RESEARCH PROJECTS BACKSTAGE

The Neutrino Platform case

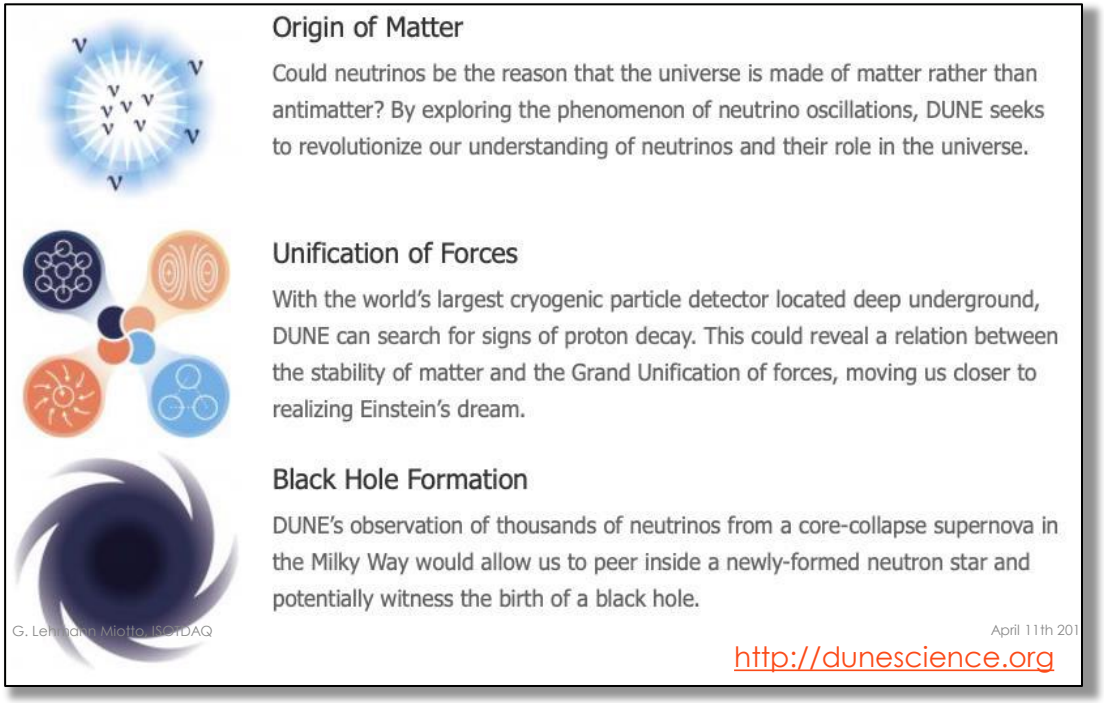
Ll. Miralles

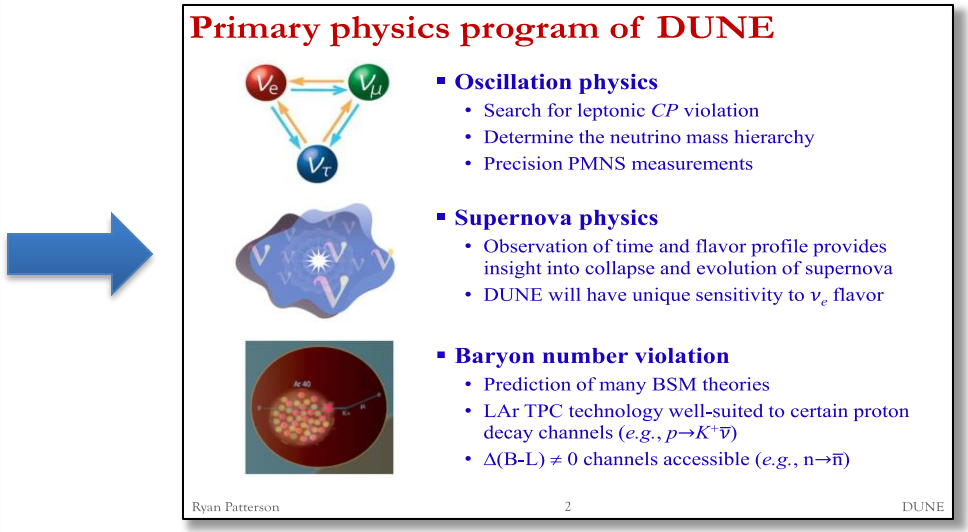
CERN. Neutrino Platform

Outlook

- The Business Opportunity
- The Business Unit implementation
- Technology. Differential factor
- The Project
- To Take Home

Neutrino Physics Landscape





NEW PHYSICS KNOWLEDGE

Neutrino Physics Landscape

CERN **2013** **US**

European Strategy Update (2013)

- CDS Doc. CERN-Council-S/106
- High-priority large-scale scientific activities
  - Four activities identified as carrying the highest priorities: *(i) full exploitation of LHC…, (ii) design studies for accelerator projects in a global context… , (iii) possible participation of Europe to a proposal from Japan for an electron-positron collider…(iv) neutrinos..*
  - Rapid progress in neutrino oscillation physics, with significant European involvement, has established a strong scientific case for a long-baseline neutrino programme exploring CP violation and the mass hierarchy in the neutrino sector.
  - CERN should develop a neutrino programme to pave the way for a substantial European role in future long-baseline experiments. Europe should explore the possibility of major participation in leading long-baseline neutrino projects in the US and Japan.
  - ➡ *Note that in the 2013 ES update document both the US and Japan LBN projects are recommended on an equal footing*

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From the P5 Report

Recommendation 12 : In collaboration with international partners, develop a coherent short- and long-baseline neutrino program hosted at Fermilab.
The minimum requirements to proceed are the identified capability to reach an exposure of at least **120 kt*MW*yr by the 2035 timeframe**, the far detector situated **underground** with cavern space for expansion **to at least 40 kt LAr fiducial** volume, and **1.2 MW beam power upgradable to multi megawatt** power. The experiment should have the demonstrated capability to search for **supernova (SN) bursts** and for **proton decay**, providing a significant improvement in discovery sensitivity over current searches for the proton lifetime.

Japan Roadmap

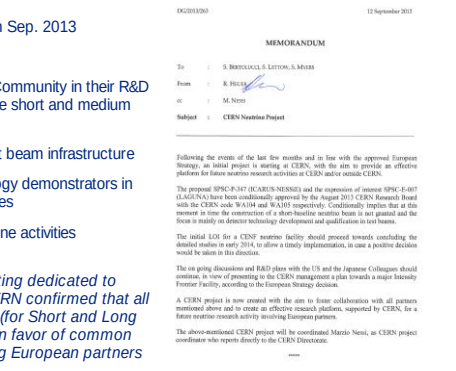
Association of Japanese High Energy Physicists (community organisation) regards that ILC and Hyper-K are the two priority projects in Japan.

- Hyper-K, through international cooperation
- ILC: hosting ILC as a global project

Neutrino Platform

- Neutrino Platform project created in Sep. 2013
- Original Mandate:
  - Support the European Neutrino Community in their R&D (detectors and components) in the short and medium term
  - Provide to the ν community a test beam infrastructure
  - Bring R&D at the level of technology demonstrators in view of major construction activities
  - Support the short and long baseline activities (infrastructure & detectors)

In the Jun 2014 APPEC Paris meeting dedicated to Large Neutrino Infrastructures, CERN confirmed that all types of Neutrino beams at CERN (for Short and Long Baseline) will not further pursued in favor of common activities in US and Japan involving European partners


MEMORANDUM

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JAPAN **NEUTRINO PLATFORM MANDATE**

High Energy Physics Framework

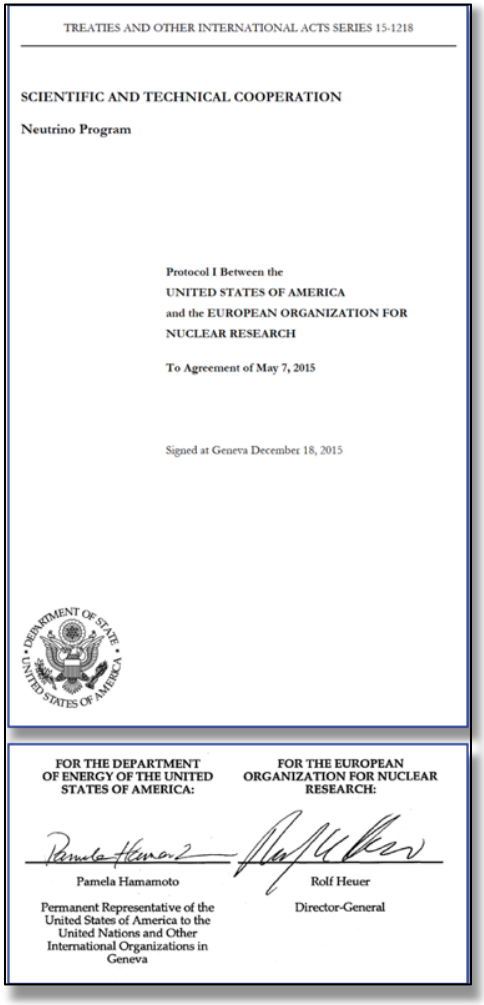
LEGAL FRAMEWORK

- CERN status as International Organization
- The main legal instruments are:
  - Protocol
  - Memorandum of Understanding (MoU)
  - Addenda
- Non legally binding
- Liability

Article 7
Liability

7.1 Each Party's participation in the work covered by this Addendum is on a best-effort basis and without any warranty.

7.2 In the event that damages are incurred in the course of, or arising out of, the execution of this Addendum, the Parties shall consult on appropriate methods of settlement.



TREATIES AND OTHER INTERNATIONAL ACTS SERIES 15-1218

SCIENTIFIC AND TECHNICAL COOPERATION

Neutrino Program

Protocol I Between the
UNITED STATES OF AMERICA
and the EUROPEAN ORGANIZATION FOR
NUCLEAR RESEARCH

To Agreement of May 7, 2015

Signed at Geneva December 18, 2015

FOR THE DEPARTMENT OF ENERGY OF THE UNITED STATES OF AMERICA:

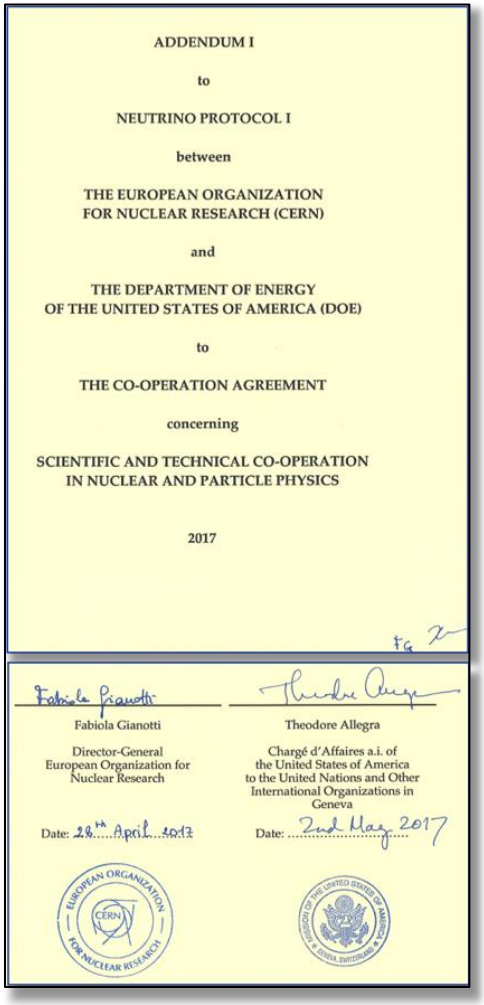
Pamela Hamamoto

Permanent Representative of the United States of America to the United Nations and Other International Organizations in Geneva

FOR THE EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH:

Rolf Heuer

Director-General



ADDENDUM I

to

NEUTRINO PROTOCOL I

between

THE EUROPEAN ORGANIZATION
FOR NUCLEAR RESEARCH (CERN)

and

THE DEPARTMENT OF ENERGY
OF THE UNITED STATES OF AMERICA (DOE)

to

THE CO-OPERATION AGREEMENT

concerning

SCIENTIFIC AND TECHNICAL CO-OPERATION
IN NUCLEAR AND PARTICLE PHYSICS

2017

Fabiola Gianotti

Director-General
European Organization for Nuclear Research

Date: 28th April 2017

Theodore Allegra

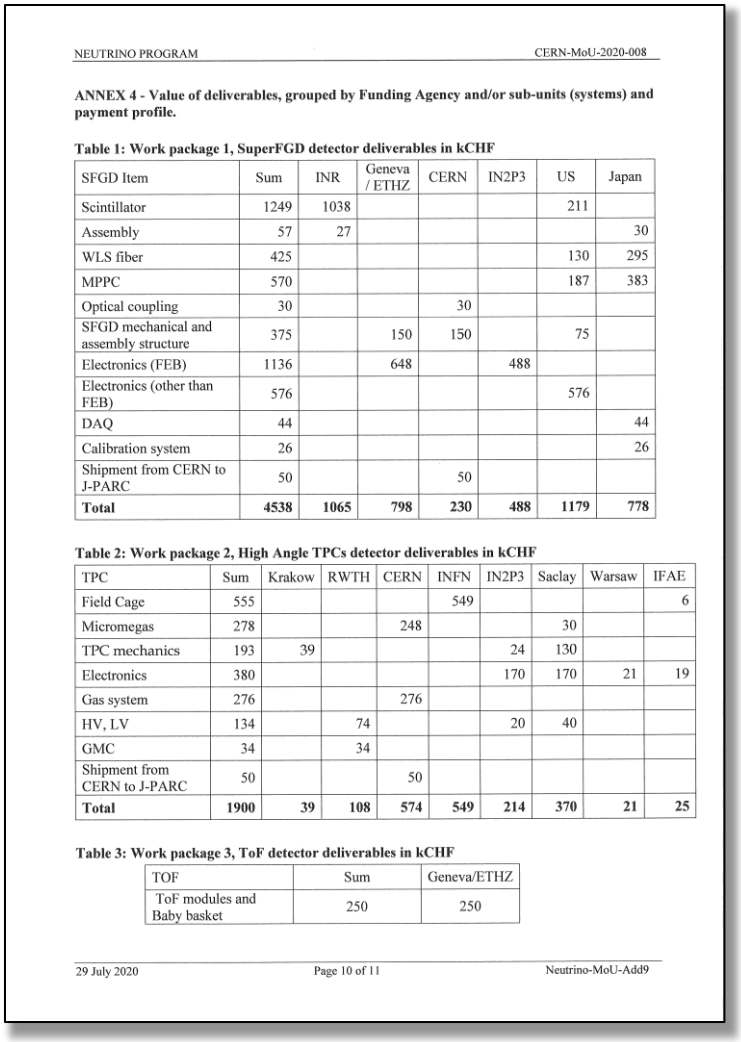
Chargé d'Affaires a.i. of
the United States of America
to the United Nations and Other
International Organizations in
Geneva

Date: 2nd May 2017

High Energy Physics Framework

FUNDING FRAMEWORK

- Host laboratories assuming infrastructures costs
- Collaborating institutions assuming detectors and experiments costs
- Sharing of costs established in a project dedicated MoU
- Estimation of costs based con CORE approach. No contingency, no institutes personnel
- Commitments conditioned to the availability of funding
- Follow-up by Finance Review Committee. Composed by, Project, Institutes Funding Agencies and CERN representatives



NEUTRINO PROGRAM CERN-MoU-2020-008

ANNEX 4 - Value of deliverables, grouped by Funding Agency and/or sub-units (systems) and payment profile.

