



Introduction to CERN and the Accelerator Complex

For the HEARTS kick-off meeting

Rende Steerenberg – BE-OP

20 January 2023

Topics

- **CERN & Collaboration**
- **The Accelerator Complex**
- **Scheduling Heavy Ions**
- **Concluding Remarks**

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Four pillars underpin CERN's mission



Science for peace

CERN was founded in 1954 with 12 European Member States



23 Member States

Austria – Belgium – Bulgaria – Czech Republic
Denmark – Finland – France – Germany – Greece
Hungary – Israel – Italy – Netherlands – Norway
Poland – Portugal – Romania – Serbia – Slovakia
Spain – Sweden – Switzerland – United Kingdom

3 Associate Member States in the pre-stage to membership

Cyprus – Estonia – Slovenia

7 Associate Member States

Croatia – India – Latvia – Lithuania – Pakistan
Türkiye – Ukraine

6 Observers

Japan – Russia (suspended) – USA
European Union – JINR (suspended) – UNESCO

CERN's annual budget is 1200 MCHF (equivalent to a medium-sized European university)

Around 50 Cooperation Agreements with non-Member States and Territories

Albania – Algeria – Argentina – Armenia – Australia – Azerbaijan – Bangladesh – Belarus – Bolivia
Bosnia and Herzegovina – Brazil – Canada – Chile – Colombia – Costa Rica – Ecuador – Egypt – Georgia – Honduras
Iceland – Iran – Jordan – Kazakhstan – Lebanon – Malta – Mexico – Mongolia – Montenegro – Morocco – Nepal
New Zealand – North Macedonia – Palestine – Paraguay – People's Republic of China – Peru – Philippines – Qatar
Republic of Korea – Saudi Arabia – Sri Lanka – South Africa – Thailand – Tunisia – United Arab Emirates – Vietnam

A laboratory for people around the world

Distribution of all CERN Users by the country of their home institutes as of 31 December 2021



Geographical & cultural diversity
Users of **110 nationalities**
19.4% women

Member States **6642**

Austria 74 – Belgium 122 – Bulgaria 39 – Czech Republic 227
Denmark 42 – Finland 71 – France 811 – Germany 1129
Greece 133 – Hungary 69 – Israel 67 – Italy 1423
Netherlands 157 – Norway 69 – Poland 278 – Portugal 89
Romania 105 – Serbia 36 – Slovakia 66 – Spain 328
Sweden 88 – Switzerland 372 – United Kingdom 847

Associate Member States

in the pre-stage to membership **55**

Cyprus 10 – Estonia 24 – Slovenia 21

Associate Member States **367**

Croatia 36 – India 130 – Latvia 11 – Lithuania 12 – Pakistan 30
Türkiye 122 – Ukraine 26

Observers **2917**

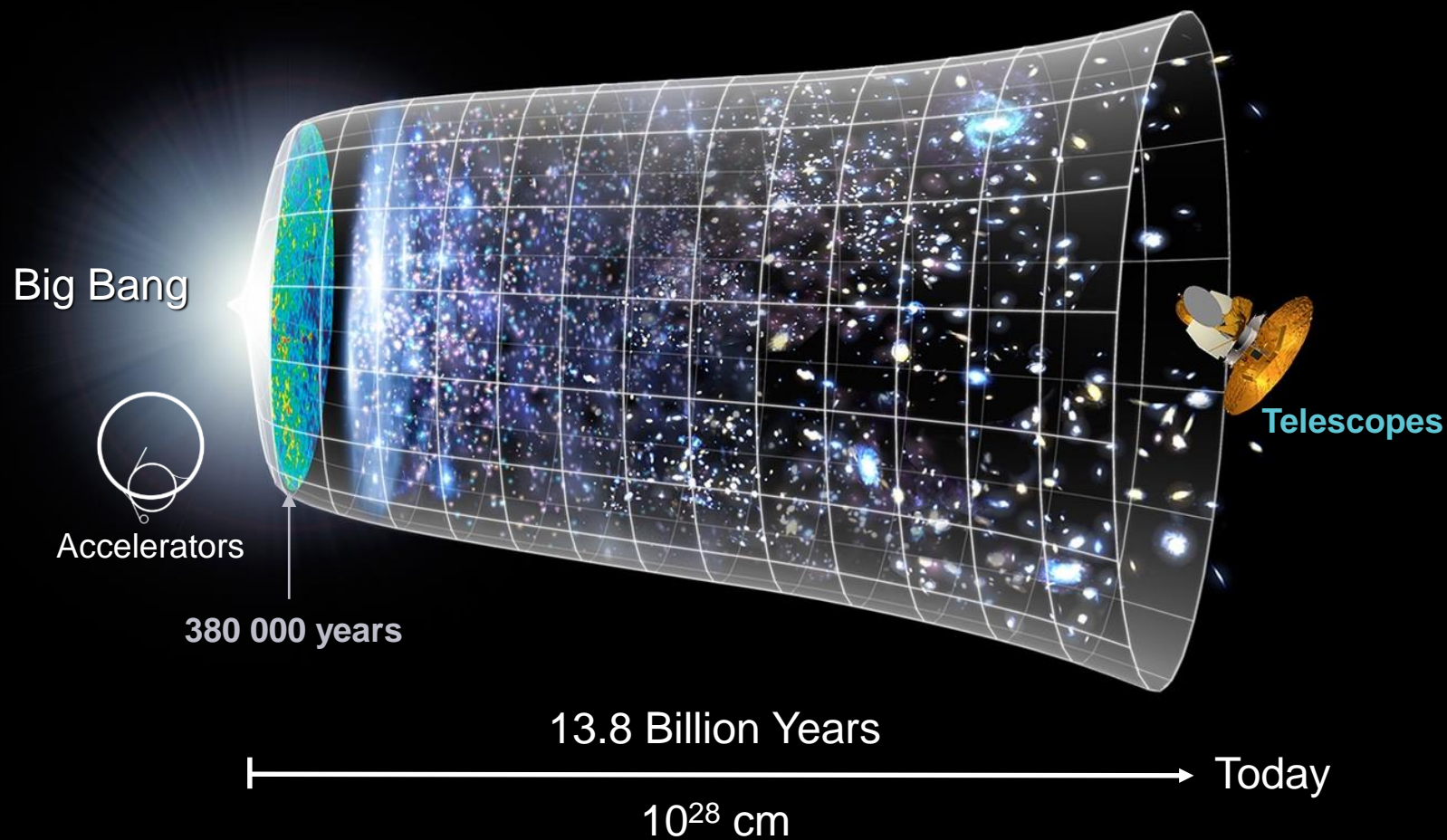
Japan 189 – Russia (suspended) 971 – United States of America 1757



A strong commitment to provide particle beams for research by external Users from different sectors from all over the world

Non-Member States and Territories **1194**

Algeria 3 – Argentina 16 – Armenia 10 – Australia 20 – Azerbaijan 3 – Bahrain 2 – Belarus 24 – Brazil 106
Canada 189 – Chile 23 – Colombia 18 – Cuba 3 – Ecuador 6 – Egypt 16 – Georgia 36 – Hong Kong 17
Iceland 3 – Indonesia 6 – Iran 11 – Ireland 6 – Jordan 5 – Kuwait 5 – Lebanon 15 – Madagascar 1
Malaysia 4 – Malta 2 – Mexico 48 – Montenegro 5 – Morocco 18 – New Zealand 8 – Oman 1 – People's
Republic of China 314 – Peru 2 – Philippines 1 – Republic of Korea 113 – Singapore 3 – South Africa 52
Sri Lanka 10 – Taiwan 45 – Thailand 18 – United Arab Emirates 6



CERN & The Universe

We reproduce the conditions a fraction of a second after the Big Bang, to gain insight into the structure and evolution of the universe.

