



# Status of the Accelerator Complex

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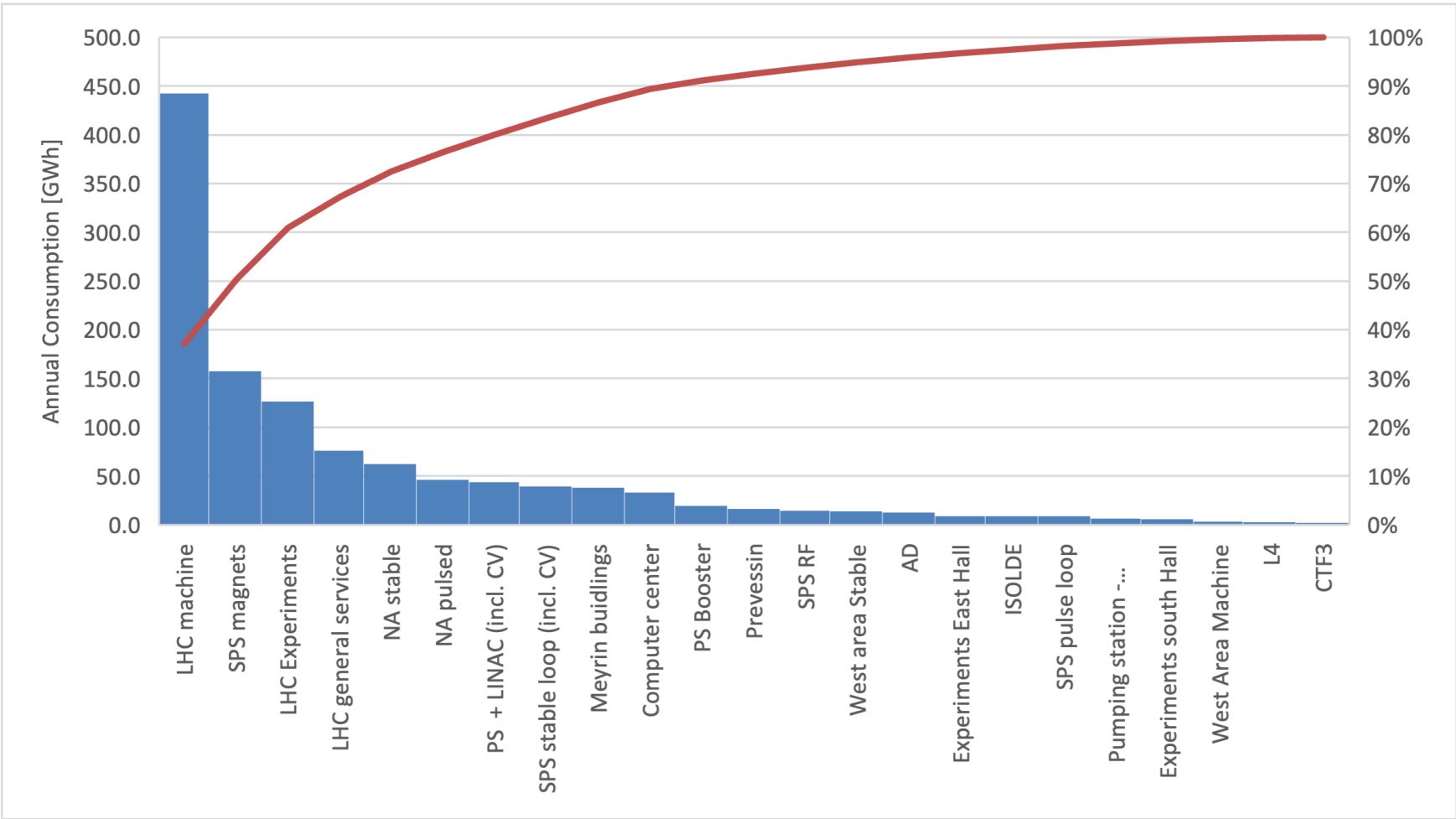
RRB, 24<sup>th</sup> October 2022

# Electrical Load Shedding - Accelerator Complex

- **EDF/RTE foresees stress on the French electrical network from 15th October 2022 onwards (weather dependent – warm October so far)**
- **If the situation requires EDF/RTE requires:**
  - A voltage drop (~ 5%) – no impact for CERN
  - Load shedding for a few hours (during days) with pre-warning – impact for CERN
  - In the worst case possible complete power cut – low probability but high impact
- **Load shedding scenarios for CERN**
  - Several scenarios identified to reduce electrical consumption
  - Workflow and procedures to execute load shedding scenarios have been defined
- **Various measures being implemented to save energy on CERN sites (public lighting, central heating reduction, etc.)**
- **Early stop of the complex...**

