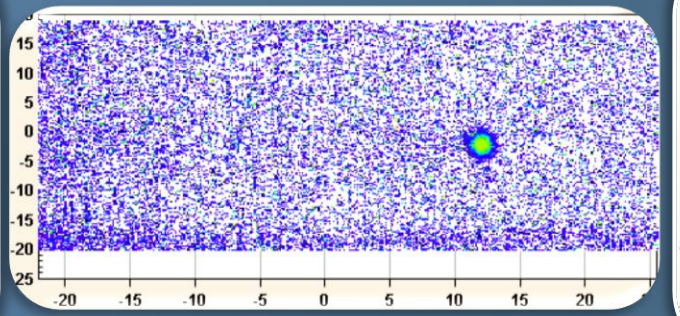
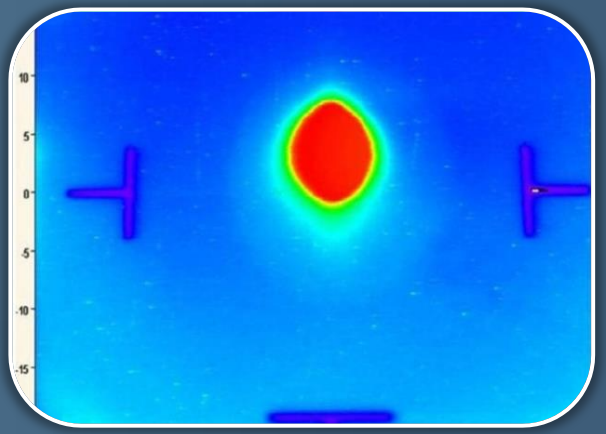
TI8: 23rd Oct 2004



TI8: 2005 The first hole



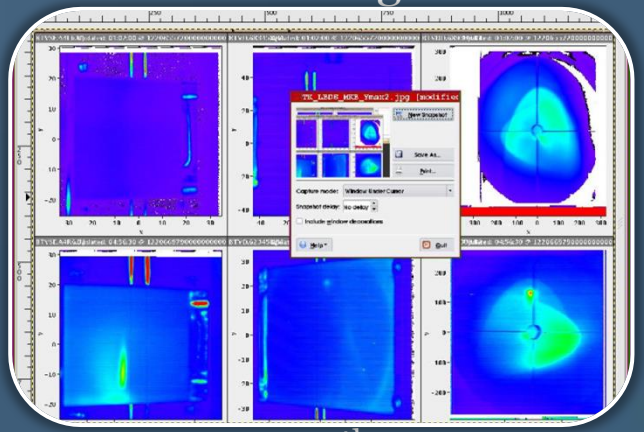
TI2: Autumn 2007

LHC TRANSFER LINES AND SECTOR TESTS

2014

TI8: 22nd Aug 2008

First: credits ➔ CO, ABT, ABP, ASR, BI, OP, RF, CV, EPC, MPE, VSC, MEF, ALICE, LHCb, CMS, ATLAS



S7826LBDS: 5th Sep 2008

Verena Kain
Reyes Alemany

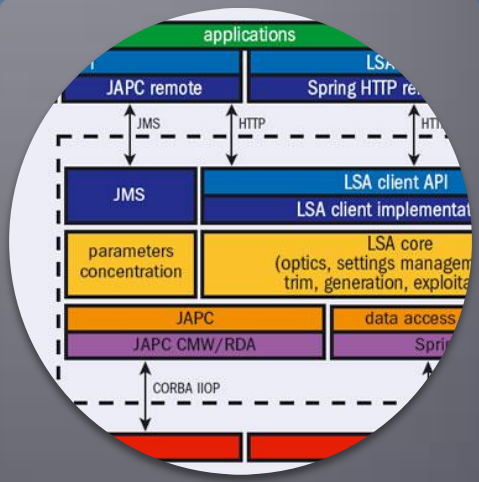
Motivation

during LS1

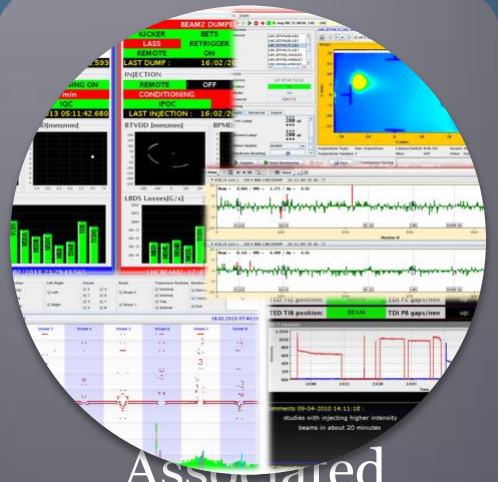
after LS1

Motivation

Machine sub-systems operational

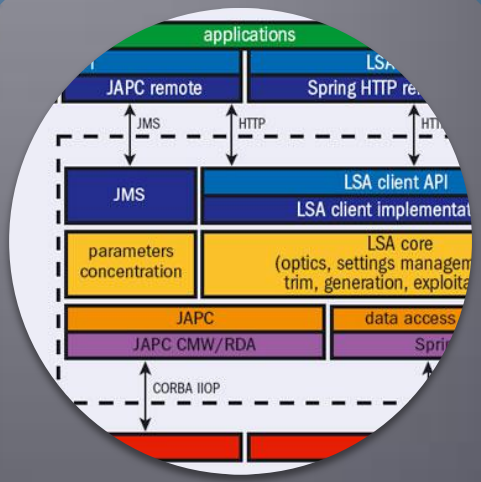


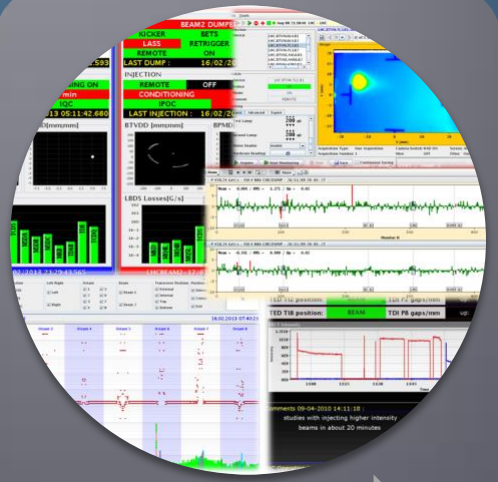
Fully integrated into the control system



Associated application software and cycle management available

Motivation





SPS-LHC Injection synchronization & Timing

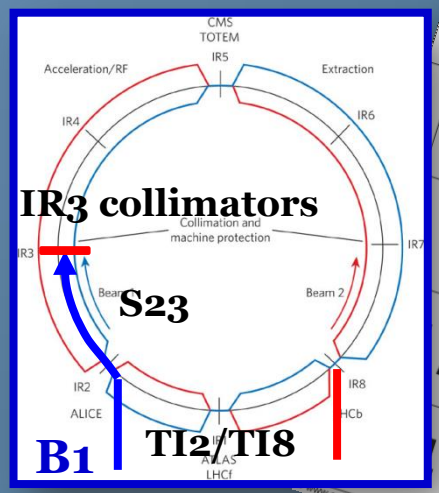
BLM, BTV, BPM Commissioning

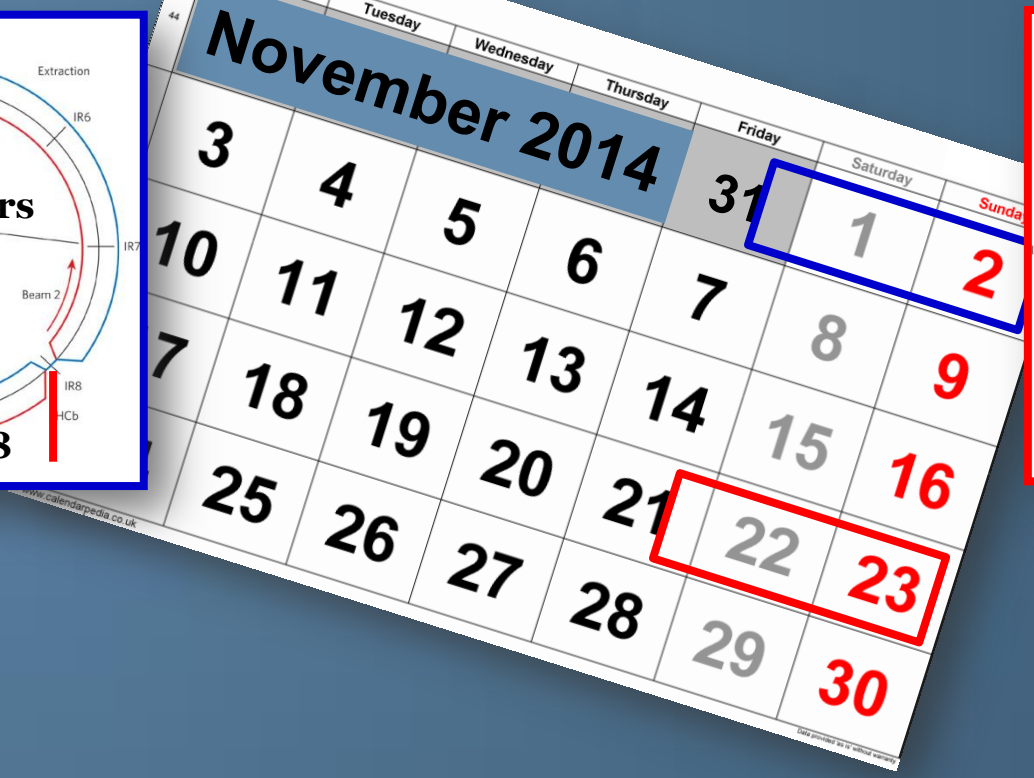
Linear Optics and Dispersion (TL+Ring matching)

