Injection test in 2006

- The installation schedule version 1.7 recently approved includes a 'possible injection test' - foreseen in April 2006
- Injection of beam down TI8, into LHC at the injection point right of point 8, though IP8 (LHCb) through sector 8-7 to a temporary beam dump located after the Q6 quadrupole just right of the warm insertion of point 7
- Many good arguments for performing this test (as outlined at Chamonix 2003 session 7)
- Also numerous consequences (some of which were presented at Chamonix 2003 session 4)

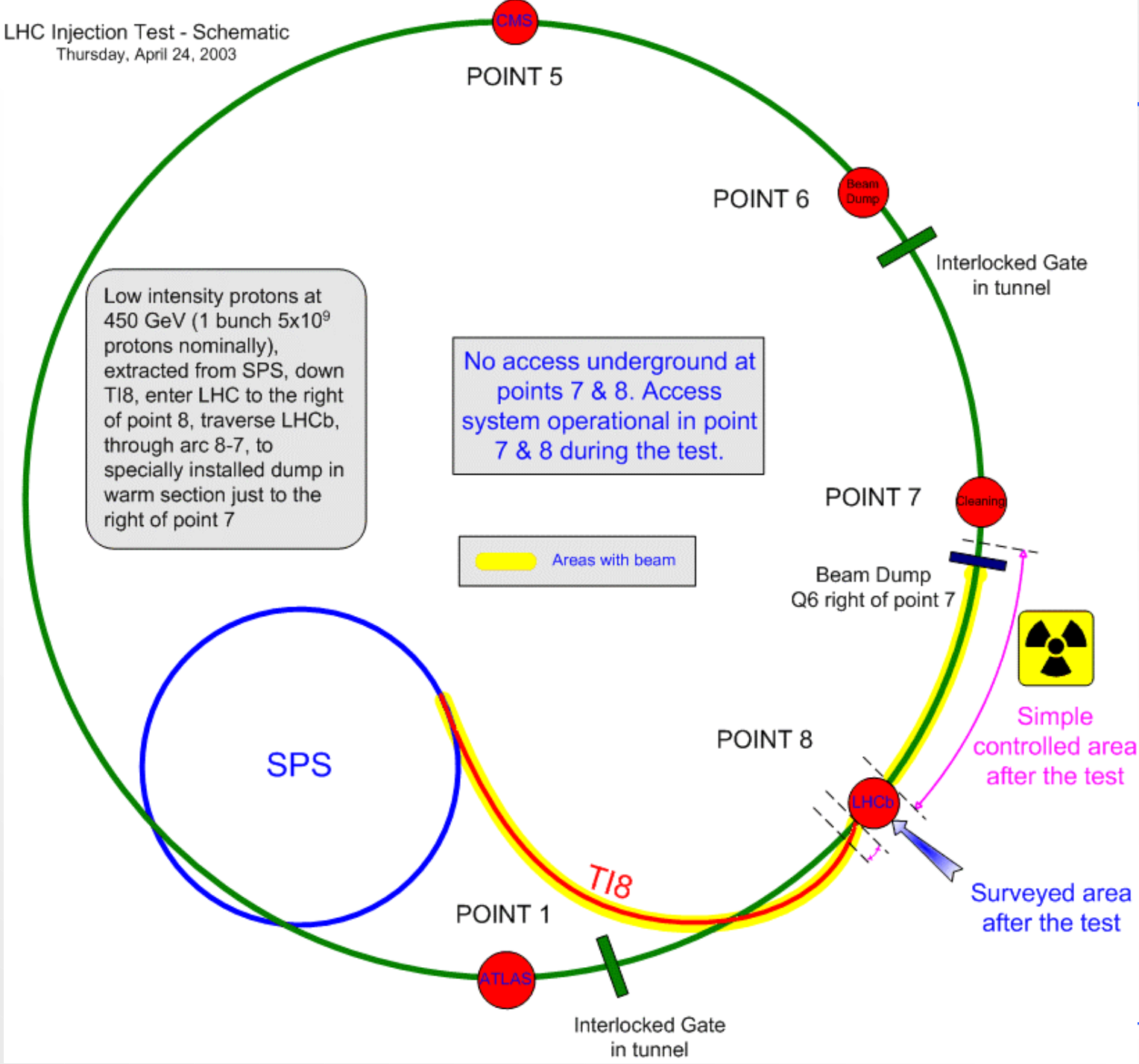
Motivation

- **Powerful diagnostic tool**
  - **Mechanical aperture checks**
  - **Field quality checks**
  - **Test diagnostic systems**
  - **Test controls, correction circuits, BPMs etc.**
  - **First hardware exposure to beam, quench limits…**
- **Major challenge/opportunity to bring everything together: full-blown systems tests, highlight oversights, debug.**
  - **Magnets, power converters, controls, timing, beam transfer etc.**
- **Provide a very important milestone for beam-based instrumentation, diagnostics and control**
- **Public relations**

