



Powering of Totem Optics

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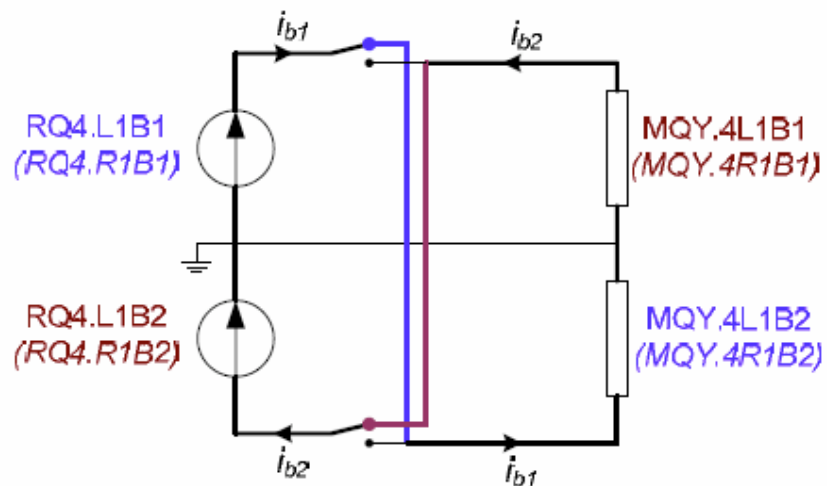


Introduction - Requirements

- Very high beta optics have been promised for both TOTEM and ATLAS:
 - Totem ($\beta^* = 1540$ m)
 - Atlas ($\beta^* = 2625$ m)
- This requires special optics settings that are different from those required for anti-symmetric physics.
- Steps were taken to modify the hardware at IR1 for the ATLAS requirements (see slide 3):
 - Implement a polarity inversion on Q4.R1 and Q4.L1)
 - <https://edms.cern.ch/document/498745/1.1> (obsolete ECR?)
- Issues concerning the TOTEM experiment are discussed in the following documents :
 - <https://edms.cern.ch/document/442925/1.0> (ECR 1999)
 - LTC Meeting 16, 12 Novembre 2003
 - The current TOTEM optics does not have a solution adapted to the installed hardware (see slide 5)

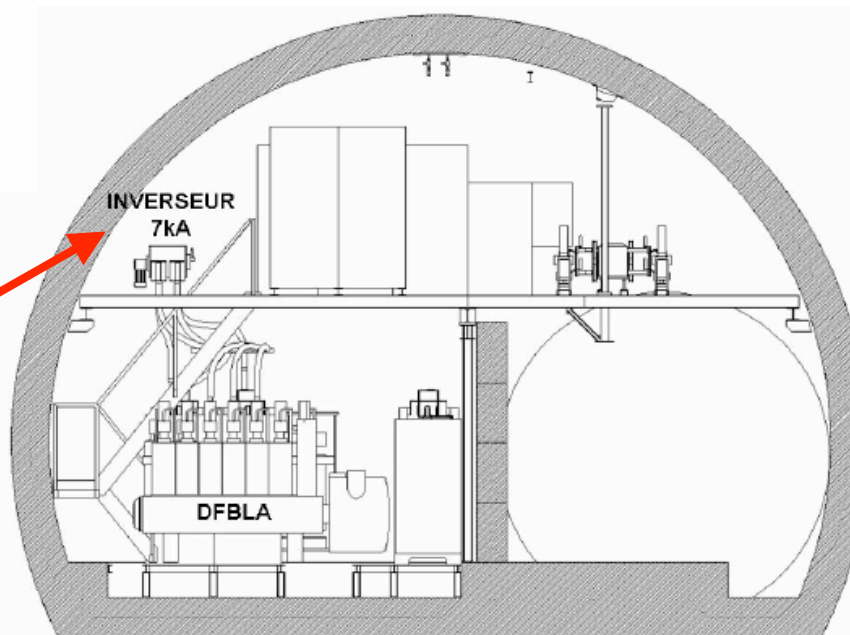


Introduction – ATLAS – Q4 with polarity switch



- Permits the high Beta optics settings without violating electrical constraints
- Ratio of 2 still applies!

Note: Not yet equipped with automated switch (budget?) – manual intervention required to setup polarity inversion...