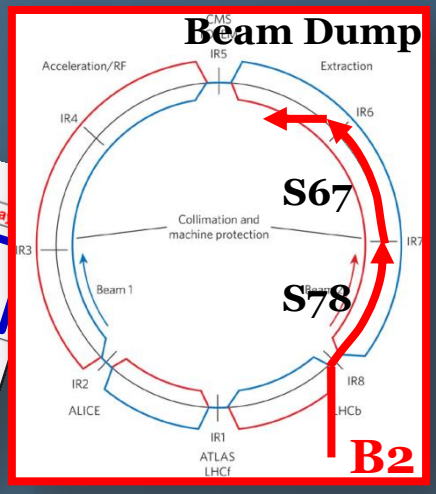
BPM & MAGNETS POLARITY

First probe of the APERTURE

Strategy

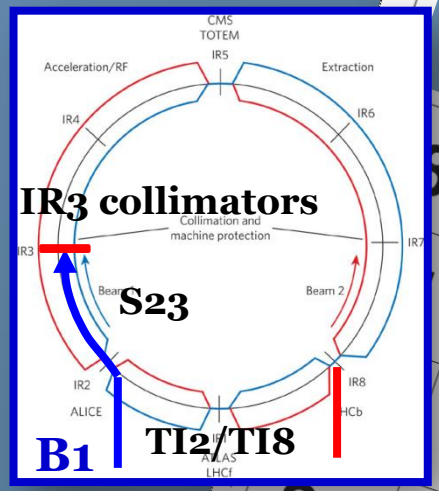


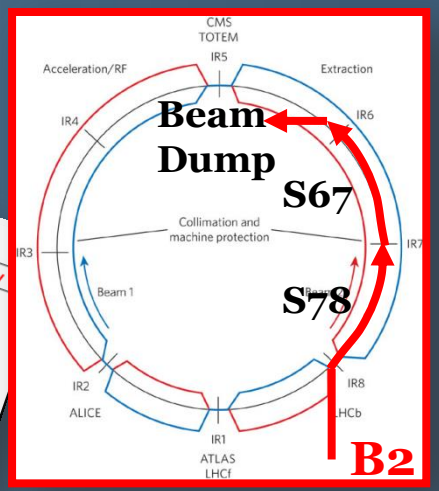




- Test scheduled **weekends** to minimize the inconvenience to the experiments and hardware commissioning
- **Pilot beam** 2-5 10^9 ➔ less intensity ➔ less radiation ➔ less impact on post test tunnel activities

Strategy

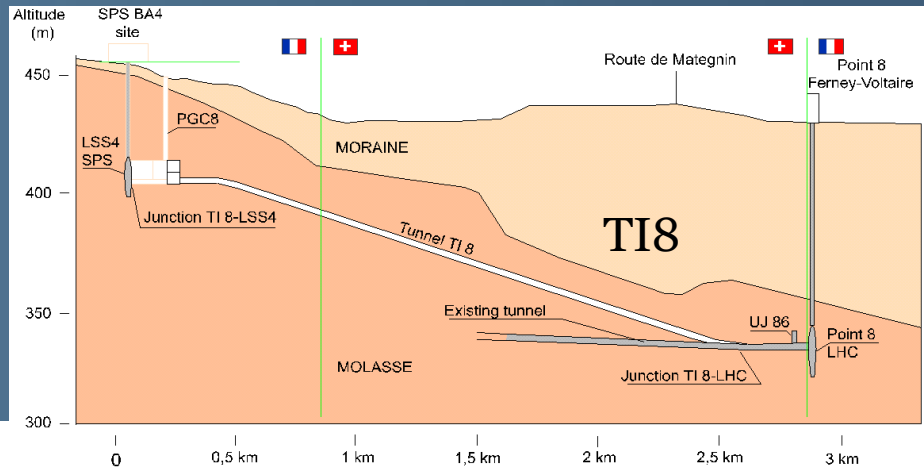


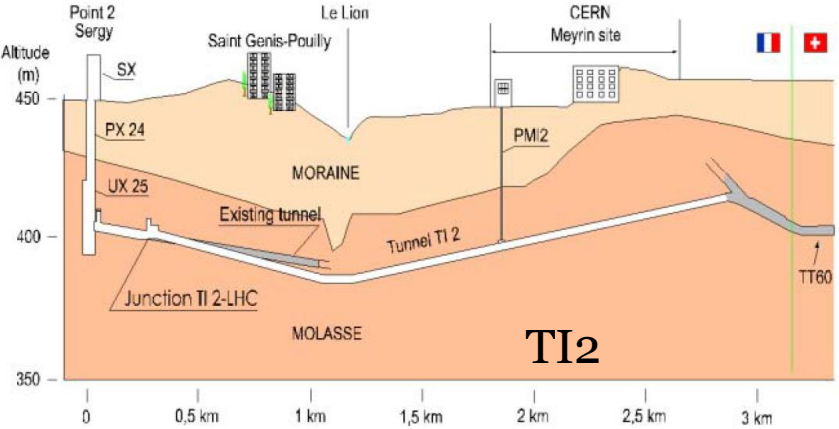


- + Contingency weekend

Strategy

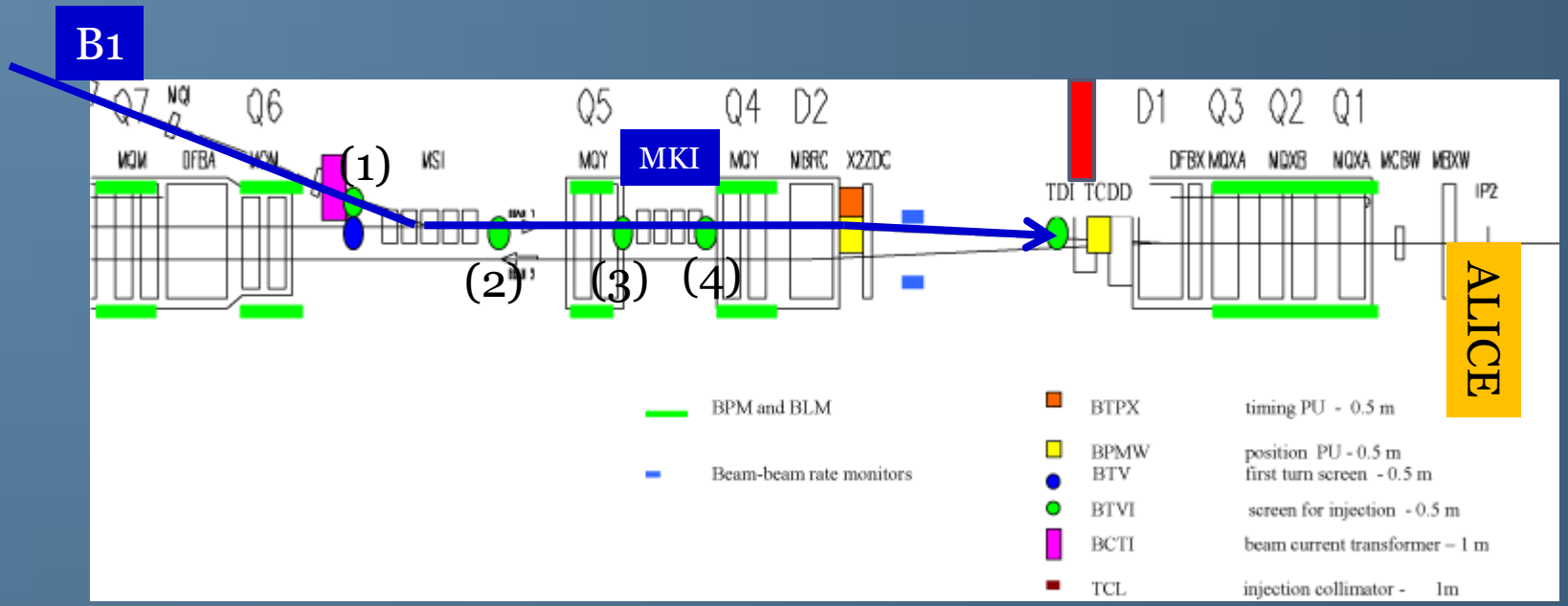
- Setting up of TT60/TT40 extraction (before sector test, date to be defined)
- Beam down to TI2/TI8 TED