Complementary to the space telescopes

CERN & Space

An antimatter detector attached to the international space station (2011)



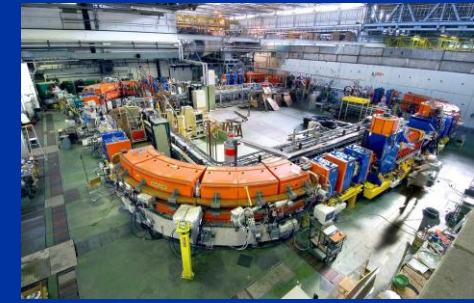
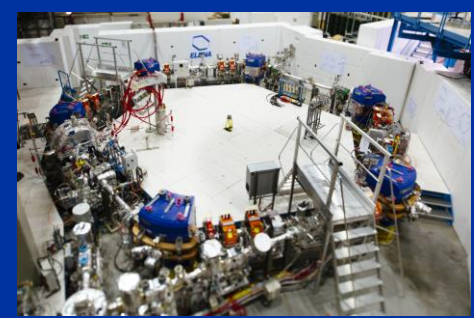
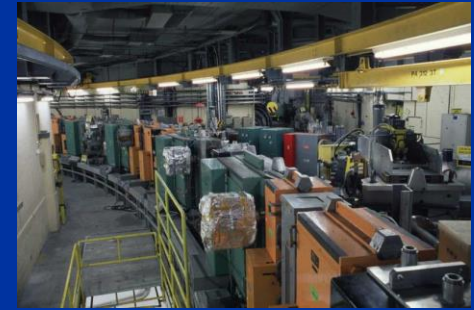
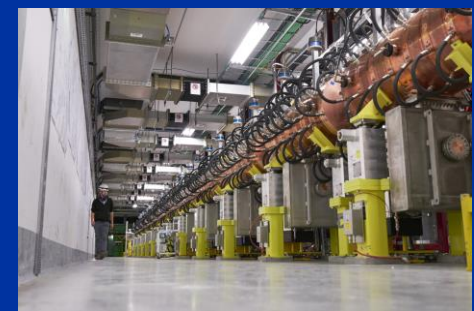
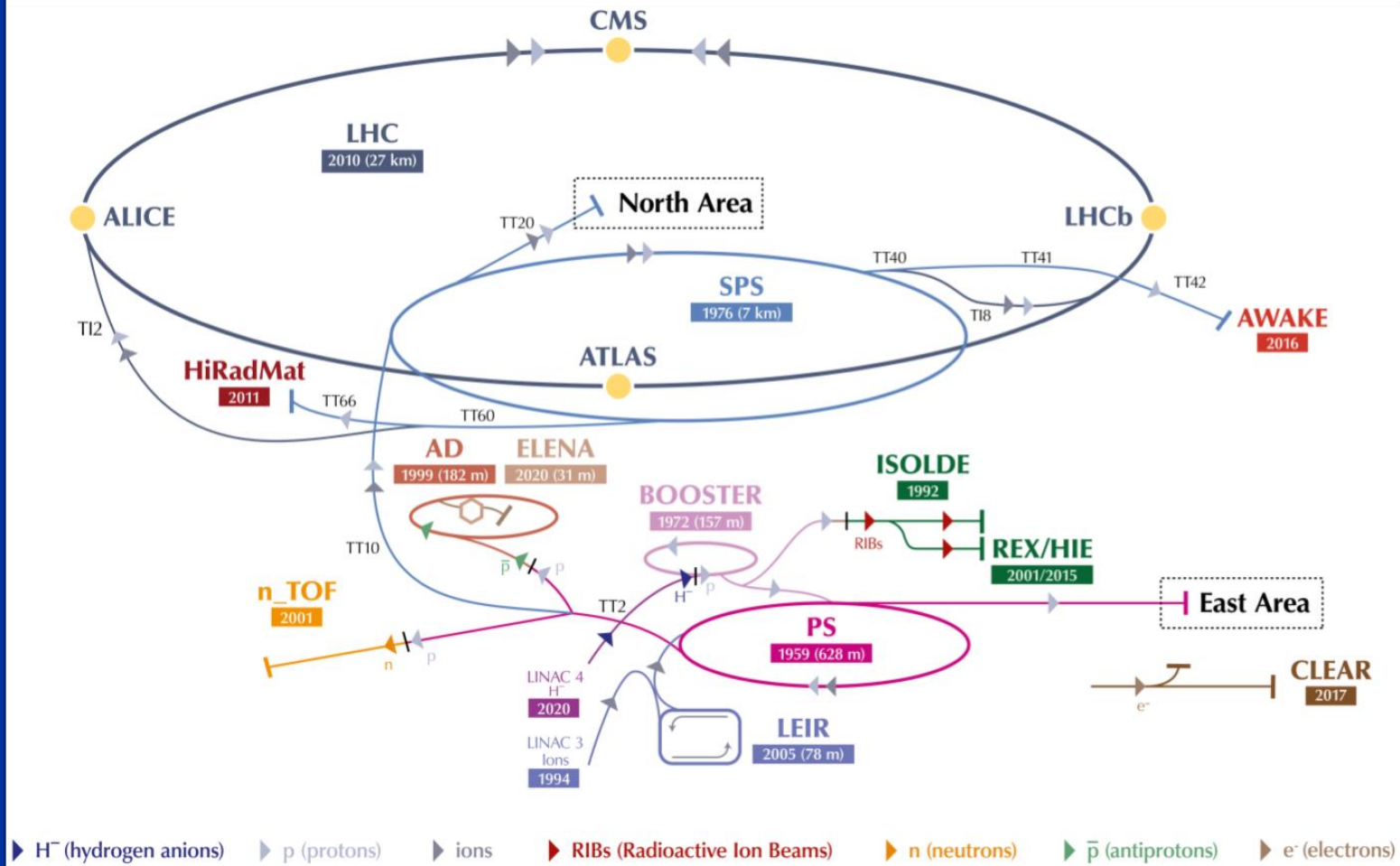
Radiation monitoring in space with CERN technology (2022)



