

BEAM REQUESTS VERSUS WHAT CAN BE DELIVERED (PROTONS AND IONS)

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2010 Schedule

- The 2010 Accelerator Schedule v. 1.3, as approved by the RB on 2 December, was used as basis taking into account:
 - The **start** and **end dates** of each facility/experiment.
 - That the **LHC monthly technical stops** that are taken as MD and technical stops, thus **no physics**
 - **Five dedicated and floating 8 hour MD's** that are put on the schedule as place holder, but that might shift in time.

Changes following recent SPSC meeting

(19 – 20 January 2010)

- The SPSC anticipated shortfalls and has made proposals to reduce the impact on certain experiments/facilities
- CNGS earlier start (2 weeks)
 - **29 April** instead of 12 May
- **1 EASTB cycle less** to give **1 nTOF cycle more** resulting in:
 - 4 EASTB cycles day and night
 - 4 dedicated nTOF cycles day and night

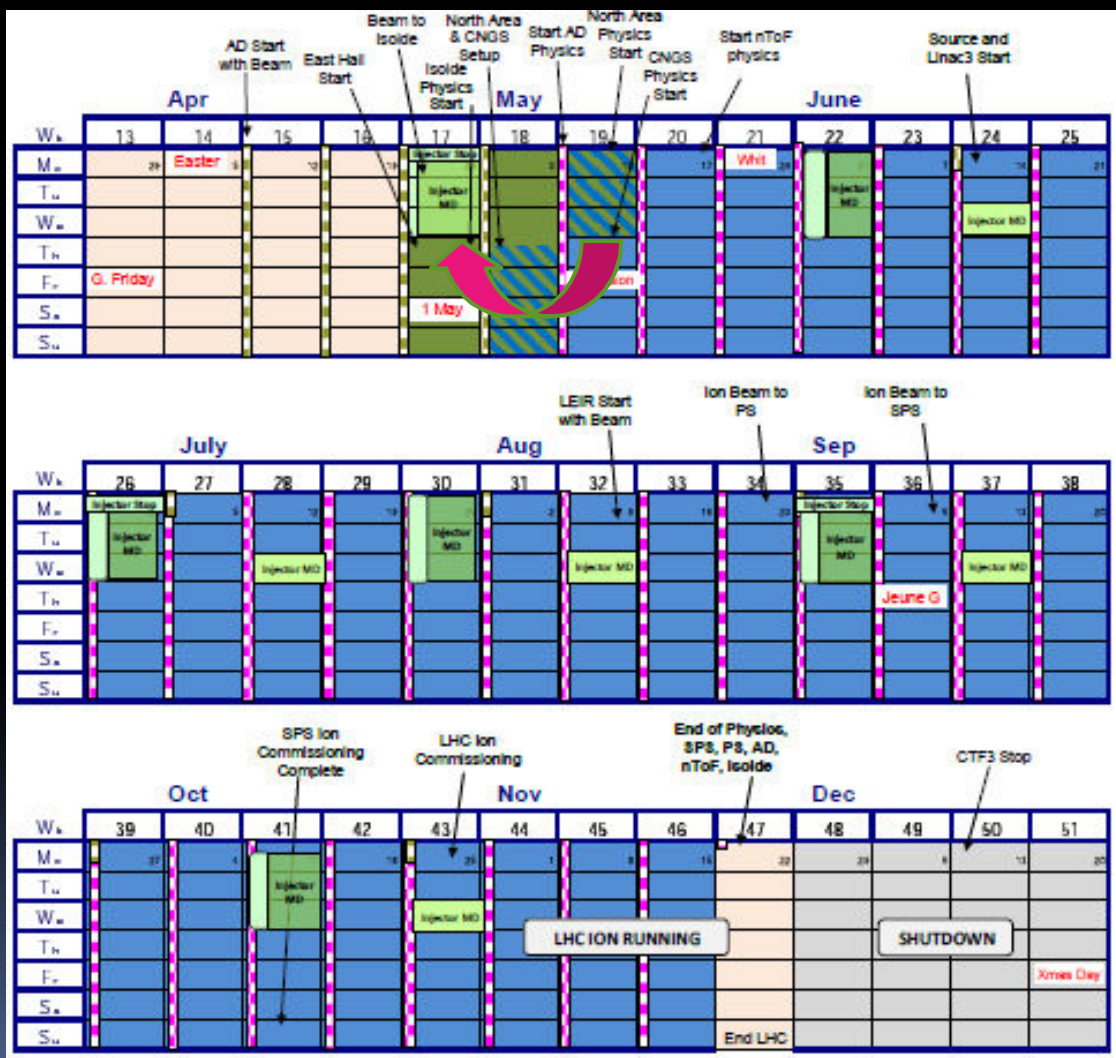
Approved User Requirements 2010

- CNGS: 4.5×10^{19} protons integrated
- North Area (Compass): 3×10^5 spills (9.6 sec.)
- nTOF: 1.6×10^{19} protons integrated
- East Area
 - North Branch:
 - Running the whole run, but no clear required number of spills or protons available
 - T9 + T10 → 335 days in total
 - T11 (Cloud) → 80 days
 - DIRAC: 2.1×10^6 spills
 - T7 irradiations: ~200 days with 2 spills per super cycle
- AD users: 28 weeks (1 cycle every 80–100 sec)
- ISOLDE: 43% duty cycle ($2 \mu\text{A}$)

