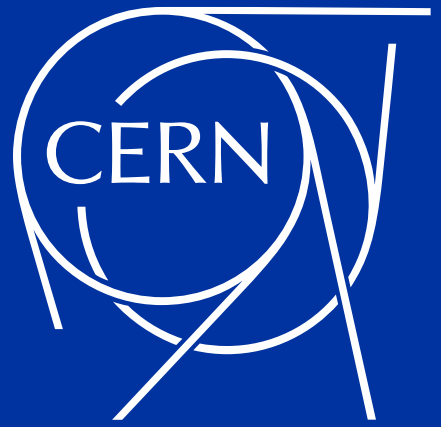


Implications for North Area Consolidation (preliminary)

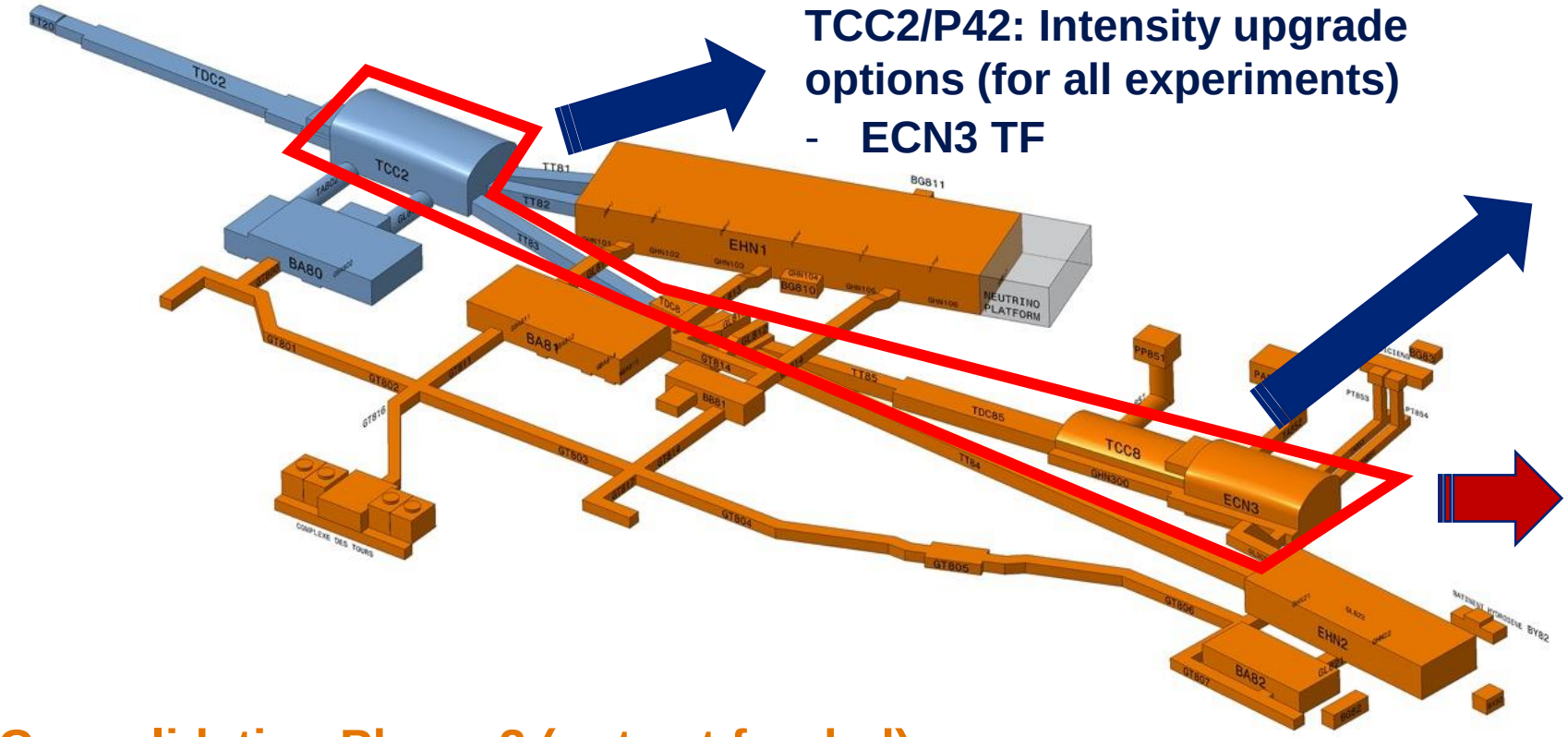
Physics Beyond Colliders Annual Workshop

