PROCEEDINGS OF SCIENCE

The ESSνSB Switchyard, Horn Studies and Facility Performances

Eric Baussan*

E-mail: eric.baussan@iphc.cnrs.fr

Marcos Dracos†
E-mail: marcos.dracos@in2p3.fr
IPHC, Université de Strasbourg, CNRS/IN2P3, F-67037 Strasbourg, France

The development of high intensity neutrino Super Beam is essential to study fondamental properties of these elementary particles and to discover matter/antimatter asymmetry in the leptonic sector. The European Spallation Source in construction in Lund, Sweden, will use a Multi Mega Watt proton driver which can also be used to provide such Super Beam. The ESSνSB project works on a neutrino long baseline facility using the ESS proton linac and a water Cherenkov detector. In the following, the main developments concerning the Target Station Facility will be be discussed.

The 20th International Workshop on Neutrinos (NuFact2018)
12-18 August 2018
Blacksburg, Virginia

*Contact
†Speaker.

PoS(NuFACT2018)110

1. A neutrino superbeam facility in Europe

The discovery of matter/antimatter asymmetry in the leptonic sector is one of the main objectives fixed by the roadmap of Particle Physics which will complete the present knowledge of this asymmetry already observed in the quark sector. A long baseline neutrino experiment research program is ongoing at the international level in which several facilities are under consideration with new generation of high intensity neutrino beams with large detectors, such the DUNE project [1] based in United States and Hyper-Kamiokande [2] in Japan. The ESSνSB project proposes a long baseline neutrino experiment in Europe using the European Spallation Source (ESS) [3] based at Lund to produce a Super Beam. As far detector ESSνSB considers the Water Cherenkov MEMPHYS [4] detector located at a distance of about 540 km from Lund in the Garpenberg mine. This project exploits the second oscillation maximum of the $\nu_\mu \rightarrow \nu_e$ oscillation probability for the CP violation measurement and thus having an improved sensitivity compared to the measurement done at the first oscillation maximum [5].

2. The ESSνSB Target Station Facility

The ESSνSB project [6] has been funded to design a high intensity neutrino beam in Europe using the ESS facility. The present study is in the line of the previous one known as EUROnu [7] whose parameters are shown in Table 1 with those of the new facility.

Parameters	EUROν	ESSνSB
Proton Power (MW)	4	5
Proton Energy (GeV)	4.5	2.5
Target	Packed Bed	Packed Bed
Target length/radius (cm)	78/1.5	53-78 /1.5
Horn Current (kA)	350	350
Number of targets/horns	4	4
Tunnel length (m)/radius (m)	15 /2	15-25/2

Table 1: Comparaison between EUROnu/ESSνSB baseline parameters.

The ESSνSB facility requires an upgrade of the ESS linac to provide an extra 5 MW proton beam at 14 Hz beam frequency for neutrino physics. This beam will be shared over four solid targets thanks to a switchyard [8] to decrease the deposited power at a level of 1.6 MW maximum per target to keep a solid target concept feasible. Each target consists of a packed bed titanium spheres inside a canister with dimensions indicated in Table 1. This design reduces the stresses and allow an efficient cooling system with pressurised helium gas (10 bars) circulating inside the canister. This design should also provide an efficient horn cooling and should withstand high static and dynamic stress levels. The large amount of pions escaping the targets are focused by a system of four magnetic horns as shown in Figure 1 (left). The magnetic field is produced by 350 kA pulses with a flattop of about 2 μs circulating in the horn's skin made of aluminium alloy Al 6061 T6. This material provides good trade-off between mechanical strength, resistance to corrosion and electrical conductivity.

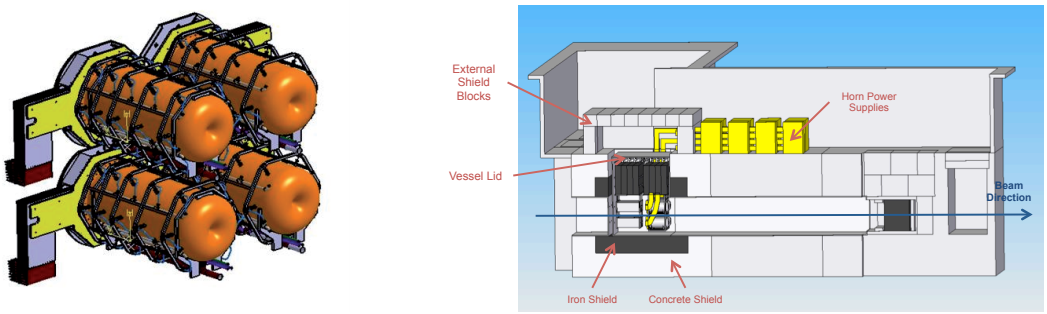

Figure 1: Four horn system (Left) / Target station building (Right).

A preliminary design of the target station has been studied by EUROnu and adopted by ESSνSB. It consists of several parts such the target station chamber surrounded by a mobile iron shielding supporting the target station, a decay tunnel and a beam dump as shown in Figure 1 (right). All the design will be updated with the new working conditions, following the ALARA (As Low As Reach Achievable) principle taking care of the safety for the workers and following the regulation rules in Sweden.

3. Acknowledgements

This project is supported by the COST Action EuroNuNet *"Combining forces for a novel European facility for neutrino-antineutrino symmetry-violation discovery"*. It has also received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 777419.

References

[1] [DUNE Collaboration], An Experimental Program in Neutrino Physics, Nucleon Decay, and Astroparticle Physics Enabled by the Fermilab Long-Baseline Neutrino Facility, Letter of Intent Submitted to the Fermilab PAC, P- 1062, January 5, 2015

[2] K. Abe *et al.* [Hyper-Kamiokande Proto- Collaboration], PTEP **2015**, no. 5, 053C02 (2015) [arXiv:1502.05199 [hep-ex]].

[3] European Spallation Source ESS AB, http://www.esss.se

[4] L. Agostino *et al.* [MEMPHYS Collaboration], JCAP **1301** (2013) 024 [arXiv:1206.6665].

[5] P. Coloma and E. Fernandez-Martinez, JHEP **1204** (2012) 089 [arXiv:1110.4583].

[6] E. Baussan *et al.* [ESSνSB Collaboration], Phys. Lett. B **885**, 127 (2014) [arXiv:1309.7022].

[7] T. R. Edgecock, O. Caretta, T. Davenne, C. Densham, M. Fitton, D. Kelliher, P. Loveridge and S. Machida *et al.*, Phys. Rev. ST Accel. Beams **16** (2013) 021002 [arXiv:1305.4067].

[8] E. Bouquerel, IPAC-2015-MOPWA017.