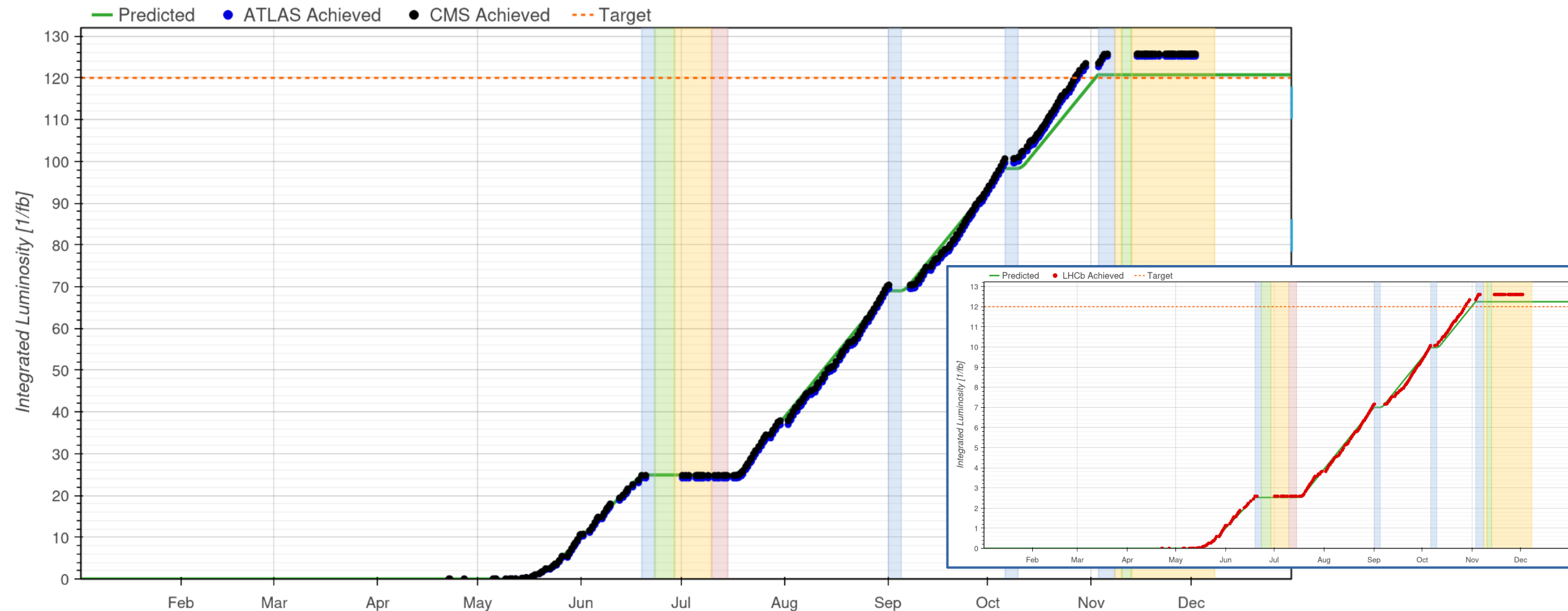


LHC performance in 2025 & what comes next...

[Chris Young](#), Chiara Zampolli (CERN)

