



# Status of the Accelerator Complex post LS2

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LHC Experiments Resources Review Boards, 24 April 2023

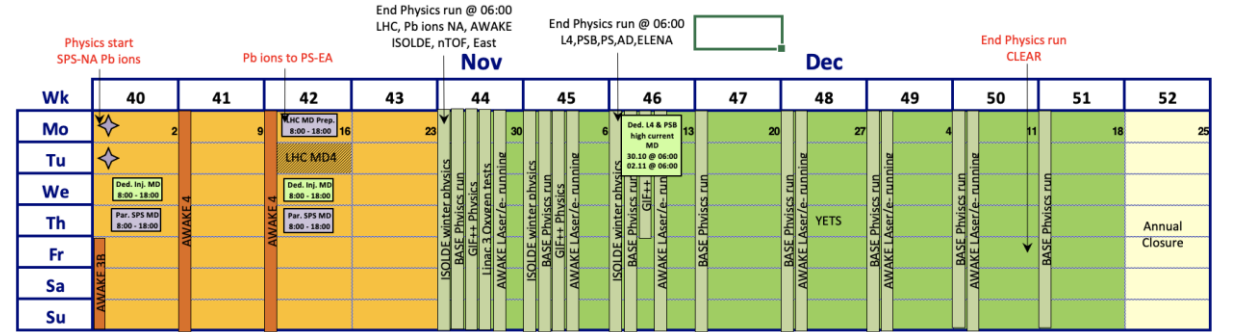
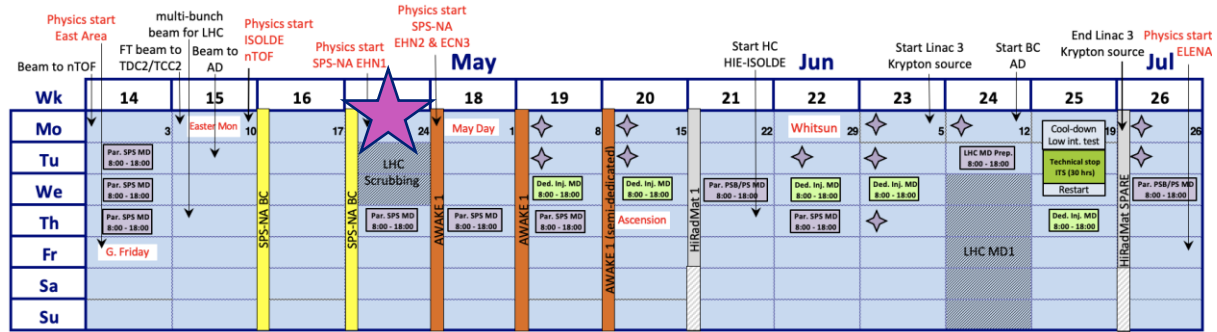
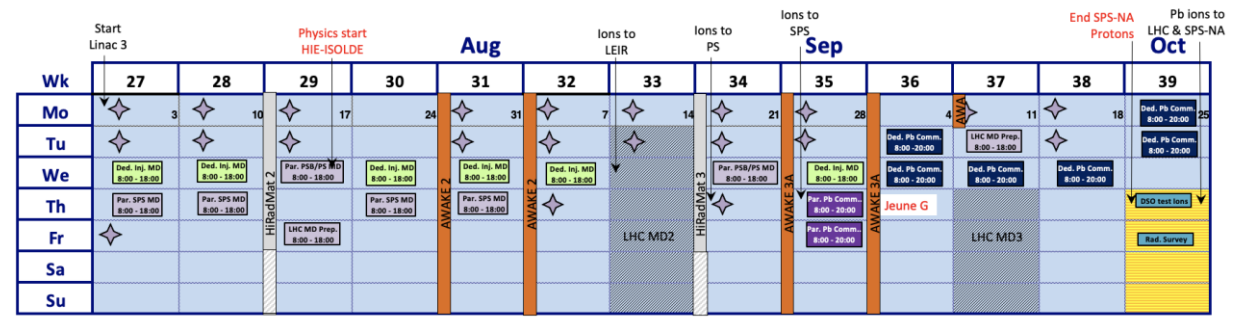
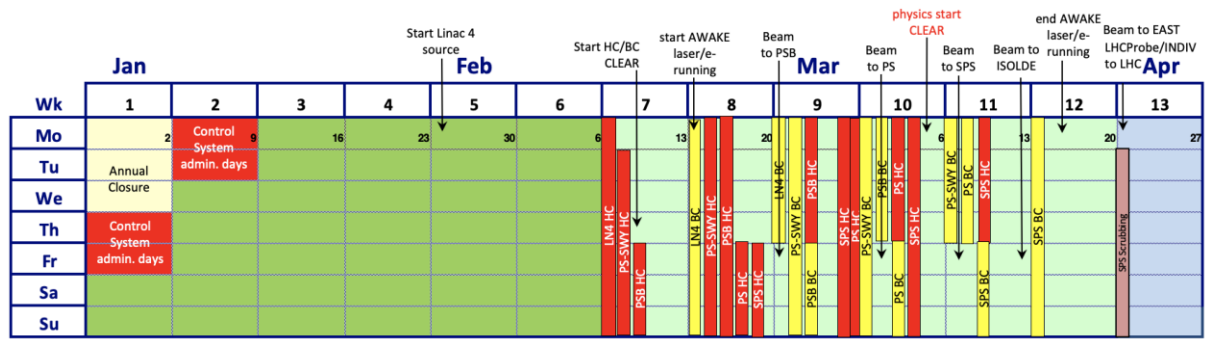
# Topics

