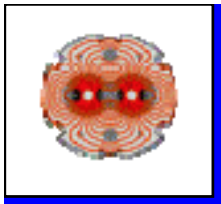
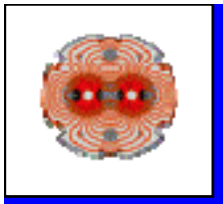


LHC Cryogenics

HWC day 19 March 2009

Serge Claudet TE-CRG-OA

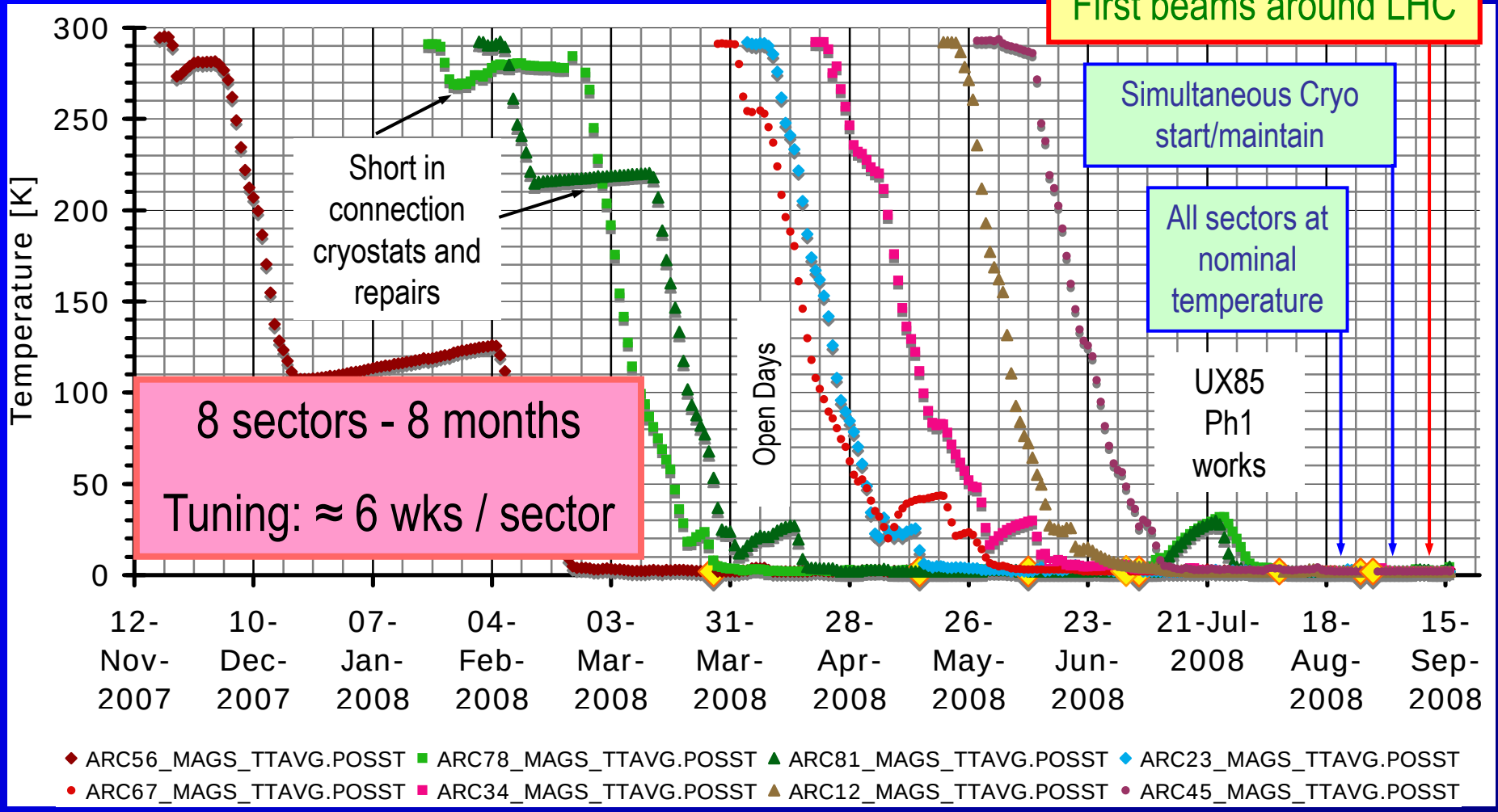
(LHC Cryo OP)



Content

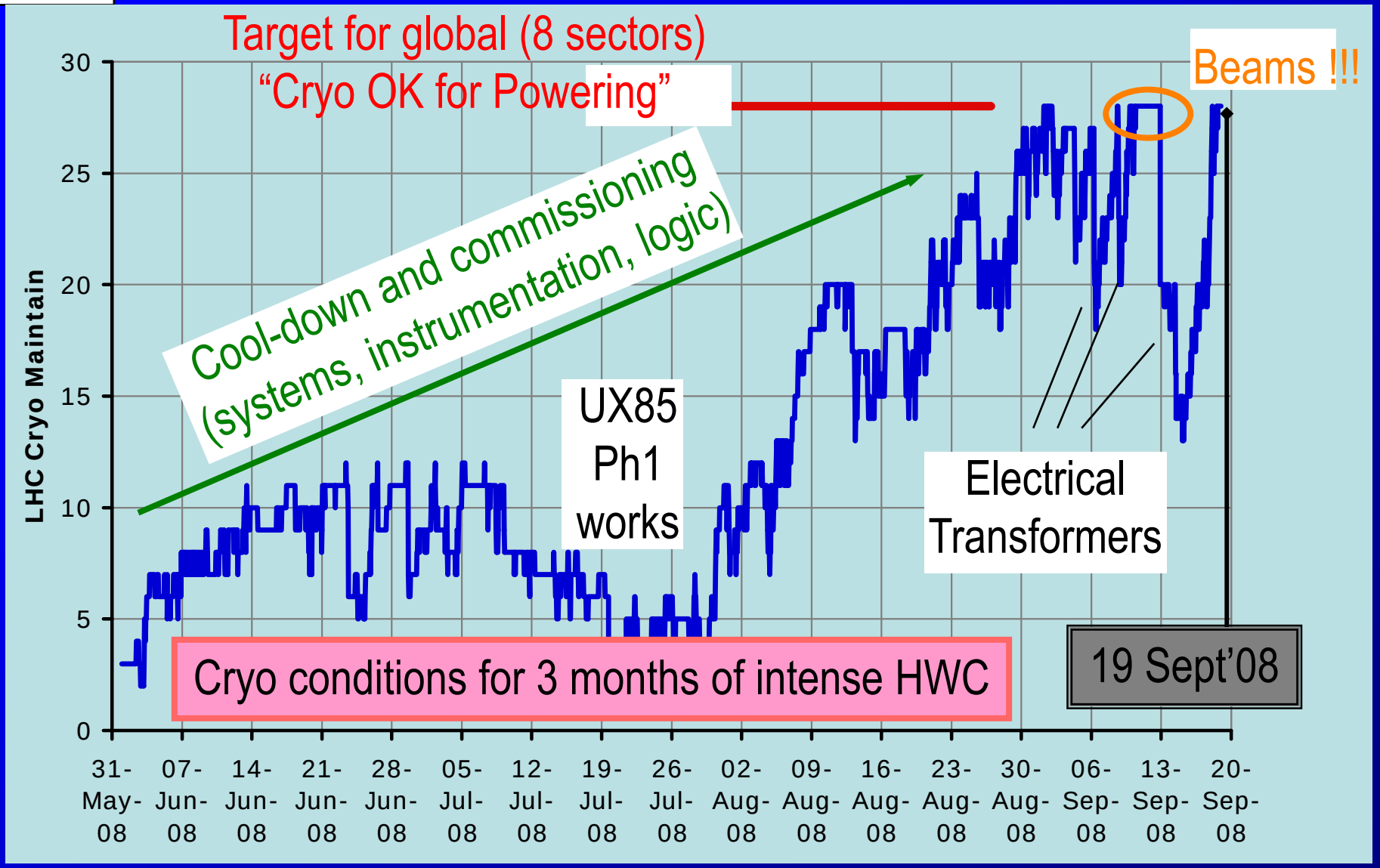
- Introduction: experience gained so far
- Consolidations and re-commissioning
- Calorimetry
- Organisation and staff matters
- Summary

