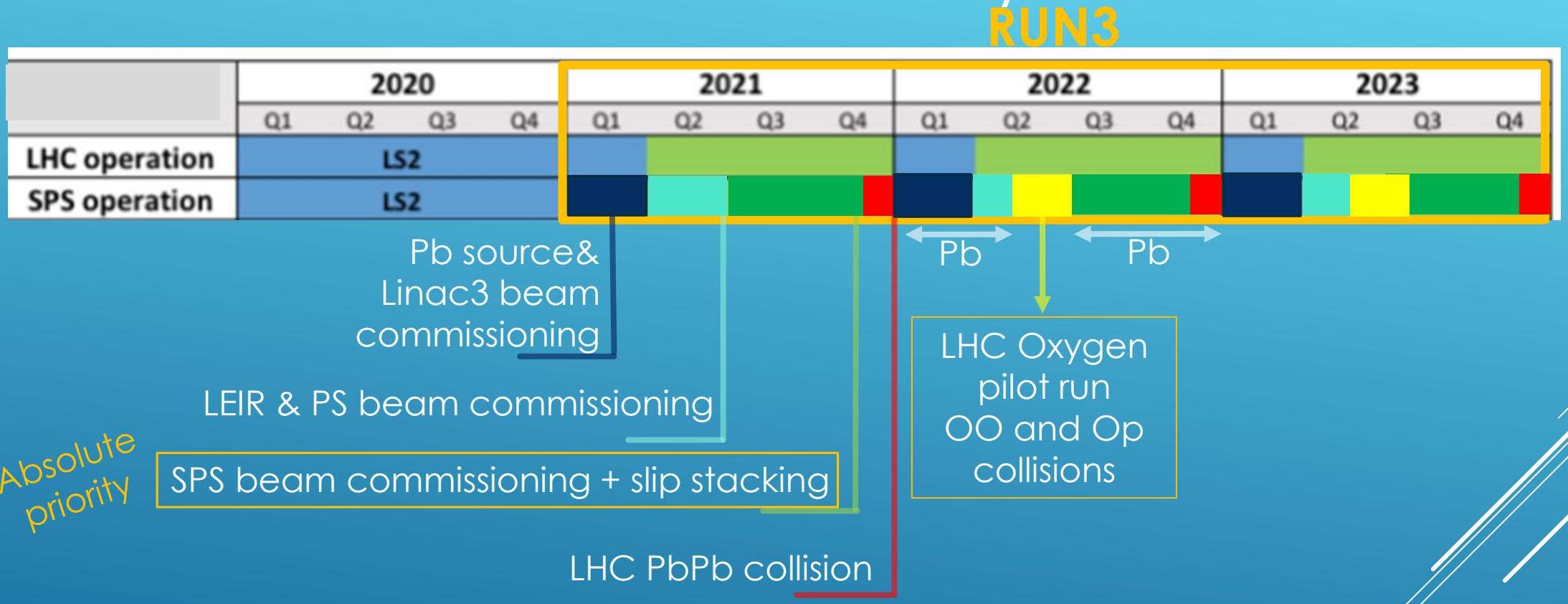
PARTIALLY STRIP ION OPERATION CONSTRAINTS: RUN3 AND RUN4

R. Alemany Fernandez BE/OP-SPS

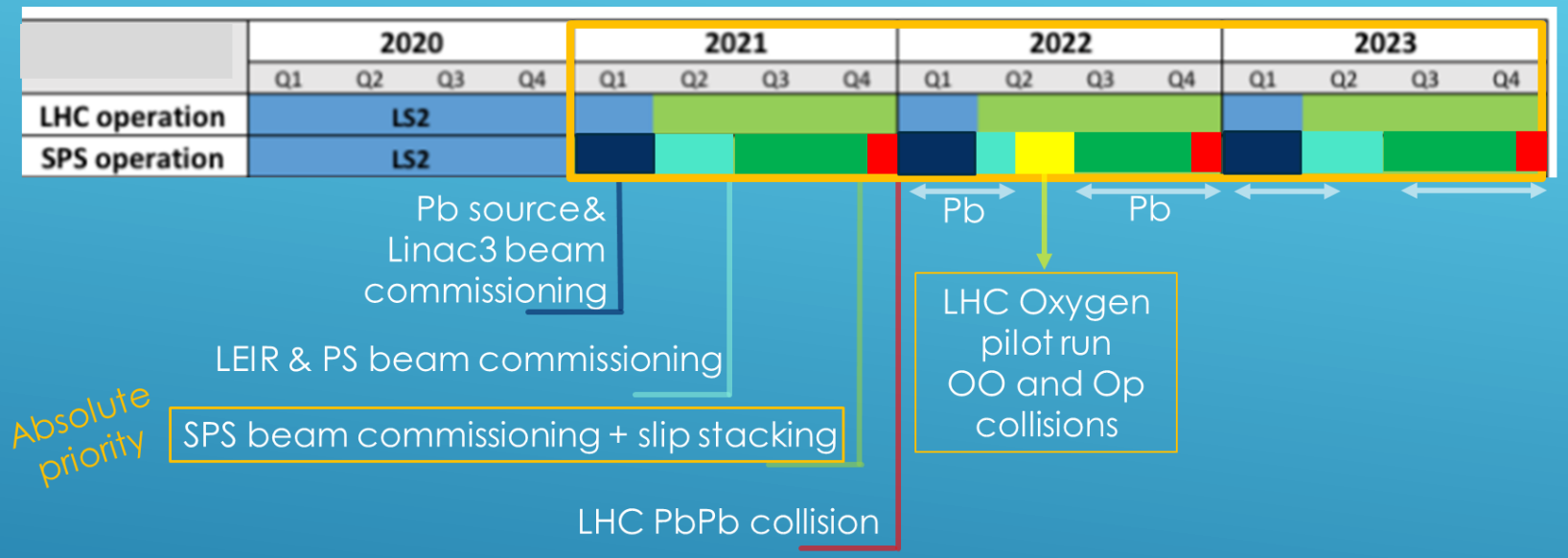
PRELIMINARY SCHEDULE OF IONS IN RUN 3 (SCHEDULE NOT APPROVED YET!!)



Difficulties in RUN 3:

- Strong competition with the proton commissioning ➔ LHC Injector Upgrade ➔ many new hardware to be commissioned for the first time
- Strong competition with the ion commissioning ➔ slip stacking in SPS is a priority

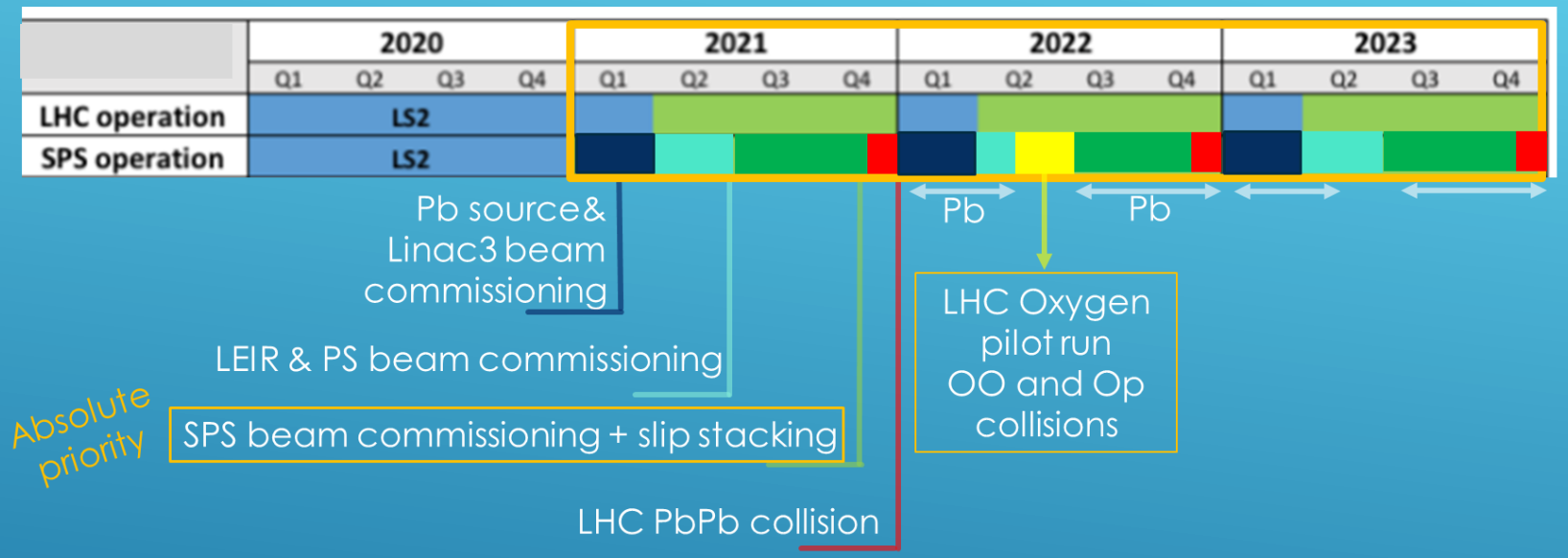
PRELIMINARY SCHEDULE OF IONS IN RUN 3 (SCHEDULE NOT APPROVED YET!!)