Machine/Facility Limitations

- Maximum beam current of 2 μA for ISOLDE
- Maximum PS MPS load until POPS is operational
 - Based on 1.16×10^8 MJoules per year/run
- RMS current SMH57
 - Less cycles required if beam sharing reintroduced.
- As long as there are enough CNGS cycles following the (long) FT cycle there is no rms issue on the SPS MPS
- PSB and PS are surface machines beam losses generate certain radiation levels outside the machine
- Every change in the SPS super cycle has knock-on consequences for the PSB and PS users

PS MPS Load calculation



- 30 weeks of PS running, not counting running for LHC alone
- 5040 hours
- Slightly lower than 2009 run time
- Therefore the average 5 MW limit for PS MPS remains valid
- Not taking into account the periods of dedicated LHC running

Proposed basic 2010 super cycles

- There are **four basic super cycles** proposed:
- Operational **day super cycle** containing:
 - SPS: Fixed target, CNGS, LHC or MD
 - PSB/PS: nTOF, AD, East Area, ISOLDE, MD
- Operational **night super cycle** containing:
 - SPS: Fixed target, CNGS
 - PSB/PS: nTOF, AD, East Area, ISOLDE, MD
- **LHC filling super cycle for protons**
- **LHC filling super cycle for ions**

Basic assumptions

- **Day super cycles** from 08:00 until 18:00
→ **10 hours**
- **Night super cycle** from 18:00 until 08:00
→ **14 hours**
- **Dedicated LHC filling** (protons & ions) will take on average **4 hours** per 24 hours, leaving 20 hours per day for other physics.
- **No Physics during MD's**
 - 5 x 3 days = 15 days → 360 hours
 - 5 x 8 hours = 40 hours
- **Ion commissioning** foreseen **on MD cycle**
- Last years' machine availabilities are taken into account

Operational Day & Night Super Cycle

Day Super Cycle (46.8 sec):

SPS	FT cycle 13 bp													CNGS1						CNGS1						CNGS1						CNGS2						LHCFAST2																											
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39																										
PS	SFTPRO	SFTPRO	EASTB/TOF	EASTB/TOF	EASTB/TOF	AD/EASTB	TOF							CNGS	CNGS	TOF	EASTA										CNGS	CNGS	TOF	AD/EASTC									CNGS	CNGS	AD/EASTC											LHC25													
	SPS	SPS	T8	T8	T8	T8	nTOF							SPS	SPS	nTOF	FTN/N										SPS	SPS	nTOF	FTN/N										SPS	SPS	FTN/N											SPS-DUMP												
	4	4	17	0	17	0	17	0	17	0	8	0	0	4	4	8	17	0	4	4	8	17	0	4	4	8	17	0	4	4	17	0	4	4	17	0	0	18	0	0	0	0	4	0																					

PSB	SFTPRO	SFTPRO	EASTB	PSB SU	EASTB	ISO	EASTB	ISO	EASTB	ISO	TOF	ISO	ISO	CNGS	CNGS	TOF	EASTA	ISO	CNGS	CNGS	TOF	TSTPS	ISO	CNGS	CNGS	TOF	EASTC	ISO	CNGS	CNGS	EASTC	ISO	LHC25A	LHC25B	ISO	ISO	ISO	ISO	ISO
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	35	37	37	39

Night Super Cycle (39.6 sec):

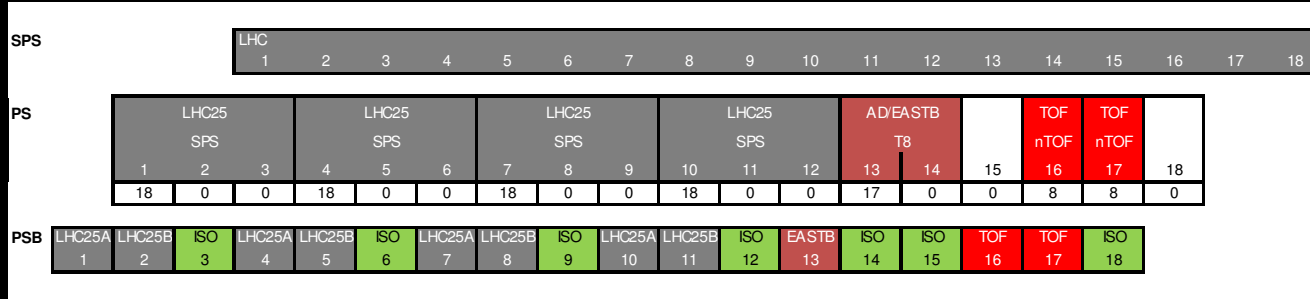
SPS	FT cycle 13 bp													CNGS						CNGS						CNGS																									
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33																		
PS	SFTPRO	SFTPRO	EASTB/TOF	EASTB/TOF	EASTB/TOF	EASTB/TOF	TOF							CNGS	CNGS	TOF	EASTA									CNGS	CNGS	TOF	AD/EASTC									CNGS	CNGS	AD/EASTC											
	SPS	SPS	T8	T8	T8	T8	nTOF							SPS	SPS	nTOF	FTN/N									SPS	SPS	nTOF	FTN/N										SPS	SPS	FTN/N										
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33																		
	4	4	17	0	17	0	17	0	17	0	8	0	0	4	4	8	17	0	4	4	8	17	0	4	4	8	17	0	4	4	17	0	4	4	17	0	0	18	0	0	0	0	4	0							

