AB-Note-2006-XXXX

Sector Test 2007

Mike Lamont

On behalf of the Sector Test team

Ralph Assmann, Roger Bailey, Helmut Burkhardt, Maissimo Giavannozzi, Brennan Goddard, Magali Gruwe, Lars Jensen, Rhodri Jones, Verena Kain, Alex Koschik, Roberto Saban, Jan Uythoven, Frank Zimmermann.

Abstract

Given the cancellation of the sector test in 2006, the motivations for a sector test in 2007 are presented. Possibilities for minimising the impact of the test on the ongoing installation are explored.

1. Introduction

After considerable preparation, the sector test planned for November 2006 has been cancelled. The motivations for the test, prerequisites, planning etc have been extensively detailed. A sector test, however, remains an important goal, and the implications, impact and motivations for performing the test early in 2007 are explored below.

2. Motivation

2.1. Lead time on major problems

A sector test is a standard procedure for all large accelerators. Performed thoroughly it has the potential to reveal potentially major problem (see LEP, RHIC etc). If we don't do it for the LHC we will be the first to skip it. If things are OK, so well and good, but if there are problems, the test gives us appreciable lead time. In this sense the test clearly implies RISK minimisation.

Is there time enough left to change anything? Yes. There had better be.

2.2. System wide integration

Beam will pull together:

System	Integration Issues
Power Converters	
Magnetic Field Model	Transfer functions, harmonics, cycling etc.
Injection kickers	Pre-pulses, diagnostics, interlocks
Septa	Diagnostics, interlocks
TDI	Controls, interlocks
Collimators	Controls, interlocks
Instrumentation: screens, BCT	
Instrumentation: BPMs	Concentration, timing, RT
Instrumentation: BLMs	Interlocks, critical settings
RF low level	Synchronisation, pre-pulses, fast timing
BST	
Timing	
Controls infrastructure	Networks, front-ends, timing, FIP, software etc.
Beam Interlock System	Kickers, safe beam parameters
Software Interlock System	
Access system	LHC Access project is highly motivated by the sector test to debug its numerous sub-systems and test all the operational procedures such as the patrol.
Radiation Monitoring	
Radiation Protection	

2.3. Check installed equipment with beam

Beam will allow checks of critical issues including:

- Septa aperture
- Kicker performance
- Aperture

- Polarities: magnets, instrumentation
- Major field errors
- BPM resolution, cabling, offsets
- BLM - beam loss patterns
- Quench levels

Note experience in this area, in, for example, TT40: wrong vacuum chamber, corrector polarity errors, BPM polarity errors, screen polarity errors. RHIC, basically missed the first year of commissioning, having missed a design flaw in their sector test.

2.4. Commission essential acquisition and correction procedures

Tool debugging - iteration will be required.

- Injection optimisation & steering
- Threading, trajectory correction etc.
- Energy matching
- Linear Optics & field errors
- Aperture scans
- IR bumps
- Magnet model

2.5. Commission essential operational procedures

Development of operational procedures is again an iterative process. Hands-on experience of control from the CCC will clearly be a very useful pre-cursor for full commissioning.

- Sequencer
- Injection sequencing
- Cycling

2.6. Milestone

Clearly acts as major milestone for the systems list in section 2.2. That they will be tested in anger, problems fixed, means we stand some change of getting the final product for full commissioning.

2.7. Saving in eventual commissioning time

Time foreseen in commissioning plan for injection and first turn of ring 2: 4 days - optimistic if none of the problems forthcoming in the sector test have been resolved. Time spent during the sector test will be directly recuperated.

Excluding the lower priority measurements, 8 days of measurements are foreseen. For proper understanding of the LHC and safe, effective commissioning, these measurements will have to be done during the commissioning phase. Time spent during the sector test will be directly recuperated.

