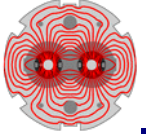
Beam requirements and operational scenarios in 2010

Rende Steerenberg
Mike Lamont

2010 - overview

- Jan: short technical stop/shutdown
- Feb: set-up for AMS and beam to AMS
- Feb: beam to LHC 17th – injection test
- Beam to LHC 22nd February – 11th April
  - Linac2, PSB, PS and SPS with (low-intensity) LHC beams only on request. Some MD OK.
- Start AD 12th April (week after Easter)
  - Followed by roll out of all users.
- Normal operation of the whole complex from April until November
  - End non-LHC physics program 22nd November
  - End LHC Ion run 28th November
- Short shutdown foreseen with start-up early in New Year
  - Details to be defined



NON LHC

Users

NB: exact realizable beam time still to be decided
LHC will impact – assume 4 hours a day in present estimates*

Facility	Start	Physics start	Physics End	Days	Early start?	Target
ISOLDE	26 April	29 April	22 Nov	184	N	
AD	13 April	10 May	22 Nov	173	Y (2 weeks granted)	
East	26 Apr	29 Apr	22 Nov	184		
nTOF	10 May	17 May	22 Nov	166	N (maybe 1 week?)	$1.6\ 10^{19}$ ($8.5\ 10^{18}$)*
North	6 May	10 May	22 Nov	173		
CNGS	6 May	13 May	22 Nov	170	(Possible 2 weeks)	$3.4\ (3.8)\ 10^{19}$

2010 – Ions

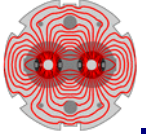
- LINAC3
- LEIR start with beam 9th August
  - EARLY to PS: 1 bunch, 2.25 10^8 [Pb54+]
  - NOMINAL: 2 bunches, 9 10^8 [Pb54+]
- Ions to PS – 23rd August
- Ions to SPS – 6th September
- Ions to LHC – 18th October – 28th November
  - 2 week setup
  - 4 week run
  - Could come under pressure

Dates open to discussion

Early ion beam only to the LHC

Beams

- PSB
  - NORMGPS, NORMHRS, STAGISO
  - AD, TOF, CNGS, EAST A,B,C, SFTPRO, LHC
  - MD
- PS
  - AD, TOF, CNGS, EAST A,B,C, SFTPRO,
  - LHC: PROBE, PILOT, INDIV, 50
  - IONS
  - Plus MTE
- SPS
  - SFTPRO, CNGS, LHCPROBE, LHCPILOT, LHC50.
  - IONS
  - COAST



Non-LHC

MACHINE DEVELOPMENT

Possible MD during dedicated LHC running

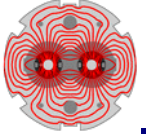
- Booster (KH):
  - two parasitic MD cycles per supercycle during the LHC run (during day time only). In case the supercycle is very long, we would ask for up to 4 MD cycles.
  - MD topics comprise LHC 25ns beam single batch transfer, emittance growth due to space charge, test of digital rf control.
- PS (RS):
  - MTE continued
  - If these MD's take place then this would be during normal working hours and any week day between the physics stop of 23rd of November and the restart of physics around Easter in 2010.
  - Appropriate cool down periods in case of PS access and interventions will have to be anticipated.

Constraints

- Still have the power consumption constraints until end March:
  - 180 MW hard limit otherwise it gets very pricey
  - Note again big display in the CCC, monitored by TI
- Precludes SPS MD
- Reminder: go ahead has been given for MD in PS and PSB during this period

MD during normal running

- MD program to slot in with LHC technical stops (see below)
- Six MD Blocks in total
  - 3 are complete 72 hours (3-days)
  - 3 are 64 hours (MD begins after an 8 hour technical stop)
- Wednesday slots suppressed but floating MD option is foreseen:
  - taking advantage of unscheduled LHC stops (1 – 2 days very possible)
  - or long LHC fills (8 – 10 hours) given luminosity lifetimes – experience to be gained on this on
  - Easy to imagine five, 8-hour blocks during the year.
  - 3 days knocked off physics time in anticipation
- Parasitic MD time throughout the year