PSB	SFTPRO	SFTPRO	EASTB	PSB SU	EASTB	ISO	EASTB	ISO	EASTB	ISO	TOF	ISO	ISO	CNGS	CNGS	TOF	EASTA	ISO	CNGS	CNGS	TSTPS	ISO	ISO	CNGS	CNGS	TOF	EASTC	ISO	CNGS	CNGS	EASTC	ISO	ISO	ISO	ISO
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33		

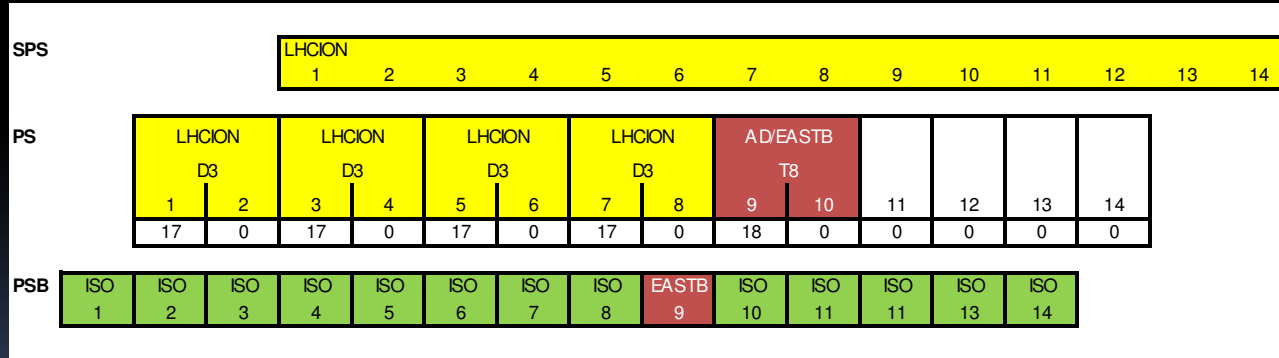
- The day super cycle can go beyond 18:00 depending on the LHC needs (lower duty cycle for others)

Dedicated LHC Filling Super Cycles

Dedicated LHC proton filling super cycle:



Dedicated LHC ion filling super cycle:



- The other physics beams displayed are not taken into account for the intensity/spill planning

ISOLDE (HRS & GPS & REX) 2010 running

- Starts 26 April, finishes 22 November giving 210 days
- Taking into account the MD's etc. this leaves $210 - 15 - 2 = 193$ days for physics (556 8-hour shifts)
- ISOLDE bases their schedule on 8-hour shifts with $2 \mu\text{A}$ on target
- To have $2 \mu\text{A}$ on target they need **43% duty cycle** with **3×10^{13} protons per cycle**
- In the proposed super cycles ISOLDE will have:
 - 36% duty cycle during day-time (excl. LHC filling time)
 - 33% duty cycle during night-time (excl. LHC filling time)
- Final **ISOLDE physics schedule available in March**

