
CERN

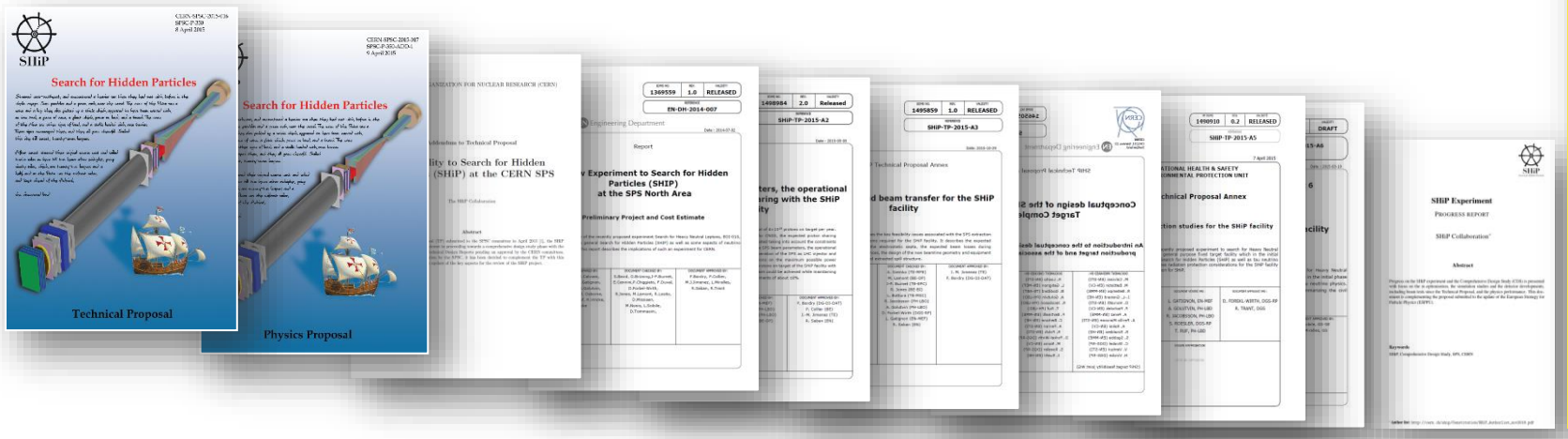
An introduction to the HI-ECN3 project

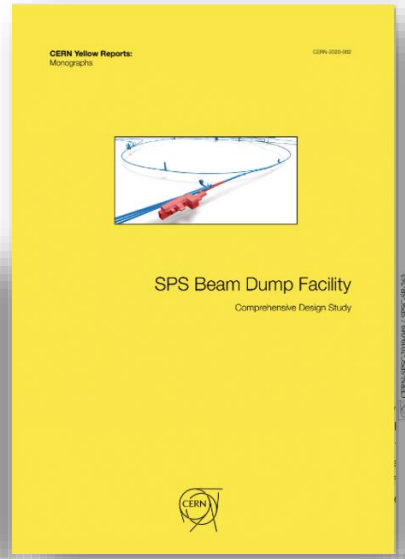
BDF Target Advisory Committee #1

M. Fraser (SY-ABT-BTP) and C. Ahdida (HSE-RP-AS) on behalf of the HI-ECN3 project team

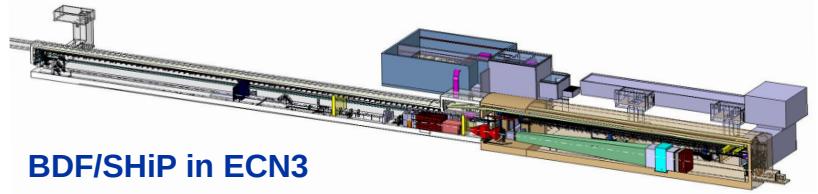
CERN, Geneva, Switzerland, 4 - 6th March 2025

