

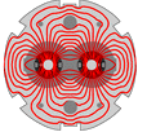


Mini-Chamonix Introduction

Where do we stand?

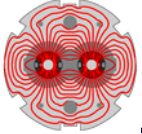
What are the possibilities?

Mike Lamont

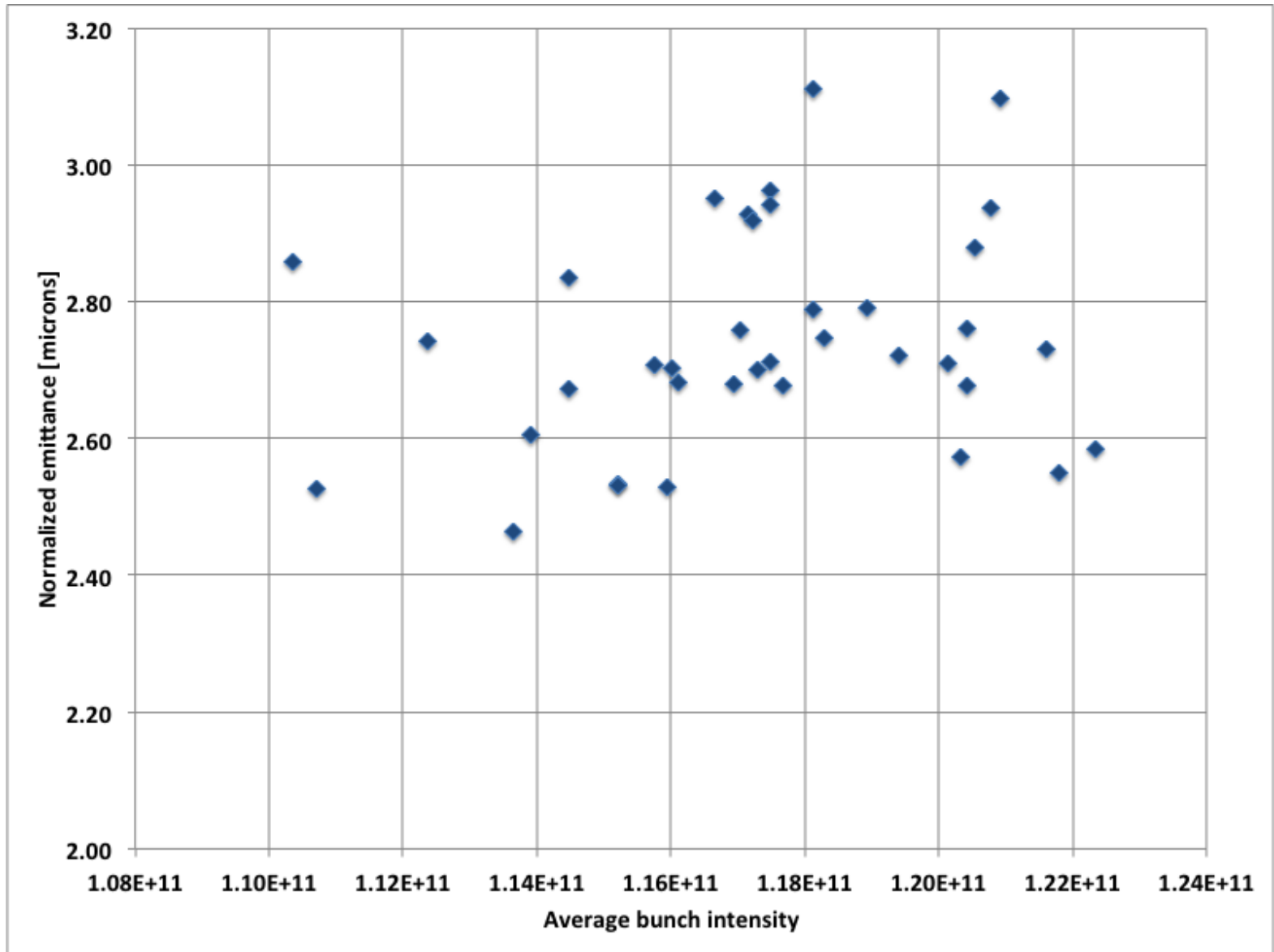


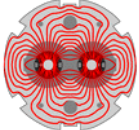
2011 parameters

Energy [TeV]	3.5
beta* [m]	1.5, 10, 1.5, 3.0 m
Emittance [microns]	2.5 – 3.1 start of fill
Bunch intensity	1.1 - 1.2e11
Number of bunches	1380 1318 collisions/IP1&5
Bunch spacing	50 ns – good choice
Stored energy [MJ]	~90
Peak luminosity [$\text{cm}^{-2}\text{s}^{-1}$]	1.27e33
Beam-beam tune shift	~0.015 – 0.017