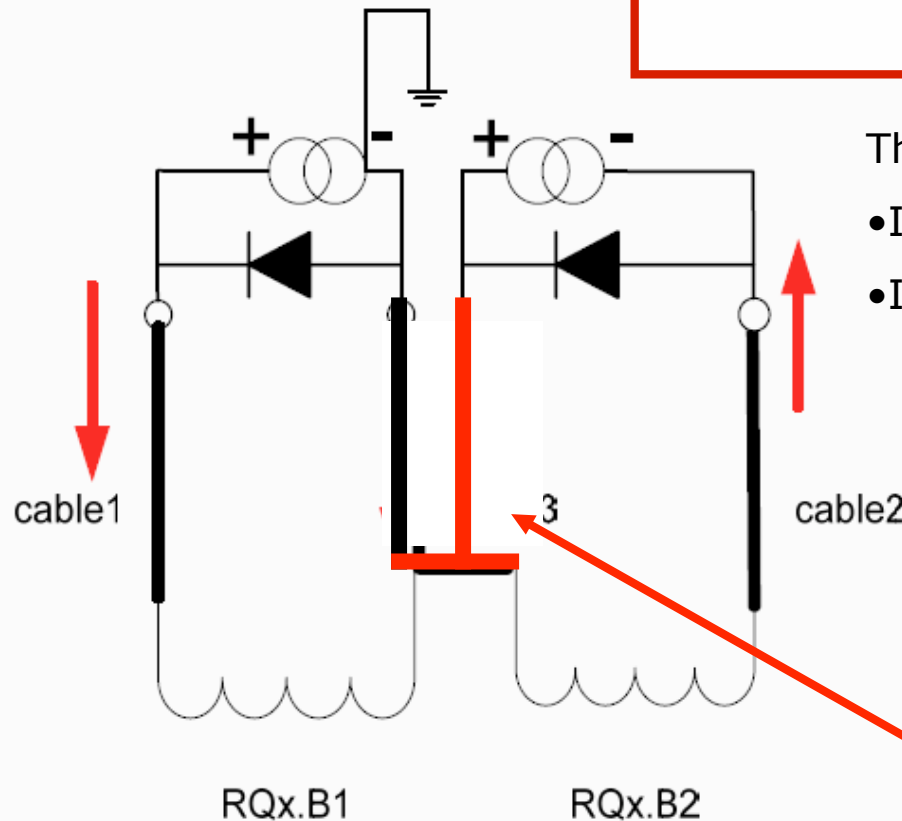


<https://edms.cern.ch/document/498745/1.1>



Introduction - IPQ PC Hardware Limitation

$$2 * I_{RQx.B2} > I_{RQx.B1} > 0.5 * I_{RQx.B2}$$



Thus, for example

- If $I_{RQ4.R1B1} = 1000A$
- $I_{RQ4.R1B2}$ must be $>500A$ and $<2000A$

Not easy for optics
and/or controls settings!

Constraint is removed if an extra
cable is added



TOTEM P5 –optics as in LHC design report (A. Verdier)

as described in LHC Project Note 369, May 2005
and shown in 16th LTC

Using existing hardware

shown for beam 1

Right side constraint by

- 0.25 phase advance to roman pot (exact in y, 0.239 in x)
- Q4 = 0 on side of roman pots
- Tune matching with Q4-Q10 left

