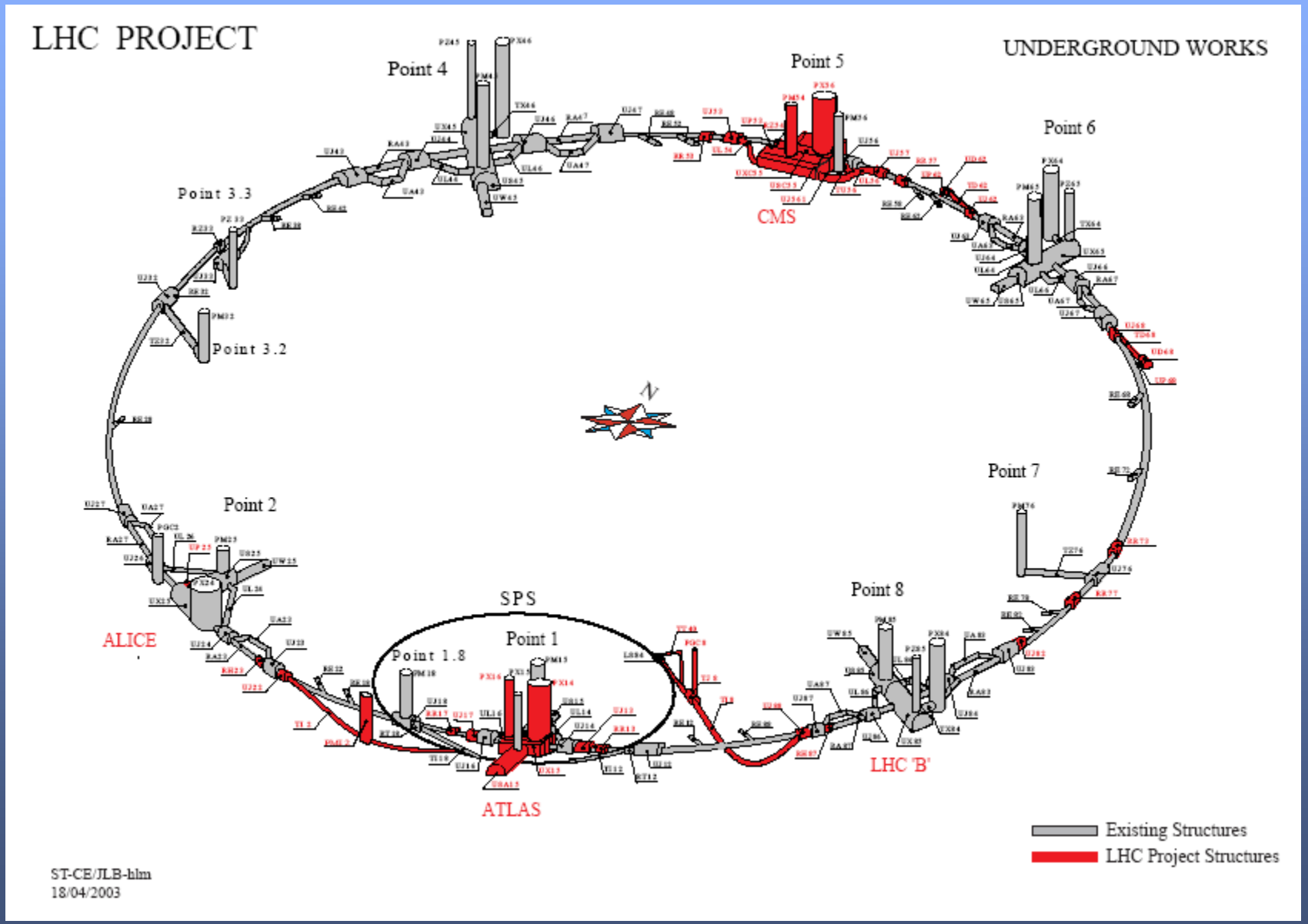
LHC: Construction and Commissioning Status

Lyn Evans

22nd Particle Accelerator Conference

Albuquerque, 25-29 June 2007

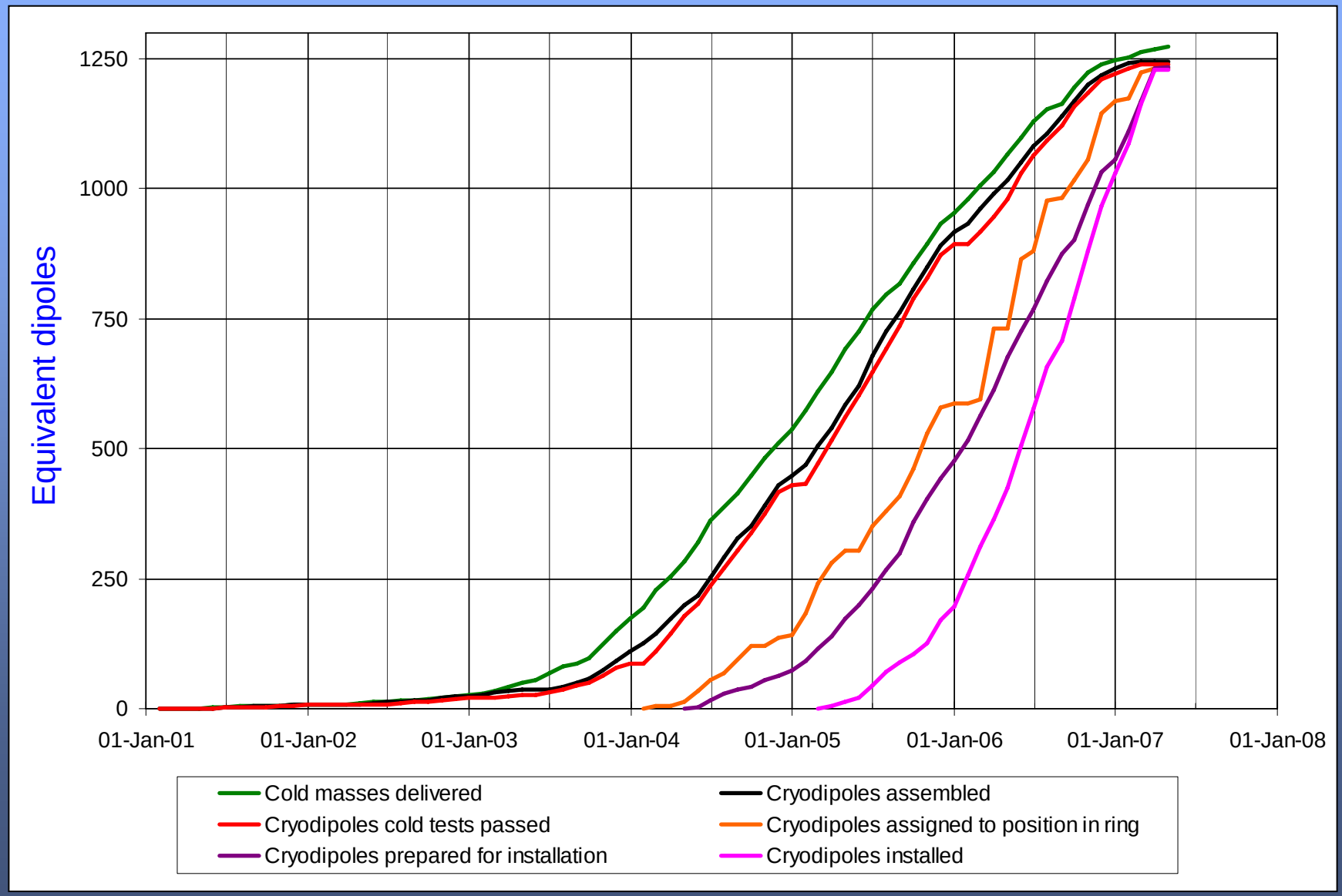
Machine layout



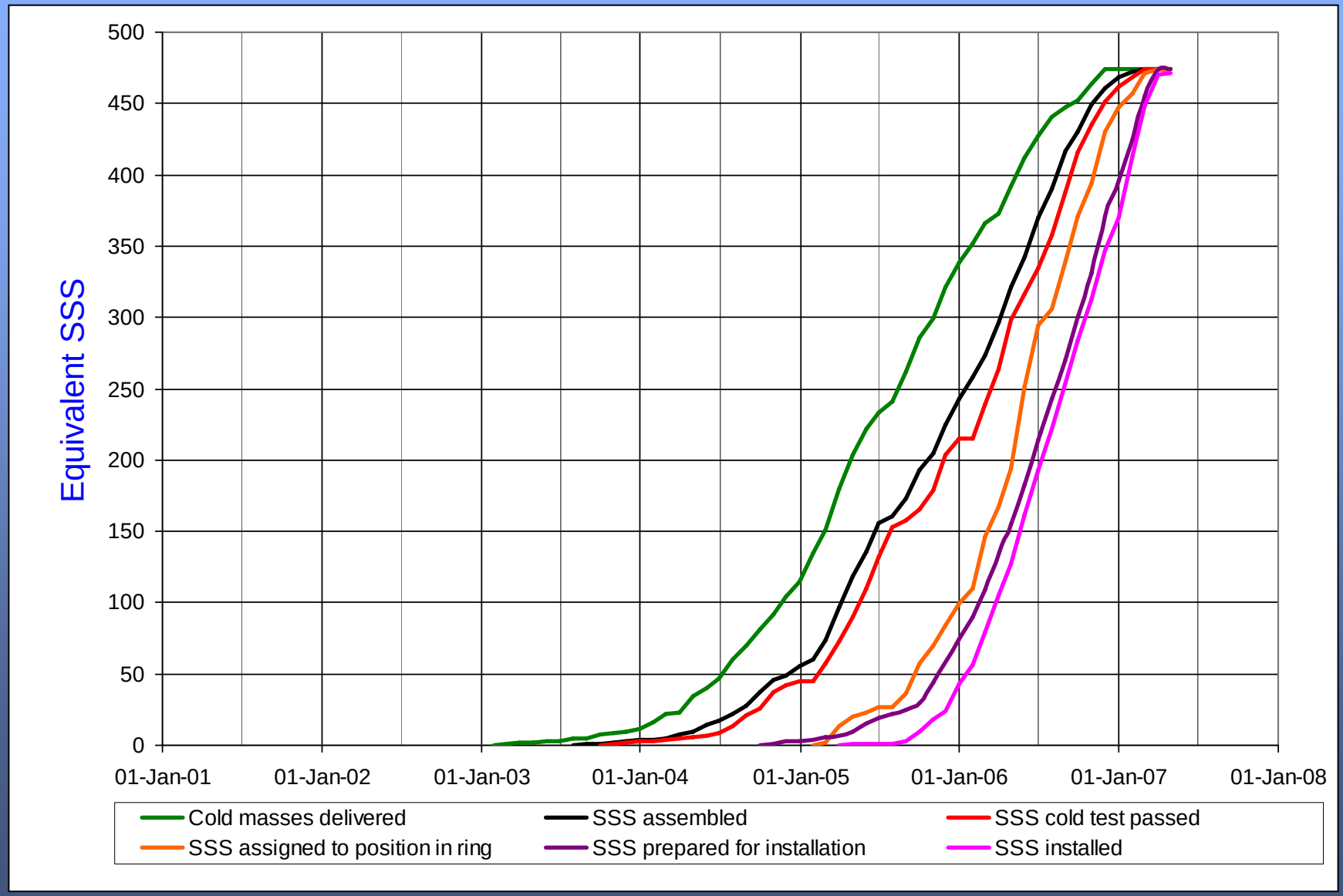
List of superconducting magnets and their function