7 - 9th November 2022

Y. Kadi, A.T. Charalambous and F. Gautheron on behalf of the NA-CONS project

NA-CONS -> ECN3 Intensity Upgrade

Consolidation Phase 1 (funded):
2019 – 2028: primary areas, BA80 & beamlines towards EHN1 & TDC8



TCC2/P42: Intensity upgrade options (for all experiments)
- **ECN3 TF**

TCC8/ECN3: Experiment specific:
- **BDF/SHiP WG**
- **CBWG**

Beam Areas concerned with the upgrade of ECN3 to a high intensity facility

Consolidation Phase 2 (not yet funded):
2029 – 2034: BA81, BA82, EHN1, EHN2, ECN3 & associated beamlines

Scope/Timeline

- Several collaborations have been putting forward their intent for post-LS3 experiments in the North Area ECN3 cavern, which will require a beam intensity increase.
- Collect and Approve Technical requirements from the different physics proposals.
- Assess technical feasibility and impact on the existing infrastructure and services of a High-Intensity Facility in ECN3 and how this can be implemented in parallel to the approved consolidation activities.

December 2022: IEFC

- To scrutinise outcome of feasibility study on facility side.

January 2023: Scope, Cost & Schedule Review for NA-CONS

- To include input from the Task Force and IEFC.