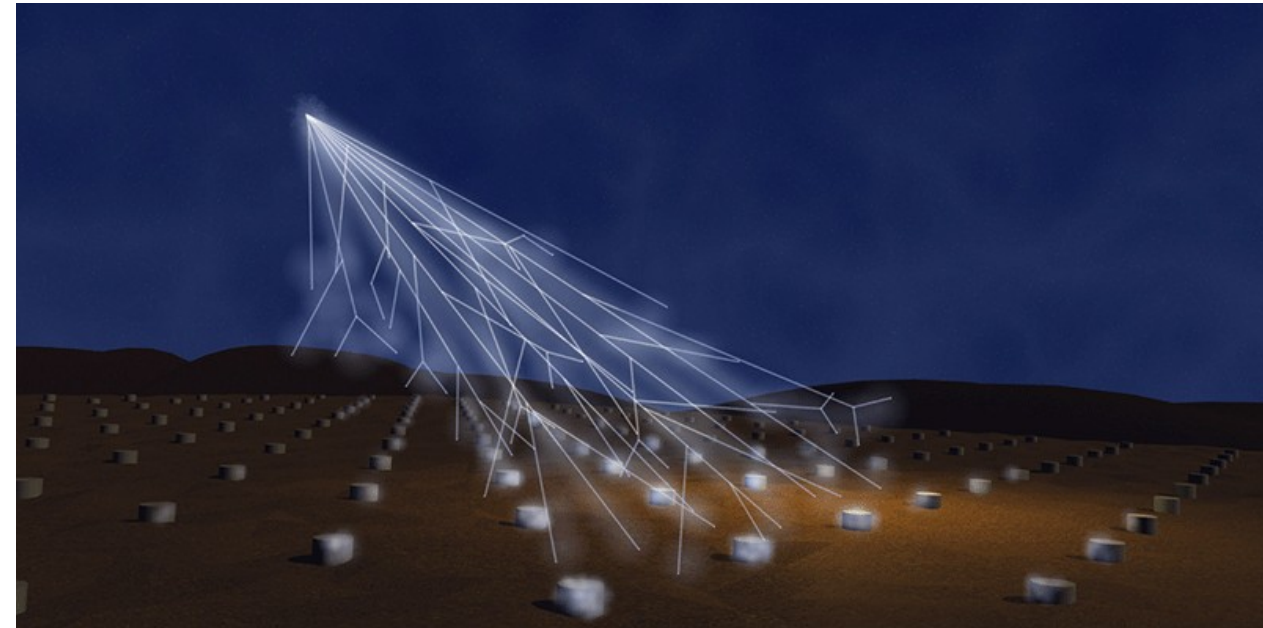
Performance in 2025 – pp

- Proton-proton data-taking dominates the yearly timetable and 2025 was a highly successful year!
- Over 125 fb^{-1} delivered to ATLAS/CMS, 12.5 fb^{-1} delivered to LHCb & 53.5 pb^{-1} delivered to ALICE!