Strength ratios B2/B1 outside limits

Magnet ratio

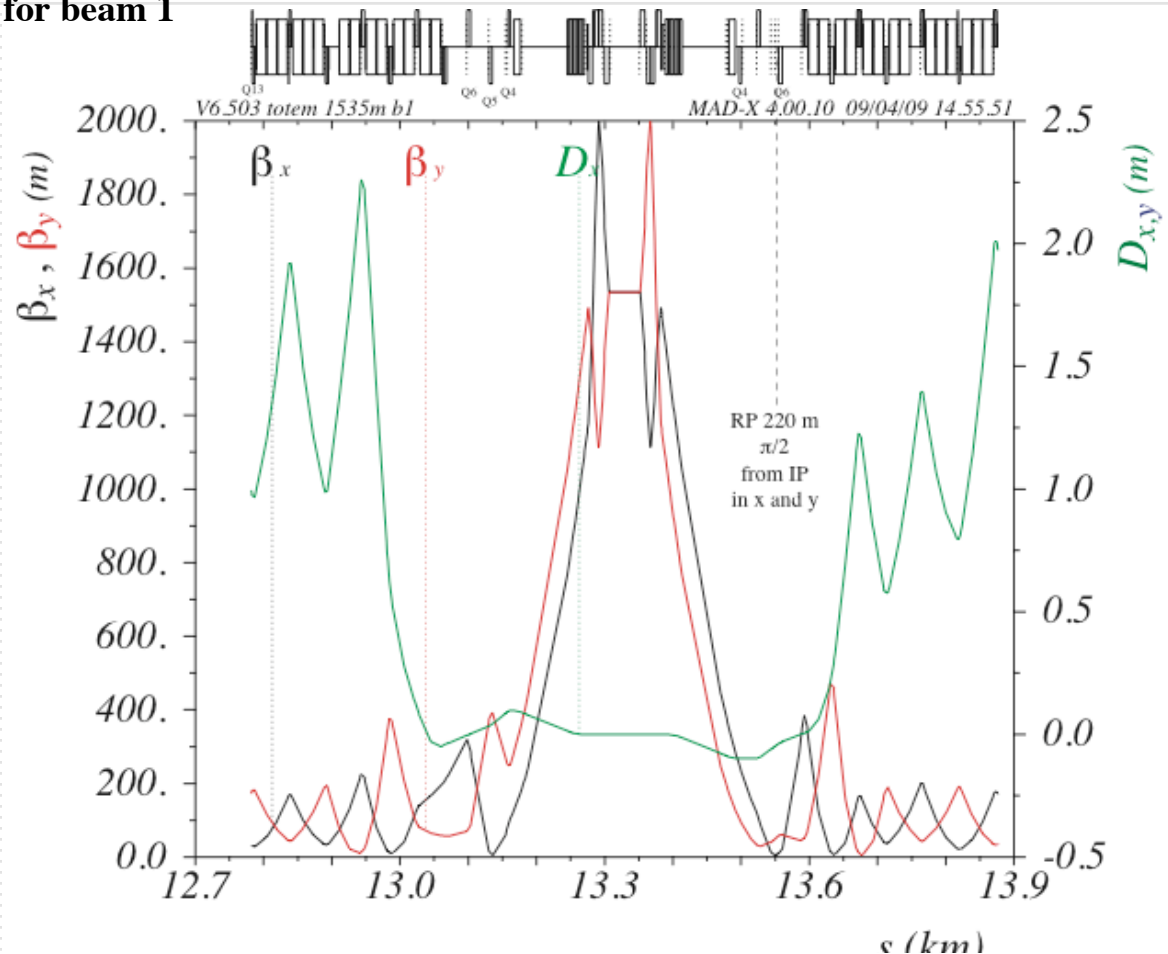
Q4L	0	0 / 0.006857
Q7L	26	-0.0027 / 0.0071
Q8L	2.1	0.0031 / -0.00855
Q8R	1 / 2.1	
Q7R	1 / 30	
Q4R	1 / 0	

and Q6 3% above nominal

Phase advance over insertion

	b1	b2
mux =	2.6925	2.6993
muy =	2.0894	2.0808

(normally 2.633, 2.649 in physics V6.503)



Would need an extra cable on Q4, Q7, Q8, both left and right, to get this back on the table

Could then be possible to keep Q4 on at normal polarity - potentially compatible with normal injection / ramp



TOTEM P5 alternative optics – inverted Q4 (as for Atlas)