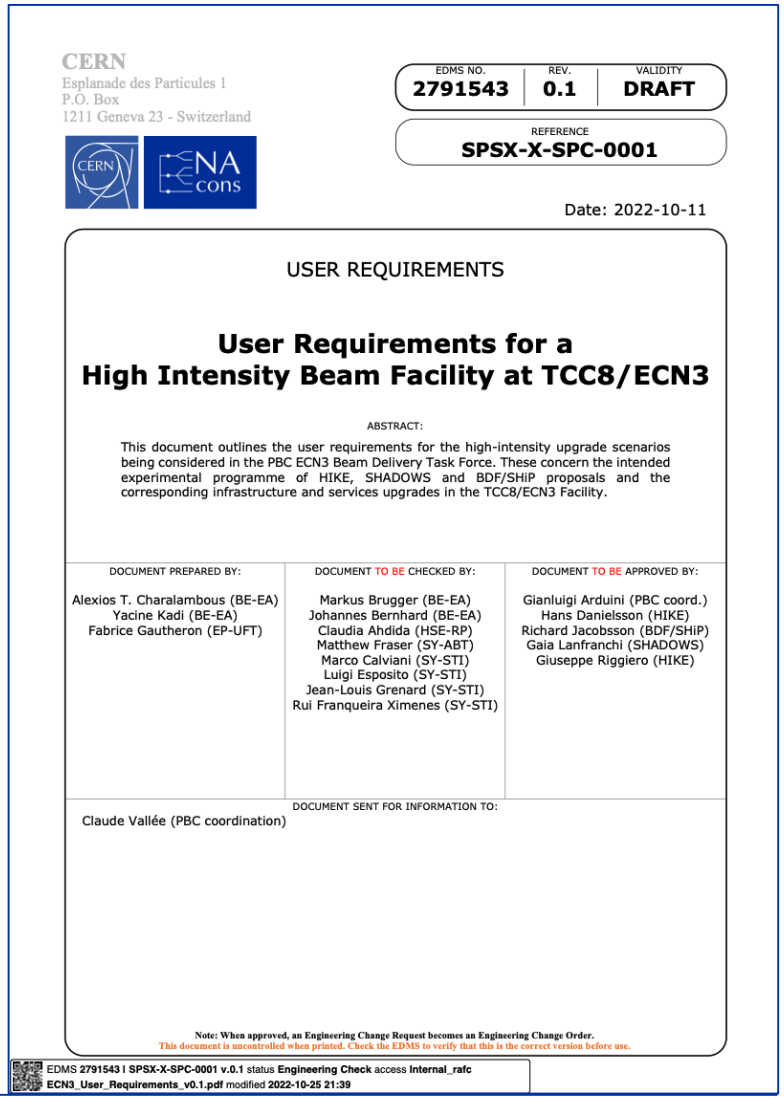
March/May 2023: MTP 2023

- ATS to put forward upgrade plan for high intensity beam delivery to ECN3.

Technical requirements for experiments

- **CERN groups to assess impact on ECN3 experimental requirements on NA-CONS: cost & schedule (phasing)**
  - Technical input from BDF and CB WG only received recently
  - Compiled by NACONS team:
    - EDMS #2791543, SPSX-X-SPC-0001 v.0.1
  - To be approved by Experiment Representatives and PBC coordination
  - Aiming for a first analysis as input to the IEFC and NA-CONS Cost and Schedule Review end of January 2023

- **We thank all CERN groups for their valuable input and support !**
  - Agreed support from all concerned CERN groups based on the current best knowledge/understanding (no detailed studies)



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EDMS NO. 2791543 | REV. 0.1 | VALIDITY DRAFT

REFERENCE SPSX-X-SPC-0001

Date: 2022-10-11

USER REQUIREMENTS

User Requirements for a High Intensity Beam Facility at TCC8/ECN3

ABSTRACT:

This document outlines the user requirements for the high-intensity upgrade scenarios being considered in the PBC ECN3 Beam Delivery Task Force. These concern the intended experimental programme of HIKE, SHADOWS and BDF/SHiP proposals and the corresponding infrastructure and services upgrades in the TCC8/ECN3 Facility.

DOCUMENT PREPARED BY:	DOCUMENT TO BE CHECKED BY:	DOCUMENT TO BE APPROVED BY:
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DOCUMENT SENT FOR INFORMATION TO:

Claude Vallée (PBC coordination)

Note: When approved, an Engineering Change Request becomes an Engineering Change Order.
This document is uncontrolled when printed. Check the EDMS to verify that this is the correct version before use.

EDMS 2791543 | SPSX-X-SPC-0001 v.0.1 status Engineering Check access Internal_rafc
ECN3_User_Requirements_v0.1.pdf modified 2022-10-25 21:39

List of Impacted Infrastructure/Services

- Beam Requirements
- Target, Collimators, Dump
- Radiation Protection & Shielding
- Beam Instrumentation
- Vacuum
- Magnets & Power Converters
- Civil Engineering
- Transport & Handling
- Cooling & Ventilation
- Electrical Distribution
- IT Infrastructure
- Gas Distribution
- Cryogenics
- Access & Safety

Target, Collimators, Dump (1/2)

Physics Exp.	Requirements
All Experiments	• T4 by-pass by bumping beam around. • Movable target as alternative option if the bump option is not working or a movable target design is found more effective (this will depend on the outcome of the first pre-study). • Required target collimator(s) and linked instrumentation. • New T4 target/TAX to cope with increased intensity. • Option of TAX with multiple holes, like the present T10 TAX concept. • Target containment under assessment (vacuum vessel vs N2 flow).

