Powering requirements for the insertion magnets

Cold D3, D4 and triplets

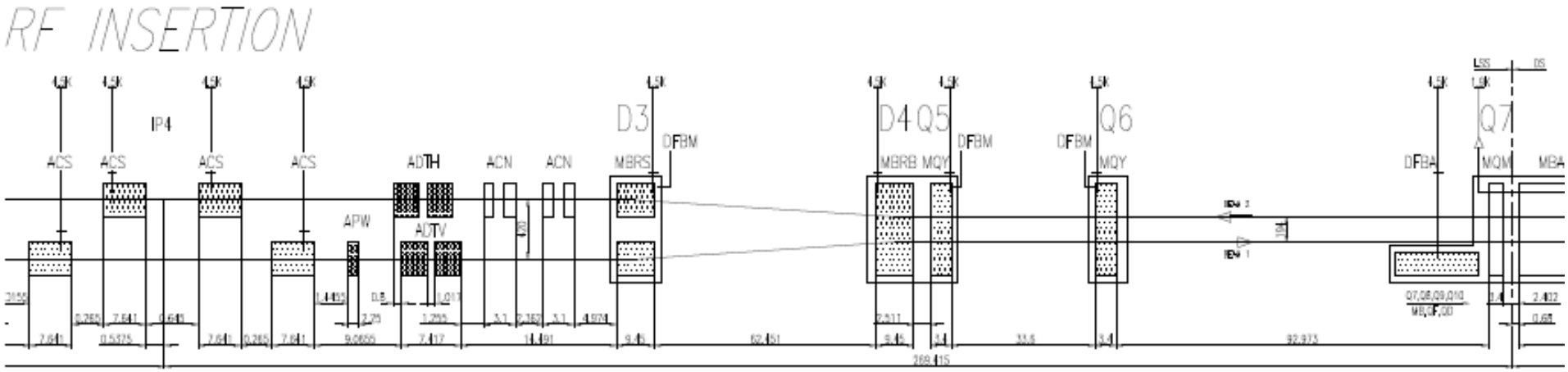
M. Giovannozzi

- History of strength evolution of cold D3/4
- History of strength evolution for triplets in IR2/8
- Summary