LHC

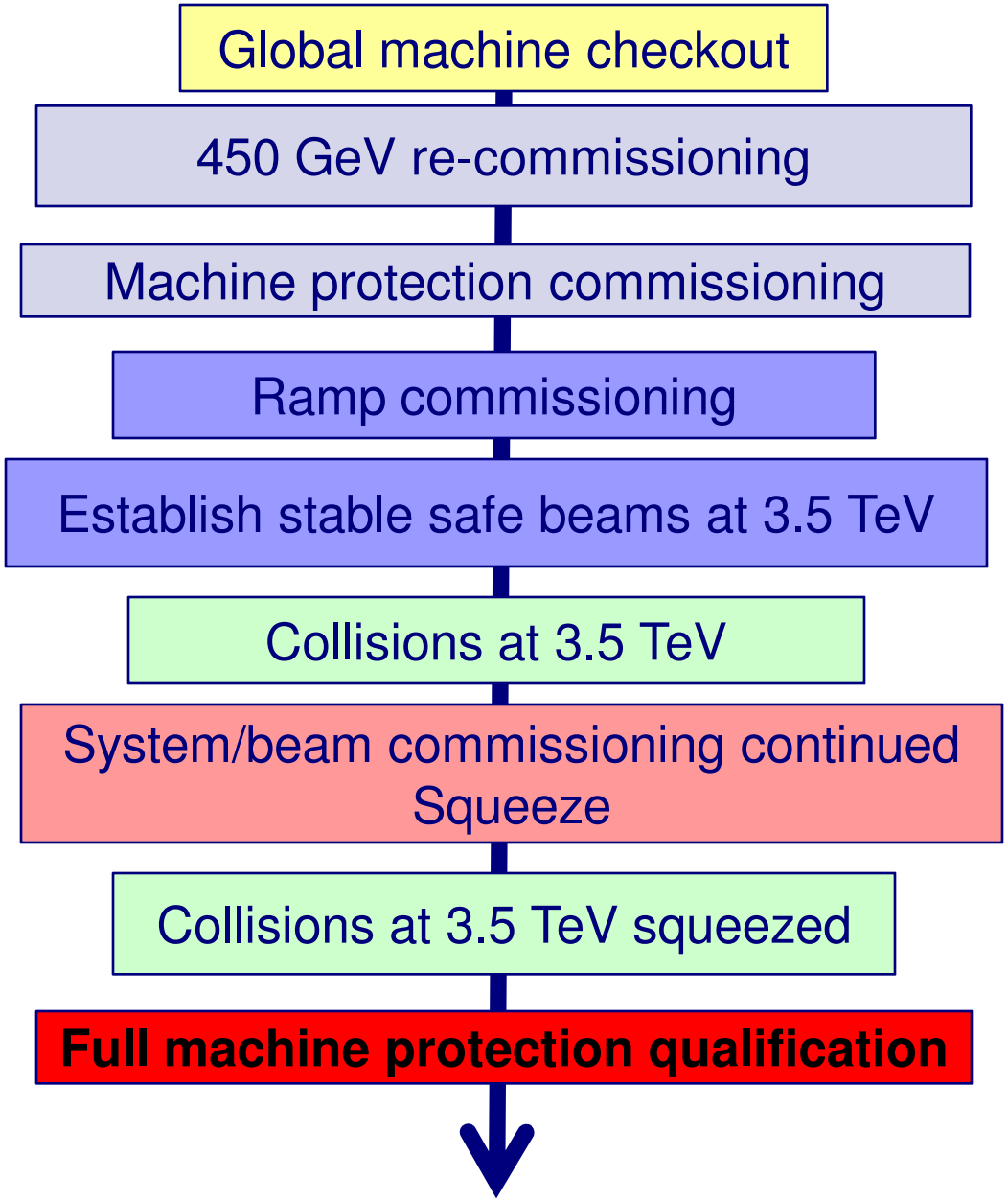
2010

- Injection test
  - 17th February – probably evening/overnight
  - Probably into point 2 only
  - No separate transfer line tests
- Start beam commissioning around Monday 22nd
  - Exact schedule depends on the progress of the nQPS commissioning
  - 4 weeks to establish stable beams at 3.5 TeV (see below)
  - Should be less frantic this time

LHC 2010 - overview

- Beam commissioning continued
  - Target: colliding, safe, stable, squeezed beams
- Consolidation & routine “pilot” physics
  - For an extended period
  - MD blocks
- Increased intensity phase 1 & associated machine protection qualification
  - Establish secure and reproducible operation
- Consolidation & routine physics
  - For an extended period
- Increased intensity phase 2 & associated machine protection qualification etc…
- Main aim is to deliver a reasonable quantity of luminosity at 3.5 TeV (100 – 200 pb^{-1})

Beam commissioning strategy 2010



Timeline - estimate

Phase	Days	
Circulating beams	2	Essential checks
450 GeV re-commissioning	7	Injection, tune, Q', C-, orbit, collimators, LBDS, instrumentation
450 optics checks	3	Beating, energy matching optimization
450 two beams	1	bumps as standard set-up, adjust TDI etc
450 GeV collisions	1	experiments on at 450 GeV
Ramp to 3.5 TeV	5	commission essential machine protection, experiments' dipoles on in ramp, orbit and tune feedback
3.5 TeV	7	machine protection (beam dumps, collimation etc.) optics
Pilot collisions un-squeezed	3-5	Safe beams at 3.5 TeV, test procedures etc.
Commission squeeze	4	feedbacks, collimation, aperture, bumps, machine protection checks, beam dumps etc.
Collisions squeezed – safe, stable beams	7	Stable beams up to safe beam limit

Heads-up – first collisions

Somewhere in the middle of March the world will turn up again

- First collisions at 3.5 TeV will be a media event
- Schedule them for first, first collisions
- Pre-commission ramp (and possibly squeeze) with non-colliding bunches
- Establish conditions for stable beams with non-colliding bunches
- First attempt to deliver colliding beams will have to be planned at least a couple of days in advance
- Choreographing the collapsing of separation bumps and subsequent steering will be attempted

What beams will the LHC need in 2009/10?

Type	Nº. Bunches /PS Batch	Intensity per bunch [x10^{+10}]	Emittance [μm]	
Pilot	1	0.5	3.5	Will always be needed
Probe	1	0.5	1.0	Used
Intermediate Physics	1	0.5 – 7	3.5	For 43x43 Physics
Intermediate Physics	4	0.5 – 7	3.5	For 156x156 Physics
50 ns	Low number/ 36	0.5 – 7	3.5	Might want to spread the beams around the LHC