HIKE	• T10/TAX to be redesigned to cope with increased beam intensity (must remain 2x1013 ppp with FT of 4.8s in Kaon mode).
	• Beryllium/low-Z for K+:
	  ○ Similar to T10, but major cooling upgrade.
	  ○ Very thin target (diameter in the order of 2mm) homogeneous (especially in phi to avoid acceptance effects).
	  ○ Movable (for Beam Dump mode) and exchangeable (e.g. 2 target heads).
	• K+ beam momentum: 75 GeV/c.
	• Phase 3 (KLEVER):
	  ○ High-Z target preferable for KL mode.
	  ○ High-Z TAX not required, but to be adapted for beam acceptance definition with tungsten insert.

Target, Collimators, Dump (2/2)

Physics Experiment	Requirements
SHADOWS	• Design and realization of a new T10/TAX complex in synergy with HIKE to cope with increased beam intensity.
BDF/SHiP	• No need for K12 beam line, T10 and TAX, replaced by beam dump facility. The magnets of the dilution system will be placed at the T10 location upstream in TCC8 with the new target complex located further down TCC8 (30 m upstream of the boundary between TCC8 and ECN3). • Design and realization of a new High-Z Target complex to cope with increased beam intensity and to be embedded in an iron shielding. • Muon flux produced by the proton target need to be reduced by up to 6 orders of magnitude (10^{11}/spill => 10^{5}/spill) by a dedicated active muon shield.

Civil Engineering

Physics Exp.	Requirements
All Experiments	• Air confinement walls both upstream and downstream of the target/TAX. • An auxiliary building will be required on surface to include all the dedicated services for the target complex to be connected to access shaft. • A shielded area/building may be required on the surface in order to sort, package and inspect radioactive components. • Hydrological survey to be carried out.

HIKE	• Floor excavation for target (works with already activated concrete floor).
	• Phase 3 (KLEVER):
	  ○ ECN3 cavern extended by ~150m (7m wide, 9m high) in downstream direction (floor-to-ceiling height similar to current TCC8) + smaller beam dump tunnel (12.5m).
	  ○ 2 shafts required by HSE -> (i) exit shaft; (ii) larger shaft for material.

SHADOWS	• Small local CE in TCC8 to accommodate the iron yoke of the dipole magnet (floor excavation: 2.8m (width) x 3.0m (length) x ~0.5m deep), or (2.8m (width) x 12.0m (length) x ~0.5m deep) with detector.
BDF/SHiP	• Floor excavation work under target complex (TCC8): 2.8m x 3m x 1m deep. • Floor excavation on ECN3 floor: 1.5 m deep x (7m x 23.5m) & (15m x 20.5m). • Partial rerouting of the drainage network under the floor of ECN3 (due to excavation works). • Alternative extra shaft at the end of ECN3 (Jura) (8m x 8m). • Potential modifications of building 918 over 21.5m. • Re-locations of HVAC units (918) + extension of parking area.

Radiation Protection & Shielding

Physics Exp.	Requirements
All Experiments	• Radiation protection studies to cope with higher prompt and residual activation, soil and air activation. • Assess environmental impact: Hydro-geological survey needed. • Assess deployment of additional RP operation and environment monitors. • Decommissioning of target complex to be defined. • Air confinement walls both upstream and downstream of the target/TAX.
HIKE	• Shielding: Floor inserts (up to 1m iron thick) + additional shielding of the secondary beamline (concrete + iron blocks). • Shielding around the target complex: various types needed over 24m in TCC8: concrete, iron, cooled, mobile shielding on top. • Phase 3 (KLEVER) specifications under assessment.
SHADOWS	• As HIKE for the shielding aspects. • Radiation 2 Electronics (R2E) concerns as a lot of detectors will have FEE electronics directly mounted on the detector surface, so it cannot be moved à dose levels, shielding options to be evaluated. • Background: re-design of neutron shielding. • Prompt radiation due to muon to be assessed.
BDF/SHiP	• Shielding around the target station: various types needed over 11m in TCC8: concrete, iron, magnetized, cooled, mobile shielding on top. • Shielding: Floor inserts (up to 1m iron thick).