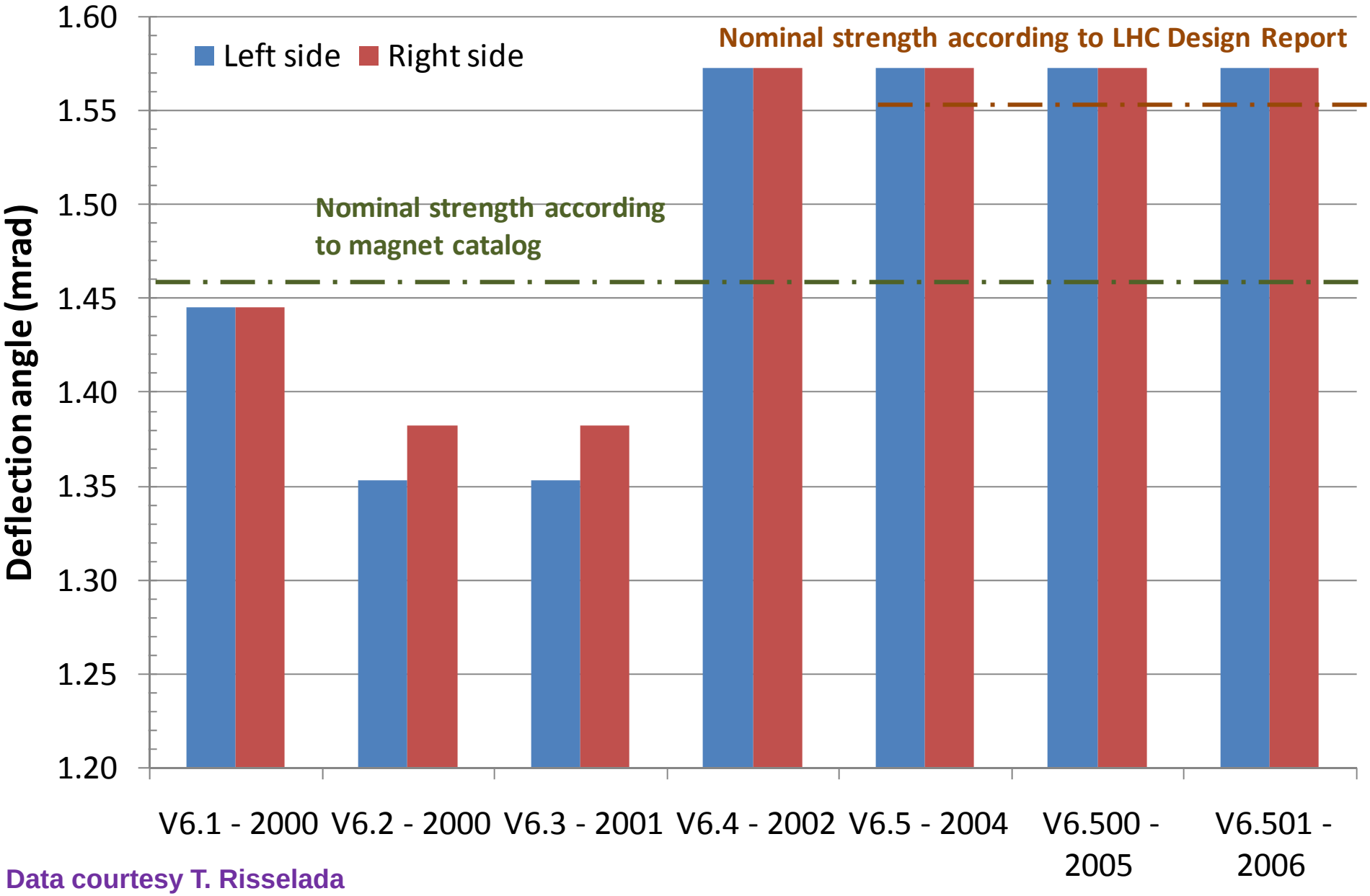
Acknowledgements: L. Bottura, S. Fartoukh, M. Lamont, D. Nisbet, R. Ostojic, T. Risselada, E. Todesco, M. Zerlauth

Few numbers for IR4

- Larger inter-beam distance to accommodate RF cavities: 420 mm
- Dog-leg is made by cold separation dipoles (D3/4) produced by BNL (RHIC-type dipoles).
- Inter-beam distance for D3/D4 changed in 2003 (see LHC-LBR-EC-0002-10-00 by R. Ostojic):
  - D3: 414 mm;
  - D4: 194 mm non-IP side; 198.4 mm IP-side;