Will be looking for longitudinal emittances closer to nominal (1 eV.s) this year

LHC filling - impact

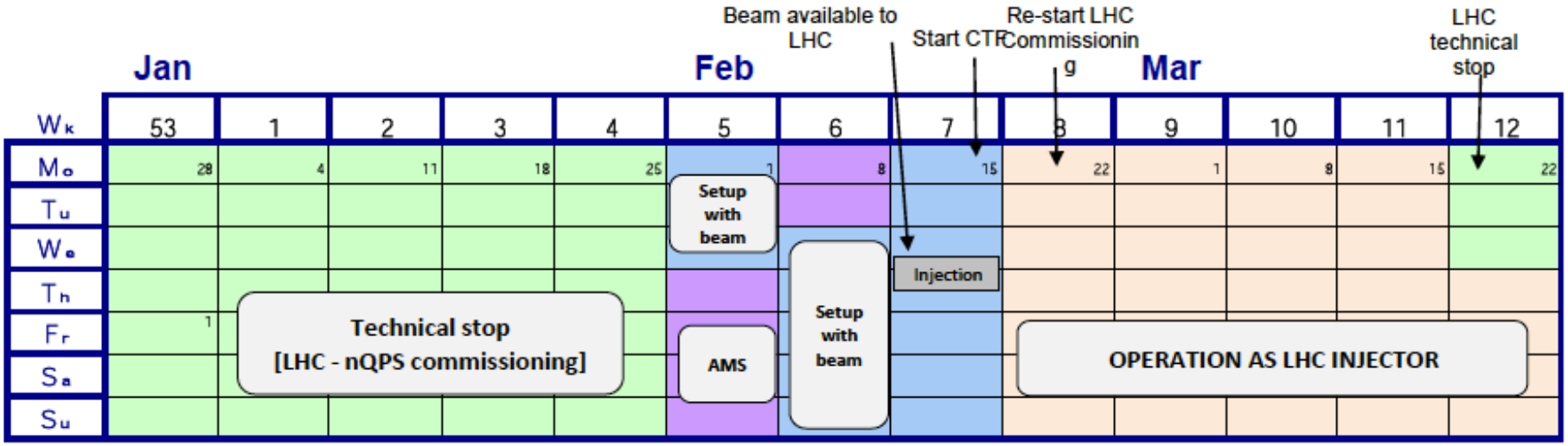
- During commissioning: embedded cycle in SPS super-cycle as at present – minimal impact:
  - LHCPROBE
  - LHCINDIV
- Production running
  - Up to 3 – 4 hours per day dedicated filling clearly a possibility (2 refills per day on average) (baseline)
  - Will kick in after 2 to 3 months if things go well
  - This time directly lost to non-LHC physics program
- Injector MD time during LHC running
  - LHC filling must take priority – see above.