Recent bunch intensity/emittance

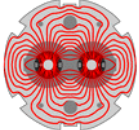




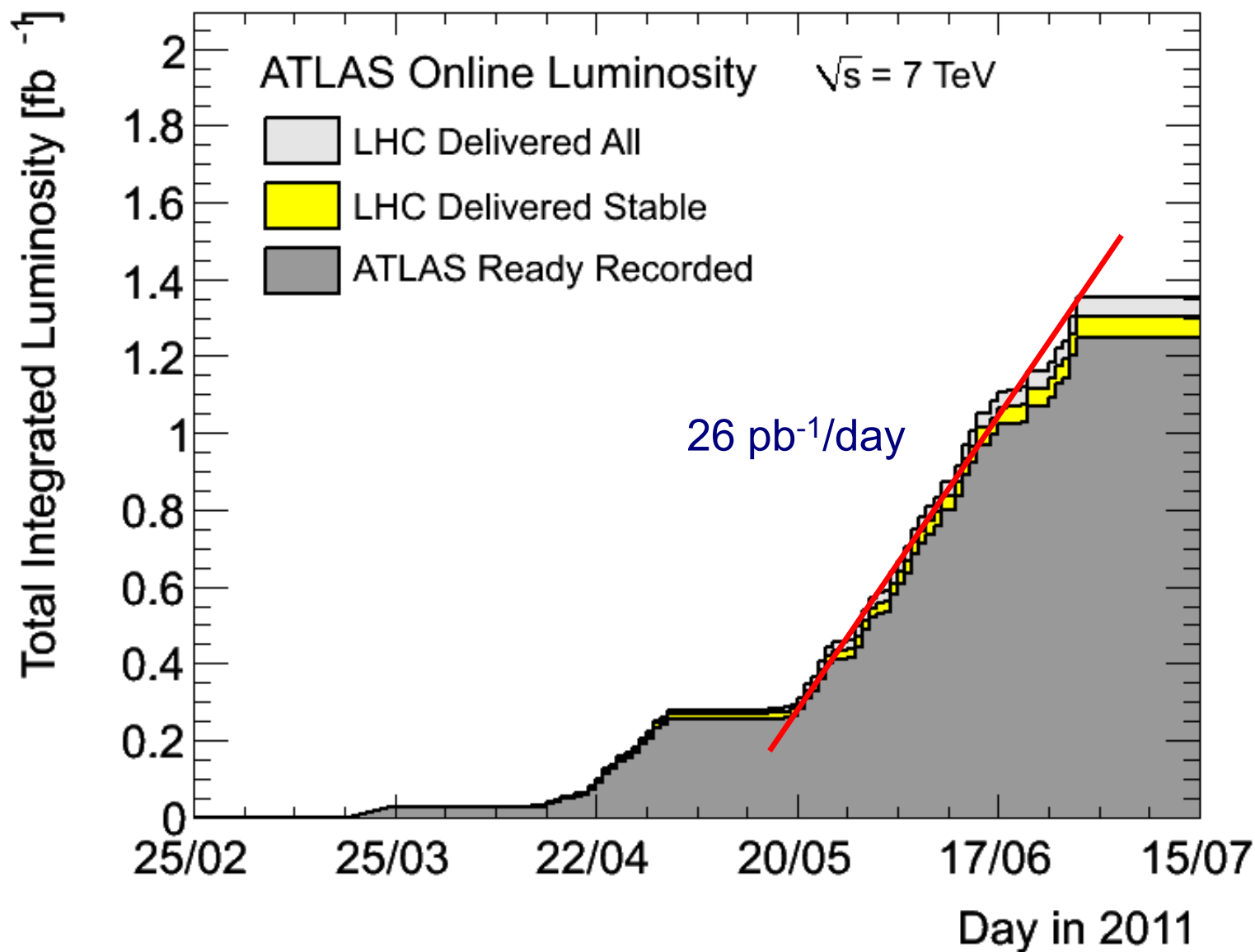
Performance

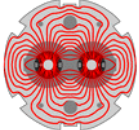
Date	Bunches/beam	Colliding bunches (Atlas & CMS)	Luminosity $\text{cm}^{-2}\text{s}^{-1}$
27th June	1380	1318	1.25e33
24th June	1236	1180	1.26e33
29th May	1092	1042	1.26e33
23rd May	912	874	1.1e33
1st May	768	700	8.4e32
27th April	624	598	6.7e32
21st April	480	424	4.67e32
16th April	336	322	3.57e32
14th April	220	214	2.28e32
24-27th March	1.38 TeV run (followed by technical stop and scrubbing)		
22nd March	200	194	2.5e32

Integrated Luminosity to date (IR1-5/IR8)	1.3 fb^{-1} /0.44 fb^{-1}
Peak Stable Luminosity Delivered	1.28 x 10 ³³ $\text{cm}^{-2}\text{s}^{-1}$
Maximum number of bunches	1380
Maximum number of colliding bunches/experiment	1318
Maximum intensity in collision	1.64 x 10 ¹⁴ p/beam
Maximum Luminosity Delivered in one day	63 pb^{-1}
Maximum Luminosity Delivered in 7 days	242 pb^{-1}

