Minimum Hardware Commissioning – Disclaimer

No compromise with safety, quality or equipment integrity

1

- Cryogenics
- Quench protection & Energy Extraction
- Powering interlocks
- Power converters

- RF
- Beam instrumentation
- Collimators
- Beam interlocks
- Warm magnets
- Injection & dump systems
- Other …

2

Only a first approximation of the circuits considered necessary and the respective highest current levels was made

TCC 060616

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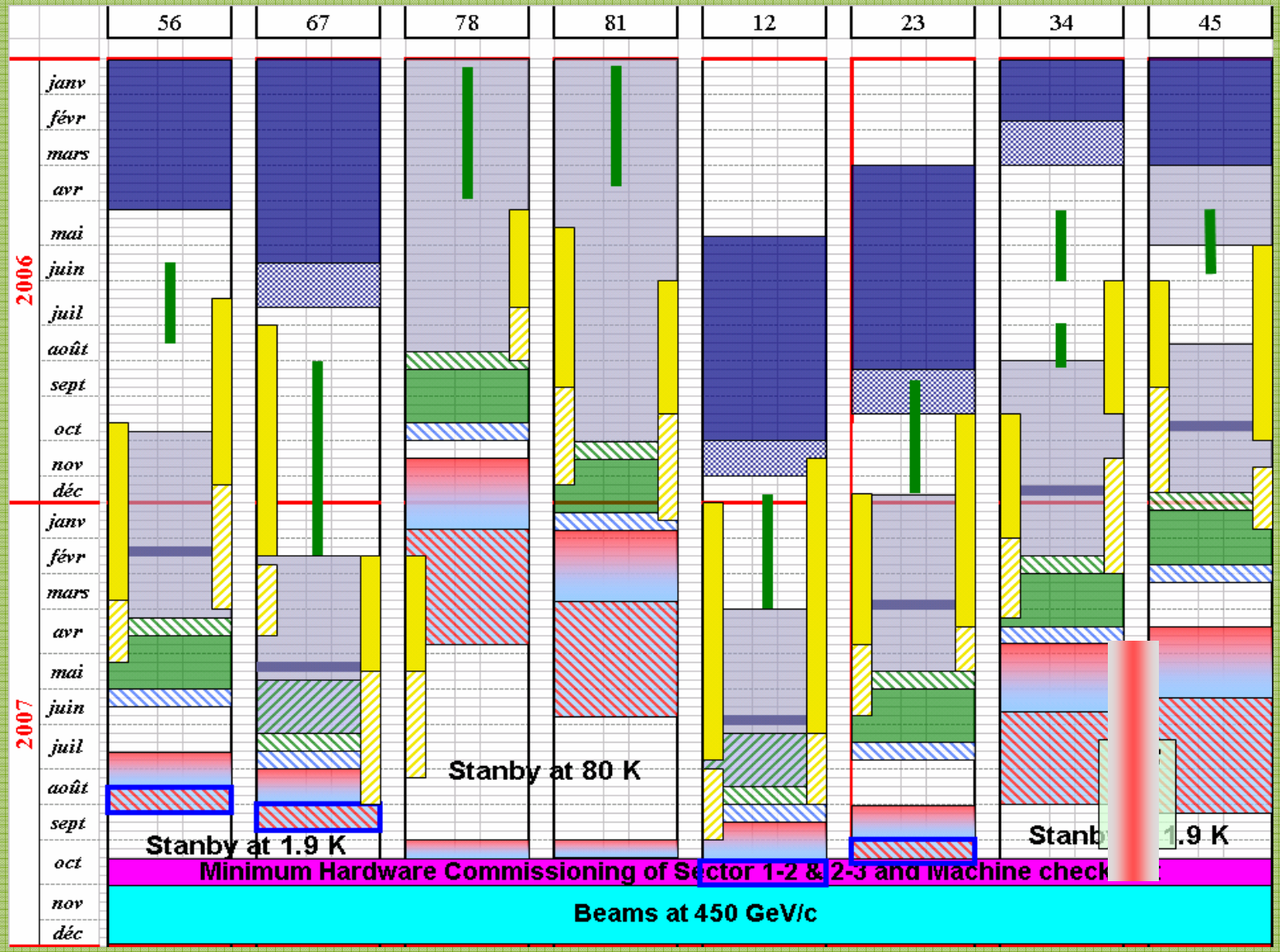
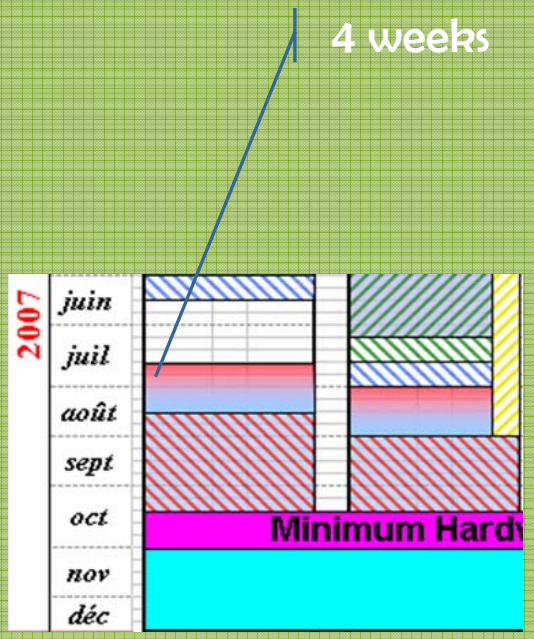