DIRAC request and particularities

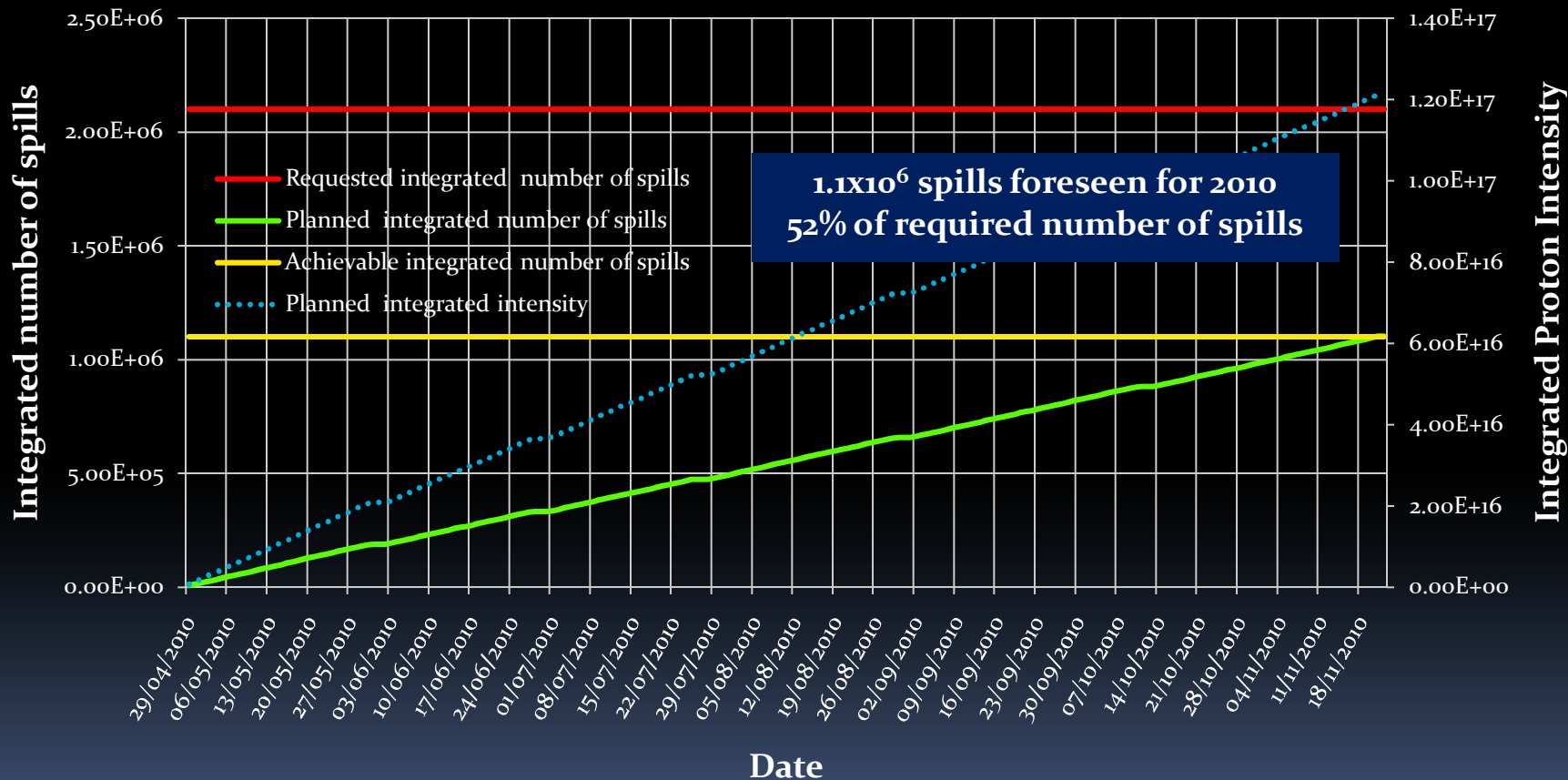
- Initially approved for **2.1×10^6 spills per year**
- The intensity per spill is 1.1×10^{11} protons
 - Produced using 4 PSB rings → very low intensity
- DIRAC cannot accept parasitic nTOF beam
 - DIRAC – nTOF bunch intensity not compatible for single beam control
 - Spill quality degrades too much (peaks/spikes)
- SPSC in January proposed to give **1 cycle less to DIRAC with respect to 2009** and give it to nTOF instead. (remains to be approved by RB)

DIRAC 2010 running (East Area T8)

- Starts 29 April, finishes 22 November giving 209 days
- Taking into account the MD's etc. this leaves $209 - 15 - 2 = 192$ days for physics
- To provide 2.1×10^6 spills we would need 35% of the super cycle for DIRAC (EASTB)
- In the proposed super cycles DIRAC will have 4 EASTB cycle per super cycle day and night ($\sim 21\%$ duty cycle)

DIRAC Integrated Spill Planning 2010

Integrated Spill Planning For the 2010 DIRAC Run



East Area T7, T9, T10, T11 2010 running

- Starts 29 April, finishes 22 November giving 209 days
- Taking into account the MD's etc. this leaves $209 - 15 - 2 =$ **192 days for physics**
- Usually:
 - **2 EASTC** cycles for T7 irradiation
 - **1 EASTA** cycle for T9, T10 & T11 (enough for Cloud ?)
- In the proposed super cycles **3 East cycles are to be shared between EASTA and EASTC**
- User time not fully scheduled
- No real shortfall in spills or protons