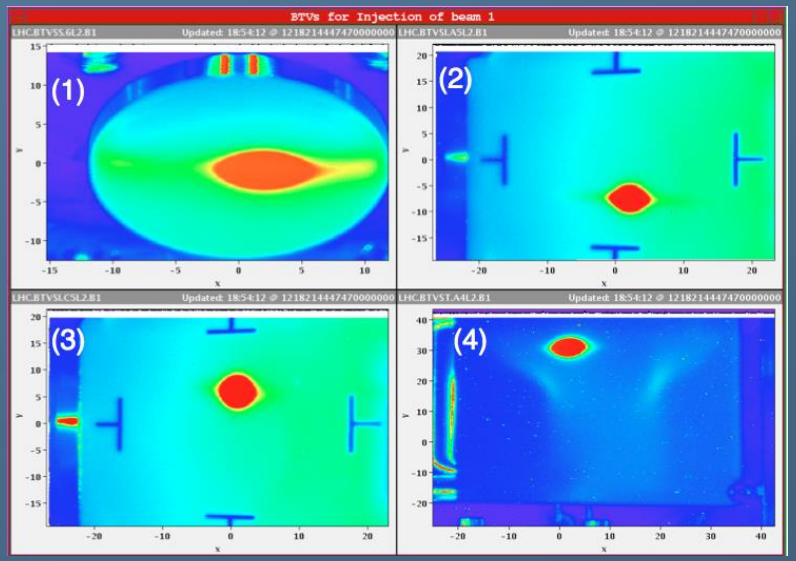




Strategy

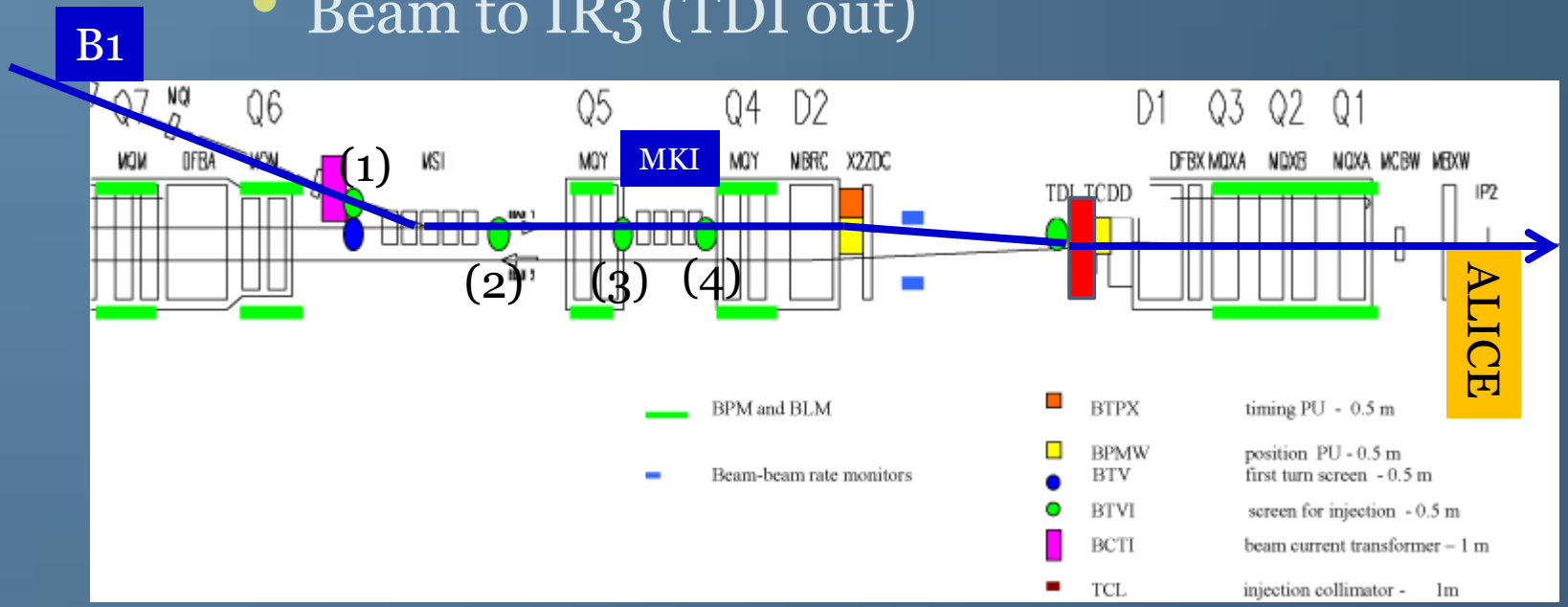
- Beam to TDI with MKI OFF (TI2 TED out)
- Beam to TDI with MKI ON

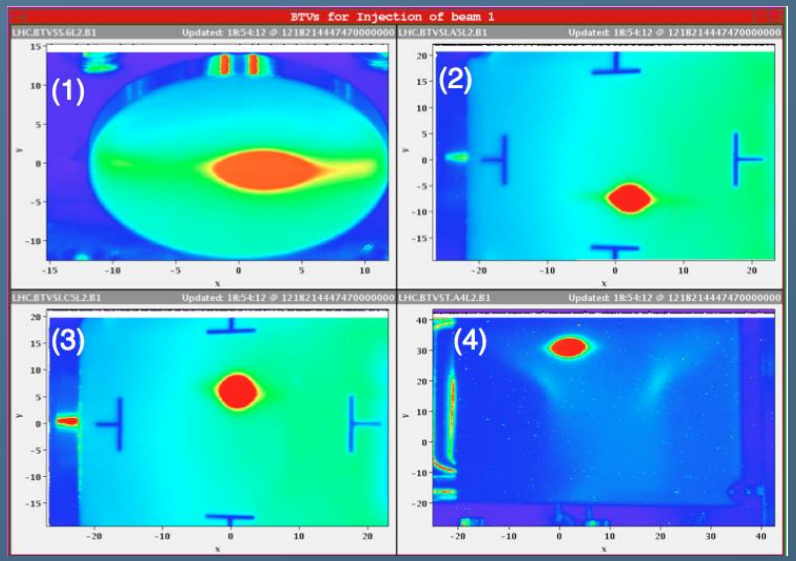


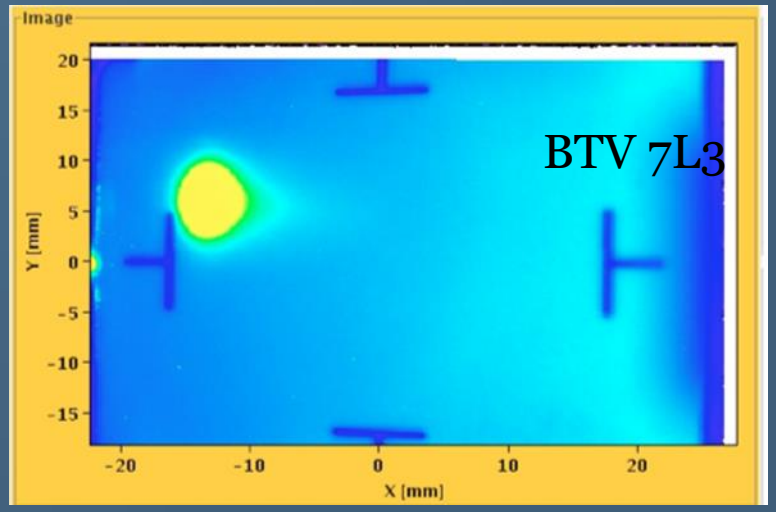


Strategy

- Beam to TDI with MKI OFF (TI2 TED out)
- Beam to TDI with MKI ON
- Beam to IR3 (TDI out)