# Annual Consumption during a Run

Annual total ~1.3 TWh



Average (17,18) [GWh]

# 2022 Schedule Adjustments

## **2022: Complex starts year end technical stop (YETS) 2 weeks early**

- Stop Monday 28<sup>th</sup> November instead of Monday 12<sup>th</sup> December
- Explicit request/offer from EDF (~10 MCHF plus savings from reduced consumption)
- Demonstration of CERN's social responsibility in difficult times

## **Schedule impact**

- No 2022 LHC ion run – compensation in future years
- Maintain shorter 2022 SPS North Area Pb ion run (reduced by 2 weeks, compensation in 23)
- Keep end of 2022 physics run dates for ISOLDE, n\_TOF, PS-EA on 28<sup>th</sup> November

## **2023/2024: 19 weeks YETS**

- Explicitly included in MTP – draft schedule in place
- Social responsibility – could easily roll-back if situation improves

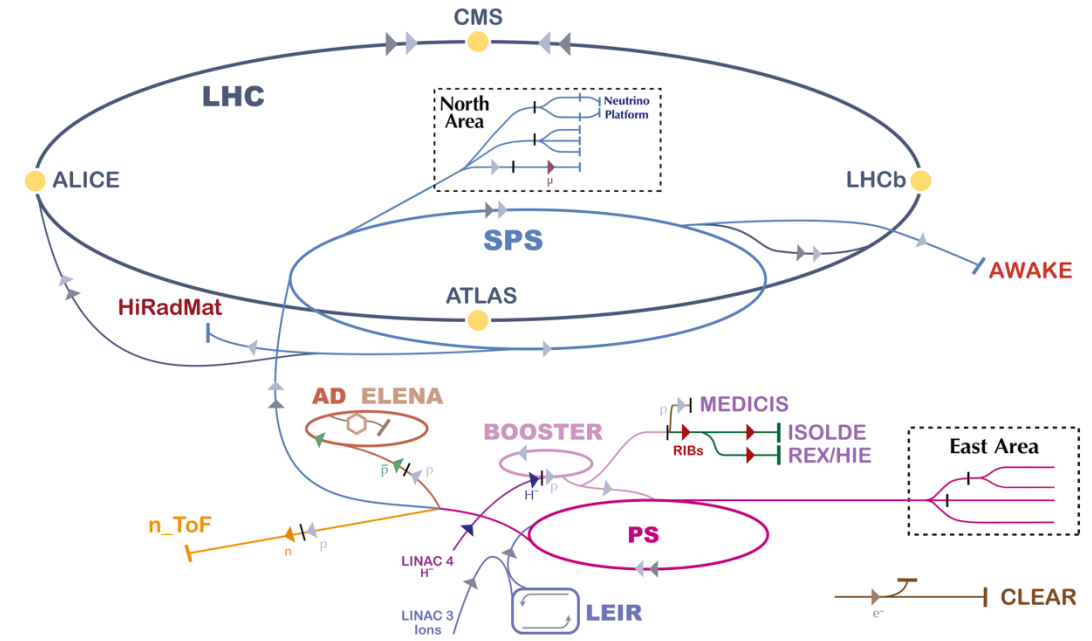
# Availability Overview - Injectors

Facility	Destination	Expected 2022 Total [%]	Achieved 2022 Total [%]*
LINAC4	-	95	96.8
PSB	PS	90	94.8
	ISOLDE		
PS	SPS	87	89.6
	nTOF		
	AD		
	East Area		
SPS	LHC	84	91.3
	North Area		71.9
	AWAKE		92.9
	HiRadMat		95.4

\* Availability since start of physics for the machine concerned  
Linac4, PSB, PS since 28.03.2022 & SPS since 25.04.2022

SPS for the North Area suffered from three long faults during the first weeks of the run

## Otherwise looking good across the complex



►  $\text{H}^-$  (hydrogen anion) ► p (protons) ► ions ► **RIBs (Radioactive Ion Beams)** ► n (neutrons) ►  $\bar{p}$  (antiprotons) ►  $e^-$  (electrons)

## Start of YETS 2 weeks earlier than foreseen

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- No impact for ISOLDE, n\_TOF, East p+



# LHC highlights - 5<sup>th</sup> July

After ~ 11 weeks of commissioning

## First Stable Beams energy record 13.6 TeV on 5th July

- Cryo managed to recover just in time from a rather heavy quench in the morning !!