Table 1: Work package 1, SuperFGD detector deliverables in kCHF

SFGD Item	Sum	INR	Geneva / ETHZ	CERN	IN2P3	US	Japan
Scintillator	1249	1038				211	
Assembly	57	27					30
WLS fiber	425					130	295
MPPC	570					187	383
Optical coupling	30			30			
SFGD mechanical and assembly structure	375		150	150		75	
Electronics (FEB)	1136		648		488		
Electronics (other than FEB)	576					576	
DAQ	44						44
Calibration system	26						26
Shipment from CERN to J-PARC	50			50			
Total	**4538**	**1065**	**798**	**230**	**488**	**1179**	**778**

Table 2: Work package 2, High Angle TPCs detector deliverables in kCHF

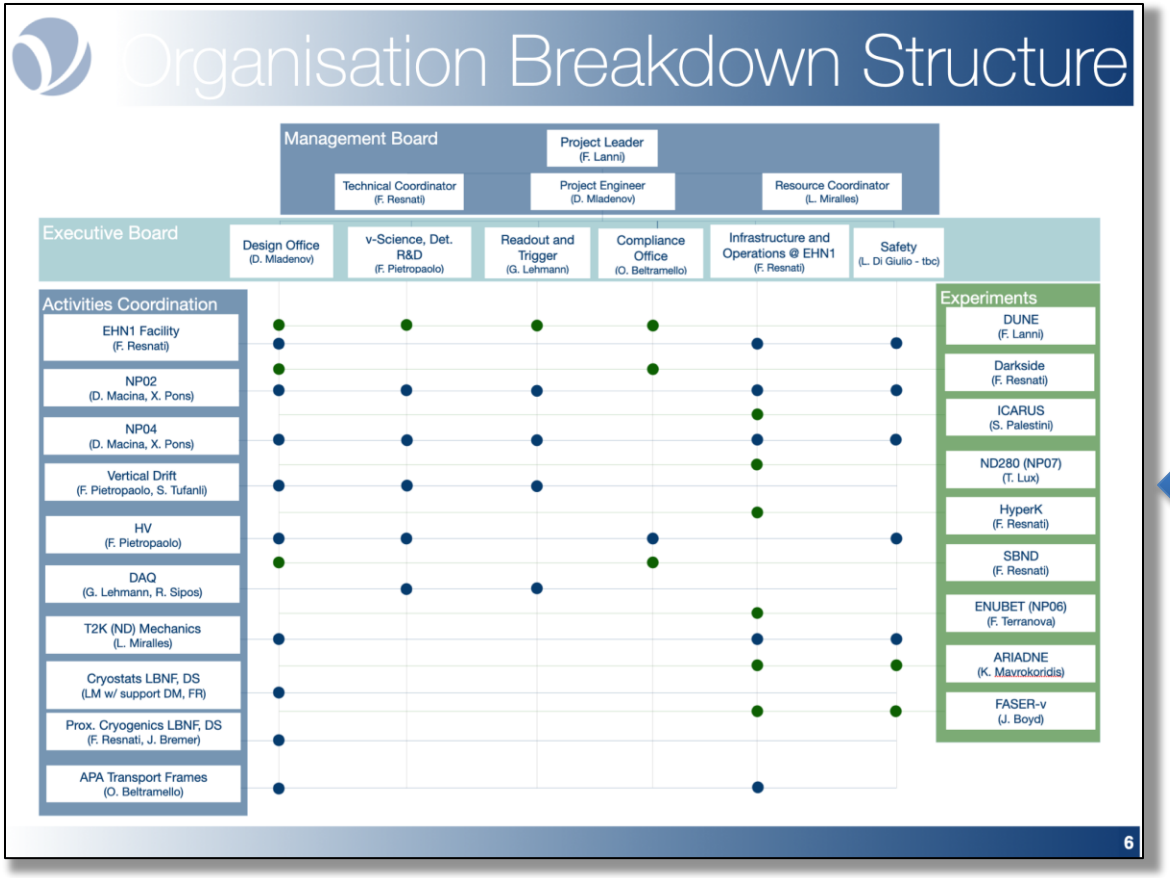
TPC	Sum	Krakow	RWTH	CERN	INFN	IN2P3	Saclay	Warsaw	IFAE
Field Cage	555				549				6
Micromegas	278			248			30		
TPC mechanics	193	39				24	130		
Electronics	380					170	170	21	19
Gas system	276			276					
HV, LV	134		74			20	40		
GMC	34		34						
Shipment from CERN to J-PARC	50			50					
Total	**1900**	**39**	**108**	**574**	**549**	**214**	**370**	**21**	**25**

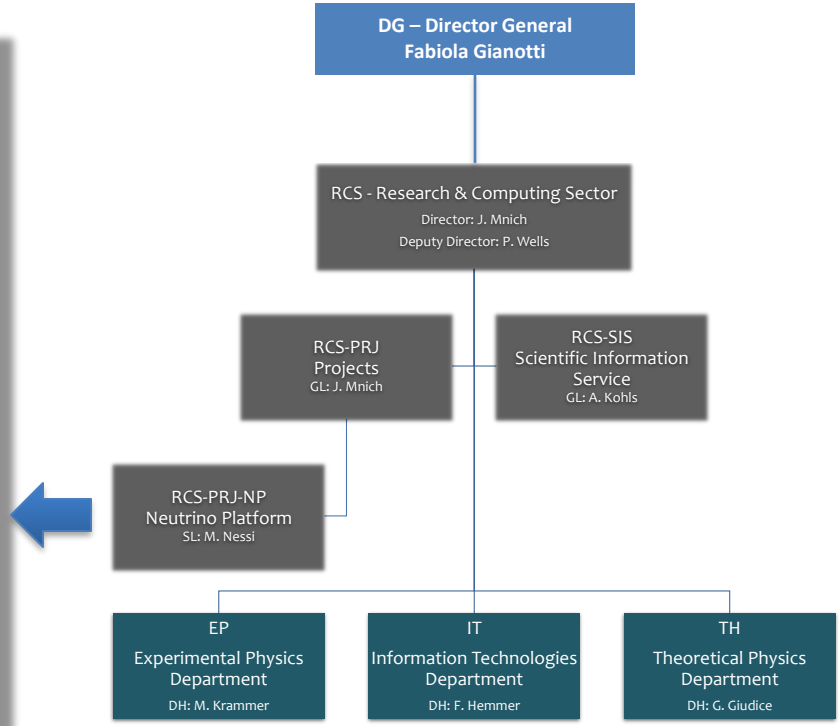
Table 3: Work package 3, ToF detector deliverables in kCHF

TOF	Sum	Geneva/ETHZ
ToF modules and Baby basket	250	250

29 July 2020 Page 10 of 11 Neutrino-MoU-Add9

Organizational Structure





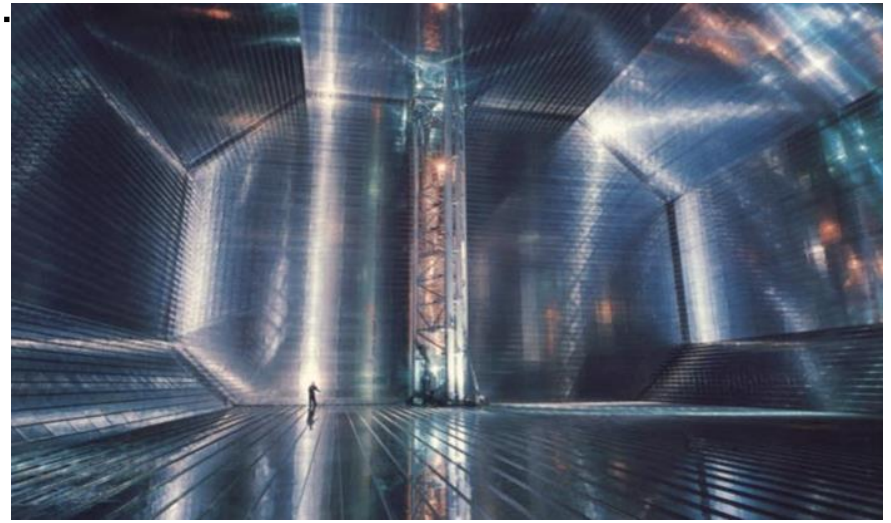
Matrix organization

Technology. Differential factor

LAr TPC : large cryostat vessels

- ✓ Cold cryostat volume ~ 13’000 m^3, an industrial type of building
- ✓ Liquid argon ~18 ktons / cryostat
- ✓ Passive insulation to minimize long-term operation risks (no vacuum insulation)
- ✓ Location : deep underground with limited elevator access : very modular assembly, minimal welding, …

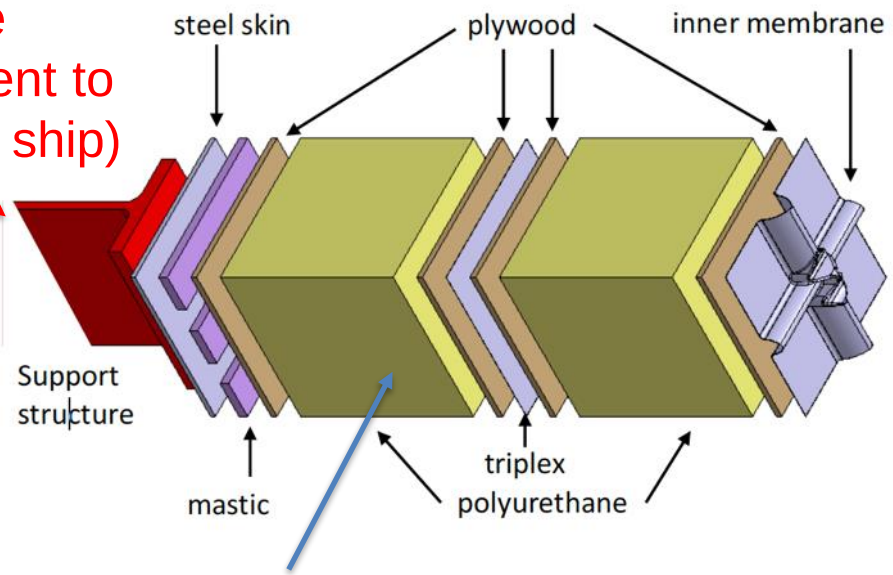
LNG technology adopted



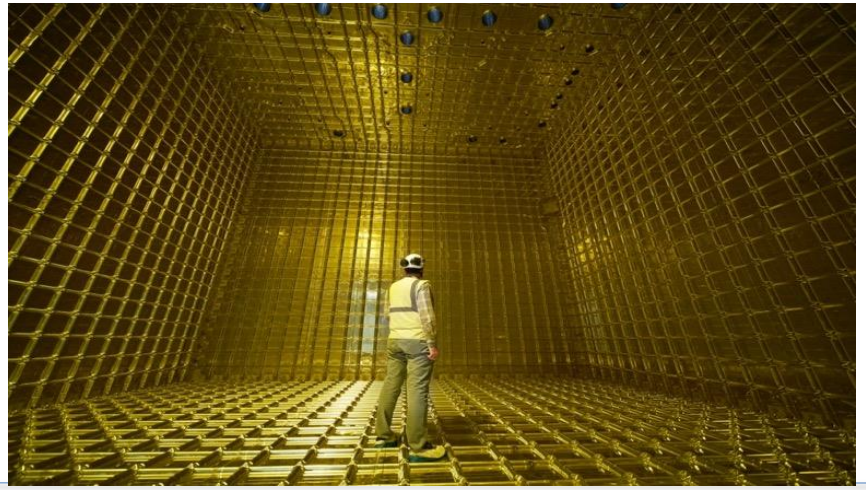
Technology. Differential factor

LAr TPC : large membrane cryostats

Warm steel structure (equivalent to the LNG ship)



Cold structure (protected by industrial IP)

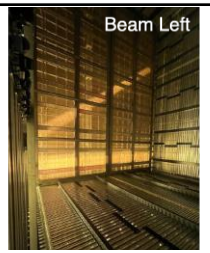


- ✓ 80 cm PU reinforces foam
- ✓ corrugated primary membrane
- ✓ additional secondary membrane
- ✓ + many details

Technology. Differential factor

HD-ProtoDUNE @ NP04

- 4 APAs now in NP04 cryostat
  - All APA tested in cryogenic conditions prior installation in NP04 cryostat
- APA1 and APA2 (beam right) installed and connected in cryostat by mid October 2022
- PDs and APAs successfully integrated in the DAQ
- Beam right drift closed on November 11th 2022
- Beam plug successfully installed at the beginning of November
- APA3 and APA4 (beam left) installed and connected in cryostat by mid Nov 2022
- Successful integration in the DAQ followed
- Beam left drift closed on the November 22nd 2022
- Close of TCO in Summer 2023
- Fill before end of the year.