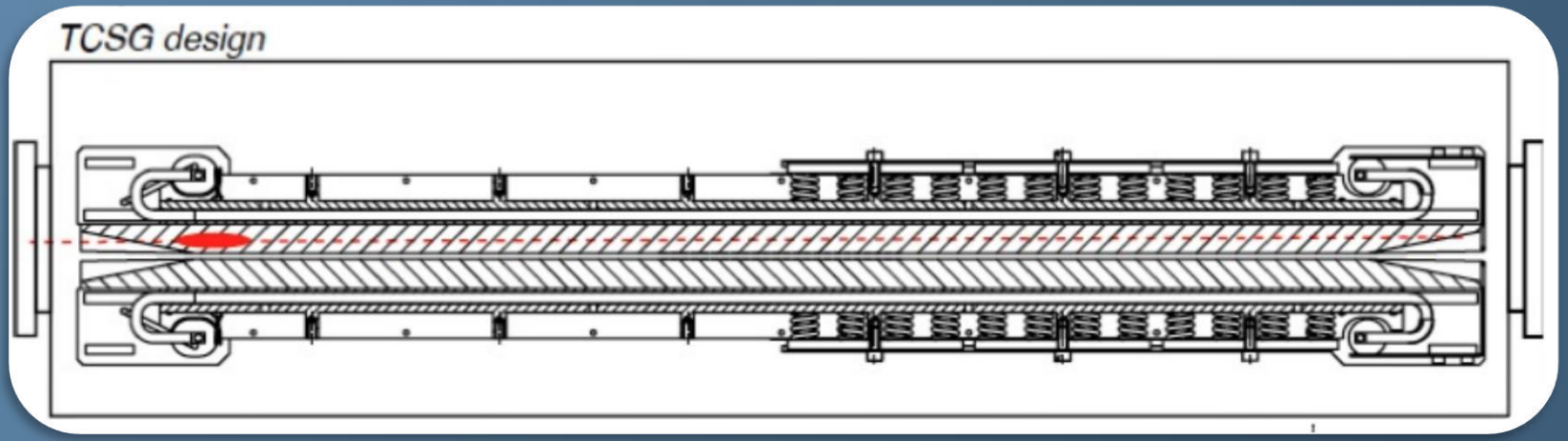


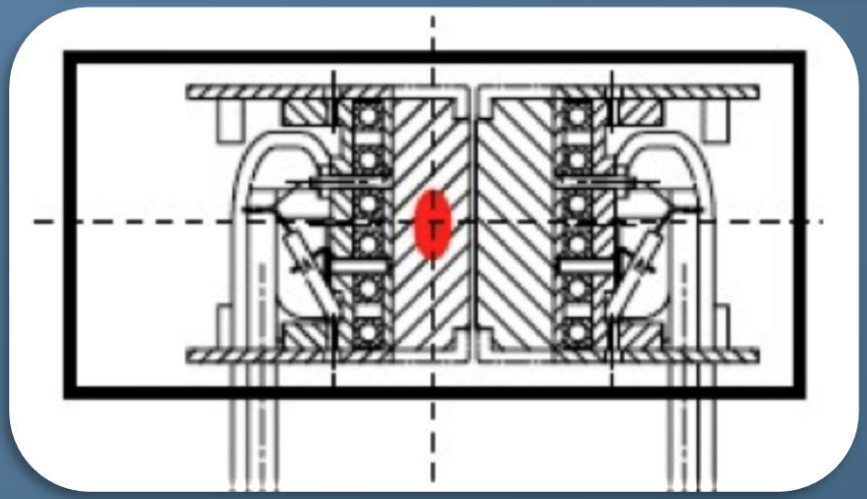


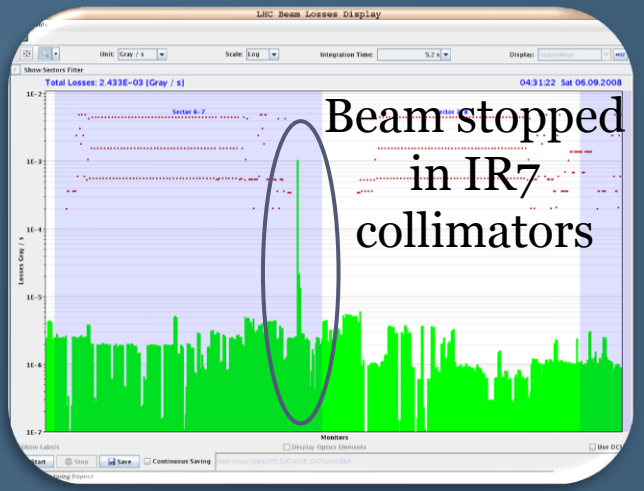
Pre-requisites

- HWC+ IST
- Powering test
- Dry runs
- Access system
- DSO
- Machine checkout

How to stop the beam







- Collimators with minimum gap on anti-collision switches = 0.5 mm
- 5 mm overshoot across nominal orbit
- Possible to tilt collimator to leave NO clearance

BIC Configuration and Energy

SECTOR TEST S23

INJ 1	**CIB.SR2.INJ1.1**	**CIB.SR2.INJ1.2**
	LHC Beam1 Permit	Nothing needed
	Operator switch	
	MKI2 status	
	Vacuum	
	MKI2 erratic	
IR2 (B1)	**CIB.UA27.R2.B1**	**L2.B1**
	MKI	BLM
	Vacuum	Vacuum
	ALICE detector	
IR3 (B1)	**CIB.UJ33.U3.B1**	**CIB.SR3.S3.B1**
	ACCESS_SB(1)	BLM
	WIC(2)	

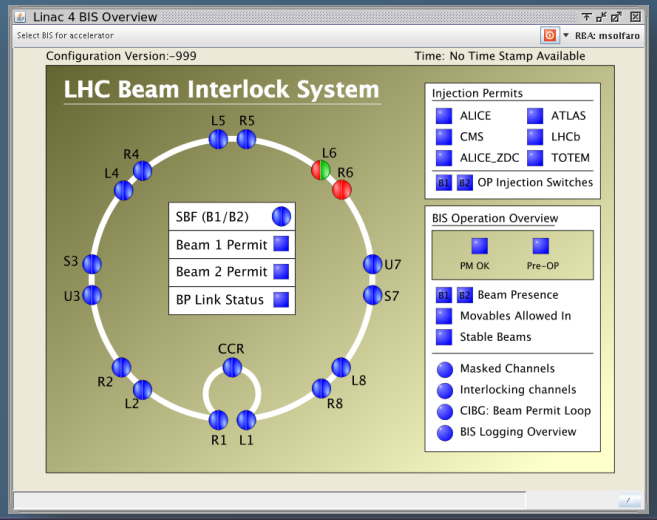
SECTOR TEST S78-S67-LBDS

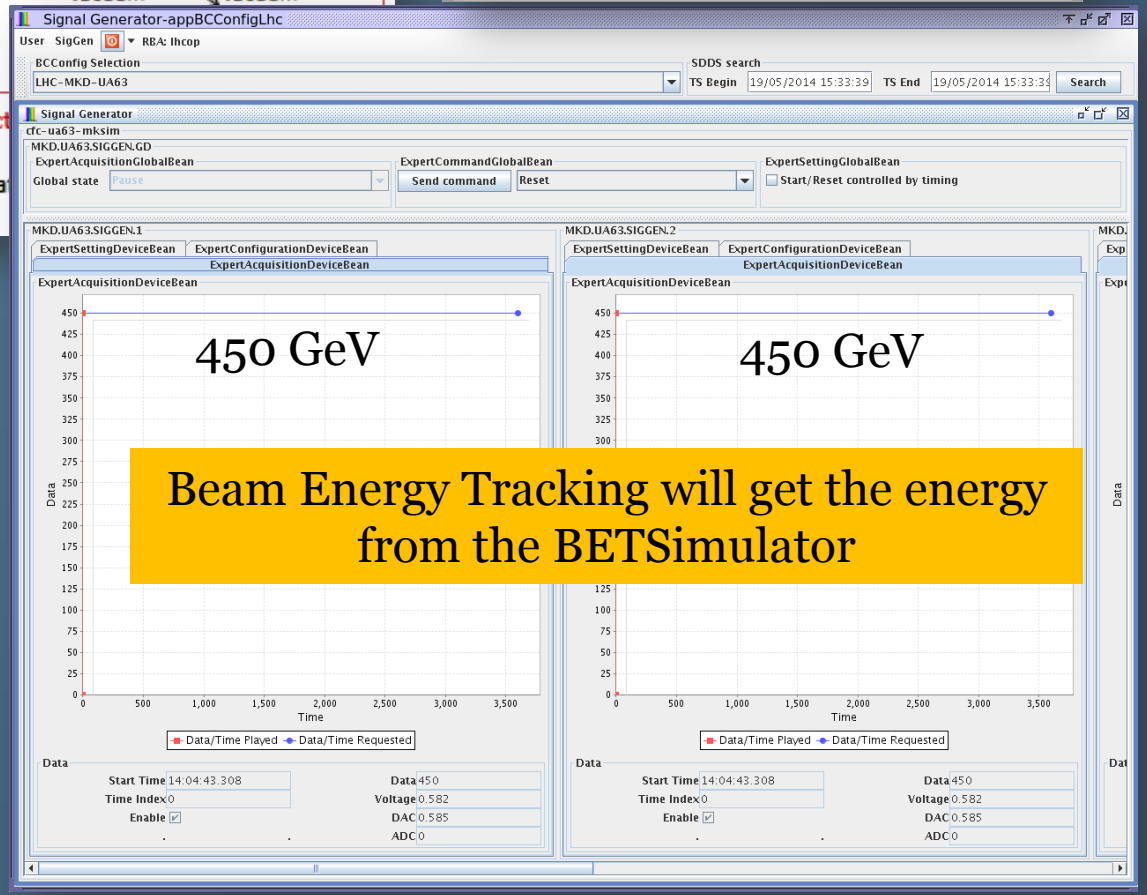
INJ 2	**CIB.SR8.INJ2.1**	**CIB.SR8.INJ2.2**
	LHC Beam2 Permit	LBDS.B2
	Operator switch	
	MKI8 status	
	Vacuum	
	MKI8 erratic	
IR6 (B2)	**CIB.UA67.R6.B2**	**CIB.UA63.L6.B2**
	Vacuum	Vacuum
	LBDS (TSU)	WIC (septa)
	LBDS (PLC)	BLM
	CIBDS B2	
IR7 (B2)	**CIB.SR7.S7.B2**	**CIB.TZ76.U7.B2**
	BLM	Vacuum
		WIC(2)
IR8 (B2)	**CIB.UA87.R8.B2**	**L8.B2**
	Vacuum	Vacuum