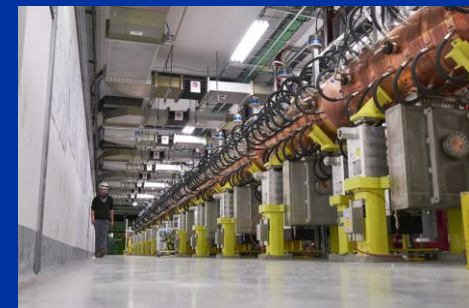
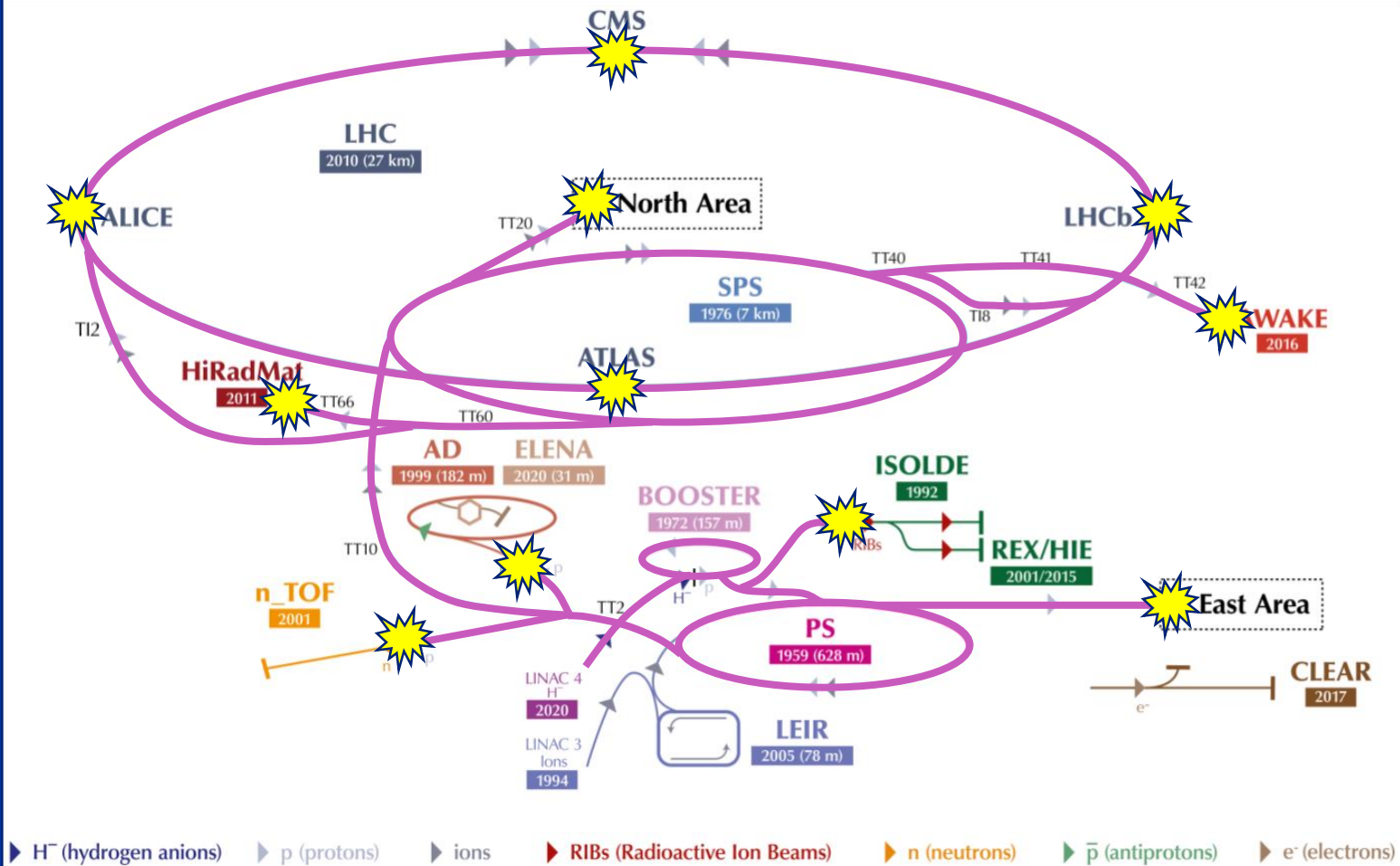
Topics

- CERN & Collaboration
- **The Accelerator Complex**
- Scheduling Heavy Ions
- Concluding Remarks

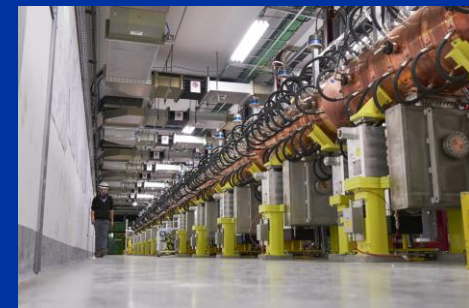
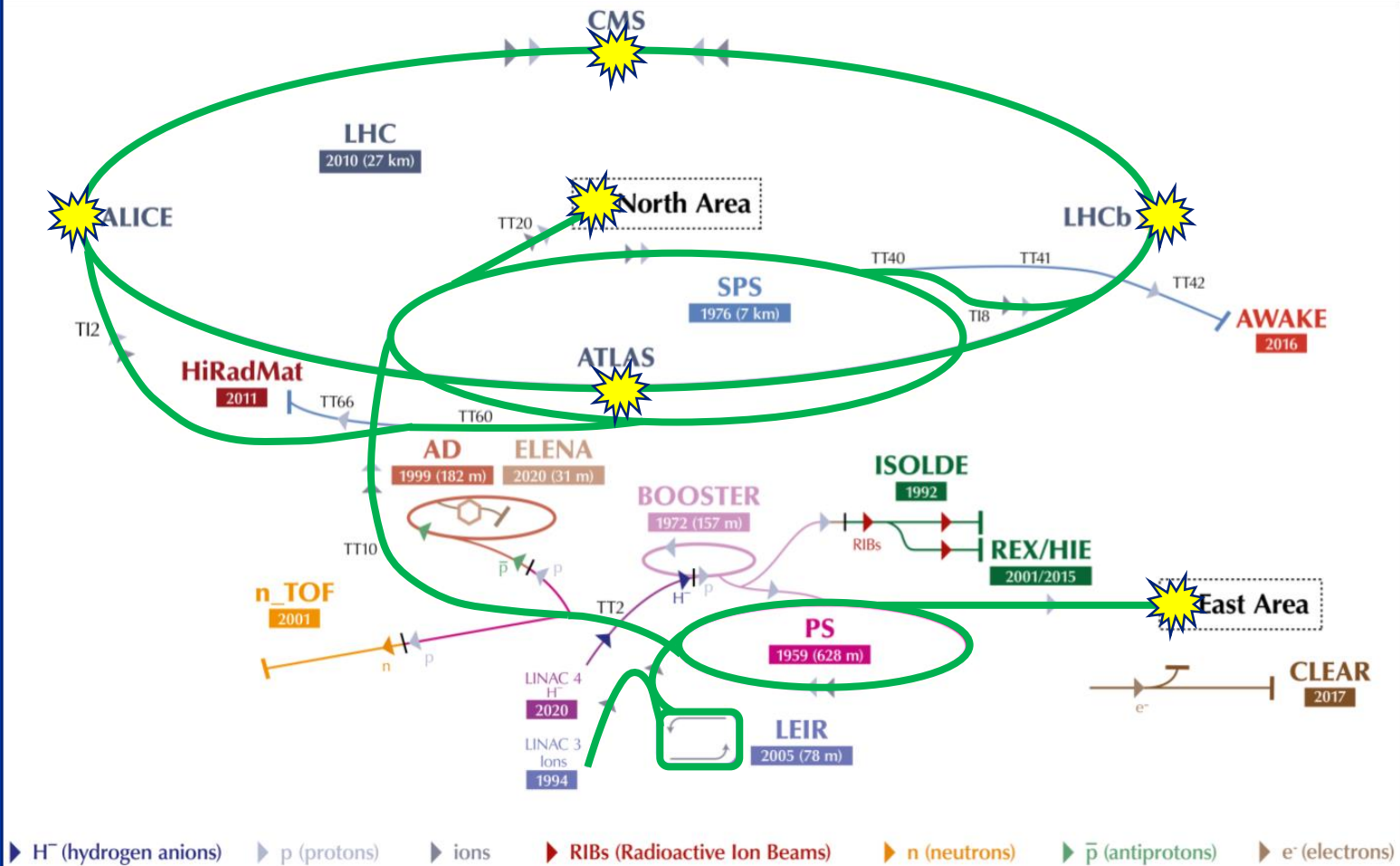
The CERN Accelerator Complex