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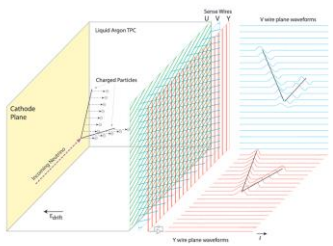
LAr Time Projection Chamber (TPC) Development

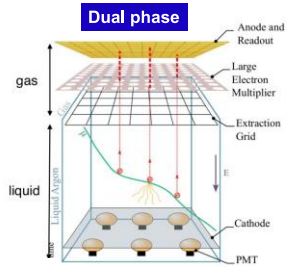
Single phase (SP) and dual phase (DP) designs

Single phase



- Ionization readout via Anode Plane Assemblies (APA)
- 3 wire planes (2 induction + 1 collection views)
- Four 3.6-m drift regions per TPC
- Scintillation light collected by SiPMs

Dual phase

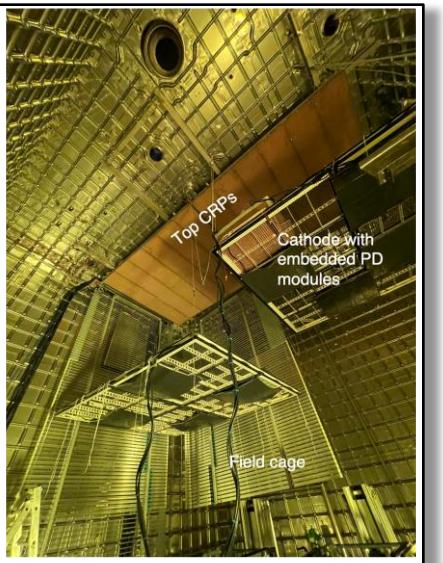


- Ionization electrons extracted, amplified through gas phase
- Charge readout by 2D segmented anode plane
- Single 12-m drift volume per TPC
- Scintillation light collected by PMTs

Ryan Patterson 17 DUNE

VD-ProtoDUNE @ NP02

- Module-0 Vertical Drift:
  - 4 DUNE-like CRPs
  - Half drift volume
- All the 4 CRPs tested in cold box.
- Top two CRPs installed in Jan 2023
- TPC field structures being produced. First modules installed in March.
- Photo-Detector (PD) modules operated on HV tested in cold box and tested in a dedicated setup.
- Cathode with embedded PD modules installed between Feb and Mar 2023
- Bottom CRPs to be installed next
  - First bottom CRP tested successfully in cold box and ready for installation
- Filling planned after NP04 operation in 2024



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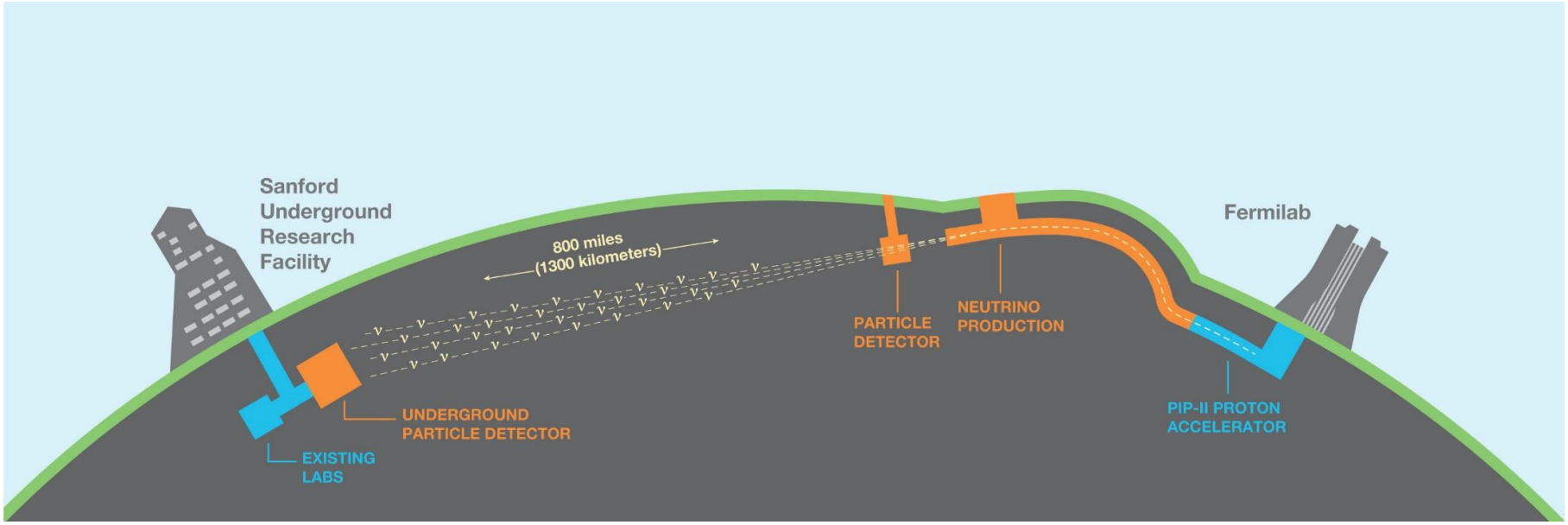
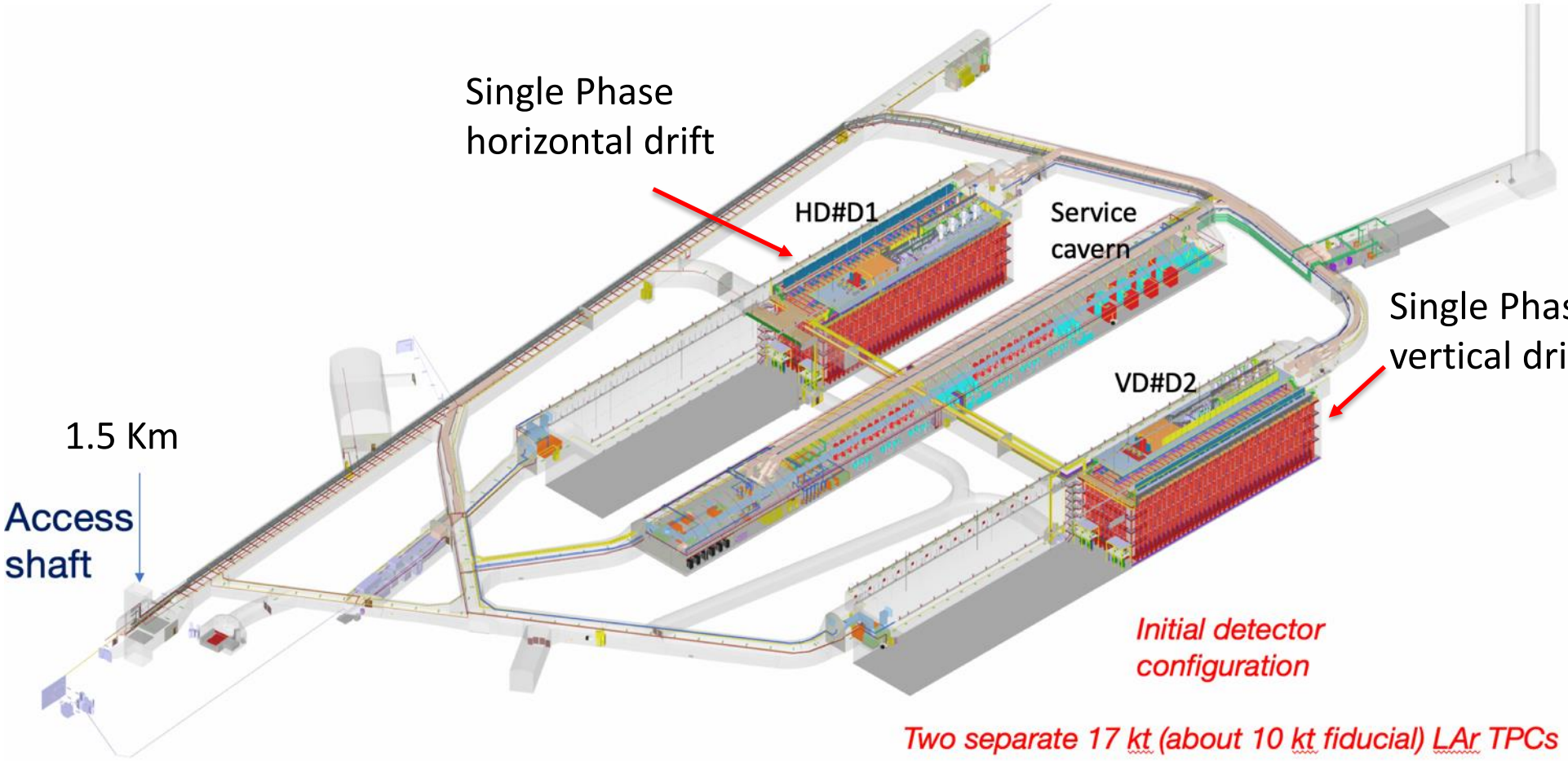
Projects

The Long-Baseline Neutrino Facility (LBNF) supporting the international Deep Underground Neutrino Experiment (DUNE)

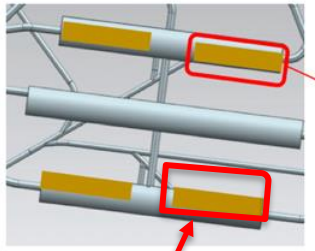


"The LBNF/DUNE project will be the first internationally conceived, constructed, and operated mega-science project hosted by the Department of Energy in the United States" - DOE

DUNE Far detectors initial configuration



LAr TPC : LBNF membrane cryostats



- High precision tracking (TPC charge collection)

- High precision calorimetry (charge and scintillation light)

- 17.5 ktons of LAr/det
- >10 ktons active/det

65'840 mm x 18'940 mm x 17'840 mm (L x W x H)

LBNF Cryostat Project Risk Management

Norms/standards

- ISO 31000:2018 Risk management guidelines
- IEC 31010:2019 Risk assessment techniques
- CERN Risk management framework(*)
- LBNF/DUNE Risk management framework