- Good news
  - The four weeks allocated for cool down include the commissioning of the instrumentation.
  - Two would be enough for the cool down if all the logistics and the operation turn-out as expected.
  - The four weeks are needed for the instrumentation. The shortening from 8 to 4 is possible because less current means more margin; this allows less precise instruments on some of the components; therefore shortened commissioning times for the instrumentation.



Cryogenics

Laurent Tavian

- Identified issues
  - **Time** for the conditioning and the flushing of the cryogenic circuits; could be done in parallel with the electrical quality assurance (evacuating the circuits at night and refilling for 8.30)
  - **Resources**
    - for operation & controls
    - one additional team and additional tooling for the commissioning of the instrumentation

Quench Protection and Energy Extraction

Karl Hubert Meß

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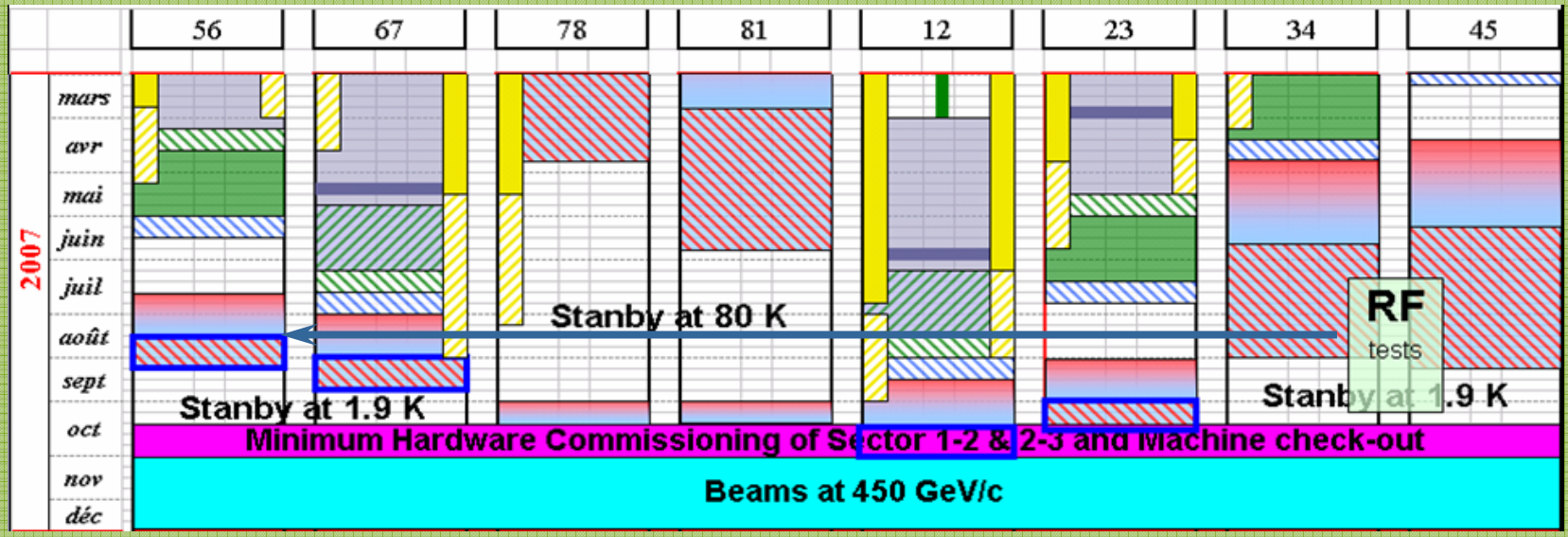
Boundary conditions - Good news