First cool-down of LHC sectors

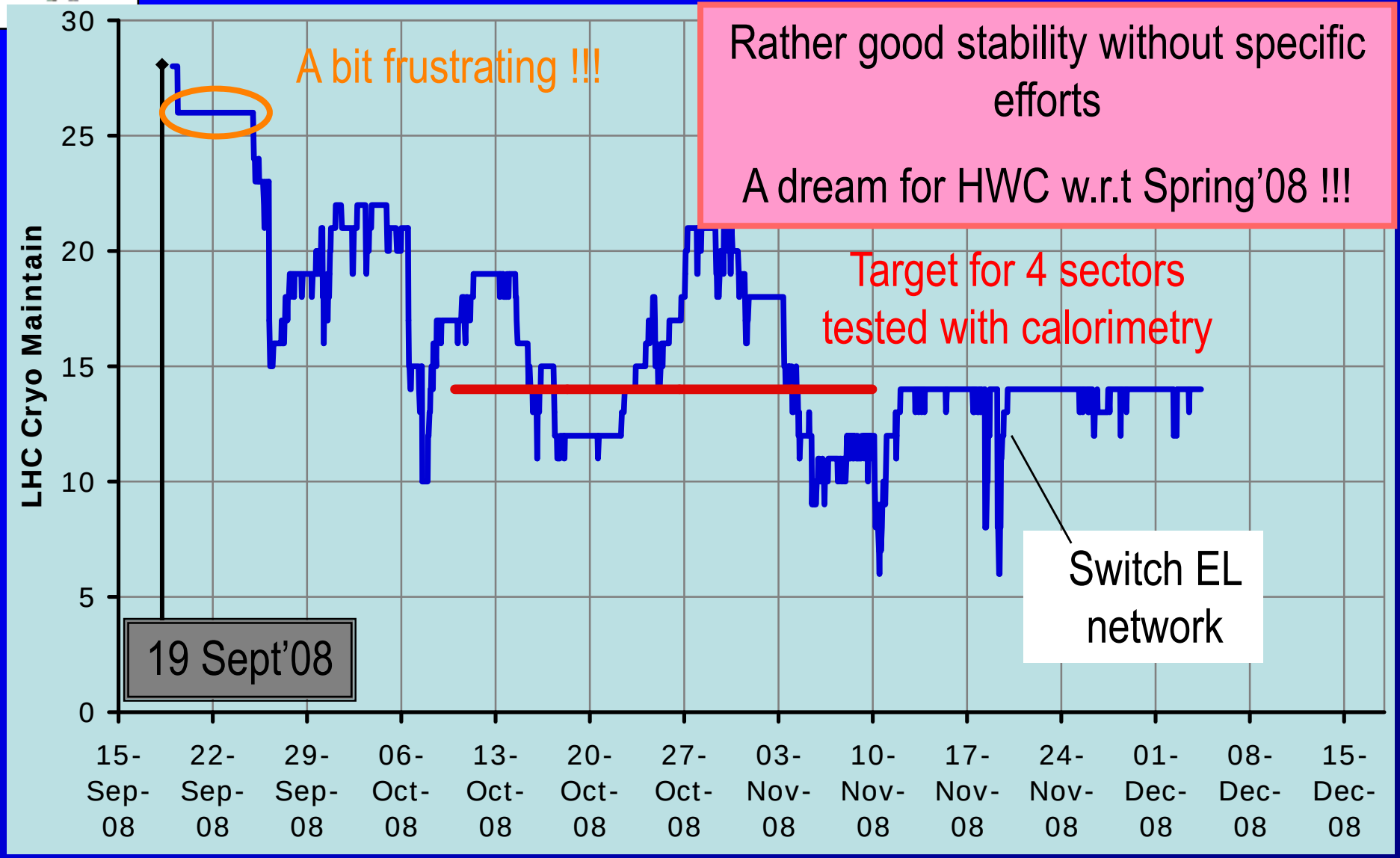


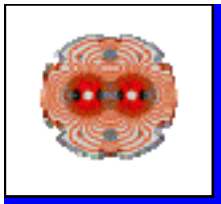
Cooling sectors + Cryo tuning + Powering activities

LHC Cryogenics: towards beams



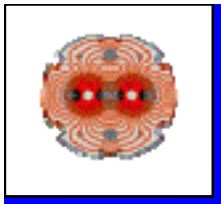
LHC Cryogenics: just after beams





Experience gained so far

- All cryo-subsystems were tuned and put into service (if it has worked once, it will come back)
- Procedures established and teams trained
- Weak points identified and consolidation programs established:
  - Already visible in 2008 for EL, CV, CO, Cryo
  - Continued since with many support teams