Magnets & Power Converters

Physics Exp.	Requirements

HIKE	• P42 not modified / K12 rebuilt.
	• Re-use of MNP33 (consolidation of power converter foreseen for LS3 through NA-CONS).
	• Field Stability level during FT of 1 per mille or better.
	• Additional spectrometer magnet: SC magnet version or new copper-based design (tbc depending on future constraints on power consumption).
	• Phase 2 (K^0):
	  ○ New BL magnets (MTRV, MTR, MTN, 2xMBPL) to be installed on KL Beam line.
	• Phase 3 (KLEVER):
	  ○ No spectrometer magnet needed.

SHADOWS	• New copper-based dipole magnet similar to MNP33, ideally with 0.3-0.4 MW power consumption (10x less than MNP33). • Two MIBs to be installed for horizontal & vertical muon sweeping. • 2 PCs for MIBs to be added.
BDF/SHiP	• K12 to be removed with the existing PCs. • New PCs for the Muon Shield magnets (x6). • New PC for magnetized hadron stopper. • New PC for Spectrometer magnet.

Cooling & Ventilation (1/2)

Physics Experiment	Requirements
All Experiments	• Air volume separation between target complex (high radiation area), ECN3 and galleries (tbc). • Dedicated cooling and ventilation of target complex through B.911 to be studied. Volume to be handled ~2000m^3 (tbc).
HIKE	• Similar type of cooling for electronics as NA62. • Probably similar type of cooling for the new silicon beam tracker. • New detectors with SiPMs may require cooling at about -30ºC (Possible new chiller for detectors). • Temperature and humidity control in the cavern, identical to what currently exists. • Estimate whether the current ventilation system of NA62 is still suitable to cope with increased intensity. • Phase 3 (KLEVER): ○ Ventilation and smoke extraction for the ~150m long cavern extension

Cooling & Ventilation (2/2)

Physics Experiment	Requirements
SHADOWS	• Need of 2 connections to chilled & demineralised water network. • Cooling for electronics (ECAL). Estimated needs 150 kW. Already 100kW available for NA62 LKr FEE.

BDF/SHiP	• Estimate whether current cooling power in TCC8/ECN3 is sufficient (8 MW for demineralized water and 800 kW for raw water).
	• No detectors need water cooling in baseline, only the normal-conducting spectrometer magnets are water cooled:
	  ○ Main spectrometer magnet (normal conducting) would need cooling by water flow with a delta T of 14 degrees at 30-35 m^3/h, and 10-12 bar pressure drop.
	  ○ ~ 15-20 m^3/h for the SND magnetised muon system (will remain normal-conducting).
	  ○ Muon shield is air cooled.
	• Total power dissipated into the air from muon shield and detectors, and residual heat from normal-conducting magnets would be ~150-170 kW.
	• Relocation of external HVAC units (central ventilation, chiller and condensers) inside B.918.

NA-CONS Infrastructure

- **Important: TCC8/ECN3 separation:** We can assume that work on the experiment side can/will last into Run4