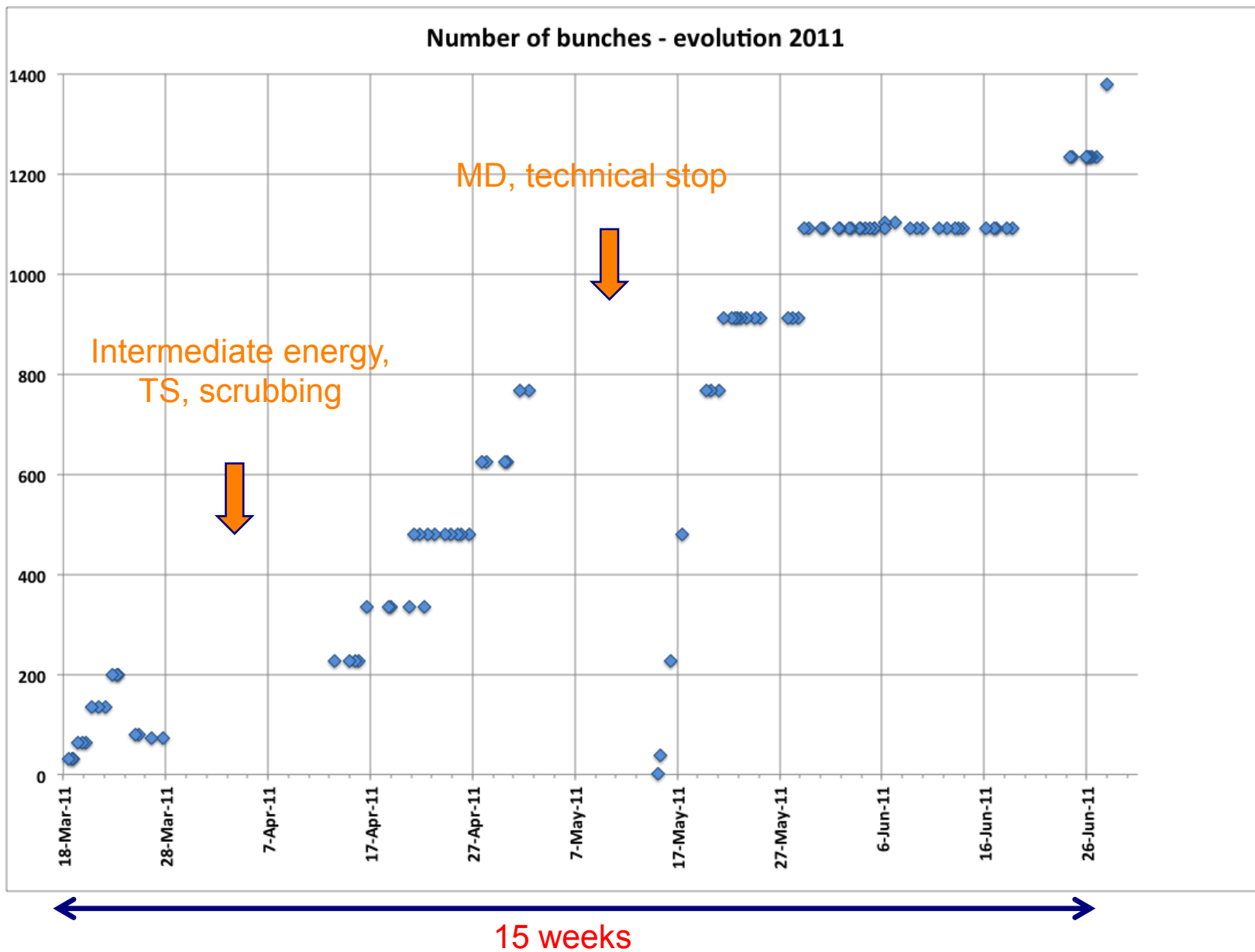


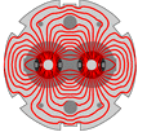
Luminosity





Ramp-up



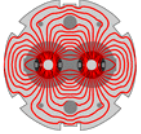


Ramp-up: not all plain sailing

From 3 to 1380 with a previous maximum of 368 in 15 weeks elapsed (via MD, TS, scrubbing, intermediate energy) has to be regarded as impressive, however...

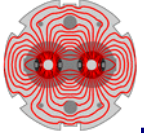
- UFOs
 - In particular MKIs
- SEUs
 - QPS et al
- RF
 - Couplers
 - RF wave-guide arc detectors
- Beam induced heating
 - injection kickers, cryogenics, collimators..
- Vacuum activity