- Commission TI 8 end, injection and thread to IR7
- Commission trajectory acquisition and correction
- Polarity checks
- Commission Beam Loss Monitor system
- Optics measurements

- Aperture checks
- Effect of magnetic cycle
- Field quality checks
- Quench limits and BLM response
- Setting up of injection machine protection

- Pre-test commissioning of all systems listed above plus subsequent problem resolution, analysis, improvements...
- Commissioning of all systems together plus subsequent problem resolution, analysis, improvements...

Two points here:

- The time spent will be saved because the commissioning & measurements have to be done anyway.
- The time after the test can be used for analysis, problem resolution and improvements (see, for example TT40/TI8) which will speed full commissioning. Beam related problems tend to arrive serially, and are solved one at a time. During full commissioning and under pressure, the quick fix will always be adapted. 6 months lead time gives the opportunity to deal with a lot of issues properly.

3. Impact

3.1. WILL THE SECTOR TEST DELAY THE START OF LHC COMMISSIONING WITH BEAM?

Properly planned the test should have no significant impact on installation schedule. There is a significant gain if problem are uncovered.

The test in 2007 can be performed largely in the shadow of ongoing installation and commissioning. The shift to 2007 should reduce the potential impact on: transport, installation, LHCb.

3.2. IR7 installation

2006: Small number of collimators/scrapers/absorbers have and D4 to be left out to leave room for temporary dump installation. .Re-visiting zone for finishing installation is not ideal.

2007: Install D3/D4 – two options:

1. Temporarily install TED between D3/D4 – leave out collimators. Some disruption of installation schedule.
2. Dump on collimators, install small block to guarantee beam stop. RP implications to be explored.

Either way there will be less impact in 2007. Collimator option reduces significantly the impact on installation in IR7.

3.3. Sector 6-7

Depending on timing of test, impact on 6-7 could be eliminated if interconnection work has finished. It would be convenient to close sector 6-7 immediately to the right of IP6 eliminating the need for a temporary gate in the tunnel.

3.4. Access

Test remains an important milestone - could close tunnel at IP6 negating the need for temporary installation of gate in 6-7.

3.5. Transport

There should be no need for magnet transport through the affected sectors - to be confirmed. If necessary could minimise time in which transport is effectively blocked.

3.6. Interconnection

Interconnection work in 6-7 should have finished.

3.7. Cool-down

Sectors 7-8 and part of 8-1 will need to be kept cool, or cooled for the test.

3.8. Resources

Some Hardware commissioning support will be required to ensure proper functioning of the QPS, PIC etc. However, this as pre-cursor to the real thing should be handled for the most part by operations from the CCC.

Cryogenics support will be required to ensure proper functioning of the cryogenics system.

3.9. LHCb

LHCb should have finished installation of the complete detector by Spring 2007. This timing is good for them. Less worries about zonage and material activation.

4. Impact minimisation of actual test on ongoing installation

Under time pressure can shorten time for sector test to one week, say, essential tests only – list already prioritised. Work to minimise foot-print.

- Depending on situation in 6-7 - could close just to right of IP6
- Minimise lead in and lead out times. Allow magnet transport past dump after installation before test.

In this scenario, 7-8 would be blocked:

- 2-3 days before test for access system installation and qualification
- 1 week test
- 4-5 days after test for access gate removal, radiation qualification, dump cool down and removal.

5. Alternatives

Beam to beam dump point 6. Difficult - would need 2 cold sectors fully hardware commissioned, knock effects into 5-6. Can't guarantee that beam dump will catch beam etc.

Sector test without beam. Don’t get to check aperture, polarities etc. etc. Would be part of machine checkout before test. Would be useful “dry run” anyway.

6. Conclusions

The test can be performed largely in the shadow of ongoing installation. It will gives us time to:

- React to any major problems
- Fix less critical problems
- Improve tools
- Gain understanding.

It could potentially save some major hassle for CERN; it will undoubtedly lead to a more effective, efficient and safe commissioning.