Towards SPS GF PoP Experiment

Concept status, open questions, WG, collaborative tools, work-plan and work-packages

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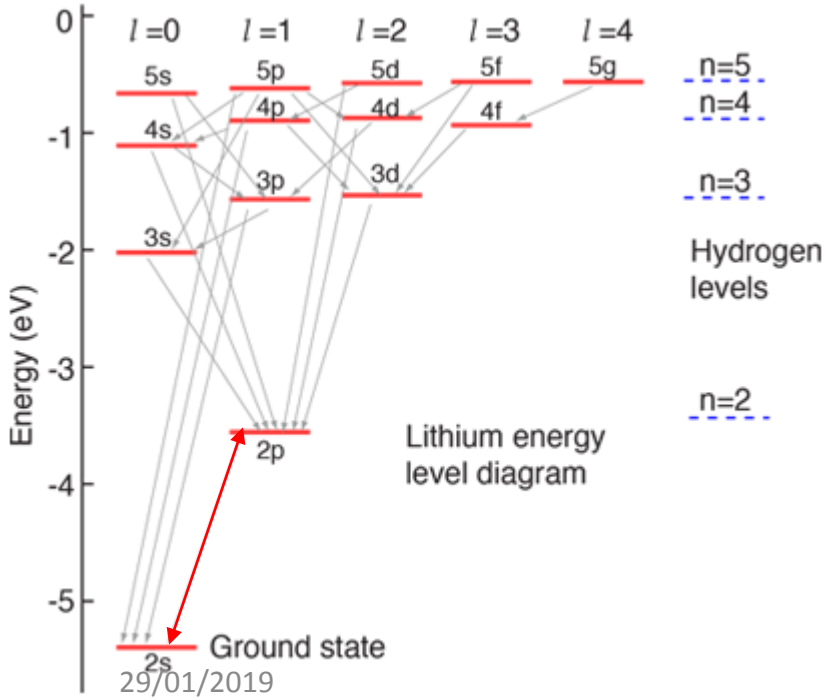
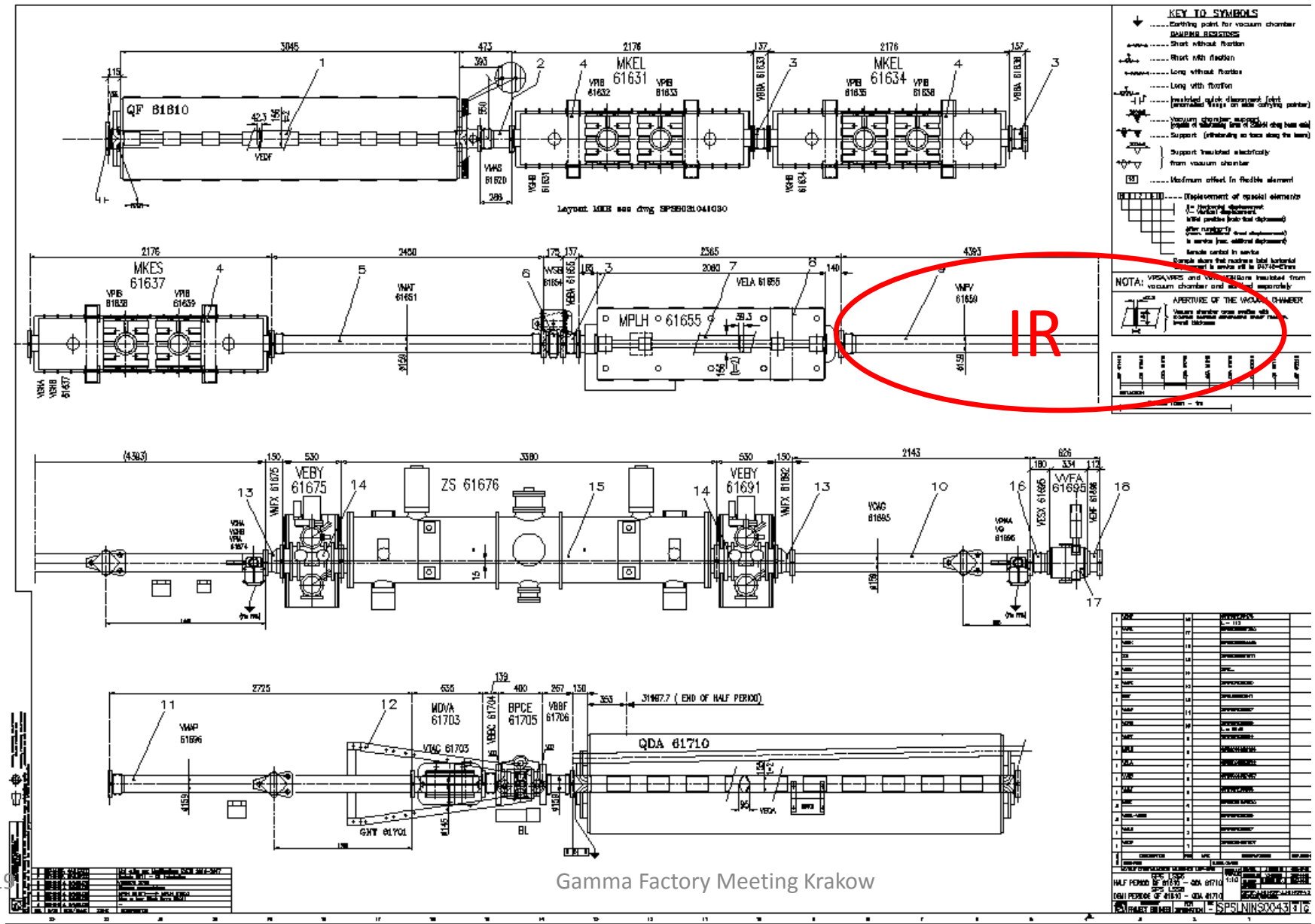
Concept

