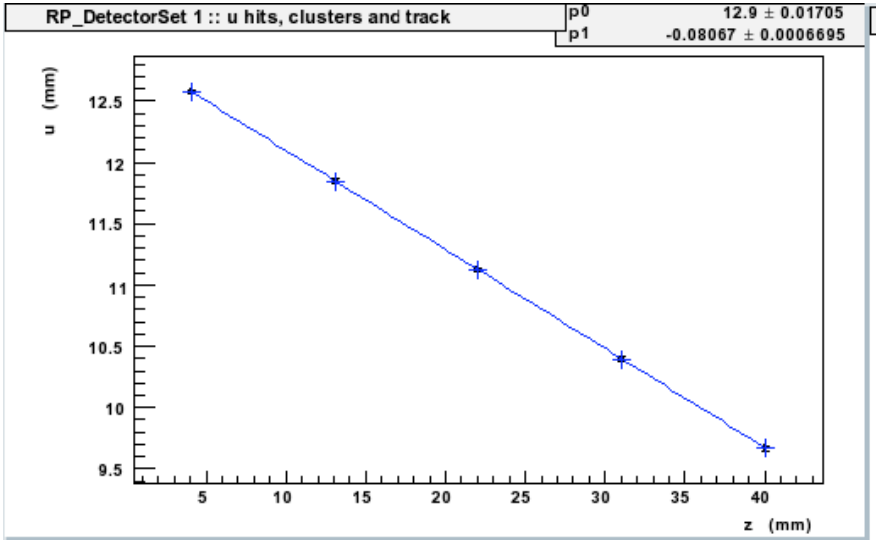
T2: $5.3 < |\eta| < 6.5$

Roman Pots:

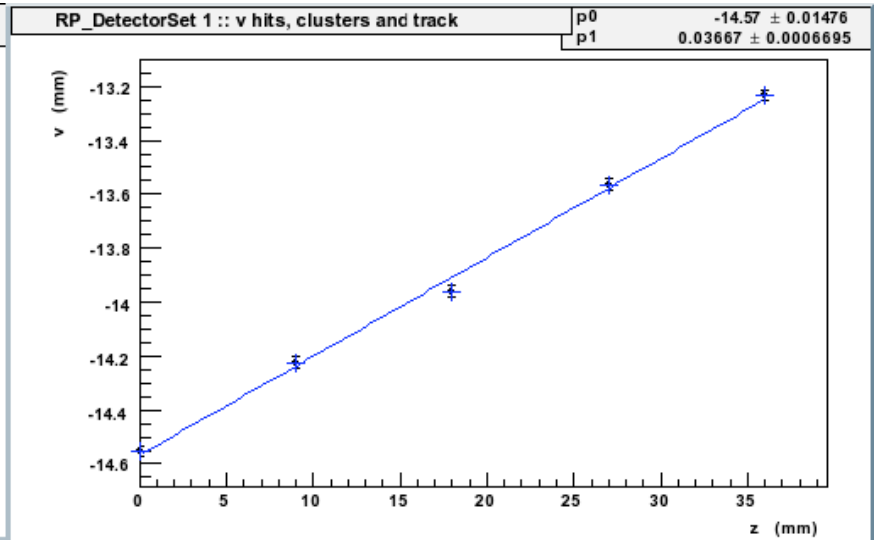


Pot 3 to Pot 7 ready for installation

Track in the Roman Pot



u (even) planes

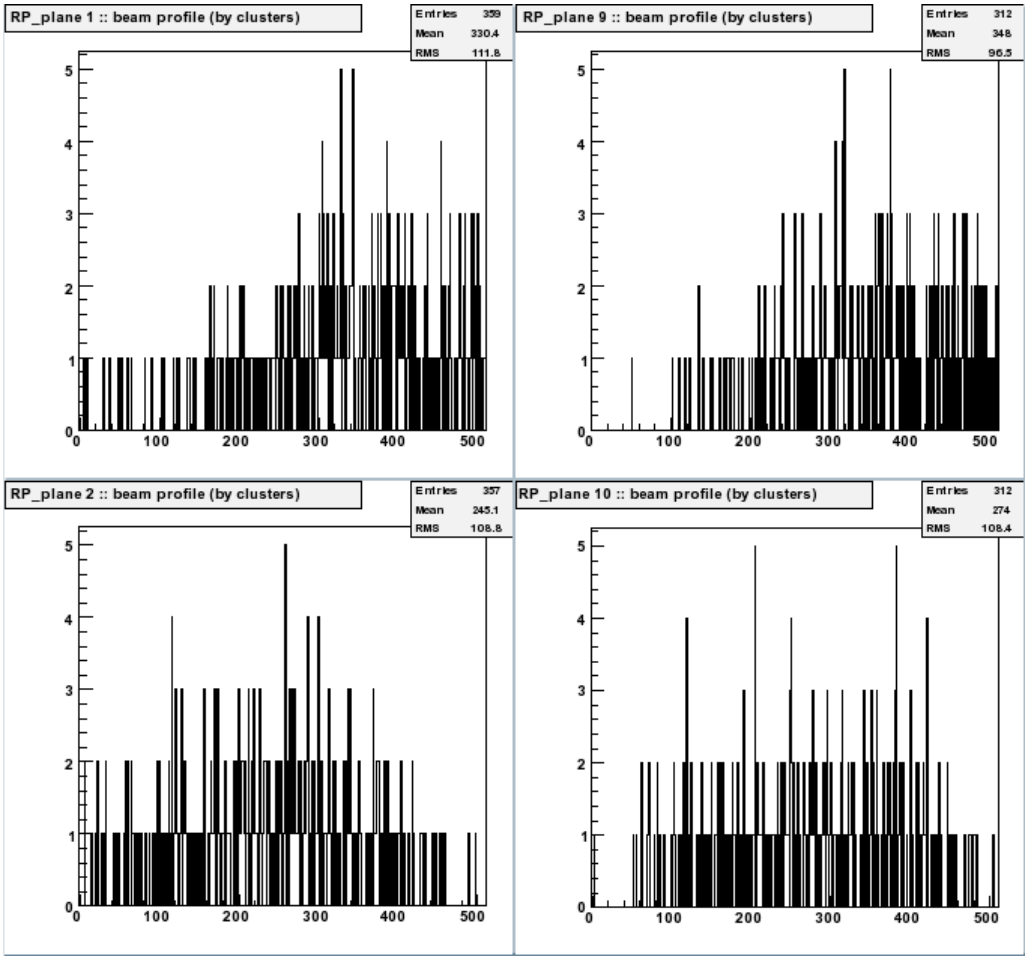


v (odd) planes

Beam profile

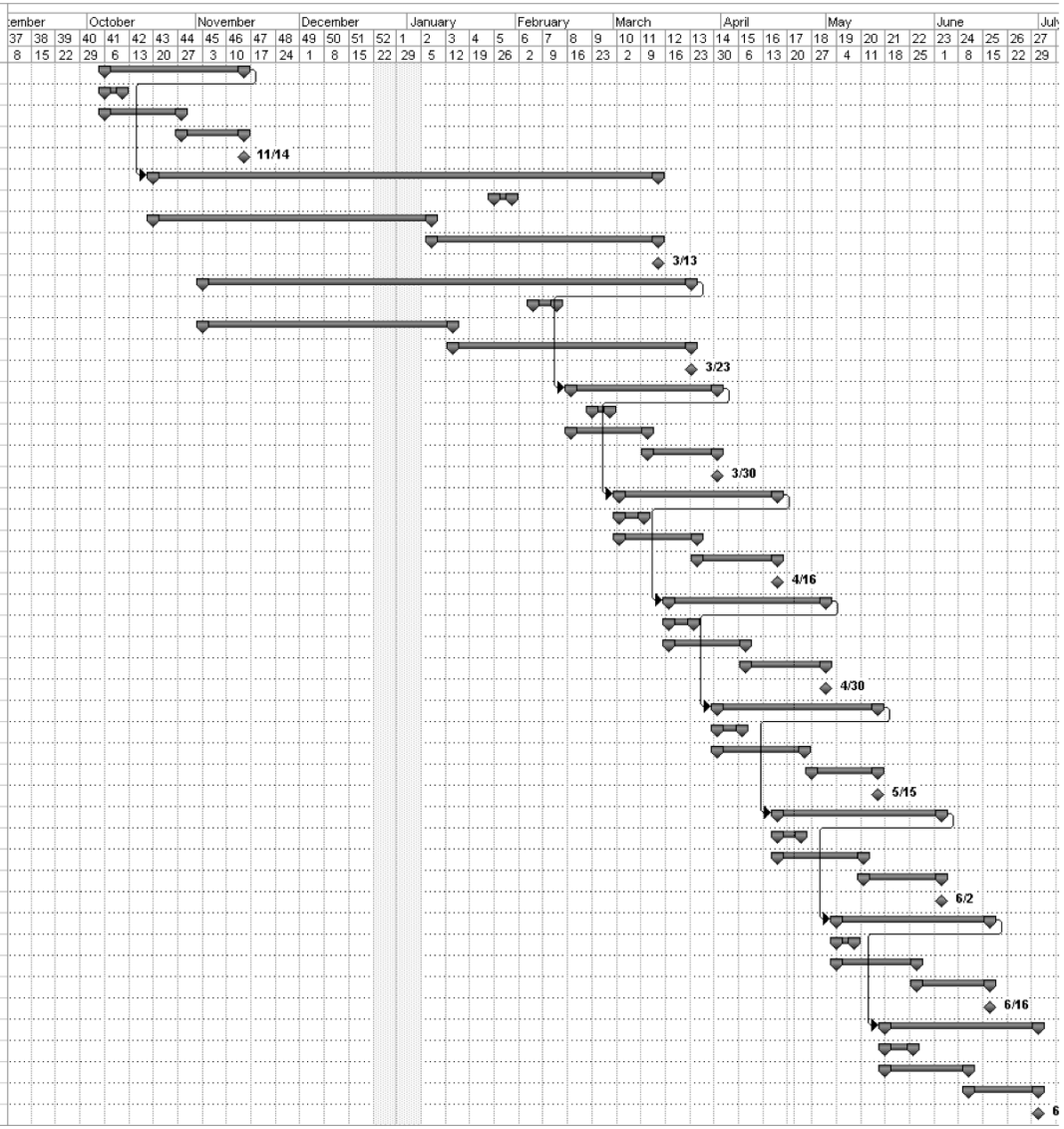
1st and last odd plane

1st and last even plane

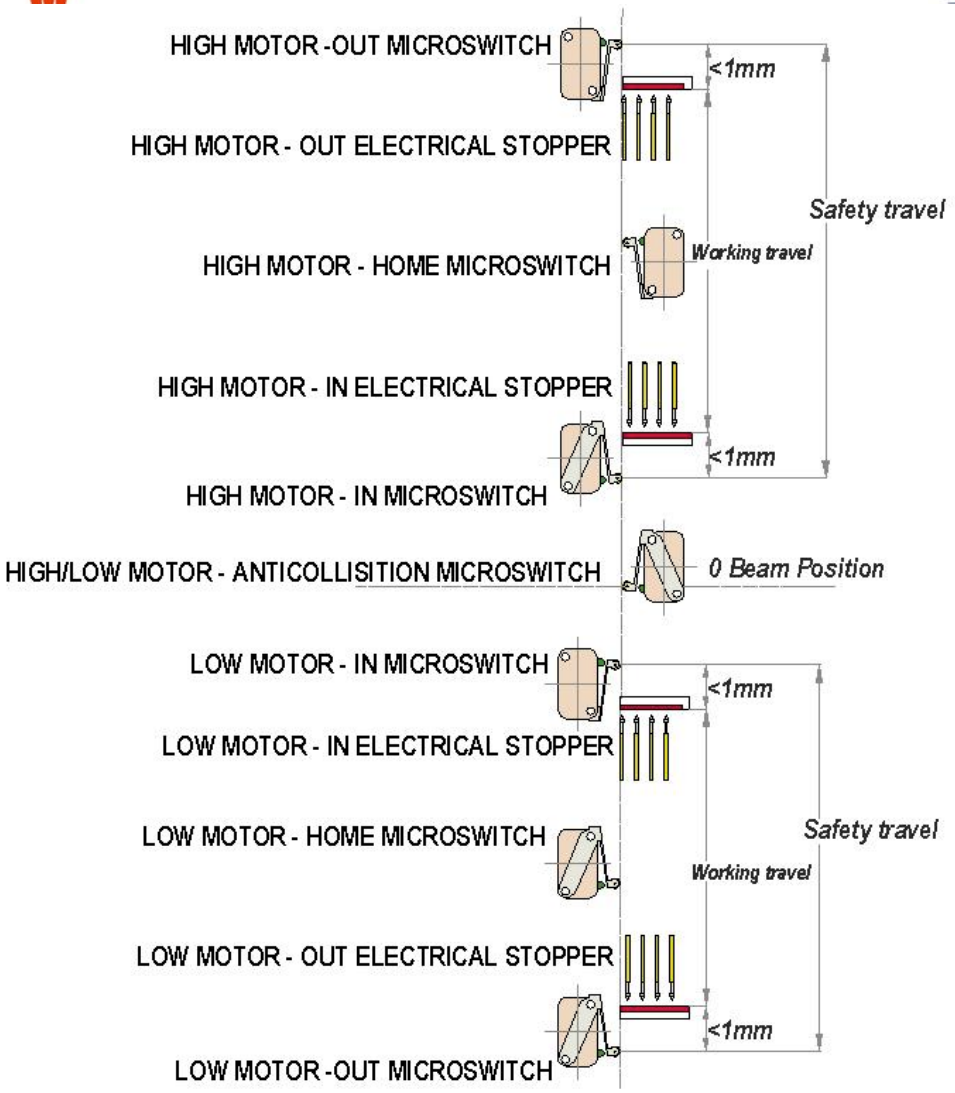


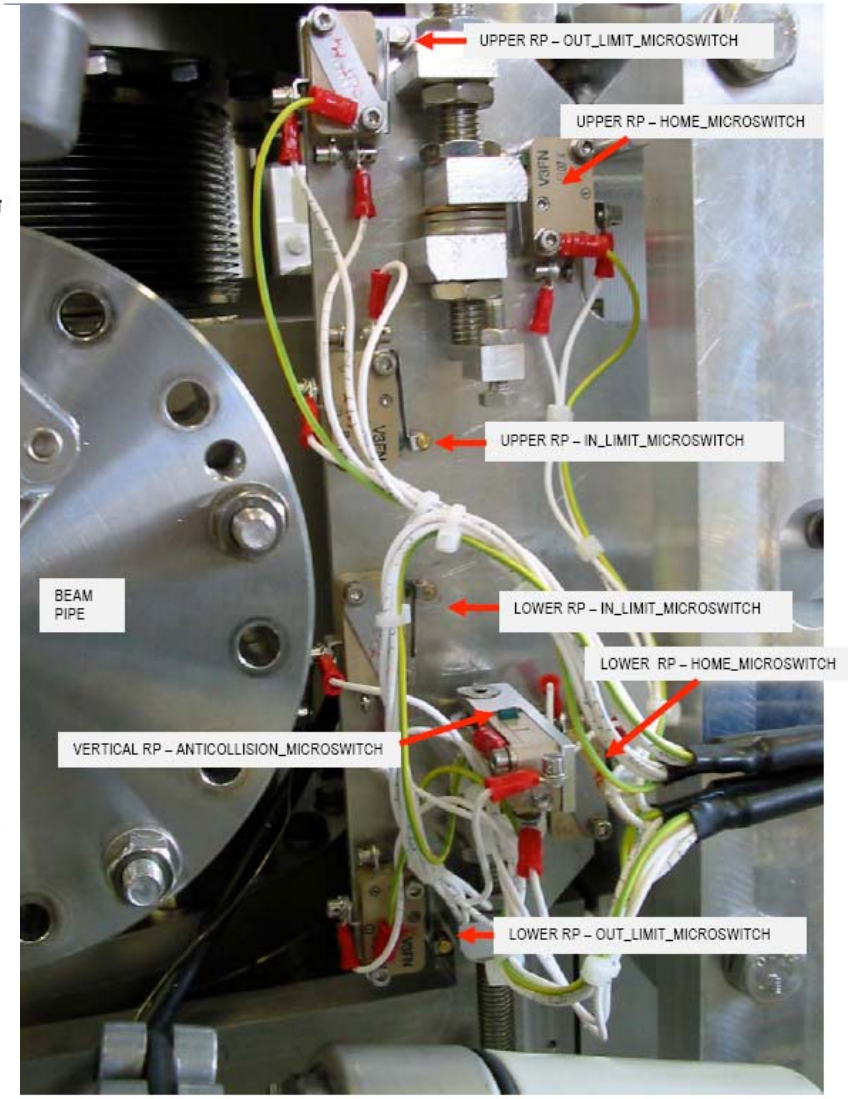
Roman Pot Planning

ID	Task Name
1	**Pot 3**
2	**MB ready**
8	**DPready**
16	**Pot completion**
21	ready for IP 5 Installation
22	**Pot 4**
23	**MB ready**
29	**DP Ready**
37	**Pot Completion**
42	ready for IP 5 Installation
43	**Pot 5**
44	**MB ready**
50	**DP ready**
58	**Pot completion**
63	ready for IP 5 Installation
64	**Pot 6**
65	**MB ready**
71	**DP ready**
79	**Pot completion**
84	ready for IP 5 Installation
85	**Pot 7**
86	**MB ready**
92	**DP ready**
100	**Pot completion**
105	ready for IP 5 Installation
106	**Pot 8**
107	**MB ready**
113	**DP ready**
121	**Pot completion**
126	ready for IP 5 Installation
127	**Pot 9**
128	**MB ready**
134	**DP ready**
142	**Pot completion**
147	ready for IP 5 Installation
148	**Pot 10**
149	**MB ready**
155	**DP ready**
163	**Pot completion**
168	ready for IP 5 Installation
169	**Pot 11**
170	**MB ready**
176	**DP ready**
184	**Pot completion**
189	ready for IP 5 Installation
190	**Pot 12**
191	**MB ready**
197	**DP ready**
205	**Pot completion**
210	ready for IP 5 Installation