Planned to show at PAC 2009 and EDS09

shown for beam 1

Addition of polarity inversion on Q4

Respects all known limits,

Largest ratios

Q4 ratio 0.55

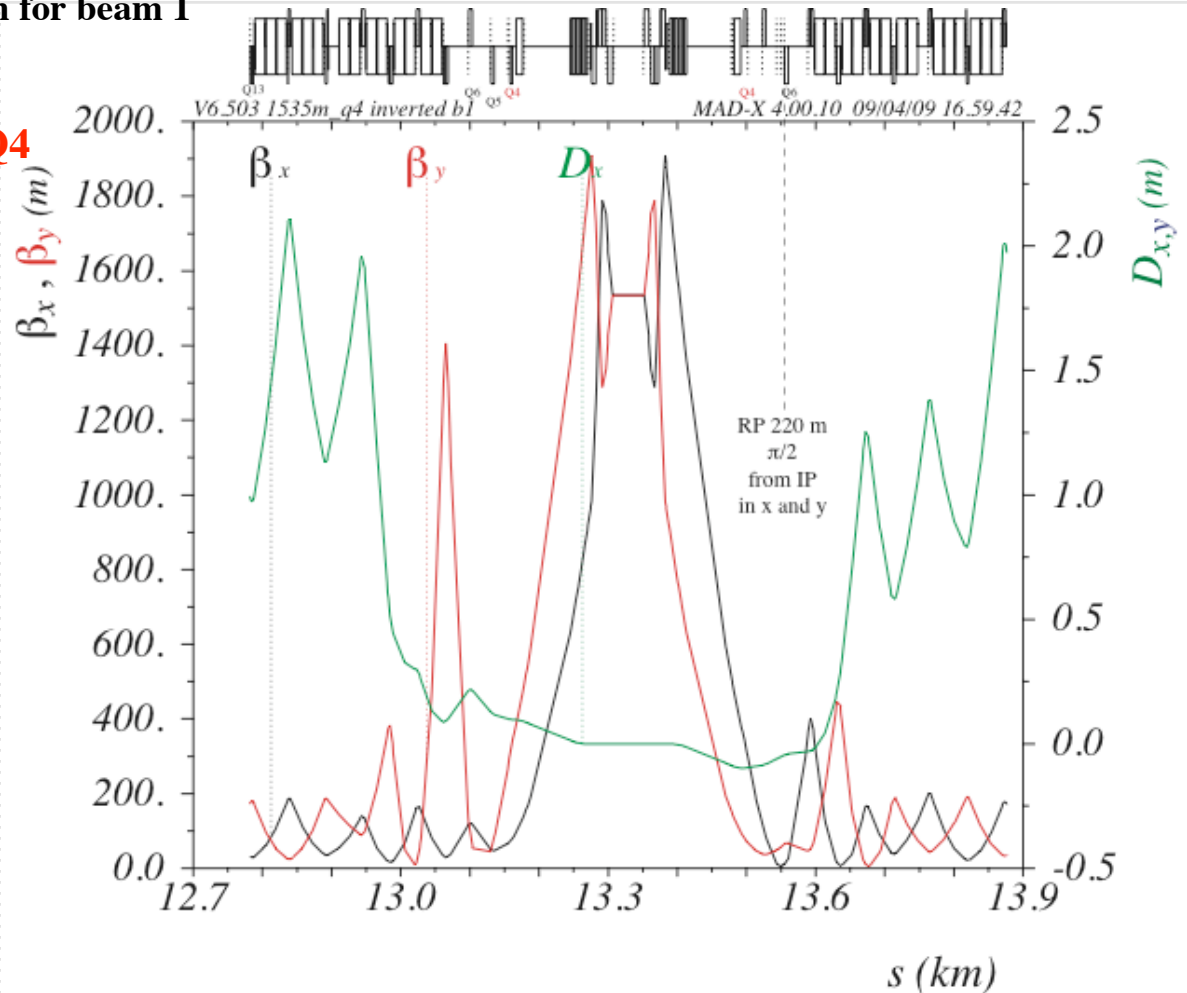
Q5 ratio 0.52

0.25 phase advance to roman pots
now exact in both planes

Phase advance over insertion

	b1	b2
mux =	2.4911	2.4979
muy =	2.5405	2.5420

(closer to the normal 2.633, 2.649 in physics V6.503)



Looks like a real, in some respects better alternative.

Not possible to do smooth un-squeeze from physics and needs extra injection, ramp, squeeze



TOTEM P5 – Polarity Switch – Preliminary Feasibility

Solution 1:

Add a polarity inverter in RR53 and RR57 (as for Q4.R1 and Q4.L1)

Issues:

- Limited optics flexibility

Activities:

1. Purchase 4x DC Cables to/from polarity switch: 25kCHF
2. Labor to remove 2x DC Cables and add 4x new DC cables : 15kCHF
3. Add polarity switch mechanics on 1st floor: 10kCHF
4. Mechanized polarity switch: 40 kCHF
5. Modification of water circuit (T-junction): ~2kCHF

Cost per location: 52 kCHF (manual); 92kCHF (mechanized)

No Access required.

Total Cost: 104kCHF (manual); 184kCHF (mechanized)



TOTEM P5 – Extra Cable – Preliminary Feasibility

Solution 2:

Add an extra cable to the central conductor of Q4, Q7, Q8 (using all IPQ gives extra flexibility)

Issues:

- Space for the extra cable if several systems should be modified
- Several Quadrupoles required to give optics flexibility

Activities:

1. Purchase 3x (7x) DC Cables from PC to DFB: 25kCHF (60kCHF)
2. Purchase 3x (7x) 2-to-1 adapters for the DFB chimney 15kCHF? (35kCHF?)
3. Labor to install 3x (7x) DC Cables : 15kCHF (35kCHF)
4. Modification of water circuit (T-junction): ~5kCHF (10kCHF)

Cost per location: 60 kCHF (Q4, Q7, Q8); 140kCHF (Q4->Q10)

Total Cost: 120kCHF (Q4, Q7, Q8); 280kCHF (Q4->Q10)



- **Action is required** to find a solution to power the TOTEM optics (Beta* = 1540m)
 - If no action taken – early TOTEM optics (in 2010) with **Beta* = 90m** is still possible with existing infrastructure
- Options are
 - (1) Polarity Inverter on Q4 (L5, R5)
 - ~184kCHF for fully mechanized solution
 - (2) Extra cable on Q4, Q7, Q8 (L5, R5)
 - ~120kCHF for additional cable on Q4, Q7, Q8
 - More invasive work required to integrate cabling
- Full mechanization of Q4 (L1, R1) should be considered (80 kCHF)