A brief history of BDF/SHiP…



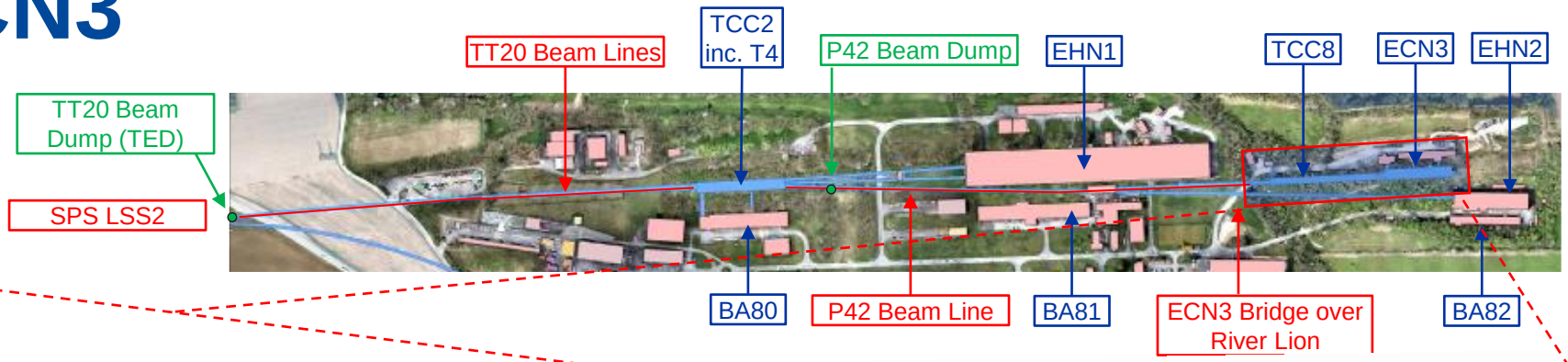


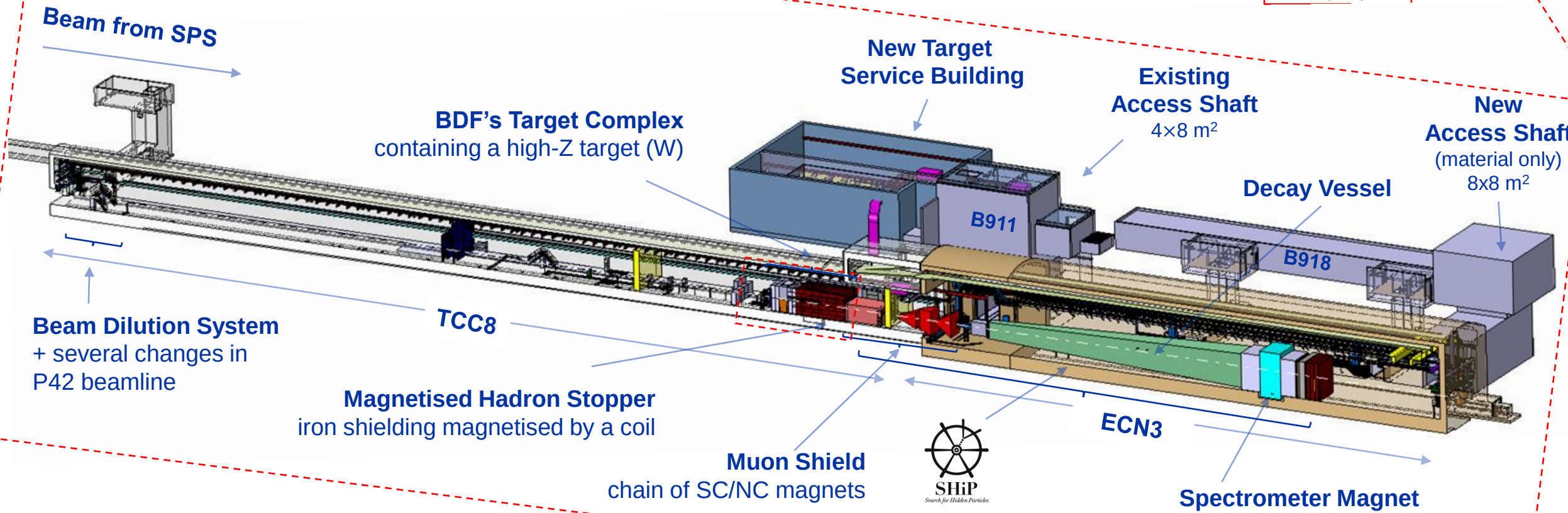
- **2013:** EOI with SHiP @ SPS North Area in a new underground area (ECN4)
- **2015:** Technical Proposal with ~700 pages by SHiP theorists, experimentalists, and CERN accelerator, engineering, and safety departments
- **2016:** Recommendation by SPSC to proceed to Comprehensive Design Study and CERN management launch of Beyond Collider Physics study group
- **2018:** European Particle Physics Strategy Update contribution submitted by SHiP and BDF
- **2019:** CDS reports on BDF and SHiP at ECN4 submitted to SPSC
- **2020:** CERN launches continued BDF R&D with SHiP MoU
- **2021: BDF/SHiP WG identified ECN3** as post-LS3 option: motivated **PBC ECN3 Task Force**
- **2023: HI-ECN3 Study Project established**
- **2024: CERN Directorate select SHiP in March 2024 with approval of HI-ECN3 Project**