B1&B2 need to be commissioned

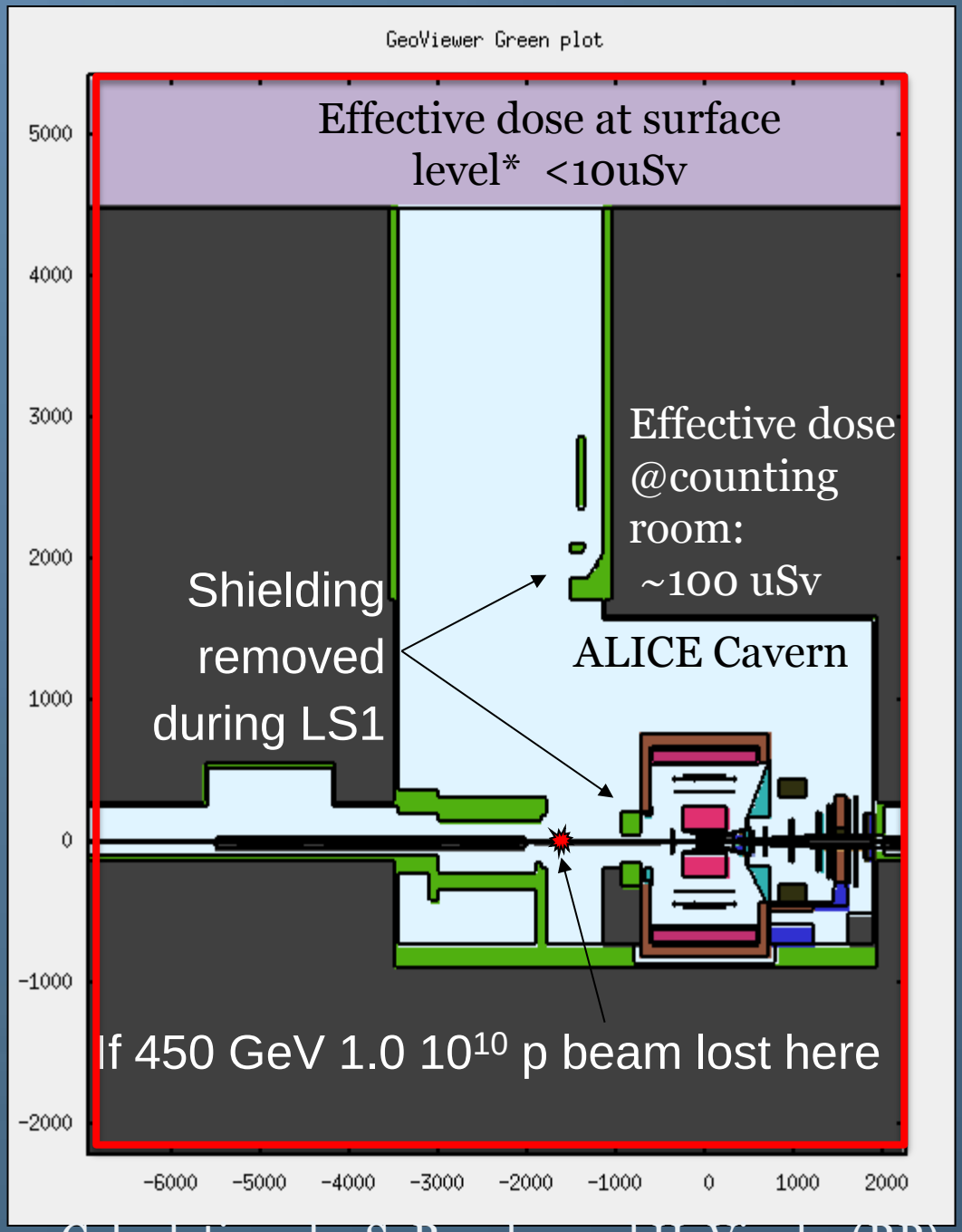
(1)Should be tested @DSO test; if there are issues could have a jumper.
(2)Covered by SIS; if doesn't work could have a jumper.

1. **PIC is covered by SIS**
2. **The unmaskable inputs not needed for the Sect and will be disabled.**
3. **The maskable inputs if not commissioned and opera will have a jumper.**





ALICE Shielding



Calculations by S. Roesler and H. Vincke (RP)

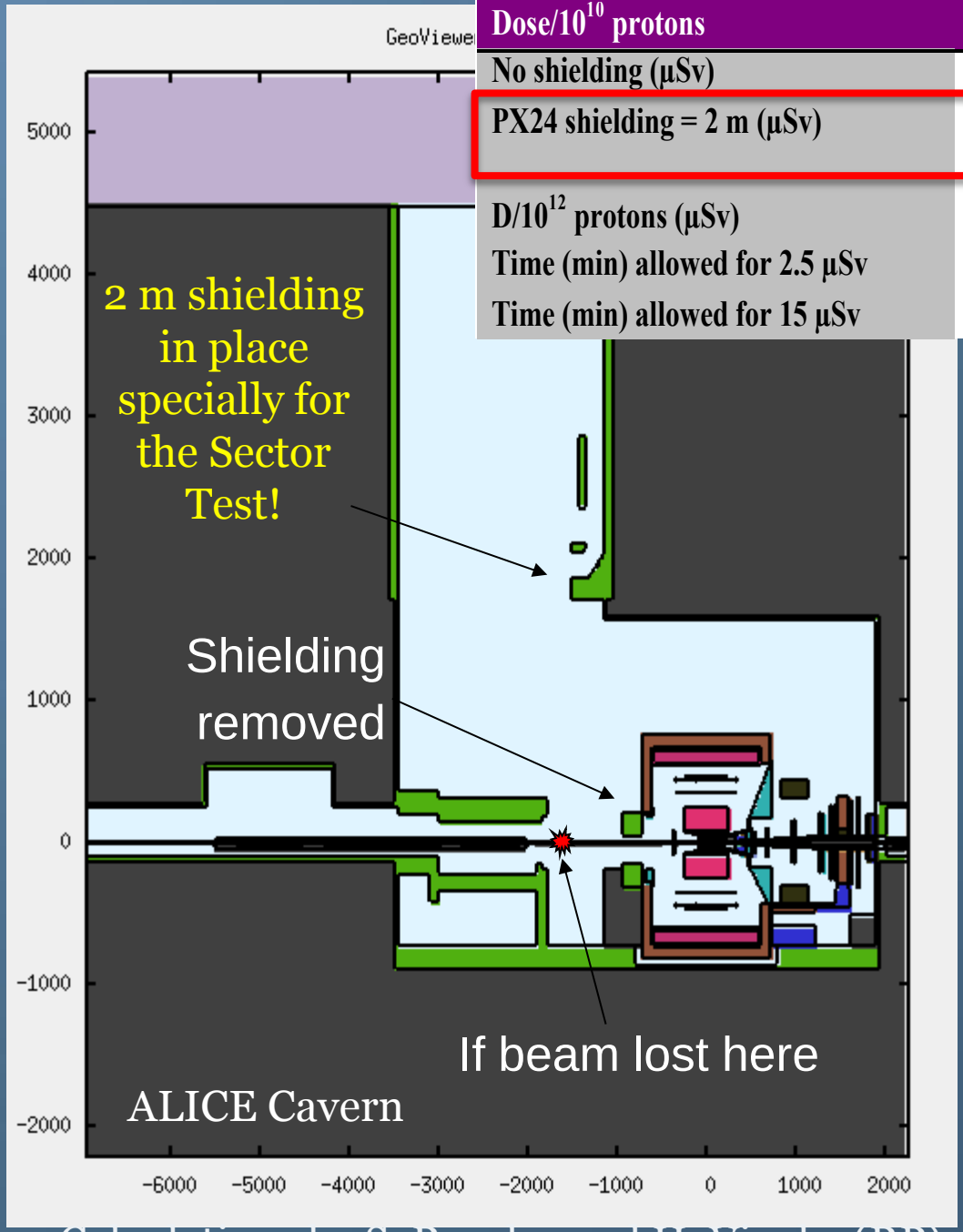
During sector test → Non-designated area

Limit= 2.5 uSv/h at the surface of the pit

One pilot lost goes beyond the dose

*One meter away from the pit the dose rate is a factor of ~10 less

ALICE Shielding



Dose/10^{10} protons	CR	Top of pit	Top of pit @ 1m
No shielding (µSv)	100	10	1
PX24 shielding = 2 m (µSv)	1	0.1	0.01
D/10^{12} protons (µSv)	100	10	1
Time (min) allowed for 2.5 µSv	1.5	15	150
Time (min) allowed for 15 µSv	9	90	900

Special procedure will be written ➔ access CR will not be possible, neither the access to PX24 through the surface building.