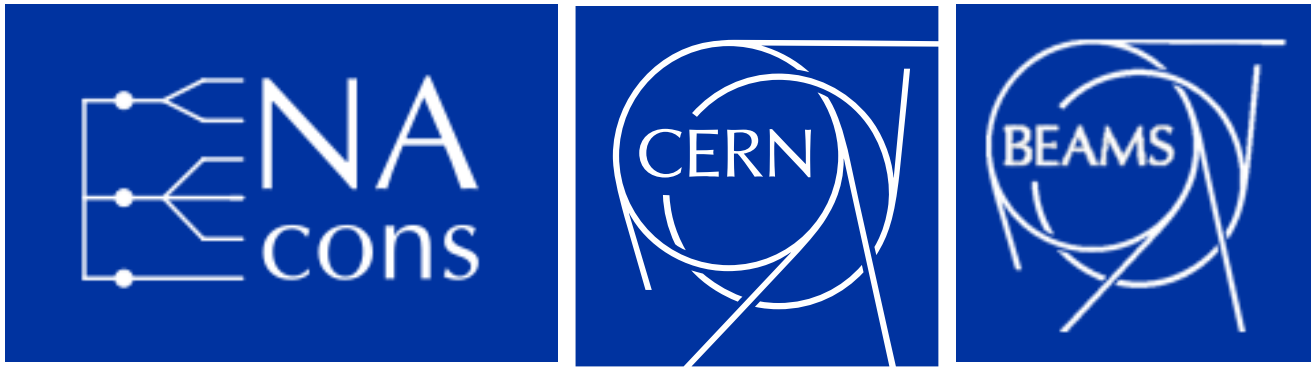
- **Cooling & Ventilation:**
  - In principle OK for Run4 with LS3 baseline: 6th cooling tower possibly beneficial (cost/resources) to be done at same time
  - TCC8/ECN3 HVAC to be reviewed
- **Electrical distribution:**
  - Powering requirements: OK from beamline perspective (TBC for long 9.6 s FT SFTPRO option), experiment -> iteration with EL required to see impact on EL-CONS/NA-CONS
  - Cabling/De-cabling: limited on beamline side -> important modifications required on the experiment side
- **Magnets / Power Converters:**
  - Laminated/not-laminated, measurements, cycling/refurbishment imply redesign, available spares
  - Including ECN3 is not 'major', P42 would be simpler for BDF/SHiP case, rather similar to today for SHADOWS/HIKE
- **Interlocking**
  - Looks compatible with NA-CONS
- **Access & Safety:**
  - Not a major change of NA-CONS baseline in TT20/TCC2/TCC8 -> ECN3: new shaft likely required, CONS, Safety etc.
- **Civil Engineering:**
  - Requiring additional shaft likely in any case, routing of services to be looked at, ECN3 extensions (KLEVER only post LS4)

Next

- Feedback from the Groups
  - Technical feasibility / constraints
  - Impact on existing infrastructure / already approved consolidation plans
  - Implementation plan => resource needs (studies, prototypes, etc…)

- Impact on Scope/Cost/Schedule of NA-CONS (Phase-1):
  - Re-scoping of BA82 (PCs + CV + EL)
  - Targets/Dumps => CONS vs Upgrades
  - Beamline (magnets, BI, vacuum)
  - Need of an additional cooling tower in CT2