- **Accelerators Schedule Overview**
- **LHC & Injectors Status**
- **Concluding remarks**

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# 2023 Injectors Schedule



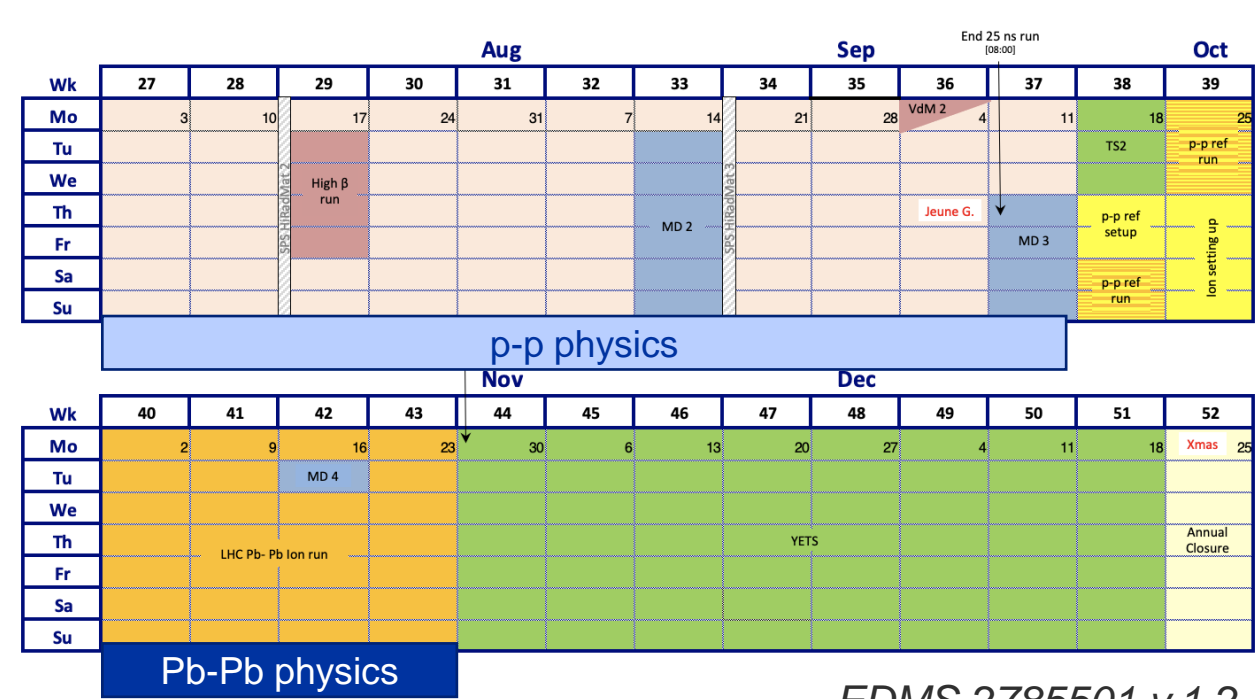
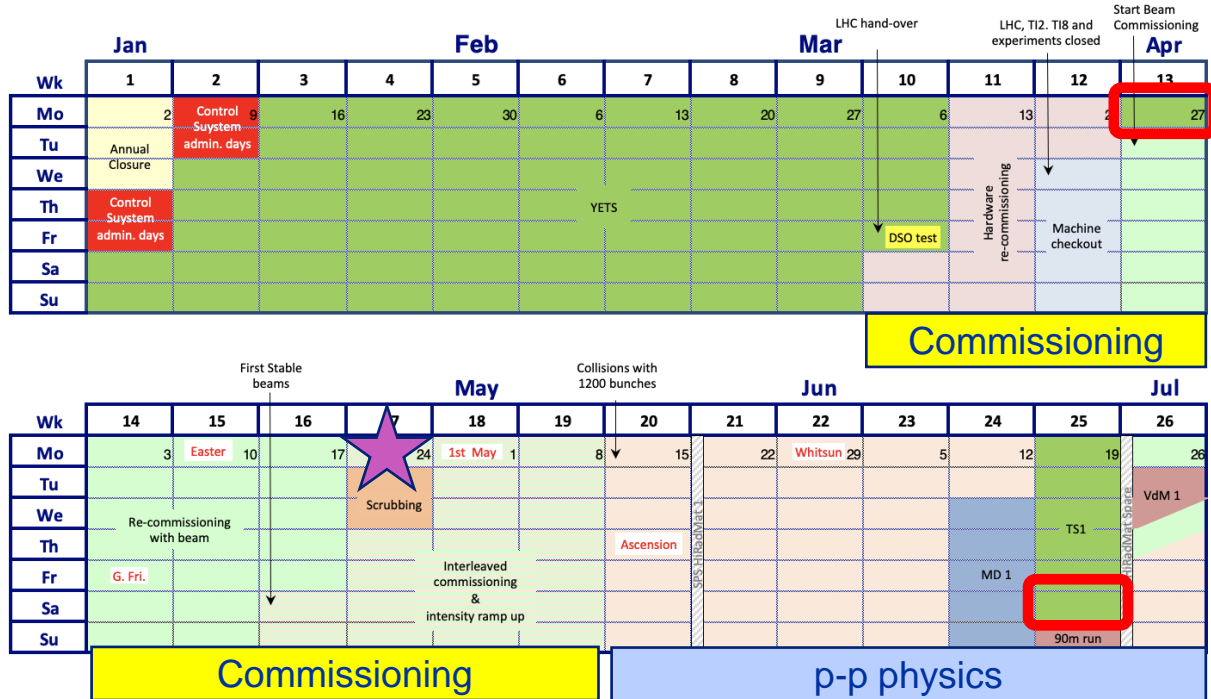
By now most fixed target experiments are taking beam

EDMS 2785499

- SPS EHN2 and ECN 3 are being commissioned with beam
- AD/ELENA delayed due to a broken magnet that is under repair



# 2023 LHC Schedule



EDMS 2785501 v.1.2

- Start of beam commissioning was delayed by 1 day due to broken crystal collimator that was removed for repair
- Technical stop 1 is extended by 1 day to re-install the crystal collimator, required for Pb-Pb physics run at the end of the 2023 run