- (Almost) head-on laser-PSI interaction, maximising spatial and temporal overlap functions and relativistic Doppler-boost
- Pb+79 (Li-like) PSI, SPS rigidity ~790 Tm, **$\gamma = 96$** (~236 GeV proton)
- 2s → 2p transition, 230 eV calculated for Pb79+ (cf 1.85 eV for Li)



- Laser: $230/(\gamma(1+\beta\cos\theta))$ eV ≈ $230/1.985\gamma$ ≈ 1.2 eV (1030 nm)
- Interaction angle as small as possible compatible with physical layout: **2.6°**

Laser-PSI interaction region: tentatively LSS6: 616



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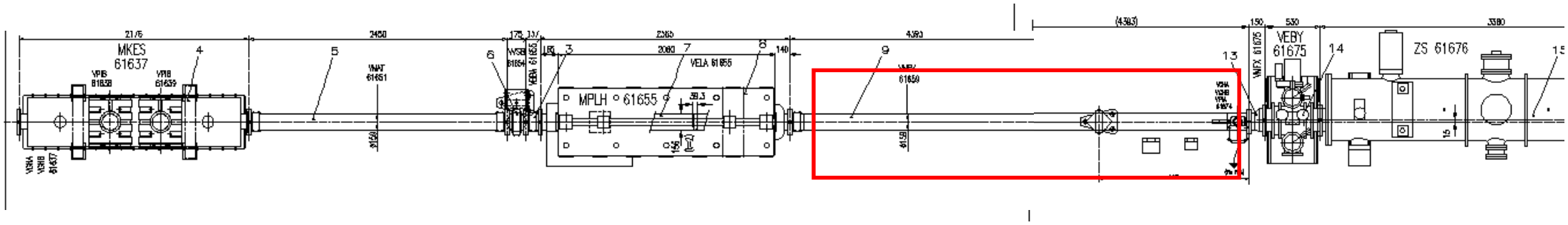

- About 4.4 m flange-flange between MPLH and ZS (VV)
- 2.6 degree cavity, **4 mJ (?)** laser pulse energy