Type	Number	Function
MB	1232	**Main dipoles**
MQ	392	**Arc quadrupoles**
MBX/MBR	16	**Separation and recombination dipoles**
MSCB	376	**Combined chromaticity and closed orbit correctors**
MCS	2464	**Sextupole correctors for persistent currents at injection**
MCDO	1232	**Octupole / decapole correctors for persistent currents at injection**
MO	336	**Landau damping octupoles**
MQT/MQTL	248	**Tuning quadrupoles**
MCB	190	**Orbit correction dipoles**
MQM	86	**Dispersion suppressor and matching section quadrupoles**
MQY	24	**Enlarged-aperture quadrupoles in insertions**
MQX	32	**Low-beta insertion quadrupoles**

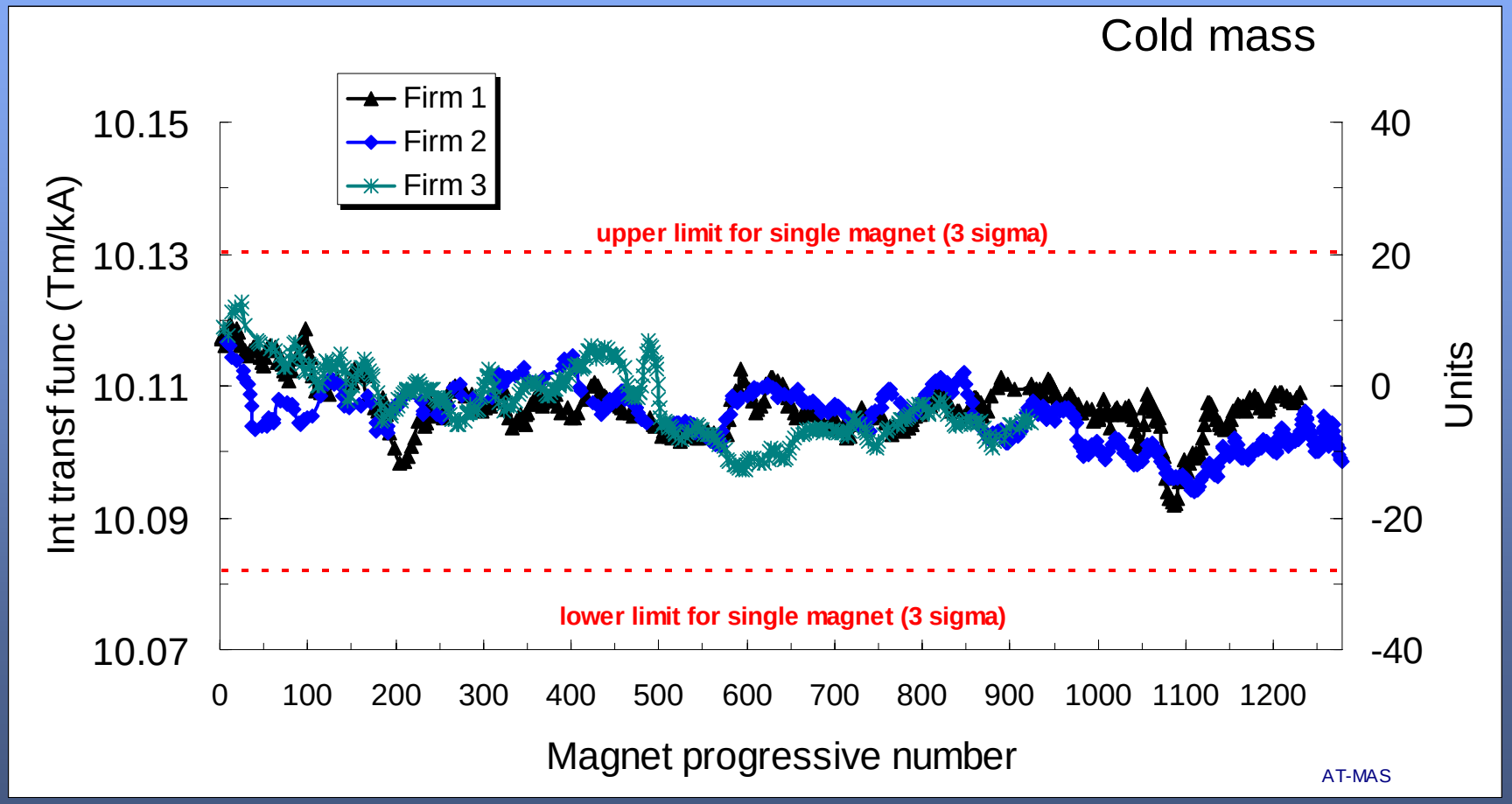
Cryodipole overview



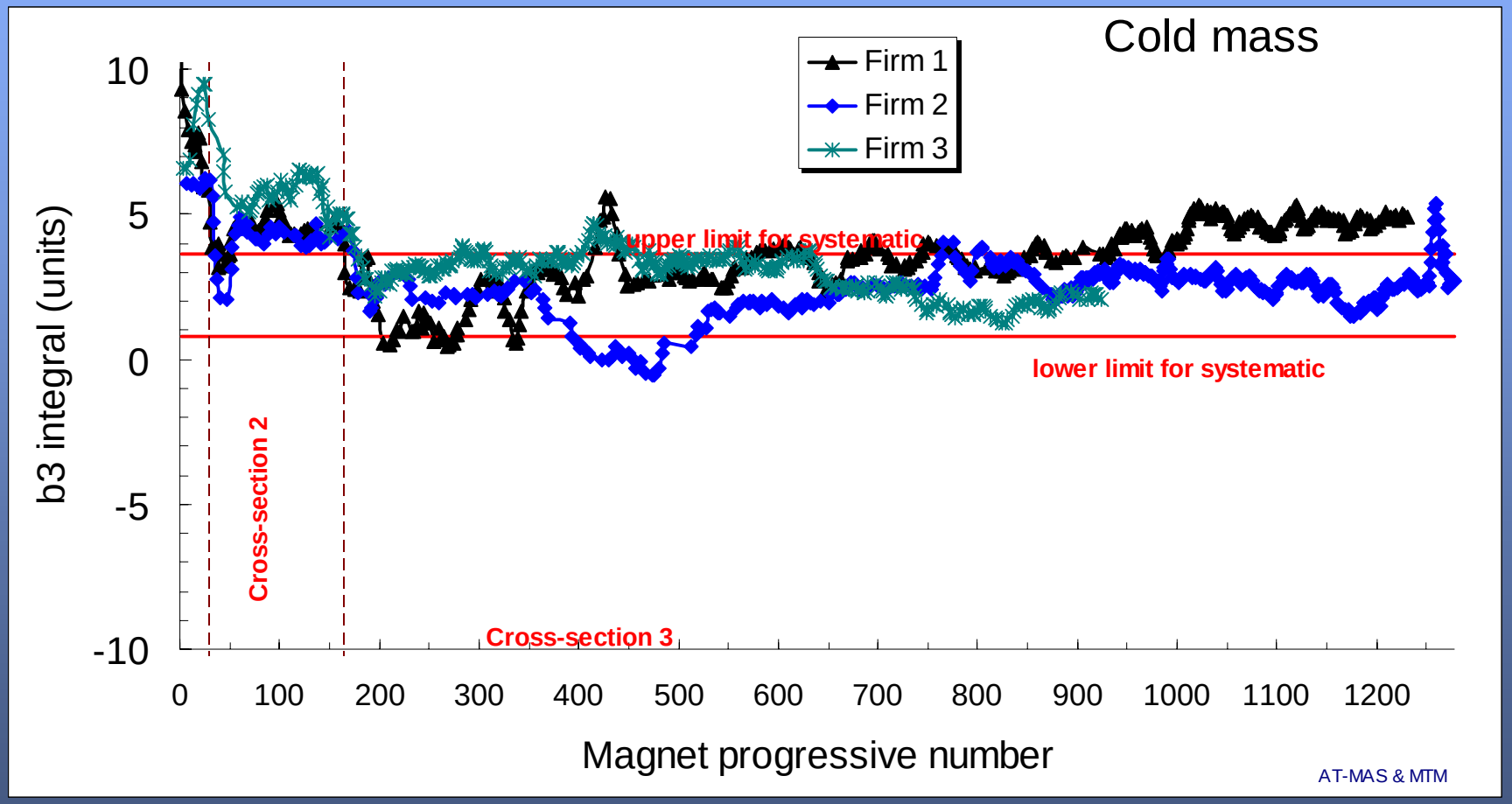
Short Straight Section overview



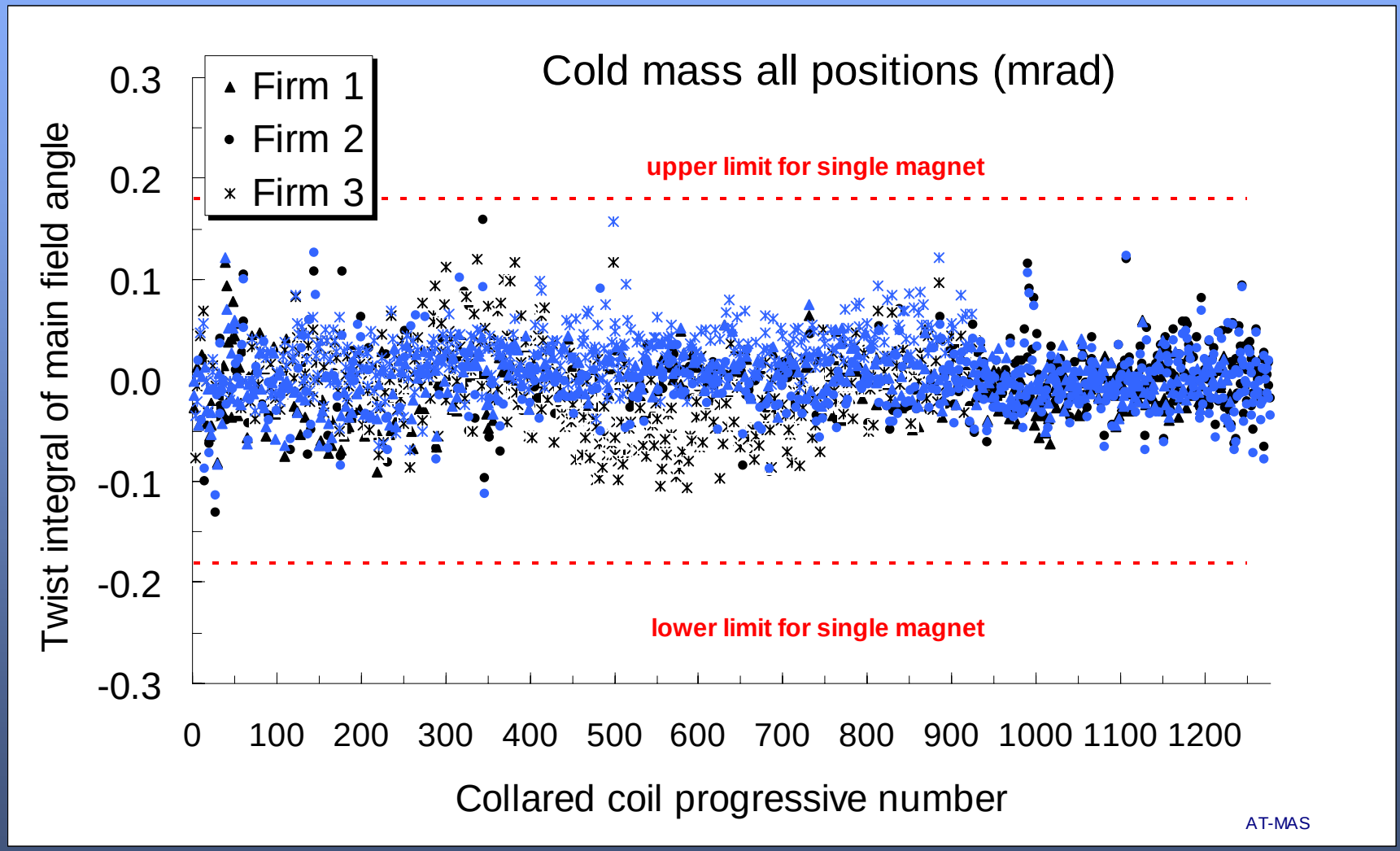
Bending strength of dipoles



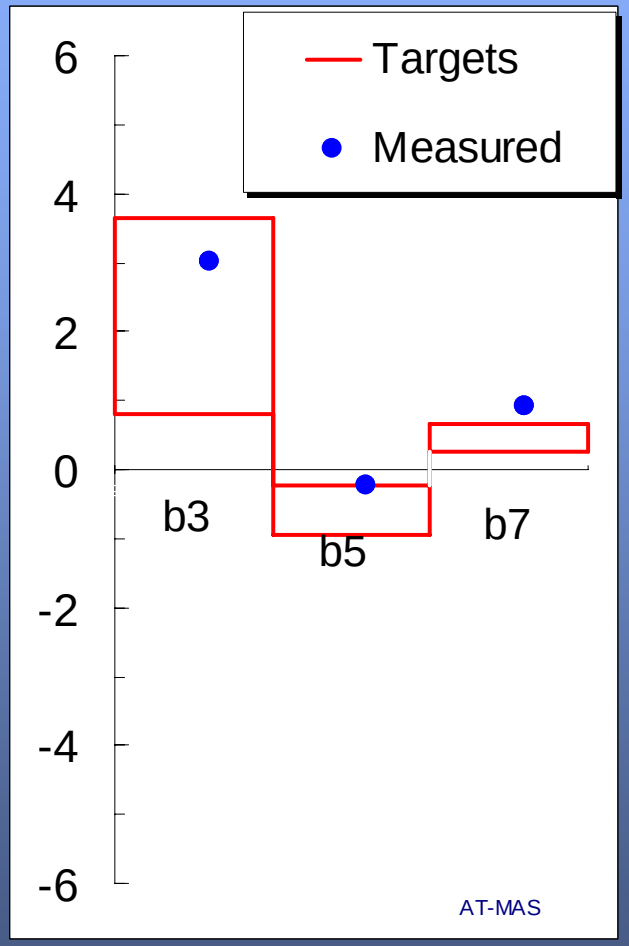
Field errors in dipole production: b3

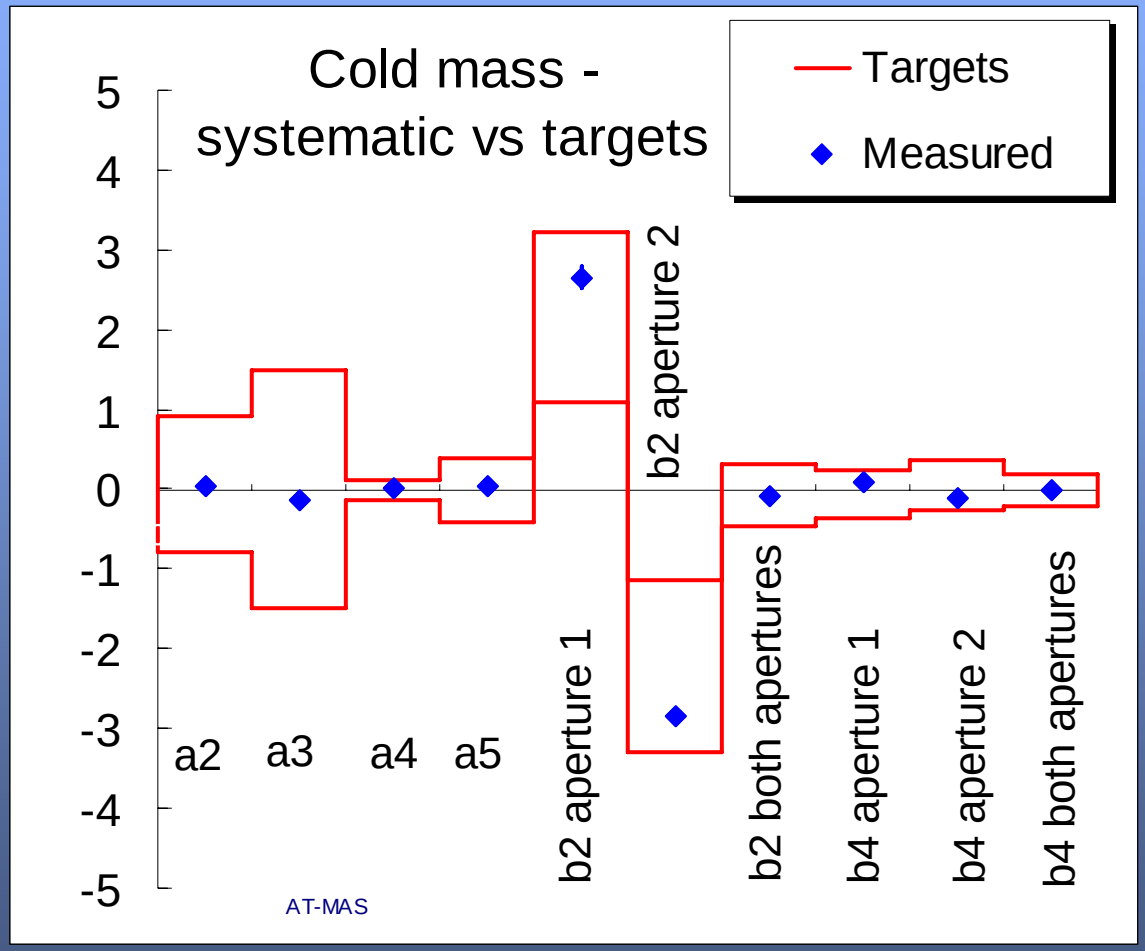


Field orientation in dipoles

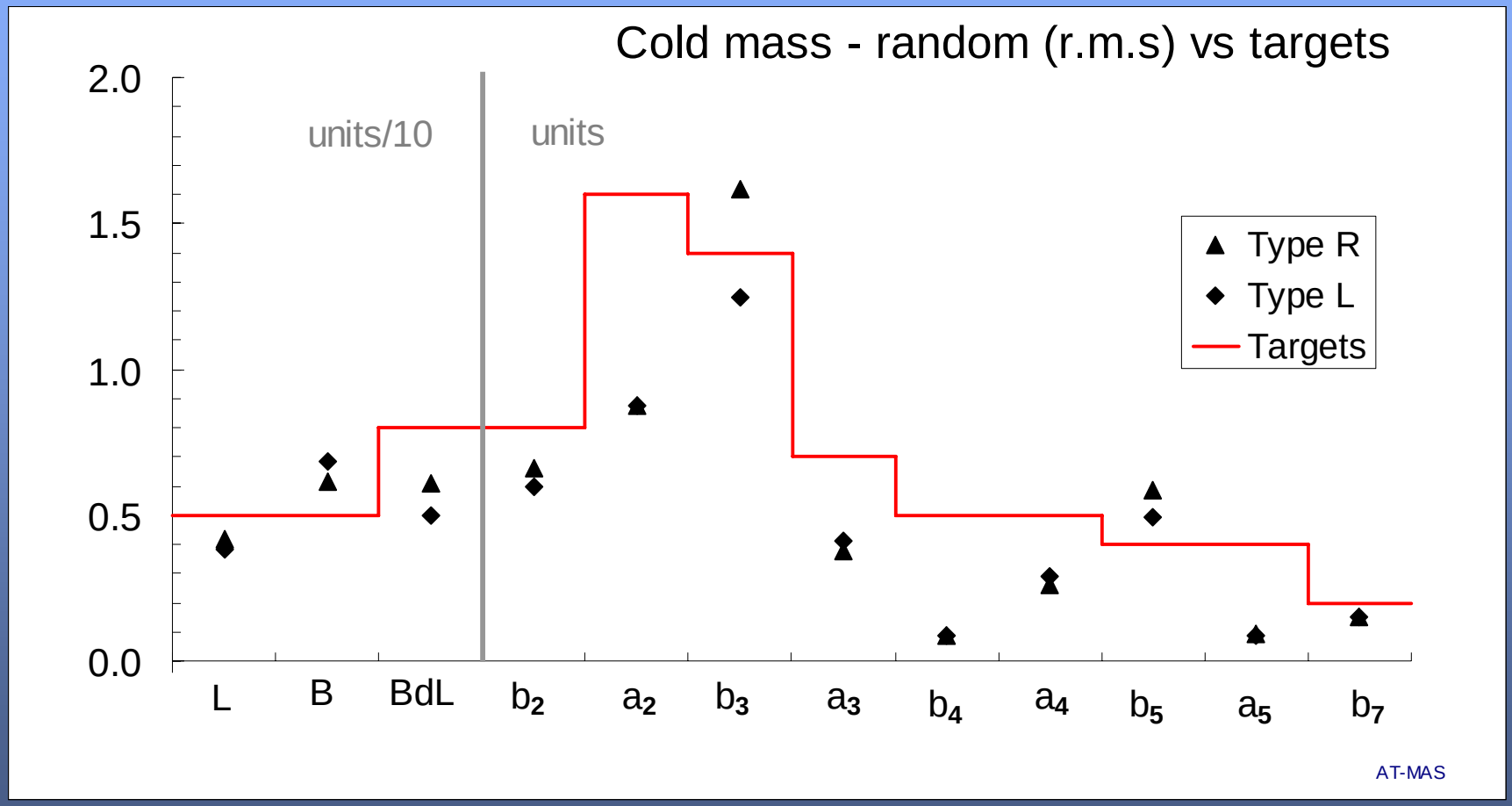


Systematic field errors in dipoles