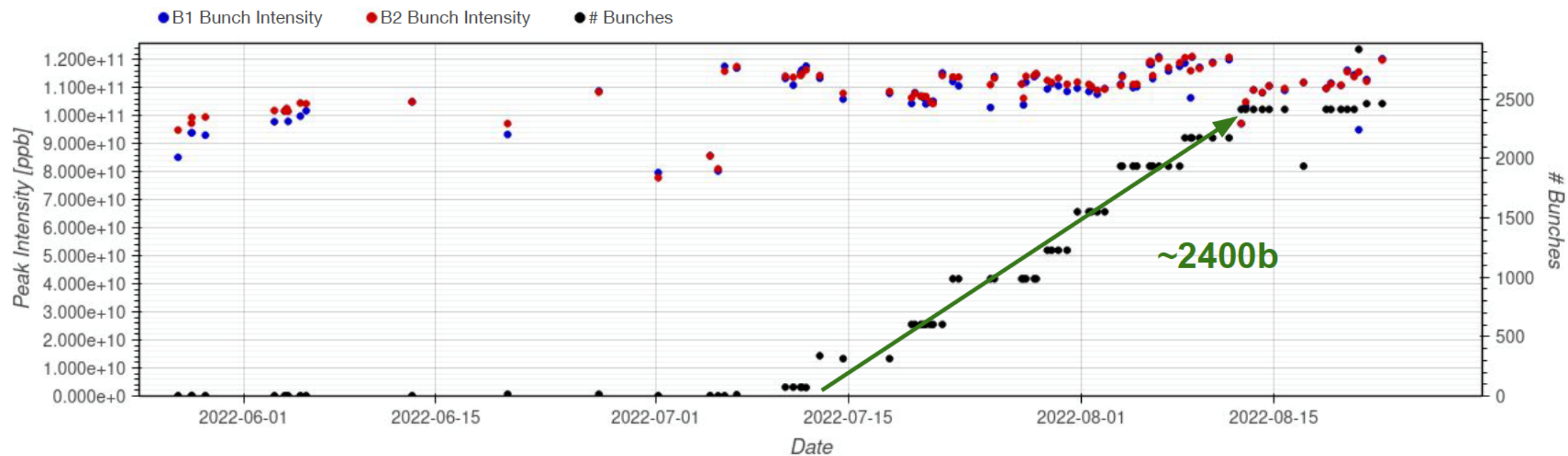
Very successful event as reported by the communication team



Many thanks to the IR-ECO and the many other services and experiments for the organization and collaboration in the event!

# LHC – intensity ramp-up

- Intensity ramp-up proceeded smoothly
  - 75b 10/07 → ~ 2400b 12/08
  - Limited to 2400b due to heatload limitation in S78 (step 2700b missing)
- Machine protection checklist approved before each step