Risk Management phases

(*) **Acknowledgement to HiLumi Project Team**

Risk identification

FirstLevel	SecondLevel	Label	Description
External	Collaborations	Member States, Research Institutes and Ø scientific community Ø demand	Risks resulting from changes in or trends in the demand for research (institutes and MS) involvement in CERN, in cost physics, facilities, etc.)?
External	Factors	Competition with other laboratories and other Ø fields in research	Risks resulting from the worldwide competition for hosting the new major projects in particle physics,? such as from competition in other fields (research astrophysics, etc.)
External	Factors	Macro-economic conditions	Risks resulting from economic conditions (macro economics, monetary and budget policy, inflation/deflation, etc.)
External	Factors	Geopolitical changes	Risks affecting Membership resulting from Geopolitical changes (crisis/War, EU Deconsolidation, new leaderships)
External	Factors	Hazards/Catastrophic loss	Risk that might result from failure, epidemic disease, terrorism, etc. CERN's ability to react to and recover from.
External	Factors	Changes in/applicable laws and regulations	Risk resulting from changes in/applicable laws and regulation impacting CERN directly or indirectly via its stakeholders, MS, Suppliers, etc.
External	Factors	New Physics?	Risks and opportunities resulting from major discovery, new theory/impacting Particle Physics
External	Factors	Shift in/public opinion	Risks resulting from a dramatic change in/public opinion in/contributors/members States, host MS, etc.) For instance, Fukushima effect (e.g. Fukushima Syndrom)
External	Market	Work Market	All risks related to/the management of/significant events, such as strikes, changes in/legal framework,..
External	Market	Market changes	Risk in/getting funding in/resources/due to changes in/trends in/markets such as/for the exchange rate EUR/CHF, Interests Rates, Electricity price, Raw material, Energy, Labor)
External	Market	Suppliers resilience and dependency	Capacity to absorb the failure of temporary/up to bankruptcy of/our suppliers
Organization	Resources	Insurance process	Inappropriate insurance/hedging coverage, Lack of/evaluation for/insurance/hedging coverage
Organization	Resources	Procurement	All risks related to/the procurement of/CERN infrastructure/support/sourcing of/goods, Materials and Services purchased by/CERN, such as Inadequate supplier selection process, Inadequate quality, Over-reliance on/sole-source suppliers, Inability to/monitor contract compliance and Sustainable sourcing/savings, Etc. Includes also In-kind contributions
Organization	Resources	Logistics	All risks related to/the Logistics of/CERN infrastructure/support (storage of/goods, Transport, Etc.
Organization	Resources	Pricing	All risks related to/the Evaluation and/pricing of/goods and Services (within/CERN) of / Prefacturation Schema"). ?
Organization	Resources	Funding	Risks affecting the/funding of/CERN activities and/the Cost base (including/post employment Benefits) of/mainly/when/the/contributions from/Member States/(level of/contribution, commitment from/MS and/enforcement of/the/payment, long/term planning), but/also/with/contribution (including/in-kind) from/other/contributors, and/self-funding (CERN/revenue)
Organization	Resources	Payment/chain	Risks resulting from/the/effectiveness and/reliability of/the/accounts/payable and/payment process (to/third parties (mainly/supplier and/Personnel)) (Supplier/credit management, Etc.) Risks linked to/the/payment process (cost/of/cash)
Organization	Resources	Budgeting/control?	Risks relating to/the/planning, budgeting, and/controlling process, (involving/mainly/EDG-SPC and/EDPs.) ?
Organization	Resources	Commitment to/fair trade and/labor conditions	CERN's capacity to/ensure/that/the/persons/companies/working for/the/organization/(independently of/their/status - that is/fair/working conditions and/ethical investments
Organization	Resources	Business/Continuity/Management (BSCM)	Risks in/the/absence of/BCM or/failure in/the/Organization's/Payment of/Suppliers, /exception of/deliveries (/payroll etc.)
Organization	Resources	Short and/medium/term planning/& budgeting	Risks in/the/planning/decision process and/communication issues and/departmental planning, failure in/achieving/alignment of/resources (in/particular/manpower/resources.) ?
Organization	Structure	Project/Communication with/Executive/Management	These risks are related to/the/quality/competences/experience/independence/&/representation of/Council and/the/sub-committees of/Council, as well as/the/quality of/communication & information from/Management to/Council and/sub-committees. Communication representation of/with/the/Scientific/policy/Committee.
Organization	Structure	Leadership/of/the/Organization	These risks are related to/the/low level of/the/top/level of/the/Directorate's/Management of/conflicts/of/interests and/requirements for/independence. Risks are/also related to/the/attention given to/strategy and/execution, as well as/the/decision/making and/delegation of/authorities. Finally/risks are/also/the/communication within the/Directorate and/between the/Directorate and/Department Heads. ?
Organization	Structure	Compensation and/performance/recognition & / top/Management (EDG, Directors, /Department/Heads)	Risks/in/the/definition of/performance/metrics to/evaluate/top/management (performance/as well as/in/the/possible/undue/emphasis on/short/term/results (5/years mandate).) ?
Organization	Structure	Watch/on/expectations from/Member States, ? relations with/them and/reputation of/the/Organization	Risks/are/due/to/expectations of/a/fast/changing/political, /economic and/research/environment and/not/monitored, /understood and/responded to. /The/reputation of/CERN with/the/Europeans and/excellence and/the/therefore/difficult to/protect and/maintain/in/the/long/run. ?
Organization	Structure	Organization/and/oversight of/Risks	Risks/are/related to/the/Organization's/overall/management of/risks, /the/management of/by/the/Directorate of/Project risks and/their/reporting to/Council. /The/risks also/in/the/lack of/definition of/risk/appetite and/tolerance.
Organization	Structure	Transparency and/integrity of/information ? reported to/Council	Risks/are/related to/the/way/financial/information is/prepared, /audited and/reported to/Council. /They/also/in/the/adequate/review and/audit of/third/party/information/by/Council/and/sub-committees (in/the/decision/making.
Organization	Structure	Long/term/planning?	Risks/are/in/the/absence of/a/scenario/planning for/the/long/term/objectives of/the/Organization
Organization	Structure	Scientific/diversification	Capacity to/provide/infrastructures/to/support/emerging/scientific/trends. /Although/could/be/hot to/provide/timely/support to/hot/to/create/infrastructures/to/support/them. ?
Project/management	Communication	Publications	Risks related to/CERN's/scientific/contribution to/collaborations/as well as/research/institutes' balance/of, /inadequate, /lack of/monitoring, /etc.) ?
Project/management	Communication	Quality/of/reporting and/availability of/ information to/top/management	Covers/all/risks related to/the/quality of/the/reporting, /failure to/provide/accurate and/complete/information, /failure to/provide/timely/information, /outdated/information and/reporting/tools, /etc. /as well as/risks related to/the/non/-availability of/financial and/operational/information, /such as/non/-availability of/information to/make/decisions, /lack of/data/quality and/integrity, /insufficient/sharing of/information, /inability to/report on/key/metrics or/ineffective/presentation of/information, /etc.
Project/management	Finance	Accounting/processes	Risks resulting from/the/ineffectiveness and/reliability of/the/book-keeping and/accounting/processes, /as basis for/the/financial statements and/to/provide/financial information to/management and/to/CERN administration. ?
Project/management	Human/Resources	Human/Resource/policies and/procedures	Covers/all/risks related to/the/management of/human resources. /Inadequate/employment standards, /violation of/or/absence of/monitoring of/employment standards, /poor/labor conditions, /absence of/stringent management/processes, /insensitivity to/employee/morale, /etc.
Project/management	Human/Resources	Delegation & approval/process	Covers/all/risks related to/organizational issues/unclear/responsibilities and/mandates, /ill/defined mandates, /absence of/or/inappropriate/delegation of/authority, /misuse of/authority, /complex/organizational/design, /inappropriate/distribution of/decision/making/authority, /etc.
Project/management	Human/Resources	Performance/management and/recognition	All risks related to/the/management of/staff's/performance and/its/recognition, /such as/unreasonable/performance/expectations, /recognition not/linked to/performance, /ineffective/oversight and/governance/over/these/processes, /ineffective/equity, /inappropriate/management of/and/or/performance/etc.
Project/management	Human/Resources	Recruitment/Talent/pipeline	All risks related to/the/recruitment of/personnel: /analysis of/personnel needs, /identification of/key/personnel, /ability to/attract and/retain/personnel, /effectiveness and/efficiency, /as well as/the/property/branding of/diversity/issues/nationality, /gender, /handicap, /etc.)
Project/management	Human/Resources	Training and/development	All risks related to/the/training and/development of/personnel: /ineffective/inadequate/training and/development programs, /training and/development programs not/aligned with/CERN strategy, /etc.
Project/management	Legal	Contractual/commitment and/management.	Risks relating to/the/control/in/contracting or/committing/towards/CERN/third/parties on/behalf of/CERN. This concerns/the/system of/delegation/and/authorities, /failure to/comply with/terms and/conditions of/agreement, /terms and/conditions not/in/compliance with/laws and/regulations
Project/management	Legal	Intellectual/property	Failure to/register /protect and/valuate/IP rights and/to/implement/a/IP policy. Failure to/respect/limitation of/the/use of/IP from/third/parties
Project/management	Legal	Litigation and/Dispute/Resolution	Risks resulting from/ineffective/litigation/risk/assessment, /inability to/defend/lawsuits, /residual/claims from/exposed/or/acquired/entities
Project/management	Planning	Hosting of/new/collaborations	Capacity to/establish/fruitful/international/collaborations and/to/host those. /Understanding of/the/needs and/the/services/to/be/provided or/the/limits to/establish. /Risks include/both/the/improper/planning of/the/impact on/CERN's/existing/new/collaborations.
Project/management	Planning	Support to/external/joint/ventures	Risks/in/the/lack of/proper/consideration of/the/impact of/joint/venture/agreements on/CERN resources, /transparency, /management of/political/objects, /etc.
Project/management	Planning	Concurrent/project/management	Risks/in/the/analysis and/approval/of/neutrino/platform/projects. /Approval/process, /conflicts of/priorities/between/different/projects, /management of/human/resources in/a/matrix/environment, /assignment of/resources. ?
Project/management	Planning	Delivery	Delay/in/the/delivery of/components or/full/project
Project/management	Planning	Production/planning	All risks related to/the/planification of/production of/good by/CERN, /such as/inaccurate/supply/forecast, /inadequate/capacity/planning, /inadequate/costing/considerations, /inability to/determine/and/maintain ? optimum/safety/stock, /etc.
Project/management	Planning	Installation	Covers/risks related to/the/installation/research/tools, /such as/inadequate/planning, /insufficient/tests, /etc.
Project/management	Planning	Process/performance/monitoring	Risks in/the/absence of/performance/indicator that/are/necessary to/assess the/quality of/planning and/to/take/corrective/action to/improve/planning/method. ?
Project/management	Planning	Dependency on/external/collaborations	Risks in/the/that CERN/becomes/over/dependent on/external/collaborations for/specific/parts of/the/mission
Project/management	Planning	Strategy for/outsourcing	Failure in/the/choice of/outsourcing, /wrong/appreciation of/risks, /wrong/appreciation of/resources needed, /poor/implementation, /etc.
Project/management	Planning	Scientific/direction/policies	Risks/in/designing policies that/could be/against the/EU policy/or/internally/conflicting policies, /as risk in/misalignment of/policy/with/strategy
Technical	Infrastructure/support	Assets/management	Risks/common/to/all/productive/and/non-productive/assets/management: /asset/tracking, /recording, /planning, /performance, /maintenance, /unproductive/assets, /(or/obsolescence/of/productive/assets), /(project/material/(i.e. /stainless/steel)
Technical	Infrastructure/support	Scientific/infrastructure	Risks/in/the/investment, /use, /maintenance, /etc. /of/scientific/infrastructures/(accelerators, /detectors, /etc). /Poor/use/of/the/infrastructure, /misuse/of/the/infrastructure/(includes/spare/parts/necessary/to/operate/this/infrastructure /for/example/cryogenics/equipment
Technical	Infrastructure/support	Tertiary/infrastructure	Risks/in/the/investment, /use, /maintenance, /etc. /of/tertiary/infrastructure. /Poor/use/of/the/infrastructure, /misuse/of/the/infrastructure. . . Include/spare/parts. /For/instance/HVAC
Technical	Process	Relations/with/Member States/and/other/resource/providers	Covers/risks/such/as/inability to/identify/and/meet/resource/providers' /expectations, /providing/inconsistent/or/poor/information, /inability to/identify/and/develop/relations with/key/decision/makers, /etc. /Specifications of/not/suited to/resource/providers/expectations ?
Technical	Process	Product/design/&/quality	Failure related to/the/design/quality of/components
Technical	Process	Production	Failure in/the/production of/components
Technical	Process	Commissioning	Failure in/the/commissioning of/a/research/tool
Technical	Process	Operation & Maintenance	Covers/all/risks linked to/the/operation of/CERN's/deliverables, /including the/planning and/quality of/the/maintenance/operations/procedures
Technical	Safety	Health and/Safety	Risks related to/the/identification, /management and/monitoring of/health/safety and/environmental/risks ?
Technical	Security	Security/management	Risks related to/the/identification, /assessment and/management and/monitoring of/security/risks ?

- Questionnaire with 60 standard risks
- Interviews with project stakeholders

NAME	Position
Beltramello, Olga	EP TSO
Catinaccio, Andrea	EP Engineer
Delille, Benoit	HSE Leader
Garino, Cedric	SCE Logistics
Geeraert, Patrick	NP Resource Coordinator
Gianotti, Fabiola	CERN DG
Krammer, Manfed	EP DH
Lobmaier, Ivo	IPT Purchasing Officer
Miralles, Lluís	NP Engineer
Mladenov, Dimitar	NP Engineer
Mnich, Joachim	RCS Director
Nessi, Marzio	NP Project Leader
Resnati, Filippo	NP Technical Coordinator
Saita, Carmelo	FAP Insurance
Sonnemann, Florian	FAP DH
Wells, Pippa	RCS Deputy
Wilbers, Maarten	Legal Service

EDMS Doc. 2515835 v.1

Risk identification

Risk Register. 88 Risks. EDMS Ref.2515120 v1

First Level	Second Level	Risk #	Risk Title	Risk level C	Risk level S	Impact C	Impact S	Probability	Risk/Issue description	Possible Impacts description	Response (Avoidance, Mitigation, Transfer, Acceptance...)
Project Management	Planning	R01	Installation logistics infrastructure at SURF	Low	Low	Low	Low	Medium	Insufficient storage and/or transportation resources at SURF underground or on surface. Ross stage lift unavailable. Crane unavailable. Site conditions (mountains, roads, communications). Spares/consumables not available locally	Installation delay, temporary storage costs, Standing army costs	Part of International collaboration agreement negotiations. Management/sharing/bearing risk and its consequences when realised. Liability, cross claims due to schedule, accidents, incidents shall be avoided.
Project Management	Planning	R02	Production Readiness review documents	Very Low	Very Low	Low	Low	Low	Design, fabrication, and assembly drawings and specifications complete prior to the production readiness review Sept. 2018	PRR not successful. Schedule delay	Design Quality assurance. Project management plan
Technical	Safety	R03	Warm cryostat structure inspection access	Very Low	Very Low	Low	Low	Low	Stairways, walkways, and platforms not meet life safety requirements	PRR not successful. Schedule delay	Design Quality assurance. Project management plan. Review recommendations follow up
Technical	Process	R04	Installation constrains included in the design	Low	Low	Medium	Medium	Low	Changes in installation plan requiering changes on design	Cost associated to modification of components. Schedule delay. Safety validation	Installation quality assurance. Project management plan
Project Management	Planning	R05	Cryostat pressure test	Medium	Medium	High	High	Low	The steel structure is part of the membrane cryostat so FESHM chapter 5031.7 "Membrane Cryostats" applies as does the Memorandum of Understanding "Design, Fabrication, Installation and Testing of LBNF/DUNE and SBND Cryostats", EDMS 1554082 v1. Both documents require a pressure test prior to filling with liquid argon. If CERN takes exception to the pressure testing requirement, LBNF management and the authority having jurisdiction will need to resolve this exception or accept responsibility for pressure testing.	Schedule delay.	Part of International collaboration agreement negotiations. Transfer of responsibility and property/ownership
Technical	Process	R06	Cryostat penetrations issues with cryogenics and detector	Low	Medium	Low	Medium	Medium	Integration issues on the top of the cryostats with cryogenics, detector and other infrastructures	PRR delay. Schedule delay. Cost and quality issues if modifications shall be executed during assembly	Design Quality assurance. Project management plan
External	Process	R07	Base of the structure	Very Low	Very Low	Low	Low	Low	Displacements of the base (leveling legs, the concrete floor, the grout placed below the steel beams, ground). Differential displacement beyond planarity or alignment tolerances.	Schedule delay. Cost associated to corrections/reinforcements	Project management plan
Technical	Process	R08	Contractor failing to fulfill welding specifications	Low	Very Low	Medium	Low	Low	Contractor not fulfilling the welding technical specifications for the warm structure and/or cold membrane. Structural, safety and leak tightness cosequences.	Schedule delay. Contractual issues	Production quality assurance plan. Tendering specs.
Technical	Process	R09	European standards and codes	Low	Medium	Low	Medium	Medium	Contractor not familiar with european codes not executing according to them. Different standards for electricity, bolts (imperial vs metric measures, drawings standards)	Schedule delay. Contractual issues. Quality issues.	Production quality assurance plan. Tendering specs.
Technical	Market	R10	FEA calculation assumptions	Very Low	Very Low	Low	Low	Low	Calculation assumptions not being confirmed by contractors. i.e. thermal and mechanical load distributions, civil engineering base tolerances/stability	Schedule delay. Cost associated to corrections/reinforcements	Production quality assurance plan. Tendering specs.
Technical	Process	R11	Final verifications as per ANSI/AISC	Low	Low	Medium	Medium	Low	Cryostat acceptance MoU condition. Final verification and certification of the documentation related to examinations, inspections of materials, in-process fabrications, and acceptance tests not conform. Acceptance conditions and consequences not clear. Conditions for transfer of responsibility and/or property/ownership.	Schedule delay. Contractual issues	Part of International collaboration agreement negotiations. Transfer of responsibility and property/ownership
Technical	Process	R12	Destructive tests cryostat components	Very Low	Very Low	Low	Low	Low	Cryostat acceptance MoU condition. Destructive tests for the weakest structural part of the steel frame are performed to validate the FEA model and the structure mechanical behaviour. The maximum stressed connections are calculated for ANSI/AISC 360 and ASME section VIII, Div.2. If required, the FEA models are modified accordingly and an update of the calculations performed.	Schedule delay. Contractual issues. Cost associated to the modification of design	Design Quality assurance. Project management plan
Technical	Process	R13	Pneumatic test	Medium	Medium	High	High	Low	Cryostat acceptance MoU. Prior to the Liquid Argon filling process, a pneumatic test is performed at a testing pressure PT: PT = 1.15 x Maximum Allowable Working Pressure = 1.15 x 350 mbars. Prior to the pneumatic pressure test, all feedthroughs and other external components shall be pressurated for a design pressure of at least 350 mbars. Test failure producing cryostat damage	Schedule delay. Contractual issues. Cost associated to repair and correct source of failure	The pressure rating shall be obtained through documented qualification process, including design calculations and testing program. Additionally, each feedthrough shall be pressure tested prior to installation into the cryostat in an appropriate setup that is described in a separate document
Technical	Process	R14	Cryostat filling	Medium	Medium	High	High	Low	Cryostat acceptance MoU. Fill of the cryostats with liquid argon in incremental steps until the service level producing cryostat damage or abnormal behaviour	Schedule delay. Contractual issues. Cost associated to repair and correct source of failure	The cryostat is instrumented with gauges to monitor deformations. The structural behaviour of the warm structure is checked during the filling process. In case of any abnormal behaviour of the structure, the cryogen is transferred to an available adjacent cryostat or drained. The gas pressure to be additionally applied at the top of the liquid level is defined via the risk assessment of the cryostat and mitigating safety measures.