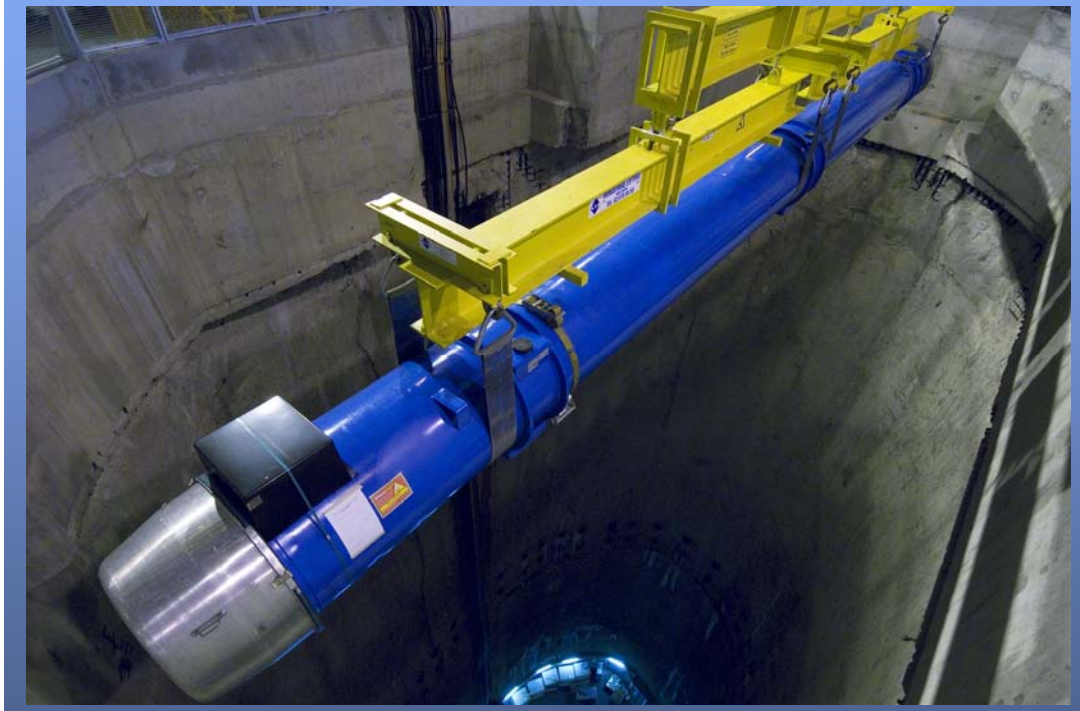


Random field errors in dipoles



Cryogenic test stands

Descent of the last magnet, 26 April 2007



30’000 km underground at 2 km/h!

Underground transport

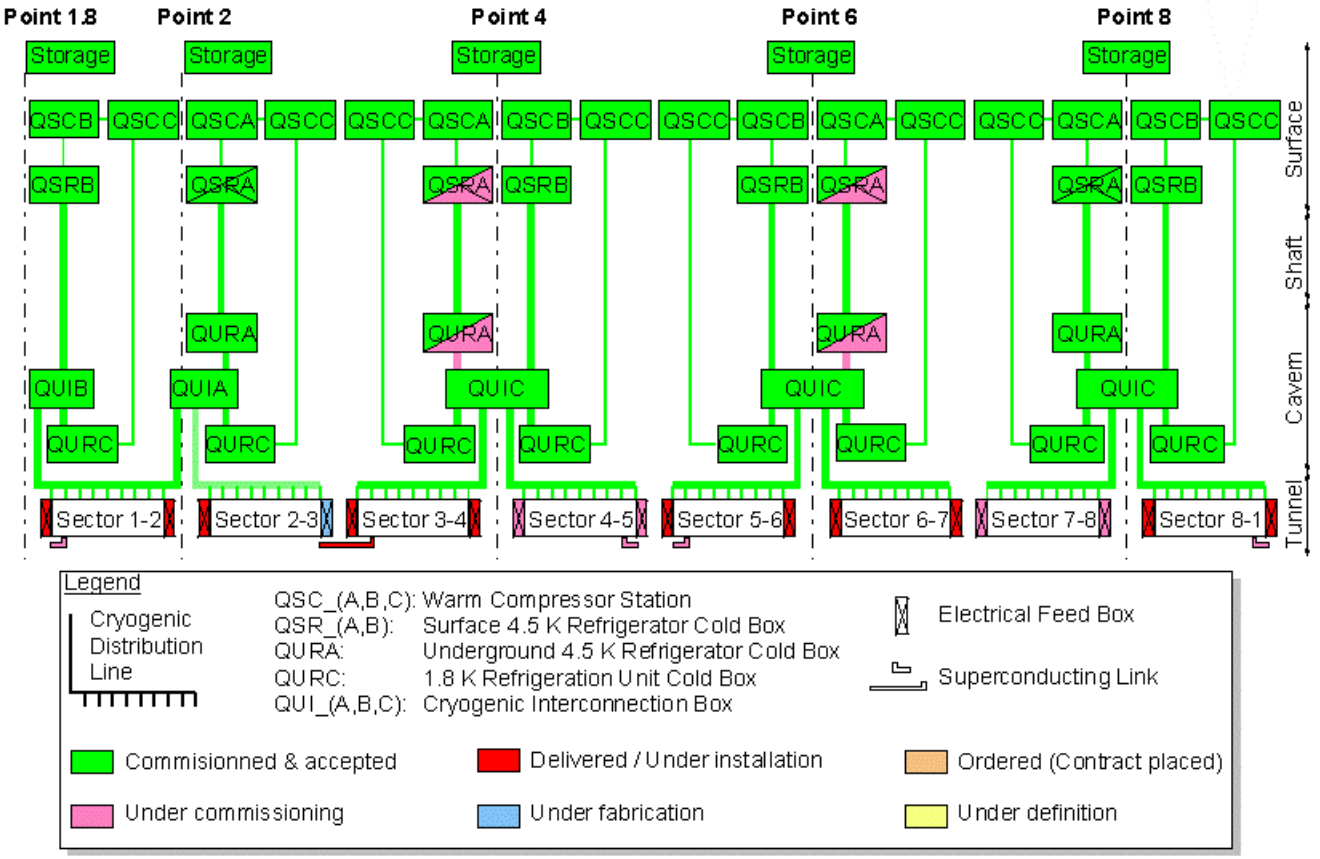
Magnet transfer

Cryogenic system overview

LHC Progress Dashboard

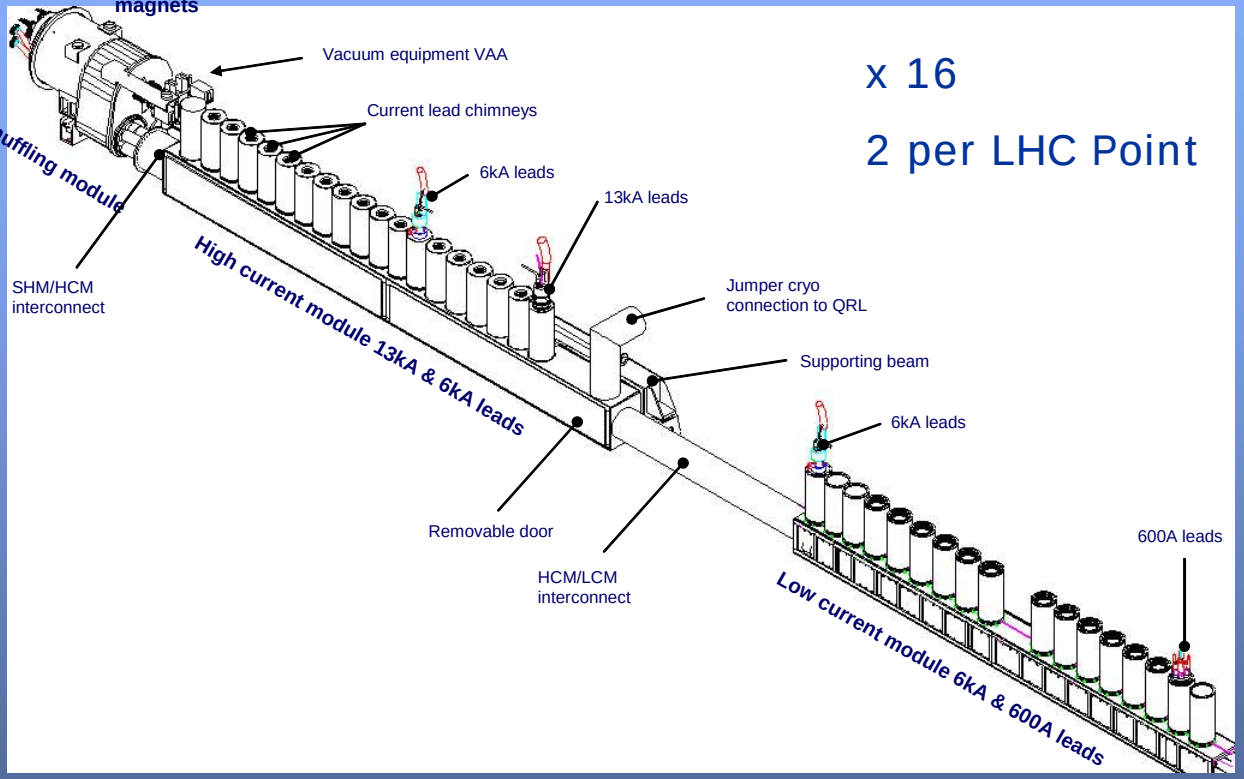
Accelerator Technology Department

Cryogenics overview



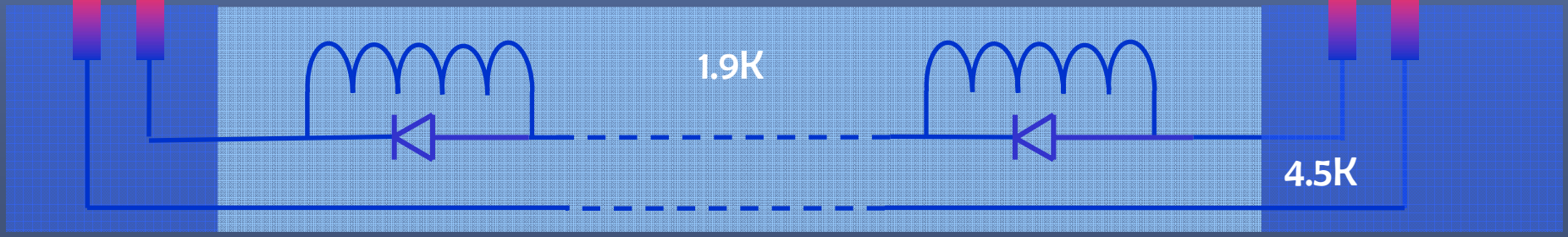
Updated 31 May 2007 Data provided by L. Tavian AT-ACR