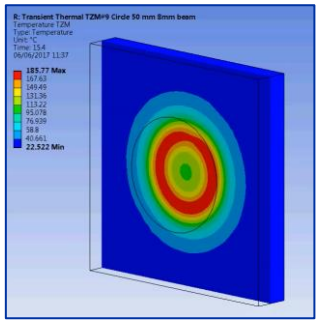
BDF/SHiP in ECN3

BDF/SHiP in ECN3



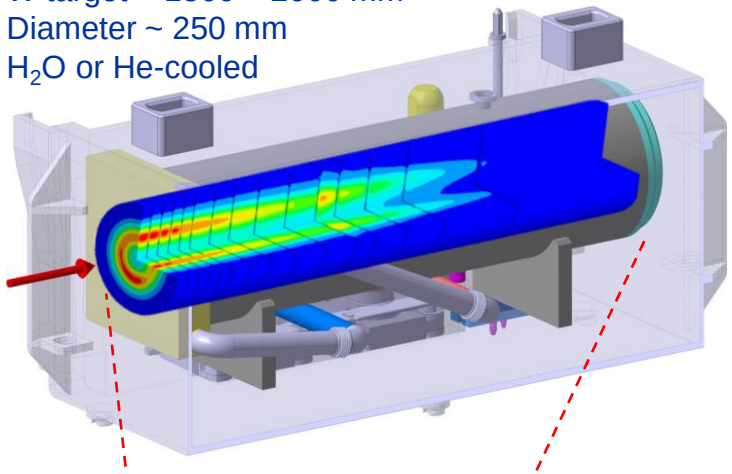


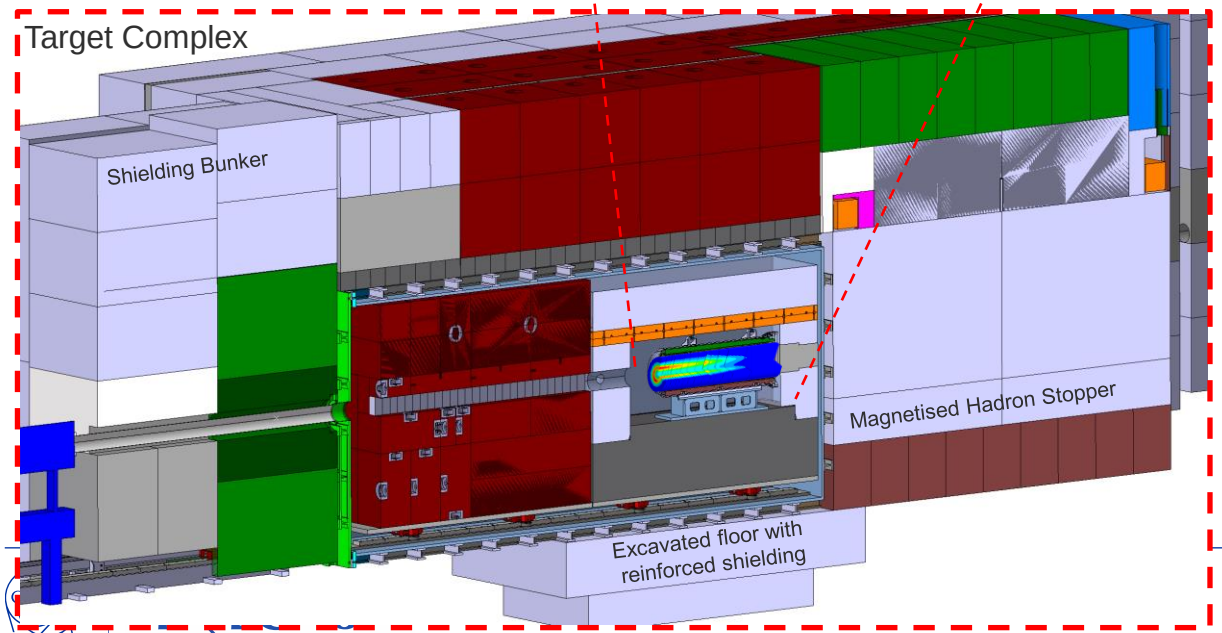
BDF Design Parameters



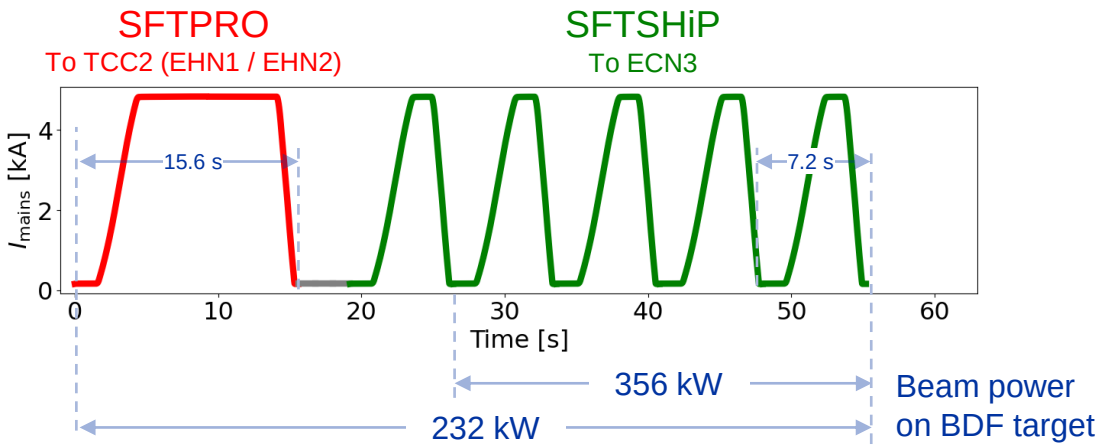
Beam size = 8 mm (σ)
Dilution freq. = 4 Hz
Sweep rad. = 50 mm

W target ~ 1500 – 2000 mm
Diameter ~ 250 mm
H_2O or He-cooled





Nominal Design Parameter	Value
Beam type	proton
Beam momentum [GeV/c]	400
Beam pulse intensity [$\times 10^{13}$ p]	4.0
Spill length [s]	1
Beam pulse power [kW]	2560
Average beam power [kW] (7.2 s)	356
POT [$\times 10^{20}$ p over 15 years]	6.0



Study Project → Approved Project

Upgrade of beam intensity at North Area and SHiP beam-dump (BDF/SHiP) experiment approved recently…

… with ~ 62 MCHF (over 7 years) reserved for the High Intensity upgrade of ECN3 (HI-ECN3) project in CERN's Medium-Term Plan ratified by CERN Council in June 2024.

Approved together with ~ 170 MCHF for consolidation of the North Area (NA-CONS project)