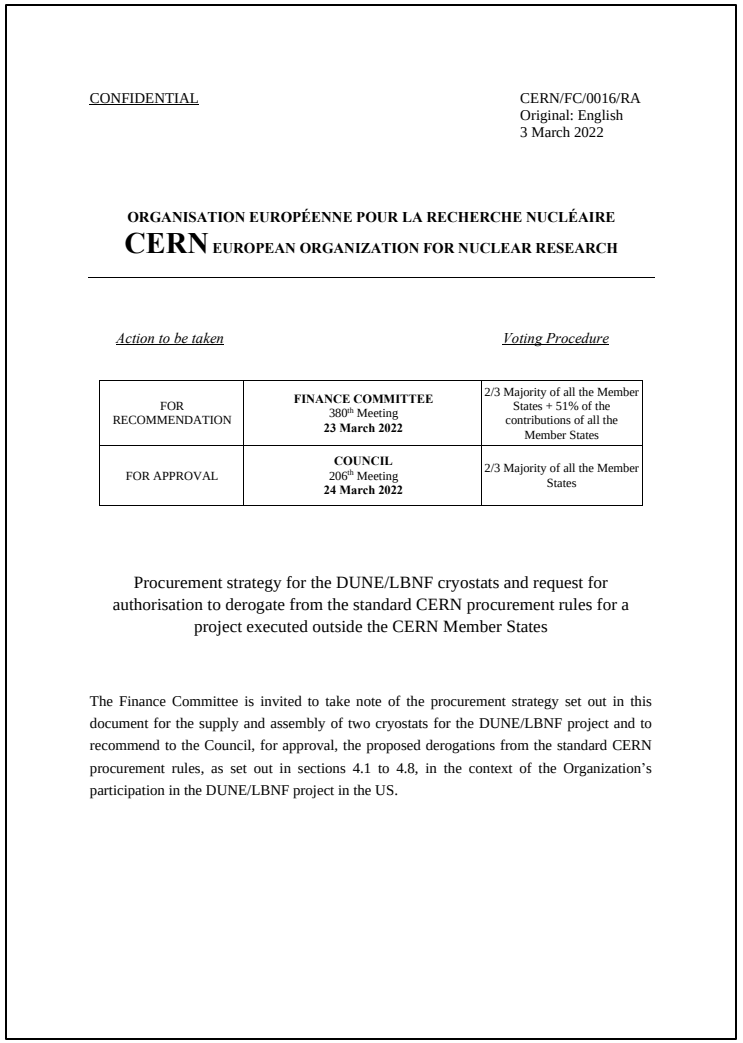
Risk analysis

TAKE HOME POINTS
Project technically sound. No major technical risk has been identified
Schedule risk impact for material delivery compensated by 3 months float between ready for installation and start of assembly @ SURF milestones
Schedule risk impact associated with the complexity of the installation @ SURF
Implementation of the mitigation measures are of capital importance to control the impact of the risks associated with Project Management and Project stakeholders responsibilities
Major uncertainty on Cost and Schedule impact risk is on the supply of the cold vessel material

Project contract breakdown

- **Warm structure material**
- **Warm structure components manufacturing**
- **Warm structure membrane manufacturing**
- **Warm structure fasteners**
- **Warm structure transport**
- **Warm structure underground assembly**
- **Cold structure material procurement**
- **Cold structure underground assembly**

Project contract strategy



CONFIDENTIAL

CERN/FC/0016/RA
Original: English
3 March 2022

ORGANISATION EUROPÉENNE POUR LA RECHERCHE NUCLÉAIRE
CERN EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH

Action to be taken *Voting Procedure*

FOR RECOMMENDATION	**FINANCE COMMITTEE** 380th Meeting **23 March 2022**	2/3 Majority of all the Member States + 51% of the contributions of all the Member States
FOR APPROVAL	**COUNCIL** 206th Meeting **24 March 2022**	2/3 Majority of all the Member States

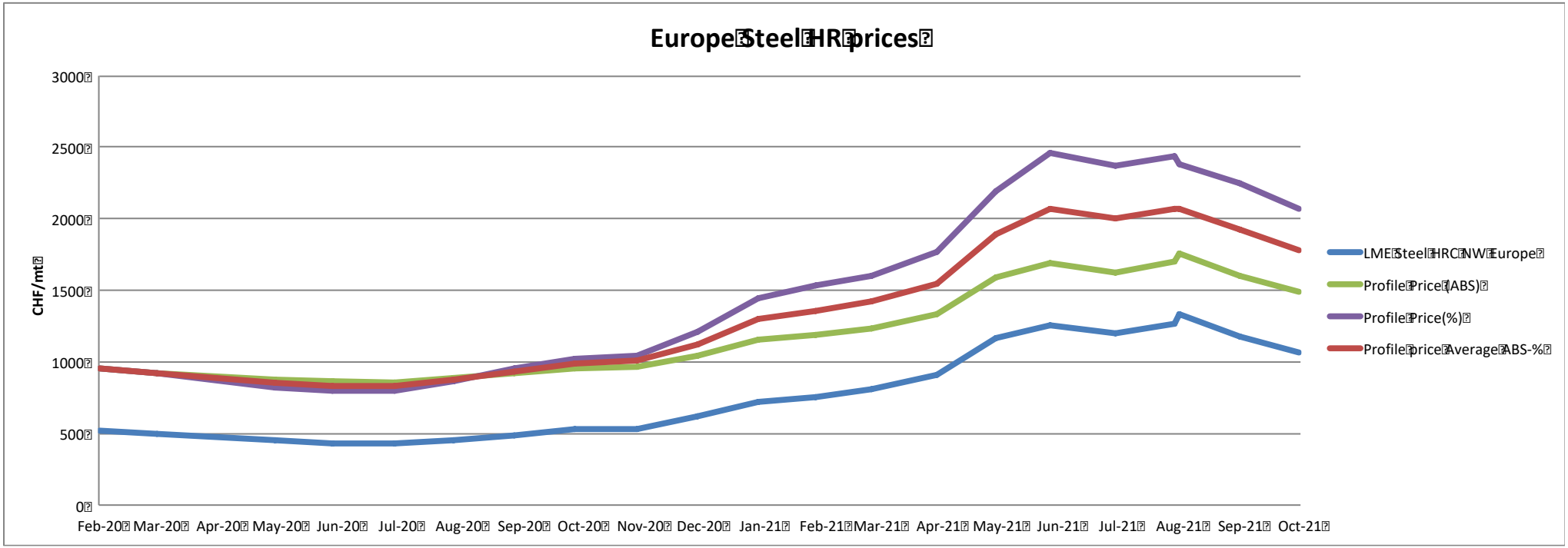
Procurement strategy for the DUNE/LBNF cryostats and request for authorisation to derogate from the standard CERN procurement rules for a project executed outside the CERN Member States

The Finance Committee is invited to take note of the procurement strategy set out in this document for the supply and assembly of two cryostats for the DUNE/LBNF project and to recommend to the Council, for approval, the proposed derogations from the standard CERN procurement rules, as set out in sections 4.1 to 4.8, in the context of the Organization's participation in the DUNE/LBNF project in the US.

- CERN purchasing rules and regulations
  - CERN purchasing rules derogation
  - Single source contracts
  - Propietary technology
  - Geographical execution of the contract
  - Risk Management and Analysis
  - Bidders Technical qualification criteria
  - Bidders Financial qualification criteria
  - Contractual framewok
  - FC proposals for adjudication timeline