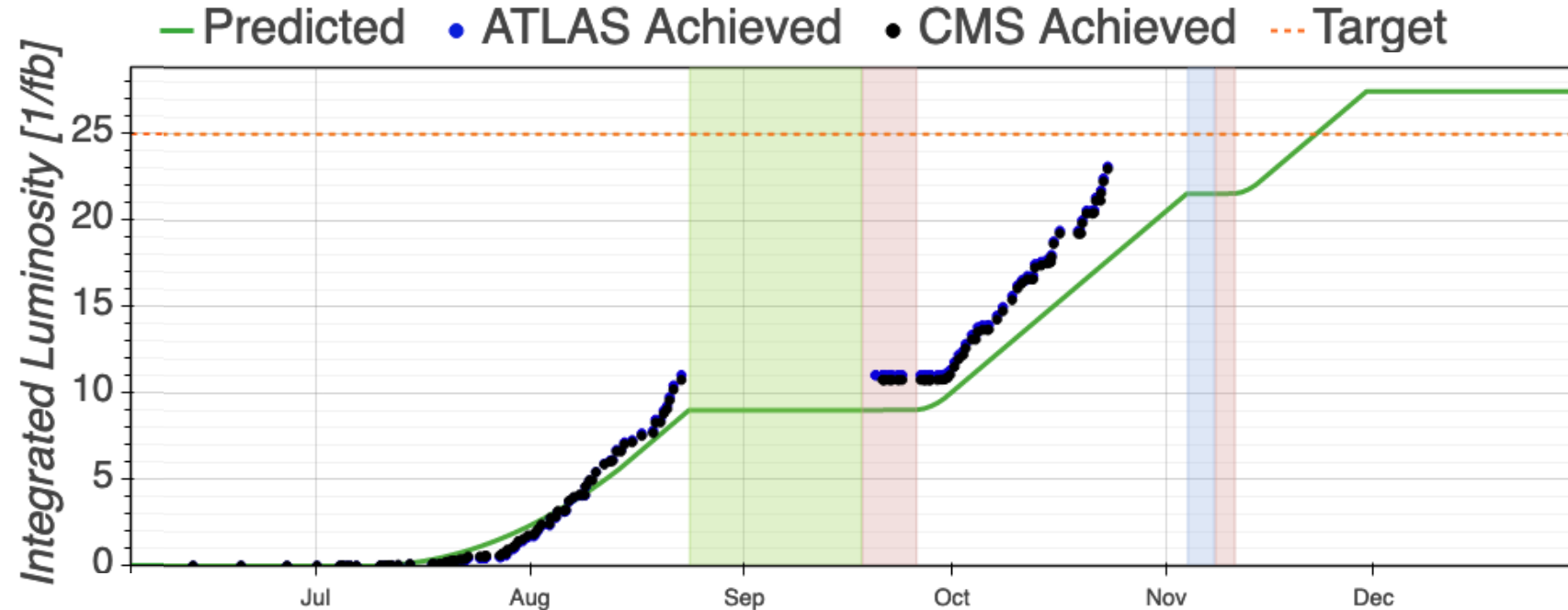
# Luminosity production

Good progress following first Stable Beams on 5<sup>th</sup> July

However, 23<sup>rd</sup> August, lost cooling, and then cryogenics in point 4 – three RF cavity pressure release discs ruptured – had to warm up cavities to flush H<sub>2</sub>O – cool back down and re-condition – **3 weeks beam time lost**

Opportunity taken to bed-in main dipoles at 6.8 TeV – continued training at nominal +100 A

Beam back 20<sup>th</sup> September after scheduled technical stop – looking good since