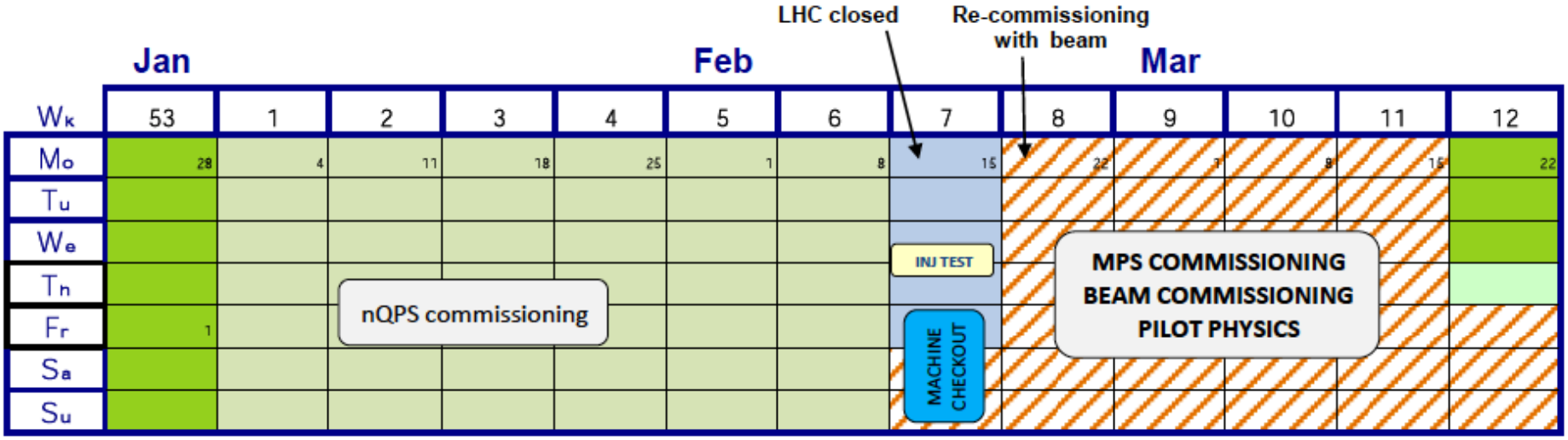
LHC - monthly technical stop

- Programmed
- 3 days including recovery and re-closure of ring
  - QPS plus power converters, controls, R2E etc.
  - Cool-down will become an issue
- Mon – Wed allowing weekday time for re-setup with beam
- Followed by one day set-up with beam and systematic checks of machine protection system
- Clearly if major breakdowns occur at other times – advantage will be taken.
- Injector stops/MD in parallel