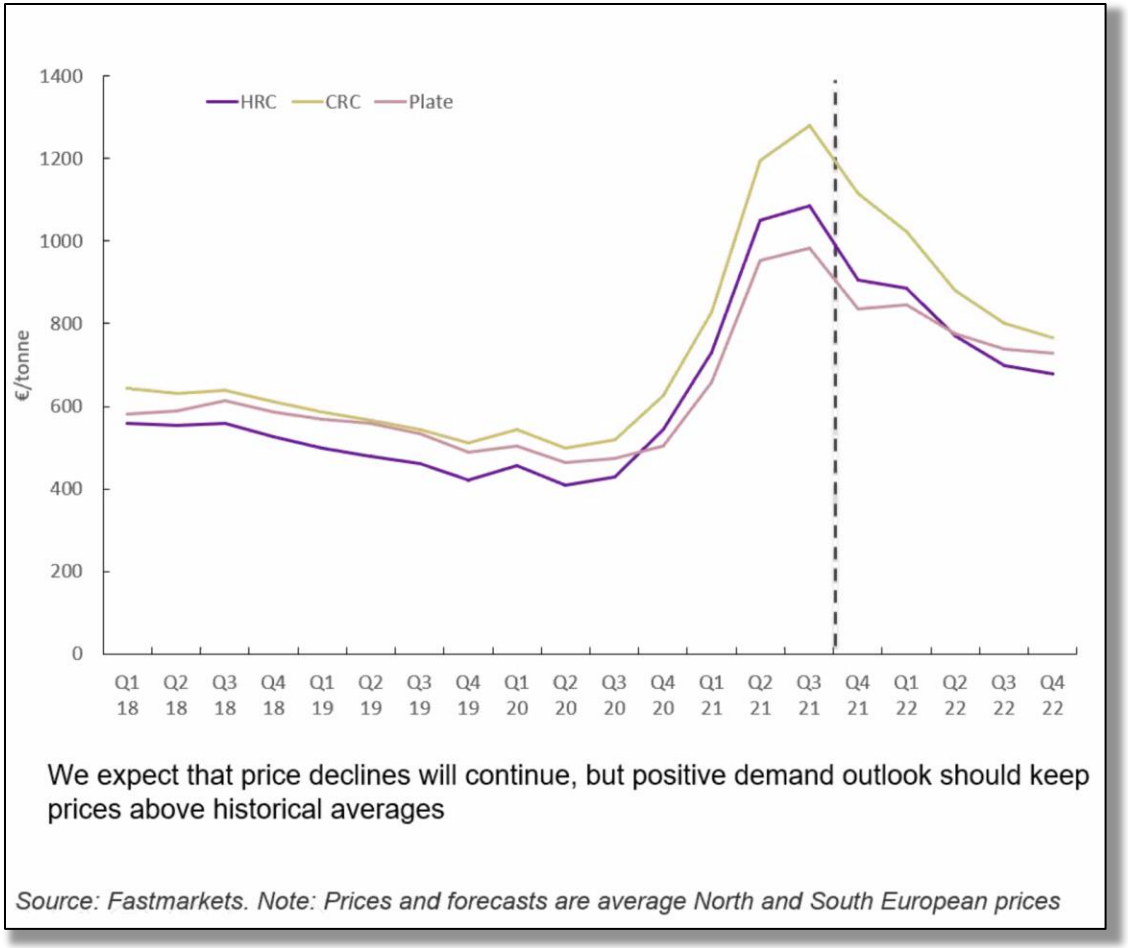
Europe HR steel market

Europe HR steel market evolution 2/20 to 10/21



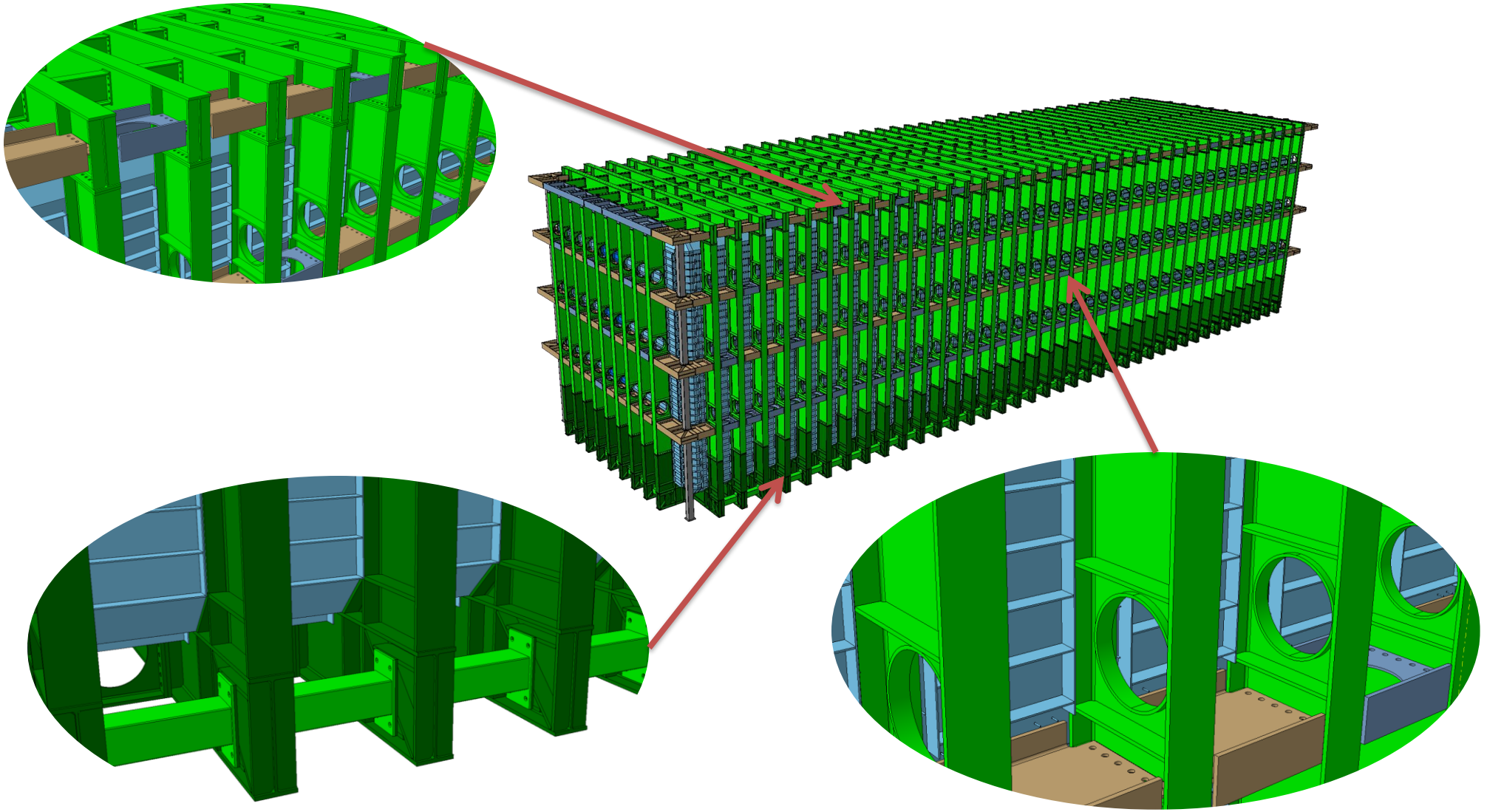
Europe HR steel market

Europe HR steel market forecast 3Q21 to 1Q23

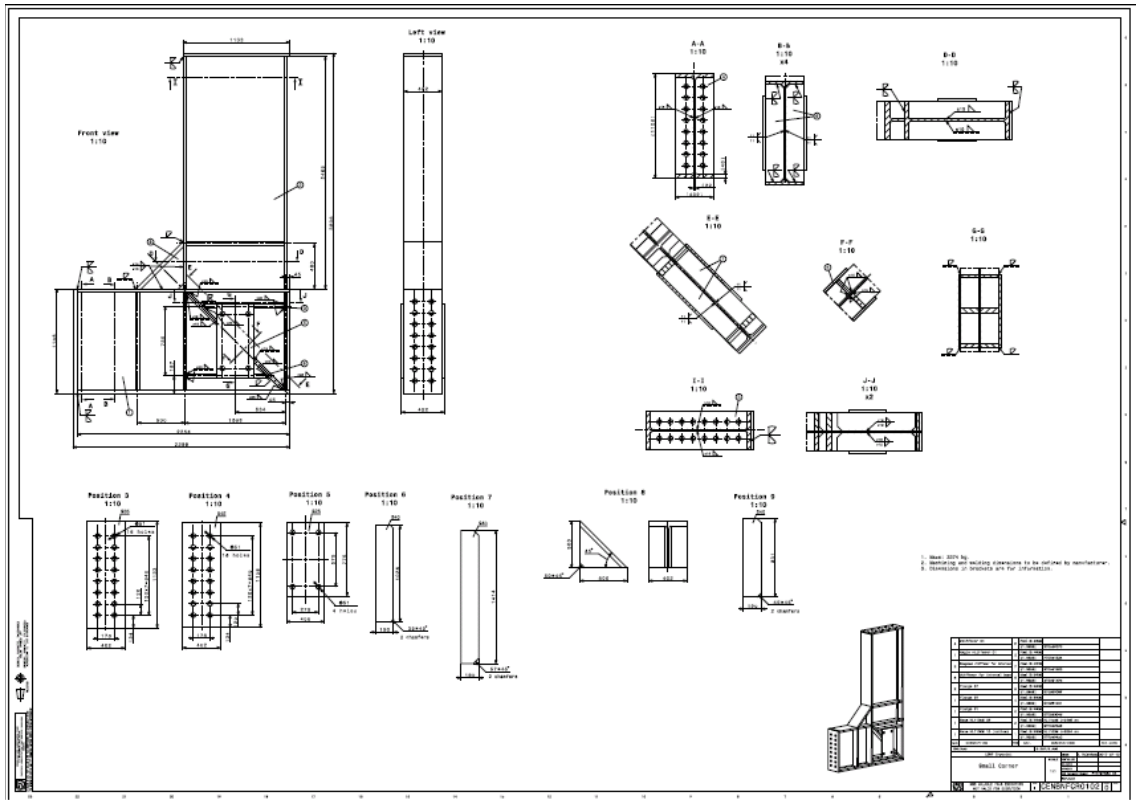


Similar qualitative forecast from other sources (S&P Platt)

Warm structure



Warm structure

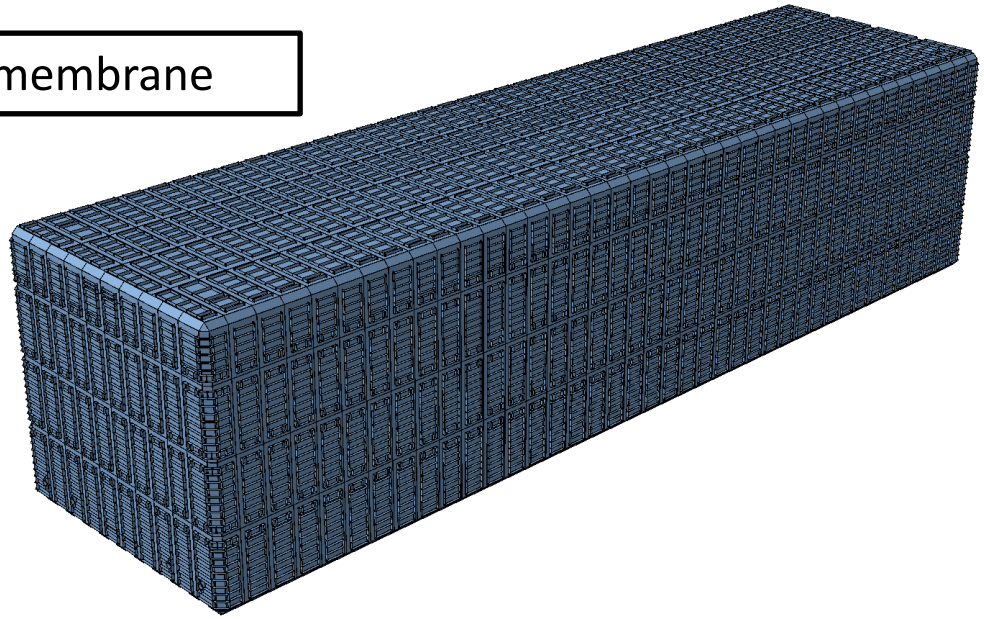


Steel structure components produced by cutting and welding standardised steel profiles

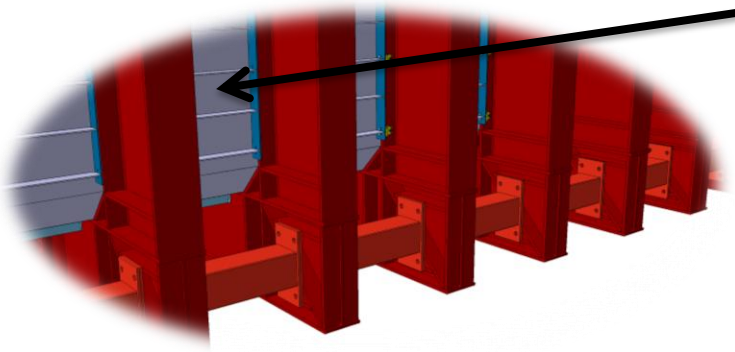
2 606 welded steel-structure components, corresponding to a total approximate weight of 4 600 tonnes

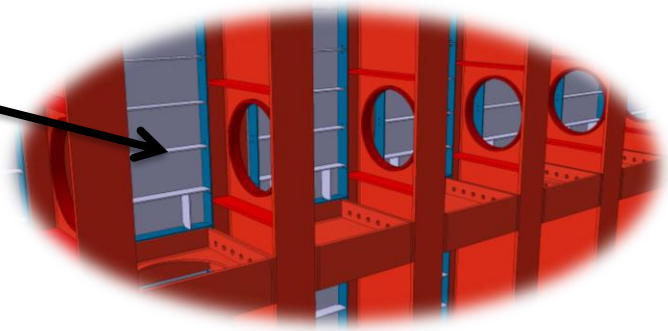
Tertiary membrane

DUNE/LBNF cryostat tertiary membrane

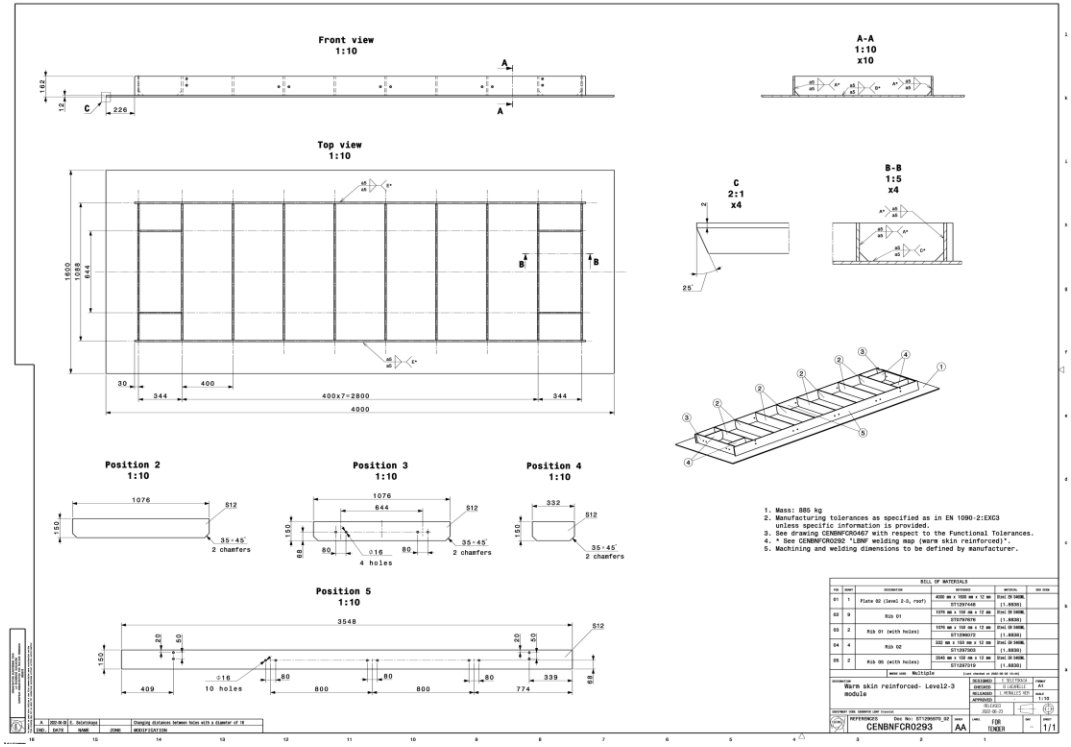


Tertiary membrane components



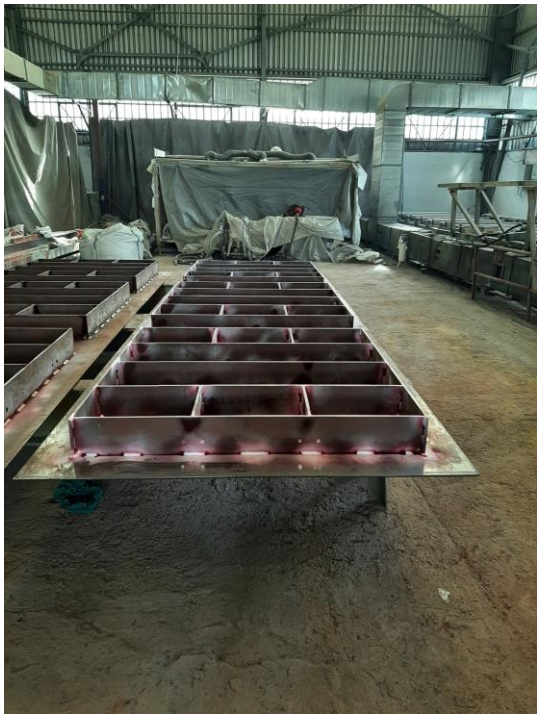


Tertiary membrane



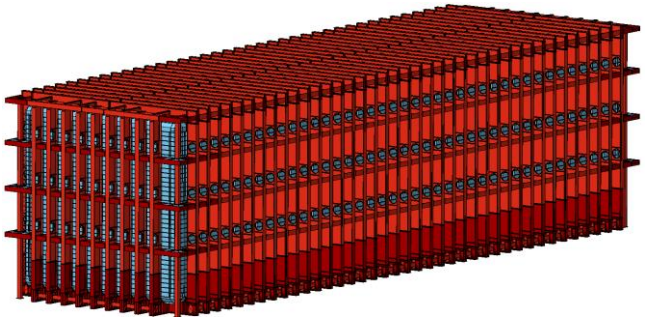
1814 Tertiary membrane components, corresponding to a total approximate weight of 1176 tonnes

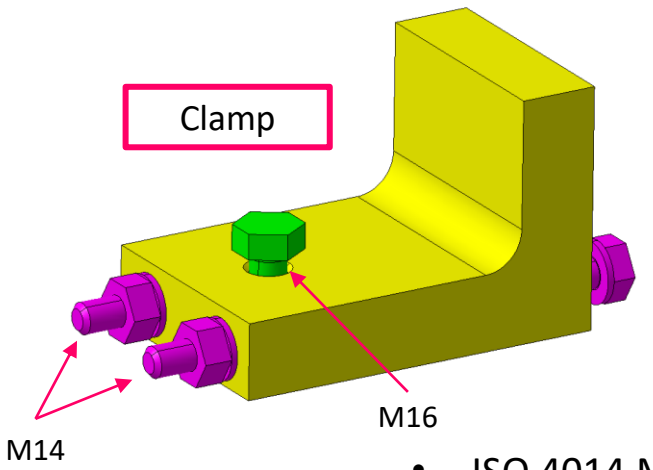
Tertiary membrane components produced by cutting and welding steel plates

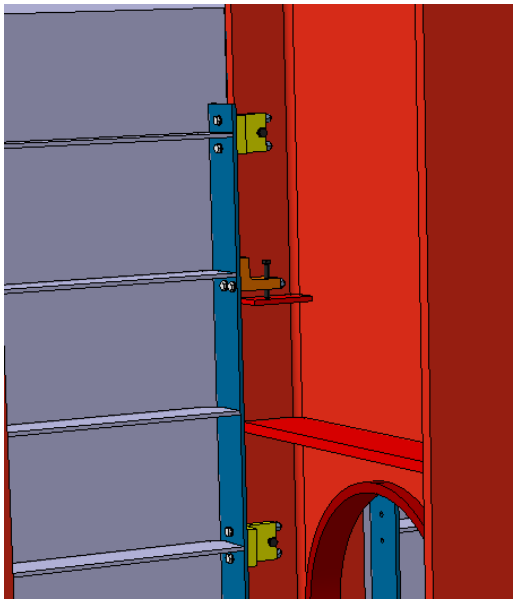


Fasteners

- The membrane of the LBNF have some ribs oriented vertically and horizontally;
- Some clamps are used in order to fix and support the weight of the plate during installation and provide stability during the vacuum load case;
- Analytical computations and simulations to verify the ribs pitch and the clamp capacity where performed.







- ISO 4014 M16 x 50 (10.9). 12600 units
- ISO 4014 M16 x 100 (10.9). 2400 units
- ISO 4014 M14 x 170 (10.9). 30000 units

Fasteners

Mechanical properties

This is a special production with the following requirements for mechanical and material properties:

Bolt (EN 14399-3)

Chemicals	ISO 898-1	**C (0.20-0.55), P (0.025 max), S (0.025 max), B* (0.003 max)**			
		If B up to 0.005, non-effective boron is controlled by the addition of titanium and/or alluminium. Approx. 90% of martensite in the core of the threaded section in the "as-hardened" conditions before tempering.			
Hardness	ISO 898-1	**320-380 HV**			
		Surface hardness shall not be more than 30 Vickers points above the measures base metal hardness of the fasteners. Carried out with HV 0.3			
Decarbonization in thread	ISO 898-1	**0.015 mm max**			
Tensile strength	**1531.92**	kN	*Rm, MPa*	**1040**	MPa
Yield, Rp0.2	ISO 898-1	**940**			MPa
Elongation, A %	ISO 898-1	**9**			**%**
Impact V-notch	**27J @ -50C**				
Property Class	**10.9**				
Product Grade	**C**	*except for dimensions c and r*	*For length:*	**+/- 4mm**	
Thread	**6g**				
Marking	**FAST 10.9HR**				

Nut (EN 14399-3)

Chemicals	ISO 898-2	**C (0.58 max), Mn (0.30 min), P (0.048 max), S (0.058 max)**				
		Alloying element may be added, provided the mechanical properties requires are fulfilled.				
Hardness	ISO 898-2	**272-353 HV**				
Proof Load	**1708.68**	kN	*Rm, MPa*	**1160**	MPa	
Property Class	**10**					
Product Grade	**B**					
Thread - uncoated	**6H**					
Impact V-notch	**27J @ -50C**			*)*		
Lubrication	**Customer / Supplier**					
Markings	**FAST 10HR**					

Washer (EN 14399-6 GALV)

Hardness	**300-370 HV**
Markings	**FAST H**

Quantities.