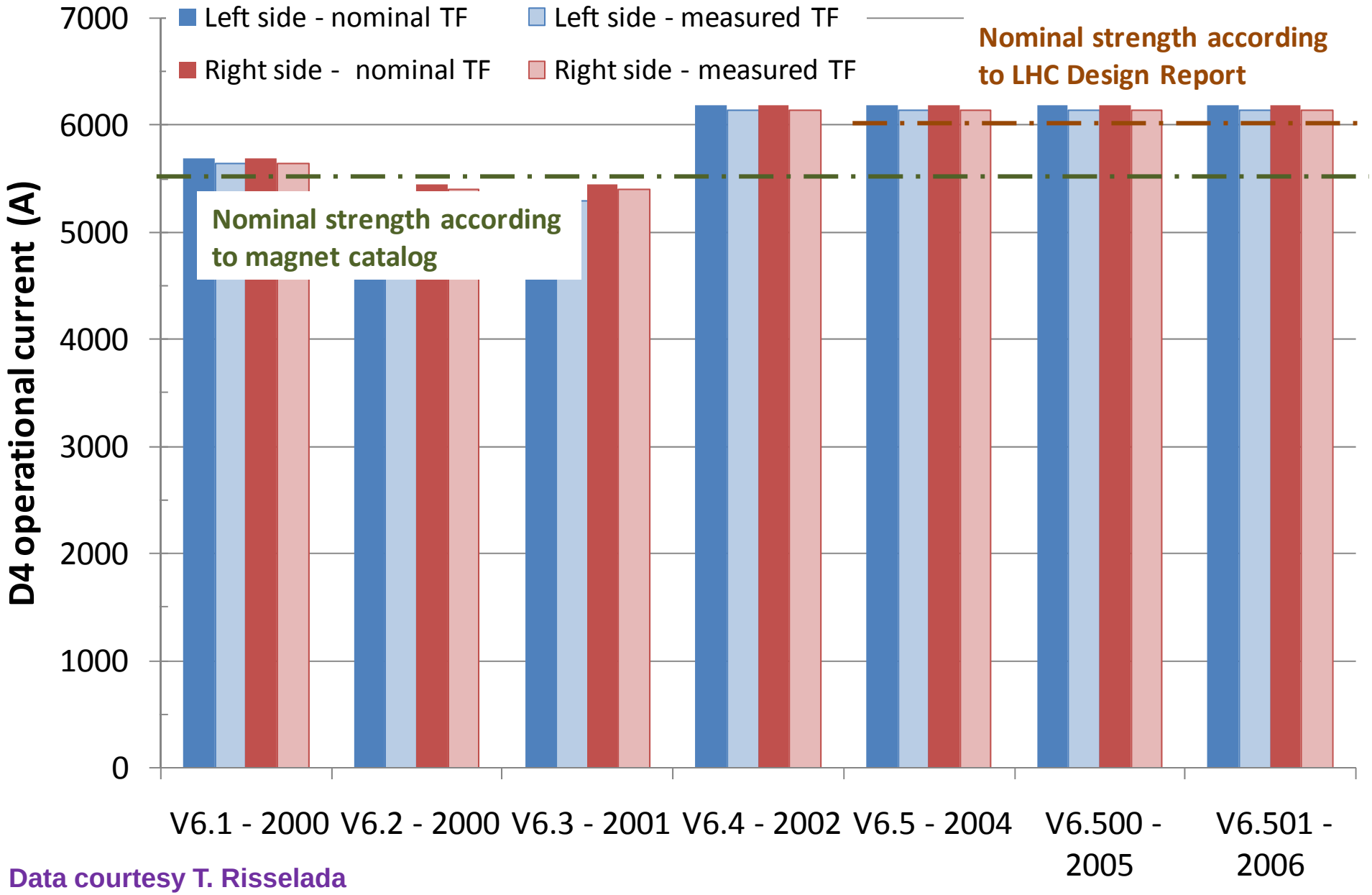


History of strength evolution of cold D3/4 - I



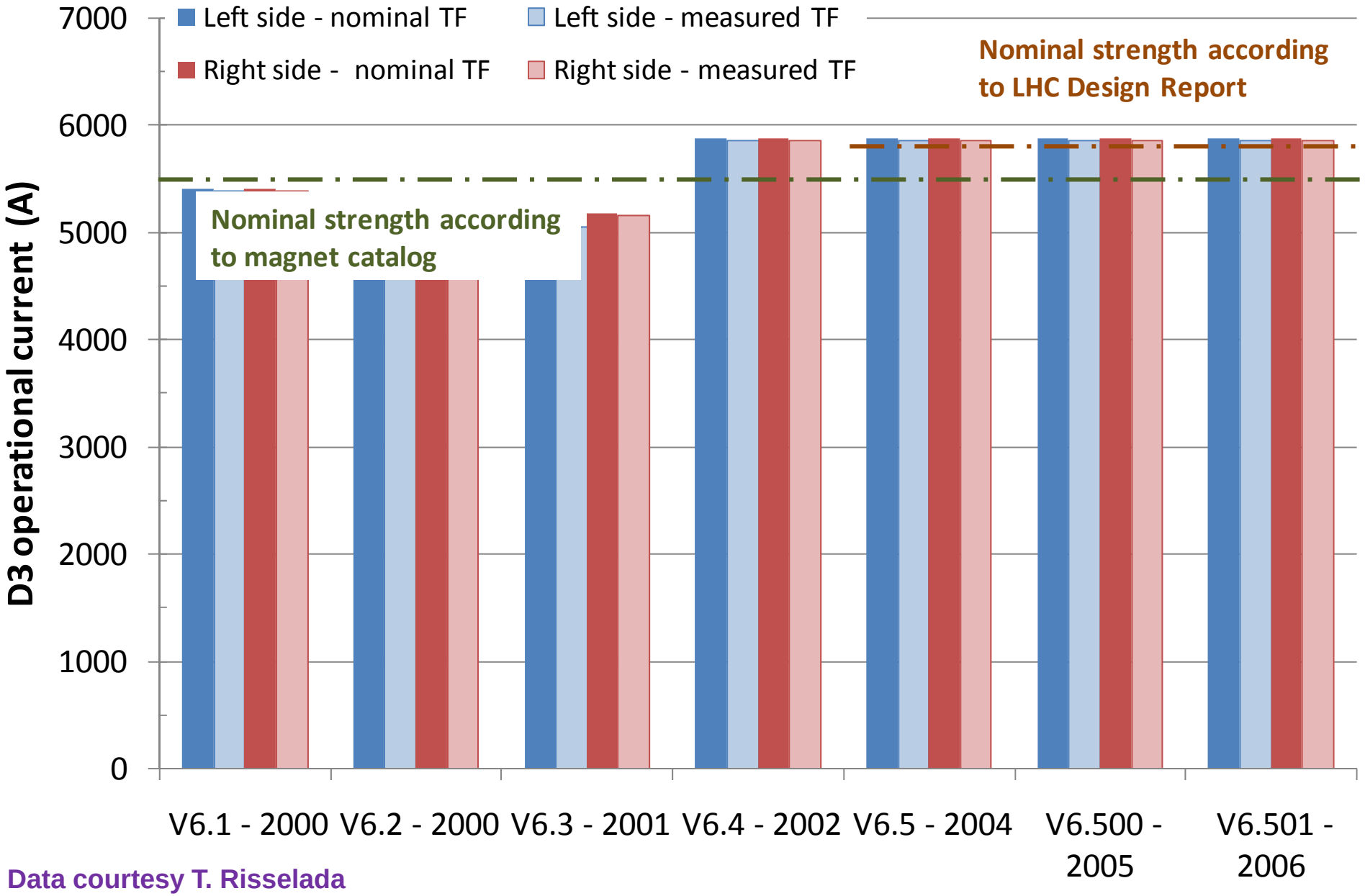
Data courtesy T. Risselada