DFBA Electrical Feed Box

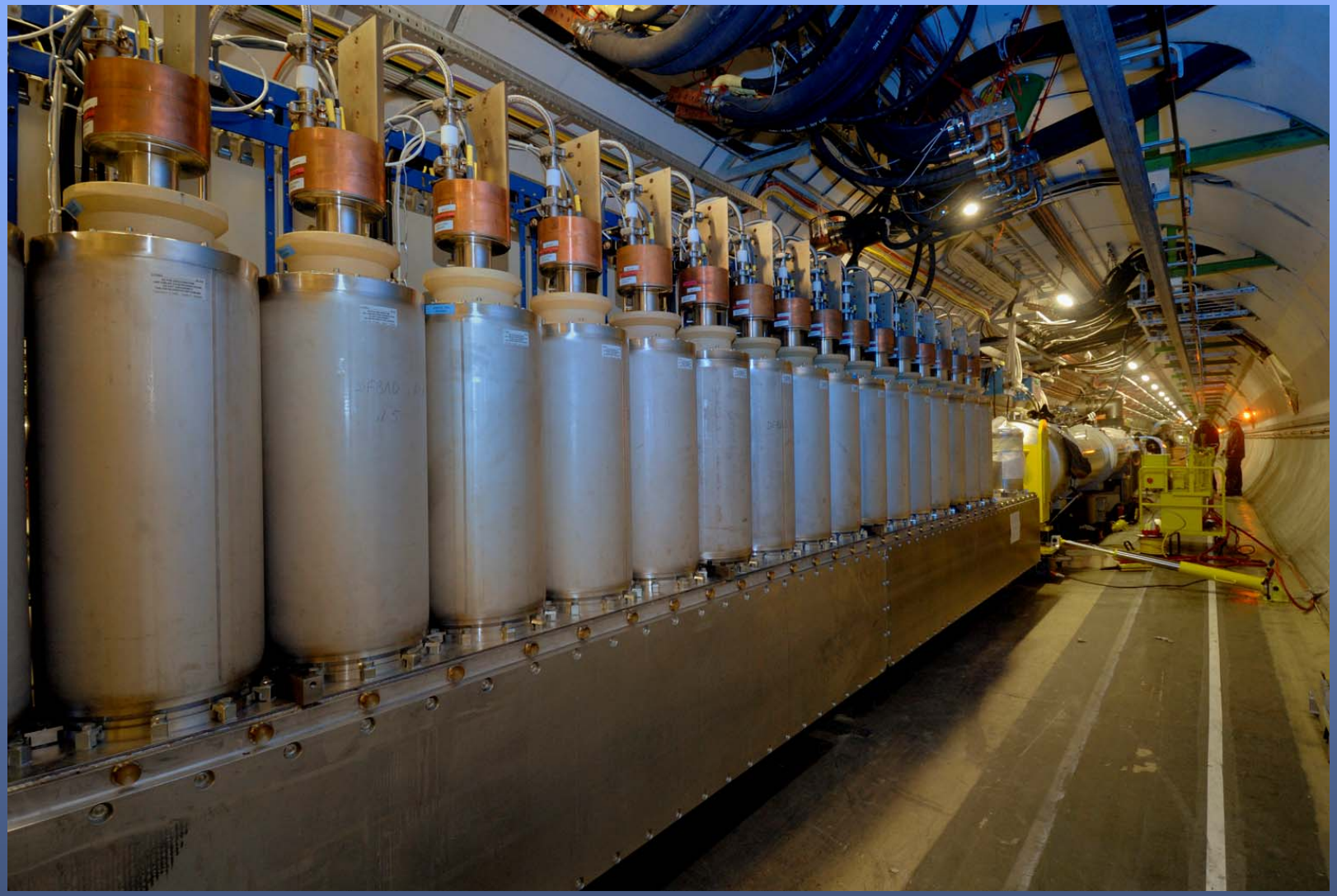


x 16

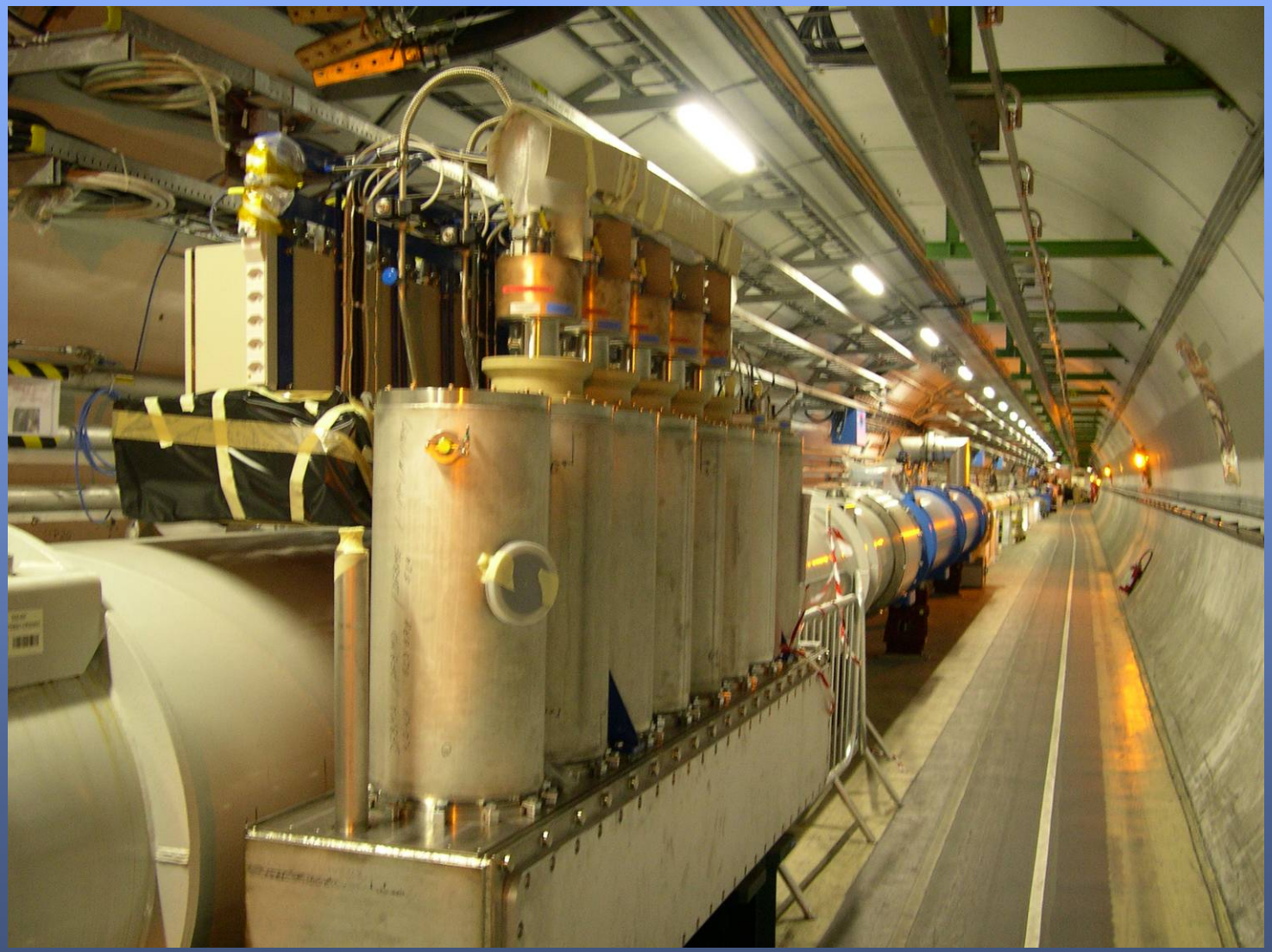
2 per LHC Point



DFBAO in Sector 7-8

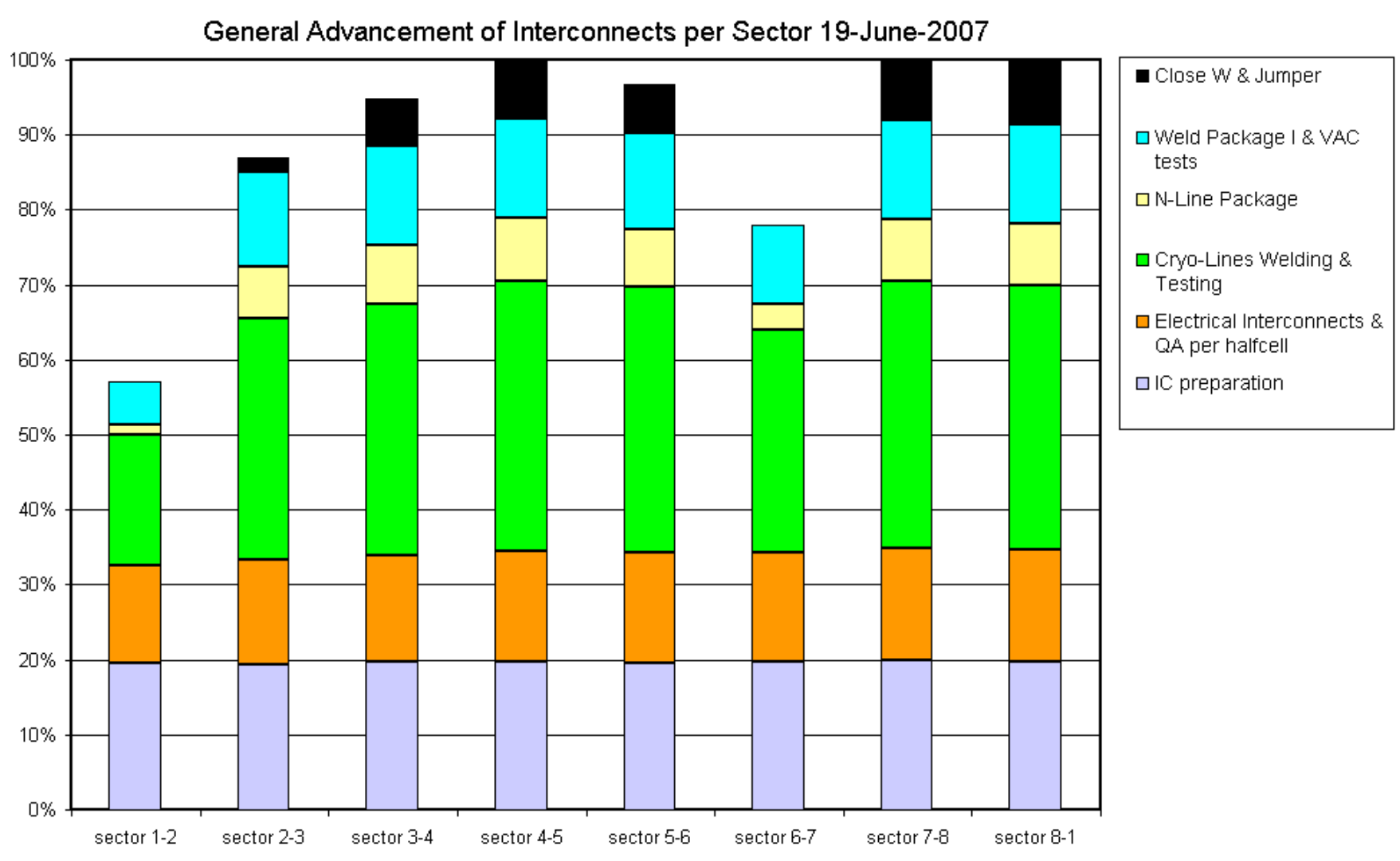


DFBMA in Sector 7-8

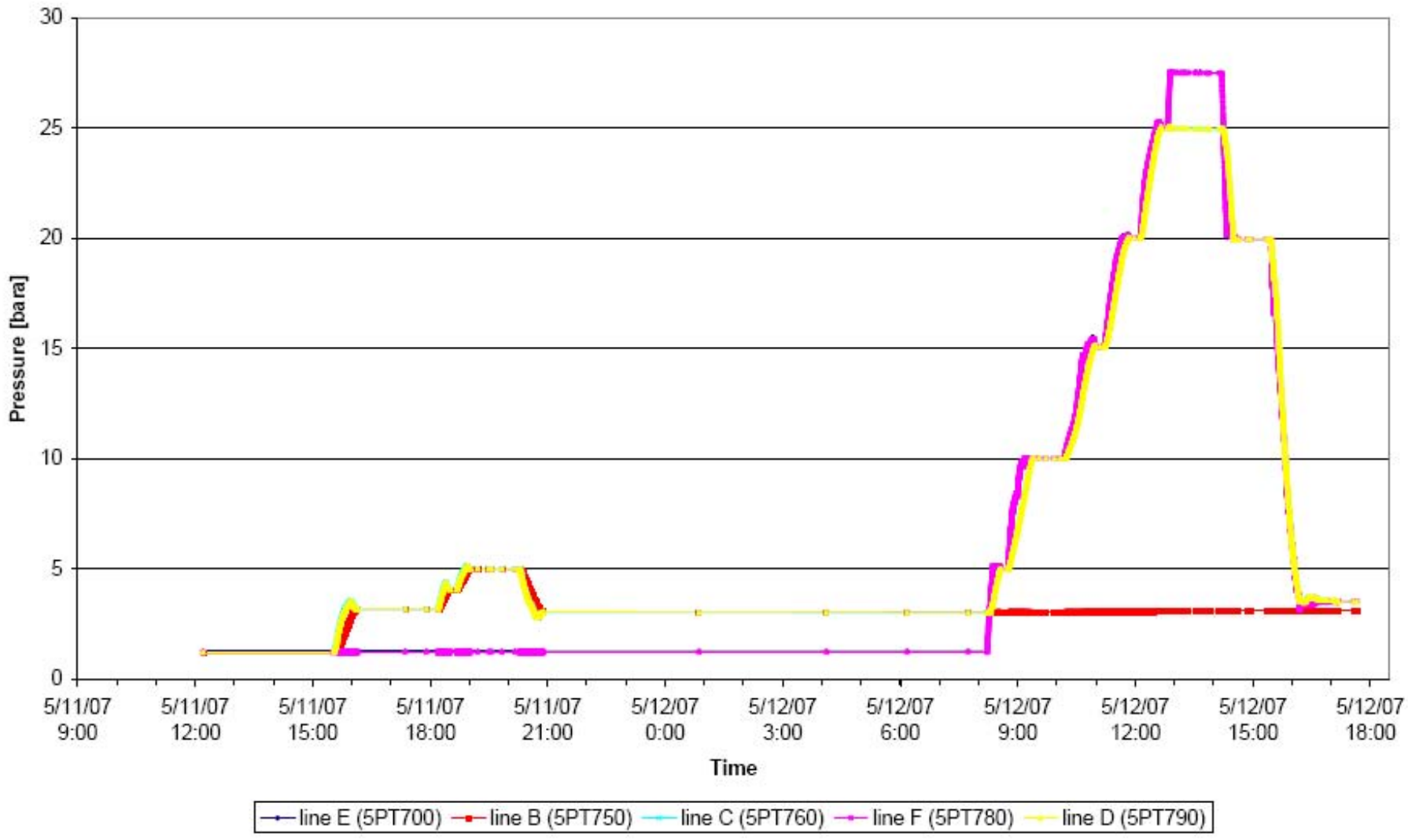


Dipole-dipole interconnect: electrical splices

Magnet interconnections



Global pressure test of Sector 4-5, 12 May 2007



Flushing machine - Wk 2 January 07

Before

After

Kapton bits

Metal strips

≈ 50 h

+ 8 L of Water

Cooldown of Sector 7-8