- Bolt M48 x 140. 10000 units
- Bolt M48 x 150 . 4000 units
- Bolt M48 x 160 .12000 units
- Bolt M48 x 180. 22000 units

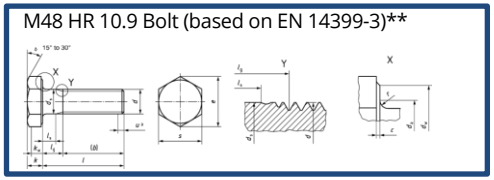
- Nuts M48. 52000 units
- Washer M48. 104000 units

Transport

Detector cryostat warm structure for DUNE/LNBF

1300 beams, weight 2300 MT

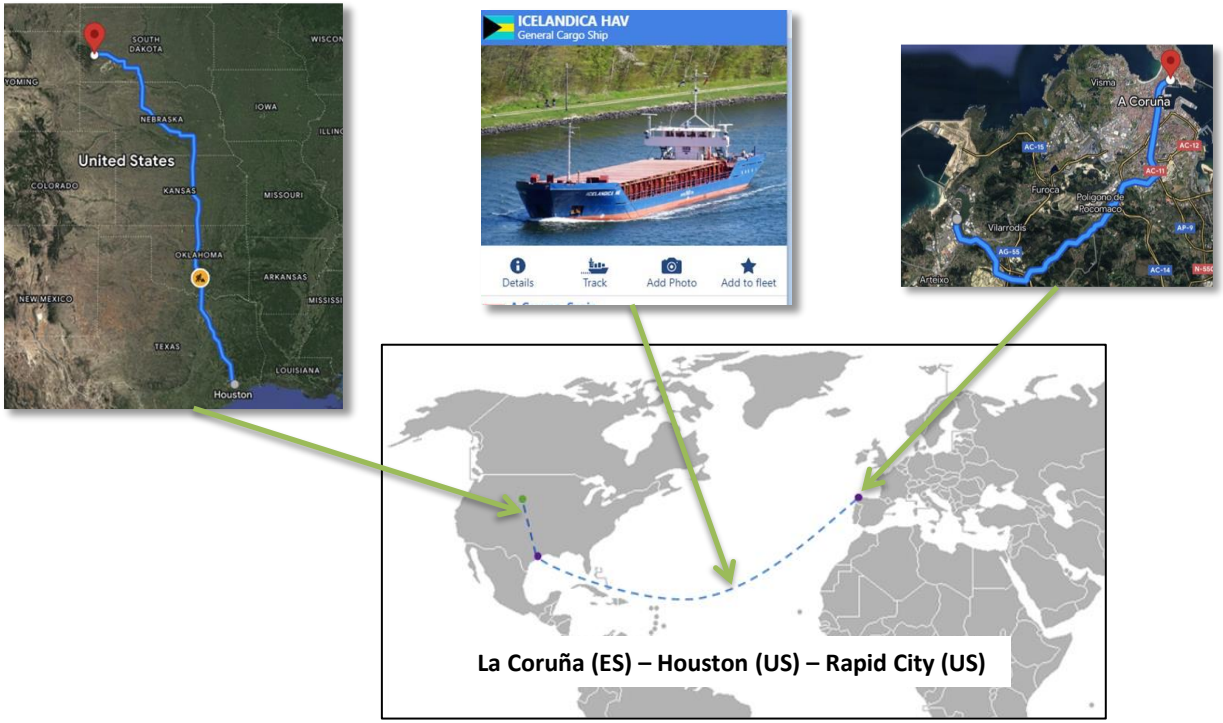
900 components, weight 600 Mt



150’000 Fasteners, weight 125 MT

Transport

The transport of the warm structure will require multimodal logistics, including maritime and inland transport, which will imply stevedoring, unloading and customs processes



Technical specifications

Fermilab
Long Baseline Neutrino Facility & CERN Neutrino Platform

Technical Report

Document EDMS identifier:	Fermilab LBNF DocDB:	Created: 8-Jan-20	
2330554		Last Modified: 12-June-20	Rev. No.: **1.0**

LBNF Cryostat

Warm Structure assembly Technical Specification

Abstract

This technical specification provides the requirements for the LBNF Warm Structure assembly in the LBNF premises.

Prepared by:	Checked by:	To be approved by:
M. Nessi RCS-PRJ-DI **D. Mladenov EP-NU** **F. Resnati EP-NU** **B. Lacarelle EP-NU** **G. Buccino EP-NU** **M. Carlini EP-NU** **E. Seletskaya EP-NU** **A. Parchet EP-NU**	**F. Resnati EP-NU** **D. Mladenov EP-NU**	**M. Nessi RCS-PRJ-DI** **F. Resnati EP-NU**

Distribution List

Fermilab
Long Baseline Neutrino Facility & CERN Neutrino Platform

Technical Specification

Document EDMS identifier:	Fermilab LBNF DocDB:	Created: 29.11.2022	
2811985		Last Modified: 09.01.2023	Rev. No.: **1.0**

LBNF Cryostat

Warm Structure installation

Abstract

This technical specification provides the requirements for the LBNF Warm Structure installation.

Prepared by:	Checked by:	To be approved by:
D. Mladenov RCS-PRJ-NP **M. Nessi RCS-PRJ-NP**		

Distribution List

Human Resources

- The mitigation measures define the framework of the project, the conditions in which will be executed, consequently the project risk scenario

- Three main measures have been identified mitigating the major part of the risks

  - International Collaboration Agreement between CERN and DOE defining the scope of CERN contribution, the conditions in which the contribution shall be done and the responsibilities of each part

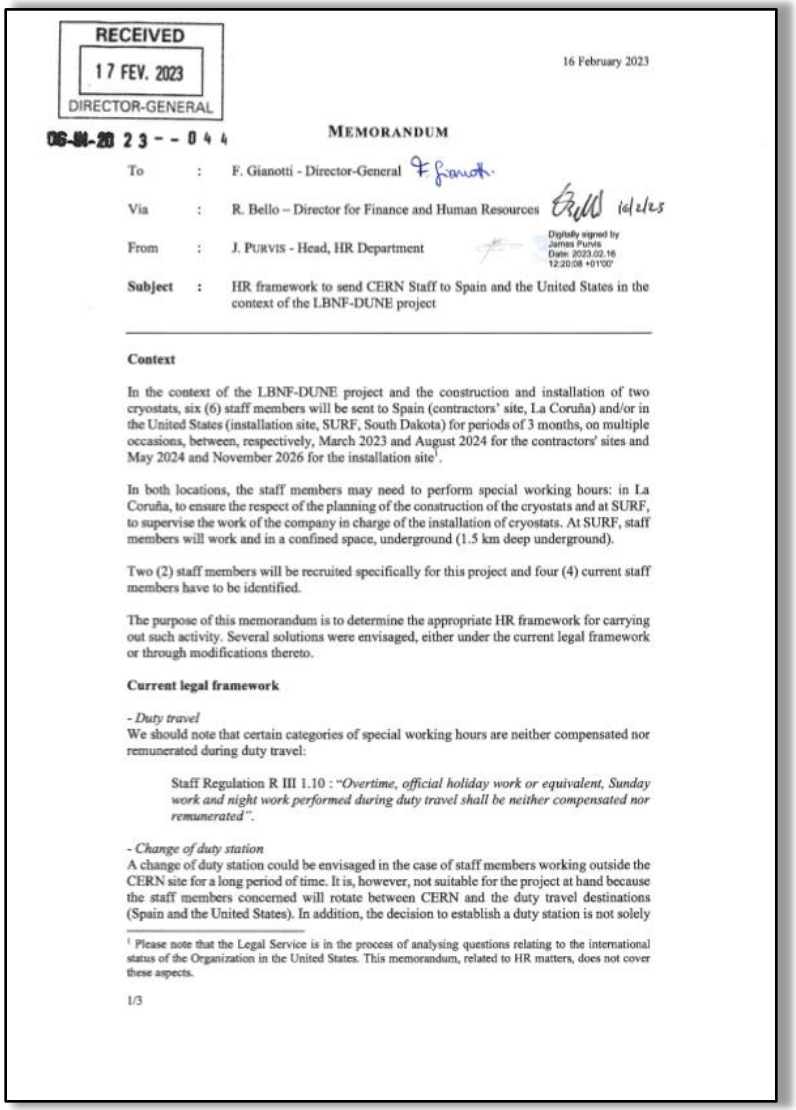
Cultural change →

  - Implementation of the existing provisions of the Project Management Plan in all aspects of the project execution (Project organization, Manpower plan, Financial plan, Planning, Safety plan, Contract Strategy Plan, Quality Assurance plan, Quality Control plan, Risk Management plan). The implementation depends on the availability of human resources with the necessary competences.

Human Resources →

  - CERN Neutrino Platform Strategy. Human and Material Resources assigned to the Project to honour the International Collaboration Agreement and the implementation of the Project Management Plan

Human Resources →



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17 FEV. 2023
DIRECTOR-GENERAL

16 February 2023

DG-AH-20 23 - - 044

MEMORANDUM

To : F. Gianotti - Director-General

Via : R. Bello – Director for Finance and Human Resources 16/2/23

From : J. PURVIS - Head, HR Department

Digitally signed by James Purvis
Date: 2023.02.16 12:20:08 +01'00'

Subject : HR framework to send CERN Staff to Spain and the United States in the context of the LBNF-DUNE project

Context

In the context of the LBNF-DUNE project and the construction and installation of two cryostats, six (6) staff members will be sent to Spain (contractors' site, La Coruña) and/or in the United States (installation site, SURF, South Dakota) for periods of 3 months, on multiple occasions, between, respectively, March 2023 and August 2024 for the contractors' sites and May 2024 and November 2026 for the installation site[1].

In both locations, the staff members may need to perform special working hours: in La Coruña, to ensure the respect of the planning of the construction of the cryostats and at SURF, to supervise the work of the company in charge of the installation of cryostats. At SURF, staff members will work and in a confined space, underground (1.5 km deep underground).

Two (2) staff members will be recruited specifically for this project and four (4) current staff members have to be identified.

The purpose of this memorandum is to determine the appropriate HR framework for carrying out such activity. Several solutions were envisaged, either under the current legal framework or through modifications thereto.

Current legal framework

- Duty travel
We should note that certain categories of special working hours are neither compensated nor remunerated during duty travel:

> Staff Regulation R III 1.10 : "*Overtime, official holiday work or equivalent, Sunday work and night work performed during duty travel shall be neither compensated nor remunerated*".

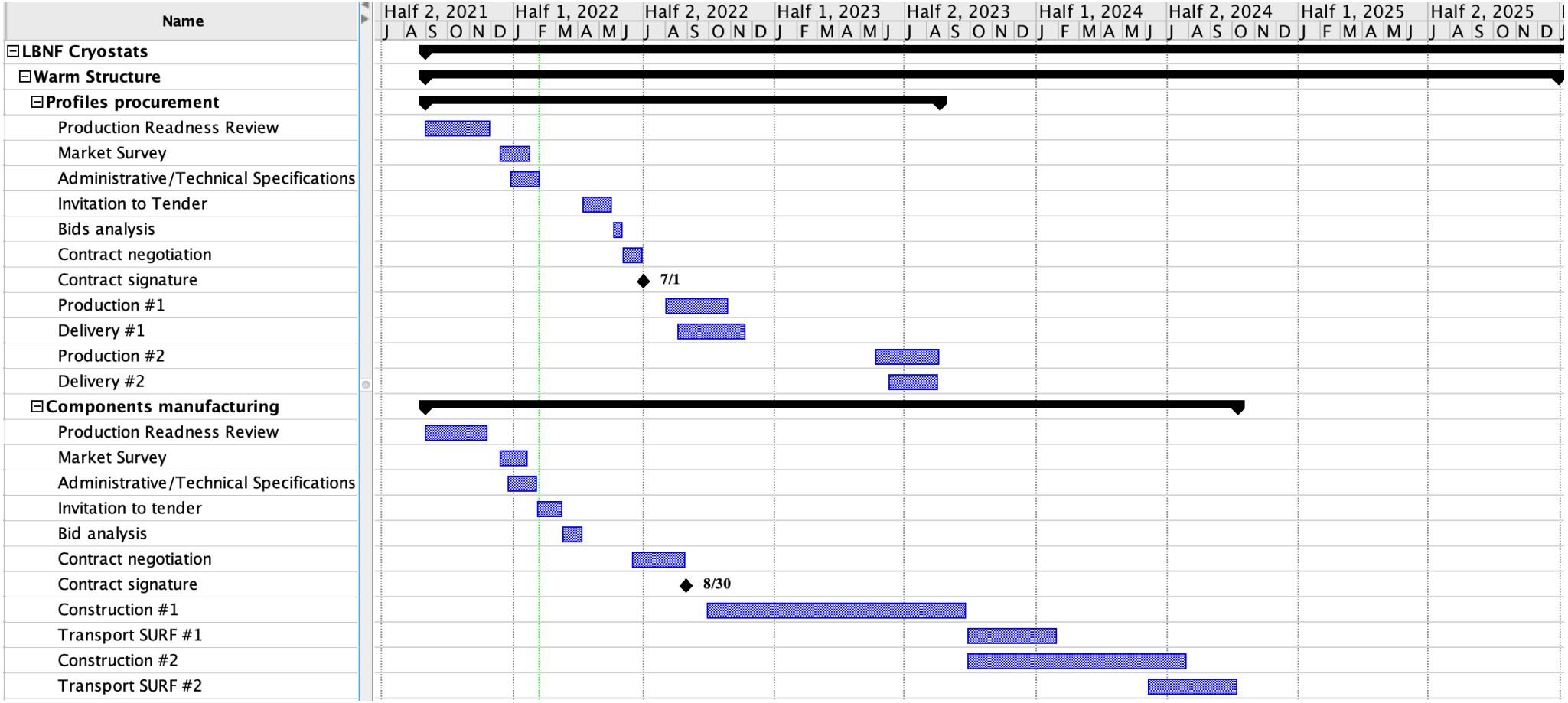
- Change of duty station
A change of duty station could be envisaged in the case of staff members working outside the CERN site for a long period of time. It is, however, not suitable for the project at hand because the staff members concerned will rotate between CERN and the duty travel destinations (Spain and the United States). In addition, the decision to establish a duty station is not solely

[1] Please note that the Legal Service is in the process of analysing questions relating to the international status of the Organization in the United States. This memorandum, related to HR matters, does not cover these aspects.

