



Transfer Line Beam Tests

- LHC transfer Line Beam Test TI 2, 28/10/2007
 - Preparations
 - Results
 - Lessons learned
- Based on slides presented LTC 5 December
 - More accent on organisational issues

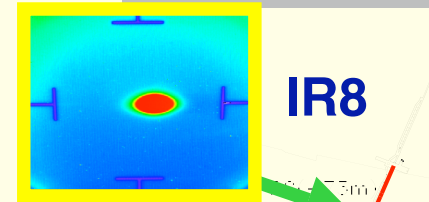


Overview of the Transfer Lines

23.10.2004, 13:39 → first beam at end of TI 8

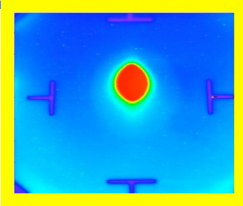
Combined length 5.6 km,
over 700 magnets = ca. 2/3 of SPS

TI 8 beam tests
23./24.10.04
6./7.11.04



Length of beam line	2004m
Length of new tunnel	2430m
Horizontal deflection	100°
Vertical deflection	4°

28.10.2007, 12:03
→ first beam at end of TI 2



Length of beam line	2043m
Length of new tunnel	2730m
Horizontal deflection	50.4°
Vertical deflection	6°