All to be discussed today

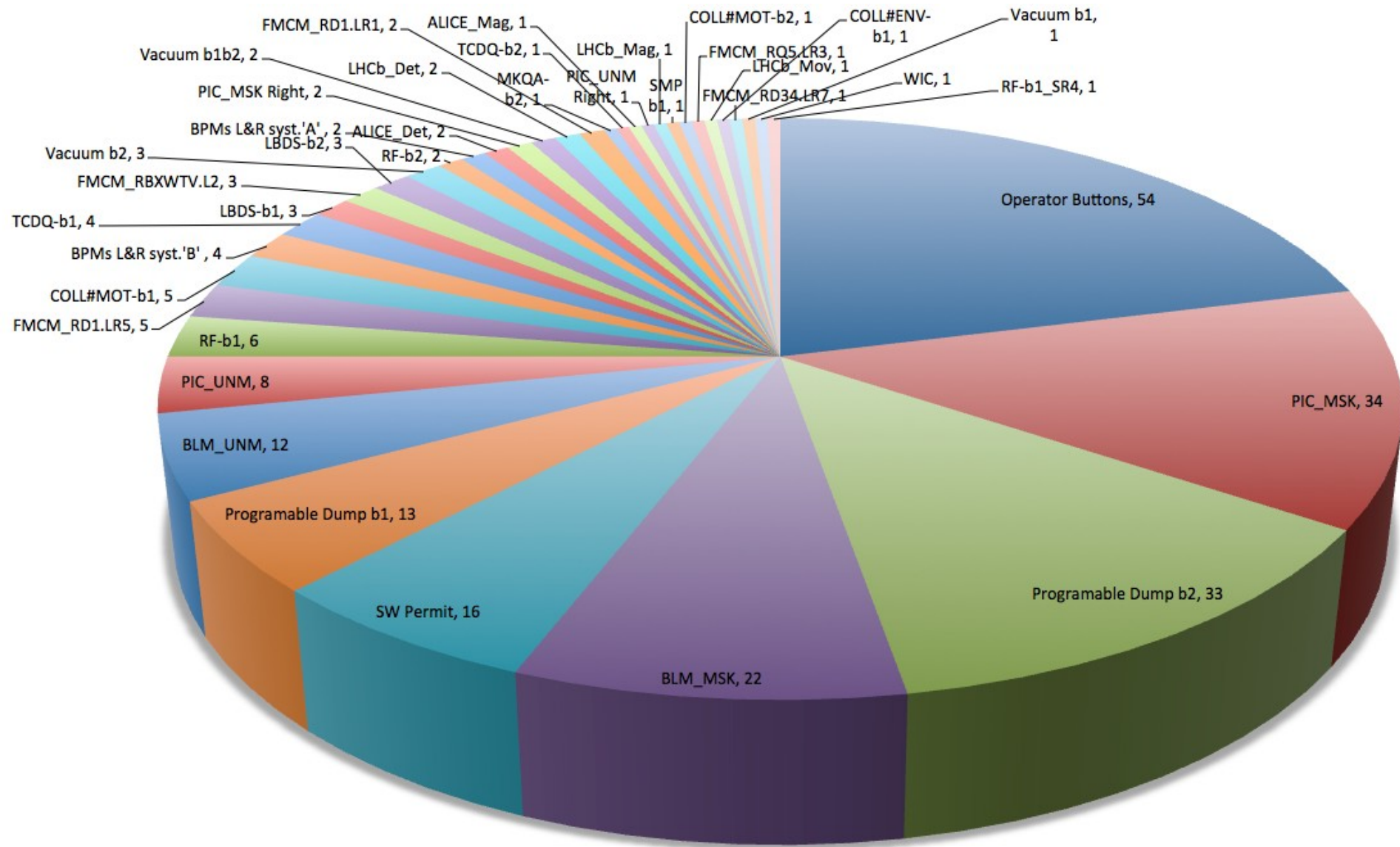


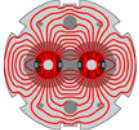
Increasing intensity – machine protection

- Collimation loss of hierarchy at 450 GeV
 - Orbit stability. Regular loss maps performed – inefficiency has increased
- 72 (108/144) bunches from SPS
 - Beam quality from injector very important
 - 144 bunches per injection from SPS > 1 MJ down the lines
- High temperature superconducting current lead quenched (7th April)
 - Invoked quench of 11 magnets
- Injection Kicker Flashover (18th April)
 - Not pretty, heavy beam loss



