IDS-NF and Euroν WP3 status and plans

Euronu & IDS Plenary meeting @ CERN 23-26 March 2009

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Euroν - WP 3 and the IDS-NF

The Euroν - WP 3 is an integral part of the international design effort IDS-NF

- To integrate additional EU partners into IDS-NF
- End to end simulation (target to decay rings) for performance and cost evaluation.
- Proton beam handling after target & safety issues
- To deliver an interims design report until 2010 with a first costing to be 50-70% accurate
- To deliver an reference design report until 2012 including a performance evaluation of facility and costing to be 30-50% accurate

WP3 - Milestones

Milestone	month (from start)
Evaluation of baseline front-end	15
Evaluation of acceleration systems	18
Evaluation of performance of alternative cooling and acceleration	24
Specification of proton-beam handling system	24
Benchmark costing for muon front-end and acceleration systems	30
Initial health-and-safety evaluation of proton-beam handling system	38
Cost and Performance evaluation complete	40
Comparison of physics performance of all facilities	43

WP3 - Deliverables

1 Completed review of ionisation-cooling and muon front end

15 month

2 Completed review of muon acceleration

18 month

3 Completed simulation of baseline and alternative ionisation-cooling channel, including a cost and performance analyses for reference muon front end.

30 month

4 Completed simulation of baseline and alternative muon acceleration system and the decay rings and evaluation of reference design for spent proton-beam handing system, including a cost and performance analyses.

38 month

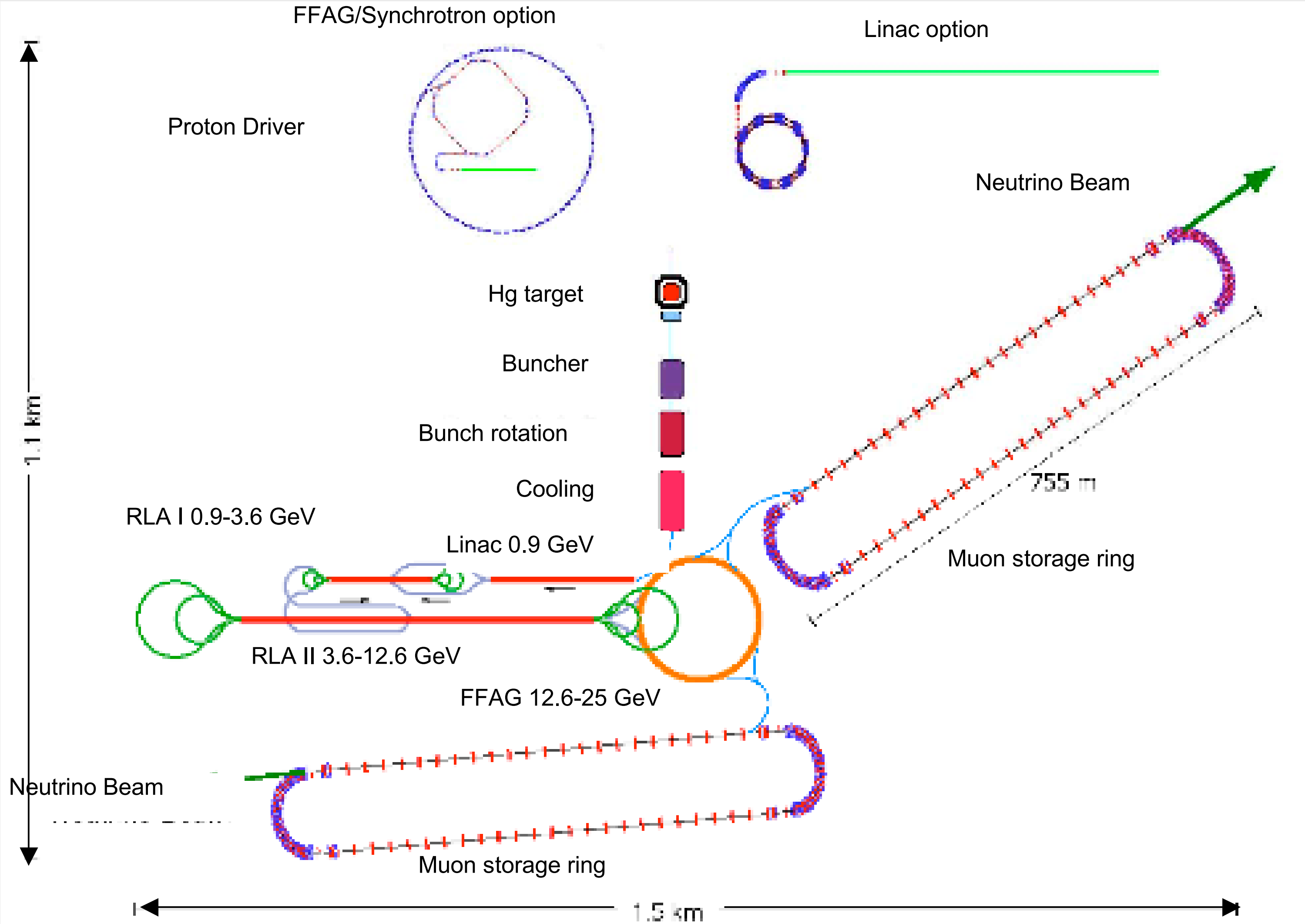
5 Complete end-to-end simulation and evaluation of the performance of the Neutrino Factory as input to the comparison