Tuning LSS components

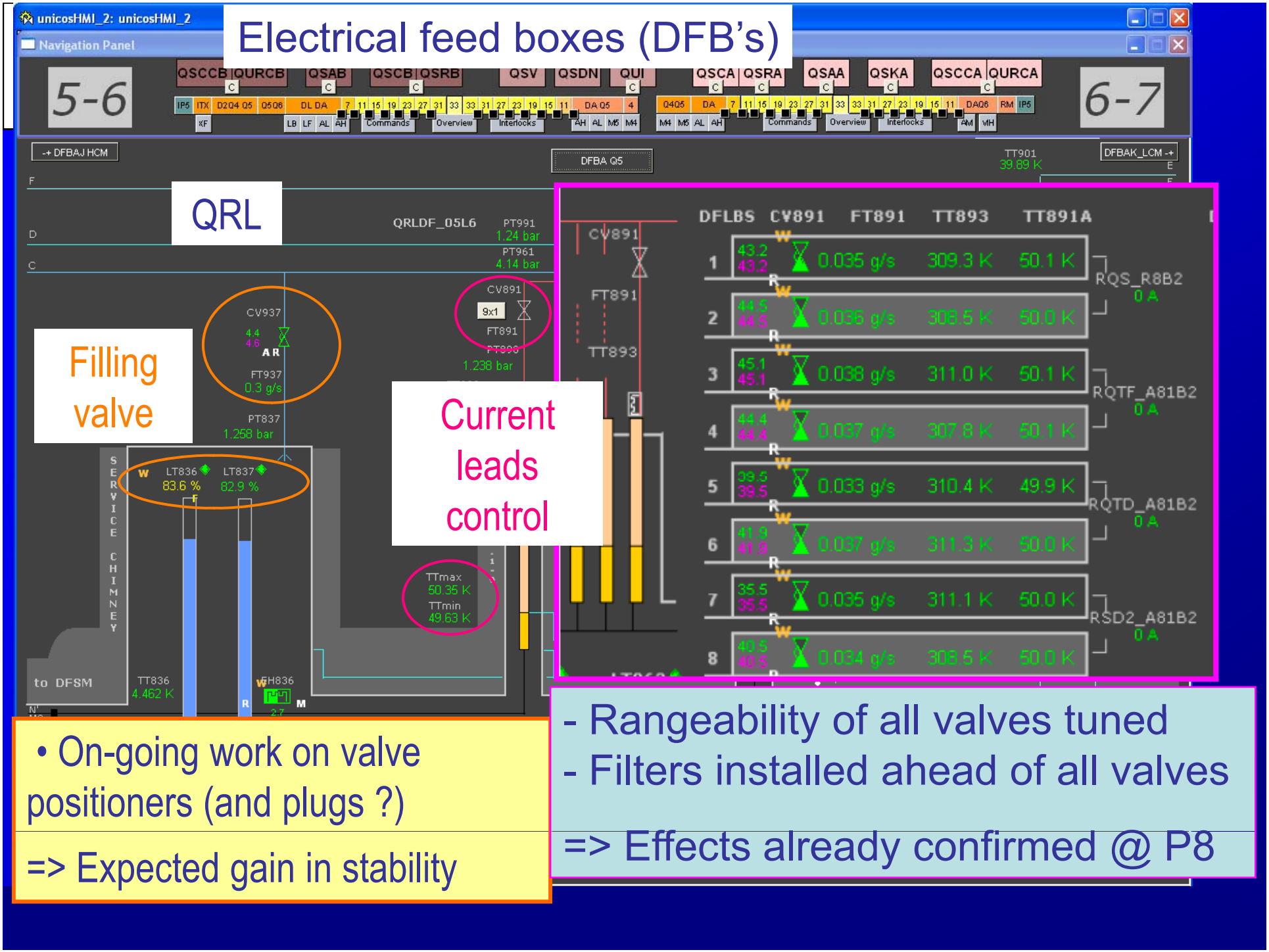
- Electrical Feed Boxes (DFBs):
  - We could operate all of them close to nominal conditions (maximum scenario required so far during HWC)
  - Few delicate cases (heat loads, levels measurements, levelling of sc link to magnets, valves for cooling current leads, thermometers and noise, High Voltage perturbation on instrumentation cards)

Might come back !

- Stand alone Magnets (SAM):
  - Difficult Level measurements due to Cold GHe capillary with too small diameter and possible low points, most delicate cases being treated
- Triplets:
  - DFBX: Commissionned with moderate ramp rates on some leads (Cu)
  - NC found on some Q1 (Missing Cu braid), being treated on critical cases in R1 and 5L
- Superconducting links (DSLs):
  - No problem encountered on four DSLs (<80m), except for DSLC_P3
  - DSLC design/installation weak point being treated

Nothing special expected for re-testing of Y-lines or DSLC

Electrical feed boxes (DFB's)



- On-going work on valve positioners (and plugs ?)

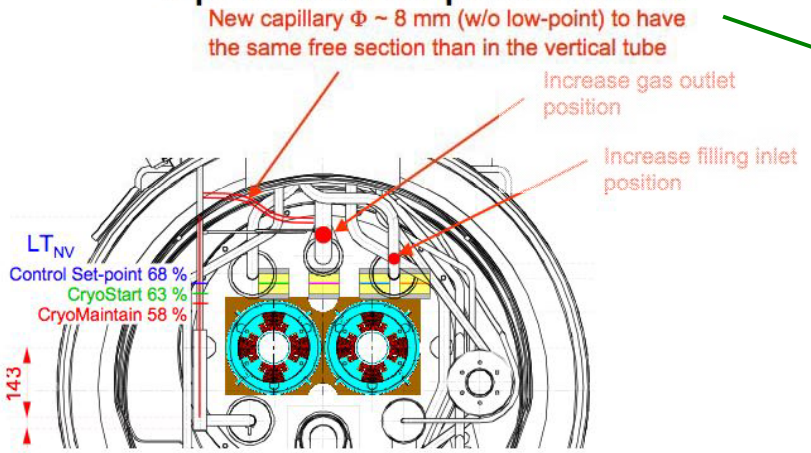
=> Expected gain in stability

- Rangeability of all valves tuned
- Filters installed ahead of all valves

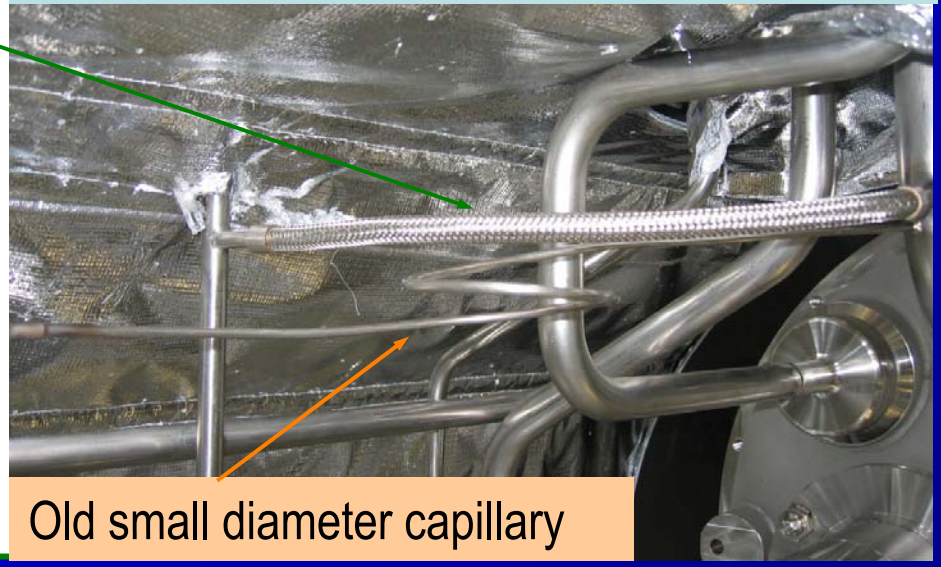
=> Effects already confirmed @ P8

Levels for stand-alone magnets

Consolidation requirements for operation improvement



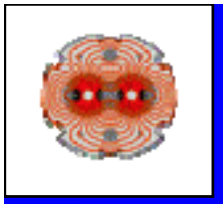
Reference: P6 already conform, due to specific design due to beam dump line