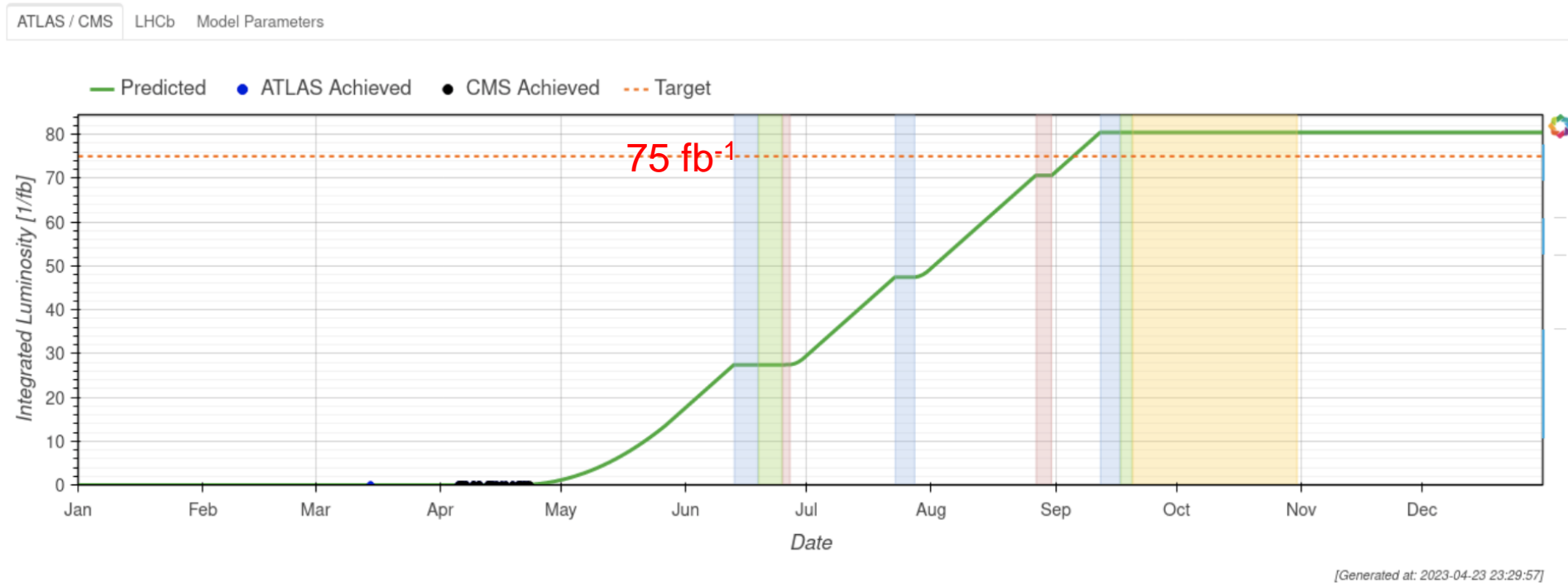
# LHC Beam time accounting

Activity	Version 1.2.		Version 1.0.	
	Duration [days]	Ratio [%]	Duration [days]	Ratio [%]
Beam Commissioning & Intensity ramp-up	46	21.2	47	21.7
Scrubbing	2	0.9	2	0.9
<b>25 ns physics (&gt;1200 bunches)</b>	<b>96</b>	<b>44.2</b>	<b>97</b>	<b>44.7</b>
<b>Special physics runs (incl. setting-up)</b>	<b>7</b>	<b>3.2</b>	<b>7</b>	<b>3.2</b>
Pb-Pb ions & p-p ref. setting-up	6	2.8	6	2.8
<b>Pb-Pb ions physics &amp; p-p ref. run</b>	<b>32</b>	<b>14.7</b>	<b>32</b>	<b>14.7</b>
Technical stop	8	3.7	8	3.7
Technical stop recovery	2	0.9	2	0.9
Other stops	2	0.9	0	0
Machine Development blocks (incl. floating MDs)	16	7.4	16	7.4
<b>Total:</b>	<b>217</b>	<b>100</b>	<b>217</b>	<b>100</b>

The 2 additional days of stop are a result of:

- Wk13: delay due to removal of crystal collimator
  - Commissioning & intensity ramp-up was reduced from 47 to 46 days
- Wk25: extra day added to TS1 for re-installation of the crystal collimator
  - 25 ns physics was reduced from 97 to 96 days