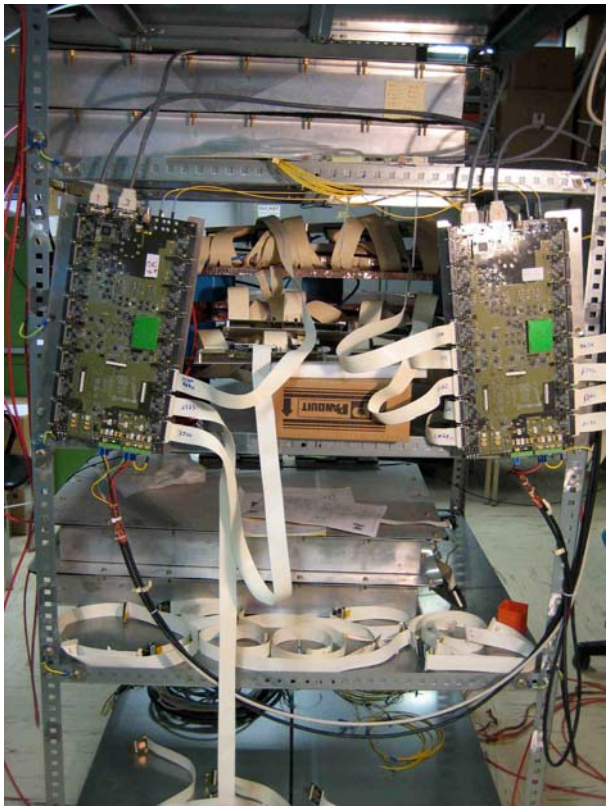
Roman Pot Motor Control





T1 chambers and supports

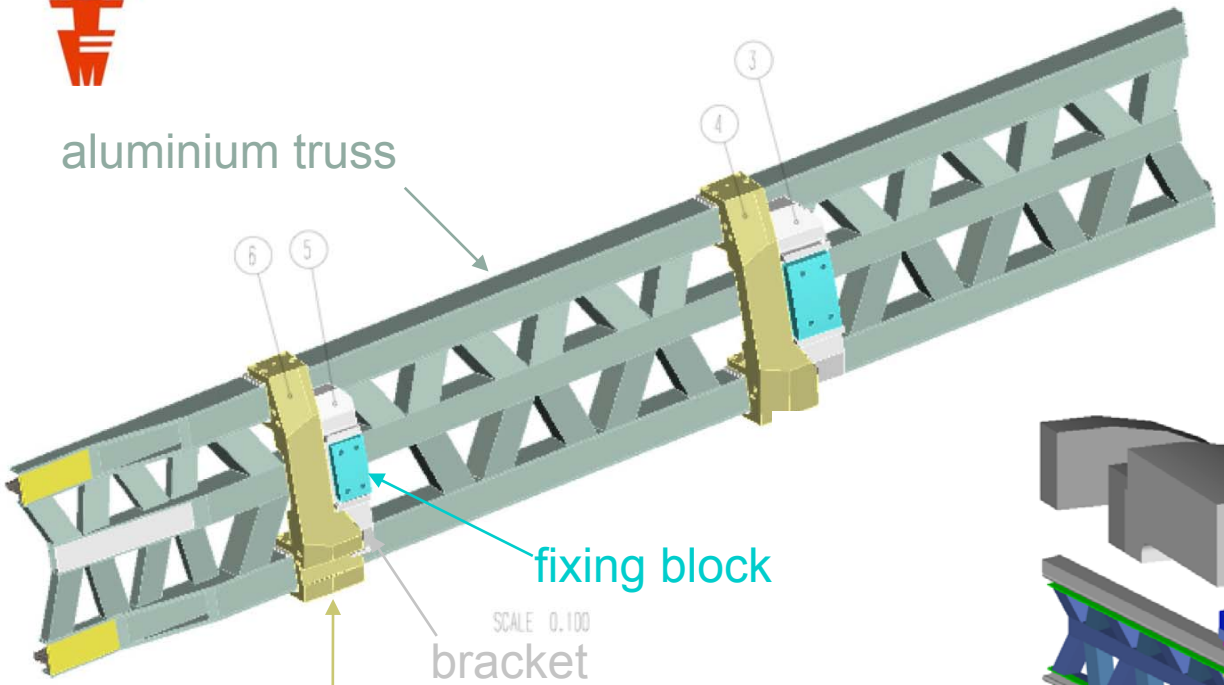
Cosmics test stand
in Genova



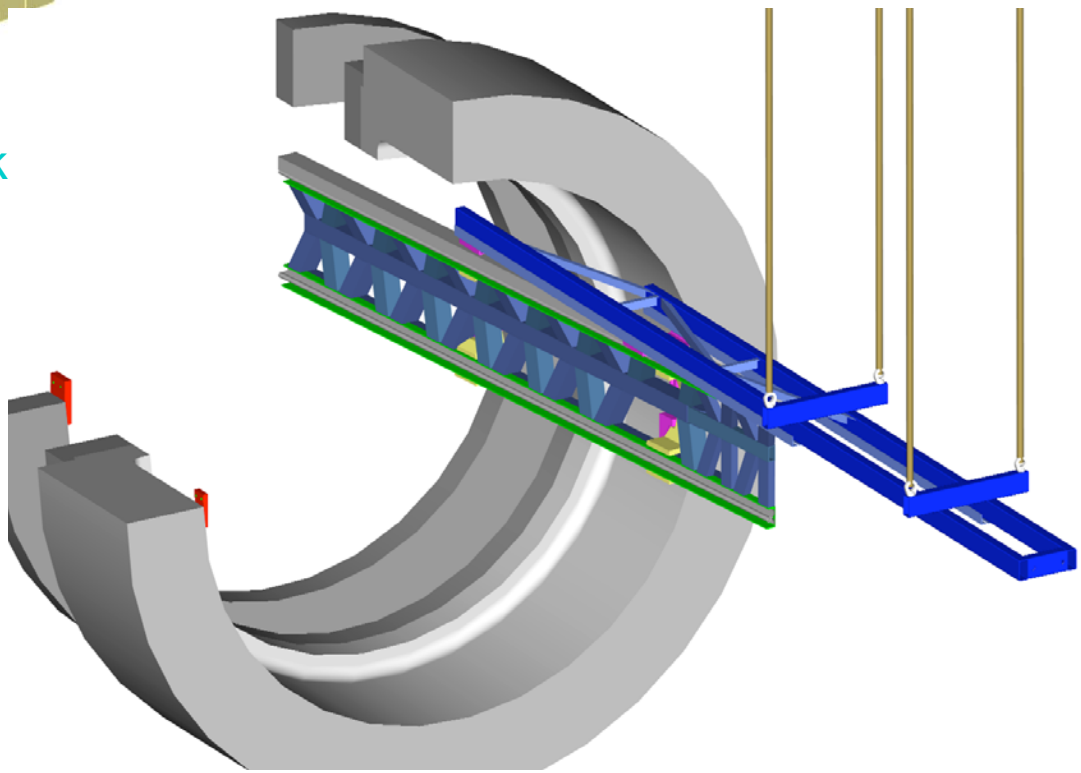
Support of
2nd half-arm

CSC stored
at CERN

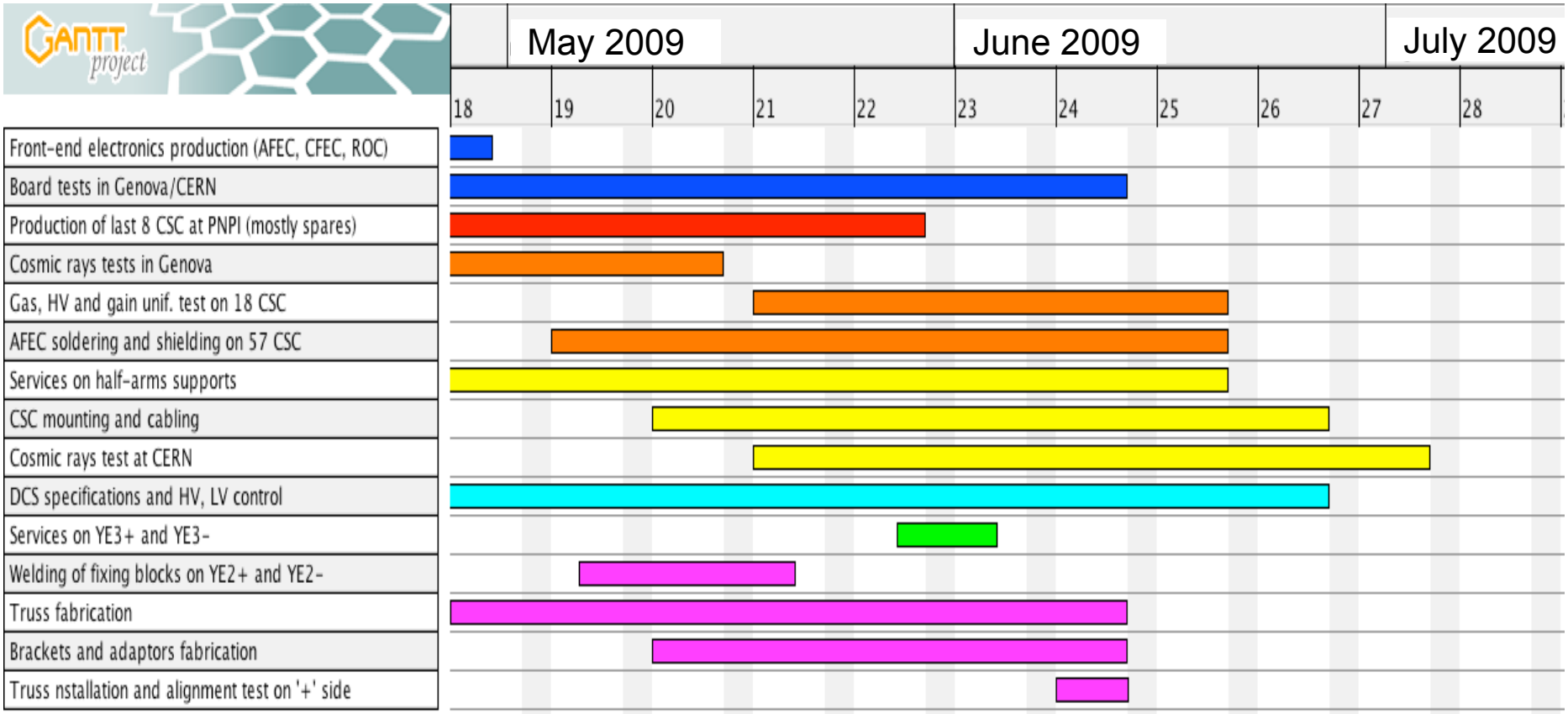
New support structure



New truss installation procedure



T1 planning



The trial installation (+ alignment) of the new support structure on one side is planned in June

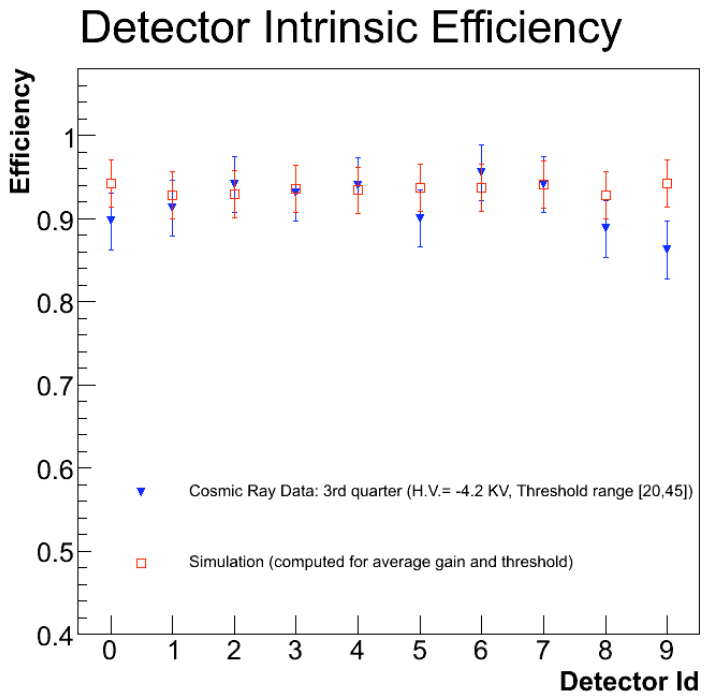
Installation of the two arms of T1 will happen in September