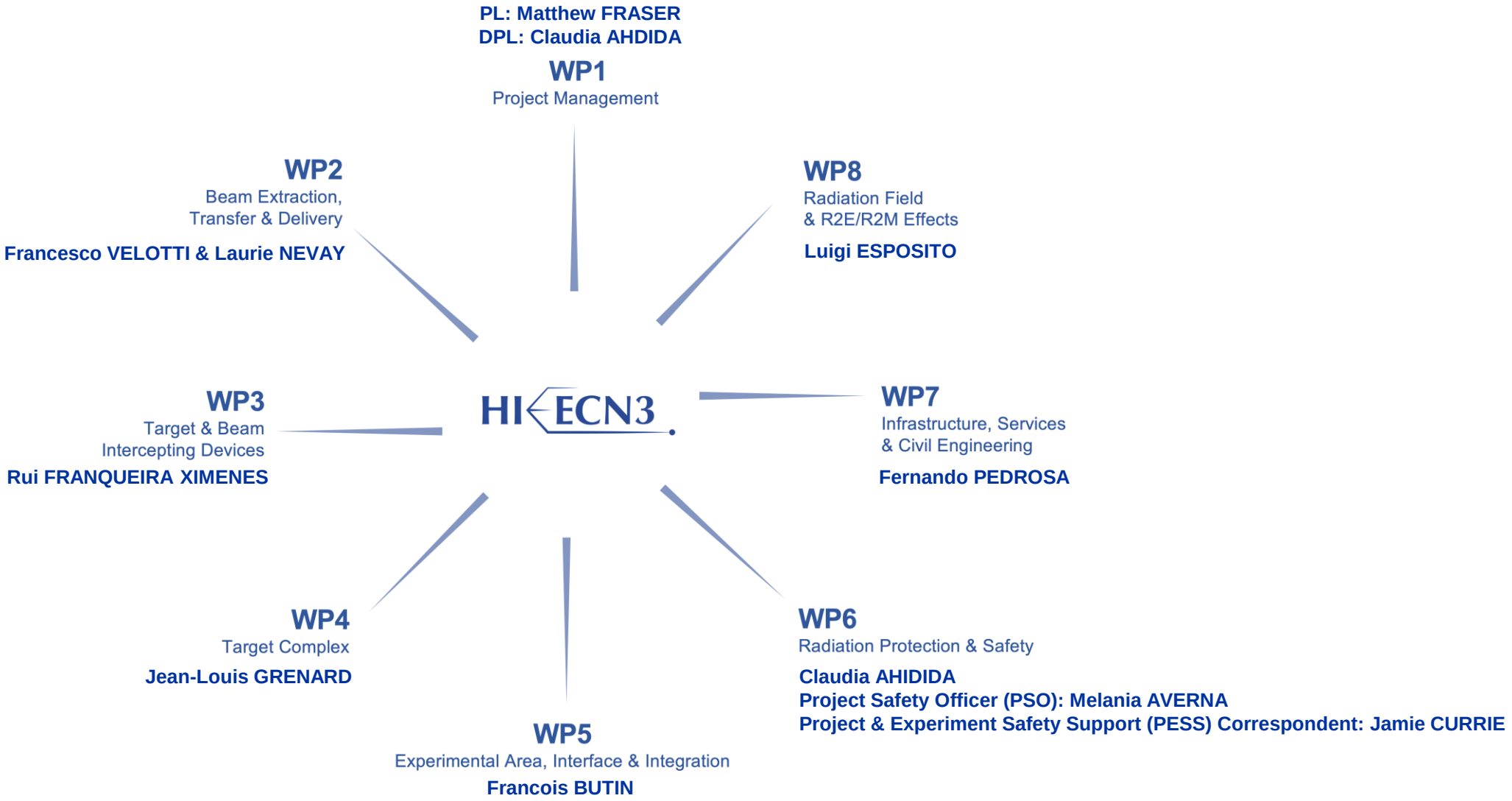
The HI-ECN3 project is a part of CERN's…

"…broad diverse scientific programme, complementary to the collider and carried out mainly at the injectors: continuously upgraded and expanded (e.g. recently the ECN3 beam intensity upgrade at the North Area)."

Fabiola Gianotti

HI-ECN3 Project Structure

Experiment Project Leader: Richard JACOBSSON
SHiP Experiment Safety Correspondent: Letizia DI GIULIO