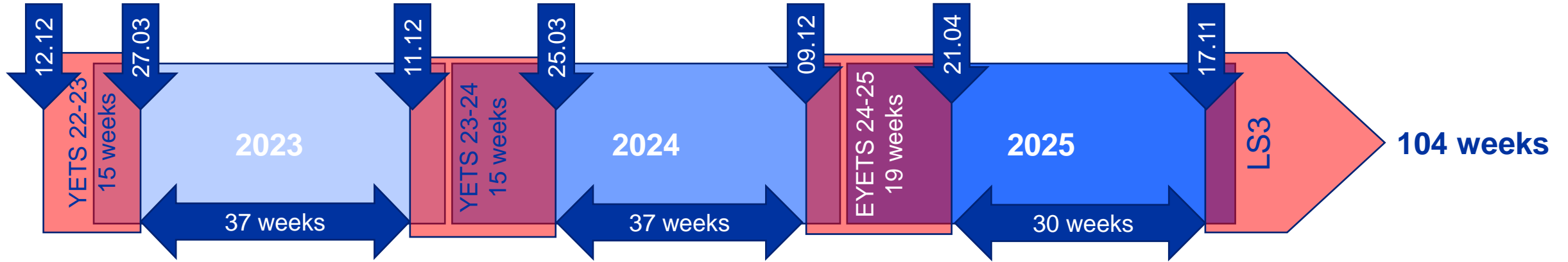
# The 2023 Goal



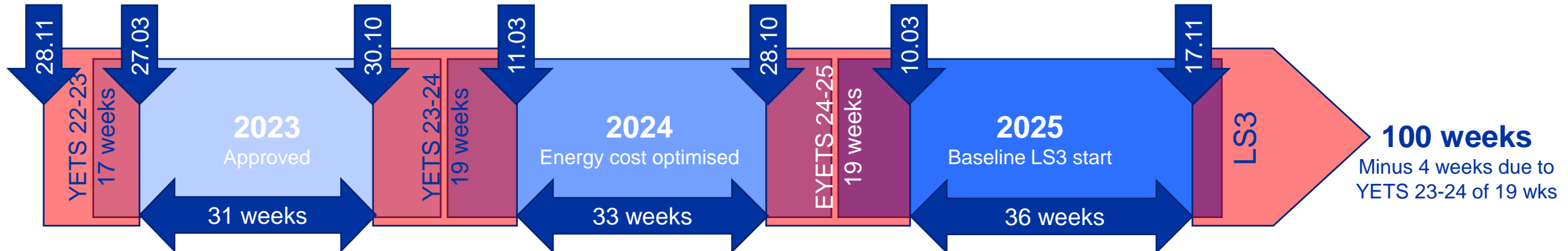
- **Forecast based on present LHC schedule and projected performance**
  - Largely influence by machine availability and stable beam time ratio

# Run 3 Baseline schedule

Initial baseline without any energy crisis related measures:



Baseline 09.03.2023 with YETS 23-24 extension of 4 weeks and anticipation by 6 weeks, EYETS 24-25 moved 6 weeks earlier, but length maintained and HL-LHC baseline for LS3 start:





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# LHC status this morning...

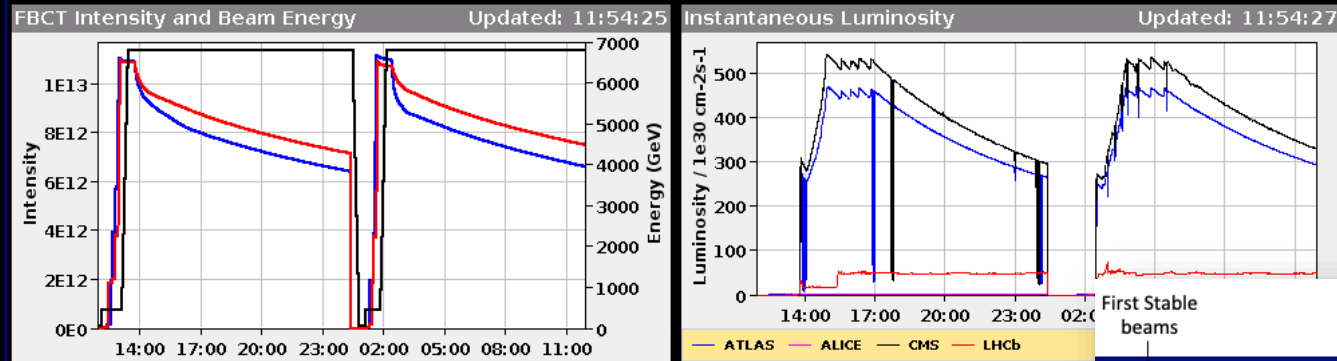
LHC Page1      Fill: 8645      E: 6800 GeV      t(SB): 09:22:30      24-04-23 11:54:26

## PROTON PHYSICS: STABLE BEAMS

Energy: 6800 GeV      I B1: 6.62e+12      I B2: 7.55e+12

Beta\* IP1: 0.30 m      Beta\* IP2: 10.00 m      Beta\* IP5: 0.30 m      Beta\* IP8: 2.00 m

