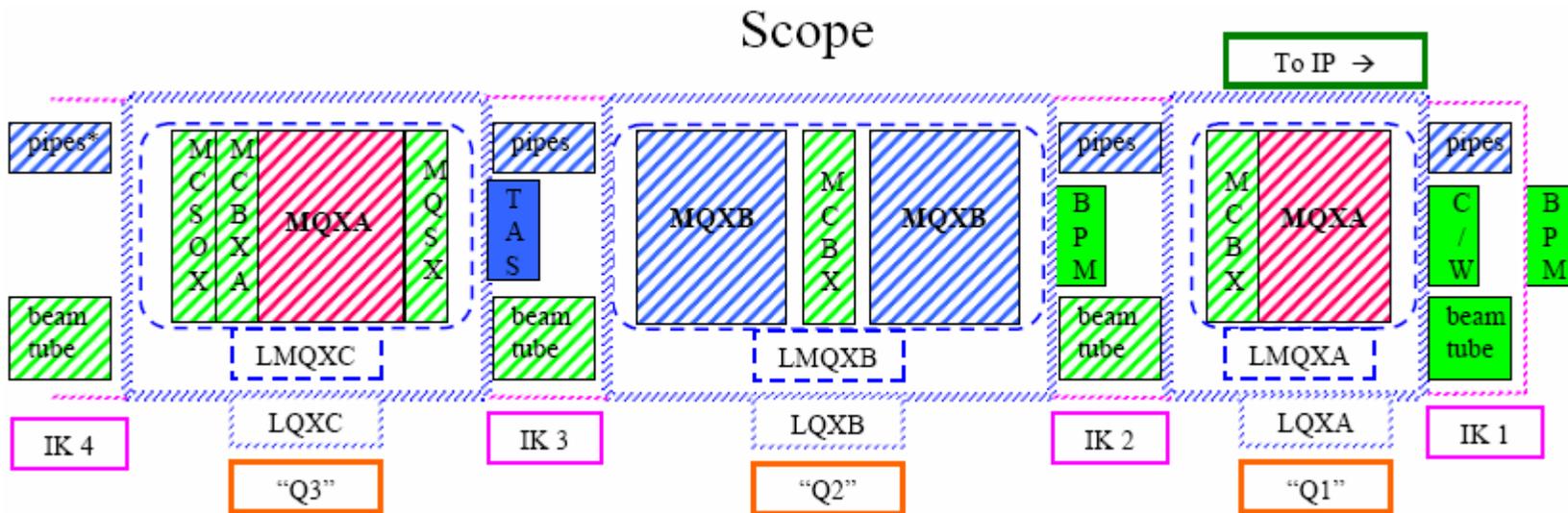


LHC Inner Triplet Status

Steve Holmes

All Experimenters' Meeting
April 2, 2007

The Inner Triplet



What Happened?



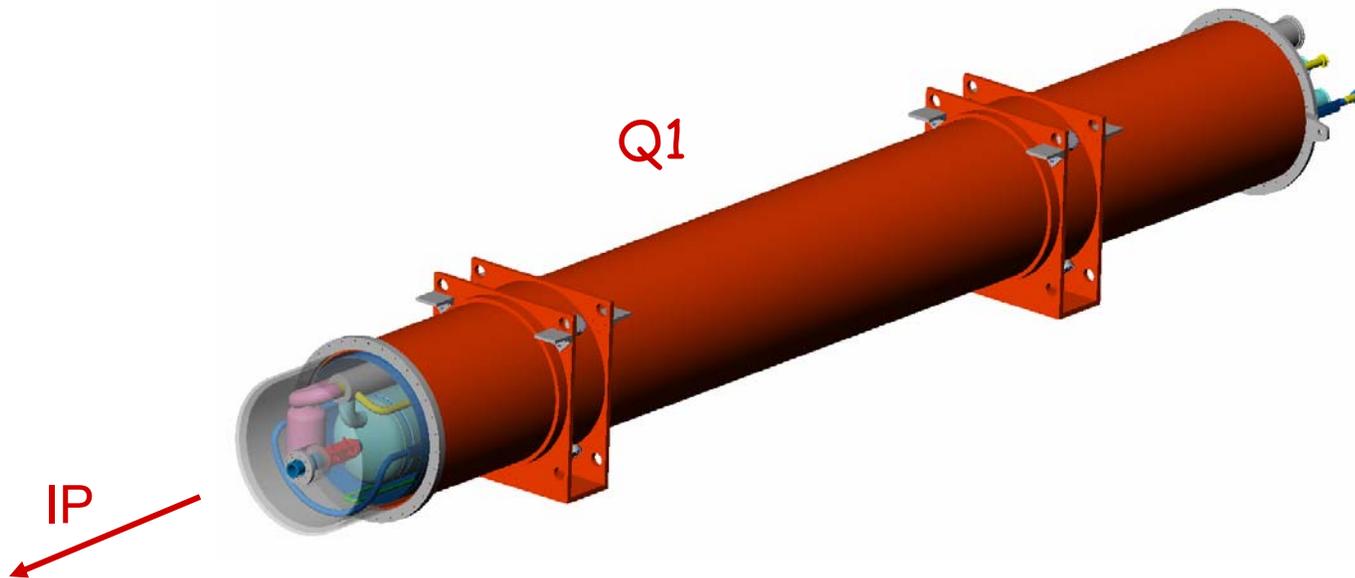
- On the evening of March 27 there was a mechanical failure of the inner triplet in sector 5L during pressure testing.
 - Triplet was being pressured to 25 bar as specified for acceptance testing
 - The design specification is 20 bar
 - Corresponds to pressure rise during a (arc) quench and other possible transients
 - The failure was in the Q1
 - Quadrupole closest to IP
 - Q1 moved ~12 cm (toward IP), leaving damaged bellows, interconnects to Q2, in its wake