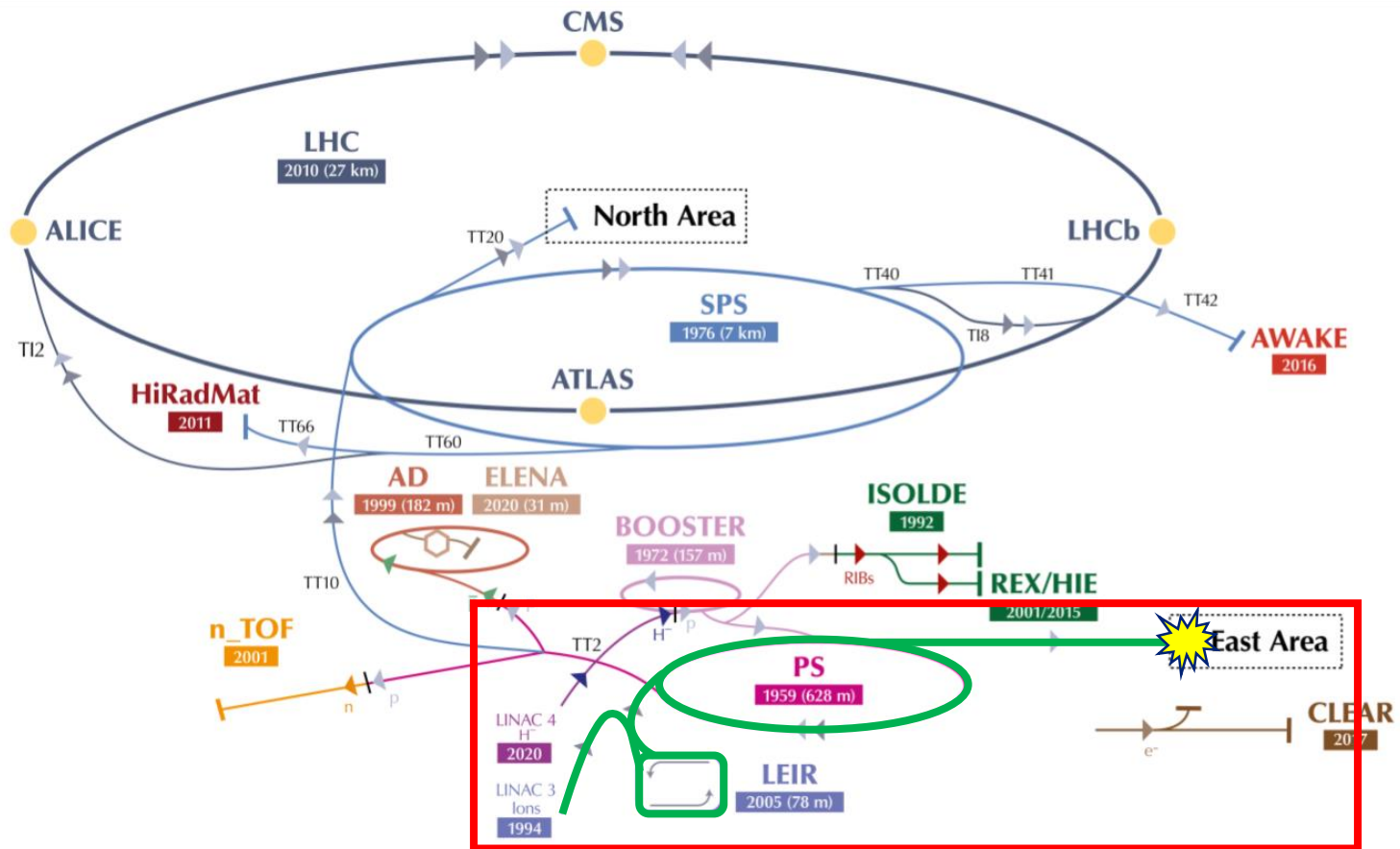
Proton Path & Users



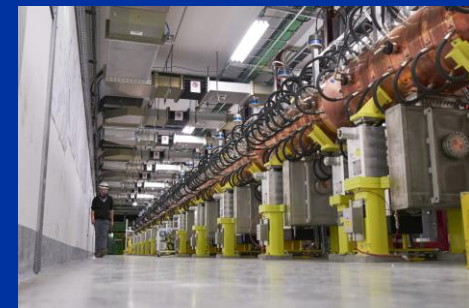
Ion Path & Users



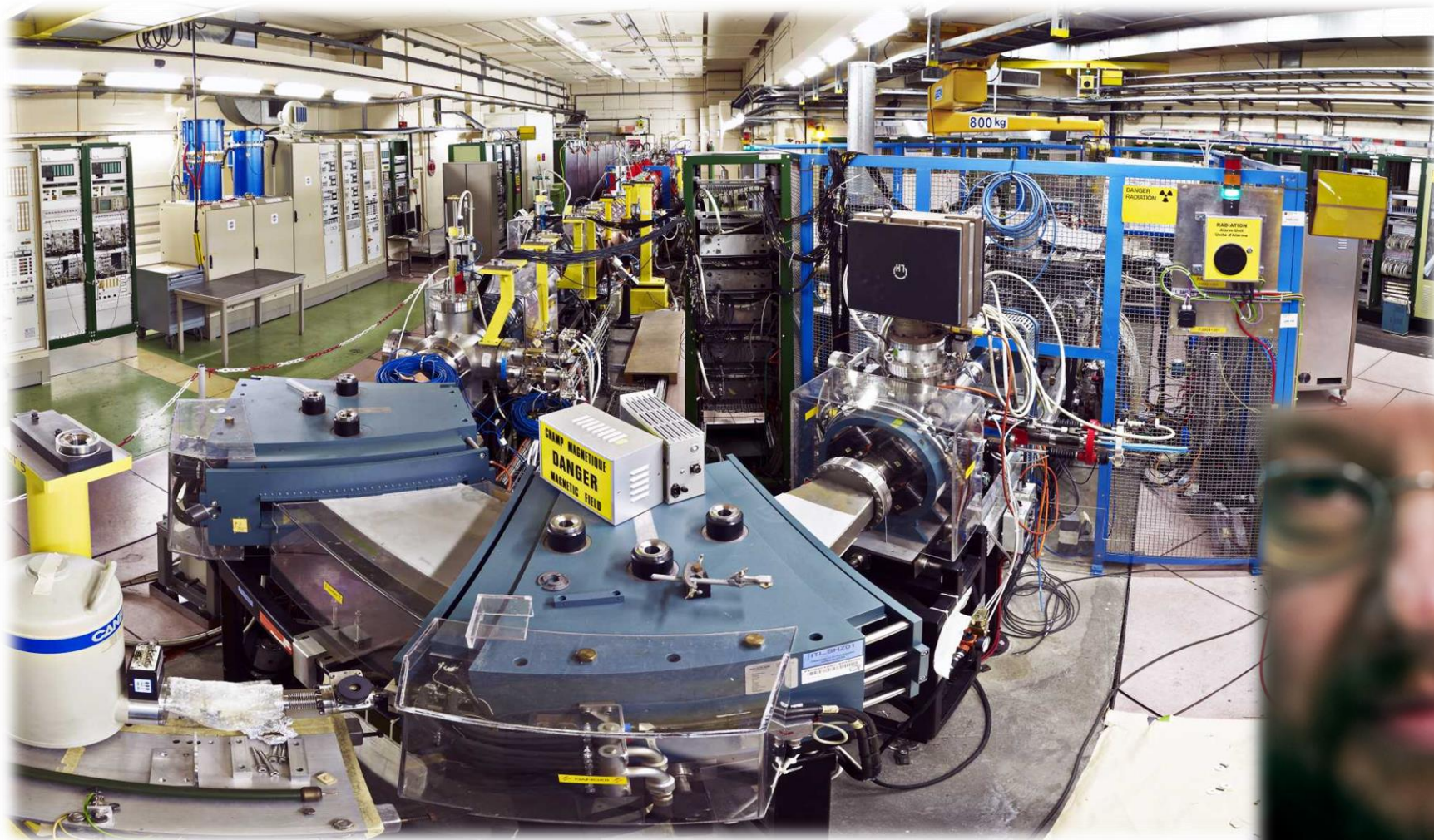
Ion Path for HEARTS