- At the 1860 A, which is the current level needed for operation up to 1.1 TeV, only 2% of the nominal energy is stored in the magnets. The heaters are not needed at this current level; therefore we don't commission them!
- The quench detection must work. It is being commissioned at warm; nevertheless we have to check it still works when the magnets are cold (1-2 days)
- Global quench detection at the circuit level (correctors, main bus-bars etc.) will work if
  - The L(I) is inferred from experience with the fully commissioned circuits and adapted
  - The dI/dt is kept low in the power converters so that a safe threshold for deciding a circuit is quenching can be imposed
- The Energy Extraction system is commissioned up to 1860 A
- All interlocks are tested except those involving the heaters

Quench Protection and Energy Extraction

Karl Hubert Meß

- Recommendation/Condition
  - Commission 78 and 81 as best as you can – by the book
  - As long as the resources are not required for the commissioning of the last four sectors, carry-out the commissioning of 34 and 45
- The consequence
  - No more parallelism
  - Much more to do in 2008



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Power Converters

Freddy Bordry

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- Good news
  - The commissioning of the power converters is considered done after the Short Circuit Tests with the exception of
    - The interlocks with the quench protection system at cold
    - The tuning of the control loops but this can be inferred from experience with the fully commissioned circuits and adapted
    - The calibration of the DCCTs; some of it can be done at warm but may be a day will be needed in the end.
- The issues
  - There is a difference between
    - a 450 GeV "inject, squeeze & dump" run and
    - a 1.1 Tev "inject, accelerate, squeeze & dump" run

Powering interlocks

Rüdiger Schmidt

- Good news
  - Before July 2007, all hardware will have been installed, and a large part of the commissioning should be finished
  - After the last sectors are cooled down to 1.9 K, there is still some time needed to finish commissioning of the system, since only then we can have "green light" from CRYO and QPS
  - Time that is required should be maximum one week (assuming that lot of experience has been gained during the commissioning before)
- The issues
  - In order to finish commissioning in 2008, (at least some of) our collaborators should still be available
  - Very well optimised automatic procedures will be key to rapid commissioning (deserves more attention)

Which circuits

Mike Lamont

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- Difficult to estimate how long it takes to commission the sector unless one has:
  - the **list of circuits** needed for the run and
  - the **maximum current level** required for each circuit

Main dipoles
Separation dipoles (warm & cold)
Spectrometer compensation
Orbit correctors
Sextupole spool
Lattice Quad
Insertion quads
Lattice skew
Tuning quads
Dispersion suppressors quads
Twin aperture warm quads
Inner triplets 20
Wide aperture insertion quads
Lattice sextupole

nominal

powering of the superconducting magnet circuits

1/2

HCA:PIC2	Stand-by current	to commission the protection functionalities of the powering interlock controllers and all its connected systems with current through the circuits to verify the compatibility of the switch-on and switch-off processes of the converters with the sensitivity of the protection systems (namely QPS)
HCA:PLI1 HCA:PLI2 HCA:PLI3 HCA:PLI4	Injection level 20% of I_{nom} 50% of I_{nom} ~~80~~ 90% of I_{nom}	to set up the power converter current loops to validate the protection mechanisms under real powering conditions and with limited amount of energy in the circuits to validate quench-related procedures, e.g. cryogenic recovery procedures to validate the sensitivity and compatibility during ramps of the systems susceptible to noise pick-up, couplings, etc to perform a last check on the polarities of the circuits by verifying voltages across current leads (at low current using QPS signals)

Circuit commissioning procedures – how long ?