Thanks ALICE!! ➔ planning modified to allow the installation/removal of the shielding for Sector Test

Calculations by S. Roesler and H. Vincke (RP)

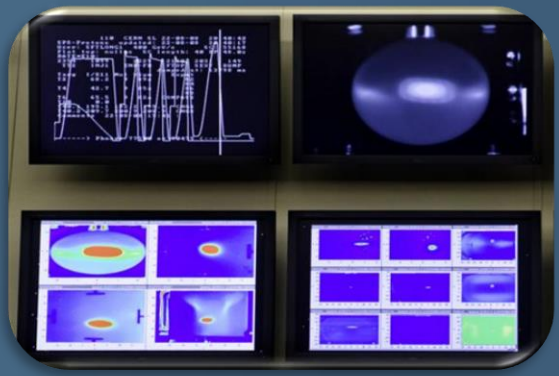
The tests were undoubtedly an essential precursor to the successful start of LHC Beam Commissioning

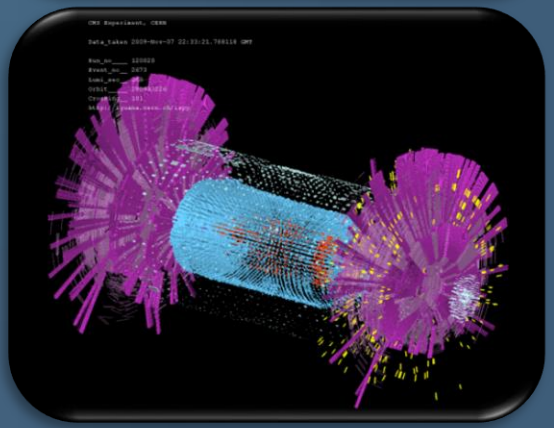
2004 TI8 test
2005 TI8 test (high intensity beam)
2007 TI2 test
2008 5 injection tests

1. S23
2. S78, S23
3. S78-S67, S23-S34-S45
4. S23-S34-S45
5. Whole ring

2009 2 injection tests

1. TI2, S23, first ions in LHC
2. TI2/TI8, S23, S78-S67-S56

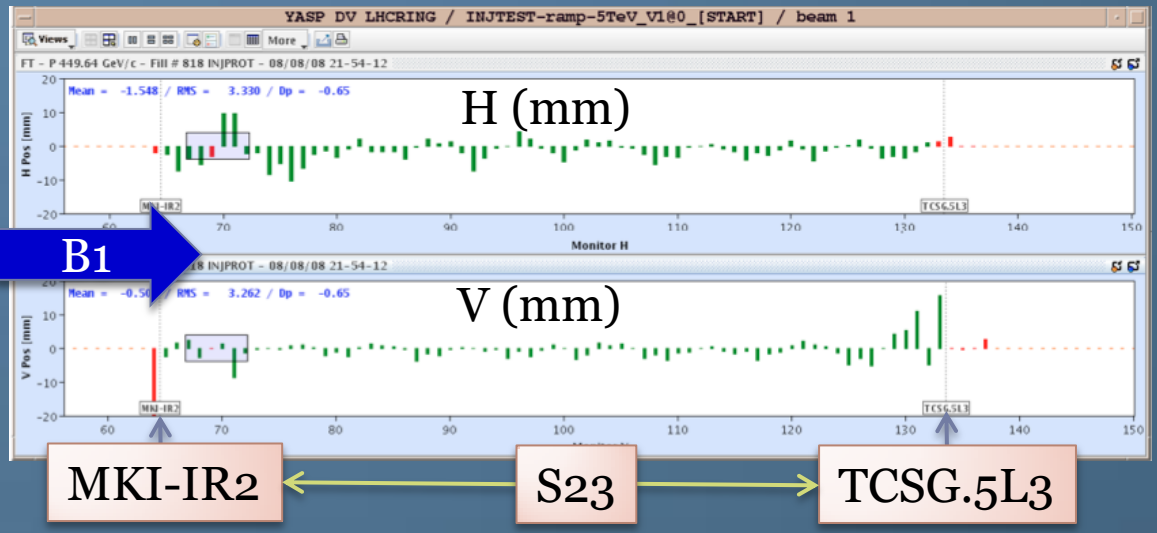




(Following plots ➔ ref: M. Lamont et al. " The LHC Injection Tests", LHC Performance Note 2008-10-21)

A bit of History

First trajectory



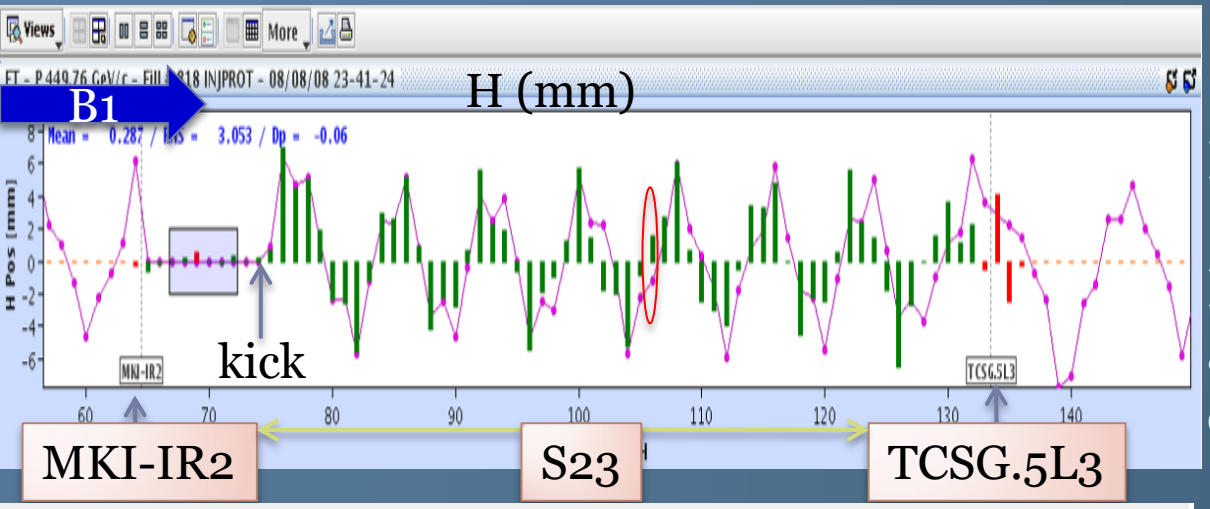
BPMs triggered at the first passage (async mode)

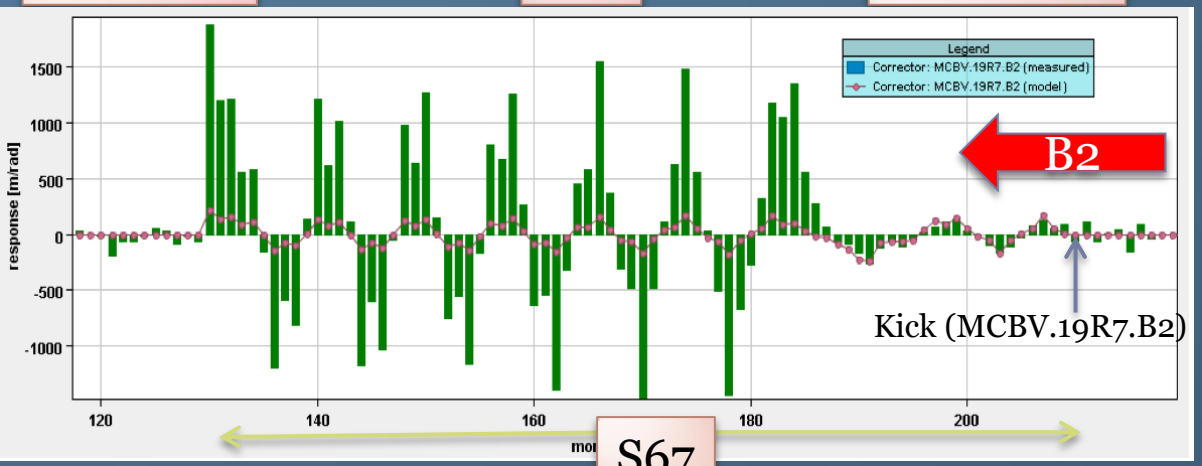
Orbit correction to **+/- 10 mm H/V within few shots**

First corrected trajectory: **+/- 3 mm** (LHC design specs: +/- 4 mm)