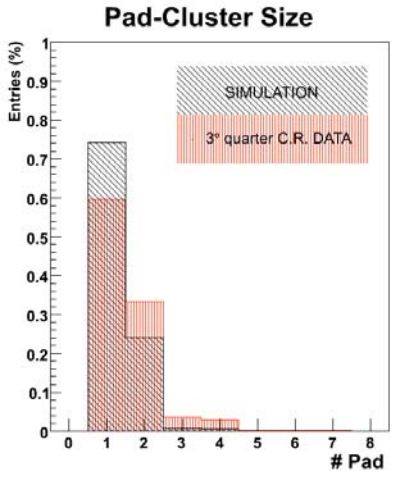
T2 Telescope on the IP5 +side

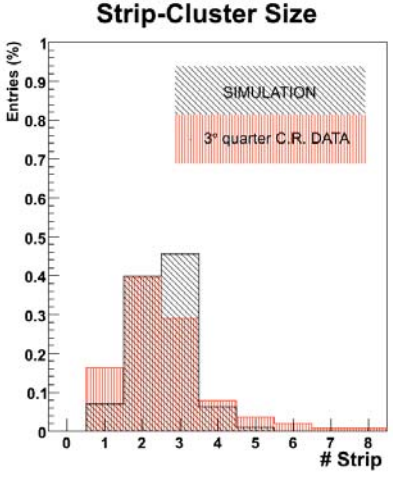
The 3rd quarter has been installed in IP5 plus end.
Cabling and piping is under way.
The first two quarters are under gas flow and the local cooling lines tested.
The electronics commissioning has just started.

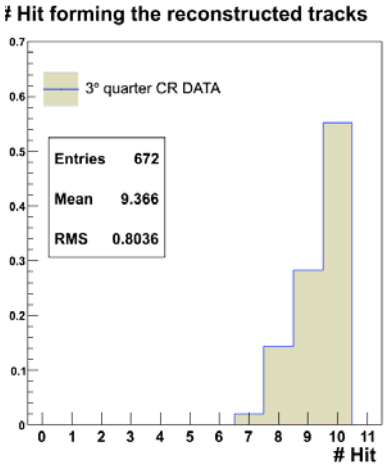
T2 test beam results

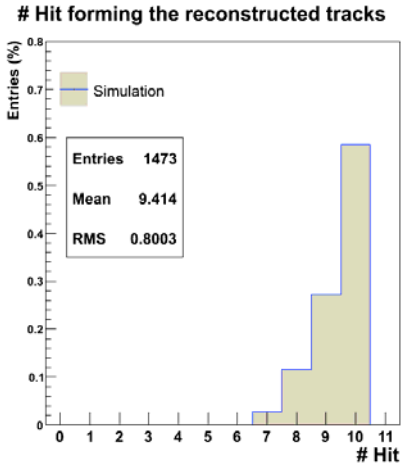
All the detectors have been tested with the final DAQ chain with cosmic rays before installation in IP5. The efficiencies found are in good agreement with detector simulation.





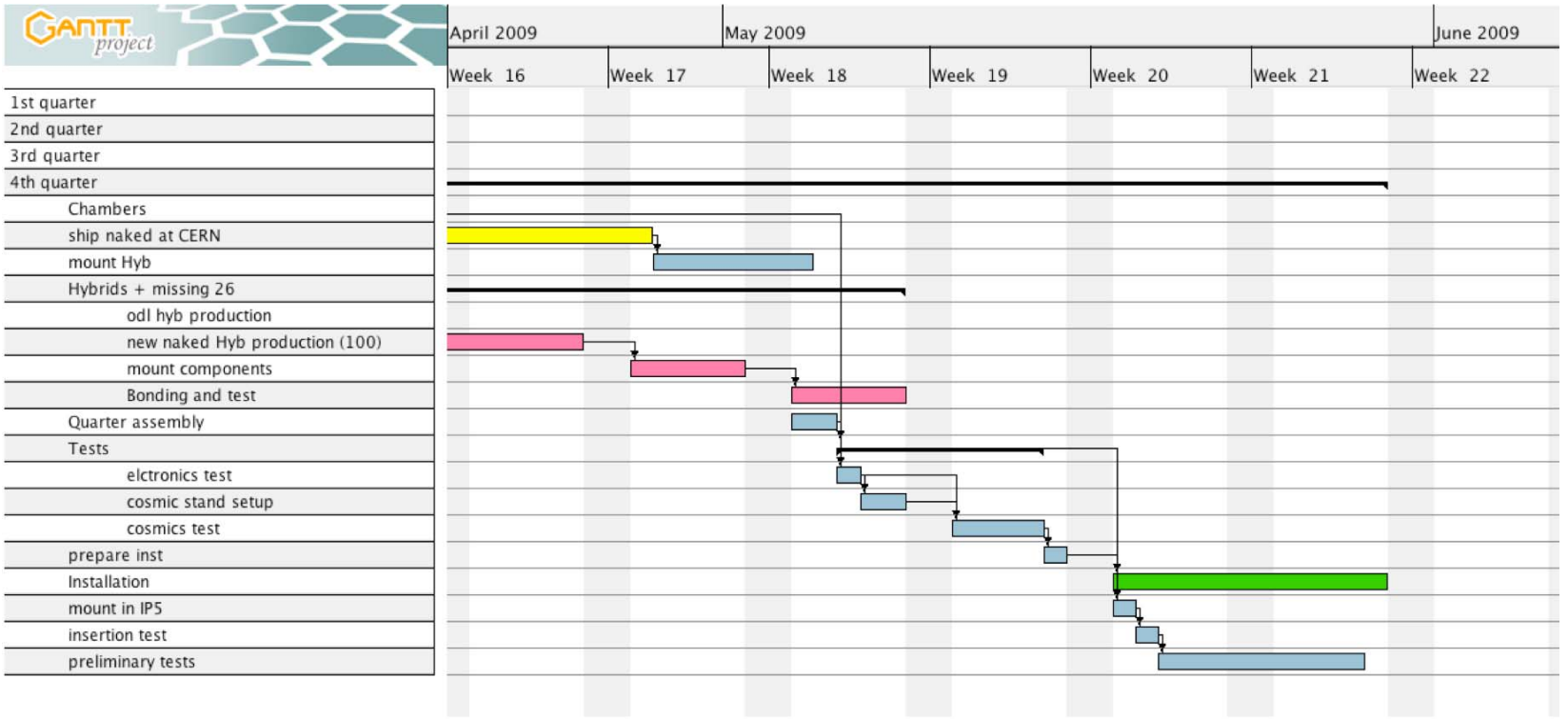






T2 planning

The 4th quarter is under assembly, 8 chambers are ready to be mounted on the telescope. The PADs VFAT Hybrids missing for the last two are produced and assembled these days. The detector will be installed the 3rd week of may, when a radioactive source will be removed from minus end garage.