Félix Rodríguez

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refined estimate of the times required for the test (2/2)

Circuit type	First method [days/circuit]	Refined method w/o anal. [days/circuit]	Time estimated for analysis [days/circuit]	Total refined method [days/circuit]	# of circuits
RB	11.0	6.0	1.6	7.6	8
RQ	5.5	4.4	1.6	6.0	16
RQX	5.5	5.0	1.4	6.4	16
Ind. Powered quads and dipoles	1.7	1.8	0.5	2.3	78
600 A average	0.8	0.6	0.4	1.0	436
80 A, 120 A	0.3	0.1	0	0.1	274
60 A	0	0.1	0	0.1	752

Reference for the General Schedule

require battery tests

HC Review

F. Rodriguez-Mateos

The minimum hardware commissioning to 1.1 TeV

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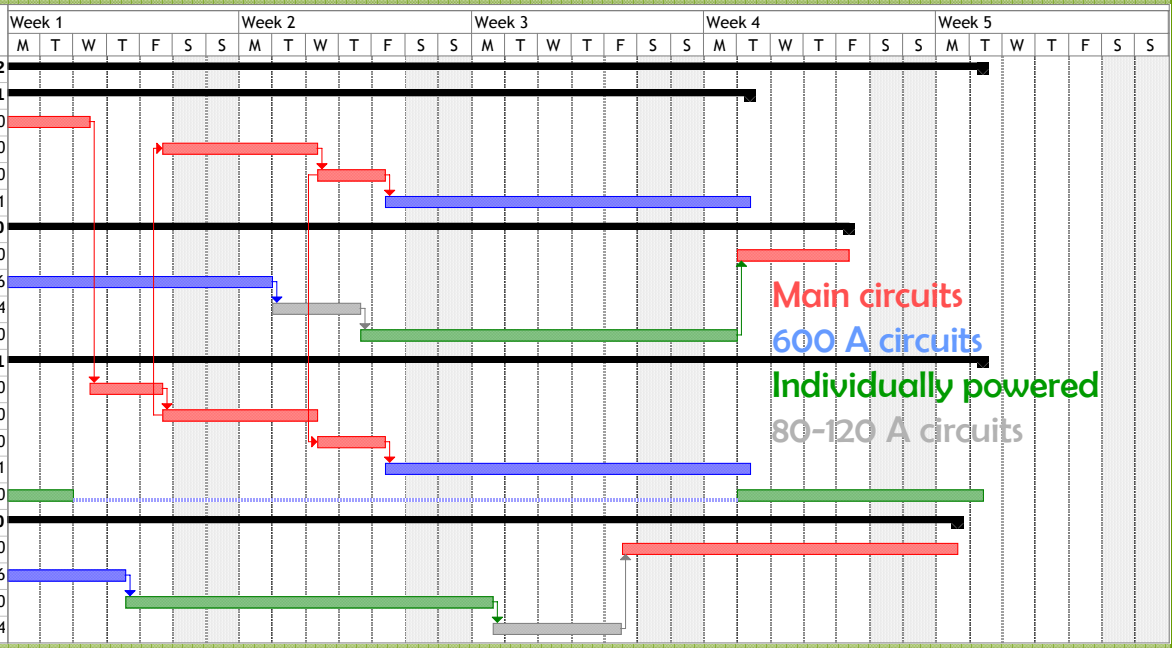
- Assumptions
  - 15 hour days & 5 day weeks
  - Two adjacent sectors in **parallel**
  - Two teams per sector (4 fronts per point)
  - At most two chimneys in a DFB commissioned at the same time
  - Only one main magnet circuit at a time except for QF (QD) which are commissioned in parallel on both sectors

ID	Task Name	Duration	Circuits PLI2	Circuits Nominal
1	**Powering Sectors 12 - 23**	**21.2 days**	**67**	**112**
2	**Front 1 R2**	**16.16 days**	**21**	**11**
3	RB.A23	2.44 days	1	0
4	RQF.A23	2.14 days	1	0
5	RQD.A23	2.14 days	1	0
6	600A (UA27)	7 days	10	11
7	**Front 2 R2**	**19.1 days**	**13**	**40**
8	Inner Triplet	3.1 days	1	0
9	600A (UJ33)	6 days	12	6
10	80-120A	2.8 days	0	34
11	Indiv Powered Q&D (UA27)	7.2 days	8	0
12	**Front 1 L2**	**21.2 days**	**21**	**11**
13	RB.A12	2.44 days	1	0
14	RQF.A12	2.14 days	1	0
15	RQD.A12	2.14 days	1	0
16	600A (UA23)	7 days	10	11
17	Indiv. Powered Q&D (UA23)	7.2 days	8	0
18	**Front 2 L2**	**20.8 days**	**12**	**50**
19	Inner Triplet	6.3 days	2	0
20	600A (RR17)	3.6 days	2	6
21	Indiv. Powered Q&D (RR17)	7.2 days	8	0
22	80-120A	3.7 days	0	44