Inst. Lumi [(ub.s)^-1]      IP1: 293.01      IP2: 0.18      IP5: 329.20      IP8: 49.50



Comments (24-Apr-2023 11:09:16)

Stable beams, XRPs are in Sep levelling in IP2 and IP8

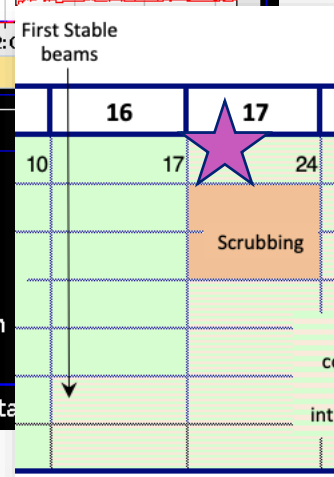
Dump planned at 13:00  
Next: RF setting up at injection

AFS: 25ns\_75b\_62\_32\_62\_12bpi\_9inj

BIS status and SMP flags

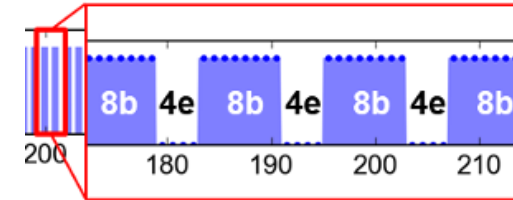
Link Status of Beam Permits  
Global Beam Permit  
Setup Beam  
Beam Presence  
Moveable Devices Allowed In  
Stable Beams

PM Status B1 **ENABLED** PM Sta

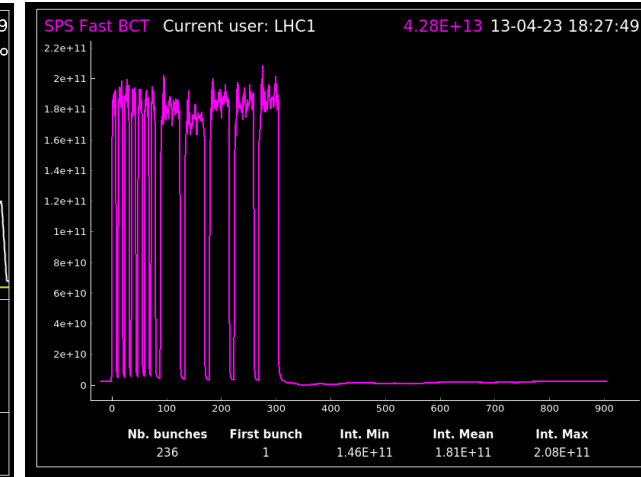
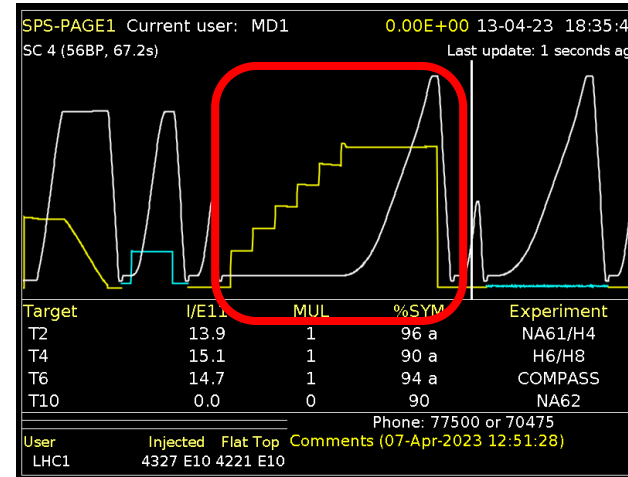


- Period of interleaved commissioning and intensity ramp-up
- First Stable Beams at 6.8 TeV were declared on Friday
- Weekend used to validate first intensity increase steps with physics in parallel
  - Present step 75 bunches
  - Next step 400 bunches
- This week e-cloud scrubbing to prepare machine for longer bunch trains