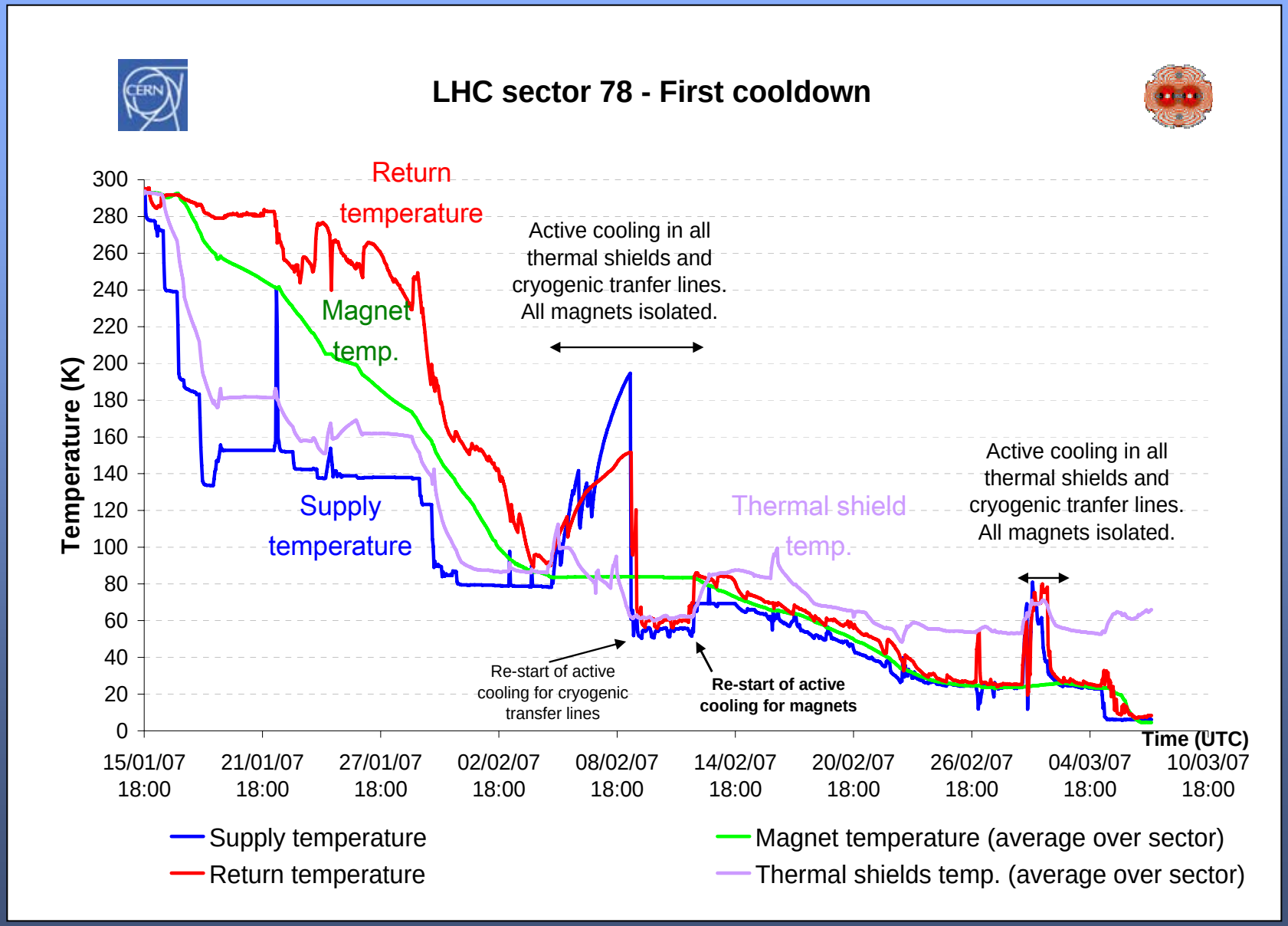
- From RT to 80K precooling with LN2. 1200 tons of LN2 (64 trucks of 20 tons). Three weeks for the first sector.
- From 80K to 4.2K. Cooldown with refrigerator. Three weeks for the first sector. 4700 tons of material to be cooled.
- From 4.2K to 1.9K. Cold compressors at 15 mbar. Four days for the first sector.

Large helium refrigerator for cooling down to 4.5 K

33 kW @ 50 K to 75 K
23 kW @ 4.6 K to 20 K
41 g/s liquefaction

600 kW precooling to 80 K
with LN2 (up to ~5 tons/h)