The schedule

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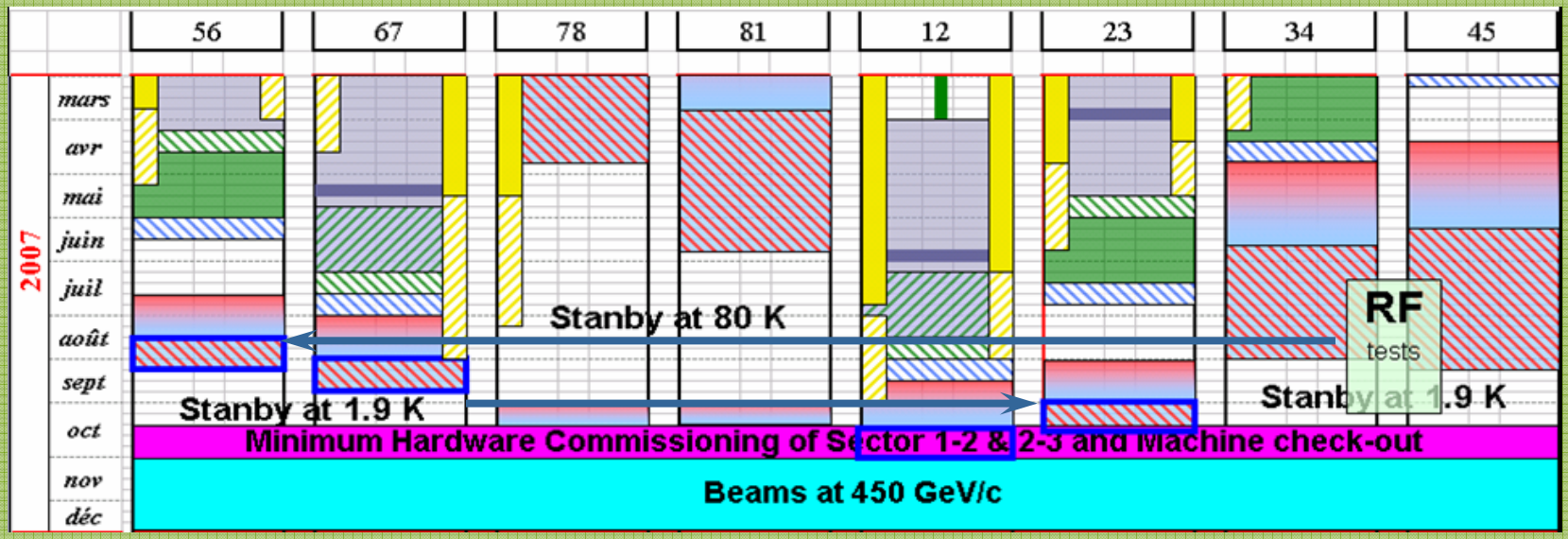