IR2

Temporary dump
TI 2 beam test
28./29.10.07

TI 2
PMI2

SPS

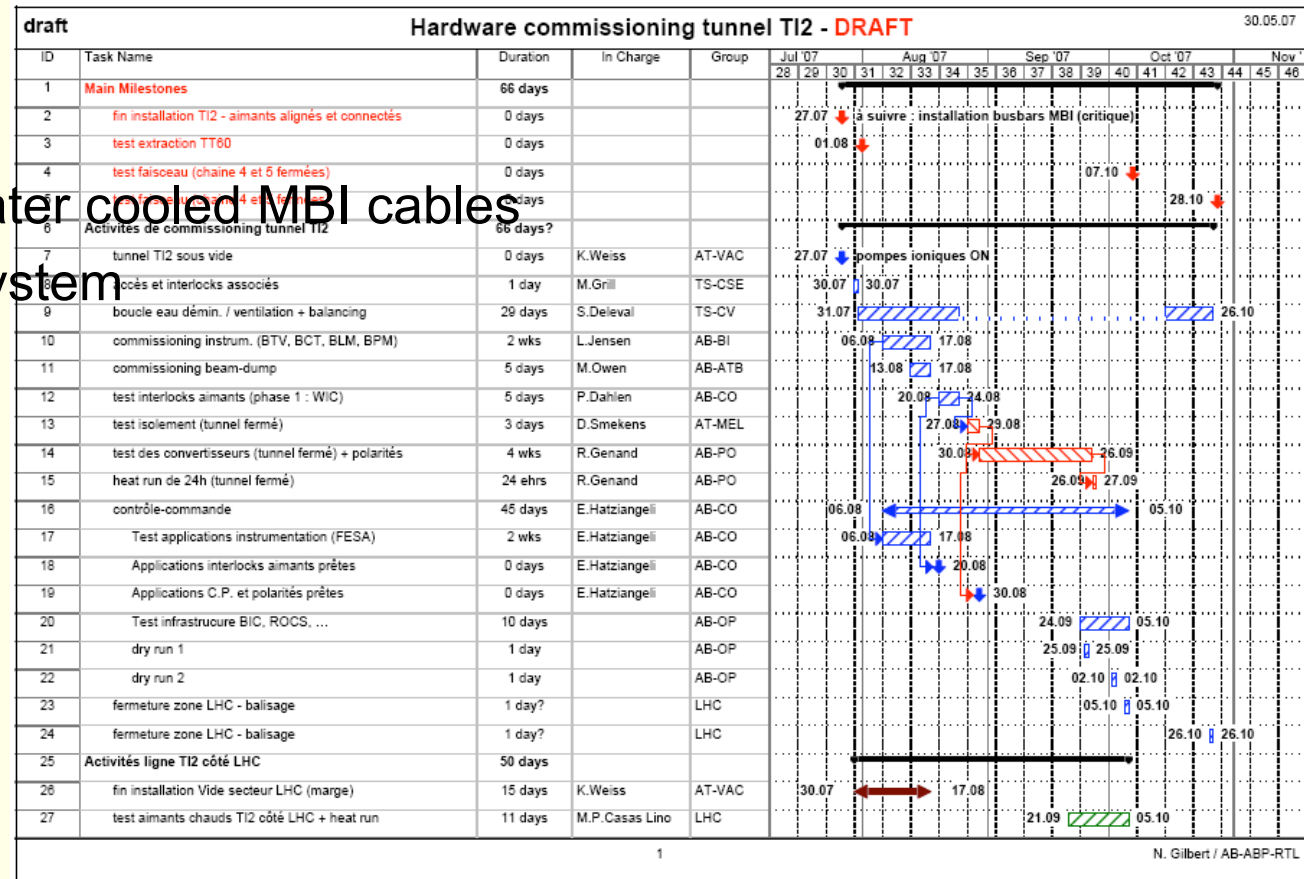
LHC

TI 2 upstream part installed and
HW commissioned by 2005.



Hardware Commissioning

- Hardware commissioning TI 2: Daily follow-up by Nicolas Gilbert
 - July – September 2007
 - Vacuum – power converters – magnet polarities – control system
 - Heat run
 - Dry run
 - Repair water cooled MBI cables
 - Access system





Weeks before Beam Tests

Coordination N.Gilbert → JU. **One Person**

- 11 & 22 October: DSO test of LHC access system IP2 and adjacent arcs
- 14/15 October: TI 2 test postponed to allow shielding in PMI2 (conform 'lettre d'engagement' to 'INB')
- Wednesday 24 October: Finished shielding PMI2
- Friday 26 October 17:00 – 21:30 : Search and close LHC machine point 2 and arc 2-3
- Saturday 27 October 18:00 – 20:30 : Search and close ALICE cavern and arc 1-2, followed by hardware tests
- **Sunday 28 October 7:00: Start beam test,...**
- Monday 29 October 5:00: Stop beam. Radiation check of adjacent LHC area. No difference measured relative to situation before beam tests
- Monday 29 October 6:45: access back to LHC and ALICE
- Decision not to carry out further beam tests in 2007

Large effort and a lot of goodwill from many people
Minimised 'footprint' of the test on LHC and ALICE works ongoing



Detailed Planning on Website for couple of weeks before beam test

TI 2 Day-to-Day Work Plan

(latest update 28 October 7:45)

Day	Work Description
28/9/07 Friday	17:30 - 23:00: Experimental Area (PX24) LASS + LACS integration test including a patrol of the experiment: ok
1/10/07: Monday	Polarity Tests: ok
2/10/07: Tuesday	8:30 - 14:00 Access TI 2: Eletta interlock for MBI (Pierre Dahlen) ok Test door for access system - work on intermediate door (Tomasz Ladzinski) ok Dry run search (Magali Gruwe) ok Fix vacuum valve (Miguel Jimenez) ok TI 2 TED - install endstops, check movement (Michael Owen) not ok ok check interface TED access system not done ok Rotation of magnets (JP Quesnel) MQ2640 to correct by 1 mrad ok Cables of corrector magnet(s) (Michel Condemine) Being checked with magnets on. ok Radiation monitoring near temporary dump (Ali Day) ok 14:00 - 17:00 Polarity Tests. not finished. ok
3/10/07: Wednesday	Test of the interface between the access system and the power converters. Postponed ok Continue Polarity Tests. ok - all polarities measured, 2 quads corrected at pc side, to be verified together with one change of I_{max}
4/10/07 Thursday	Dry run: Test sum signal BPMI ok Collimator control and logging: postponed to Monday 8/10 ok Power converter stability check from logging ok Presentation of vacuum system and valve control in the CCC: ok
5/10/07 Friday	RBIV.26407 function does not load, I _{max} problem Solved with I_{max} change, ok RBIV.610304 sign (Jorg) ok 14:00 - 17:30: TED: Check movement of TI 2 TED (Michael Owen) ok Check TED electronics (Alessandro Masi) ok