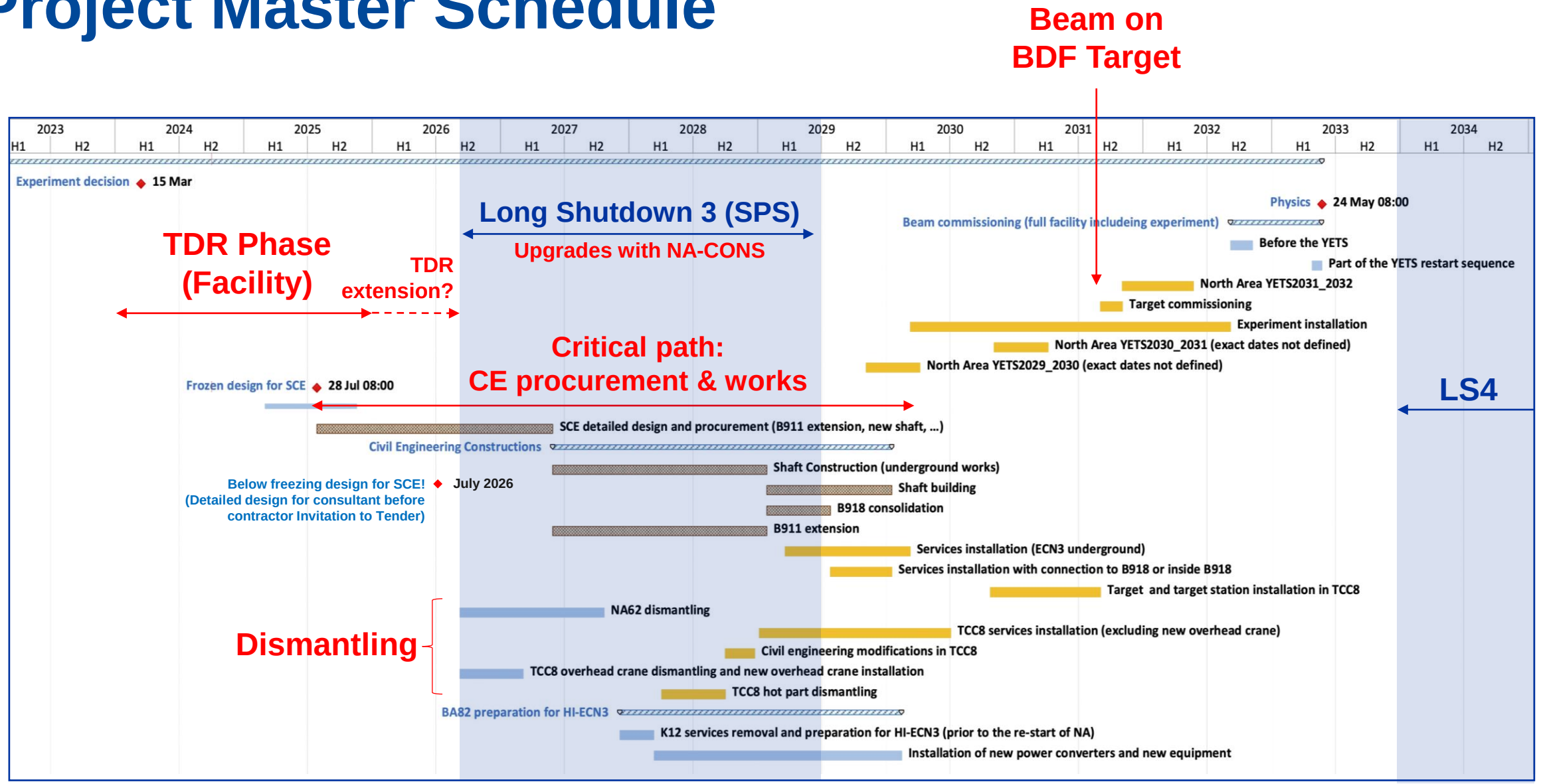


HI-ECN3 Work Breakdown Structure

HI-ECN3 TDR GRAD Team

Person	Role	Group	Supervisor	Programme	BC Description	PRQ	Start Date
Ixone VAQUERO	Planning & Coordination	EN-ACE	Fernando PEDROSA	ORIGIN	HI-ECN3 / NA-CONS	Completed	1/10/2023
Xavier PALLE	Planning & Coordination	EN-ACE	Fernando PEDROSA	ORIGIN	HI-ECN3 / NA-CONS	Completed	1/3/2024
James CURRIE	TDR	HSE-OHS	Simon MARSH	ORIGIN	HI-ECN3	Completed	1/2/2024
Rahul JANARDHAN	FIRIA	HSE-OHS	Oriol RIOS	QUEST	HI-ECN3 / HSE	Completed	1/9/2024
Guillaume CNUDDE	TDR (& implementation)	SCE-PPM	David GOMEZ	QUEST	HI-ECN3	Completed	1/10/2024
Nikola ZARIC	TDR	EN-CV	Roberto BOZZI	QUEST	HI-ECN3	Completed	1/2/2024
Angelo PETRELLESE	Secondary Vacuum	BE-EA	Miguel SANTOS	ORIGIN	HI-ECN3 / NA-CONS / PBC	Completed	1/4/2024
Fabian METZGER	TDR	BE-EA	Laurence NEVAY	GRAF	HI-ECN3	Completed	1/4/2024
TBC	TDR / LS3 prep	BE-EA	Francois BUTIN	ORIGIN	HI-ECN3	Pre-LS3	Q3 2026
Beatriz MARTINEZ SUTIL	TDR	BE-EA	Michael LAZZARONI	ORIGIN	HI-ECN3	Completed	2/5/2024
Ming LIU	TDR	EN-EL	Eva CANO GONZALEZ	QUEST	HI-ECN3 / NA-CONS	Completed	2/5/2024
Cristina DURAN GUTIERREZ	TDR	EN-HE	Roberto RINALDESI	ORIGIN	HI-ECN3	Completed	1/6/2024
Olin PINTO	TDR	HSE-RP	Claudia AHDIDA	QUEST	HI-ECN3	Completed	1/2/2024
Mike PARKIN	TDR	SY-STI	Rui FRANQUEIRA XIMENES	QUEST	HI-ECN3	Completed	1/4/2024
Patrick CURRAN	TDR	EN-MME	Stefano SGOBBA	QUEST	HI-ECN3	Completed	1/2/2025
Gemma HUMPHREYS	TDR	SY-STI	Jean Louis GRENARD	QUEST	HI-ECN3	Completed	1/12/2024
Giuseppe MAZZOLA	R2E / FLUKA	SY-STI	Luigi ESPOSITO	QUEST	HI-ECN3	Completed	1/2/2022
Anna HUNCIKOVA	TDR	BE-GM	Camille VENDEUVRE	QUEST	HI-ECN3 / NA-CONS	Completed	1/12/2024
TBC	BLM	SY-BI	Christos ZAMANTZAS	ORIGIN	HI-ECN3	TBC	Q3 2026
TBC	BLM	SY-BI	Christos ZAMANTZAS	TECH	HI-ECN3	TBC	Q3 2026
Panagiotis MENACHILIS	TCSC CONS	SY-STI	Nicolas SOLIERI	QUEST	NA-CONS	Completed	1/10/2024
Iasonas CHATZIGEORGIOU	XTAX CONS	BE-EA	Miguel SANTOS	QUEST	NA-CONS	Completed	1/2/2023
Giorgio GARLASCHELL	TDC2 / TCC2	HSE-RP	Helmut VINCKE	QUEST	NA-CONS	Completed	1/9/2024
Alexander GORN	TDR	SY-ABT	Matthew FRASER	GRAF	PBC / SY / HI-ECN3	Completed	1/10/2023
Tamara BUD	ECN3 tasks on request	SCE	John OSBORNE	QUEST	PBC	Completed	1/1/2024
Francesca LUONI	ECN3 tasks on request	HSE-RP	Claudia AHDIDA	FELL	PBC	Completed	1/9/2023
Tirsi PREBIBAJ	ECN3 tasks on request	BE-ABP	Hannes BARTOSIK	GRAF	PBC	Completed	1/3/2023