# Injectors ready for optimised LHC filling

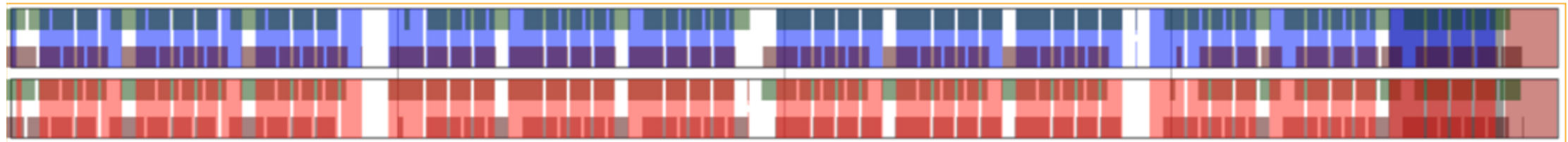


- **Hybrid beam was successfully accelerated in the SPS with  $\sim 1.8E11$  p/b**
  - $\sim 15\%$  reduction of total heat load in S78
  - 6 injections from PS
    - 1 x 8b4e (8 bunches + 4 empty buckets)
    - 5 x 36 bunches
  - Batch spacing currently 250 ns and will be brought down to 200 ns
  - In addition the filling time has been optimised
- **Made possible thanks to the huge versatility and flexibility of the injector chain and its experts**