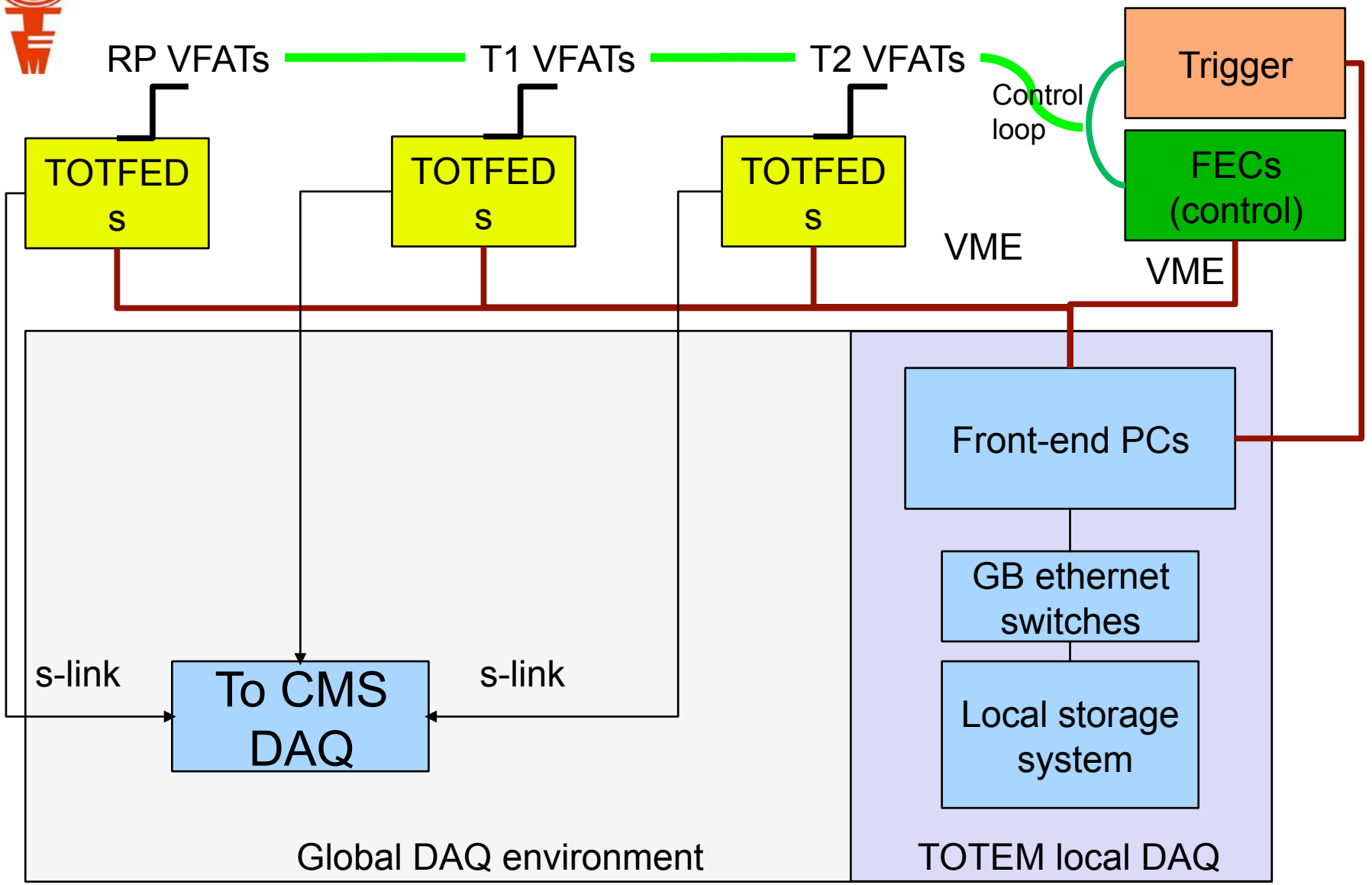
Electronics status (1)

W. S. 24.04.2009	Quantity													
	RP	T1	T2	Test setups + spare	Total	who	design	proto	test	Start Prod	End Prod	Start Test	End of Test	
RP Cards														
RP Hybrid	240			40	280	CERN					Nov-08	Jan-08	Dec-09	final batch in rework, available for 220m
RP Motherboard	24			4	28	CERN					Nov-08	Feb-08	Jun-09	final batch in rework, prod&test ok for 220 m
T1 Cards														
T1 anode hybrid (*)		120		20	140	Genova					Apr-09	Jan-08	May-09	remaining 5 % for installation in production
T1 cathode hybrid (*)		360		30	390	Genova					Apr-09	Jan-08	May-09	remaining 5 % for installation in production
Anode FrontEnd Card (AFEC)		60		10	70	Genova							May-09	final batch just delivered
Cathode FrontEnd Card (CFEC1)		120		20	180	Genova							May-09	final batch just delivered
T1 Readout Card (ROC)		40		5	45	Genova					Apr-08	Jan-08	May-09	Production to be delivered this wk
T2 Cards														
GEM strip hybrid (*)			160	20	180	Pisa								installation quantity delivered
GEM Pad hybrid (*)			520	60	580	Pisa					Apr-09	Jan-08	May-09	remaining 5 % for installation in mounting
Horseshoe Card			40	5	45	Pisa								
11th Card			4	1	5	Pisa								
Kaptons between Horseshoe & 11th			40	7	47	Pisa								
			40	7	47									
			40	7	47									
H,P,T card (sensor carrier)			4	2	6	Pisa							Jul-09	postponed, not essential
Opto TX			8	2	10	Pisa								
Trigger cards														
TriggerTimingControl Card (TTCci)	1			4	5	CMS								
Local Trigger Control Card (LTC)	1			1	2	CMS								not yet delivered
Optical splitter	1			1	2	CMS								not yet delivered
Coincidence Chip hybrid	48		52	20	120	Hungary					Apr-09	Mar-08	May-09	final 25 % in rework, ok for 220m
VFAT Trigger mezzanine	24	40	8	6	78	CERN						Mar-08	Jun-09	90% delivered, last 10 % in test after rework
Repeater Card	124			12	136	CERN							Jul-09	produced, tested, fix developed, in verif
Optocoupler card	2			1	3	CERN							Jul-09	
Trigger output card	1			1	2	Pisa							Jul-09	
T1 Trigger Merger Mezzanine		2		1	3	Genova							Dec-09	Postponed not needed for early operation
DAQ Cards														
Gigabit Opto Hybrid (GOH)	120	100	72	53	345	CMS								
OptoRX	12	10	10	9	41	Preshower								
VME64x Host Board	6	4	4	8	22	CERN							Jun-09	Naked card reproduced, mounting starts May
VME Back Plane	4			1	5	Bari								
Slink64 card	8	6	4		18	CMS								
Interlock Cards														
Interlock card				2	2	CERN							May-09	In production after new iteration with machine
(*) The GEM strip hybrid and T1 hybrids are identical, for the cathodes the wire bonding is different if only the digital part of the VFAT is used. The GEM pad hybrid is only slightly different to match the channel to trigger sector correspondence.														

Electronics status (2)

- Several production problems with printed circuit boards.
- Succeeded to produce sufficiently for installation this year, need more for RP 147 m and spares.
- Interlock card needed many design iterations, now in production.
- Cabling in tunnel finished in the next weeks, DCS and DSS cabling in counting room underway.

Overview of the DAQ system



DAQ Schedule

- Installation of VME crates and related software for detector test in IP5: following detector schedules.
- Installation of local storage and event-builders: as local storage needs arise, or latest end June.
- Integration tests with detectors, DCS and Trigger: September 2009.

Offline Software

The TOTEM Offline Software is developed based on the CMSSW Framework.

The TOTEM related packages can be incorporated in the CMS Software, allowing in future a combined detector simulation and analysis.