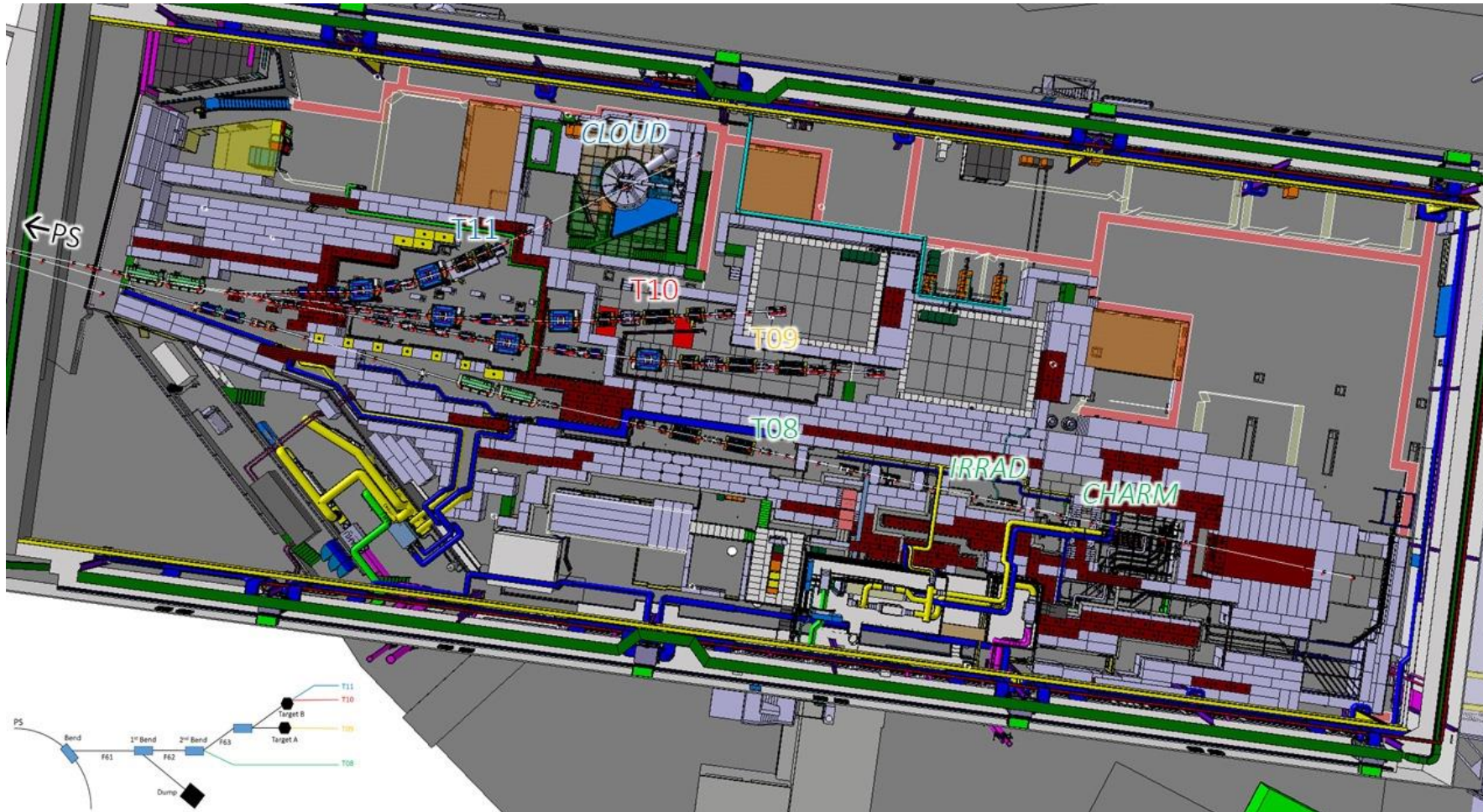
▶ H^- (hydrogen anions) ▶ p (protons) ▶ ions ▶ RIBs (Radioactive Ion Beams) ▶ n (neutrons) ▶ \bar{p} (antiprotons) ▶ e^- (electrons)