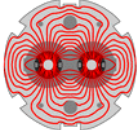
Wrestling with a mixed bag





Dumps from Stable beams 1/2

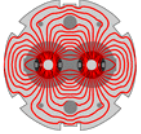
20-MAY-11	1795	DFB	Problem in the controls of the valves in one DFB due to an electronics crate. Cryo Maintain lost, and beam dumped. Clean dump.
20-MAY-11	1796	QPS	QPS system detected quench on Q10.L1. This was not a real quench, but it seems that 50Hz noise was induced in the Ures sig
22-MAY-11	1800	RF ARC	RF main coupler interlock (arc). Dump is clean, losses on TCTs good. 3 minutes before, the ALICE solenoid tripped, but a cor
22-MAY-11	1801	RF ARC	RF coupler interlock (arc). Clean dump, losses at TCTs are OK.
23-MAY-11	1802	RF ARC	RF interlock, again main coupler arcing, dump looks ok
24-MAY-11	1804	RF ARC	RF interlock, again main coupler arcing, observed for two cavities, dump looks ok. The RF team will increase the threshold
25-MAY-11	1805	RF	RF control crate PS down - RF distribution was interrupted.
28-MAY-11	1809	EL GLITCH	Many FMCMs tripped (RD1.LR5, RD34.LR3, RD34.LR7). The dump is clean. A ~ 10 micron rms oscillation is visible on both bea
29-MAY-11	1813	UFO	UFO detected by BLM in Quadrupole 28L8. Very fast, risetime about 0.2 ms. Beam 1, also visible on several TCTs for Beam 1.
29-MAY-11	1815	CONVERTER	Clean dump, normal losses on TCTs. No visible orbit change - PIC interlock clean and fast. Internal PC fault.
30-MAY-11	1816	SEU	False QPS interlock to PIC. SEU? Dump was clean. No visible orbit change.
31-MAY-11	1822	UFO	Very strong UFO at the MKI2. Far above threshold.
31-MAY-11	1823	SEU	SUE on cryo crate in 56.
01-JUN-11	1835	POWER SUPPLY	Initial thought: SEU on collimator crate in UJ56. Later analysis showed that it was a power supply failure, unlikely to be an SE
02-JUN-11	1839	UFO	UFO on B1 in triplet MQXA 1L8, still quite far below threshold for LHC BLMs.
03-JUN-11	1841	CONVERTER	PC internal fault (I_meas). Dump is clean.
03-JUN-11	1844	OP	Undulator U-res. In some sense a OP mistake... Dump clean.
04-JUN-11	1845	SEU	Clean dump. QPS system trip, SEU ?
04-JUN-11	1846	CONVERTER	PC fault. Clean dump.
05-JUN-11	1848	RF	New total voltage interlock triggered. Dump clean, no sign of any increased abort gap population despite full module trip.
05-JUN-11	1851	UFO	Another UFO. Very strong, losses peak at TCT.iR2... Dump clean.
06-JUN-11	1852	QPS	False trigger of QPS on RQTL11.R7B1, clean dump. BLM signals on Q4.L6 exceeded by factor of 3 in RS1 without quench...