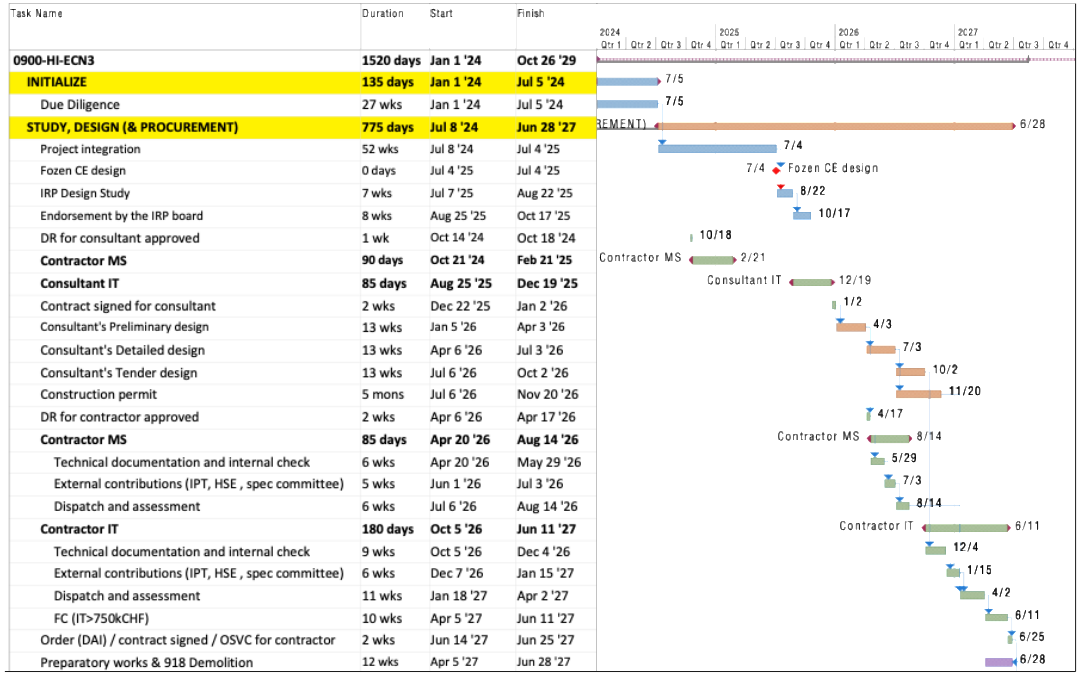
Project Master Schedule



HI-ECN3 TDR

Aiming for TDR publication mid-2026: with updated cost & resource estimates of project baseline

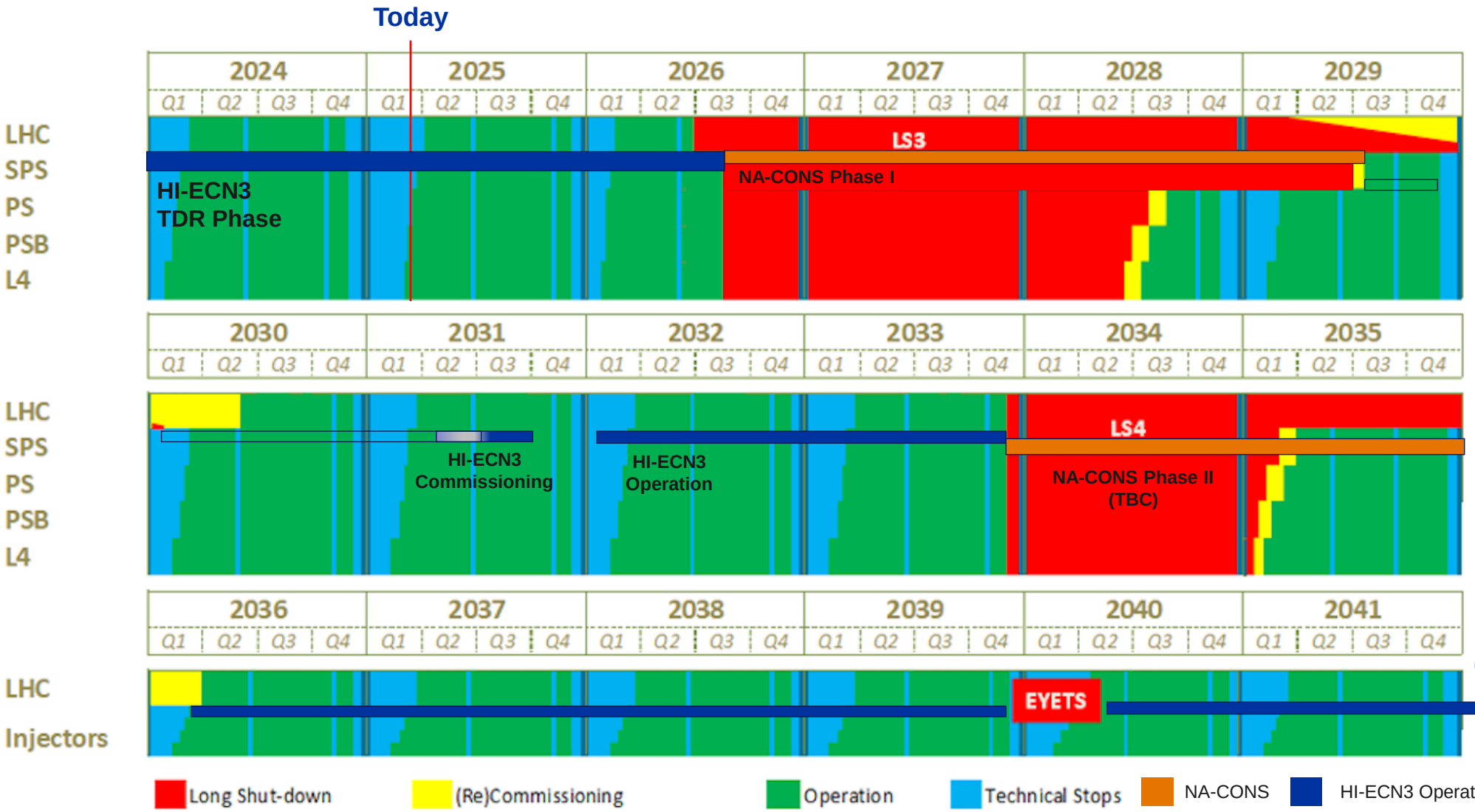
- **Timeline:**
  - **September 2025 (Q3 2025)**: **Frozen design*** as part of completion of IRP Design Study needed for consultant Invitation to Tender (IT)
  - **Scope, with loads & volumes needed in 2025**
  - **Choice of target technology (H2O vs. He) must not impact envelopes for civil engineering:**
    - Final validation of He-cooled design will not be available until after the beam tests in 2025 and 2026
  - **The Service Cell must not impact civil engineering**
  - **December 2025:** Preliminary design for consultant
  - **July 2026:** Detailed design for consultant
  - **October 2026:** Launch contractor IT: significant cost impact and delay with any further changes