Linac 3: Source of Ions at CERN

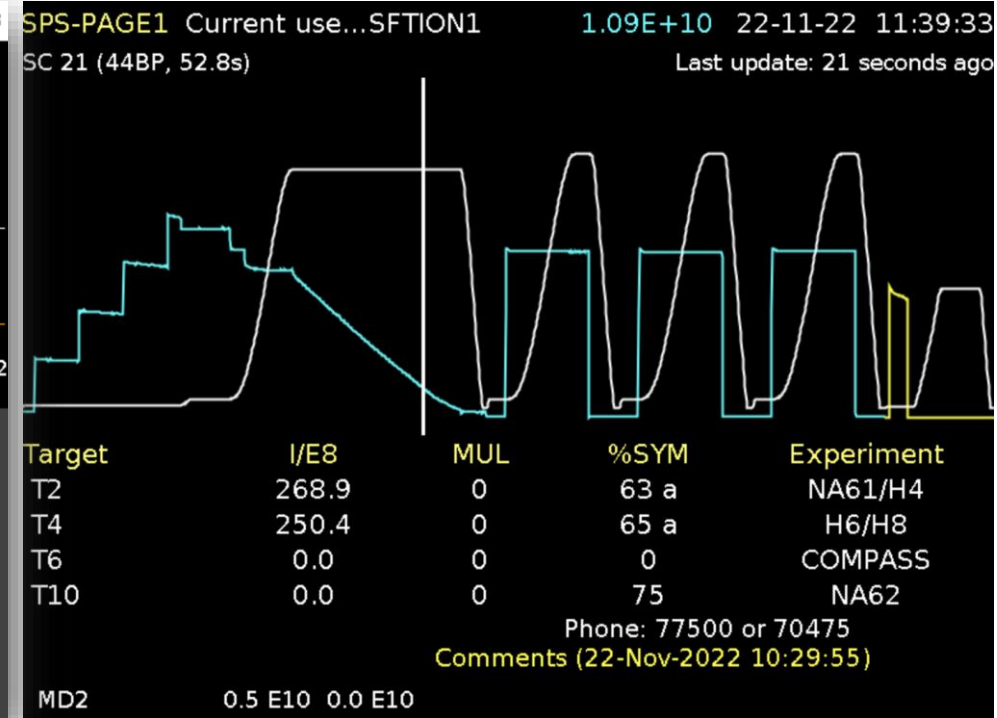
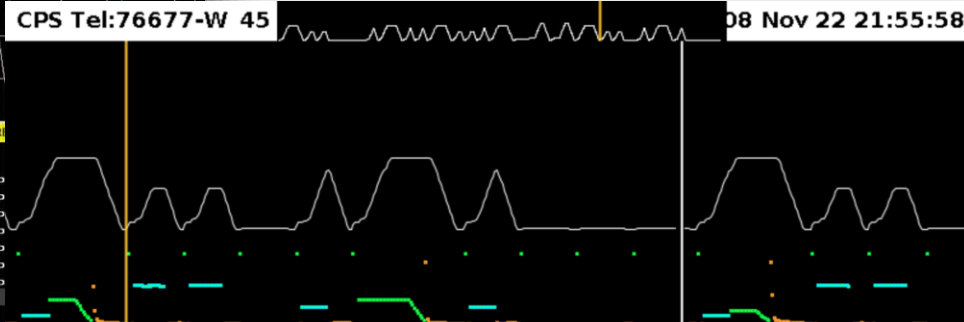
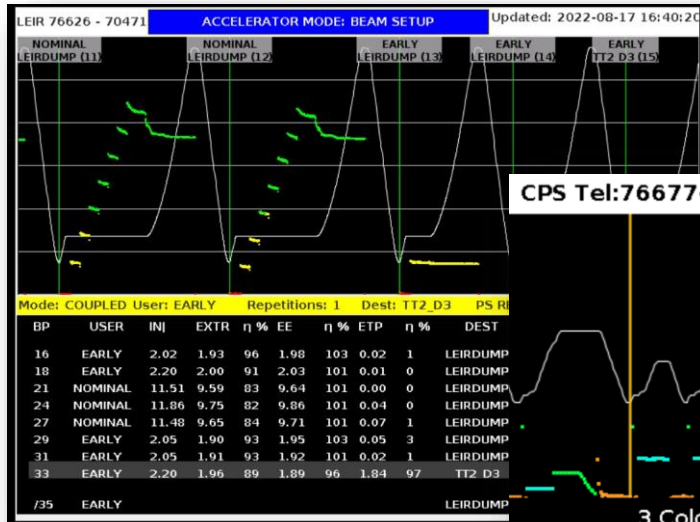


CERN Proton Synchrotron East Experimental Area



- The EA renovation was completed and physics was resumed in October 2021
- Prior to this renovation the CHARM-IRRAD area was already installed
- Both protons and ions can be sent by the PS

The Versatile Injectors Complex – serving many Users



PSB Fixdisplay - W 45

Comments (08-Nov-2022 11:28:54)
Supervisor : JF Comblin 168060
Operator : CCC: 76671

BP	User	Pls	Inj.	Acc.	b.Ej.E10	Ej
36	STAGISOHRS_2022	22	●●●●	●●●●	1485	
1	MD5643_MTE_2022	13	●●●●	●●●●	1897	
2	MD5643_MTE_2022	13	●●●●	●●●●	1896	
3	MD8024_LHC25A_3	4	●●●●	●●●●	295	
4	TOF_2022	23	●●●●	●●●●	858	
5	EAST_T8_2022	2	●●●●	●●●●	60.42	€ /36
6	STAGISOHRS_2022	22	●●●●	●●●●	1490	1222 ISOHRS
7	TOF_2022	23	●●●●	●●●●	857	862 TOF_22
8	STAGISOHRS_2022	22	●●●●	●●●●	1487	1223 ISOHRS
9	---ZERO---	1	●●●●	●●●●	0.00	0.36 BDUMP
10	STAGISOHRS_2022	22	●●●●	●●●●		
11	EAST_N_2022	25	●●●●	●●●●	1492	1229 ISOHRS
	STAGISOHRS_2022					ISOHRS

11/36 No Message

E10 Charges Comments (08-Nov-2022 18:38:38)

BP	USER	INI	EXTR	η %	EE	η %	ETP	η %	DEST
35	EAST_T8_22	25	389	60.28	P+	NTOF+			
1	MD5643_MTE_22	30	1872	P+	SFTPRO1				
2	MD5643_MTE_22	30	1874	P+	SFTPRO1				
3	~~zero~~	1	-	-					
4	TOF_22	23	838	P+	NTOF				
5	EAST_T8_22	25	59.91	P+	EAST_T8				
7	TOF_22	23	834	P+	NTOF				
8	~~zero~~	1	-	-					
9	~~zero~~	1	-	-					
10	~~zero~~	1	-	-					
/36	EAST_N_22	2	-	-	PS_DUMP				