2010 PS Fixed Target Planning

		P1				P2				P3				P4				P5				P6										
		35 29 Apr 3 Jun				35 3 Jun 8 Jul				35 8 Jul 12 Aug				35 12 Aug 16 Sep				35 16 Sep 21 Oct				32 21 Oct 22 Nov										
T7	Setup	Irradiation				Irradiation				Irradiation				Irradiation				Irradiation														
	7	35				35				35				35				32														
T8	Setup	DIRAC				DIRAC				DIRAC				DIRAC				DIRAC														
	7	11	24			35				35				35				32														
T9	Setup	CALICE GRPC	KLOE2	CMS PLT	CMS PLT	NA62_TB	FACTOR	FACTOR	OPERA Bricks	COMPASS CALO	Irradiation				NA62_TB	CMS PLT	WHCAL	PANDAM														
	7	14	14	7	4	21	10	7	11	21	31				13	8	14	32														
T10	Setup	ALICE TOF		NA62_TB	ALICE VHMPID	ALICE TOF	ALICE TOF	ALICE FARICH	ALICE VHMPID	Irradiation				ALICE EMCAL	ALICE TOF	SUPERB	SUPERB	ALICE VHMPID	Irradiation													
	7	11		14	10	4	9	15	7	11	14	10	4	28				3	11	14	10	11	14	7								
T11	Setup	Irradiation				CLOUD				Irradiation				CLAS12				CLOUD														
	7	32				30				35				35				18				11				6				32		

3 EASTA cycles in S.C.

3 EASTC cycles in S.C.

AD 2010 running

- Machine setting up: 12 April until 10 May
- Physics starts 10 May, finishes 22 November giving 196 days (4 weeks longer than in 2009)
- 6 AD dedicated 8 hour Monday MD's
- 5 Different user groups:
 - ACE, ALPHA, ASACUSA, ATRAP, AEGIS (MD-time)
- Taking into account the MD's etc. this leaves $196 - 15 - 2 - 2 = 177$ days for physics
- The **position in the PS super cycle is optimised** to maximize AD duty cycle (1 injection per ~ 80 sec)
- No real impact on other users

Approved nTOF Physics program (1)

- The INTC has approved **5 proposals**:
 - CERN-INTC-2006-006: Proposed study of the neutron-neutron interaction at the CERN nTOF facility.
Number of protons accepted: **0.2×10^{19}**
 - CERN-INTC-2006-012: The role of Fe and Ni for s-process nucleosynthesis in the early Universe and for innovative nuclear technologies
Number of protons approved: **1.8×10^{19}**
 - CERN-INTC-2006-016: Angular distributions in the neutron-induced fission of actinides
Number of protons approved: **0.15×10^{19}**
 - CERN-INTC-2008-035: n_TOF: New target commissioning and beam characterization
Number of protons accepted: **2.45×10^{18}**
 - CERN-INTC-2009-025: Neutron capture cross section measurements of ^{238}U , ^{241}Am and ^{243}Am at n_TOF
Number of protons accepted: **8×10^{18}** (only for $^{241,3}\text{Am}$)
- **Grand total: 3.2×10^{19} protons**

Approved nTOF Physics program (2)

- Grand total of approved experiments: **3.2×10^{19} protons**
- In 2009 **7.45×10^{18}** protons were **delivered** and the following was partially done:
 - Commissioning (50% to be done in 2010 with borated water)
 - 50% of the Fe&Ni proposal completed (CERN-INTC-2006-012)
- Approved protons remaining: 2.4×10^{19}
- **nTOF realistically requests 1.6×10^{19} for 2010**