Updated several times per day



Many people involved in the coordination job

- The result of the work and collaboration of many people over a long period
- 'Daily contact' with many people – some of the names:
 - Design and Installation (V.Mertens and AB, TS and LHC departments)
 - Hardware commissioning (N.Gilbert, equipment groups, ...)
 - Cold Check Out = Dry Runs (V.Kain, M. Gourber-Pace, operators, ...)
 - Radiation Protection (H.&H.Vincke, D. Forkel-Wirth, ...)
 - Safety (G.Roy, E.Paulat, ...)
 - Access System (P.Ninin, T.Ladzinski, T.Pettersson, ...)
 - AB/OP (M.Gruwe for search, J. Ridewood, ...)
 - LHC Coordination (K.Foraz, S.Weisz, E.Barbero Soto, M.P. Casas Lino)
 - ALICE (S. Evrard, C.Fabjan, L.Leistam, M.Tavlet, H.Taureg, ...)
 - The Actual Beam Test (G.Arduini, J.Wenninger, V.Kain, M.Lamont, B.Goddard, V.Mertens, T.Kramer, A.Koschik, R.Assmann, S.Redaeli, Y.Kadi, M.Jonker, L.Jensen, R.Jones, E.Benedetto, SPS-PS-TI Operators, equipment experts, ...)
 - ...



Planning for day of beam test at very global level

JU, 22/10/07

TI 2 BEAM TEST, STUDIES TO BE PERFORMED

Participants: JW, GA, ML, VK, BG, VM, SR, TK, AK, JU

Collimation team: RA, SR, YK, MJ

Task	timing		t cycle delta	8.4 I beam intensity on TI 8 TED	EM.	sec (use TT60 / TT60 cycle, low intensity, twice the same in on BC)	Tools	Points of interest
	from	to						
FIRST WEEKEND 28 - 29 October 2007								
Set-up SPB beams and extraction (GA, VK, JU) Check extraction interlocks	7:00	11:00	4:00	5.00E+09	0	-		
Threading, first beam down the line (GA, VK, VM, JU) Check images on screens qualitatively Check BPMs & sum signal last BPMI	11:00	15:00	4:00	5.00E+09	4	0.5	4.26E+12	Beam threading application / steering Response of pick-ups & correctors, polarities
Kick response - optics check & dispersion (GA, VK, ML, JU) Check polarities and pick-ups Basic optics check (for post-processing) Beam Stability Twiss parameters via screens	15:00	18:00	3:00	5.00E+09	3	0.5	3.21E+12	First go at the optics
Energy / Dispersions (GA, ML, VM) Dispersion measurement Delphine Energy Acceptance of the line Rematch line to energy off-set	18:00	20:00	2:00	5.00E+09	2	0.5	2.14E+12	Change energy SPB via dff Knob for energy of line
Verification of aperture (BG, AK, TK) Using oscillating bumps (and local bumps)	20:00	0:00	4:00	5.00E+09	6	0.5	6.43E+12	Automated program, creating bumps: no Compare BCT up- and downstream Look at BLM signals
Collimators Collimator hardware checks with beam (Coll. Team) Setting up 2 x 1 collimator (VK, SR, BG)	0:00 2:00	2:00 5:00	2:00 3:00	5.00E+09 5.00E+09	2 3	0.5 0.5	2.14E+12 3.21E+12	Details of program? Special application? At least try something in first beam test?? No downstream BCT

Multi bunch - low intensity (?)
Check BDI - - 2:00 4 x 2e10

Ripple measurements extraction kickers?

Measurement of beam stability
Measurement of beam reproducibility

Wrapping up (JU)

Conclusion on total intensity on temporary dump:
Should not have the beam on "all the time" but stop the beam when possible!