Strongly endorsed at Chamonix 2003

Downside

- On-going installation of 3-4, 5-6, 6-7
- Hardware commissioning 4-5
- Will clearly pull in resources from the above
  - Preparation for the test
  - Test itself
- Force the installation schedule of some systems
  - e.g. access and interlocks
- Interrupt the installation and commissioning schedule of LHCb
- Potentially force 7-8 to be declared simple controlled radiation area with some knock-on effects


LHC Injection Test - Schematic
Thursday, April 24, 2003
CMS
POINT 5
POINT 6
Beam Dump
Interlocked Gate in tunnel
Low intensity protons at 450 GeV (1 bunch 5x10^9 protons nominally), extracted from SPS, down TI8, enter LHC to the right of point 8, traverse LHCb, through arc 8-7, to specially installed dump in warm section just to the right of point 7
No access underground at points 7 & 8. Access system operational in point 7 & 8 during the test.
POINT 7
Cleaning
Areas with beam
Beam Dump Q6 right of point 7
Simple controlled area after the test
SPS
POINT 8
LHCb
TI8
Surveyed area after the test
POINT 1
ATLAS
Interlocked Gate in tunnel

Test outline

Test	Duration [hours]	Intensity	Number of shots	Integrated Intensity	Comments
Injection Steering, commission screens, IBMS, timing	12	5.00E+09	360	1.80E+12	
Trajectory acquistion commissioning, trajectory correction, threading	24	5.00E+09	288	1.44E+12	
Commission BLMs	24	5.00E+09	720	3.60E+12	
Linear Optics from kick/trajectory, coupling, BPM Polarity checks	24	1.00E+10	288	2.88E+12	
Dispersion, energy offset	3	5.00E+09	100	5.00E+11	
Energy offset versus time on FB	12	5.00E+09	100	5.00E+11	Cycle & repeat
Aperture limits, acceptance	12	5.00E+09	360	1.80E+12	Pi bumps, BLMs, BCT
Momentum aperture	6	5.00E+09	60	3.00E+11	Move energy of SPS beam
IR bumps, aperture	6	5.00E+09	60	3.00E+11	Careful in LHCb
Study field errors	12	1.00E+10	72	7.20E+11	Collect data, off-line analysis
Effects of magnetic cycle, variations during decay, reproducibility	24	5.00E+09	360	1.80E+12	12 cycles
Multi-bunch injection - determination of quench level	12	3.6E+11	72	2.59E+13	1 batch (72 bunches)
Effects of thermal cycling					
TOTAL	171		2840	4.16E+13	
DAYS	7.1				

Injection test

Coupled with preparation time and high operational inefficiencies

Classification of Radiation Areas

- **Areas with dose rates below an average of 2.5 μSv/h are called surveyed areas. There is no restriction on access to such areas.**
- **Simple controlled areas have average dose rates of up to 25 μSv/h.**
  - **They are marked by warning signs and are generally enclosed in physical boundaries.**
  - **Persons working in such controlled areas must wear their film badge all the time.**

Even at extremities of proposed beam intensity envelop (several nominal bunches) – "not disastrous"

- **In any case one should anticipate that the areas that have seen beam to be declared a "simple controlled area"**
- **Life would be a lot simpler if we remain below 2.5 μSv/h**
- **NB LHCb expects minimal losses, and will need to be classified only as "surveyed" after the test**