Task Name	Duration	Start	Finish
0900-HI-ECN3	**1520 days**	**Jan 1 '24**	**Oct 26 '29**
INITIALIZE	**135 days**	**Jan 1 '24**	**Jul 5 '24**
Due Diligence	27 wks	Jan 1 '24	Jul 5 '24
STUDY, DESIGN (& PROCUREMENT)	**775 days**	**Jul 8 '24**	**Jun 28 '27**
Project integration	52 wks	Jul 8 '24	Jul 4 '25
Fozen CE design	0 days	Jul 4 '25	Jul 4 '25
IRP Design Study	7 wks	Jul 7 '25	Aug 22 '25
Endorsement by the IRP board	8 wks	Aug 25 '25	Oct 17 '25
DR for consultant approved	1 wk	Oct 14 '24	Oct 18 '24
Contractor MS	**90 days**	**Oct 21 '24**	**Feb 21 '25**
Consultant IT	**85 days**	**Aug 25 '25**	**Dec 19 '25**
Contract signed for consultant	2 wks	Dec 22 '25	Jan 2 '26
Consultant's Preliminary design	13 wks	Jan 5 '26	Apr 3 '26
Consultant's Detailed design	13 wks	Apr 6 '26	Jul 3 '26
Consultant's Tender design	13 wks	Jul 6 '26	Oct 2 '26
Construction permit	5 mons	Jul 6 '26	Nov 20 '26
DR for contractor approved	2 wks	Apr 6 '26	Apr 17 '26
Contractor MS	**85 days**	**Apr 20 '26**	**Aug 14 '26**
Technical documentation and internal check	6 wks	Apr 20 '26	May 29 '26
External contributions (IPT, HSE , spec committee)	5 wks	Jun 1 '26	Jul 3 '26
Dispatch and assessment	6 wks	Jul 6 '26	Aug 14 '26
Contractor IT	**180 days**	**Oct 5 '26**	**Jun 11 '27**
Technical documentation and internal check	9 wks	Oct 5 '26	Dec 4 '26
External contributions (IPT, HSE , spec committee)	6 wks	Dec 7 '26	Jan 15 '27
Dispatch and assessment	11 wks	Jan 18 '27	Apr 2 '27
FC (IT>750kCHF)	10 wks	Apr 5 '27	Jun 11 '27
Order (DAI) / contract signed / OSVC for contractor	2 wks	Jun 14 '27	Jun 25 '27
Preparatory works & 918 Demolition	12 wks	Apr 5 '27	Jun 28 '27

***Frozen design = volumes, loads & structural definition (small openings and internal integration have some flexibility)**

CERN Accelerator Schedule



NA available exclusively for EHN1/2 from mid-2029:
Test-beam users & other POT demanding experiments (e.g. AMBER, MuonE)

ECN3 beam to dump in P42 for commissioning of TCC2 whilst construction ongoing

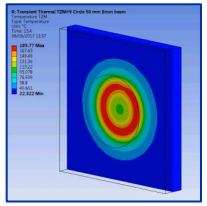
Operation out to late 2040s:
beyond HL-LHC
(frequency & length of LS's TBC)

Commissioning High Intensity for ECN3

The commissioning of HI-ECN3 can be grouped into two phases:

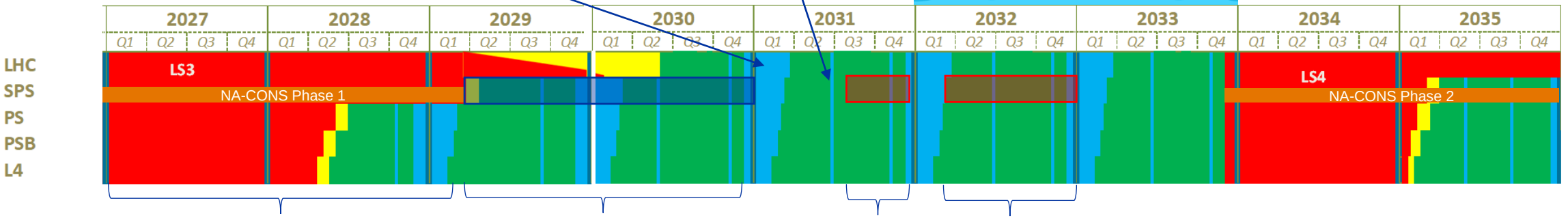
- **Commissioning TCC2 (2029 – 30, ~ 2 yr) with NA-CONS:** inc. SPS, slow extraction
- **Commissioning of ECN3 (2031 – 32, ~ 1.5 yr):** inc. BDF in TCC8, beam transfer from TCC2 to TCC8, before ramping up to nominal operation together with SHiP before end 2032

YETS30/31:
Remove P42 beam dump & reconfigure beam line



Q3 2031:
Beam on BDF Target

Operation of BDF/SHiP @ 4×10^{19} POT



Upgrades of TCC2 for HI-ECN3

Commissioning of SPS and NA (TCC2) for HI-ECN3

BDF commissioning (flexible with SHiP installation)

Commissioning of SHiP: ramping intensity

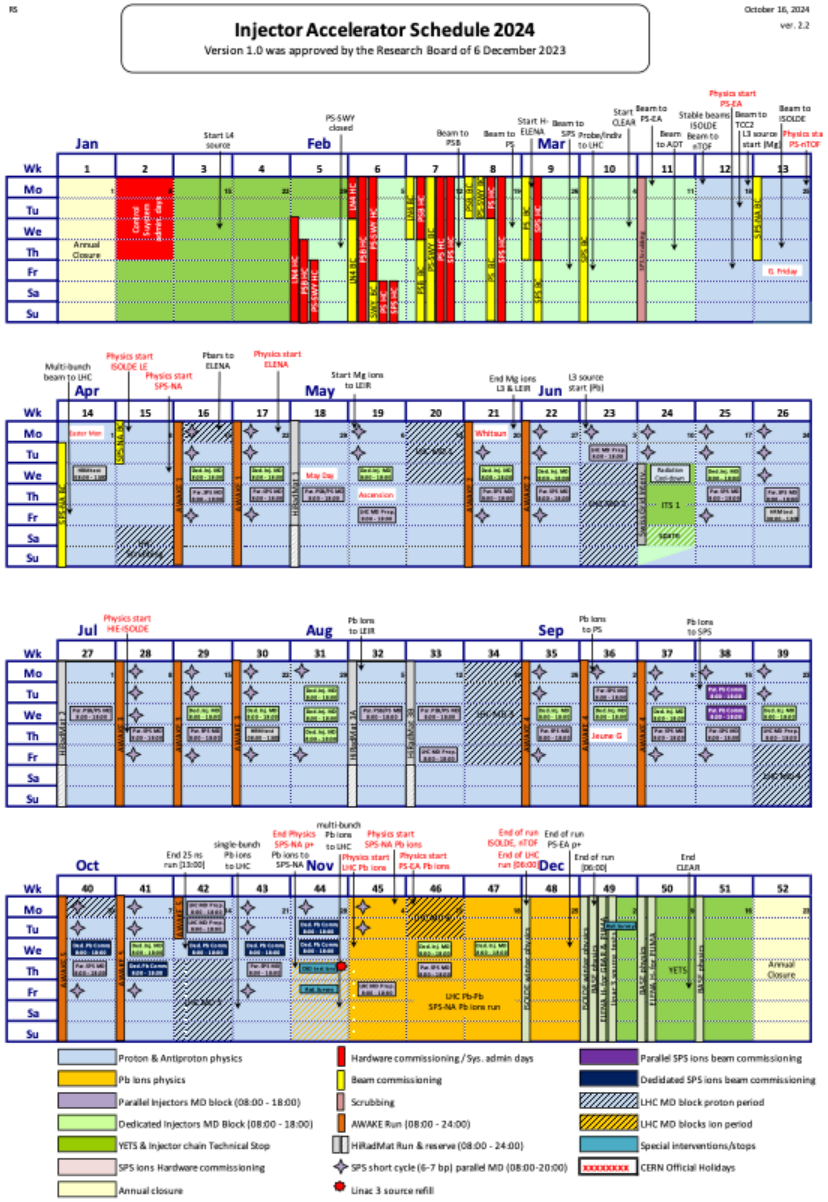
CERN Operation

Operation:

- 30 to 35 weeks (~200 days per year) of protons on target (depending on ion run) per year
- Yearly Year End Technical Stops of about ~ 3 - 4 months
- 1 or 2 Injector Technical Stops during the year for a few days
- Wednesday Machine Development < 10 per year (10h each): some MDs will need to use the BDF target and send beam to ECN3

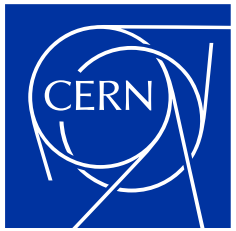
BDF POT @ 4×10^{19} / year:

- POT will be competitive and scarce in the future
- POT computed assuming a machine availability of 80%
- Operation for SHiP will not be stopped outside of planned access/maintenance periods, unless unforeseen maintenance is absolutely needed



Let’s have a productive few days…!

Any questions…?



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