PSI in 2021 ➔ STRONG COMPETITION WITH SPS SLIP STACKING COMMISSIONING:

1. If needed, installation during LS2 of a stripper foil in a BTV optimized for Pb79+
2. Machine studies will be requested to study in SPS Pb79+:
   - Setting up of the Pb79+ cycle ➔ ready for 2022
   - Stripping efficiency and life time studies

PRELIMINARY SCHEDULE OF IONS IN RUN 3 (SCHEDULE NOT APPROVED YET!!)



PSI in 2022/2023 ➔ STRONG COMPETITION WITH LHC OXYGEN & LEAD RUN :

1. Machine studies will be requested for the proof of principle experiment in SPS Pb79+:
   - Setting up of the Pb79+ cycle ➔ if not done in 2021
   - Stripping efficiency and life time studies ➔ if not done in 2021
   - Gamma production and detection
   - Possibly beam cooling demonstration

GAMMA FACTORY ACTIVITIES SCHEDULE VS ION OPERATION IN THE CERN COMPLEX

Pb79+ machine studies

RUN3

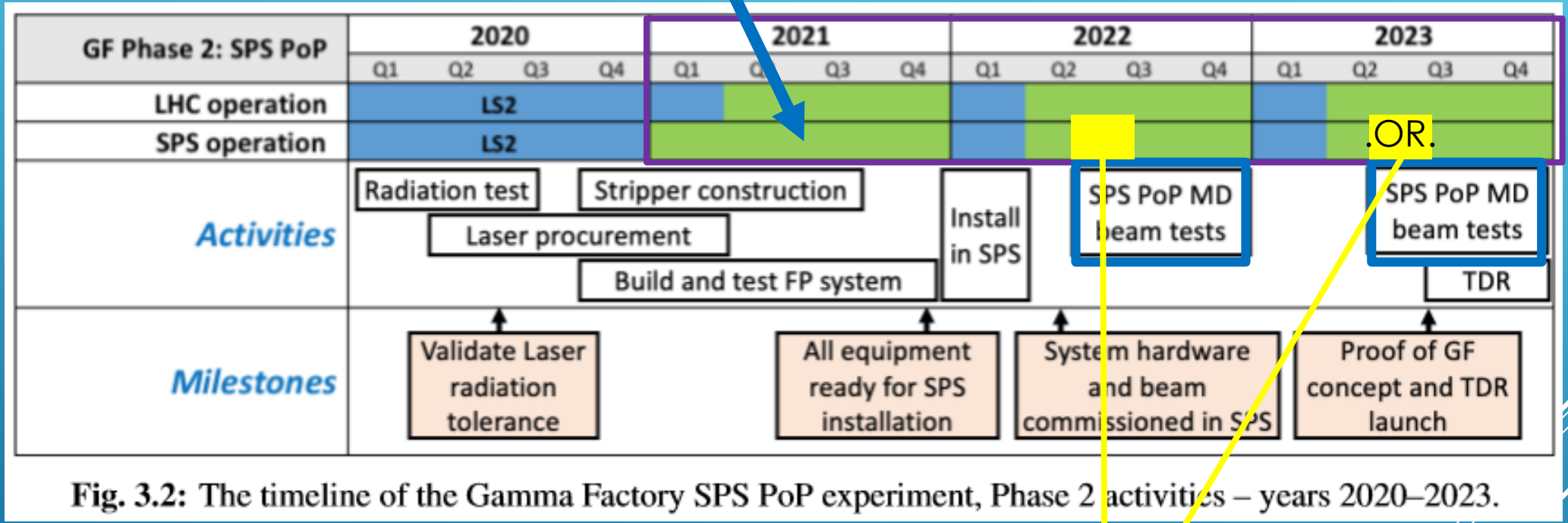


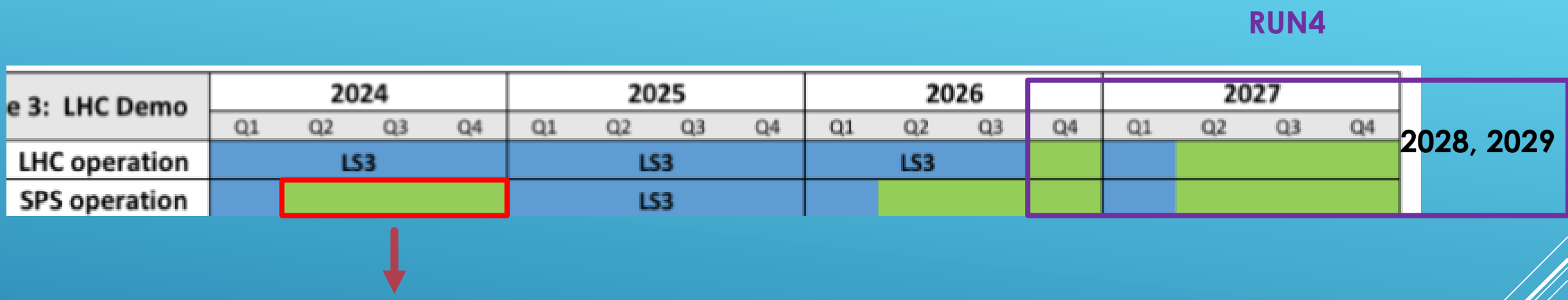
Fig. 3.2: The timeline of the Gamma Factory SPS PoP experiment, Phase 2 activities – years 2020–2023.

.OR.