CCC : 76677
Coordinator: D.Cotte
167921

IRRAD ACCESS at 00h00

Topics

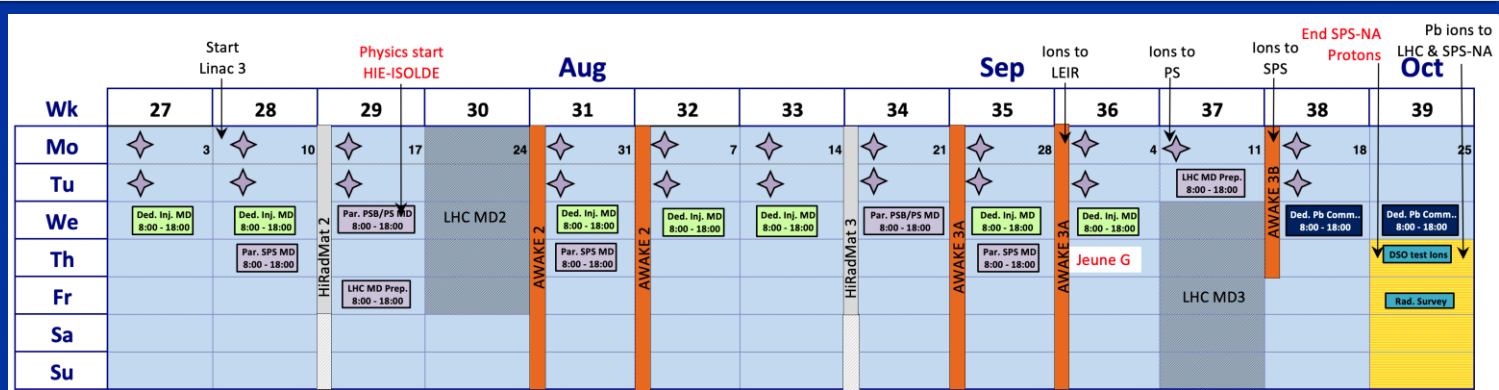
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The 2023 Injectors Schedule

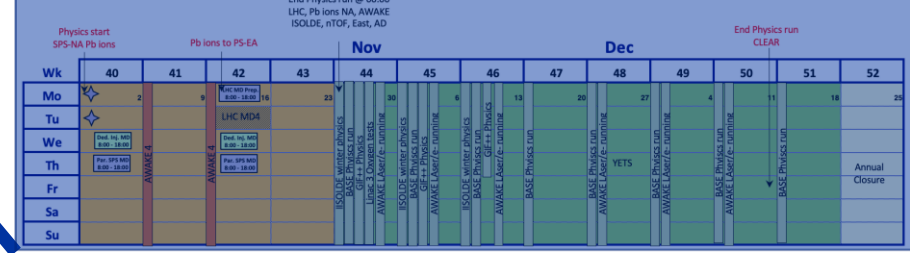
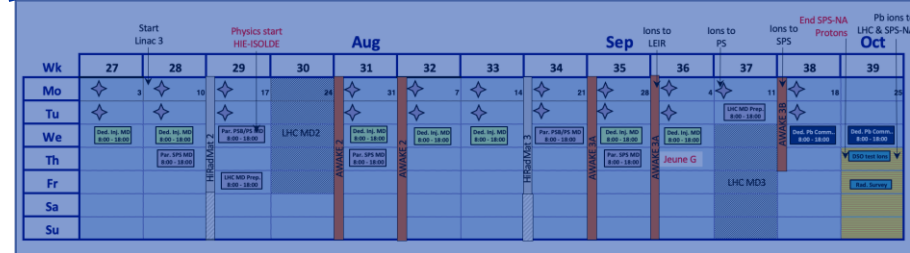
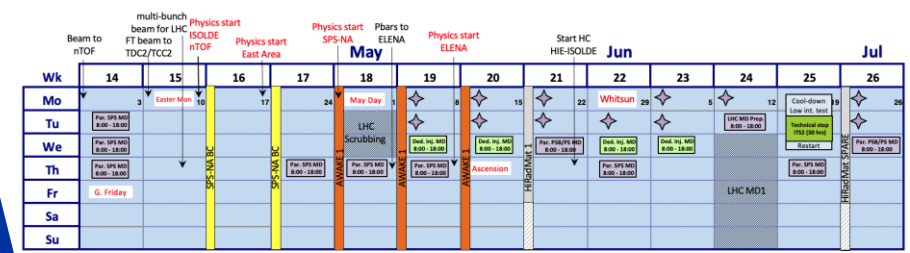
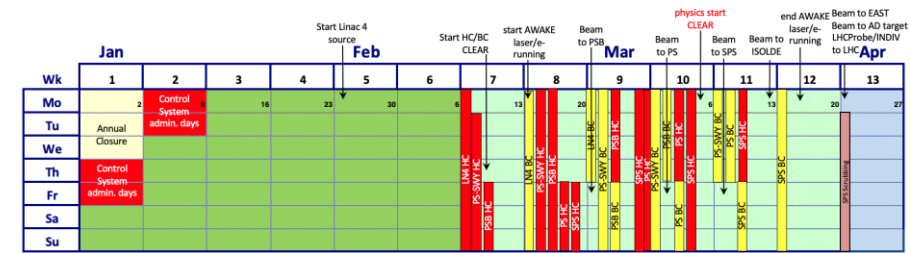
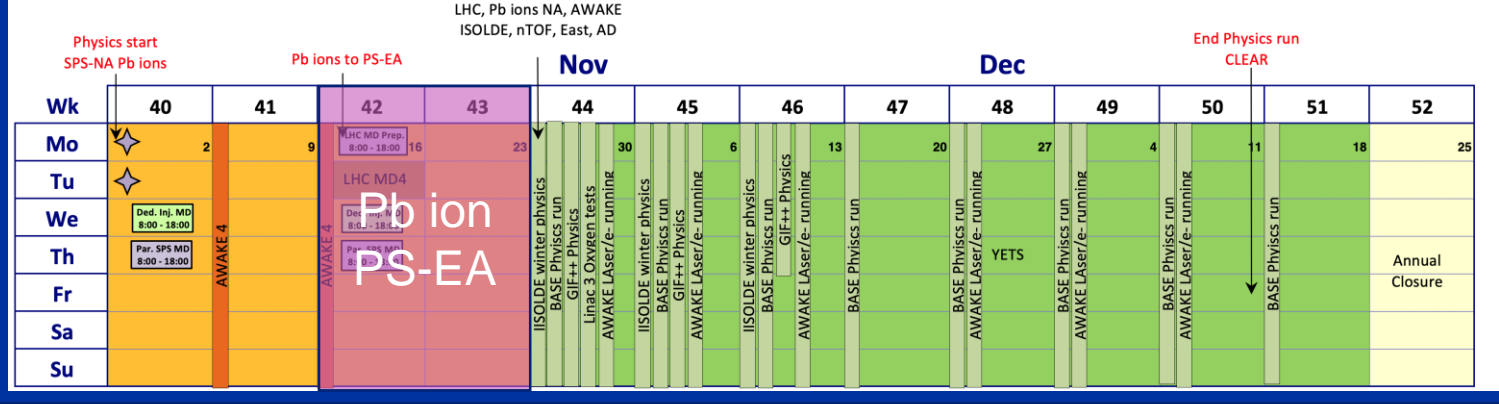
RS