2008: Case by case lengthy tuning AND global QRL_line_D pressure stability required

LSD0809: Pipe work being consolidated for most cases

2009: At least first sector to be re-assessed with complete boil-off tests, should become more straight forward once consolidation validated



Calorimetry

- Operation:
  - Establish global stable conditions, with specific settings for cooling and filling valves
  - Almost on-line assessment of temperature drifts (mK/hr) mostly to validate the test or identify possible non-standard zones
- Analysis (off-line so far):
  - Evaluation of the power deposited in helium (internal energy) to define the total resistance of a cryo sub-sector, and by comparison quantify singularities.
  - Specific studies required to confirm the origin of the singularities

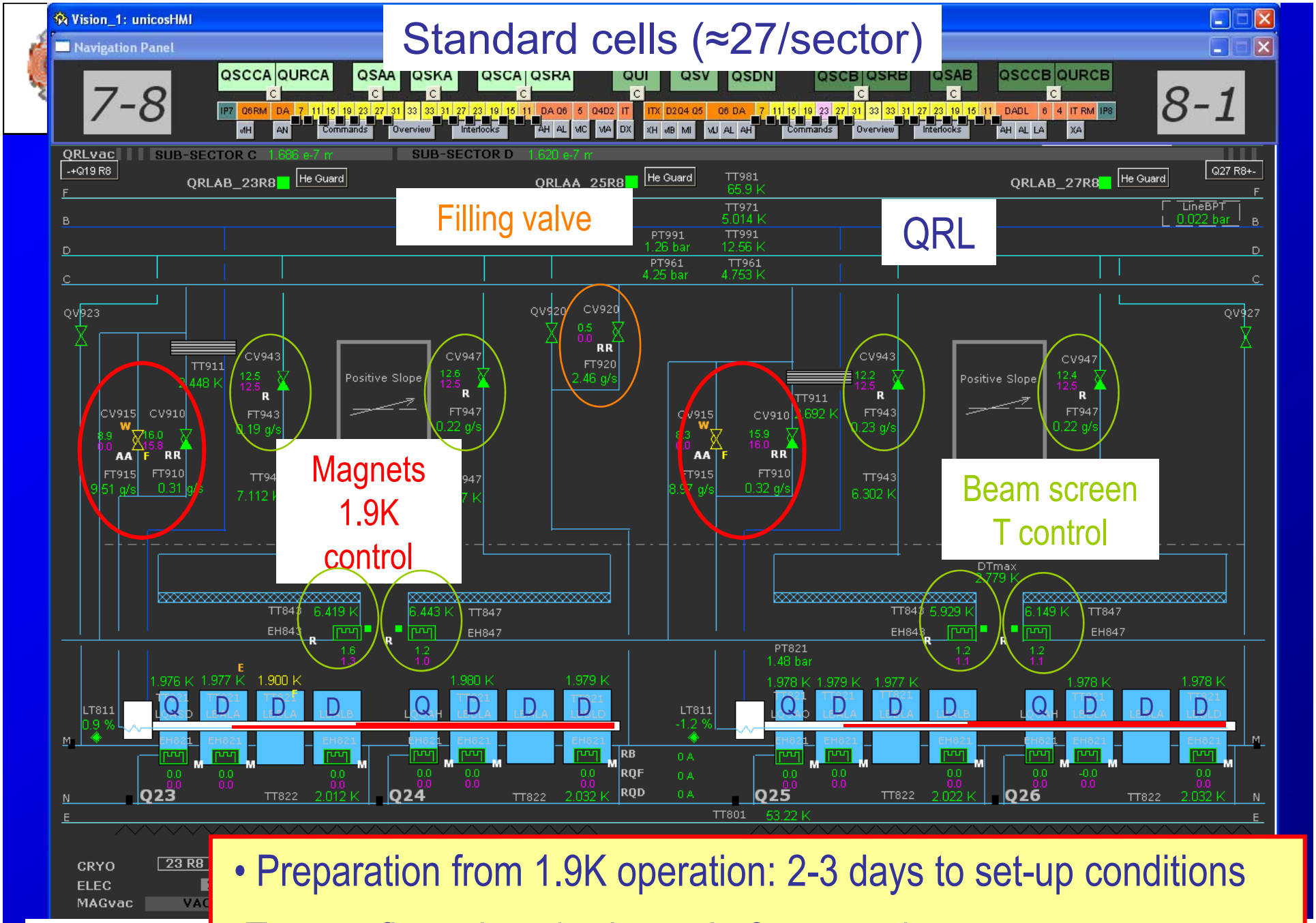
Manual tuning

So far manual, drifts to be included in supervision

So far manual (Timber & XL)

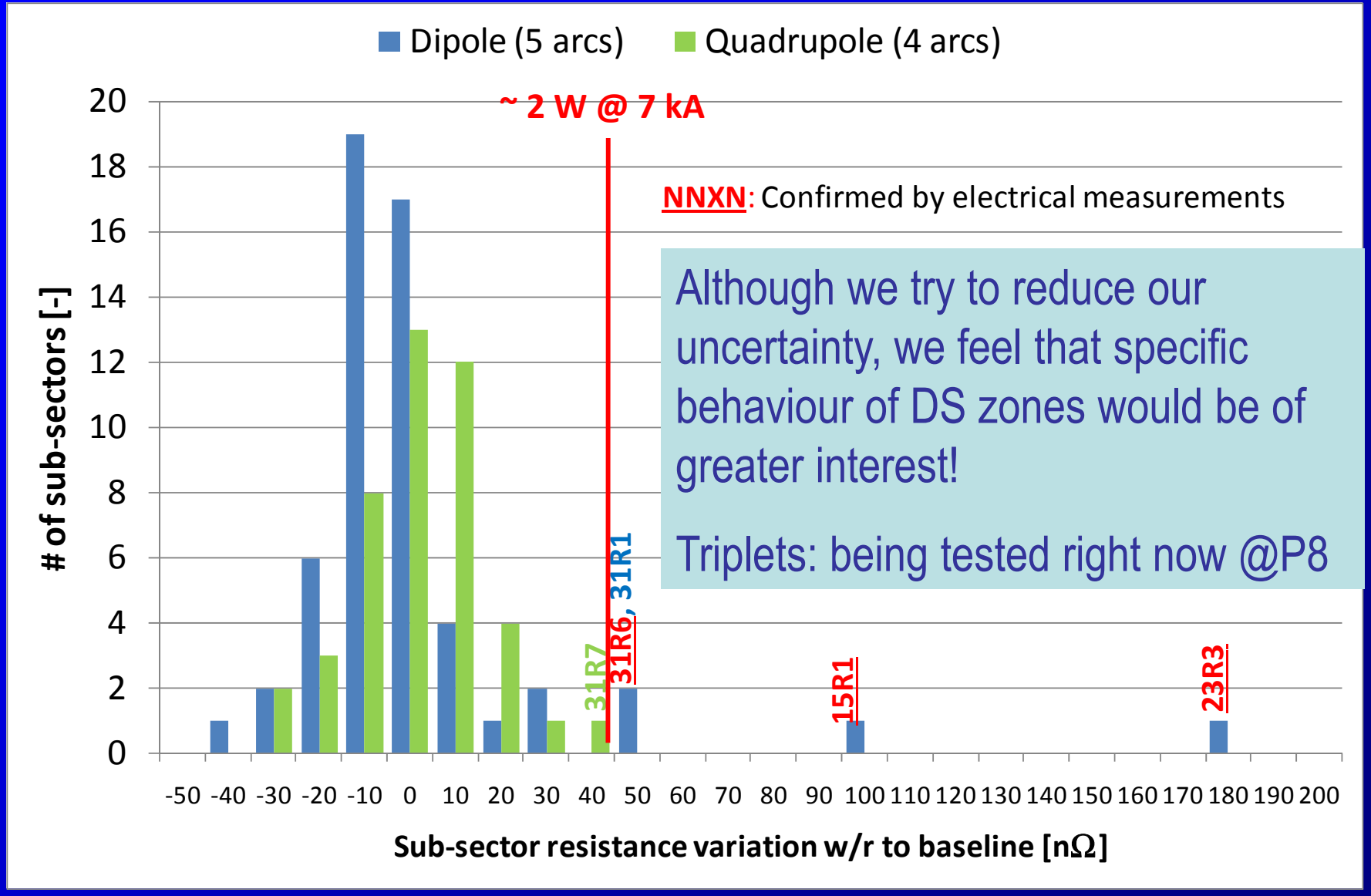
Many specific cases (cryo cells, instrumentation, operation facts and accuracy) being considered, so far with success