nTOF particularities

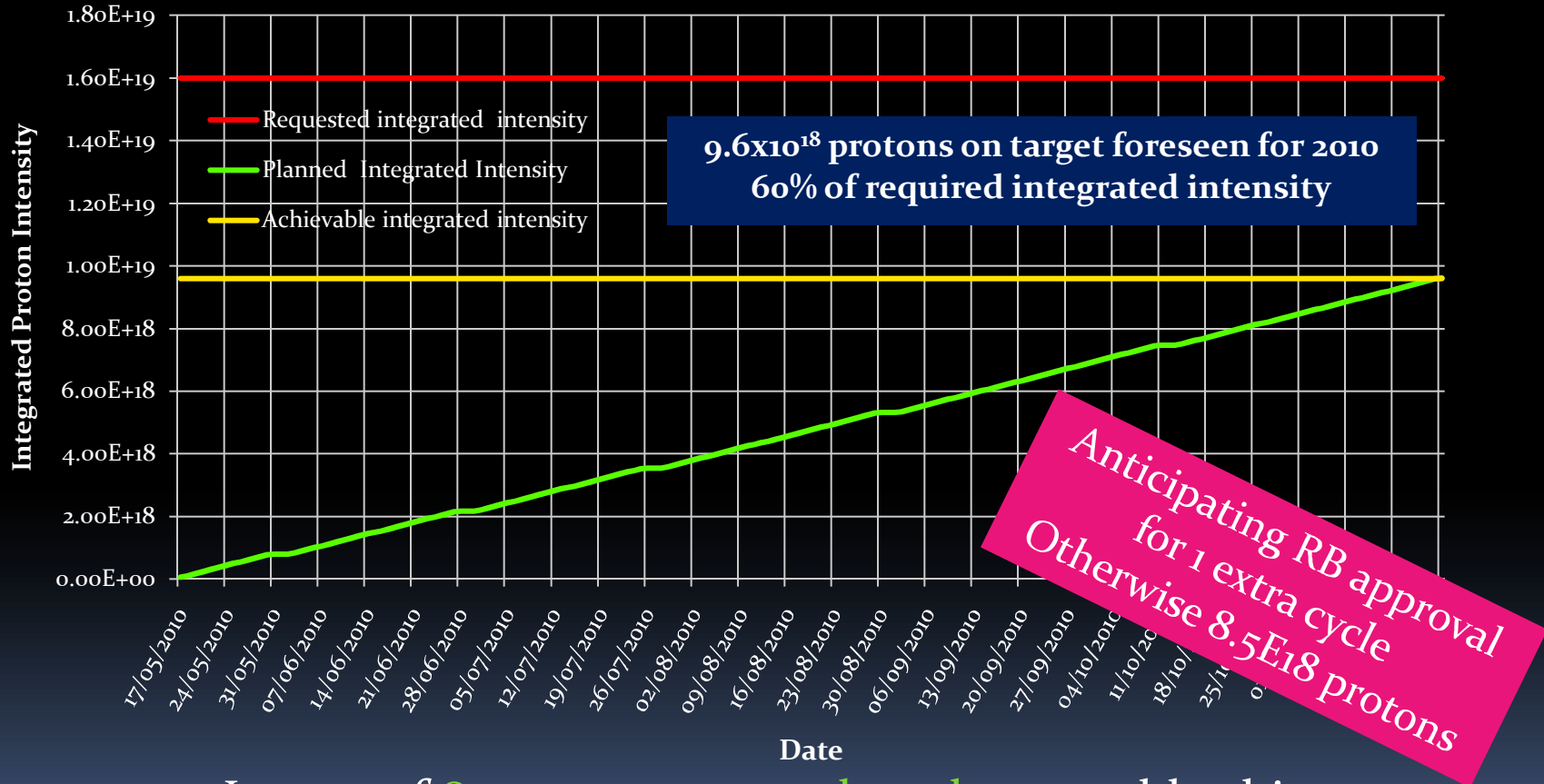
- Two types of beam are produced
 - **Dedicated** single bunch: **7×10^{12} protons**
 - **Parasitic** single bunch: **3.5×10^{12} protons**
- Just before extraction there is a bunch rotation to shorten the bunch to below 25 ns (4σ).
- The **nTOF facility can** practically **receive 4.9×10^{19} p.o.t. per year**
 - Improved cooling, ventilation and shielding
- At start-up **2010** the experimental zone will be a **“Class A Laboratory”**

nTOF 2010 running

- Starts 17 May, finishes 22 November giving 189 days
- Taking into account the MD's etc. this leaves $189 - 15 - 2 =$ **172 days for physics**
- Day & night **4 dedicated + 3 parasitic cycles** in the super cycle

