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IDS-NF: initial division of responsibilities within the Accelerator Working Group

The IDS-NF Steering Group

1 Scope

The purpose of this note is to list the top-level breakdown of the tasks that must be accomplished to deliver the accelerator sections of the Interim Design Report. The design work required for the IDR must be sufficient to deliver a cost estimate for each of the subsystems at the 50—75% level [1]. For each of the top-level tasks, the work required to meet this requirement must be defined by the task leaders identified below.

It is likely that this note will have to be re-issued from time to time as the task list and responsibilities evolve.

2 Accelerator complex

2.1 System-level summary

The baseline for the accelerator complex (IDS-NF baseline 2007/1.0) is shown in Figure 1 [2]. The various systems are described in [3]. At the top-level, the breakdown of the accelerator complex design-activity contains the following tasks:

1. *Proton driver:*

   The IDS-NF baseline specifies a proton driver that delivers 3 bunches, 2 ns long of 10 GeV protons at 50 Hz onto the pion-production target. Figure 1 shows two generic proton-driver options: a linac feeding accumulator and bunch compression rings; and acceleration in two rapid-cycling synchrotrons (RCSs), or an RCS followed by a fixed-field, alternating-gradient (FFAG) accelerator. The development of proton-driver designs capable of meeting the IDS-NF requirements is likely to continue at a number of laboratories including CERN, FNAL, and RAL;

2. *Target:*

   The target task encompasses the liquid-mercury-jet delivery and recirculation system; the proton-beam/mercury jet interaction region; the collection of nested solenoids that collects the pions and produces a pion beam with a large energy spread in three 2 ns bursts;

3. *Muon front-end:*

   The muon front-end contains the muon collection, bunching, phase rotation, and ionisation cooling systems. The muon collection section is a solenoid transport channel. Bunching and phase rotation are achieved using a series of RF cavities, the frequency of which decreases along the phase-rotation section. Cooling is achieved using lithium-hydride absorbers interspersed with 201 MHz RF cavities. Beam transport through the bunching, phase-rotation, and cooling sections is achieved using a solenoid lattice. Both positive and negative muons are processed in the muon front-end such that the bunches making up the bunch train contain, alternately, positive and negative muons;

4. *Muon acceleration:*

   Acceleration of the cooled muon beam to 25 GeV is performed using a linac, two recirculating (dog-bone) linear accelerators (RLAs), and a fixed field alternating gradient (FFAG) accelerator;

the systems accelerating both positive and negative muons. The acceleration task may therefore be divided into two sub-tasks: the linear accelerator system design task; and the FFAG design task;

5. *Storage rings:*

   Two race-track storage rings are required to direct the neutrino beams to the two far detectors. The IDS-NF baseline is that both positive and negative muons are stored in the rings at the same time; and

6. *Transfer lines:*

   A number of transfer lines are required, principally to link the various stages in the muon acceleration system. It is therefore proposed that responsibility for the design of the transfer lines has therefore been taken by the designers of the muon-acceleration system.

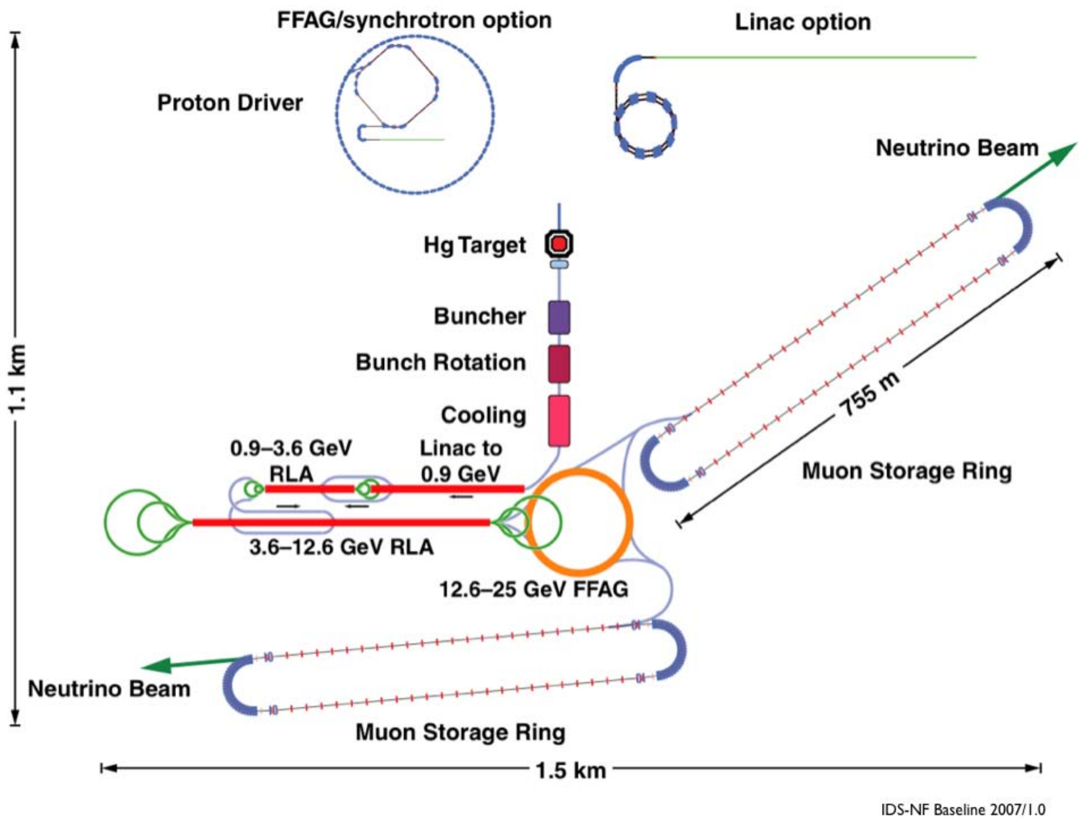

Figure 1: Schematic drawing of the ISS baseline 2007/1.0 for the Neutrino Factory accelerator complex [1]. The various systems have been drawn to scale.