A bit of History

First BPM and COD polarities check





Theoretical response

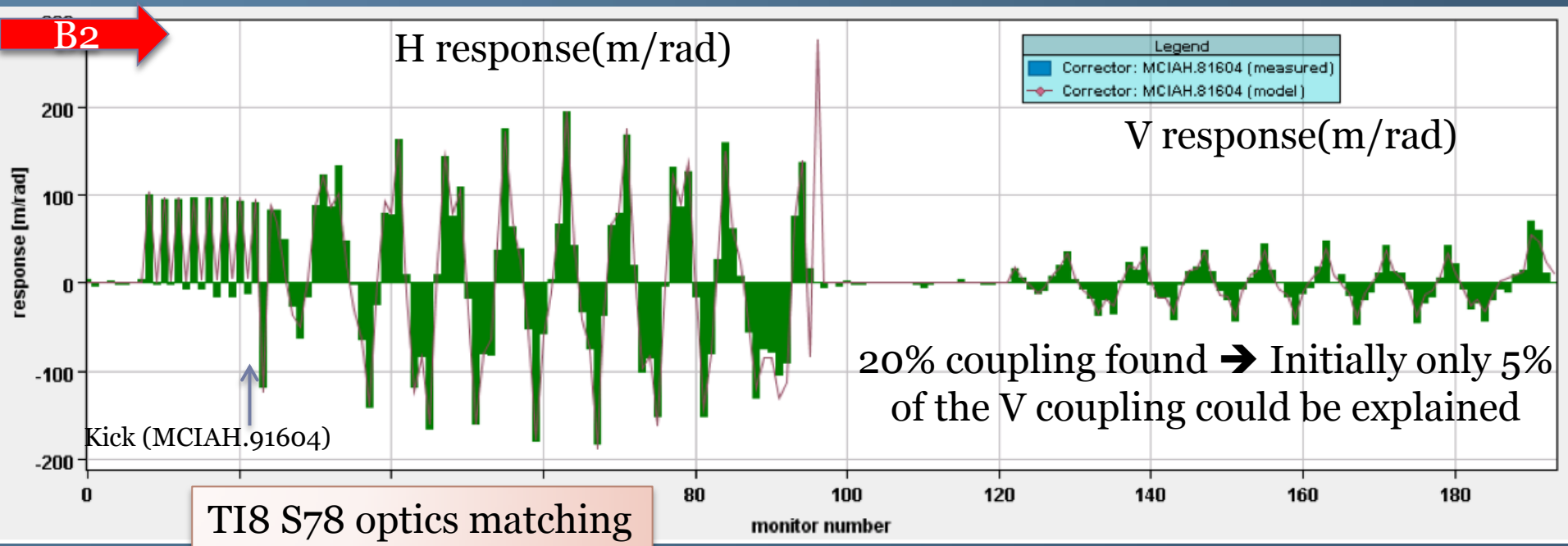
BPM measurement

BPMs polarity errors spotted

Phase error S23: erroneous application of b2 harmonic compensator (Fig. top)

Wrong amplitude S67: Inversion of polarity of Q6.L7 (Fig. bottom)