nTOF integrated intensity planning 2010

Integrated Intensity Planning For the 2010 nTOF Run



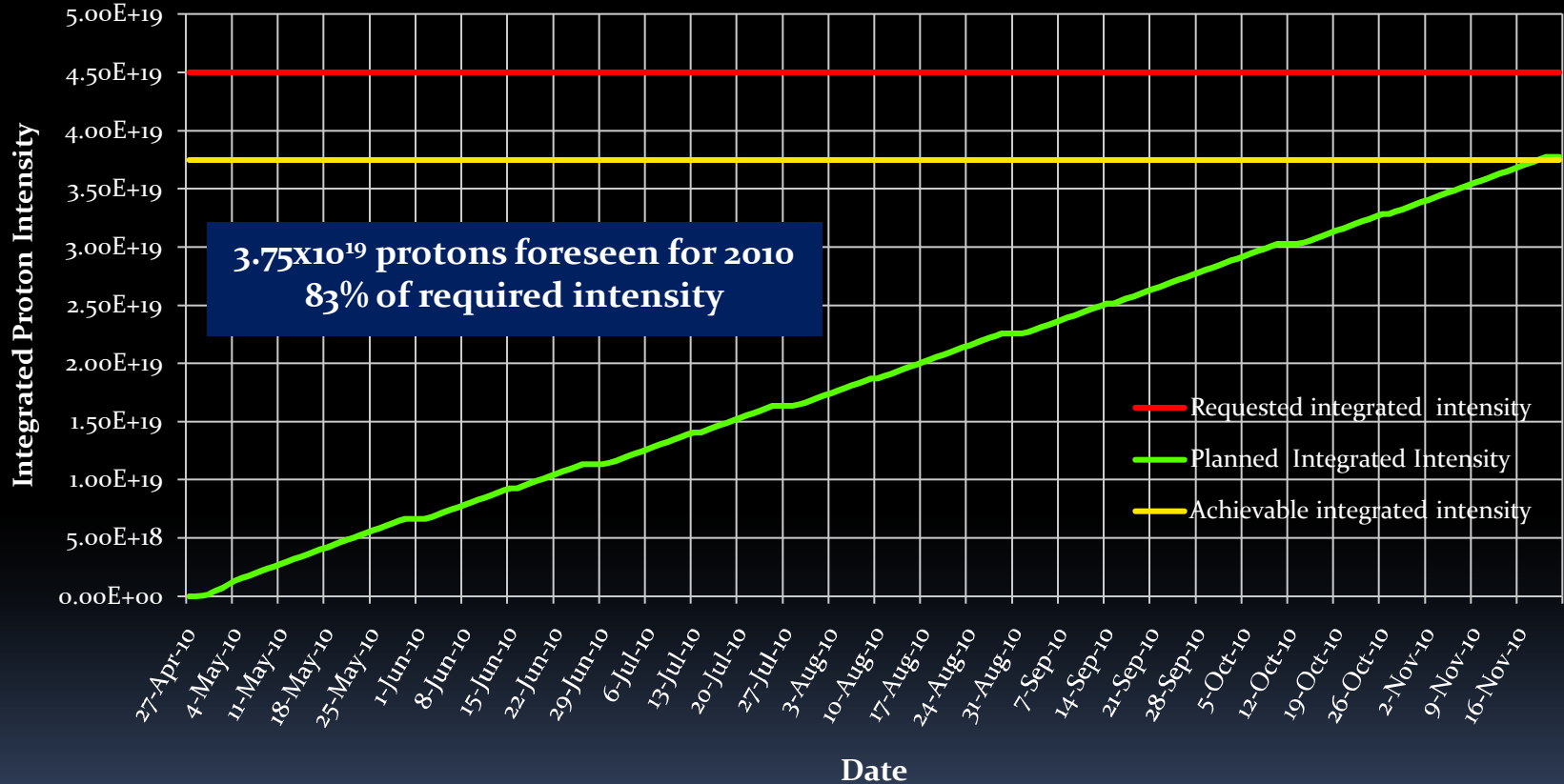
In case of 8×10^{12} protons per bunch we could achieve 1.05×10^{19} protons integrated for 2010.

CNGS 2010 running

- Recently SPSC proposed moving the CNGS start forwards by two weeks (approval RB ?)
- Starts 28 April, finishes 22 November giving 207 days
- Taking into account the MD's etc. this leaves $207 - 15 - 2 =$ **190 days for physics**
- Access to CNGS beam area requires often slightly longer stops than the 3 day MD period.

CNGS Integrated Intensity Graph 2010

Integrated Intensity Planning for the 2010 CNGS run



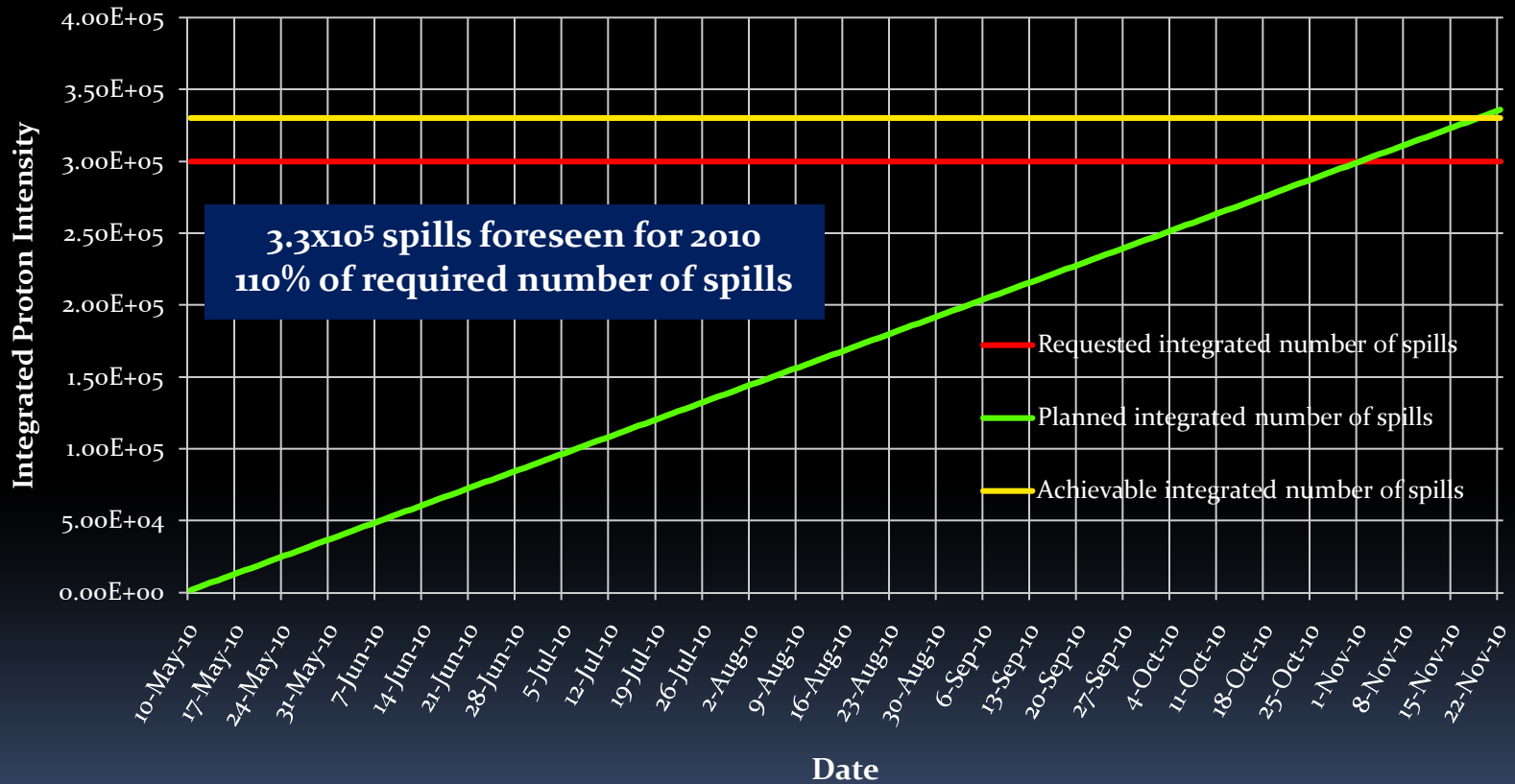
Without 2 week extension we will achieve
3.4x10¹⁹ protons integrated for 2010.