History of strength evolution of cold D3/4 - II



Data courtesy T. Risselada

History of strength evolution of cold D3/4 - III



Data courtesy T. Risselada

History of strength evolution of cold D3/4 - IV

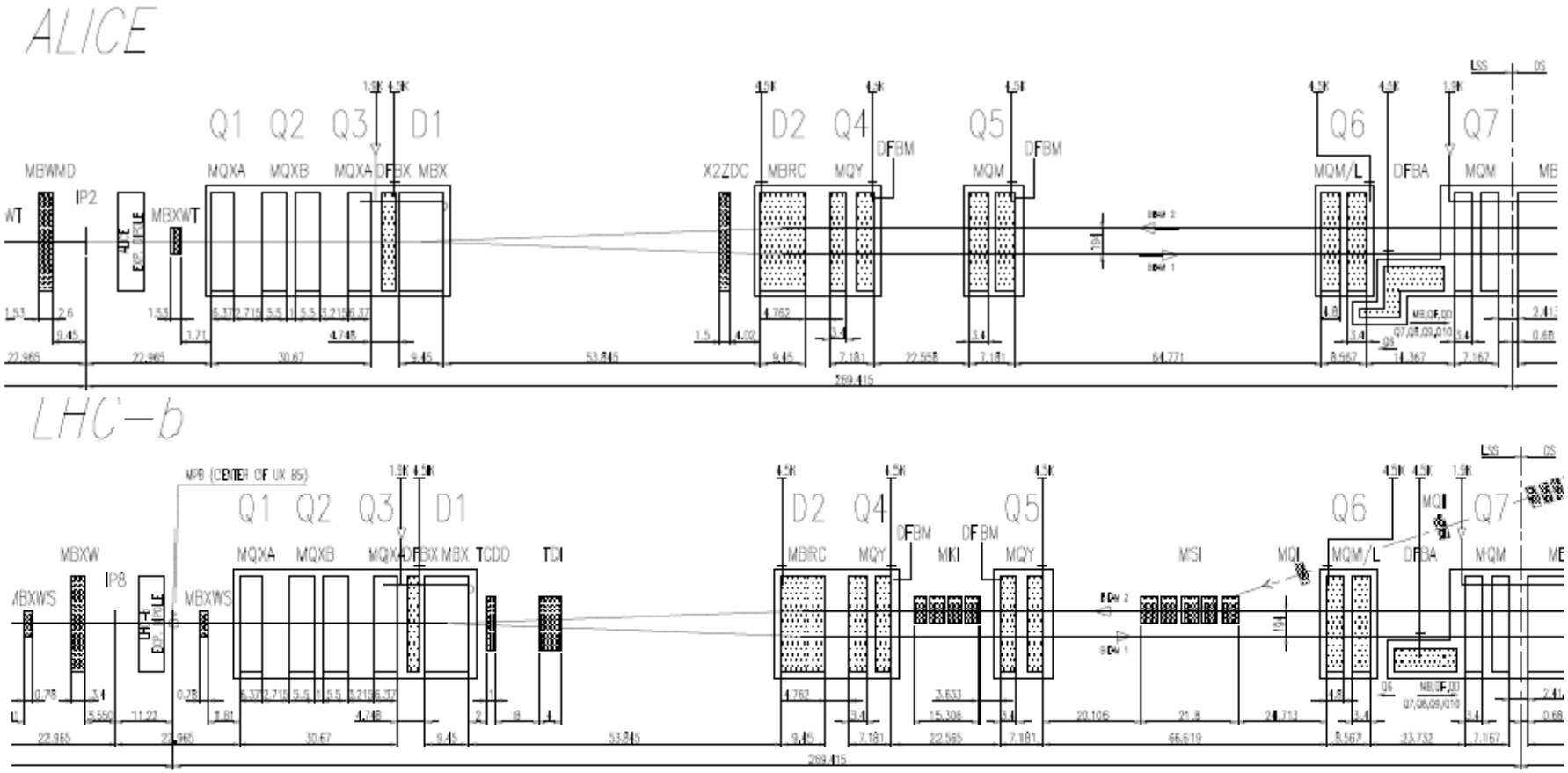
Computations based on measured transfer function.