Status / open questions

- Ion species and transition: defined (pb79+, 2s→2p)
- Ion beam parameters: defined
- IR location: identified (IR6). Confirm?
- SPS optical parameters: Defined (for LSS6)
- IR layout & FP design: proposed 2.6 deg crossing. Confirm?
- Laser characteristics: to finalise
- Timing & synchronisation aspects: to define
- Radiation aspects: 2018 dosimetry measurements: to analyse and implications to evaluate
- Simulation benchmarking: in progress
- Parameter list (including uncertainties): to complete
- Emitted photon distribution f(t): in progress
- PSI beam 6D evolution f(t): in progress
- Detector requirements: to define
- Experimental procedures: to define
- Atomic physics prospects: to define

SPS PoP WG: scope

- Limit to the SPS PoP experiment, aiming for an installation end 2021
- Answer remaining questions: technical, schedule, budget, resources, responsibility
- Coordinate simulation, laser, detection, machine, control experts to finalise experimental design
- Follow-up of the production, installation and experiment? tbd

Objectives/deliverables

- Identify and answer remaining questions
- Produce and maintain list of all required parameters and inputs
- Produce specifications for subsystems
  - Laser
  - Interaction FP cavity
  - Detection systems
  - Controls, timing & SW
- Produce specifications for beam and operational aspects
  - Cycle
  - Beam type
- Develop a realistic experimental procedure
  - Finding resonance
  - Measuring key parameters
  - Demonstrating damping
- Define the detailed planning and budget

Work breakdown

	New HW and controls						Simulations				SPS machine			
	Laser	FP cavity	Photon detector	Vacuum system	Services (cables, cooling, …)	Controls, timing	Impedance	IR and photon Sims	Radiation to electronics	Cooling beam dynamics Sims	Parameters, aperture, optics	Layout and integration	PSI beam diagnostics	Experimental procedure
K. Cassou	X	X		X	X	x			X			X		X
A.Mertens	X	X	X	X			X	X	X	X	X			X
R. Alemany Fernandez						X					X		X	X
Y. Dutheil					X			X		X	X	X		X
V. Fedosseev	X								X			X		X
B. Goddard				X	X				X		X	X	X	X
R. Kersevan				X								X		X
M. Krasny								X						X
T. Lefevre		X	X		X								X	X
B. Marsh	X								X					X
A. Petrenko								X		X				X
J.Bieron								X						X
M.Lamont														X
C.Curatolo			X					X						X
M.Sapinski			X										X	X
H.Bartosik							X			X	X		X	X
F.Velloti						X					X	X	X	X
S.Gibson	X													X
V.Chevelko								X						X

Draft representation
Add Institutes, and update!

Collaboration tools (thanks Yann)

- SPS PoP mailing list (egroup): **PBC-acc-GammaFactory-SPSpop@cern.ch**
- A Microsoft workspace here
- An INDICO branch here
- SLACK (mattermost clone) chatrooms here

Deadlines: phase 1

- Detailed Proposed: End June/July 2019 (~6 months)