2.2 Task status, requirements, and initial attribution of responsibilities

The status of the design work on the various systems outlined above is summarised in the following categories:

- *Optics:* The initial design work on a system is often performed using linear, matrix descriptions of the accelerator components;

- *Tracking:* The validation of the initial design is often performed using codes that track particles through electric and magnetic fields in the lattice defined in the optics analysis. In order to gain confidence in the performance of the design, it is proposed to compare the results obtained using two independent tracking codes, if possible run by independent groups. These two tracking studies will be referred to as 'Tracking 1' and 'Tracking 2';
- *Conceptual design review (CDR):* Before an engineering assessment of the design can be initiated it is important to determine whether the conceptual design is sufficiently mature that rapid changes are no longer likely. It is proposed to review each of the various systems and sub-systems in a series of 'Conceptual design reviews' (CDR). The reviews are 'seminal' in the sense that each one marks the start of the engineering consideration of a particular system. Engineering and cost considerations may change the specifications of the system. It is therefore of great importance that close contact be maintained between the 'concept developers' and the engineers. The CDR, which will be initiated by the IDS-NF Steering Group, will consider the status of the design of the system, the specification of its components, and the types of engineering expertise required to produce a cost estimate suitable for inclusion in the IDR; and
- *IDR cost estimate:* Once the design has passed the CDR, the engineering of the system and its components will be considered to determine a cost estimate at the 50—75% level.

For each system outlined in section 2.1, Table 1 contains a summary of the status of the design work (using the categories defined above) and identifies the work that remains to reach a costing appropriate for inclusion in the IDR. In addition, the groups that seek to contribute to the various stages of the work are listed along with the persons responsible for coordinating the various tasks.

2.3 Timeline

To arrive at a costing at the 50—75% for the IDR requires that the conceptual designs for the various sub-systems be reviewed early enough that sufficient engineering-design work can be carried out, but late enough that the conceptual design is mature and no longer subject to rapid change. To identify the work required to prepare for the CDR, it is proposed to hold a series of short workshops, one per top-level task, to be organised by those seeking to contribute to a particular system. In addition, it is proposed that the target dates for the CDRs will be discussed and agreed at the third IDS-NF plenary meeting (CERN, 23-24Mar09).

References

1. https://www.ids-nf.org/wiki/FrontPage/Documentation?action=AttachFile&do=get&target=IDS-NF-001.pdf
2. https://www.ids-nf.org/wiki/FrontPage/Documentation?action=AttachFile&do=get&target=IDS-NF-002.pdf
3. https://www.ids-nf.org/wiki/FrontPage/Documentation?action=AttachFile&do=get&target=ISSAcceleratorReport.pdf

Table 1: Summary of the status of the design work on the various systems that make up the accelerator complex. The systems and sub-systems are outlined in section 2.1 while section 2.2 defines the categories in design work is broken down. Responsibility for the design of the various transfer lines required rests with the muon-acceleration system designers. In some cases, some of the tasks that have been performed must be repeated. These cases are indicated by a arrow pointing toward the 'Required' column from the 'Performed' column.

System **Sub-system**	**Task list** **Performed**	 **Required**	**Coordinators**	**Comments**
Target	Optics Tracking 1 Tracking 2	CDR IDR costing	C.Densham (RAL), H.Kirk (BNL)	Particle production must be revisited when HARP results are included in MARS/Geant4
Muon front-end ***Capture***	Optics Tracking 1	Tracking 2 CDR IDR costing		
Bunching and phase rotation	Optics → Tracking 1 →	Tracking 2 CDR IDR costing	C.Rogers (ASTeC), D.Neuffer (FNAL)	Risk mitigation: evaluate to what extent minor lattice revisions are required if it is demonstrated that the baseline gradient can not be achieved in the magnetic field.
Cooling	Optics → Tracking 1 →	Tracking 2 CDR IDR costing		Risk mitigation: evaluate to what extent minor lattice revisions are required if it is demonstrated that the baseline gradient can not be achieved in the magnetic field.
Acceleration ***Linear accelerators***	Optics	Tracking 1 Tracking 2 CDR IDR costing	A.Bogacz (JLab), J.Pozimski (ICL)	
FFAG	Optics → Tracking 1 →	Tracking 2 CDR IDR costing	S.Berg (BNL), S.Machida (RAL)	While initial optics and tracking work has been done, the fact that an injection and extraction scheme has not been proposed implies that it is necessary to revisit both the optics analysis and the tracking.
Storage ring		Optics Tracking 1 Tracking 2 CDR IDR costing	C.Prior (ASTeC), ANO	Present lattices store muons of a single charge only. A modification of the optics is required to allow positive and negative muons to be stored simultaneously.