		D3	D4
Nominal (A)		**5864**	**6144**
Ultimate (A)		**6338**	**6641**
Hardware limits:	PC (A)	8000	8000
	DCCT (A)	6000	6000

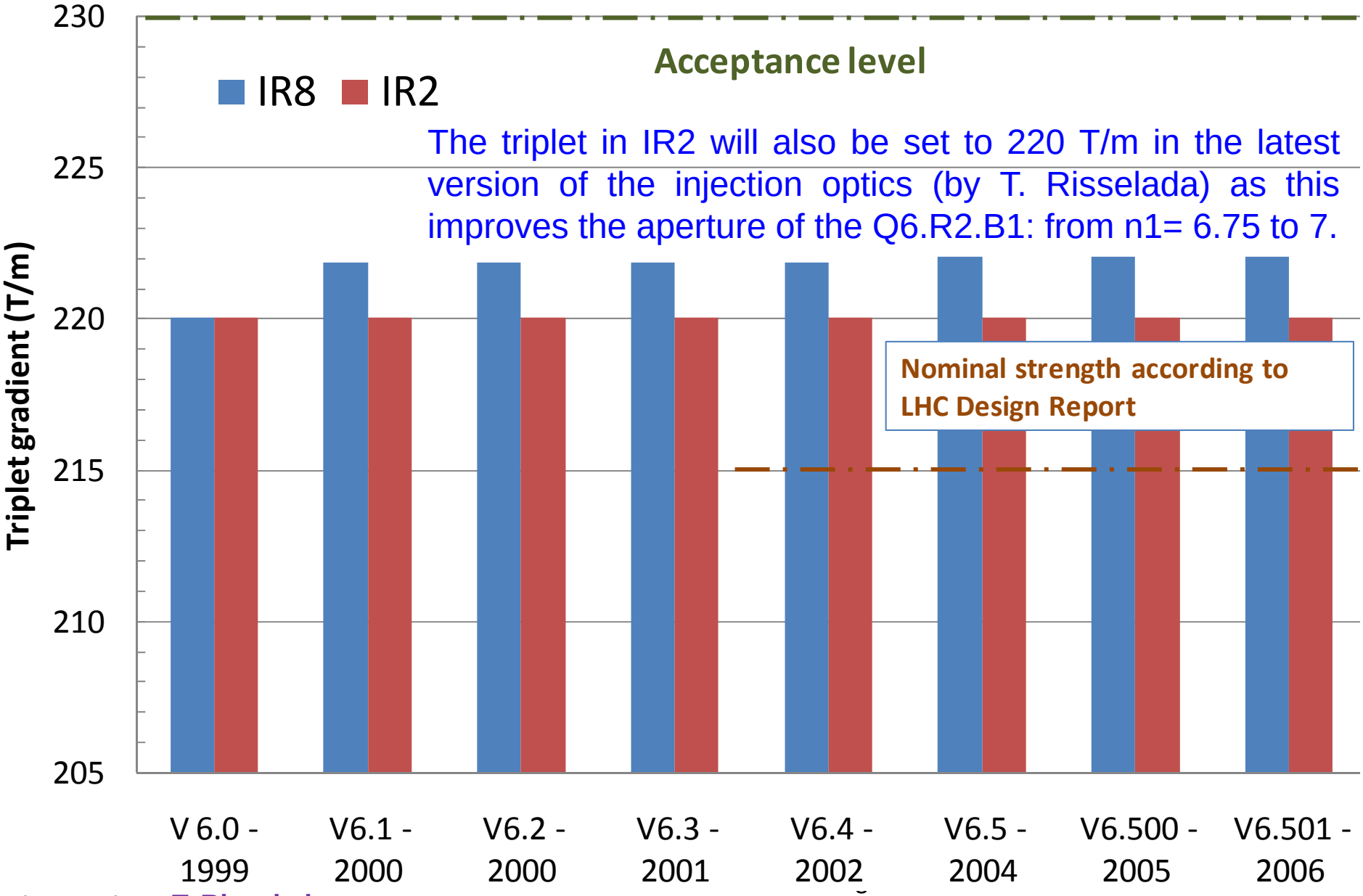
- No problem for the 2008 5 TeV run.
- Installed hardware (DCCT) is not compatible with nominal performance (D4).
- Installed hardware (DCCT) is not compatible with ultimate performance (D3 and D4).
- A new DCCT rated 7kA is not a major issue (cost and procurement).
- The replacement should be launched following an ECR.

Special situation of triplets in IR2/8

- Injection process imposes a number of constraints on phase advance (kicker/septum, kicker/TDI).
- Solution presented in LHC PR Notes 188 (IR2) and 193 (IR8) by O. Brüning.
- The gradient for injection optics is 220 T/m.