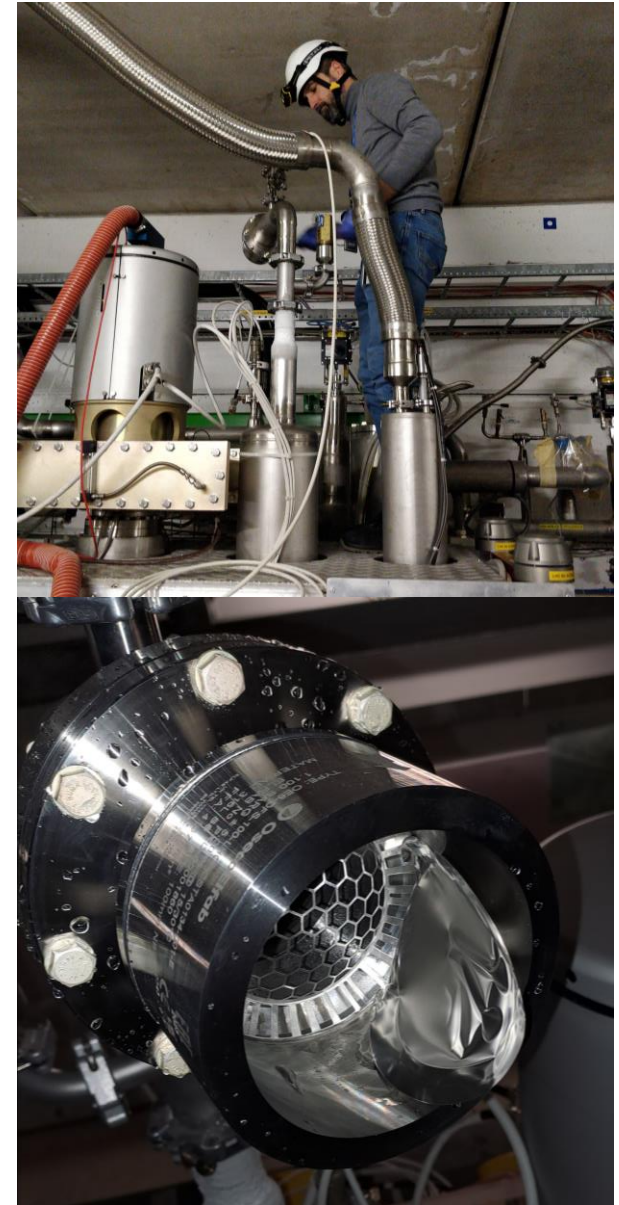
8b+4e 25 ns

2365 b, 28% 8b+4e

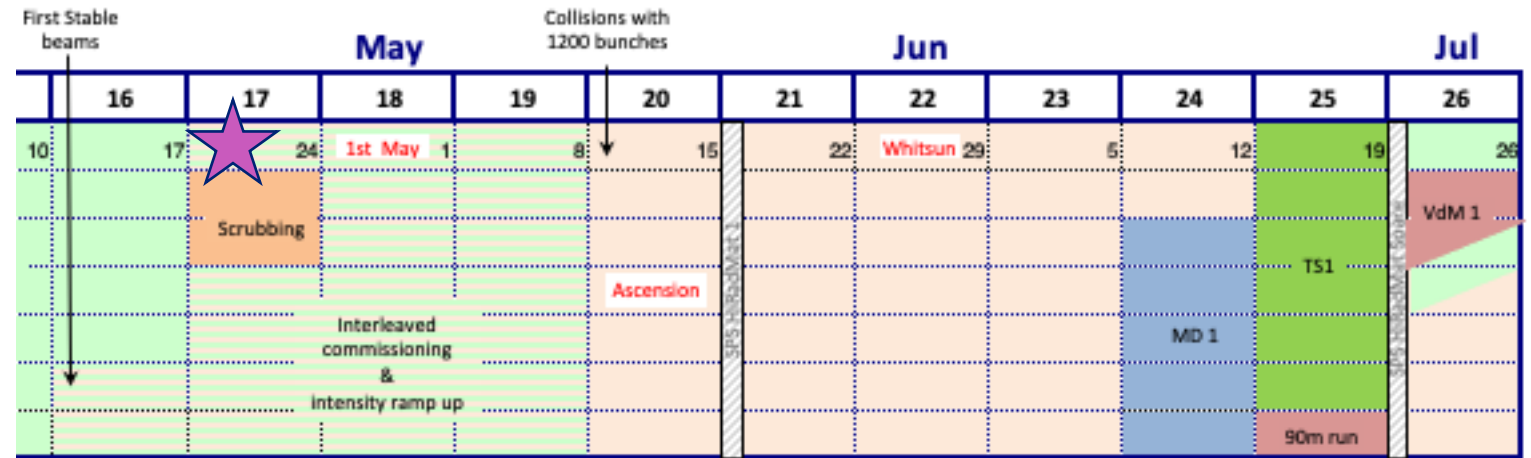


# RF rupture discs incident

- **Following incidents last year new rupture discs were installed**
  - Increased pressure and tighter tolerances
- **On April 2<sup>nd</sup> during beam commissioning a power cut in LHC point 4 caused a stop of all cryo in point 4**
  - RF cryo modules vented through safety release valves – *normal procedure*
  - Nevertheless two rupture discs burst below specified pressure
  - Disc were quickly replaced to avoid lengthy warm-up and re-conditioning cycle – experienced gained from last year and procedure followed
  - Situation, including re-conditioning, recovered in ~2.5 days
  - Burst disc task force will further investigate
- **Only ~2.5 days recovery, absorbed in commissioning period**
  - Valuable lessons learned successfully applied, reduced down time substantially



# Next steps:



- **Complete intensity ramp-up step with 75 bunches interleaved with commissioning activities**
  - RF adjustment at injection
  - Cycle cleaning – adjusting working point (tune)
  - Abort gap cleaning
  - ....
- **Scrubbing**