TOTAL 2.14E+13 Calculations based on 5e13 in 1 hour
'Extension' up to 7e13 ok by RP

To be checked:

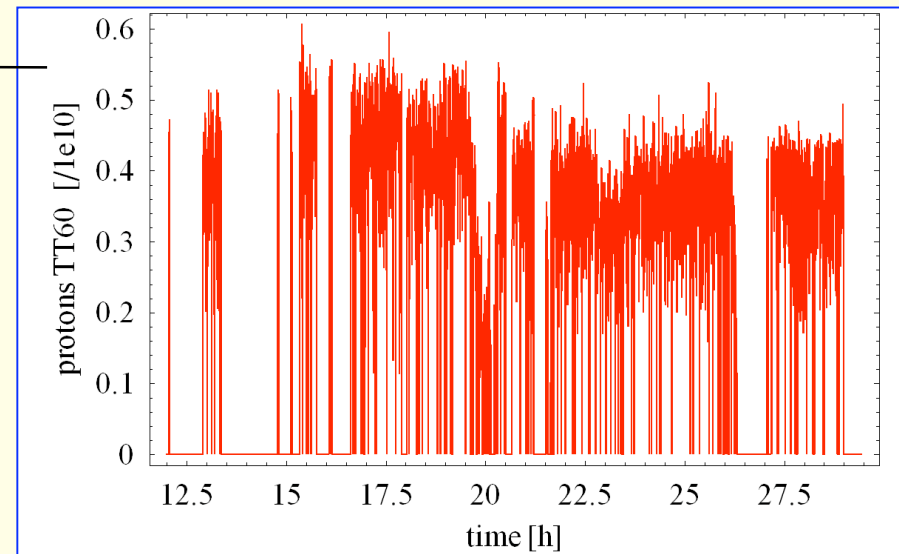
After TT40/TT60 check with Mike Owen that we can move the TT60 TED out - try this out before the beam test
Check that sum signal of extracted beam works on TT60 BCT
Check application of Delphine still runs



Intensity and Radiation

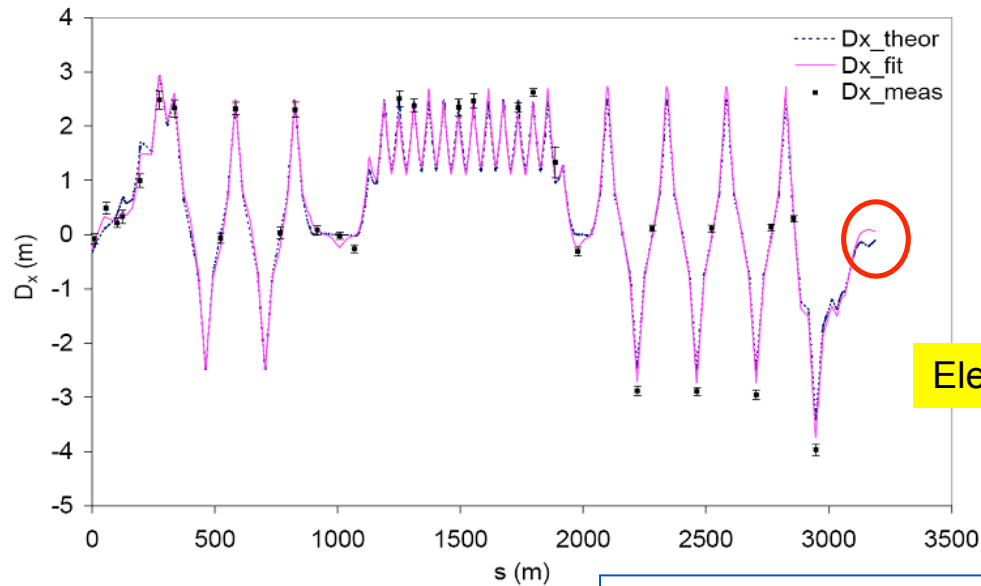
- No remnant radiation problems in the adjacent LHC areas
- Radiation level on temporary iron dump 1 week after test: $95 \mu\text{Sv/h}$