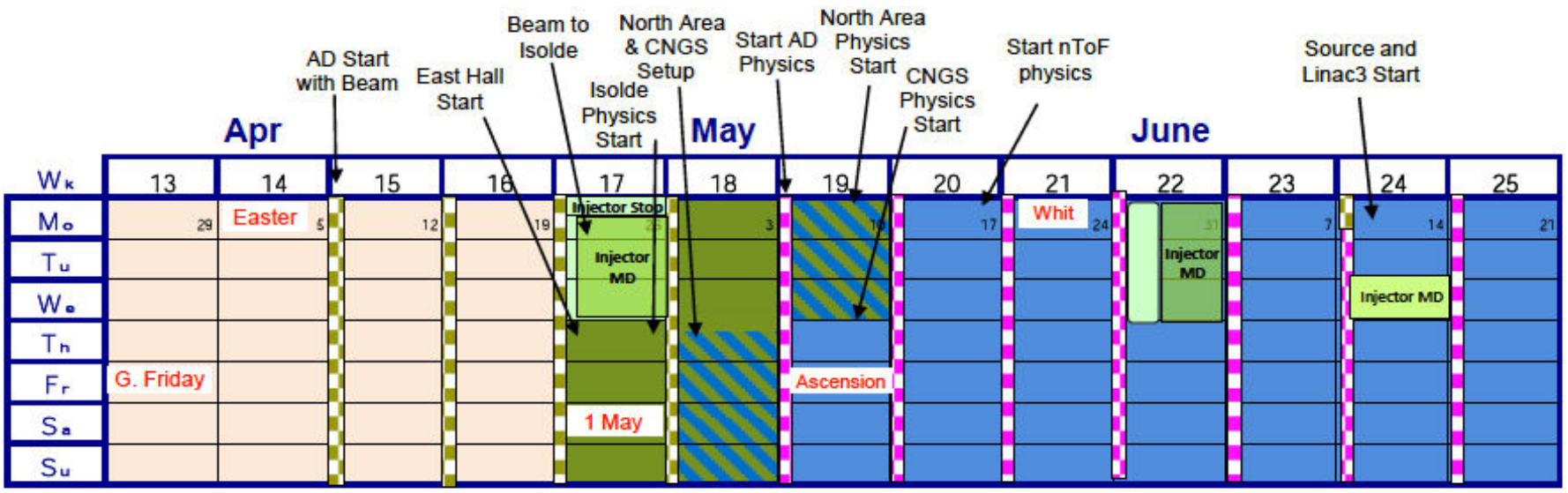
2010 Schedules

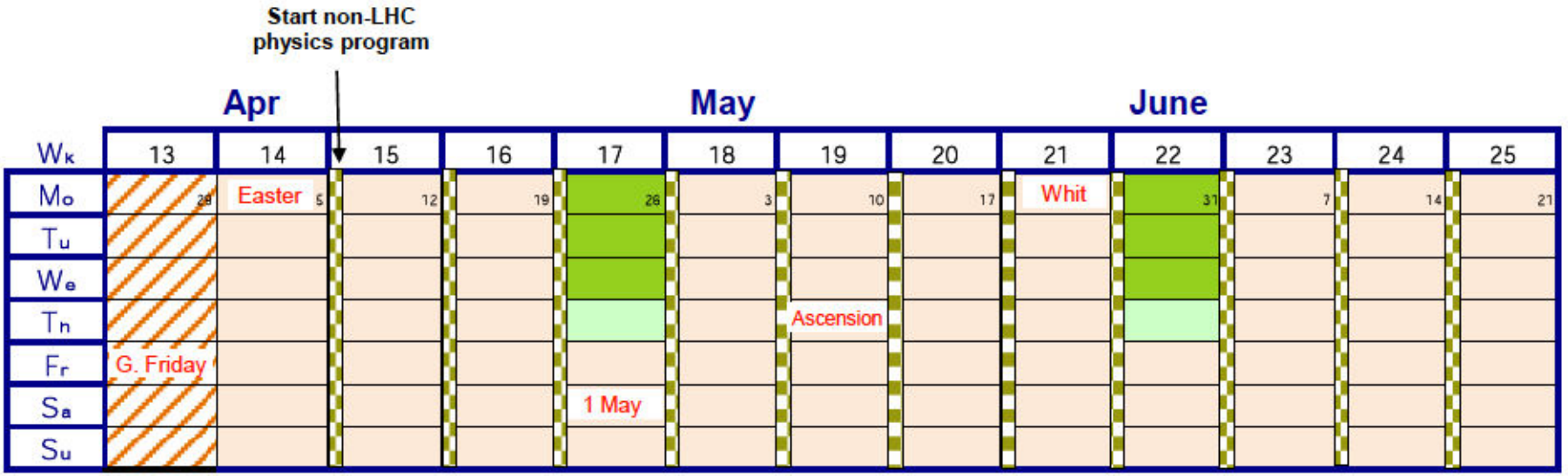
1st quarter – restart, AMS, LHC



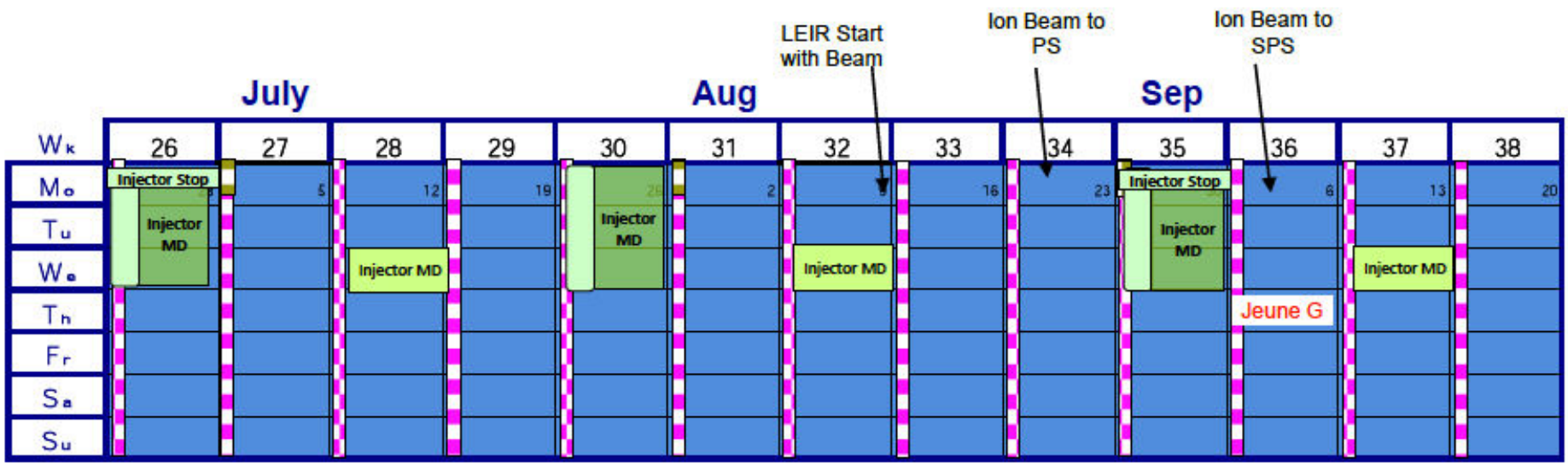