Component Status



- Q1 internal supports are broken. Bus work is damaged, including the Q2 interconnect. Cold mass status is TBD.
- Q2 and Q3 status is TBD. No evident damage (visual)
- DFBX G-10 support plate moved 5 cm but not rigidly connected to the inner vessel \Rightarrow status TBD

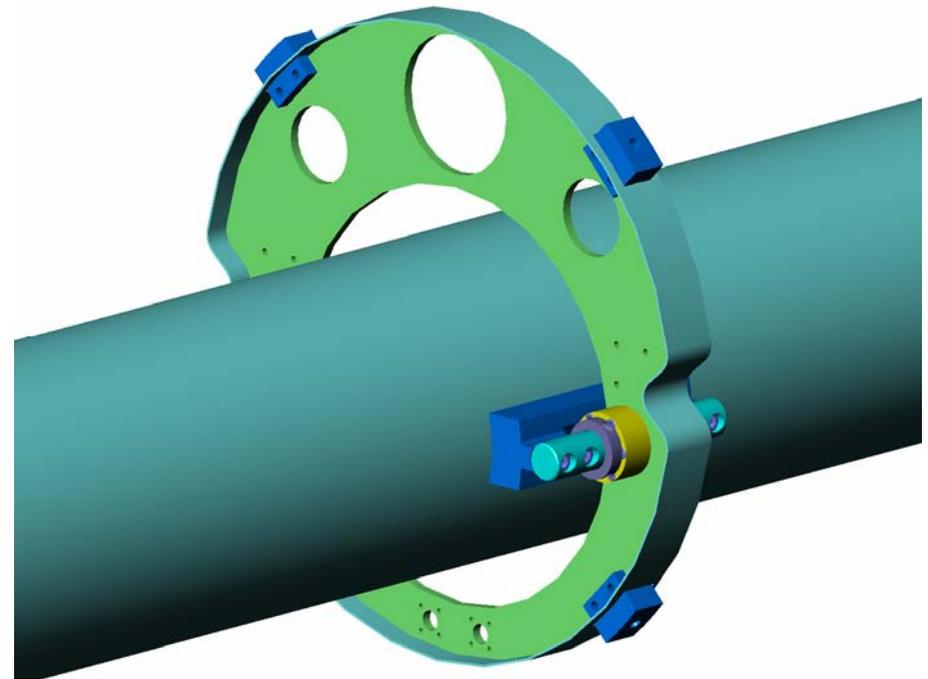


Diagnosis



Because of its location the Q1 (and the Q3 also) is subject to substantial longitudinal force (tons) under pressure.

- The pressure broke the G-11 supports in Q1.
- The specification of the magnet designates 20 bar as the design pressure, 25 bar as the acceptance test.
- We can find no evidence that the longitudinal force generated by the asymmetric loading was accounted for in the engineering design.



Diagnosis



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- We can find no evidence that the longitudinal loading was ever raised in an issue in the (four) design reviews.
 - ANSYS calculations completed independently by Fermilab and CERN on 3/28 show that the G-11 support structure is well beyond shear strength at 20 bar.

⇒ We are now through the “discovery” phase and we know that this is an intrinsic design flaw that needs to be fixed.

The Plan



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- The goal is to fix this so that it does not delay LHC start up.
 - Oddone spoke with Aymar on March 28 to assure him that getting this fixed asap is the highest priority at Fermilab
 - Both labs committed to the current LHC schedule
 - Sector 5 pressure testing will proceed with the triplet & DFBX out of the loop. Whether cooldown will wait for triplet repair is TBD.
 - Both CERN and Fermilab are pursuing possible (magnet) fixes
 - Goal is an in-situ repair
 - CERN is looking at moving the “fixed point” to the magnet end
 - Fermilab is looking at independent anchor for the existing fixed point
 - Immediate goal is to have repair implemented so triplet can participate in the 1L-8R pressure test scheduled for June 1.
 - Assessing condition of the DFBX is a current priority

The Plan



- Effort between Fermilab and CERN is being closely coordinated
 - Peter Limon is on site at CERN
 - Jim Kerby and Jim Strait are full time on the issue, along with a team of Fermilab engineers (and soon technicians)
 - We expect they will spend considerable time at CERN over the next few months.
 - CERN is assuming responsibility/authority for designing the fix
 - CERN has scheduled a design review of the proposed fix on April 24-25
 - We will be directly involved in this
 - We are preparing for a request from CERN for direct Fermilab help at CERN
- We are examining all aspects of US supplied components to identify any other potential vulnerabilities.

The Plan



- Oddone has also communicated with Aronson and Suzuki who have offered help.
- Periodic updates will continue in Fermilab Today, in coordination with CERN
- The Director will be setting up an external review to identify how our management and engineering practices allowed this to happen, and to suggest changes to prevent recurrence.
 - This will start up after we have fixed the problem

Bottom Line: Fermilab is responsible and doing whatever it takes to get this fixed is the lab's highest priority. Our goal is to support LHC startup on the current schedule.