06-JUN-11	1854	CONVERTER	Power converter failure, clean dump.



Dumps 2/2

07-JUN-11	1855	CONVERTER	Powering Failure from triplet R1 due to bad current reading on RTQX2.R1. Losses in dump region, also on Q4.L6 a
08-JUN-11	1856	EXPERIMENT	Alice dipole tripped (reason of fault not fully clear). Clean dump.
09-JUN-11	1859	EL GLITCH	Network glitch, seen by FCMs on RD1.LR5, RD34 in IR3 and IR7. Clean dump.
10-JUN-11	1862	CONVERTER	Trip of power converter which is not (yet) included in PIC configuration induced slow losses in IR7 (following an o
11-JUN-11	1863	CRYO	Lost CRYO_MAINTAIN in Matching section L1, dump clean.
12-JUN-11	1864	CRYO	Quench of RD2.L1 magnet (+ due to suspected imbalance as well RQ4 some 17 seconds after the dump), traced b
13-JUN-11	1865	COLLIAMATORS	PRS problem in for TCTH.4L1.B1 and TCTVA.4L1.B1 of IR1, needed access to exchange RS power supply. Dump ok.
13-JUN-11	1866	RF	SIS interlock on RF voltage while switching ON an RF module in stable beams. The dump occurred while switching
13-JUN-11	1867	RF	Trip of ACS module due to a faulty power supply on the line 3B1. Clean dump.
14-JUN-11	1868	EL	Trip of sector 81, notably through RB.A81. 13kA Switch cooling in RR13 failed due to problem on 400V departure
16-JUN-11	1871	QPS	nQPS BS trip: B11R8_RQF which was for an unknown reason (again) at a threshold of 500uV (instead of the stand
17-JUN-11	1873	BIS	Glitch on Beam Permit Loop A (originating in link between BICs in IR7 and IR8. To be watched. Clean dump.
17-JUN-11	1875	MAGNET	Trip of undulator RU.L4 (due to the loss of local powering for a few ms) induced orbit oscillations in H plane up to
18-JUN-11	1880	MAGNET	Identical to previous dump, again a glitch on BPL B2/A detected by receiver in TZ76. Clean dump.
21-JUN-11	1883	BI	SIS dumped the beam after 10 minutes without orbit data. There was a bad 'crash' of the OFSU in the form of a b
24-JUN-11	1889	EL	AUG problem on TI2. A faulty AUG box had to be replaced. Clean dump by PIC, no orbit change visible. Losses fine
25-JUN-11	1890	CRYO	Cryo control problem - power lost on a crate. Dump is OK. No orbit change.
26-JUN-11	1893	VACUUM	Vacuum interlock in IR4, not clear why. Dump clean.
26-JUN-11	1894	VACUUM	Vacuum interlock in IR4, not clear why. Dump clean.
26-JUN-11	1895	VACUUM	Systematic problem of vacuum in Pt4.
26-JUN-11	1898	QPS	Beam dumped because of QPS problem, circuit breaker of the UPS rack. Dump clean.