LHC Oxygen pilot run OO and Op collisions

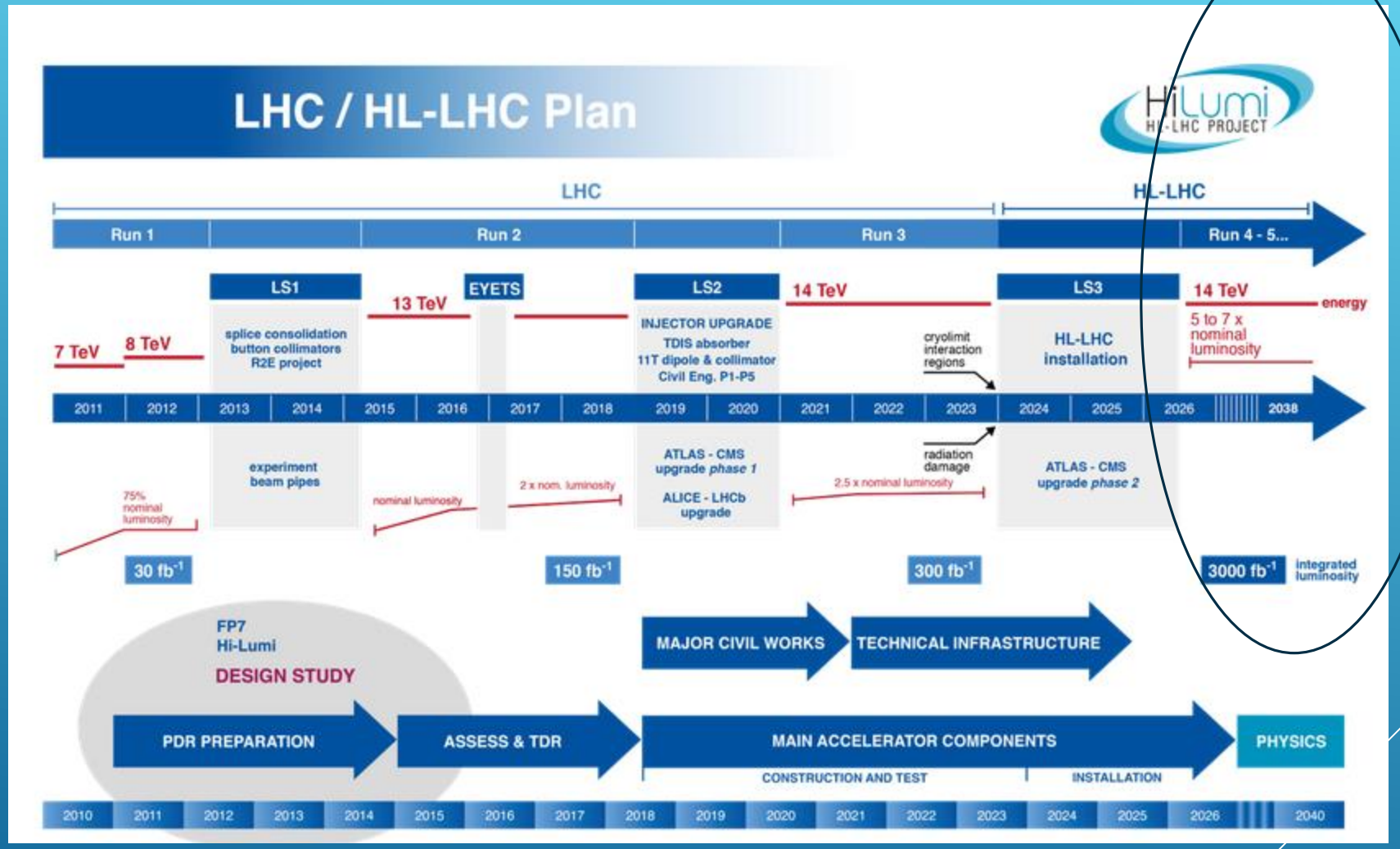
Synergy: PSI oxygen!

GAMMA FACTORY ACTIVITIES SCHEDULE VS ION OPERATION IN THE CERN COMPLEX



- Contingency year. o LHC running other experiments get more study time
- In case of issues in RUN3 (delays, not enough machine studies time, …) we could use 2024

- RUN 4:
  - STRONG COMPETITION WITH COMMISSION OF LHC AS HL-LHC MACHINE, this risk is not negligible.


LHC / HL-LHC Plan
HiLumi
HL-LHC PROJECT
LHC
HL-LHC
Run 1
Run 2
Run 3
Run 4 - 5...
LS1
EYETS
LS2
LS3
7 TeV
8 TeV
13 TeV
14 TeV
14 TeV
energy
splice consolidation
button collimators
R2E project
INJECTOR UPGRADE
TDIS absorber
11T dipole & collimator
Civil Eng. P1-P5
cryolimit
interaction
regions
HL-LHC
installation
5 to 7 x
nominal
luminosity
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
2026
2038
experiment
beam pipes
ATLAS - CMS
upgrade phase 1
ALICE - LHCb
upgrade
radiation
damage
ATLAS - CMS
upgrade phase 2
75%
nominal
luminosity
nominal luminosity
2 x nom. luminosity
2.5 x nominal luminosity
30 fb-1
150 fb-1
300 fb-1
3000 fb-1
integrated
luminosity
FP7
Hi-Lumi
DESIGN STUDY
MAJOR CIVIL WORKS
TECHNICAL INFRASTRUCTURE
PDR PREPARATION
ASSESS & TDR
MAIN ACCELERATOR COMPONENTS
PHYSICS
CONSTRUCTION AND TEST
INSTALLATION
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
2026
2040