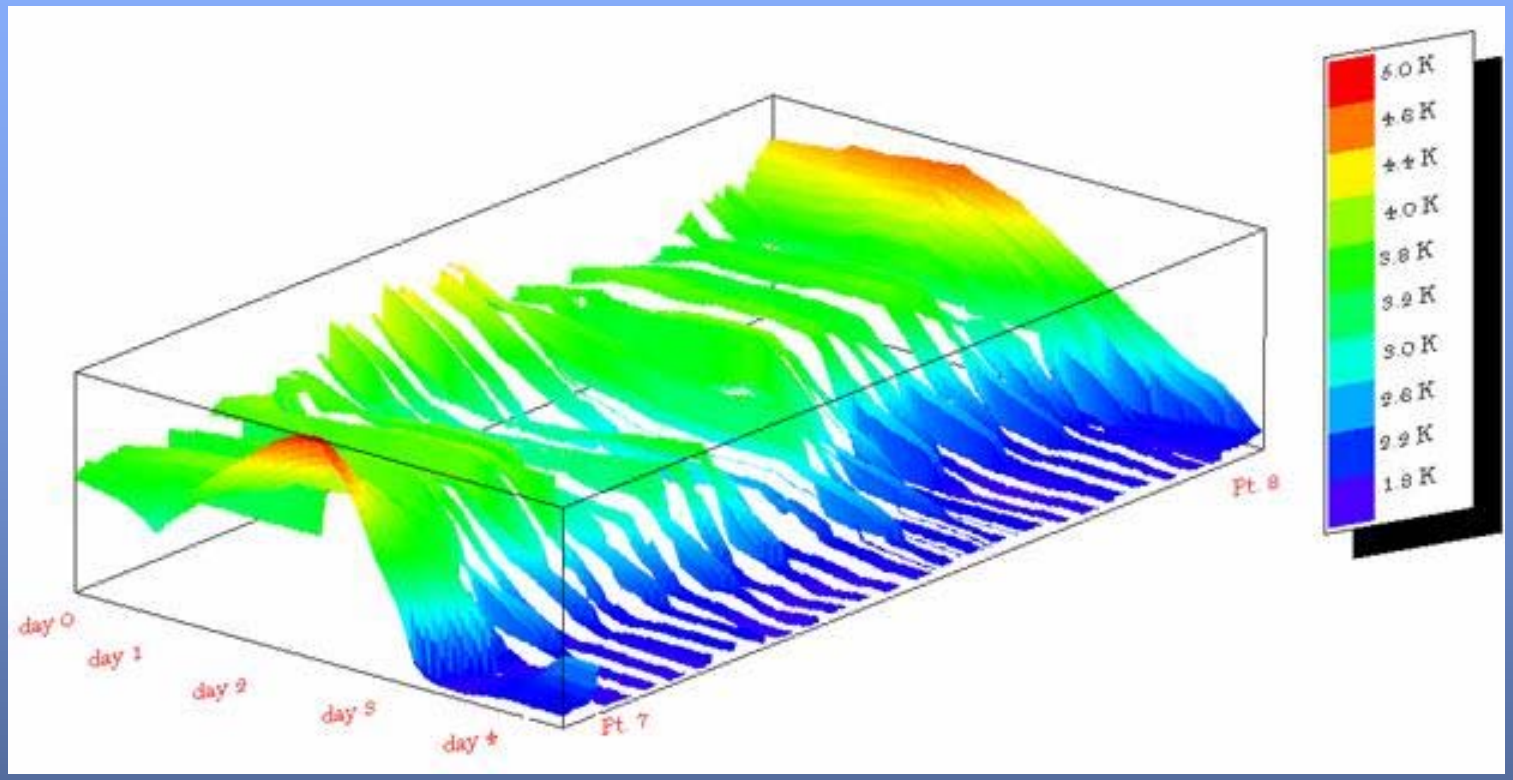
First cool-down of Sector 7-8



Hydrodynamic cold compressors for 1.8 K refrigeration

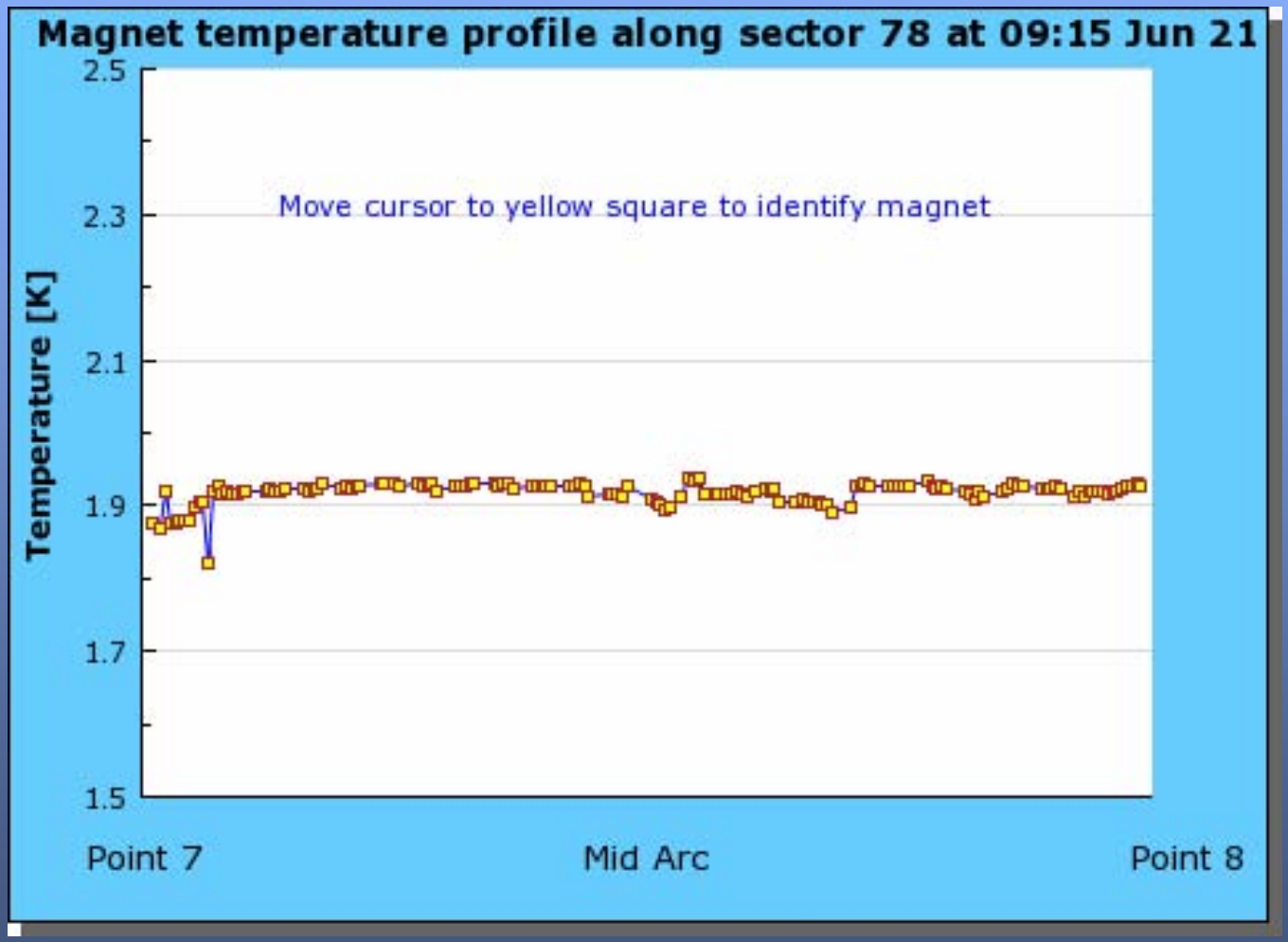
120 g/s GHe from 15 mbar with 4 stages

First cool-down of Sector 7-8

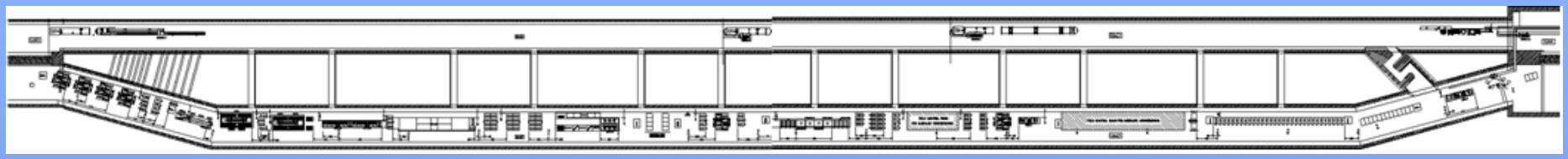


Magnet temperature profile along Sector 7-8 during final cool down to He II

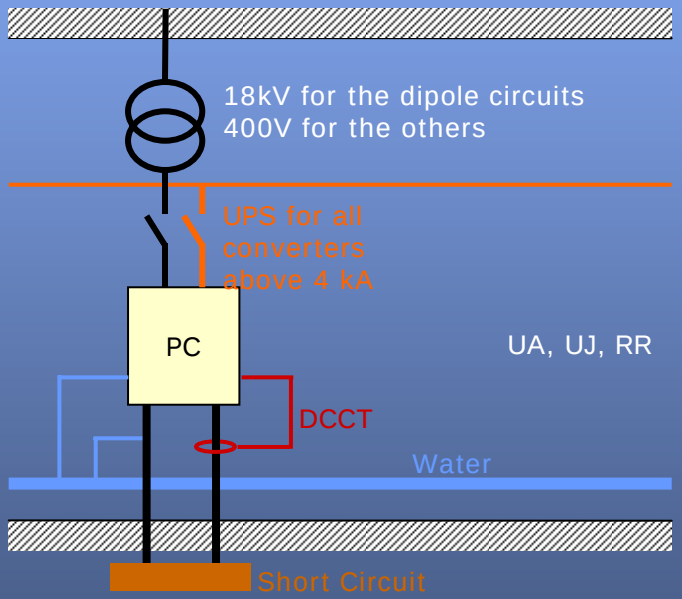
Sector 7-8 Cooldown



Commissioning of the power converters

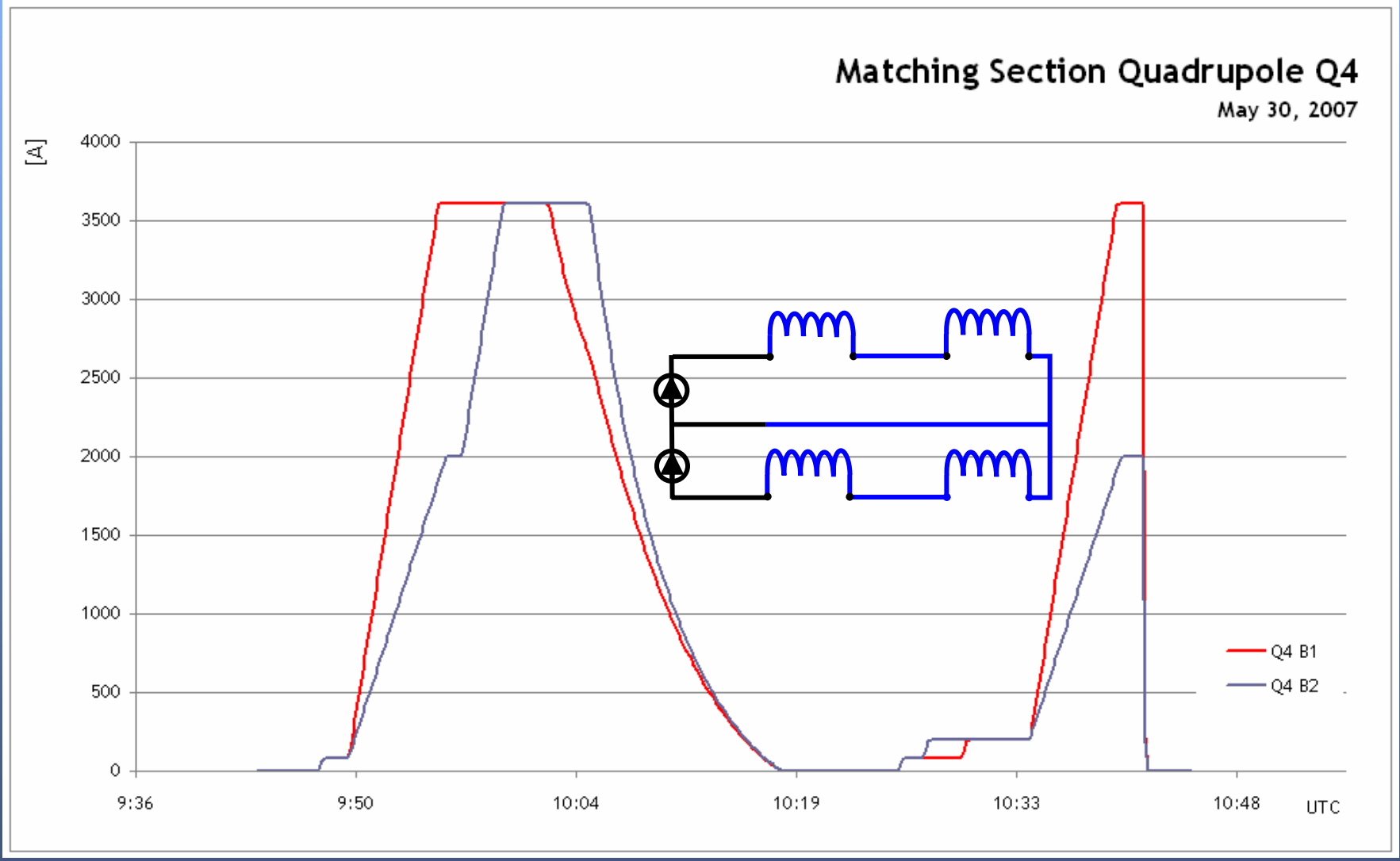


968/968 installed

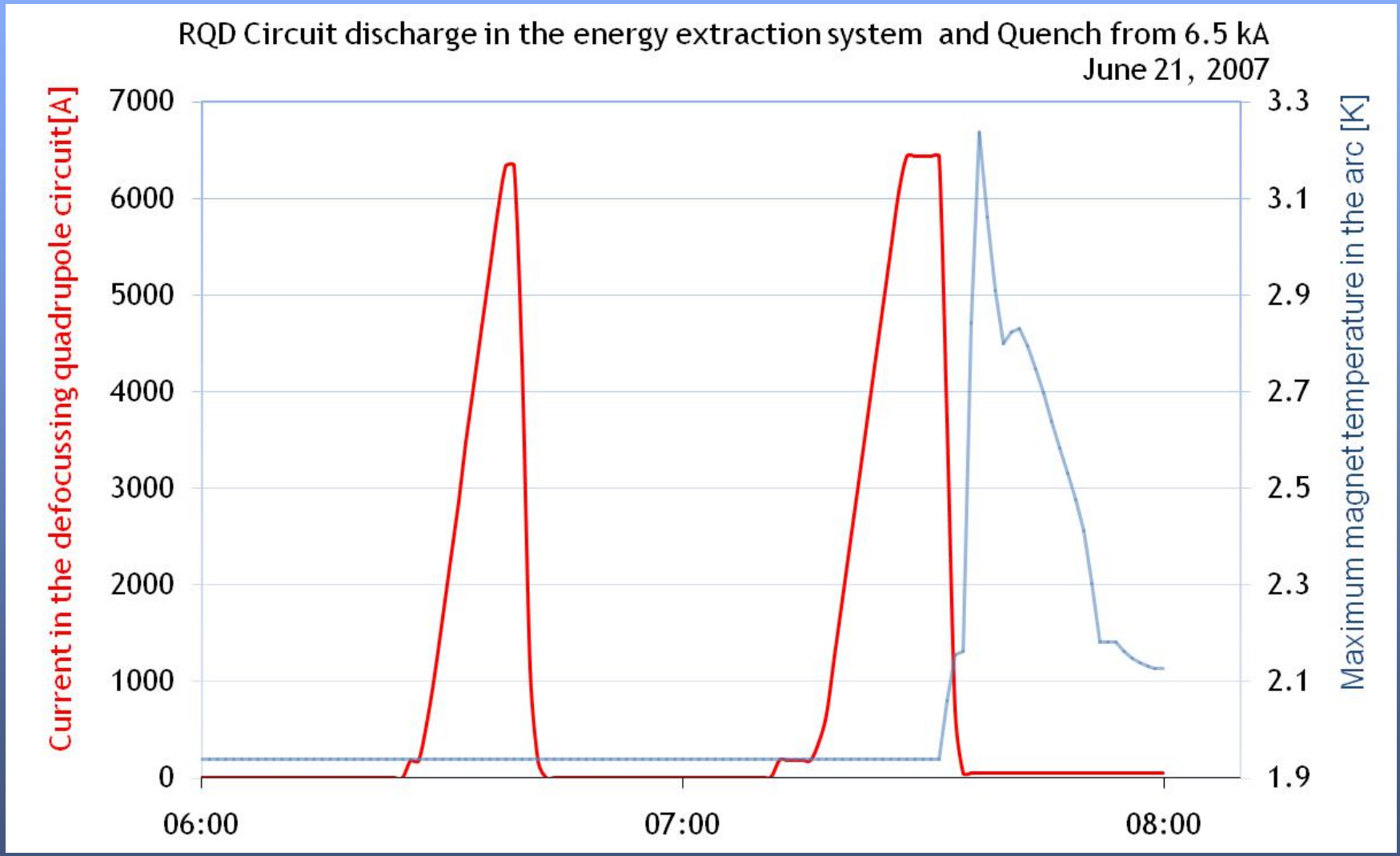


70% commissioned on short circuits

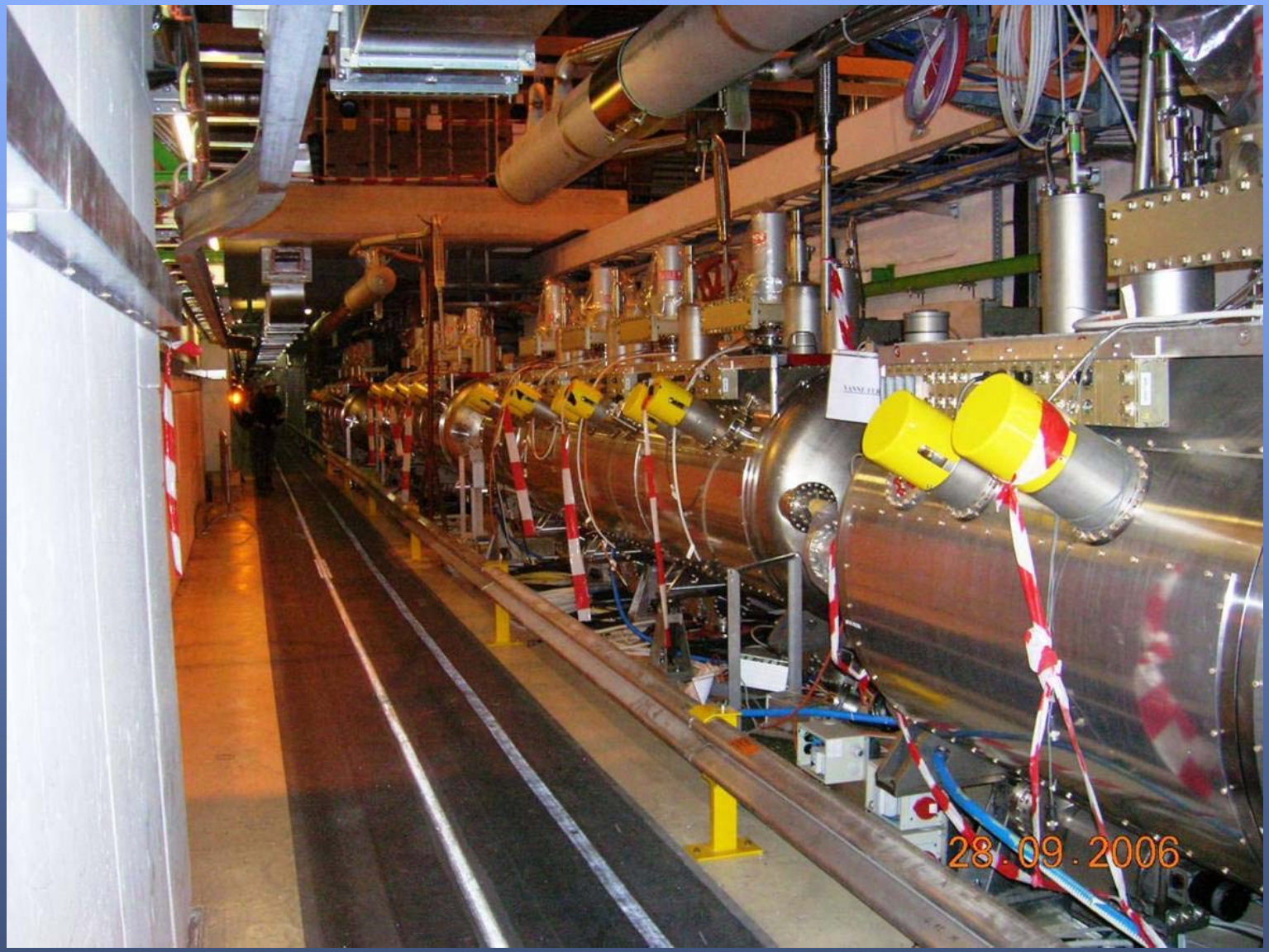
Q4


Matching Section Quadrupole Q4
May 30, 2007
[A]
4000
3500
3000
2500
2000
1500
1000
500
0
9:36
9:50
10:04
10:19
10:33
10:48
UTC
Q4 B1
Q4 B2

First powering of main quadrupoles

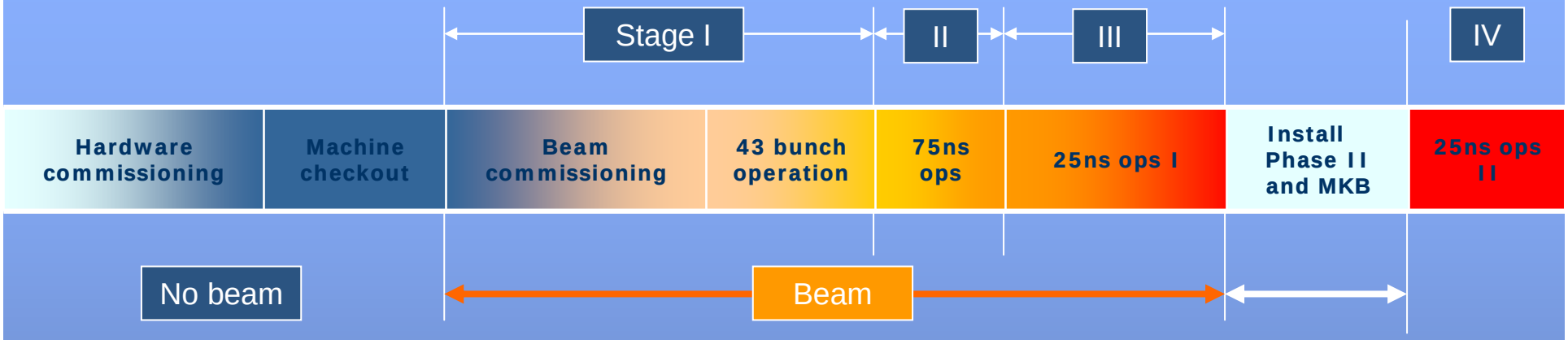


RF cavities



Two 300 kW klystrons with circulators and loads

Staged commissioning plan for protons (R. Bailey)



I. Pilot physics run

- First collisions
- 43 bunches, no crossing angle, no squeeze, moderate intensities
- Expected performance ~10^{31} cm^{-2} s^{-1} at ~1 event/crossing
- Push performance (156 bunches, partial squeeze in 1 and 5, push intensity)