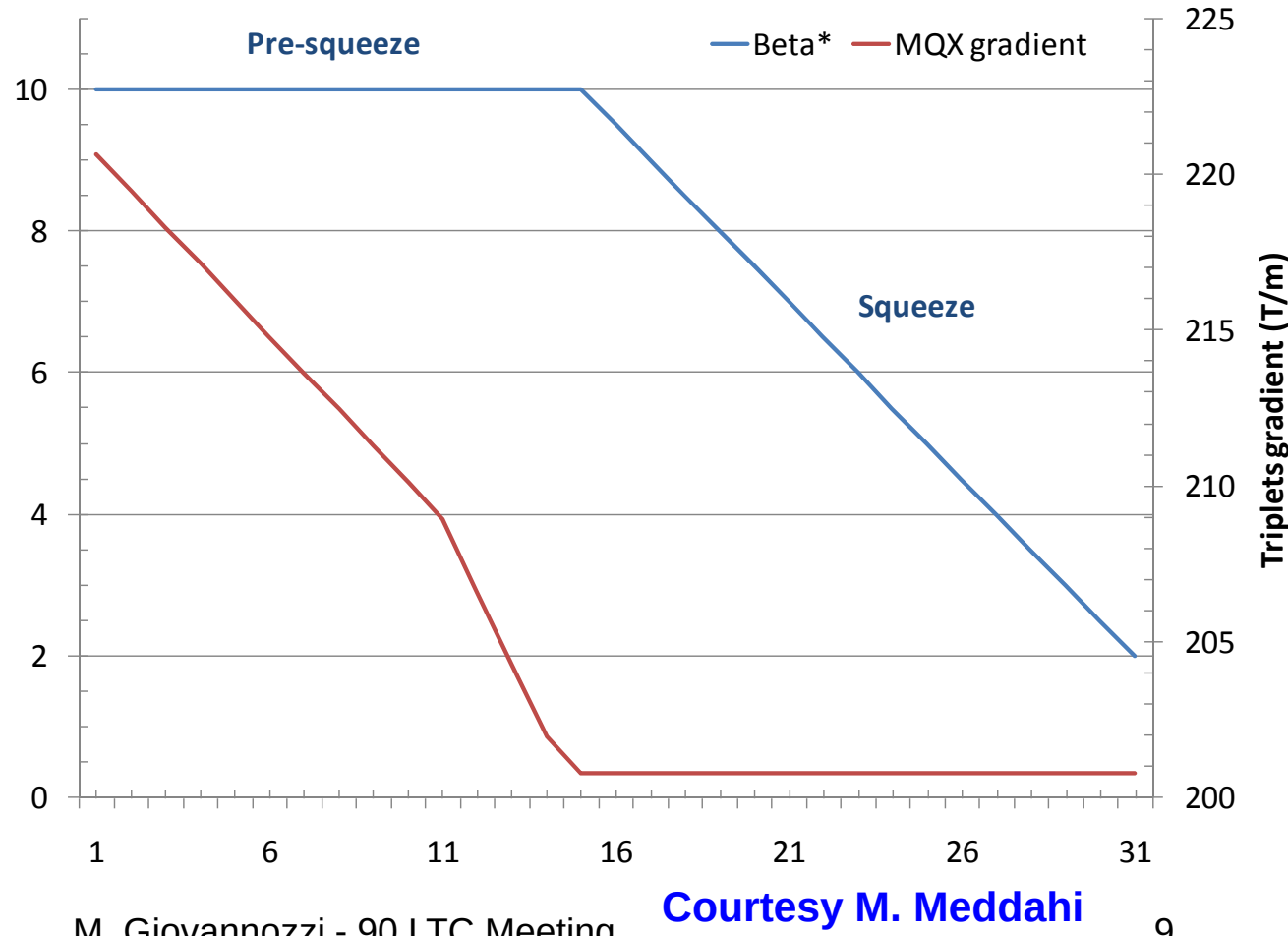
History of strength evolution of IR2/8 triplets



Data courtesy T. Risselada

Comments on triplets strength - I

- Acceptance tests were performed up to 230 T/m.
- The nominal gradient can be exceeded provided the beams are not in collision. Hence:
  - Optics is kept constant from injection to top energy. This choice simplifies the initial operation. It can be relaxed and the optics change performed during the ramp.
  - Triplets strength is decreased at constant beta*
  - Beta* squeeze starts afterwards



Courtesy M. Meddahi

Comments on triplets strength - II

Computations based on measured transfer function.

		Q1/3	Q2
Nominal (A)		**7430**	**12345**
Ultimate (A)		**8031**	**13343**
Hardware limits:	PC (A)	8000	8000+6000
	DCCT (A)	7000	7000+5000

- No problem for the 2008 5 TeV run.
- Installed hardware (DCCCT) is not compatible with nominal and ultimate performance (Q1/2/3).
- However:
  - The pre-squeeze can be performed during the ramp.
  - If the energy is < 6.5 TeV then no hardware limitations!
- NB: a DCCT rated 8kA is not currently installed in the LHC machine! A lead time of six months should be assumed.

Summary - I

- D3/4:
  - The installed hardware is compatible with running conditions in 2008.
  - Hardware modifications are required for D3 (ultimate) and D4 (nominal and ultimate).
  - The required DCCTs do not pose particular problems (procurement, availability, cost).
- Triplets in IR2/8:
  - The special requirements for beam injection impose higher-than-nominal gradient in the triplets.
  - The special setting is compatible with running conditions in 2008.
  - Since 2009, the pre-squeeze should be performed during the ramp (tests in 2008?). This would fix the potential hardware (DCCT) limitations.

Summary - II

- The current situation should be summarised in an ECR (in preparation by M. Zerlauth), which will be used for launching the hardware modifications.
- T. Risselada verified that the operational current values for other insertion magnets are compatible with the limits provided by the layout database. This was done using nominal transfer function: a new check should be done as soon as FiDeL transfer functions will be available.