GAMMA FACTORY ACTIVITIES SCHEDULE VS ION OPERATION IN THE CERN COMPLEX

No LHC ion run requested

contingency

HL-LHC ERA

RUN4

2028, 2029

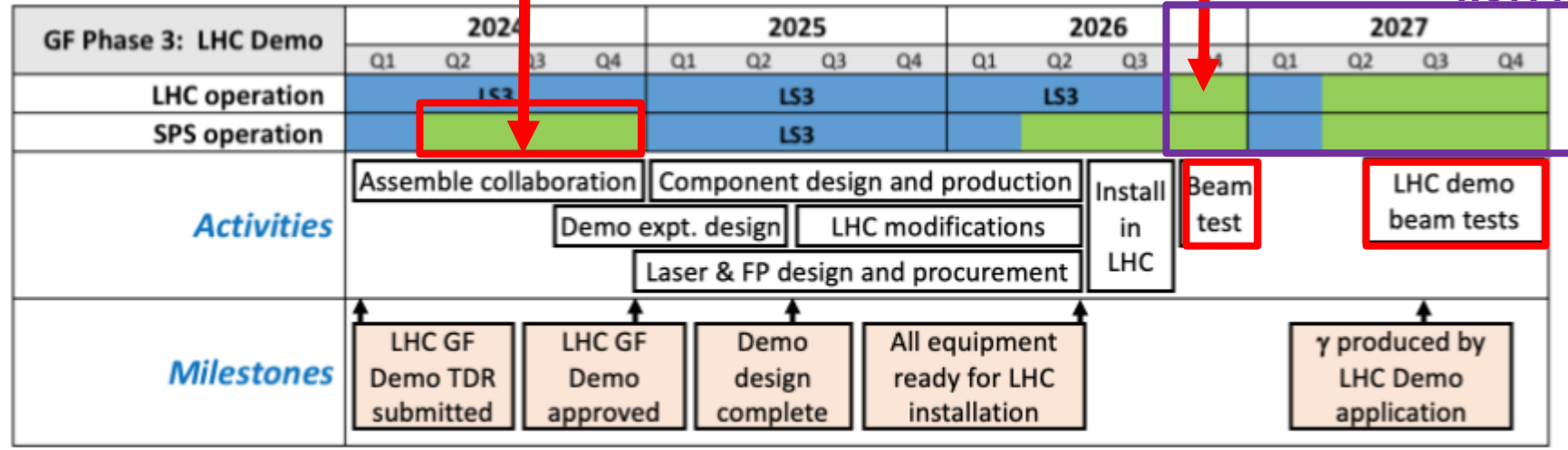


Fig. 3.3: A potential timeline of a Gamma Factory LHC Demonstrator Application, Phase 3 activities – years 2024–2027.

IONS BEYOND RUN4

- HL/HE-LHC physics workshop has considered lighter species for beyond Run 4
  - Full intensity, 1-month runs, eg, Ar-Ar
  - Good opportunity for Gamma Factory to find synergies in terms of species requested to share expenses or profit from LHC investment.

https://indico.cern.ch/event/783141/contributions/3310069/attachments/1804693/2945230/run5_HE_LHC_Milhano.pdf

HL/HE-LHC physics workshop

Proposed Run Schedule

	Year	Systems, time, L_{int}	Total per Run (3 and 4)
RUN3	2021 (4 weeks)	Pb-Pb 5.5 TeV, 3 weeks pp 5.5 TeV, 1 week	Pb-Pb: 6.2/nb ALICE/ATLAS/CMS, 1/nb LHCb p-Pb: 0.6/pb ATLAS/CMS, 0.3/pb ALICE/LHCb pp 5.5: 300/pb ATLAS/CMS, 25/pb LHCb, 3/pb ALICE pp 8.8: 100/pb ATLAS/CMS/LHCb, 1.5/pb ALICE O-O: 500/μb p-O: 200/μb
	2022 (6 weeks)	p-O + O-O 7 TeV, 1 week (after EYETS?) Pb-Pb 5.5 TeV, 5 weeks	
	2023 (4 weeks)	pp 8.8 TeV, few days p-Pb 8.8 TeV, 3.x weeks	
	LS3	ATLAS/CMS upgrades, ALICE: ITS3? FoCal?	
RUN4	2027 (4 weeks)	Pb-Pb 5.5 TeV, 3 weeks pp 5.5 TeV, 1 week	Pb-Pb: 6.8/nb, ALICE/ATLAS/CMS, 1/nb LHCb p-Pb: 0.6/pb ATLAS/CMS, 0.3/pb ALICE/LHCb pp 5.5: 300/pb ATLAS/CMS, 25/pb LHCb, 3/pb ALICE pp 8.8: 100/pb ATLAS/CMS/LHCb, 1.5/pb ALICE
	2028 (6 weeks)	Pb-Pb 5.5 TeV, 2 weeks p-Pb 8.8 TeV, 3.x weeks pp 8.8 TeV, few days	
	2029 (4 weeks)	Pb-Pb 5.5 TeV, 4 weeks	
	LS4		
RUN5		Intermediate A-A, 11 weeks pp reference, 1 week	E.g. Ar-Ar 3-9/pb (optimal species to be defined)