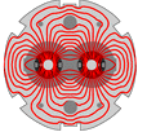
- Clear number of these related to the increase in intensity
- Some problems revealed and solved or in the process of being solved



Summary 1/2

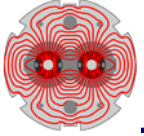
How has the observed performance been possible?

- Ramp & squeeze essentially without loss
- Excellent performance of Machine Protection related systems
 - No quenches with beam above 450 GeV
- Optics close to model (and well corrected)
- Excellent reproducibility and stability
 - Magnetic machine, orbit, collimation...
- Aperture as expected
- Better than nominal emittance and intensity from injectors

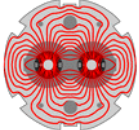


Summary 2/2

- Beam-beam – no problem (head-on/long range)
- Excellent single beam lifetime
- Healthy luminosity lifetime
- Emittance growth
 - Minimal through the cycle
 - Acceptable in collisions
- Excellent machine availability via performance:
 - Cryogenics, QPS, BIS, LBDS, injection, power converters, ADT, RF, collimators, controls, instrumentation, vacuum, access, EL, CV...



NEXT FEW MONTHS



Schedule

	July						Aug						Sep	
Wk	26	27	28	29	30	31	32	33	34	35	36	37	38	
Mo	27	4	11	18	25	1	8	15	22	29	5	12	19	
Tu														
We														
Th											J. Genevois			
Fr			X											
Sa														
Su														

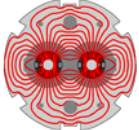
Ion Beam to SPS

	Oct					Nov		Dec					
Wk	39	40	41	42	43	44	45	46	47	48	49	50	51
Mo	26	3	10	17	24	31	7	14	21	28	5	12	19
Tu													
We													
Th											End ion run		Xmas eve (comp)
Fr									IONS				
Sa													
Su													Xmas Day

Ion beam setup

Start ion physics

End non-LHC proton physics



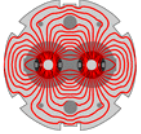
What are days for?

*Ah, solving that question
Brings the priest and the doctor
In their long coats
Running over the fields.*

15th July to 29th October inclusive

	Days
Calendar	107
Special runs	3 (say, see Anders..)
Technical stop	5
TS recovery	1
Ramp-up	1+3
Machine development	5
Floating MD	2
Physics	~87

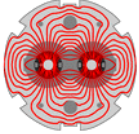
+25 ns studies to come during MDs (to sort out injection and beam stability issues) and possibly an operational development period to validate scrubbing and future operation



Maximize peak luminosity

$$L = \frac{N^2 k_b f}{4\pi\sigma_x\sigma_y} F = \frac{N^2 k_b f \gamma}{4\pi\epsilon_n \beta^*} F$$

N	Number of particles per bunch
K _b	Number of bunches
f	Revolution frequency
σ _y	Beam size at interaction point
F	Reduction factor due to crossing angle
ε	Emittance
ε _n	Normalized emittance
β*	Beta function at IP



Maximize integrated luminosity

- Possible turnaround time is ~2.5 hours
- Effective turn around time is long:
 - Problem resolution, accesses etc...
- Message that long fills are good has got through
- Exposed to the intersecting failure space of a number of complex systems with huge number of components.
- This failure space is inflated by high intensity
- Holding is sometimes more effective than raising although “conditioning” and mitigation (UFOS, vacuum, RF, QPS, SEUs) is clear...

1380 * 1.5e11 = 2e14 protons per beam is over 60% nominal intensity... machine protection is, as always, the priority