1/3

- Detect competences required for each phase of the project
- Define profiles
- Working conditions vs CERN framework
- Recruitment strategy

Schedule


Name
Half 2, 2021
Half 1, 2022
Half 2, 2022
Half 1, 2023
Half 2, 2023
Half 1, 2024
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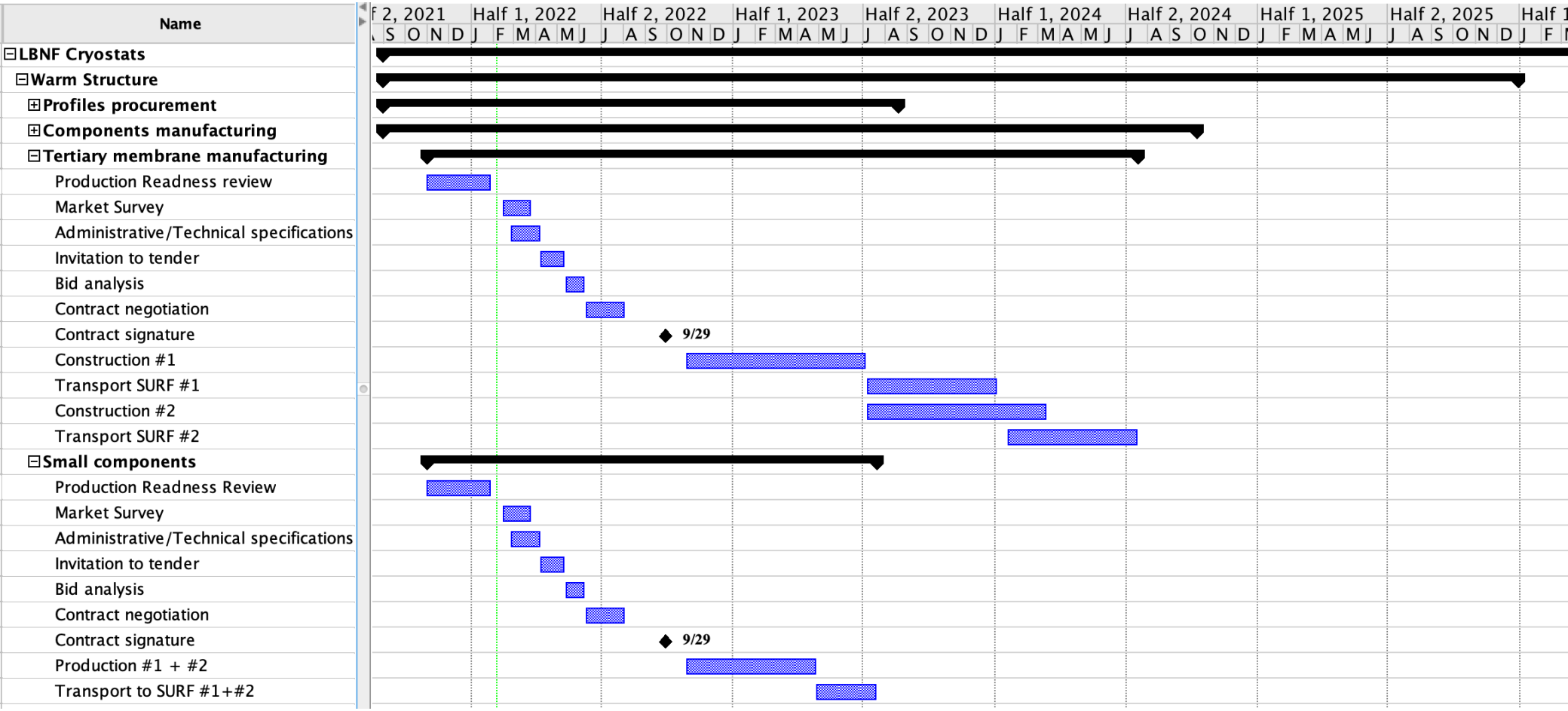
Half 2, 2025
J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
LBNF Cryostats
Warm Structure
Profiles procurement
Production Readness Review
Market Survey
Administrative/Technical Specifications
Invitation to Tender
Bids analysis
Contract negotiation
Contract signature
7/1
Production #1
Delivery #1
Production #2
Delivery #2
Components manufacturing
Production Readness Review
Market Survey
Administrative/Technical Specifications
Invitation to tender
Bid analysis
Contract negotiation
Contract signature
8/30
Construction #1
Transport SURF #1
Construction #2
Transport SURF #2

Schedule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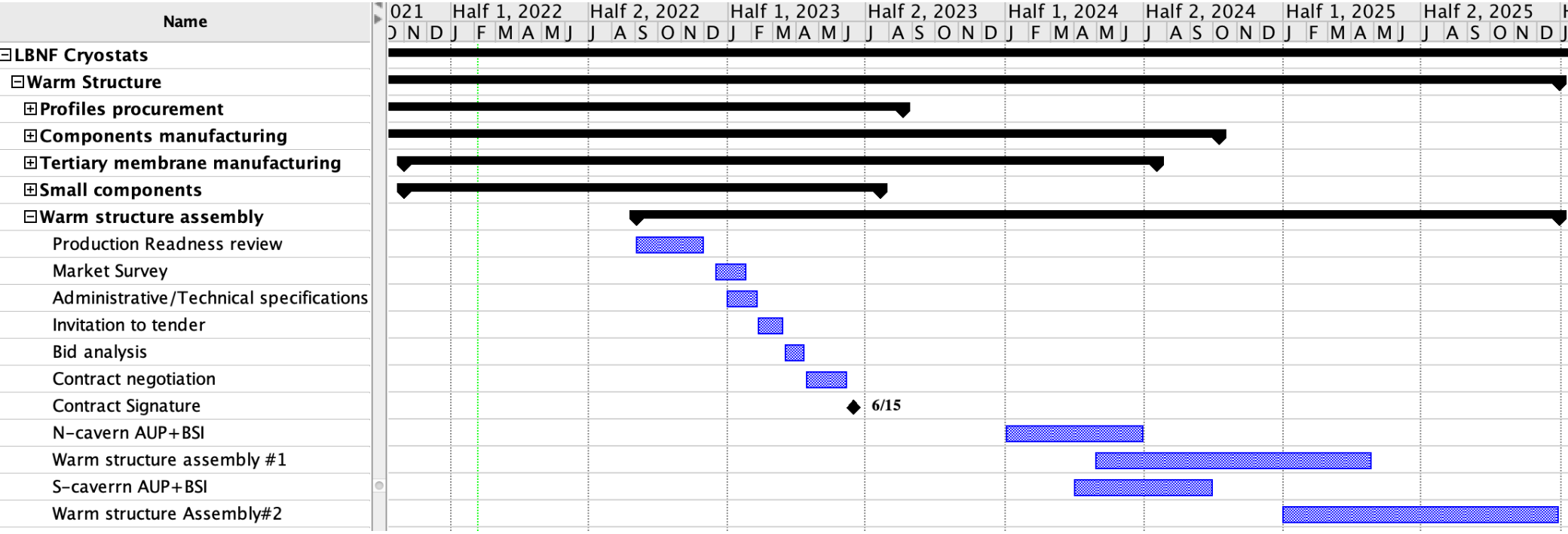
Half 1, 2023
Half 2, 2023
Half 1, 2024
Half 2, 2024
Half 1, 2025
Half 2, 2025
LBNF Cryostats
Warm Structure
Profiles procurement
Components manufacturing
Tertiary membrane manufacturing
Production Readness review
Market Survey
Administrative/Technical specifications
Invitation to tender
Bid analysis
Contract negotiation
Contract signature
9/29
Construction #1
Transport SURF #1
Construction #2
Transport SURF #2
Small components
Production Readness Review
Market Survey
Administrative/Technical specifications
Invitation to tender
Bid analysis
Contract negotiation
Contract signature
9/29
Production #1 + #2
Transport to SURF #1+#2

Schedule


Name
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Half 1, 2022
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Half 2, 2024
Half 1, 2025
Half 2, 2025
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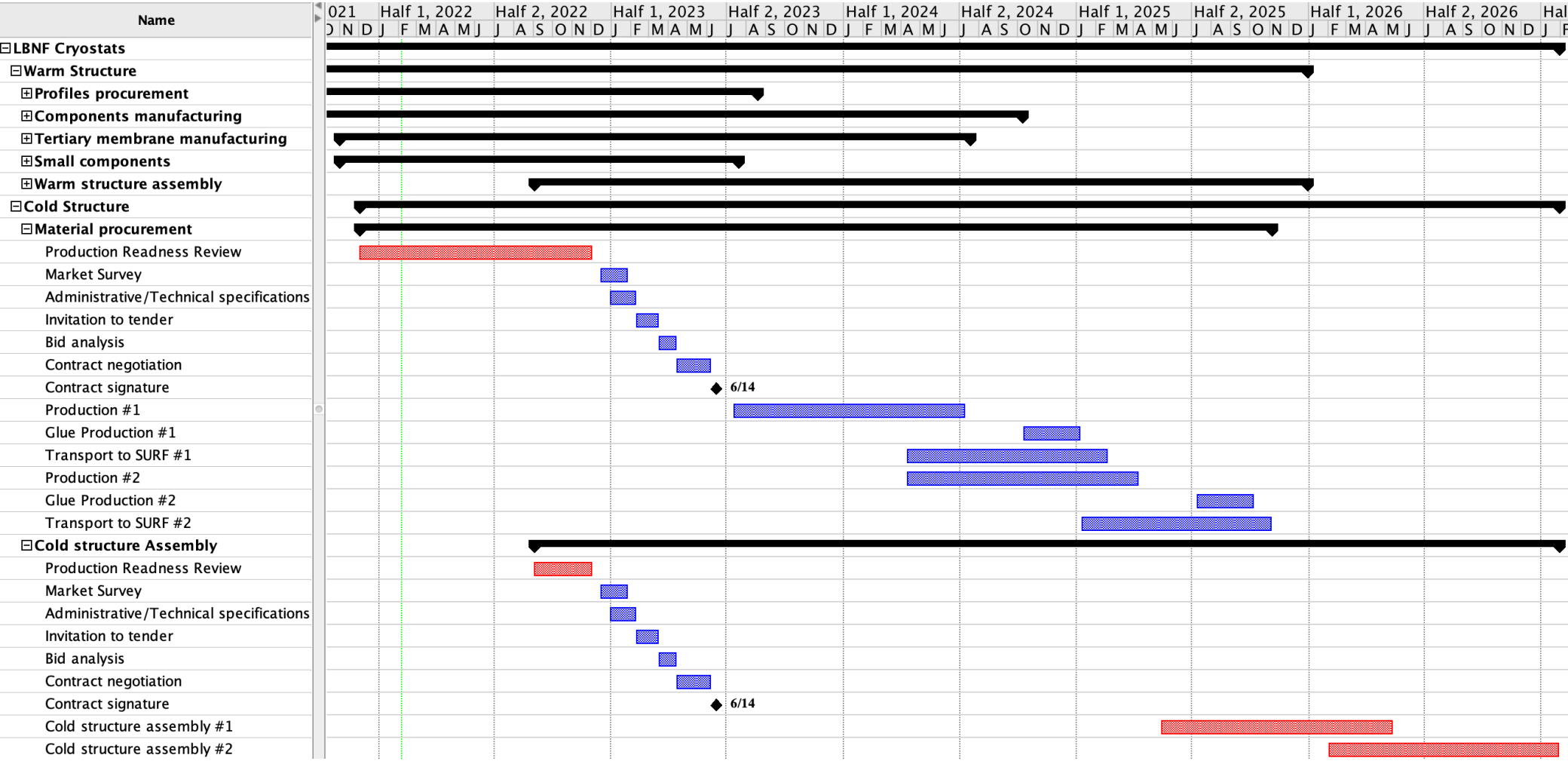
LBNF Cryostats
Warm Structure
Profiles procurement
Components manufacturing
Tertiary membrane manufacturing
Small components
Warm structure assembly
Production Readness review
Market Survey
Administrative/Technical specifications
Invitation to tender
Bid analysis
Contract negotiation
Contract Signature
6/15
N-cavern AUP+BSI
Warm structure assembly #1
S-caverrn AUP+BSI
Warm structure Assembly#2

Schedule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Half 2, 2022
Half 1, 2023
Half 2, 2023
Half 1, 2024
Half 2, 2024
Half 1, 2025
Half 2, 2025
Half 1, 2026
Half 2, 2026
LBNF Cryostats
Warm Structure
Profiles procurement
Components manufacturing
Tertiary membrane manufacturing
Small components
Warm structure assembly
Cold Structure
Material procurement
Production Readness Review
Market Survey
Administrative/Technical specifications
Invitation to tender
Bid analysis
Contract negotiation
Contract signature
6/14
Production #1
Glue Production #1
Transport to SURF #1
Production #2
Glue Production #2
Transport to SURF #2
Cold structure Assembly
Production Readness Review
Market Survey
Administrative/Technical specifications
Invitation to tender
Bid analysis
Contract negotiation
Contract signature
6/14
Cold structure assembly #1
Cold structure assembly #2

DUNE/LBNF CRYOSTATS TENDERING MILESTONES ACCORDING TO DUNE/LBNF PROJECT SCHEDULE

CONTRACT	Market survey	Invitation to tender	Finance committee
Procurement of warm structure materials	FEBRUARY 2022(*)	APRIL 2022(*)	JUNE 2022(*)
Manufacture of warm structure components	JANUARY 2022(*)	MARCH 2022(*)	JUNE 2022(*)
Manufacture of warm structure membrane	MAY 2022(*)	SEPTEMBER 2022(*)	DECEMBER 2022(*)
Procurement of small components	APRIL 2023(*)	JUNE 2023(*)	OCTOBER 2023(*)
Transport warm structure #1	APRIL 2023(*)	JUNE 2023(*)	OCTOBER 2023(*)
Underground assembly of the warm structure	APRIL 2023(*)	JUNE 2023(*)	DECEMBER 2023
Procurement of cold structure materials	NA (**)	JUNE 2023(*)	DECEMBER 2023
Transport warm structure #2	NA(**)	APRIL 2024	JUNE 2024
Underground assembly of the cold structure	NA(*)	APRIL 2024	JUNE 2024

(*)On time according to project schedule

(*) Proprietary technology licensed firms

(**) Previous MS

DUNE/LBNF CRYOSTATS PROJECT STATUS

Components ready for packaging

To Take Home

- First step. Risk Analysis
- Realistic planning is the key. Real life constrains considered systematically
- The team as key for success. Competences available when needed. Not everybody can do everything.


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Neutrino
PLATFORM