Intensity in TT60, from first TI 2 extraction onwards. Total intensity 1.2×10^{13} p+, announced $5 - 7 \times 10^{13}$ p+



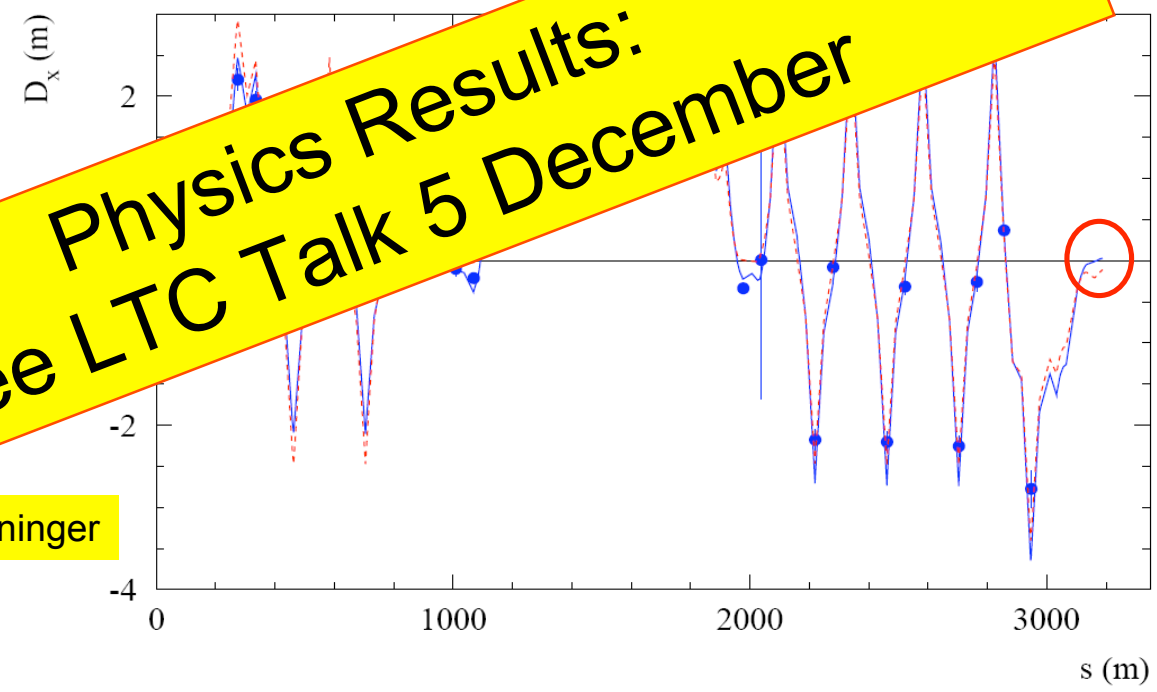
- Horizontal dispersion: measurements, theoretical value and fitted values, the latest obtained starting from $Dx_0 = -0.25\text{m}$, $Dx_0p = 0.013$ @ beginning TI2

Dispersion H-Plane



Elena Benedetto+Delphine Jacquet

**Physics Results:
See LTC Talk 5 December**



Dispersion
10 cm in bo

Jorg Wenninger

Jan Uythoven, AB /BT



Some Hardware Related Items

- Critical water flow on vertical dipole magnet circuit MBIAV
 - Temperature interlock on magnet when running with 8.4 seconds cycle
 - Went to 2/3 of this duty cycle during the beam tests
 - Increased the water flow after the beam tests: ok with 8.4 seconds
 - Water cooling system overflow vessel was regulated at a too high level
 - Was not found out during dry runs, because this took place on a different cycle
- 2 downstream pairs of correctors (2H, 2V) were inverted
 - Not at all understood how this could happen after thorough polarity checks



List of Outstanding Items created after the beam tests: to do for 2008

JU, 8/11/07

Outstanding items for 2008 (TI 2)