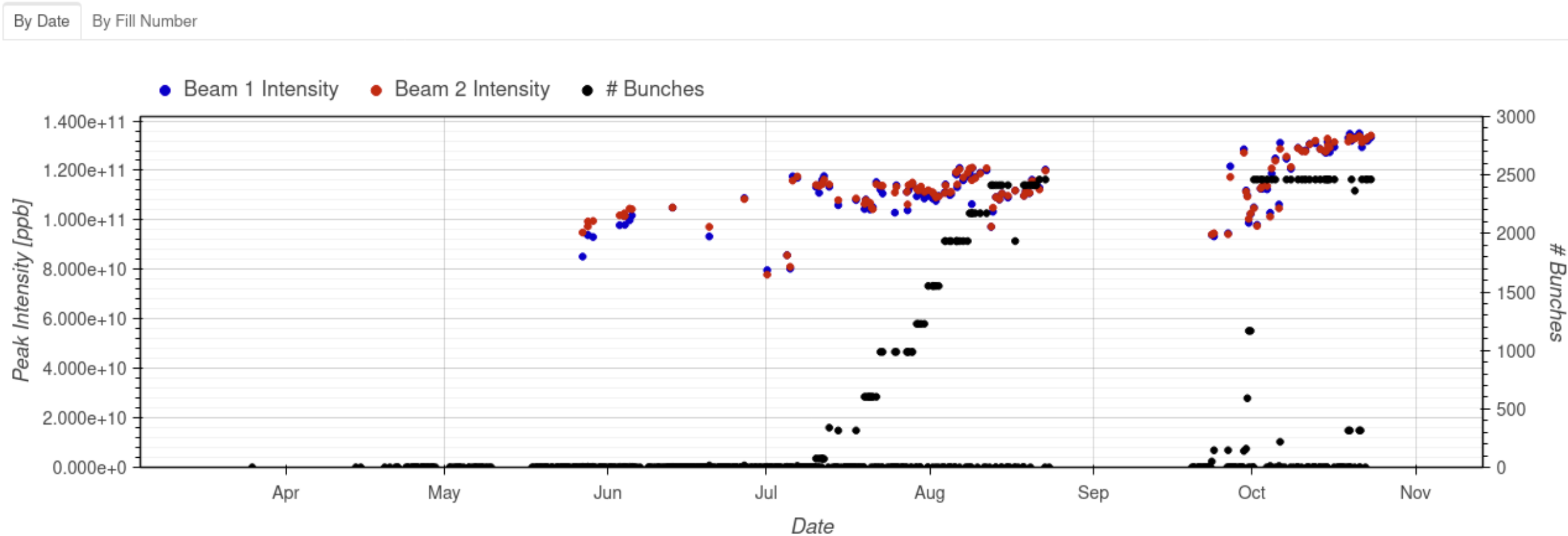


# 2022 GPD records (courtesy ATLAS)

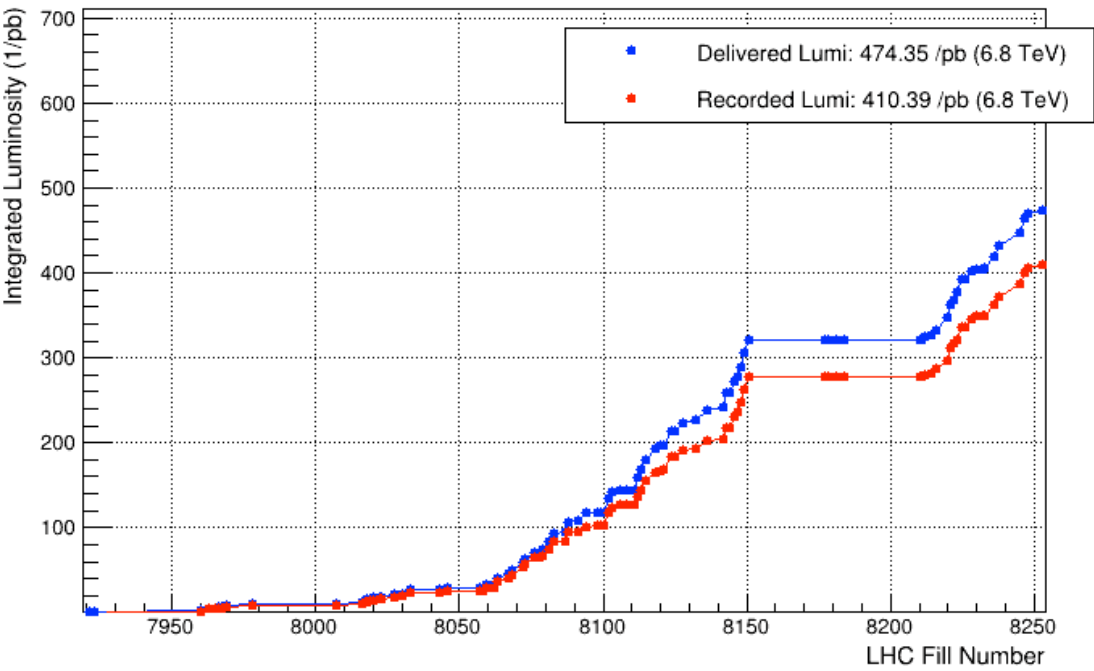
Peak Stable Luminosity Delivered	$1.98 \times 10^{34} \text{ cm}^{-2} \text{ s}^{-1}$	Fill 8230	22/10/05 20:53
Maximum Average Events per Bunch Crossing	65.6	Fill 8301	22/10/21 18:53
Maximum Stable Luminosity Delivered in one fill	$775.8 \text{ pb}^{-1}$	Fill 8274	22/10/15 22:23
Maximum Stable Luminosity Delivered in one day	$1133.8 \text{ pb}^{-1}$	Sunday 23 October, 2022	
Maximum Stable Luminosity Delivered for 7 days	$4.167 \text{ fb}^{-1}$	Monday 10 October, 2022 - Sunday 16 October, 2022	
Longest Time in Stable Beams for one fill	2 days, 9 hrs, 23 min	Fill 8178	22/09/24 00:21
Longest Time in Stable Beams for one day	1 day, 0 min	Sunday 25 September, 2022	
Longest Time in Stable Beams for 7 days	3 days, 14 hrs, 1 min	Thursday 29 September, 2022 - Wednesday 05 October, 2022	
Fastest ATLAS Ready from Stable Beams	0 min	Fill 7966	22/07/11 19:19
Fastest Turnaround to Stable Beams	1 hr, 51 min	Fill 8112	22/08/09 04:54
Maximum Colliding Bunches	2450	Fill 8267	22/10/14 22:28
Maximum Charge per Bunch Colliding	$1.38 \times 10^{11}$	Fill 8299	22/10/21 13:12
Maximum Charge per Beam Colliding	$3.33 \times 10^{14}$	Fill 8306	22/10/23 17:35
Maximum Total Charge per Beam	-	Fill 7920	22/07/05 16:47
Average Specific Luminosity	$6.96 \times 10^{30} \text{ cm}^{-2} \text{ s}^{-1} (10^{11} \text{ p})^{-2}$	Fill 8216	22/09/30 22:47

Stunning performance!