Standard cells (≈27/sector)

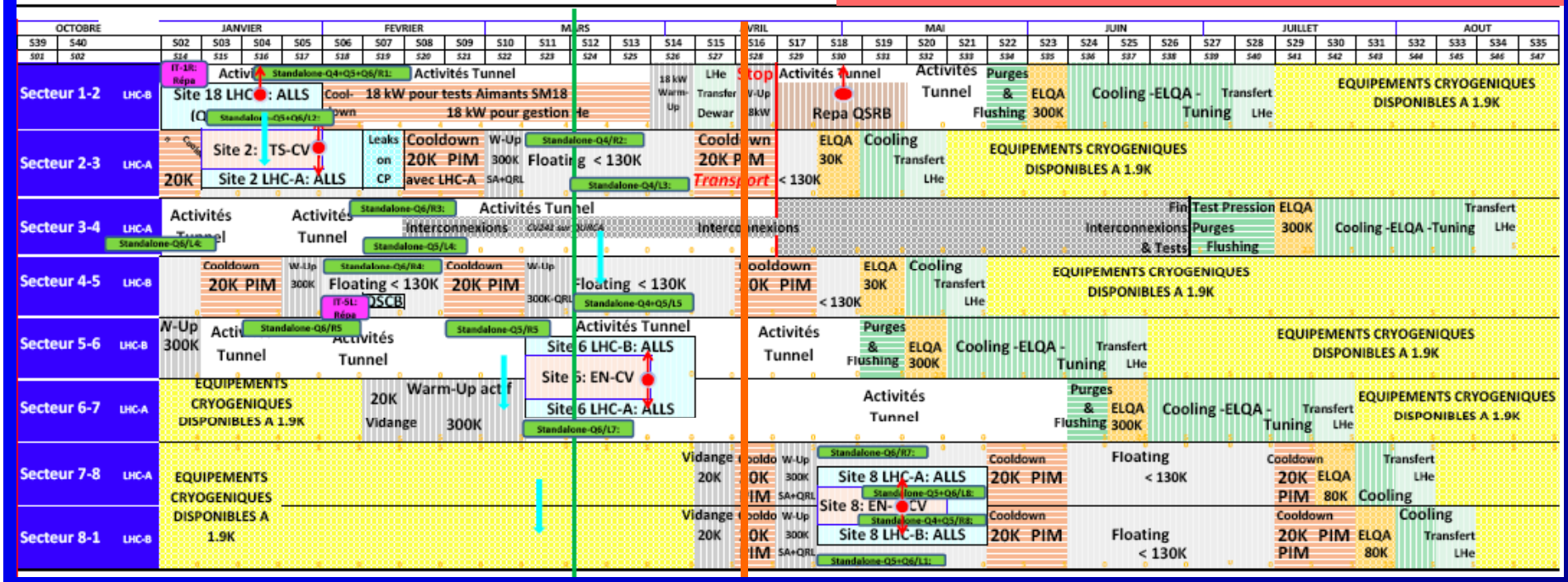


- Preparation from 1.9K operation: 2-3 days to set-up conditions
- Test configuration: 4-5 hours before ramping current

Arc sub-sector resistance variation assessed by calorimetry



“Cryo view” of tasks ahead this year



Challenges for this year:

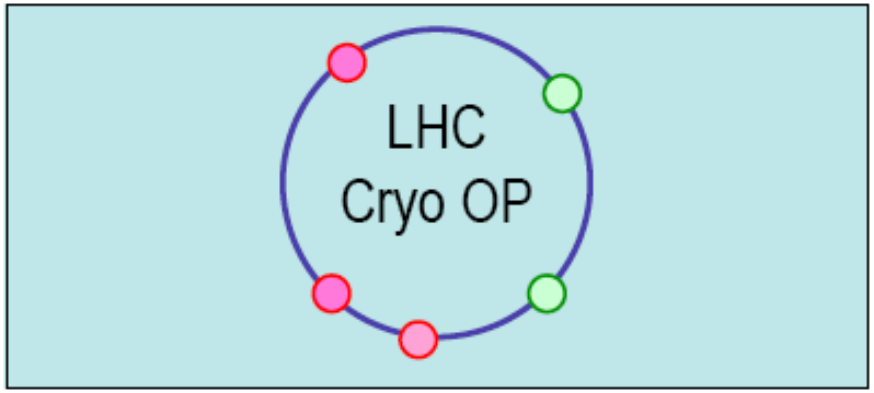
Completion of consolidations (like others!)

Cooling 4 sectors + filling/tuning 8 sectors in four months !!!