All of this is to be assessed for the end of the year



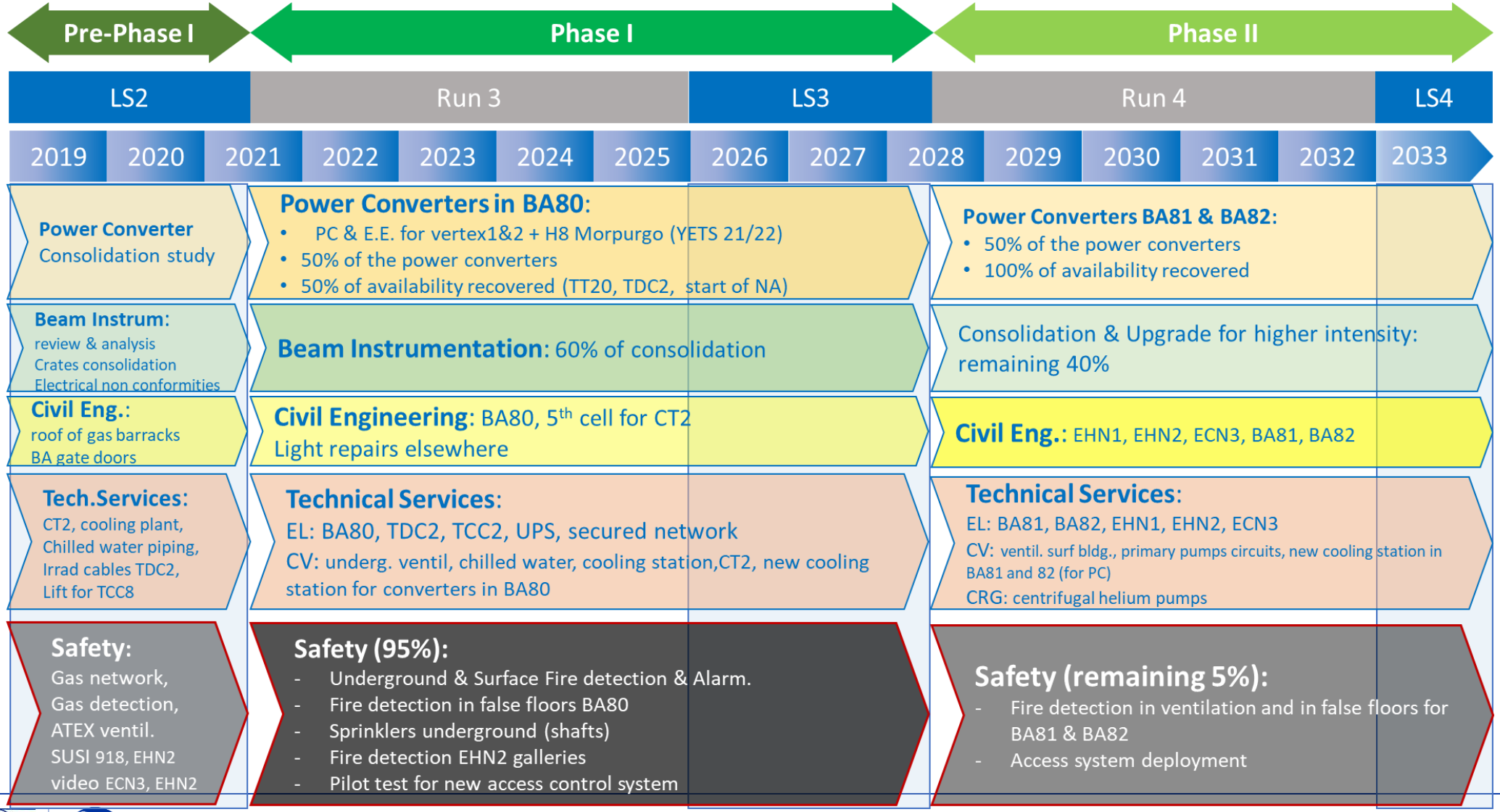
Thank you!

Questions?

home.cern

Back-up Slides

Project Roadmap



Electrical Distribution

Physics Exp.	Requirements
All Experiments	• Cabling (cables, trays and racks) for target complex. • Power supply and control cubicles for cooling system. • Fibre cables between data servers and experiment. • Need new UPS (incl. cabling & network).
HIKE	• Phases 1 & 2: Same as in ECN3 today. • Phase 2 (K^0): New BL magnets (MTRV, MTR, MTN, 2xMBPL) to be installed on KL Beam line. • Phase 3 (KLEVER): Rerouting of the cables + trays because of the extension. ➢ Experimental power requirements not yet defined
SHADOWS	• New copper-based dipole magnet. • Two MIBs to be installed for horizontal & vertical muon sweeping. ➢ Experimental power requirements not yet defined
BDF/SHiP	• Impact of excavations for new shaft: ○ Surface: Racks in 918/R-010. ○ Cavern: Re-routing of power distribution cables, signal cables, optical fibre and relocation of electrical switches. • Magnetized hadron stopper, Muon Shield magnets (~x6), Spectrometer magnet (~0.5-0.6 MW) plus all sub-detectors ~1.2 MW power consumption.

Transport & Handling

Physics Exp.	Requirements

All Experiments	• Overhead crane for installation.
	• Complete upgrade of the crane (TCC8) [20].
	  ○ Integration of redundancy on the 3 movements of the crane.
	  ○ Integration of a motorized hook.
	  ○ Integration of a video system.
	  ○ Integration of a positioning system for the 3 movements.
	  ○ Off-board control cubicles.
	  ○ Remote tools connection on the hook.
	• Support overall logistics needs for target complex and experiment installation.
	• Need transport cask for irradiated target.
	• Handling equipment for service building.