A bit of History
First BPM and COD polarities check



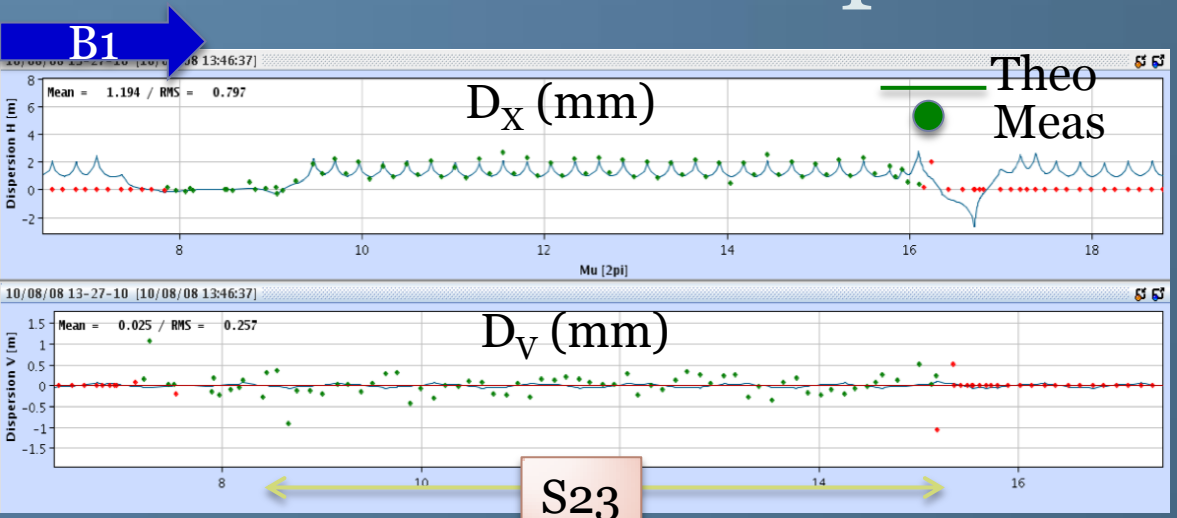
TI8 S78 optics matching

Kick response measurements can spot cross-plane coupling

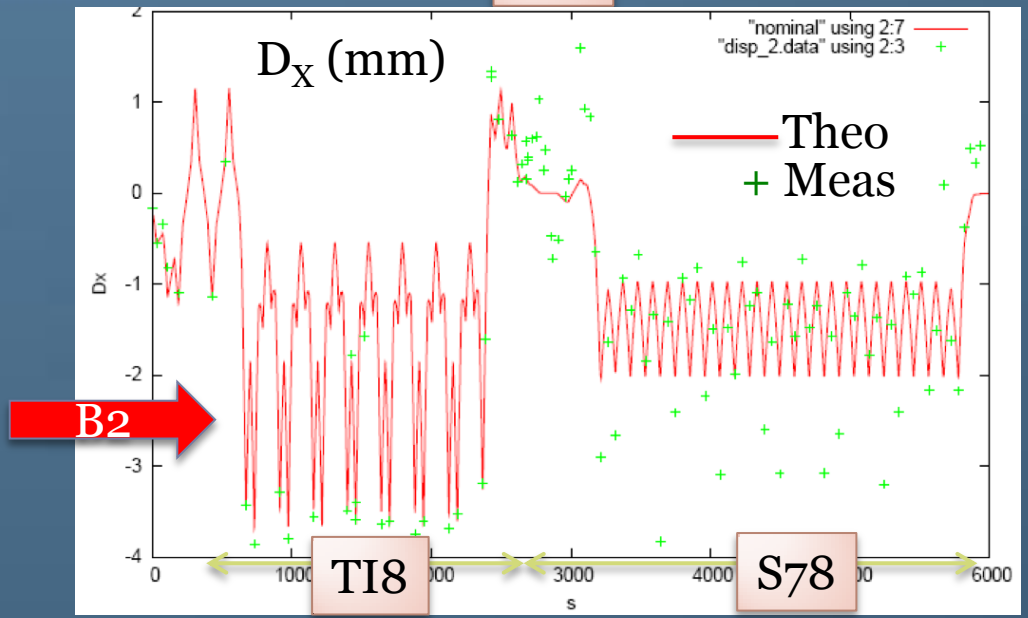
Theoretical response

BPM measurement

A bit of History
First dispersion measurement

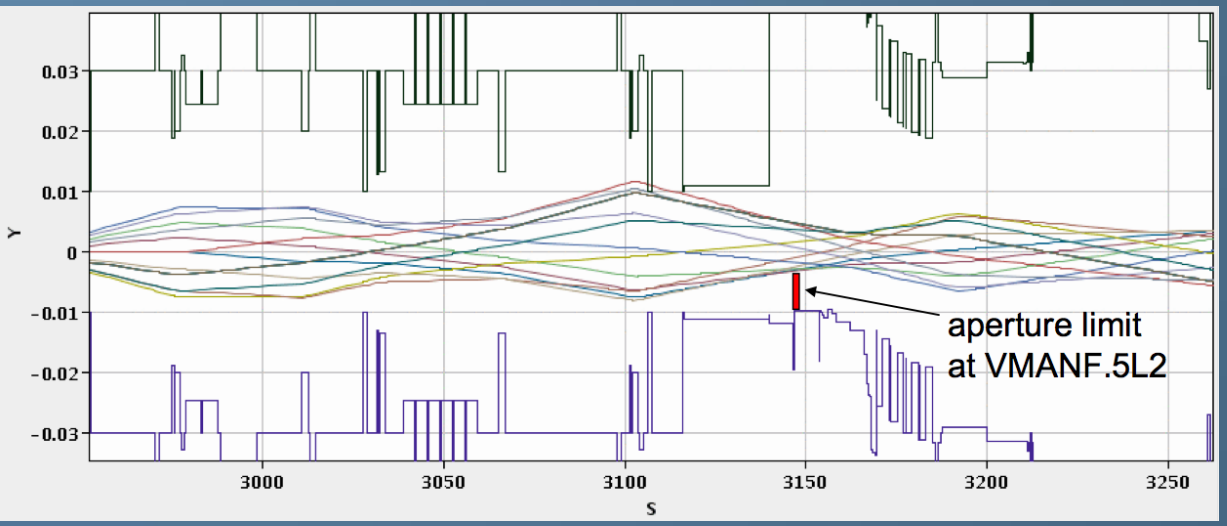


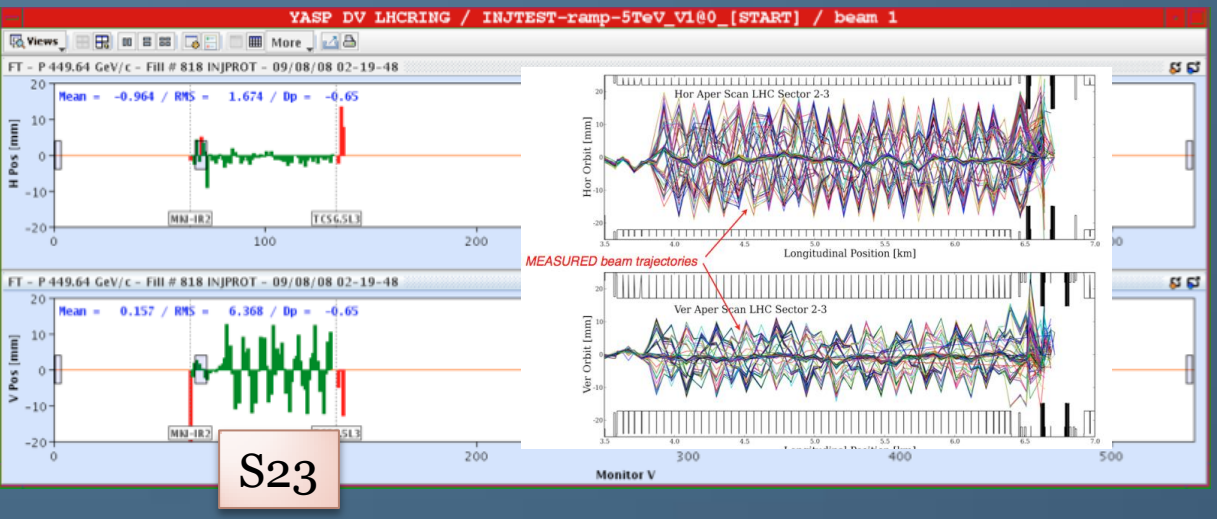
Dispersion measurement revealed optics problem in IR3 Right ➔ some of the trim quads powered with the wrong polarity,



and a strong mismatch between TI8 and S78 ➔ a real puzzle and took some time to understand

A bit of History





First aperture

First aperture scan (first quench with beam, 1 pilot ~ 4 10^9 p) ➔ two COD/plane 90^0 phase advance; BLM determine the loss location

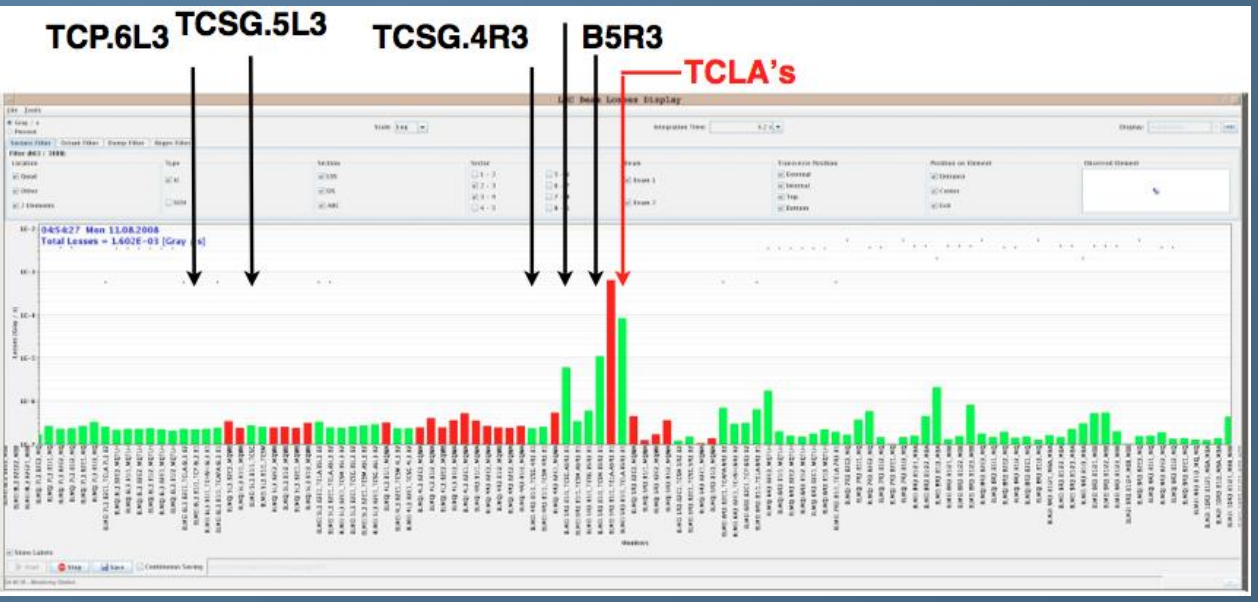
Bottleneck in injection region found, confirmed by radiation survey and fixed (Fig. top)

H ARC Aperture 18-20 mm. V limitation at Q8/Q7-L3 of about 10 mm (Fig. bottom)

Coupling errors detection

A bit of History

BLM commissioning



BLM response at collimators

TI2/TI8/S23 test schedule

	Time	SECTOR TEST 1: TI8, TI2 & S23	Δt (h)
Friday	12	Patrol and closure of LHC and Experiments. Magnets pre-cycle. Last interlock checks/tests. TT40/TT60 extraction (TEDs in)	3
	15	Beam down to TI2 TED, establish rough trajectory. LHC mastership. MSI & MKI pulsing. First TL BI commissioning. Timing of beam and	4
	19	TI2 TED out, MKI off/on, beam to TDI. Thread last part of TI2 and MSI. Set TDI, TCLI	2
	21	TDI out, beam to IR3 right. First BI commissioning (BLM, BPM, BTV). Threading	3
Saturday	0	BPMs and orbit corrector polarity checks TI2 & Ring, Linear optics & dispersion TI2 & Ring	8
	8	Beam down to TI8 TED, establish rough trajectory. LHC mastership. MSI & MKI pulsing. First TL BI commissioning. Timing of beam and	4
	12	Screen matching TI2 - Injection	2
	14	TDI in, physical aperture measurements in TI2 and the injection region. ALICE BCM+BLM calibration in parallel	8
	22	MKI2 waveform scan	2
Sunday	0	TL trajectory stability TI2 beam on TED. More TL BI commissioning	3
	3	MKE waveform scan LLS4/LLS6	4
	7	BLM latency check	1
	8	BLM response (collimator splashes)	2
	10	Aperture IR2 and S23	8
	18	Magnet polarity (skew quads, sample of MQT, MQTL)	3
	21	BMPs and orbit corrector polarity checks TI8	2
	23	Set TCDI, automatic application TI2	3
Monday	2	Rough LSS4 extraction region aperture scan	1
	3	Pre-cycle effects	3
	6	End of TI2/TI8/S23 test. RP survey	2

Could be combined

Preliminary

ALICE BCM+BLM calibration > 1 hour

TOT: 66 h ➔ 8.25 shift

S78-s67-LBDS test schedule

	Time	SECTOR TEST 2: TI8, S78-S67, LBDS B2	Δt (h)
Friday	12	Patrol and closure of LHC and Experiments. Magnets pre-cycle. Last interlock checks/tests. TT60 extraction (TEDs in)	3
	15	Beam down to TI8 TED, establish trajectory. LHC mastership. MSI & MKI pulsing. LHCb TED shots in parallel.	2
	17	TI8 TED out, MKI off/on, beam to TDI. Thread last part of TI8 and MSI. Set TDI, TCLI. More TL BI commissioning	2
	19	TDI out, beam to IR7 right. First BI commissioning (BLM, BPM, BTV). Threading	3
	22	Beam to IR6 LBDS B2 with orbit correctors (TCDQ & TCSG in beam and interlocked). Steering. Beam dump line BI commissioning. Synchronization. Rough check of extraction channel aperture.	3
Saturday	1	Beam to IR6 LBDS B2 with "inject and dump" (TCDQ & TCSG in beam and interlocked). Steering. More check BI. Synchronization. Rough check of extraction channel. MKD knob test. MKB	6
	7	BPMs and orbit corrector polarity checks TI8 & S78-S67, Linear optics & dispersion TI8 & S78-S67	9
	16	Screen matching TI8 + injection	2
	18	TDI in, physical aperture measurements in TI8 and the injection region. LHCb BCM+BLM calibration in parallel	8
Sunday	2	MKI8 waveform scan	2
	4	TL trajectory stability TI8 + beam on TED. More TL BI commissioning. LHCb TED shots in parallel	3
	7	Rough LSS6 extraction region aperture scan. LHCb TED shots in parallel	1
	8	BLM latency check	1
	9	BLM response (collimator splashes)	2
	11	Aperture IR8 and S78S67	9
	20	Magnet polarity (RCO.A78B2, Q5L8, skew quads, sample of MQT, MQTL)	4
Monday	0	Set TCDI, automatic application TI8 (if not done in ST1)	3
	3	Pre-cycle effects	3
	6	End of TI8/S78S67/LBDS B2 test. RP survey	2

Could be combined

Very Preliminary

ST2 program = f(outcome of ST1)

LHCb TED shots = 2+3+1 hours

TOT: 66 h ➔ 8.25 shift

Conclusion

- Sector tests are **essential precursor** and a **high profile milestone** in preparation for full beam commissioning
- Two sector tests are proposed for 2014:
  - ST1: 1-2 Nov 2014 ➔ ti2/ti8 & s23
  - ST2: 22-23 Nov 2014 ➔ ti8 & s78-s67-lbds b2
  - ST3: 13-14 Dec 2014 ➔ contingency
- First draft plan is circulating for comments and optimization