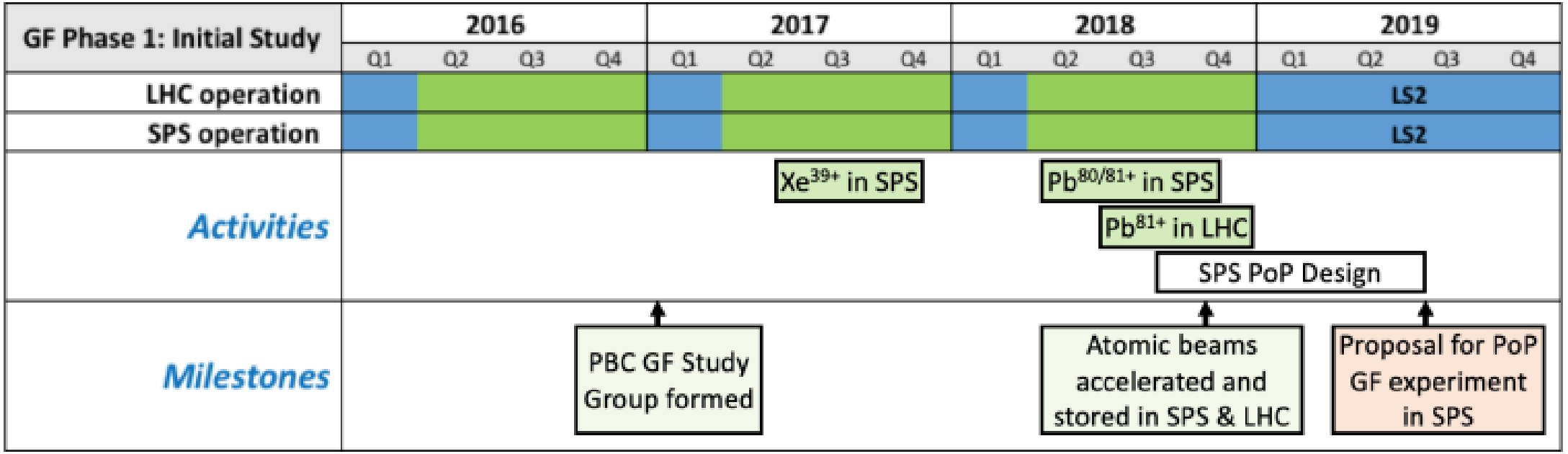

Fig. 1: The timeline of the Gamma Factory Initial Study, Phase 1 activities – years 2016–2019.

Deadlines: phase 2

- Systems ready for installation: End December 2021 (30 months)
- Beam tests: 2022 and 2023

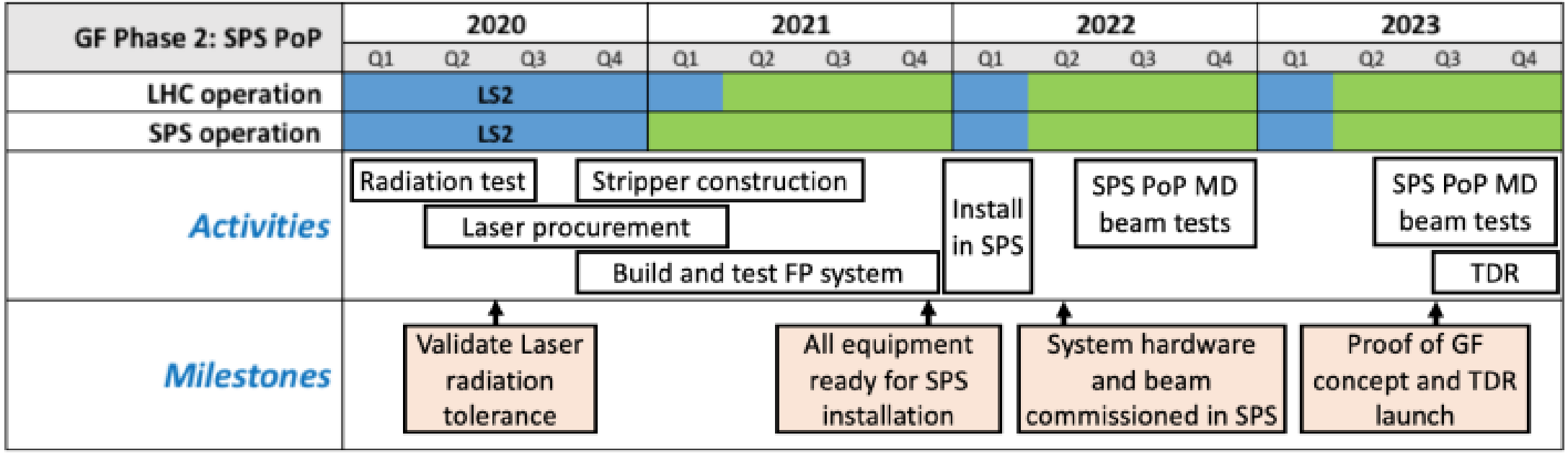

Fig. 2: The timeline of the Gamma Factory SPS PoP experiment, Phase 2 activities – years 2020–2023.