Affectations LHC Cryo CRG-OA

Team Leader: S. Claudet

Apr'09



	P18	P2	P4	P6	P8
HWC	\--	U. Wagner	--/	\--	G. Ferlin --/
Site coordination	\--	JP. Lamboy --/	S. Junker	L. Herblin	A. Suraci
CCC interface	E. Lussi	E. Millet	M. Combe	N. Navion	A. Eychenne
		OP 2	OP 1	A. Gallon	K. Hafi

Ing. OP référents experts académiques

Ing. production Encadrement site

Opérateurs Sites + Shifts

+ M. Soubiran (Analyse fonctionnelle)

+ Industrial partner teams in local control rooms (≈ 20 personnes ALLS)

	P18	P2	P4	P6	P8
No Tel SdC	70081	79240	79440	79640	79840
	75084	79241	79441	79641	79841

LHC Cryo shifts 2009: 15 Avril

			P18/P2		P4	P6		P8		
Personnel			EL	DM	MC	NNM	AG	Aey	KH	Nombre de jours moyen travaillés dans un mois:
Jours travaillés / mois			21	21	21	20.5	21.5	20	21	21.03
Nombre de jour normaux			21	21	21	20	24	19	21	
sur les 2 mois			16%	16%	15%	15%	16%	13%	15%	
Nombre de matin			7	7	5	7	7	7	7	
sur les 2 mois			15%	15%	11%	15%	15%	15%	15%	
Nombre d'apres-midi			7	7	7	7	7	7	5	
sur les 2 mois			15%	15%	15%	15%	15%	15%	11%	
Nombre de nuit			7	7	7	7	5	7	7	
sur les 2 mois			15%	15%	15%	15%	11%	15%	15%	
AVRIL	16	1 Me	J	J	J	J	J	J	J	
		2 Je	J	J	J	J	J	J	J	
		3 Ve	J	J	J	J	J	J	J	
		4 Sa								
		5 Di								
	17	6 Lu	J	J	J	J	J	J	J	
		7 Ma	J	J	J	J	J	J	J	
		8 Me	J	J	J	J	J	J	J	
		9 Je	J	J	J	J	J	J	J	
		10 Ve								
		11 Sa								
		12 Di								
	18	13 Lu								
		14 Ma	J	J	J	J	J	J	J	
		15 Me	J	M	A	J	J	J	N	
		16 Je	J	M	A	J	J	J	N	
		17 Ve	J	A	N	M	J	J		
		18 Sa		A	N	M				
		19 Di		A	N	M				
	19	20 Lu	J	N		A	J	M	J	
		21 Ma	J	N		A	J	M	J	
		22 Me	M		J	N	J	A	J	
		23 Je	M		J	N	J	A	J	
		24 Ve	A	J	J		M	N	J	

Final adjustments being implemented

Timing:
6h - 14h - 22h
(+/- 1/4h over-lap)

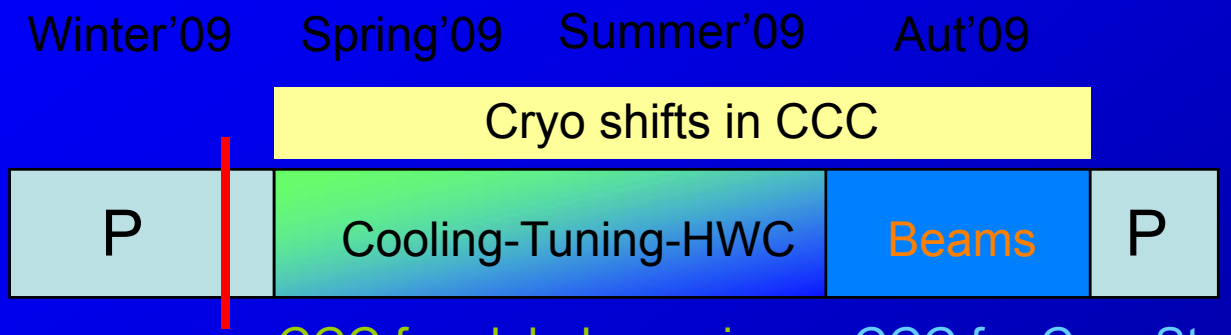
Tel Cryo CCC:
70463-70464

+ Additional support am/pm (2x2 pers.) for CCC or LN2 logistics

+ Double on-call service for interventions + Eng. Support via “Best Effort”

Proposal for definition of tasks site/shifts

Being reviewed and more closely precised



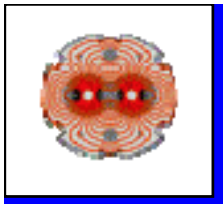
CCC for global overview and continuity of activities

CCC for Cryo Start/Maintain Direct interface for BE/OP

Local CCR for cool-down, tuning and HWC activities

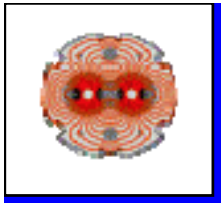
Local CCR for support and site periodic activities

We will adapt to reality and needs for global efficiency



Summary

- LHC Cryogenic system has been put in operation with success in 2008 and was “ready” for 5 Tev operation
- Since september 2008, test programs were conducted and improved our understanding and tuning of sub-systems (calorimetry, 1 refrigerator on two sectors)
- Consolidation programs were launched to improve safety and to increase availability (to be completed)
- We should manage foreseen program with less stress, but we know we have about 500 PID control loops per sector to be active simultaneously, and we will have surprises and temporary down-time to be dealt with!