December 7, 2022
ver. 1.0

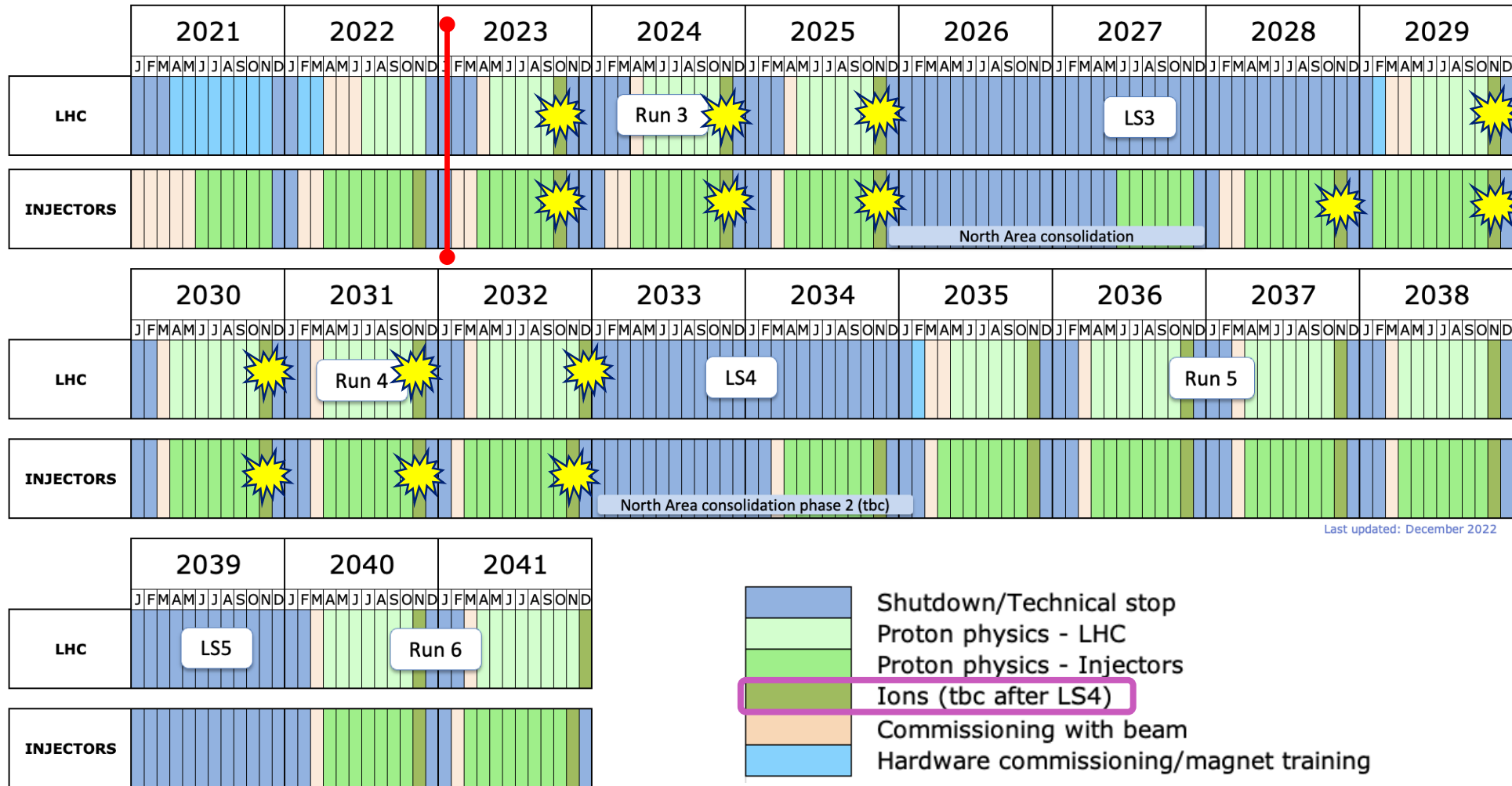
Injectors Accelerator Schedule 2023
Version 1.0 was approved at the Research Board of 7 December 2022



End Physics run @ 06:00
LHC, Pb ions NA, AWAKE
ISOLDE, nTOF, East, AD



The Long-Term Commitment for Heavy Ions at CERN



Preliminary Draft 2024 LHC Schedule

RS

LHC Schedule 2024
 Draft (Optimised for energy cost: 19 weeks YETS and shifted early)

September 13, 2022
 ver. 0.2

	Jan				Feb				Mar				
Wk	1	2	3	4	5	6	7	8	9	10	11	12	13
Mo	1	8	15	22	29	5	12	19	26	4	11	18	25
Tu	Annual Closure										Machine checkout		
We													
Th													
Fr	Control System admin days				YETS			D50 test	Hardware re-commissioning				
Sa											Re-commissioning with beam		
Su												G. Fri.	

	Apr				May				Jun				
Wk	14	15	16	17	18	19	20	21	22	23	24	25	26
Mo	Easter 1	8	15	22	29	6	13	Whitsun 20	27	3	10	17	24
Tu			Scrubbing				MD 1						
We					1st May								TS1
Th					Ascension								
Fr			Interleaved commissioning & intensity ramp up								MD 2		
Sa													
Su													

	Jul				Aug				Sep				Oct
Wk	27	28	29	30	31	32	33	34	35	36	37	38	39
Mo	VdM program	1	8	15	22	29	5	12	19	26	2	9	16
Tu		O-O & p-O ion run				MD 3							TS2
We	ion setting up												
Th									Jeune G.				
Fr												MD 4	ion setting up
Sa													
Su													

	Nov				Dec								
Wk	40	41	42	43	44	45	46	47	48	49	50	51	52
Mo	30	7	14	21	28	4	11	18	25	2	9	16	23
Tu			MD 5										
We													Xmas Annual Closure
Th		Pb-Pb ion run						YETS					
Fr													
Sa													
Su													

	Jul				Aug				Sep				Oct
Wk	27	28	29	30	31	32	33	34	35	36	37	38	39
Mo	VdM program	1	8	15	22	29	5	12	19	26	2	9	16
Tu		O-O & p-O ion run				MD 3							TS2
We	Oxygen ions ion setting up												
Th									Jeune G.				
Fr												MD 4	ion setting up
Sa													
Su													

	Nov				Dec								
Wk	40	41	42	43	44	45	46	47	48	49	50	51	52
Mo	30	7	14	21	28	4	11	18	25	2	9	16	23
Tu			MD 5										
We													Xmas Annual Closure
Th		Pb ions						YETS					
Fr													
Sa													
Su													



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Concluding Remarks

- **CERN and space is a longstanding history, HEARTS strengthens this relationship**
 - It will answer important questions for future space applications
- **CERN has a long-term commitment towards heavy ions physics programmes for the LHC and the Injectors**
 - The CHARM-IRRAD facility behind the PS offers excellent and flexible beam conditions for radiation testing, using heavy ions
- **The CERN Accelerator Complex is highly versatile and offers the possibility to produce protons and ions in the same super cycle**
- **Ions in the PS East Area are scheduled in October 2023**
 - Oxygen ions will potentially also be available in 2024



**I wish you a fruitful HEARTS kick-off meeting today
&
a successful project collaboration for the future**