Current Release (2.0) includes (for all TOTEM detectors):

- Simulation (Geant4 + Digitisation), Reconstruction
- Simulation of the Coincidence Chip
- L1 Trigger response
- Proton transportation in the accelerator

2009 Schedule:

- Production of simulated data+Trigger, for the early physics scenarios: first samples already under analysis to optimise software performances, develop analysis tools, define trigger strategy for early runs

- Offline Data Base: characterization of the data, list of requirements, Oracle technology.
Develop the access to the data

- Mapping and Calibration: follows the commission and the installation of the detectors in the tunnel

- Finalize the Aligment procedure of all detectors

Physics of 2009-2010 runs

TOTEM will operate in all running conditions.

Programme at $\sqrt{s}$ = 900 GeV:

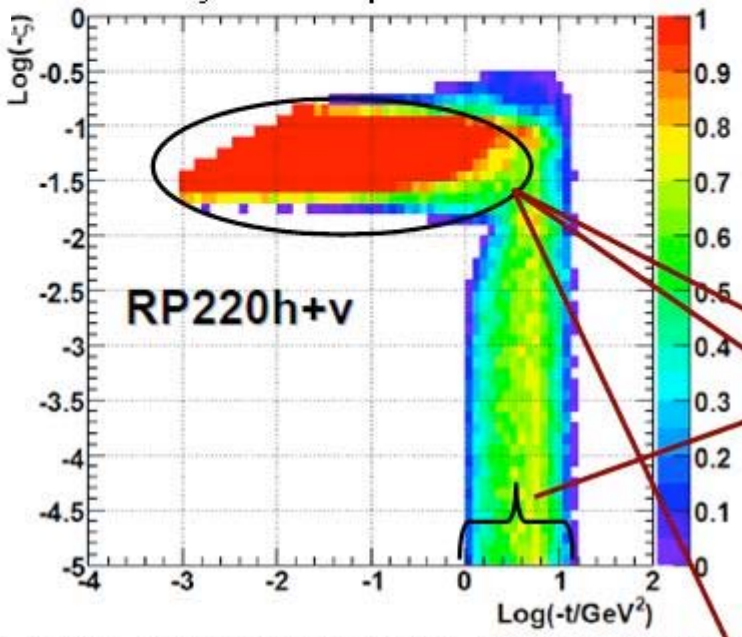
- poor acceptance for elastic scattering due to large beam size at the Roman Pots and the limitations due to TAS / quadrupole triplet aperture
- alignment of Roman Pot detectors using beam halo and diffractive protons
- study of outgoing protons with momentum losses $\xi = \Delta p/p > 0.1$ in a limited $|t|$ range → first look at high mass single diffraction
- study of forward charge particle event topology with T1 and T2 (pseudorapidity distributions and multiplicities)

Programme at $\sqrt{s}$ = 8 – 10 TeV:

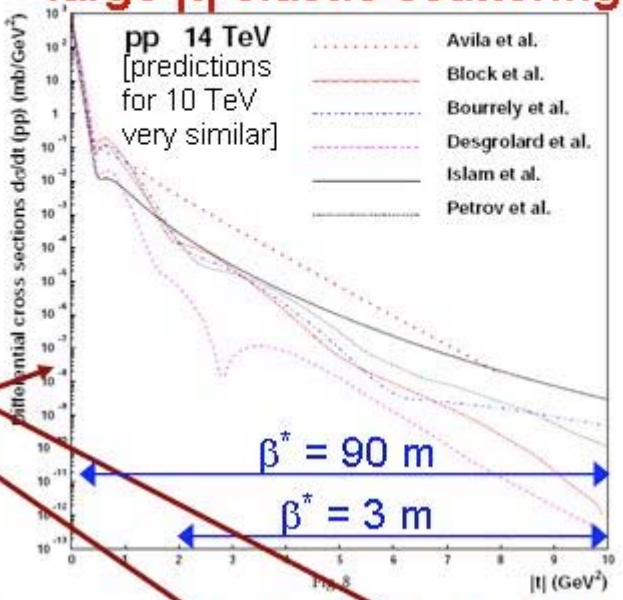
- early optics (e.g. $\beta^* = 3$ m): large-$|t|$ elastic scattering, high mass single and central diffraction + forward charge particle event topology
- as soon as technically feasible: request short LHC runs with $\beta^* = 90$ m optics → first measurement of σ_{tot} with T1, T2, RP (precision: ~ 5 %)

Physics of early runs (e.g. E_p = 5 TeV, β^* = 3 m)

RP220 ξ–t acceptance:

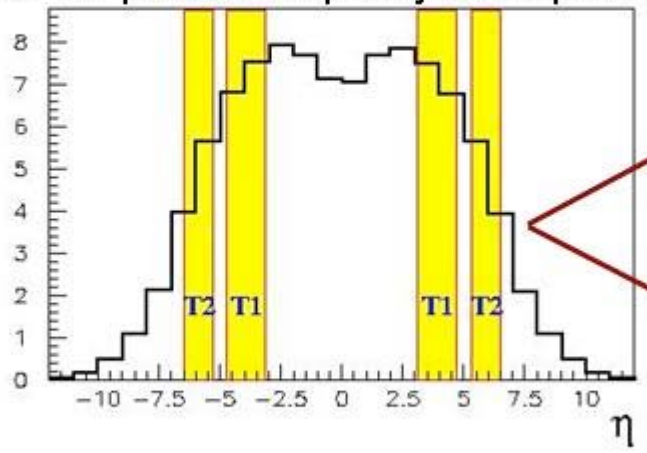


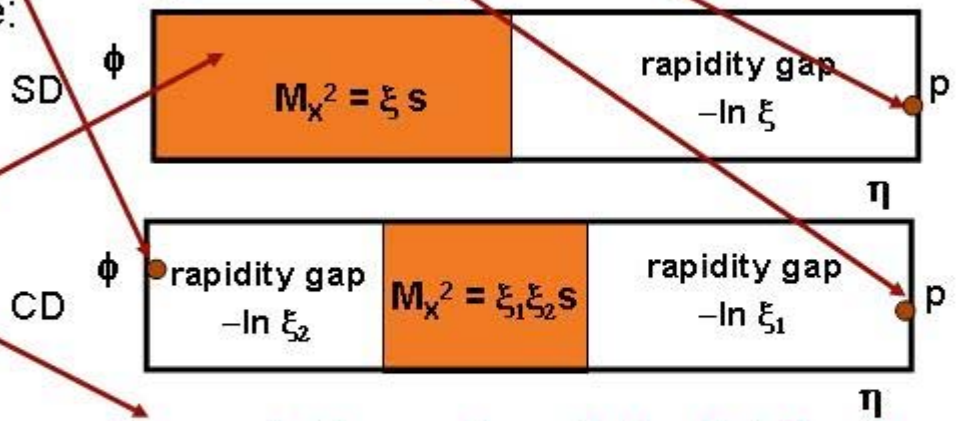
large |t| elastic scattering



high mass single & central diffraction

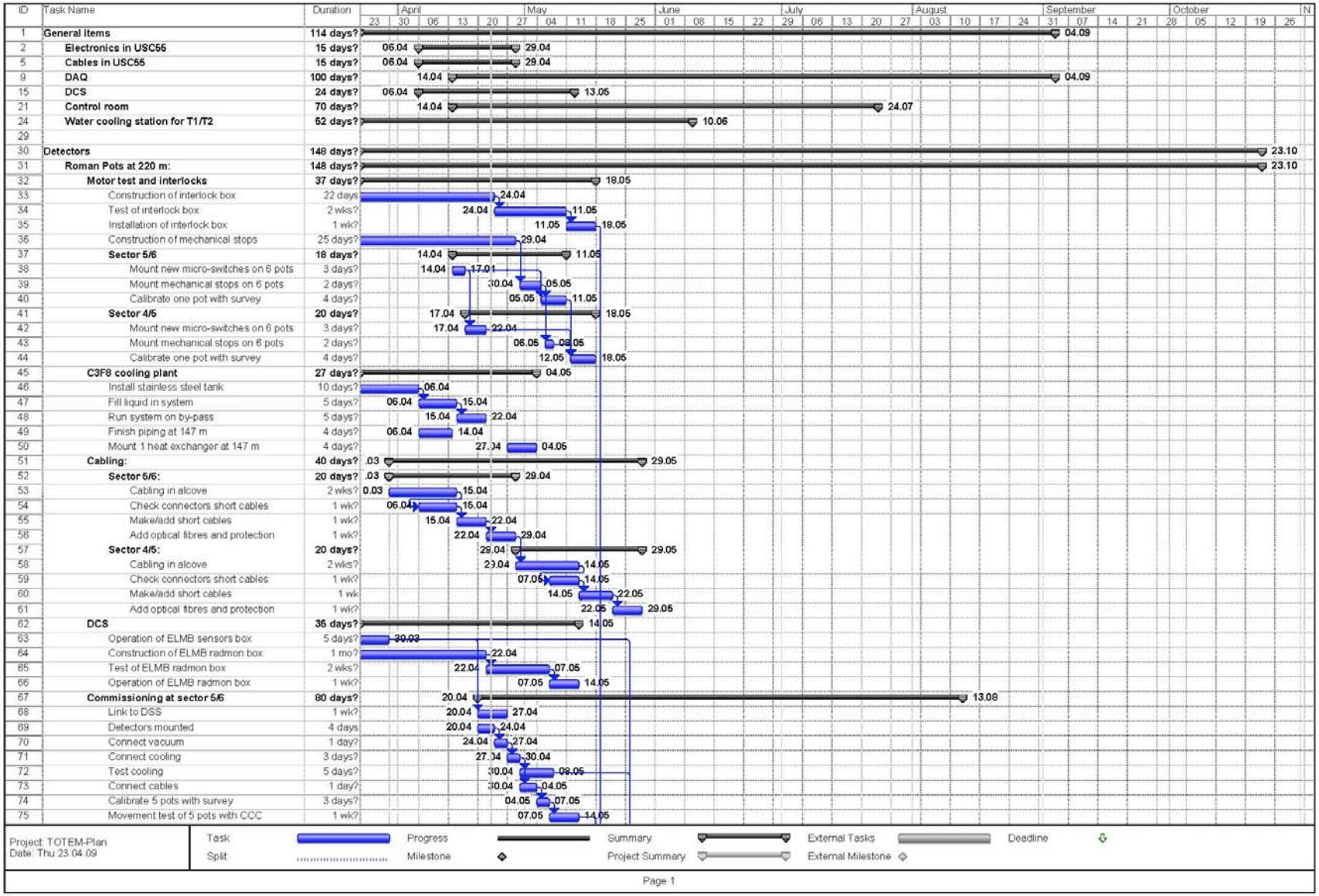
T1 & T2 pseudorapidity acceptance:



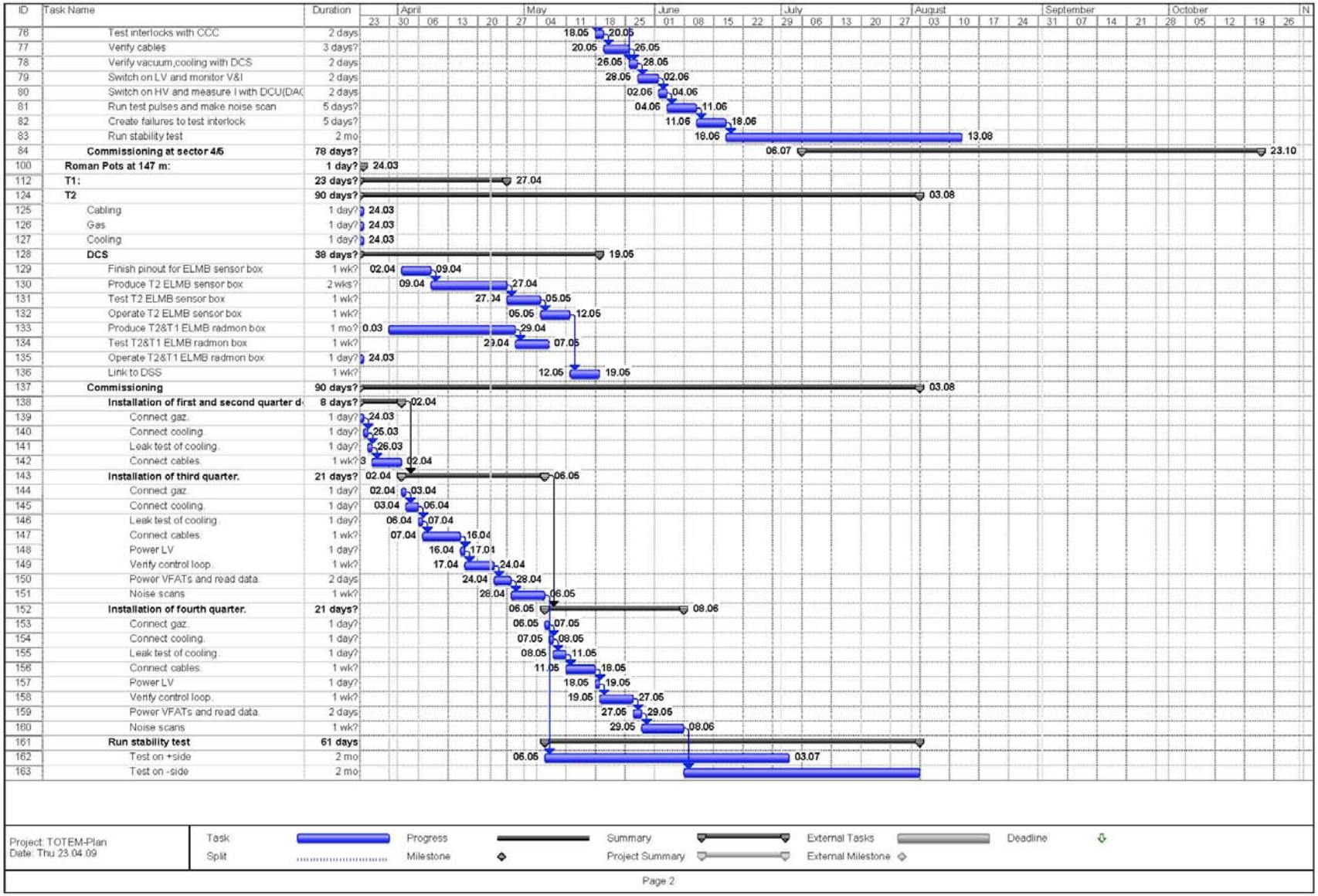


forward charged particle distribution

Current Commissioning Planning (1)



Current Commissioning Planning (2)



Summary

- The Roman Pot detectors are now installed in sector (5,6), the sector (4,5) will be equipped end of June.
- Few Roman Pot detectors will be mounted at 147 m to gain experience with the first beams (background !).
- Three quarters of the T2 Telescope are installed, the last one follows latest end of May.
- For T1 a pre-mounting of the new support structure is foreseen beginning of June if the CMS schedule allows it.
- Installation of T1 can only be done in September.
- For the Roman Pots and T2 the commissioning can start now.