Complements

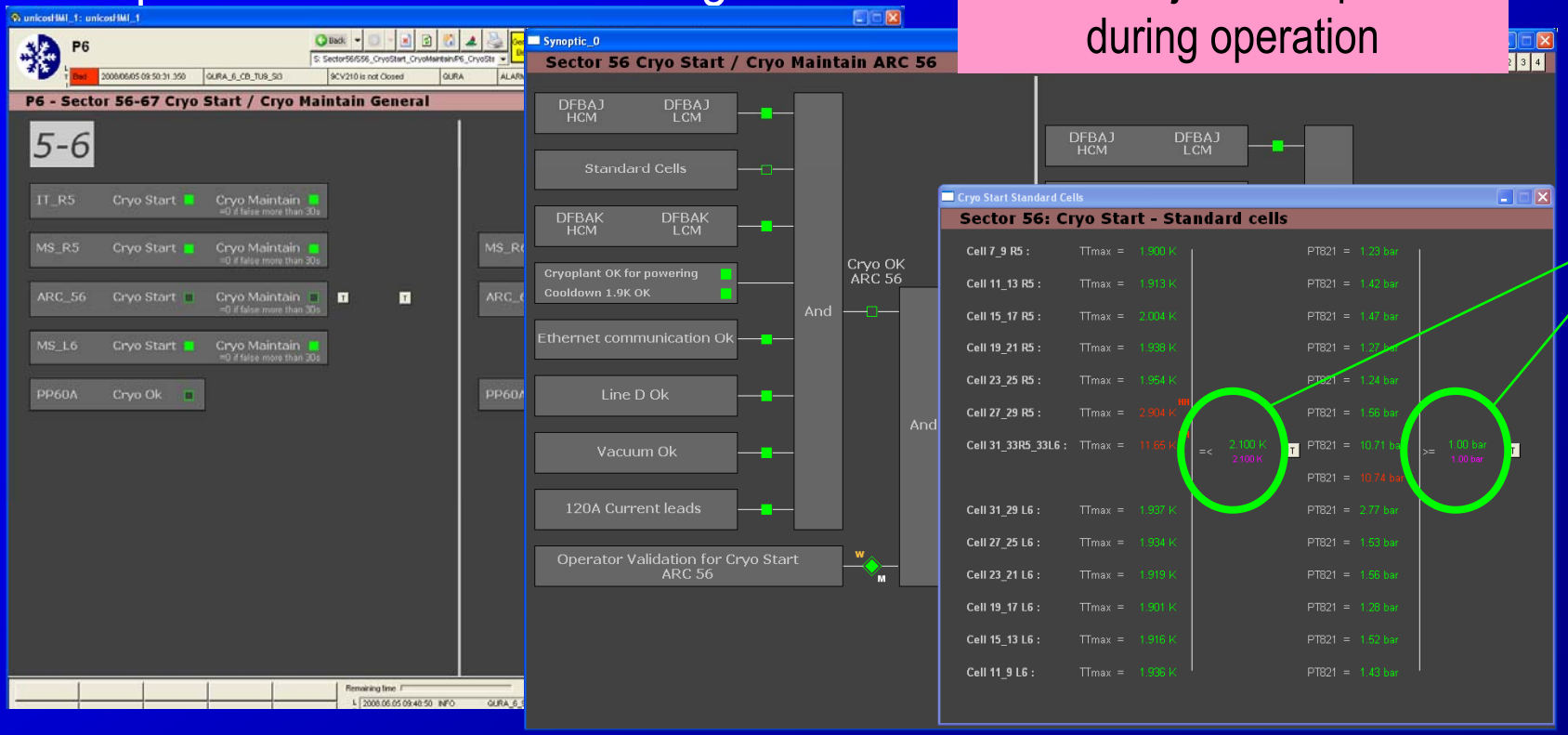
Cryo conditions for powering

Cryo Start: set of conditions to allow powering of concerned sub-sector (rather strict = good stability of process)

CS: Adjustments within pre-set limits

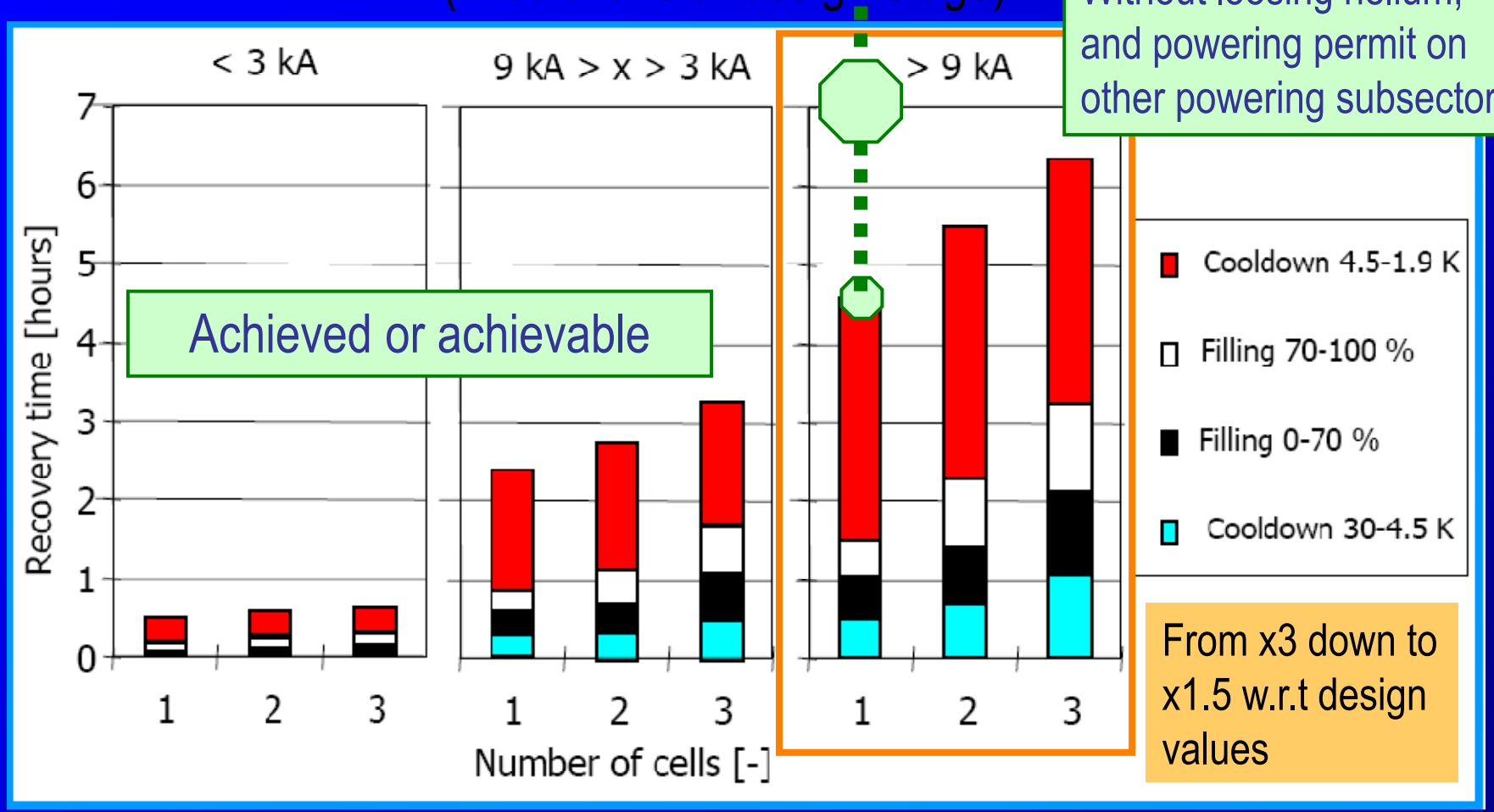
Cryo Maintain: Few important conditions checking integrity of HW, with slow power abort in case this signal is lost