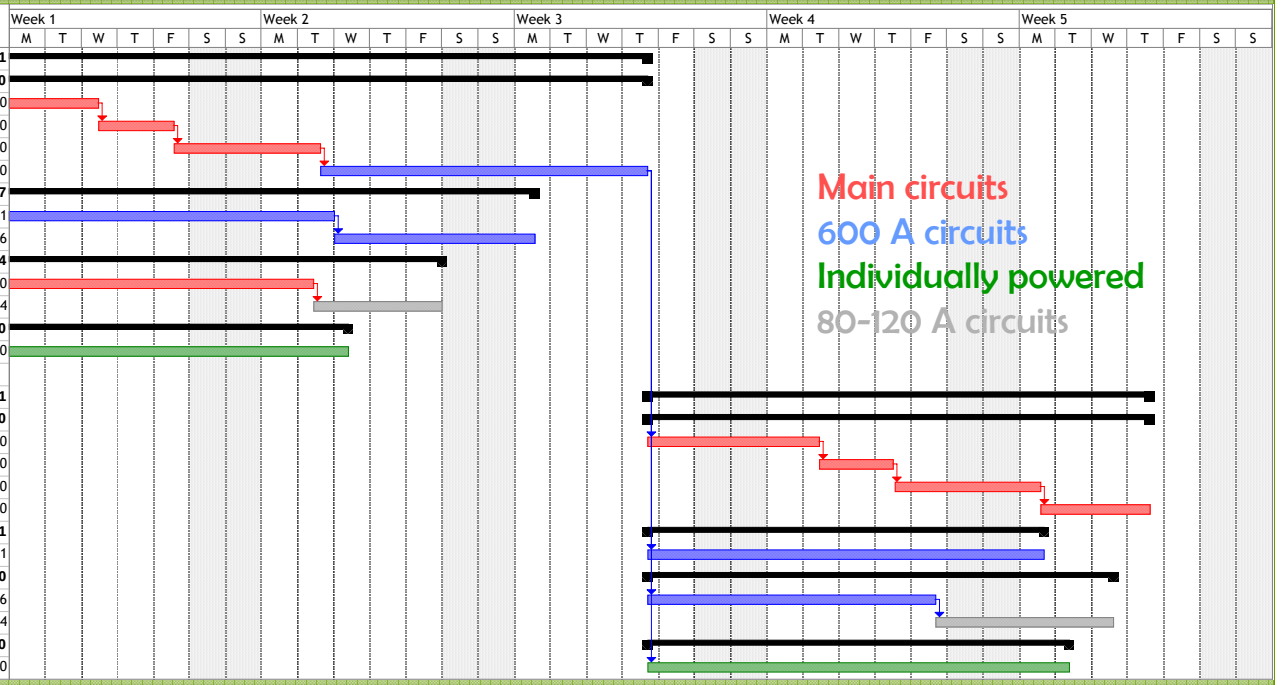
Not in parallel

The minimum hardware commissioning to 1.1 TeV

No compromise with safety, quality or equipment integrity

- Assumptions
  - 15 hour days & 5 day weeks
  - Two adjacent sectors in **not in parallel**
  - **Four** teams per sector
  - At most two chimneys in a DFB commissioned at the same time
  - Only one main magnet circuit at a time except for the inner triplet circuits which are commissioned in parallel the main magnets

ID	Task Name	Duration	Circuits PLI2	Circuits Nominal
1	**Powering Sector 12**	**13.92 days**	**33**	**61**
2	**Front 1 L2**	**13.92 days**	**11**	**0**
3	RB.A12	2.44 days	1	0
4	RQF.A12	2.14 days	1	0
5	RQD.A12	2.14 days	1	0
6	Indiv Powered Q&D (UA23)	7.2 days	8	0
7	**Front 2 L2**	**10.6 days**	**12**	**17**
8	600A (UA23)	7 days	10	11
9	600A (RR17)	3.6 days	2	6
10	**Front 3 L2**	**10 days**	**2**	**44**
11	Inner Triplet	6.3 days	2	0
12	80-120A	3.7 days	0	44
13	**Front 4 L2**	**7.2 days**	**8**	**0**
14	Indiv Powered Q&D (RR17)	7.2 days	8	0
15				
16	**Powering Sector 23**	**9.82 days**	**34**	**51**
17	**Front 1 R2**	**9.82 days**	**4**	**0**
18	RB.A23	2.44 days	1	0
19	RQF.A23	2.14 days	1	0
20	RQD.A23	2.14 days	1	0
21	Inner Triplet	3.1 days	1	0
22	**Front 2 R2**	**7 days**	**10**	**11**
23	600A (UA27)	7 days	10	11
24	**Front 3 R2**	**8.8 days**	**12**	**40**
25	600A (UJ33)	6 days	12	6
26	80-120A	2.8 days	0	34
27	**Front 4 R2**	**7.2 days**	**8**	**0**
28	Indiv Powered Q&D (UA27)	7.2 days	8	0



What about 2008

- The brute force approach:
  - every cool down which was cut down to 4 weeks needs another 4 to refine the commissioning of the cryogenic instrumentation of the sector
  - every powering test which was cut down to four weeks needs the complement to 10 or 12 depending on the sector

Sector	Cool down	Power tests	Total
12	4	8	12
23	4	8	12
34	0	2	2
45	0	2	2
56	4	6	10
67	4	6	10

Two sectors in parallel could give 12+2+10=24 weeks i.e. 5-6 months

- More refined approaches include:
  - benefit from the 450 Gev run and measure, refine, validate
  - more resources from the equipment & operation groups, hence more parallelism
  - optimization – wait until 78 is commissioned
  - learning curves, hence shorter test time

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Conclusion

- In 2007, it looks it can be done, but its tight!
- Careful tuning of co-activities is needed
- Some additional resources will be needed in 2007 (man power and hardware)
- Resources not originally planned for will be needed in 2008
- The program for 2008 must be closely watched to ensure that the remaining commissioning can really be done