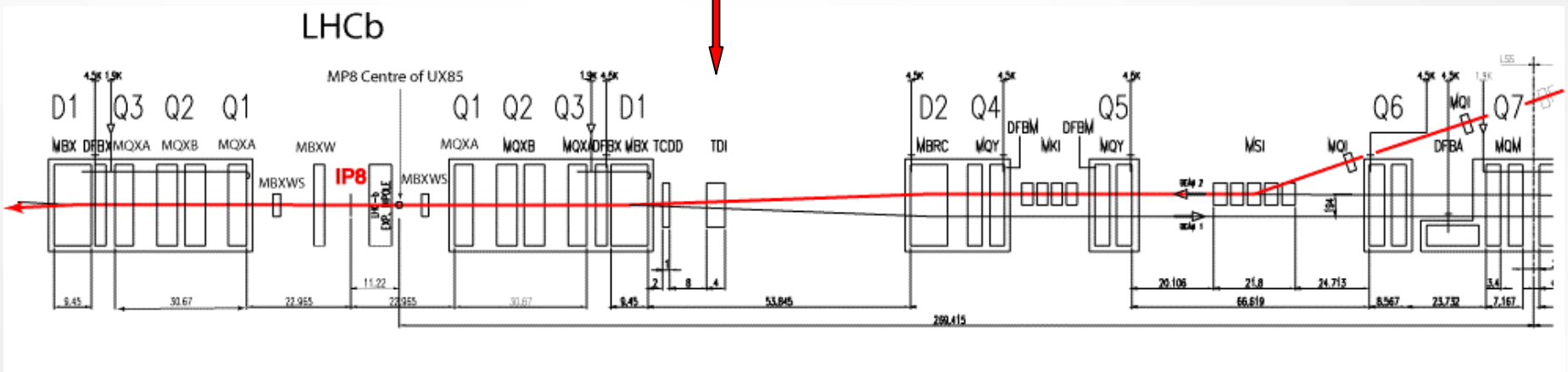
Studies and discussions ongoing

Point 8

TDI

Can be closed fully during injection optimisation

Reasonable aperture ≈ 20σ

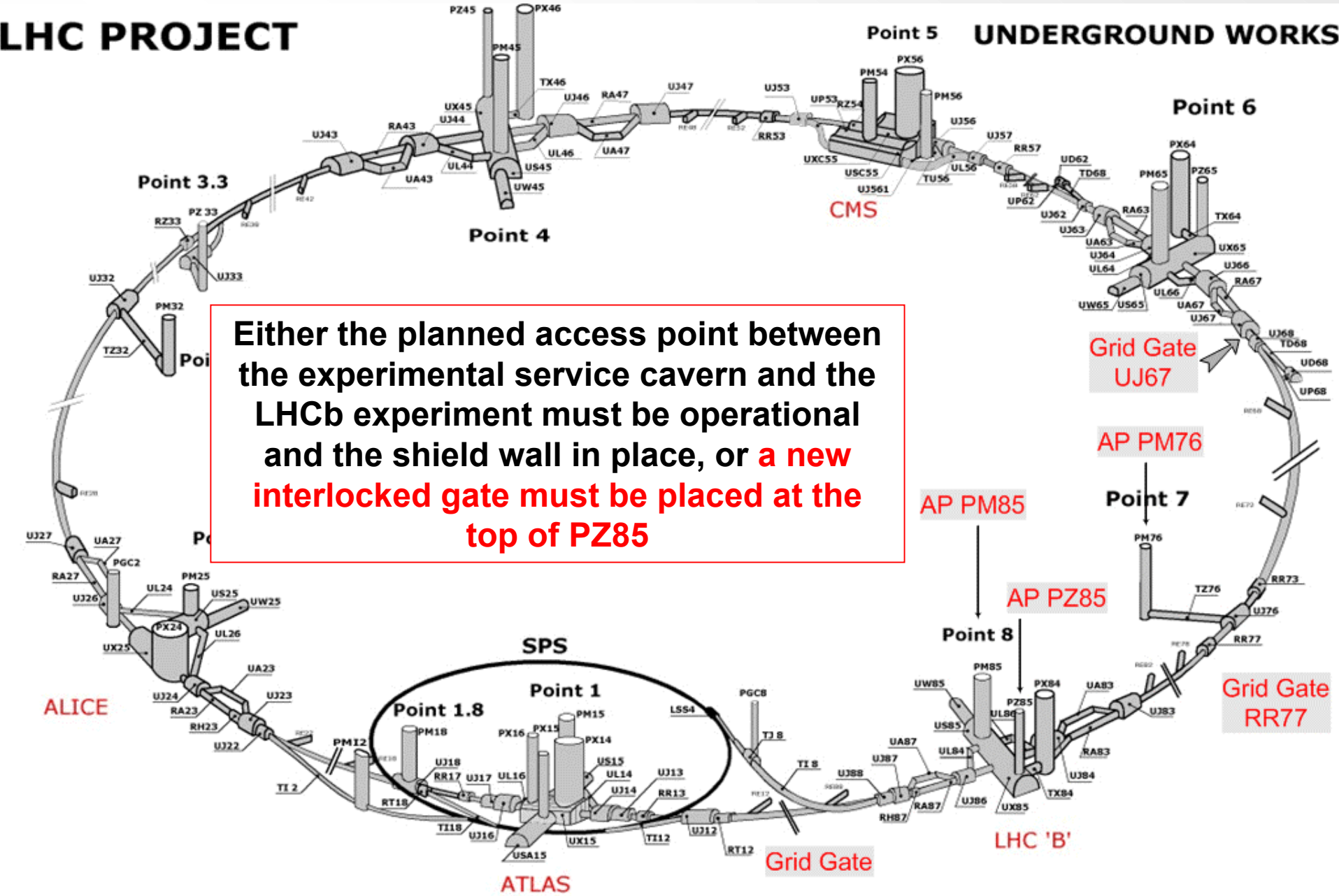


Detuned insertions

Smaller beam size

Low emittance pilots injected

Access


LHC PROJECT
Point 5
UNDERGROUND WORKS
Point 6
Point 3.3
Point 4
CMS
Grid Gate
UJ67
AP PM76
Point 7
AP PM85
AP PZ85
Point 8
SPS
Point 1
Point 1.8
ALICE
ATLAS
LHC 'B'
Grid Gate
Grid Gate
RR77
Either the planned access point between the experimental service cavern and the LHCb experiment must be operational and the shield wall in place, or a new interlocked gate must be placed at the top of PZ85

Injection test in 2006?

To obtain project-wide approval we need to;

Detail the test itself and elaborate requirements:

- **Critically evaluate the arguments used to justify injecting beam into sector 8-7 of the LHC.**
- **Establish the required duration for the test and find the optimum time-slot taking into account the availability of injectors and its potential impact on the installation schedule.**
- **Elucidate requirements of, and the consequences for, the injector chains.**
- **Fully define the foreseen beam parameters and, in particular, estimate the integrated beam intensity involved.**

and …

Injection test in 2006?

We need to elaborate and detail the consequences of the test:

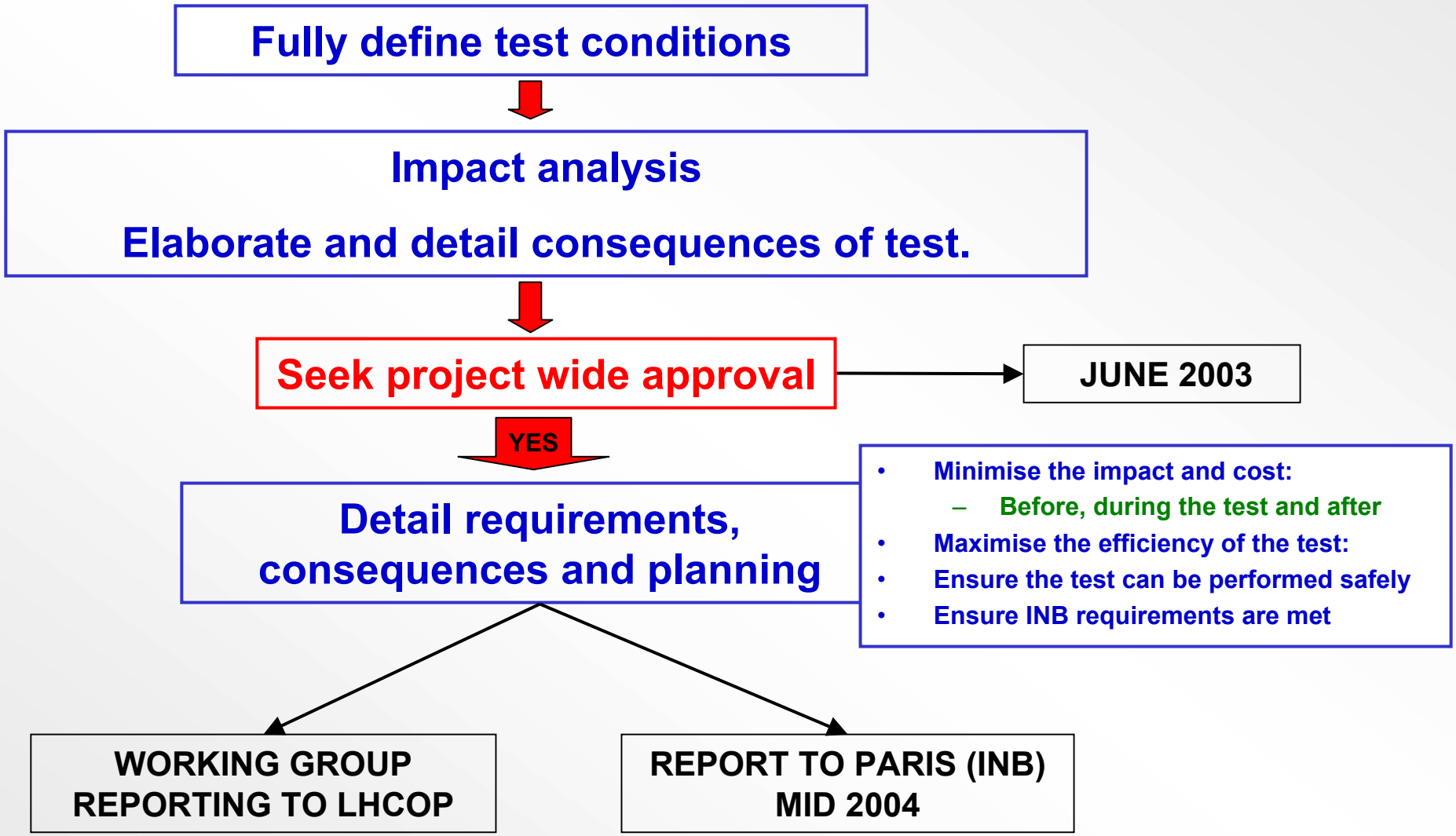
- **Injectors :**
  - Elucidate requirements of, and the consequences for, the injector chains.
- **Radiation after the event**
  - Quantify the expected activation levels resulting from the test and potential knock-on effects due to remnant radiation, e.g. access, traceability.
- **Consequences of installation and commissioning of other sectors**
  - before, during and after the test. Preparation time for test.
- **Consequences of installation and commissioning LHCb**
  - Identify the consequences for installation and commissioning of before, during and after the test.
- **Access**
  - Evaluate the requirements, the cost of implementation and potential impact for the access system. Evaluate possible shortcuts.
- **Interlock system**
  - Evaluate the requirements, the cost of implementation and potential impact
- **Evaluate required resources. What can go wrong?**

Injection test in 2006

If go ahead is given:

- Fully define the beam parameters, the studies to be performed, and draw up detailed planning for the test itself.
- Fully define the required configuration for the sector.
- Fully define requirements of machine protection and interlock systems. Liaise with those responsible to ensure that installation and test schedule will meet requirements.
- Fully define requirements for controls, instrumentation, and beam-related equipment. Liaise with those responsible to ensure that installation and commissioning schedule will meet requirements.
- Fully define the access requirements of the test. Liaise with groups involved to ensure requirements established above are met. Define the access conditions after the test.
- Define the radiation monitoring needed during and after the test. Establish how to deal with any implications of remnant radiation (access, traceability).
- Liaise with hardware commissioning team and establish responsibilities during overlap.
- Establish detailed consequences for installation and commissioning of other sectors of the machine, before, during and after the test.
- Establish detailed consequences for installation and commissioning of LHCb before, during and after the test.
- Establish a detailed planning from now to the test
- Ensure that the necessary formalities required by INB are in place

Plan


Fully define test conditions
Impact analysis
Elaborate and detail consequences of test.
Seek project wide approval
JUNE 2003
YES
Detail requirements, consequences and planning
• Minimise the impact and cost:
– Before, during the test and after
• Maximise the efficiency of the test:
• Ensure the test can be performed safely
• Ensure INB requirements are met
WORKING GROUP REPORTING TO LHCOP
REPORT TO PARIS (INB) MID 2004