SPS North Area (COMPASS)

- Starts 10 May, finishes 22 November giving 196 days
- Taking into account the MD's etc. this leaves $196 - 15 - 2 =$ **179 days for physics**
- 3×10^5 spills of 9.6 sec requested
- User time nearly fully scheduled

SPS North Area Integrated Spill Planning 2010

Integrated number of spill Planning for the 2010 SPS North Area run



What and Where are the Short Falls?

Client	Unit	Requested	Achievable	Missing
CNGS	p+	4.5×10^{19}	3.75×10^{19}	17%
TOF	p+	1.6×10^{19}	0.85×10^{19}	47%
East Area (DIRAC)	Spills	2.1×10^6	1.2×10^6	48%
ISOLDE	Duty cycle	43%	~ 34%	21%

Possible means to reduce short falls (1)

- ISOLDE:
 - Pulse PSB at 600 ms, while keeping PS with same bp length
 - > 50% guaranteed duty cycle for ISOLDE
 - Every 2nd cycle for PS if required (more than at present)
 - Can we use synergy for LHC upgrade proposal ?
 - Higher primary beam energy → fewer protons required ?
- East Area:
 - Large number of East Area cycles required in super cycle
 - Re-instate beam sharing to avoid cycle duplication
 - Cycle requirements in new East Area lay-out proposal ? (see talk Lau Gatignon)
 - Future of DIRAC in PS ? (plans to move to SPS after 2011)
 - More effective use of EASTB cycles for DIRAC
 - Higher intensity with less cycles gives same integrated intensity ?
 - Would make parasitic nTOF perhaps possible

Possible means to reduce short falls (2)

- nTOF:
 - Try to produce higher intensity for dedicated nTOF cycle (8×10^{12} instead of $7 \times 10^{12} \rightarrow + 14\%$)
 - Fission experiments could accept multiple bunches with specific spacing \rightarrow to be checked
- In general:
 - Prolong run for PS complex into reduced power consumption period (PS complex cycling is not so expensive)
 - Evaluate possibilities to optimise cycles following POPS commissioning in PS

Conclusions

- The requests for certain facilities exceed by large the production means
- A set of reasonably achievable goals for 2010 are proposed.
- For the longer term we will have to improve the production capability and try to use our facilities more efficiently if we have to meet the requests
- Some possible fields of improvement:
 - 600 ms pulsing of PSB → guaranteed 50% ISOLDE duty cycle
 - Reintroduce East Area beam sharing to minimize cycle duplication (depends on approval of newly proposed lay-out)
 - Increase dedicated nTOF bunch intensity to 8×10^{12}
- Profit from possible synergy with LHC upgrade proposal

Acknowledgements

- Horst Breuker for providing the data as requested/approved for the different experiments
- Karel Cornelis for his input on the CNGS intensity predictions
- The nTOF collaboration for their discussions on the required intensity and the target capabilities, in particular Enrico Chiaveri, Vasilis Vlachoudis and Marco Calviani
- Alexander Josef Herlert for his input on ISOLDE.

Thanks for your attention