This is a proposal agreed in WG5 and reflects the physics discussed in the YR. The final run schedule is decided by the LHCC upon discussion with the experiments.

FUTURE LHC FULL INTENSITY RUNS: PLAUSIBLE SCALING (P=1.5)

	$^{16}O^{8+}$	$^{40}Ar^{18+}$	$^{40}Ca^{20+}$	$^{78}Kr^{36+}$	$^{84}Kr^{36+}$	$^{129}Xe^{54+}$	$^{208}Pb^{82+}$
γ	3760.	3390.	3760.	3470.	3220.	3150.	2960.
$\sqrt{s_{NN}}$ /TeV	7.	6.3	7.	6.46	6.	5.86	5.52
σ_{had} /b	1.41	2.6	2.6	4.06	4.26	5.67	7.8
σ_{tot} /b	1.48	3.85	4.18	17.1	18.3	72.5	508.
N_b	6.24×10^{9}	1.85×10^{9}	1.58×10^{9}	6.53×10^{8}	6.53×10^{8}	3.56×10^{8}	1.9×10^{8}
ϵ_{xn} /μm	2.	1.8	2.	1.85	1.71	1.67	1.58
f_{IBS} /(m Hz)	0.0662	0.0894	0.105	0.13	0.12	0.144	0.167
W_b /MJ	68.9	45.9	43.6	32.5	32.5	26.5	21.5
L_{AA0} /$cm^{-2}s^{-1}$	1.46×10^{31}	1.29×10^{30}	9.38×10^{29}	1.61×10^{29}	1.61×10^{29}	4.76×10^{28}	1.36×10^{28}
L_{NN0} /$cm^{-2}s^{-1}$	3.75×10^{33}	2.06×10^{33}	1.5×10^{33}	9.79×10^{32}	1.14×10^{33}	7.93×10^{32}	5.88×10^{32}
P_{BFPP} /W	0.0031	0.179	0.303	5.72	5.72	43.4	350.
P_{EMD1} /W	4.98	16.5	16.9	40.5	43.7	76.7	141.
τ_{L0} /h	16.4	21.3	23.	13.5	12.7	5.87	1.57
T_{opt} /h	9.04	10.3	10.7	8.23	7.96	5.42	2.8
$\langle L_{AA}\rangle$ /$cm^{-2}s^{-1}$	8.99×10^{30}	8.34×10^{29}	6.17×10^{29}	9.46×10^{28}	9.32×10^{28}	2.23×10^{28}	3.8×10^{27}
$\langle L_{NN}\rangle$ /$cm^{-2}s^{-1}$	2.3×10^{33}	1.33×10^{33}	9.87×10^{32}	5.76×10^{32}	6.57×10^{32}	3.71×10^{32}	1.64×10^{32}
$\int_{month} L_{AA}\ dt$ /nb^{-1}	11700.	1080.	799.	123.	121.	28.9	4.92
$\int_{month} L_{NN}\ dt$ /pb^{-1}	2980.	1730.	1280.	746.	852.	481.	213.
R_{had} /kHz	20700.	3340.	2440.	653.	686.	270.	106.
μ	1.64	0.266	0.194	0.0518	0.0544	0.0215	0.00842

By J.M. Jowett, O-O p-O meeting 20/03/2019