# Intensity (Start of Stable Beams)



LHCb Integrated Luminosity in p-p in 2022



LHC Page1

Fill: 8307

E: 6800 GeV

t(SB): 01:09:38

24-10-22 13:32:53

PROTON PHYSICS: STABLE BEAMS

Energy:

6800 GeV

I B1:

6.85e+13

I B2:

7.15e+13

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: 5119.22

IP2: 8.33

IP5: 5163.04

IP8: 103.05

FBCT Intensity and Beam Energy

Updated: 13:32:51

Instantaneous Luminosity

Updated: 13:32:53

Comments (24-Oct-2022 12:26:28)

600b fill for VELO insertion

\*\* STABLE BEAMS \*\*

B\* levelling IP1/5

sep levelling IP2/8

Wednesday access from 8am to 4pm

AFS: 25ns\_591b\_578\_510\_540\_72bpi\_12inj\_3INDIV

BIS status and SMP flags

Link Status of Beam Permits

Global Beam Permit

Setup Beam

Beam Presence

Moveable Devices Allowed In

Stable Beams

B1

B2

true

true

true

false

true

true

true

true

PM Status B1

ENABLED

PM Status B2

ENABLED

LHCb VELO Position **IN** Gap: 4.0 mm

# 2022 – Q4 – updated LHC schedule

Start of YETS 2 weeks earlier than foreseen

Version 1.2.

	Nov							Dec					
Wk	40	41	42	43	44	45	46	47	48	49	50	51	52
Mo	3	10	17 MD 1	24 ★	31	7 MD 2	14	21	28	5	12	19	26
Tu								FMD4					
We													
Th						VdM run	Pb ions test			YETS			
Fr												Annual	
Sa					MD 2								
Su												Xmas	

End 25 ns run [08:00] (between Nov 46 and 47)  
 End of run [06:00] (between Nov 47 and 48)

- **Pb ion run 2022 run postponed**
  - Longer ion runs in the coming year(s) to compensate
  - Short (2-day) Pb ion test run
- **End of 2022 run 06:00 28<sup>th</sup> November**



# Conclusions

## Electricity

- Ending 2022 Run 2 weeks early
- Prepared for load shedding when and if required

## Accelerator complex in good shape overall – all facilities operating

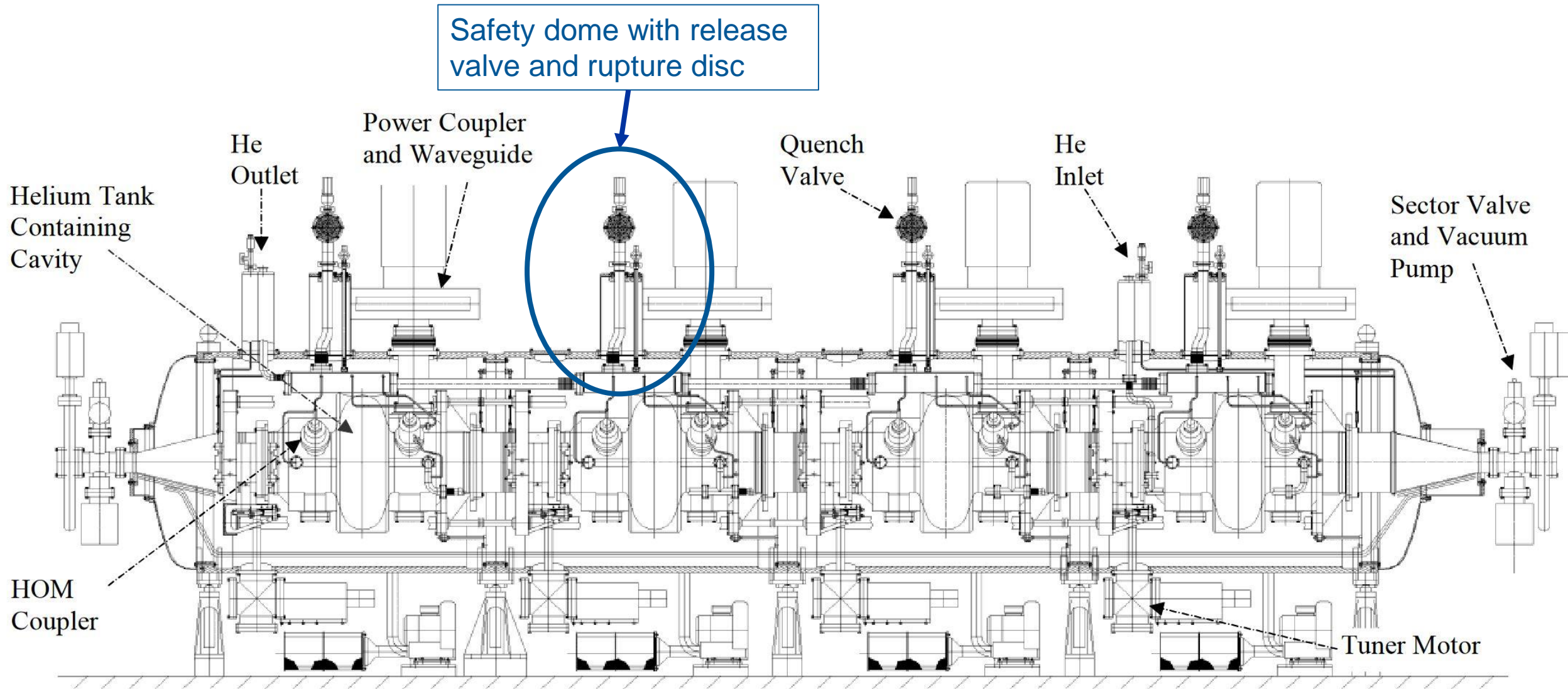
## LHC commissioned successfully, Run 3 physics started on July 5th