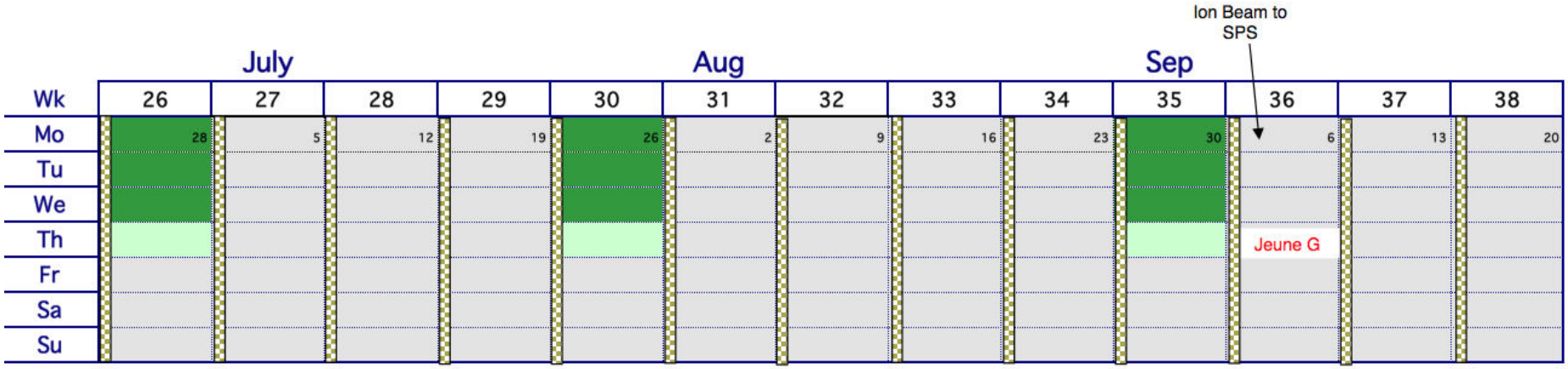
2nd quarter – physics start-up & LHC



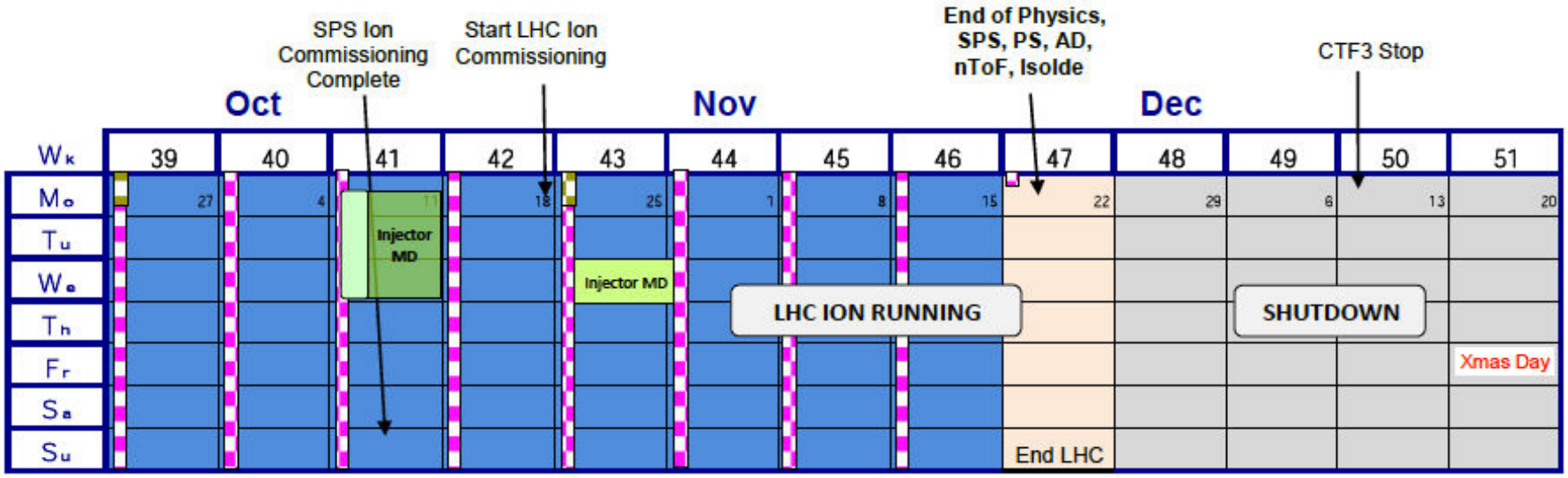


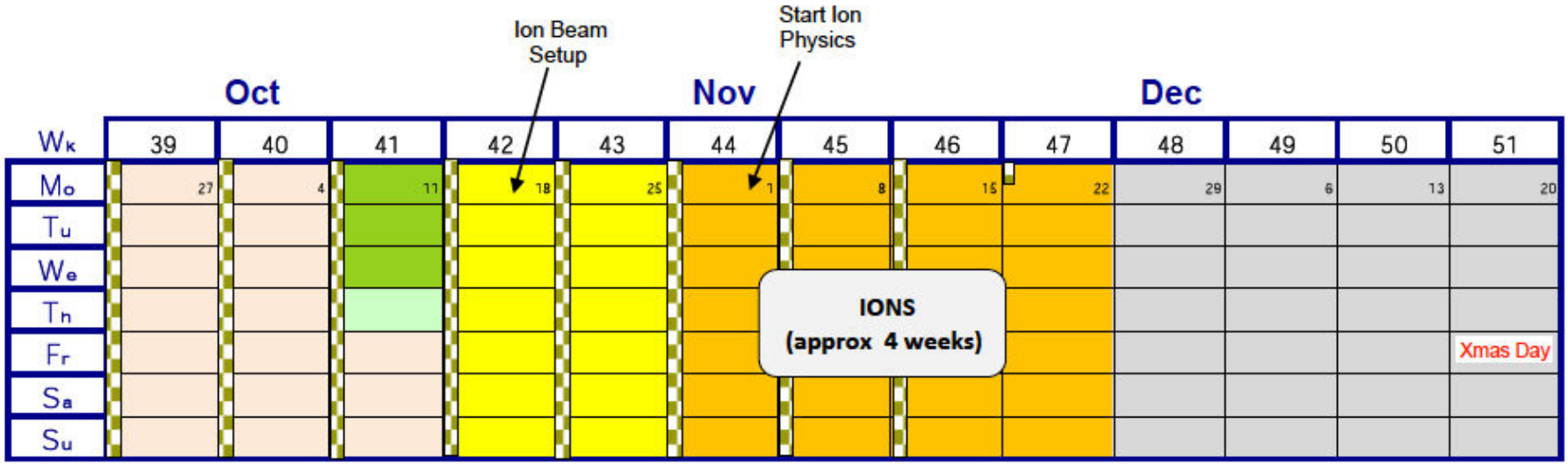
3rd quarter – production running





Fourth quarter - ions





Conclusions

- Another very busy, very long year…
- Start early, finish late
- Full program of non-LHC physics
  - Mostly old friends
  - Expect LHC to start to make a real impact this year
- LHC
  - Commissioning continued follow by luminosity production at 3.5 TeV
  - Politically important that we deliver a reasonable amount this year.