HIKE	• Phases 1 & 2: Same as in ECN3 today. • Phase 3 (KLEVER): ○ Overhead crane required for the extension as in ECN3 today (today 40t+ for NA62, but possibly ok with 25t).
SHADOWS	• Additional bridge crane (optional). • Assess handling of the K12 frontend magnets.
BDF/SHiP	• Overhead crane required for the new shaft. • Need trolley (LHCb like) to transfer equipment between ECN3 and new shaft.

Beam Instrumentation

Physics Experiment	Requirements
All Experiments	• New beam instrumentation for more precise evaluation of POT (required accuracy on intensity <5%) for neutrino physics). • Dedicated luminosity detector (only for HIKE K+). Re-use of existing Argonion counter (XION). • High frequency spill monitor.

Vacuum

Physics Experiment	Requirements
All Experiments	• P42 vacuum will have to be upgraded.

HIKE	• Phases 1 & 2: Same vacuum levels than currently used.
	• Phase 3 (KLEVER):
	  ○ 10^{-7} mbar in the tank (current 10^{-6} mbar @ NA62). Will depend on tank dimensions (currently limited by outgassing of last part, LAVs dominating).
	  ○ Volume significantly increased in the extended version (+150m long beamline) à more pumps will be required.

SHADOWS	• 1 mbar over 125m^3. • No cryopumps will be needed. • 20m long decay volume in vacuum.
BDF/SHiP	• 1 mbar over 1150m^3 (decay volume in ECN3). • 50m long decay tube.

Gas Distribution

Physics Experiment	Requirements
HIKE	• Phases 1 & 2: No specific needs indicated (NA62 sufficient). • Phase 3 (KLEVER): ○ Gas distribution in the ~150m long cavern extension (tbc).
SHADOWS	• Needs for SHADOWS to be clarified.
BDF/SHiP	• Needs for BDF/SHiP: CO_2, Ar (and N_2, He tbc)

Cryogenics

Physics Experiment	Requirements

HIKE	• Phases 1 & 2:
	  ○ Need to keep cryostats for LKr (until there is a replacement).
	  ○ Cold box needed if MNP33 replaced by SC magnet.
	• Phase 3 (KLEVER):
	  ○ No cryogenics currently foreseen: LKr replaced by Shashlyk.

SHADOWS	• No cryogenics needed for detector.
BDF/SHiP	• No need of LKr.

Access & Safety

Physics Experiment	Requirements
All Experiments	• Experiment needs -> DSS system with EP/DT (collaboration funding). • New interlocks, airlocks in TCC8/ECN3 to cope with increased intensity. • Gas detection + ODH already consolidated in LS2 (NA-CONS). • Fire detection will be consolidated in LS3 (NA-CONS). • FIRIA study for new target complex (TCC8). • Assess access control system separation between target complex, experimental area and beam line. • Redefine emergency evacuation path.
HIKE	• Phases 1 & 2: No specific needs indicated. • Phase 3 (KLEVER): Assess access to cavern extension + new shaft. Extend/reroute Fire detection system underground (cavern extension + new shaft).
SHADOWS	• No specific needs indicated.
BDF/SHiP	• Assess access to new shaft. • Extend Fire detection system (new shaft + new target surface building).

IT Infrastructure

Physics Experiment	Requirements
HIKE	• Readout server and PCFarm (in new data center + dedicated set of PCs). • Phase 3 (KLEVER): Needs for KLEVER to be clarified.
SHADOWS	• Needs for SHADOWS to be clarified.
BDF/SHiP	• Space in building 918 is adequate for SHiP detector-related computing infrastructure. Fibre to IT for data and databases will be needed.