- Intensity and luminosity followed a steep curve despite a battle against UFOs and electron cloud
- The complex luminosity levelling mix of Run 3 was implemented in a record time – now fully operational – excellent performance
- The beam intensity is currently limited by electron cloud
- **Schedule updates following RF incident and a 2-week shorter run**

**Acknowledgements and thanks to everyone in ATS and our colleagues from across the organization.**

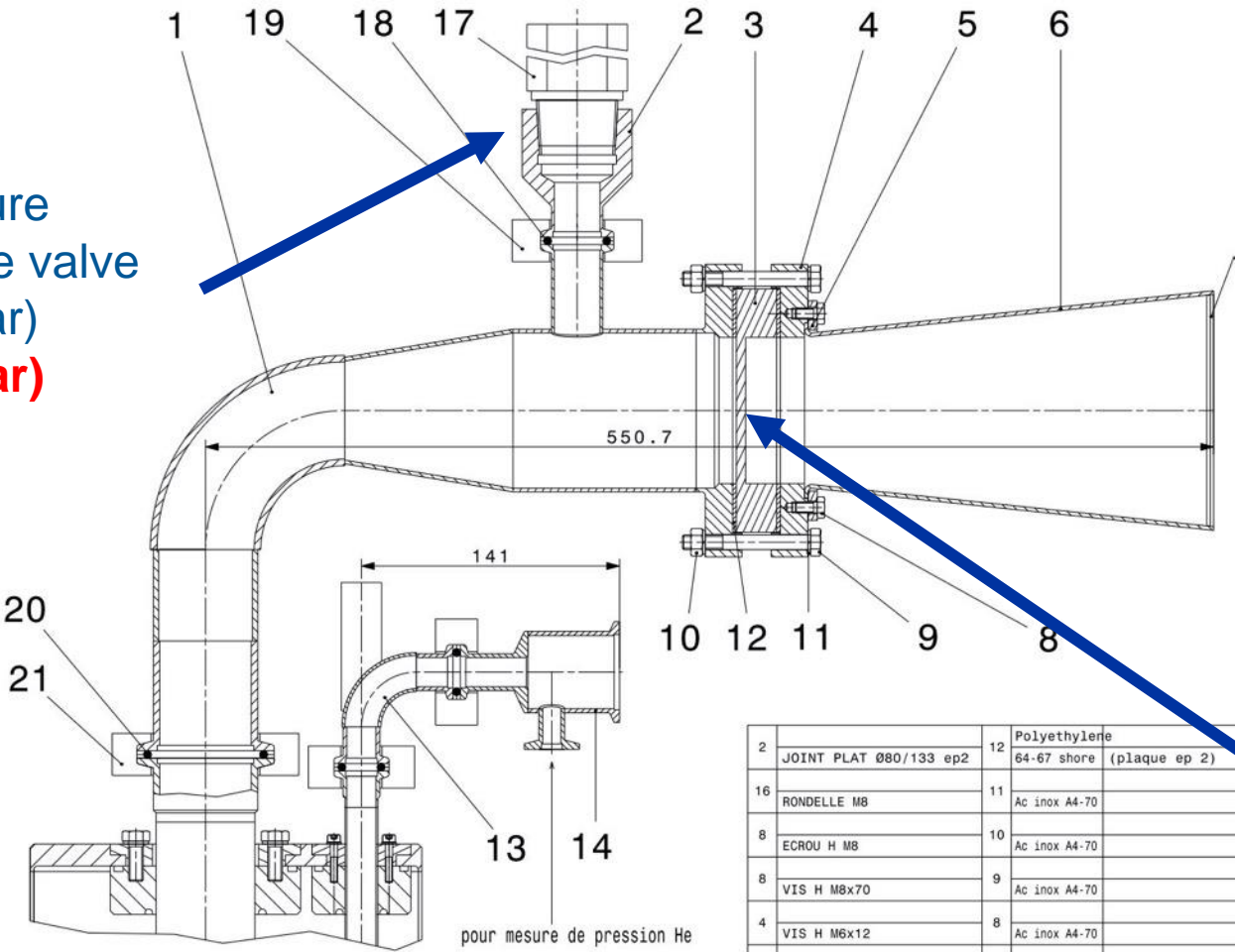
# Backup

# Cryomodule with safety valve assembly



# Safety valve assembly

Pressure  
release valve  
(1.8 bar)  
**(1.9 bar)**



2	JOINT PLAT Ø80/133 ep2	12	Polyethylene 64-67 shore (plaque ep 2)
16	RONDELLE M8	11	Ac inox A4-70
8	ECROU H M8	10	Ac inox A4-70
8	VIS H M8x70	9	Ac inox A4-70