Timelines - for discussion…

		DELIVERABLE		1	2	3	4	5	6	7	8	9	10	11	12
Simulatio	1.1	Define ion species and transition. Assign maximum uncertainty to energy values	Mar-19		K										
	1.2	Check impedance of FP cavity design and vacuum layout (for heating of mirrors and SPS beam)	Jul-19												
	1.3	Check impedance of detector (for heating and SPS beam)	Jul-19												
	1.4	Define photon flux at detector plans for Phases 1,2 & 3 (resonance finding, optimisation, cooling)	Mar-19		K										
	1.5	Simulate detector response for Phases 1,2 & 3 including background	Jul-19												
	1.6	Simulate longitudinal cooling and 6D distribution for Phase 3 (cooling)	Jul-19												
	1.7	Simulate beam observation response of Phase 3 (cooling)	Jul-19												
	1.8	Perform sensitivity analysis for Use-Case 1 (Monte-Carlo?) with foreseeable ripple & errors	Jul-19												
	1.9	Perform FLUKA simulations for radiation dose to laser and cavity electronics	Jul-19												
Specificat	2.1	Finalise ion beam parameters	Mar-19		K										
	2.2	Finalise IR location and layout (vacuum, physical integration)	Jul-19												
	2.3	Define shielding requirements	Jul-19												
	2.4	Finalise FP cavity requirements including impedance shielding	Jul-19												
	2.5	Finalise laser specification	Jul-19												
	2.6	Finalise operational SW/Control specification for Phases 1,2 & 3	Jul-19												
Document	12.1	Write-up of LOI	Jun-19												
	12.2	Write-up of Yellow Report	Jun-19												
	12.3	Generate SSR for IR/detector region	Sep-19												
	12.4	Generate ECR for IR/detector region	Jun-20												
	12.5	Final reporting of experimental results	Dec-23												

Today: morning

10:00	**SPS PoP overview** *H-0-11, Faculty of Physics, Astronomy and Applied Computer Science*	*Brennan Goddard* 10:00 - 10:30
	Parameters, uncertainties and subsystem specification status, outline of assume 'real' experimental scenarios *H-0-11, Faculty of Physics, Astronomy and Applied Computer Science*	*Yann Dutheil*
11:00	**Ion and charge state choice** *H-0-11, Faculty of Physics, Astronomy and Applied Computer Science*	*Jacek Bieron* 11:00 - 11:30
	Beam dynamics implementation and output *H-0-11, Faculty of Physics, Astronomy and Applied Computer Science*	*Alexey Petrenko* 11:30 - 12:10
12:00	**Orsay studies Laser+FP, feasibility of required laser characteristics** *H-0-11, Faculty of Physics, Astronomy and Applied Computer Science*	*Aurelien Martens et al.* 12:10 - 13:00
13:00		

Today: afternoon

14:00		
	Constraints on Laser system implementation in SPS tunnel	*Valentine Fedosseev*
	H-0-11, Faculty of Physics, Astronomy and Applied Computer Science	14:30 - 15:00
15:00	**Requirements and feasibility of the photon detection system**	*Mariusz Sapinski et al.*
	H-0-11, Faculty of Physics, Astronomy and Applied Computer Science	15:00 - 15:30
	Atomic physics measurements with the SPS Li-like Pb beam	*Andrey Surzhykov et al.*
	H-0-11, Faculty of Physics, Astronomy and Applied Computer Science	15:30 - 16:00
16:00	**Discussion on next steps, including actions, agenda for Upcoming Workshop, Yellow Report**	
	H-0-11, Faculty of Physics, Astronomy and Applied Computer Science	16:00 - 16:30

Key questions

- Laser spectral, temporal and spatial characteristics
- Laser and FP cavity electronics location and radiation resistance
- Impedance aspects (on beam and on cavity)
- Photon detector specification and design
- Timing and synch to SPS RF
- Experimental uncertainties and procedure for the 3 “phases”
- Expected cooling (realistic spectrum, jitter, heating) and observable(s)
- Atomic physics?