- Performance limit 10^{32} cm^{-2} s^{-1} (event pileup)

II. 75ns operation

- Establish multi-bunch operation, moderate intensities
- Relaxed machine parameters (squeeze and crossing angle)
- Expected performance ~10^{32} cm^{-2} s^{-1} at ~1 event/crossing
- Push squeeze and crossing angle
- Performance limit 10^{33} cm^{-2} s^{-1} (event pileup)

III. 25ns operation I

- Nominal crossing angle
- Push squeeze
- Increase intensity to 50% nominal
- Performance limit 2 10^{33} cm^{-2} s^{-1}

IV. 25ns operation II

- Push towards nominal performance

General schedule

- Engineering run originally foreseen at end 2007 now precluded by delays in installation and equipment commissioning.
- 450 GeV operation now part of normal setting up procedure for beam commissioning to high-energy
- General schedule being reassessed, accounting for inner triplet repairs and their impact on sector commissioning
  - All technical systems commissioned to 7 TeV operation, and machine closed April 2008
  - Beam commissioning starts May 2008
  - First collisions at 14 TeV c.m. July 2008
  - Pilot run pushed to 156 bunches for reaching 10^{32} $cm^{-2}.s^{-1}$ by end 2008
- No provision in success-oriented schedule for major mishaps, e.g. additional warm-up/cooldown of sector