4	VIS H M6x12	8	Ac inox A4-70



Rupture disc  
(2.1 bar)  
**(1.9 bar)**



# Summary of intervention on RF cryomodules

## Tuesday 06/09: Installation of new safety valve configuration

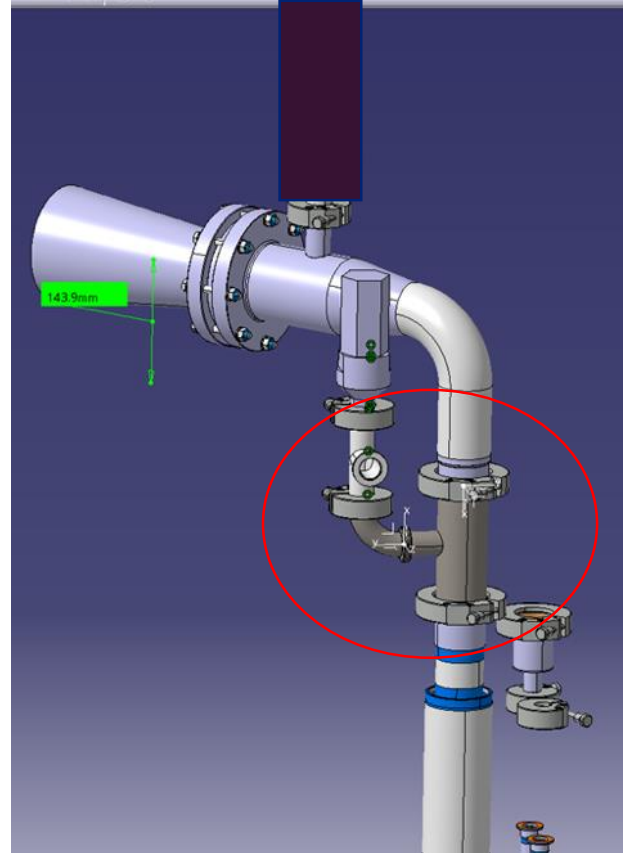
- New parts arrived from Germany Tues. 13:00
- Intervention completed during afternoon/evening

## Wednesday 07/09:

- Leak checks of valve assemblies @1.5 bar and insulation vacuum

## Friday 09/09:

- He circuit purge
- Cooldown started on all 4 modules
- Cooldown and module filling completed over the weekend
- Thermalisation sufficient to start RF conditioning on Monday 12/09



New configuration  
Pressure release valves @ 1.7 bar



**Beam back 20/09 following the cool-down, RF conditioning, and foreseen technical stop**



# Heatload