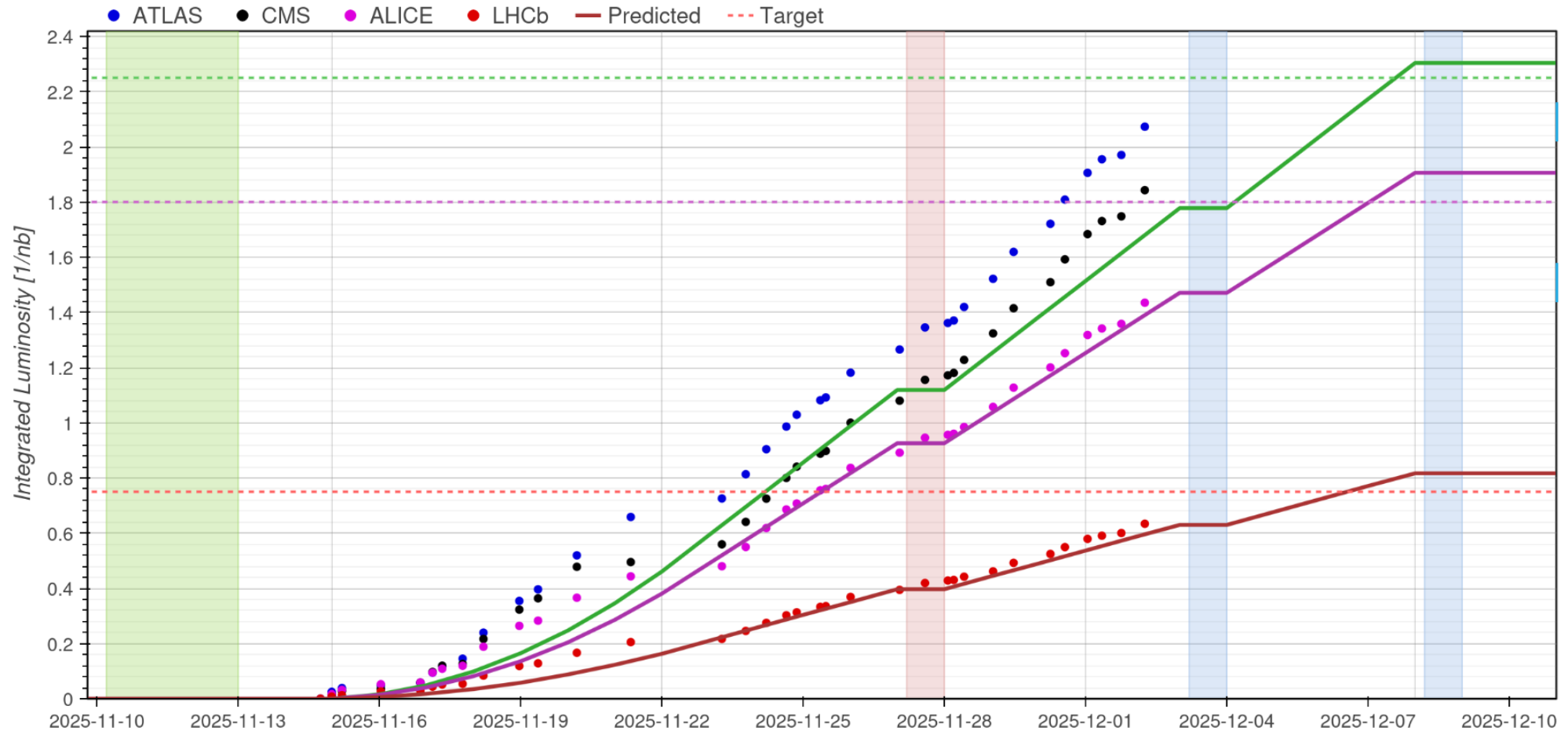
Performance in 2025 – pO/OO/NeNe

- At the beginning of July there was a short run for light ions – many more details in Theo’s talk.
- **This was highly successful collecting large p-O, O-O and Ne-Ne datasets – vastly exceeding the expectations!**
- The Oxygen program (both p-O & O-O) consisted of 8 days, with 1 additional day for Ne-Ne data taking.
- A significant fraction of the 9 days of LHC time was machine setup & commissioning
→ it is important to account for this when thinking about the future!
- A significant motivation for the run was from the astrophysics community which wanted benchmarks for high energy protons impacting the upper atmosphere which are then detected on the surface at eg. Auger.
 - Note that the community wrote a letter to CERN management motivating this, and the timeframe for when the data was needed.
- The Oxygen time was a “special run” such that the pp and Pb programs were both reduced to create the time for this program.
- The 1-day of Ne-Ne was taken from the Pb program by reducing the time assigned to heavy ion data-taking in 2026.



Performance in 2025 – Pb-Pb

- We are finishing the year with Pb-Pb data-taking which is currently on-going.
- Despite some issues with the machine availability in the past weeks a good dataset is being accumulated by all four large LHC experiments. (Lumi. calibrations are *work in progress*...)



Plans for 2026

- The 2026 schedule has been approved by the research board last week.
- No light ion physics is scheduled.**
- It is a short year starting mid-March, ending at the start of July.

	Jan				Feb			Mar					
Wk	1	2	3	4	5	6	7	8	9	10	11	12	13
Mo	29	5	12	19	26	2	9	16	23	29	5	12	19
Tu	Annual Closure												
We													
Th	New Year		YETS					Machine checkout		Scrubbing			
Fr						DSO test							
Sa							Hardware re-commissioning						
Su								Re-commissioning with beam		Interleaved commissioning & Intensity ramp up			

LHC hand-over to BE-OP (Feb 6)
 LHC, T12, T18 and experiments closed all valves open (Feb 7)
 Start Beam Commissioning (Mar 8)
 First Stable beams (Mar 9)
 Collisions with 1200 bunches (Mar 11)

	Apr			May				Jun					
Wk	14	15	16	17	18	19	20	21	22	23	24	25	26
Mo	30	Easter 6	13	20	VdM/Lumi program 27	4	11	18	Whitsun 25	1	8	15	
Tu				MD 1				MD 2		MD 3			
We													
Th							Ascension	TS		PbPb or p+Pb Run			High Intensity beam test
Fr	G. Fri.			1 TeV SMOG	1st May								
Sa								Heavy ion setting up					
Su	Easter												

End of p+ physics run [06:00] (Jun 21)
 Start physics Pb ions (Jun 22)

	Jul		Aug						Sep				
Wk	27	28	29	30	31	32	33	34	35	36	37	38	39
Mo	↓	29	6	13	20	27	3	10	17	24	31	7	14
Tu													
We													
Th													
Fr													
Sa													
Su													

End of run [06:00] (Jul 27)

Were Light Ions Considered for 2026?