Related to 2007 beam tests:

1. Correct and verify 2 pairs of interchanged correctors - hardware problem (**action:** TS/EL, polarities to be re-checked afterwards by AT/MEL; **period:** soon; **SPS shutdown coordination**)
H correctors MCI AH.27204 and MCI AH.27404 are interchanged.
V correctors MCI AV.24304 and MCI AV.24504 are interchanged.
2. Fix broken BTV camera (BTVI.26606) (**action:** AB/BI - S.Burger; **SPS shutdown coordination**)
3. Time stamping of logged data, mugef was only logging 1 out of 3 of the data, for the used sc configuration
M.Jonker knows and understands the details.
Correlate logged data with SPS supercycle number
4. Get BPM sum signal working on BPMI 22304 - BPMI 25504 - BPMI 28704 (**action:** AB/BI)
(Should also be working in TI 8.)
5. Fixed Display:
Labels of the BLMs are wrong
Select low intensity BCT of TT60, if running low intensity
Use low intensity BCT for integrated intensity (and reset to zero)
6. Action on MKE if out of BETS window: agreed to do in shutdown. Functionality to be checked.
7. Check thermal behaviour of MBLAV264xx and increase water flow if needed: Done, see details
8. Some analogue temperature sensors to be added to some magnets ? (**SPS shutdown coordination**)
Check with P.Dahlen / M.Zerlauth
Add interlock that low water flow cuts out all converters of water cooled magnets in TI 2
9. Improve RAMSES application to survey radiation: difficult to use, adapt scaling and alarms; display seems to stop at 24:00 (**action:** SC/RP)
10. Check collimator pick-up due to power converter(s) running (**action:** A.Masi/S.Redaeli) Done. The likely cause for this in TI 2 is cross-talk between cables; a re-rerouting of certain cables should be studied To note that there is no such phenomenon in TI 8; (**SPS shutdown coordination**)
11. Dry runs on the proper SPS cycle.
12. Check knobs to measure aperture of the beginning of TI 2.

Shutdown TI 2 and TI 8
2007-2008 organised in
SPS-style (N.Gilbert)

Related to general installation:

1. Repair hard soldering on all MRI water cooled cable connections (**action:** TS/EL; **period:** soon; **SPS shutdown coordination**)



Many Measurements Outstanding for 2008

- Steering, momentum and linear optics issues
 - Detailed checks with bend families & correctors at the start of TT60/TI2
 - Correct optics for vertical phase error and re-measure (needs rematch)
 - High statistics kick-response measurement
 - Accurate measurement of phase error in vertical plane and H plane effects
 - Measure HV coupling
 - Measure momentum aperture (trim TT60/TI 2), match to SPS
- Perform collimator setting-up
 - Jaw centering, tilt and alignment
- Finish aperture measurements
 - Measure aperture of TT60 and first 200 m of TI 2
 - Accurate measurement with transmission
- High-quality data taking for screen matching and optics checks
- Operation with higher beam intensities, multi bunches

Different for 2008:

- Standard TED dump at end of line
- BCT and Screen in front of TED can be used
- Interlocking with full master BIC
- Higher Intensities



Organisation for 2008

- Organisation of 2007 Transfer Line beam test under special conditions:
 - Footprint on HC work and Alice was minimised
 - Rapidly changing 'boundary conditions'
 - New elements: Access System, Search, Radiation, 'INB' regulations
 - With a lot of efforts and goodwill from all parties involved

- Organisation Transfer Line and Injection Commissioning in 2008:
 - Access system should be fully operational and accepted; safety elements defined
 - Special mode for providing safe conditions for running beam up to the end of the transfer line while access in other parts of the LHC
 - How to change between different States (=tests) on a day-to-day basis?
 - Footprint on Experiments and HC will again be a major item
 - To be combined with preparations for Injection (Sector) Tests

- Body required for:
 - Daily coordination of all activities, for the phases following the IST of the equipment
 - Work together with LHC HC team
 - Roles and responsibilities need to be well defined