General Question 1: Scope and Institutional Responsibilities

1) Our committee charge question 4 asks "Are the scope and institutional responsibilities for the major elements defined? Is all essential scope covered?" To answer this question it would be useful for us to have tabulated the major detector elements for each subdetector system and the institutions that are committed or may commit to these elements.

Name	Institution(s)	Funder	Funding Status	Description
SC Magnet	Bologna, LNS, Ferrara, Genova, LNF, Milano, MI-B, Padova, Lecce	INFN	In baseline	Magnet dismantling, transportation to FNAL, re-assembling in ND hall. Safety certification
Cryogenic servicing		LBNF	In baseline	cryogenic piping, cryoplant, coldbox, compressor
EM-CAL	Bologna, LNS, Ferrara, Genova, LNF, Milano, MI, Padova, Lecce	INFN	In baseline	Dismantlng, trasportation, re-assembling in ND hall. Front-End electronics, TDC, ADC, DAQ, triggering
LAr Meniscus	Bologna, LNS, Ferrara, Genova, LNF, Milano, MI, Padova, Lecce	INFN	In baseline	Design, construction, installation, integration with tracker
Tracker	US, Russia, France, India, S. Korea, Georgia, Czech, INFN, …	various funding agencies	In discussion	3DST, TPC, STT: design, contruction, installation

Comments:

- A very large part of SAND (about 90%) is already fully committed and allocated (INFN).
- The remaining part will come from international resources.
- The table does not reflect any eventual interplay between Institutions and sub-systems.
- LBNF is providing cryogenics in the ND-hall.

Side comment: any release on public of funding matrix should be previously agreed upon the Agencies (e.g. the KLOE in-kind amount).

SAND sensitivity to all beam parameters

In the table SAND sensitivity is reported together with also the sqrt($\Delta\chi 2$) calculated between the nominal and the variated beam for neutrino spectrum and for muon spectrum.
The dk2nu beam flux given by beam people has been used, and we have generated the events of 1 week of data collected in ECAL and STT, then the sqrt($\Delta\chi 2$) between the nominal and the variated beam for neutrino spectrum and for muon spectrum, have been calculated by considering the **true** neutrino energy or the **true** muon energy. The results are shown in the column called "true".

As one can see for all the beam parameters where the SAND sensitivity is low, (for proton beam theta-phi variation, for proton beam theta variation, for Horn 2X and Horn 2Y variations) also the sqrt($\Delta\chi 2$) in the "true" column is very low (<0.7) and this means that the nominal neutrino spectrum differ with respect to the variated beam of less than 1 sigma of confidence level.

For this reason the effect on the long baseline analysis should be negligible or very low.

On the contrary, a large sensitivity to the shifted parameters corresponds to a large effect to the oscillation analysis, as demonstrate in the case of the Horn Current.

Beam parameter	Variation	ECAL				STT			
		$\Delta\chi^2(E_\nu)$		$\Delta\chi^2(E_\mu)$		$\Delta\chi^2(E_\nu)$		$\Delta\chi^2(E_\mu)$	
		true	rec	true	rec	true	rec	true	rec
Horn current	+3 kA	107.6	76.1	26.0	25.4	50.6	29.5	11.4	10.4
Water layer thickness	+0.5 mm	21.2	16.2	8.7	8.5	9.1	6.0	3.4	3.0
Decay pipe radius	+0.1 m	42.0	34.3	12.0	11.9	19.9	13.7	5.1	4.8
Proton target density	+2%	18.0	14.3	8.9	8.7	7.6	5.3	3.3	3.1
Proton beam radius	+0.1 mm	34.9	27.6	18.2	17.8	13.5	9.8	6.6	6.1
Proton beam offset X	+0.45 mm	24.6	16.9	9.0	8.7	9.5	5.3	3.0	2.7
Proton beam θ, ϕ	0.07 mrad θ, 1.57 ϕ	0.5	0.1	0.1	0.1	0.3	0.1	0.0	0.0
Proton beam θ	0.070 mrad	0.7	0.2	0.1	0.1	0.4	0.1	0.0	0.0
Horn 1 X shift	+0.5 mm	16.2	10.7	4.3	4.1	7.2	3.9	1.7	1.6
Horn 1 Y shift	+0.5 mm	20.6	13.6	5.7	5.5	7.3	4.1	1.8	1.7
Horn 2 X shift	+0.5 mm	0.4	0.2	0.1	0.1	0.2	0.1	0.0	0.0
Horn 2 Y shift	+0.5 mm	0.4	0.1	0.0	0.0	0.2	0.1	0.0	0.0

Table 25: Sensitivity to variations of the main beam parameters with respect to the nominal FHC beam settings. The values of $\Delta\chi^2$ are calculated for both the neutrino (E_ν) and muon (E_μ) energy distributions in the front ECAL and STT with inclusive ν_μ CC samples equivalent to one week of data taking (7 days, 3.78×10^{19} pot). The values obtained using both the true and the reconstructed variables with 80 bins are reported for comparison.