- **Interleaved intensity ramp-up and commissioning with physics in parallel until ~ 1200 bunches**
  - After that Physics with intensity ramp-up until full machine

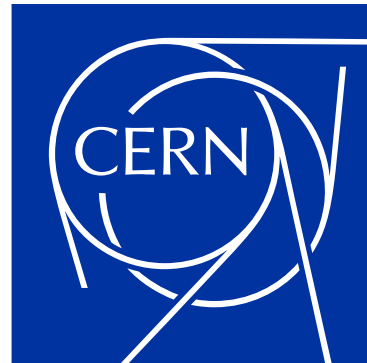
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# Concluding Remarks

- **The Injectors complex is operational and delivering beam for LHC and most fixed target physics**
  - New SPS injection kicker working well, Initially some difficulties re-conditioning the SPS dump kicker
  - Various beam schemes available for the LHC to mitigate e-cloud induced heat load while maximising luminosity production
- **LHC beam commissioning is well under way:**
  - First stable beams declared last Friday and intensity ramp-up started
  - Still some commissioning items to be completed, as scheduled
  - Electron cloud scrubbing is one of the next major steps to allow for longer bunch trains
- **No delays until now and physics with increasing number of bunches has started**
  - ~1200 bunches scheduled around mid-May
  - 2 – 3 weeks later a full machine is expected

Thank you for your attention



Any questions...?

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