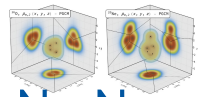
- YES!
- After the highly successful Oxygen and Neon data-taking various members of the experimental and theory community reached out to see if further light ion running was possible as part of the 2026 timetable.
- As 2026 is a short year, and there is a Pb run planned in the injector complex in August 2026, & radiation cool-down required for the start of LS3 – there were several restrictions...
 - These mainly stem from the time taken to prepare and commission the beams, and also the time that it takes to switch to Pb from some noble gas ion O[6 weeks], or from a noble gas ion to Oxygen O[2-3 weeks].
 - Noble gases also can mean that source maintenance is required that adds an additional O[1 week].
- Viable options were:
 - Replacing all Pb data-taking with O-O data (where we know source maintenance is not required).
 - A short light ion run at the very start of the year followed by a shortened Pb run (or O-O run) to end the year.
- **We also needed agreement on the ion species!** – considered options included: He⁴, C¹², Ar³⁶...
- **There wasn't wide-spread support from the experiments for any option, so no light ion running was scheduled.**
 - The fact that the Pb run would become very short, and the complications from split ion running in a short year certainly played a role in the positions of the experiments.

Light Ion Running in the Future? (Run 4)

- There is clearly large interest in light ion physics, and the experiments have voiced interest in light ion running in the future expanding the physics program from the pO/OO/NeNe data taken this year.
 - **The fast, high profile results obtained from the short run shows the excitement in this program!**
- It should be noted that the success of the 2025 run relied on many tests in advance of the actual LHC running.
 - This included testing the source at multiple occasions, simulations of radiation in the injectors (which don't have large shielding), and many tests in the injector chain: the Oxygen beam was passed all the way through the injector complex, and the Neon beam tested in the first parts of the injector chain, switching tested twice.
 - The LHC beam parameters, optics and machine setup also all had to be prepared.

→ **planning well in advance what ions are desired clearly increases the chances of a successful program.**
(the Oxygen run was first proposed during Run 2 and a close-to-final plan was in place in 2021!)
- **Time in the LHC is incredibly valuable and sought after.**
 - Therefore light ion running competes against other physics interests for time.
 - **The CERN Research Board has made it clear that light ion running in Run 4 would not be counted as a “special run” and therefore would come out of Pb-Pb/p-Pb running time.**
 - The agreement between the experiments on a program (including time-taken from Pb) is essential to make light ion running in Run 4 a reality...

Light Ion Running in the Future? (Run 4)

- During Run 4 there are three periods of 29 days assigned to ion physics in 2031 / 2032 / 2033. [1]
- For example, if it is desired by the experiments then some time could be taken out of these blocks for a **short light ion run**, similar in style to the Oxygen run with another ion(s). (Other lengths/scenarios are also possible...)
 - the experiments/community would need to agree on a program – **this links to the aims of the workshop!**
 - predictions would be very useful for this – to demonstrate the impact, show the relative importance of the uncertainties, and motivate the amount of data needed (luminosity/number of events/relative to OO?).
- Several different ions could be considered. Note that $Z/A=1/2$ could mean that the same machine setup could be recycled for multiple species, but it does result in *transmutation* effects (see John's presentation).
 - Examples of $Z/A=1/2$: He^4 , C^{12} , O^{16} , Ne^{20} , Mg^{24} , Ar^{36} .
- This (taking time from Pb, citing pheno papers eg. [3]) was done for Ne-Ne. 
- For beyond Run 4, Roderik gave a talk earlier this morning detailing the possibilities & performance estimates. (Note the motivation is collecting the most luminosity of a significantly large system, not light ion physics...)
- Any questions...?