CM: No adjustment possible during operation



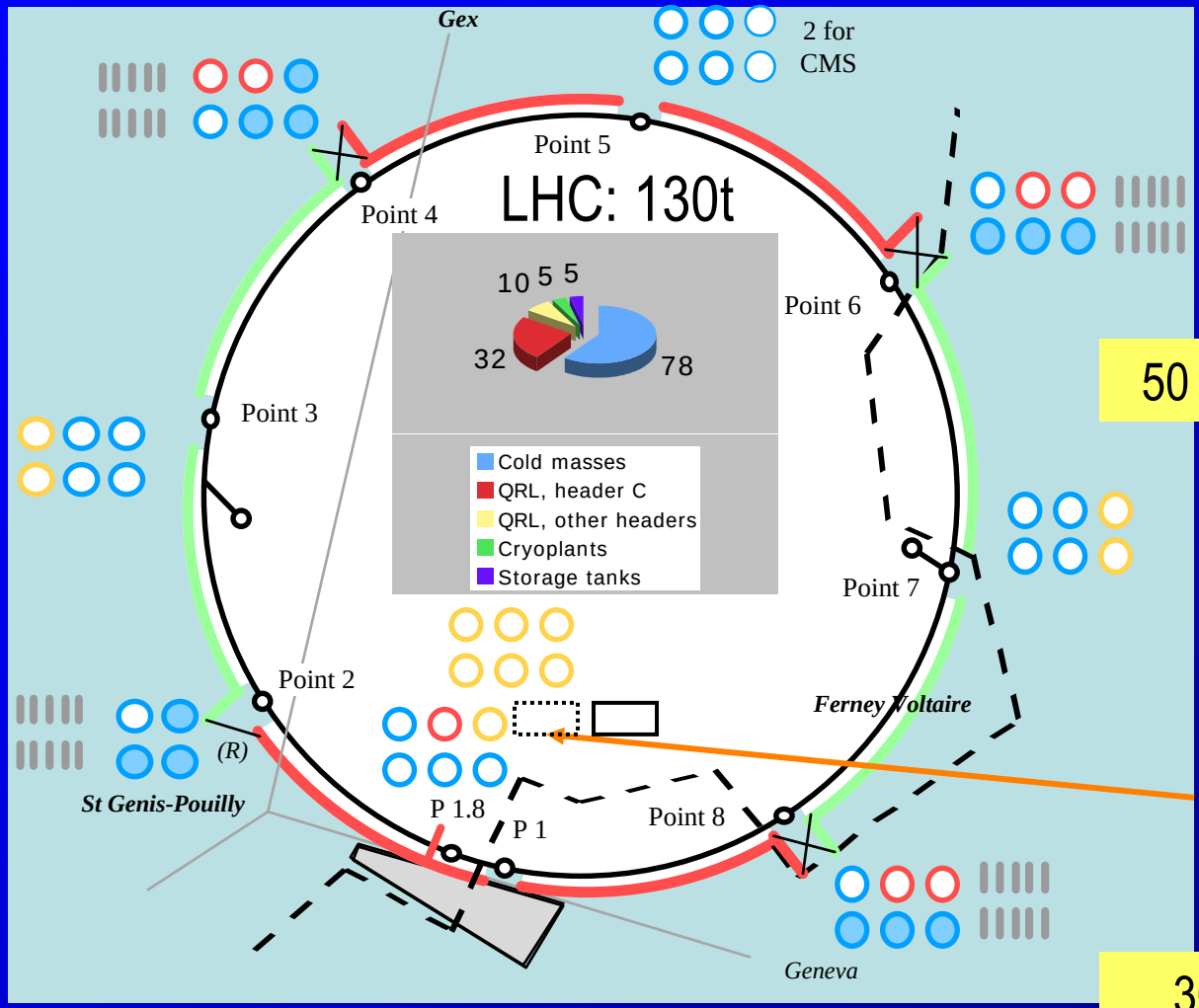
Recovery Time after Limited Resistive Transitions

(Predictions at design stage)



- More than 14 cells or full sector: recovery up to 48 hours
- In case of fast discharge (even w/o quench): 2 h recovery (heating due to eddy currents).

Helium storage



50 t: 50 x 250 m3 + 40 x 76 m3

Now completed by (Ph. 1):

30 t: 2 x 15 t for Spring 2008 !

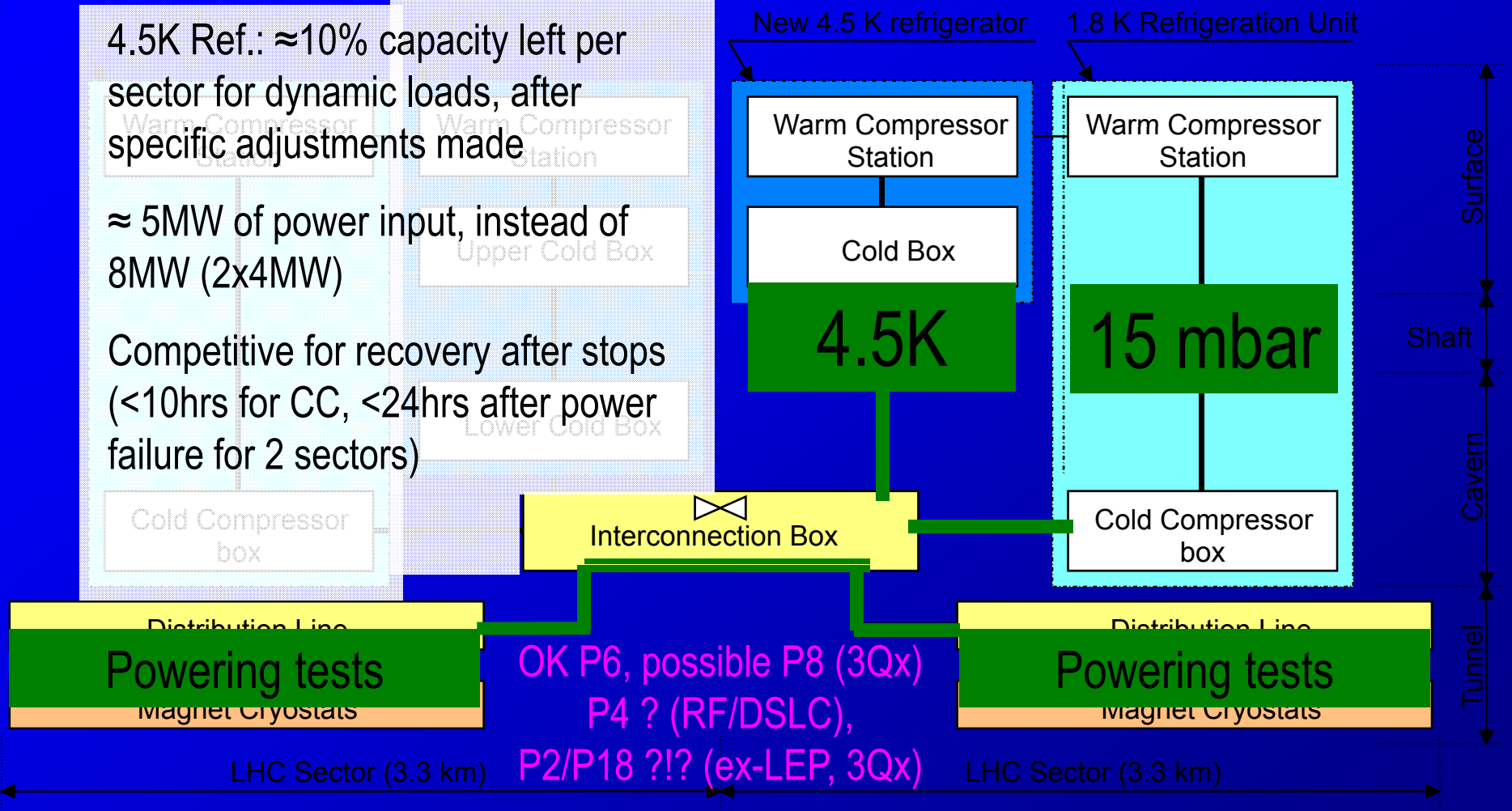
A good basis, but “rather long” logistics

Two sectors on one cryoplant

4.5K Ref.: ≈10% capacity left per sector for dynamic loads, after specific adjustments made

≈ 5MW of power input, instead of 8MW (2x4MW)

Competitive for recovery after stops (<10hrs for CC, <24hrs after power failure for 2 sectors)



Not valid for large transients, but an interesting feature for low beam loads, or validated fall-back scenario if serious problems with a refrigerator