42 month

Organisation of the working group

System / Sub-system	Task list: Performed	Task list: 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	C.Rogers (ASTeC), D.Neuffer (FNAL)	
Bunching and phase rotation	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.
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.

The IDS baseline-overview



The IDS baseline 1

Sub-system	Parameter	Value
Proton driver	Average beam power (MW)	4
	Pulse repetition frequency (Hz)	50
	Proton kinetic energy (GeV)	10±5
	Proton rms bunch length (ns)	2±1
	Number of proton bunches per pulse	3
	Sequential extraction delay (μs)	≥17
	Pulse duration, liquid-Hg target (μs)	≤40
Target: liquid-mercury jet	Jet diameter (cm)	1
	Jet velocity (m/s)	20
	Solenoidal field at interaction point (T)	20
Pion collection	Tapered solenoidal channel Length (m)	12
	Field at target (T)	20
	Diameter at target (cm)	15
	Field at exit (T)	1.75
	Diameter at exit (cm)	25

The IDS baseline 2

Sub-system	**Parameter**	**Value**
Decay channel	Length (m)	100
Adiabatic buncher	Length (m)	50
Phase rotator	Length (m)	50
	Energy spread at exit (%)	10.5
Ionisation cooling channel	Length (m)	80
	RF frequency (MHz)	201.25
	Absorber material	LiH
	Absorber thickness (cm)	1
	Input emittance (mm rad)	17
	Output emittance (mm rad)	7.4
	Central momentum (MeV/c)	220
	Solenoidal focussing field (T)	2.8

The IDS baseline 3

Sub-system	Parameter	Value
Acceleration system	Total energy at input (MeV)	244
	Total energy at end of acceleration (GeV)	25
	Input transverse acceptance (mm rad)	30
	Input longitudinal acceptance (mm rad)	150
Pre-acceleration linac	Final total energy (GeV)	0.9
RLA(1)	Final total energy (GeV)	3.6
RLA(2)	Final total energy (GeV)	12.6
NFFAG	Final total energy (GeV)	25
Decay rings	Ring type	Race track
	Straight-section length (m)	600.2
	Race-track circumference (m)	1,608.80
	Number of rings (number of baselines)	2
	Stored muon energy (total energy, GeV)	25
	Beam divergence in production straight (γ-1)	0.1
	Bunch spacing (ns)	≥100
	Number of μ decays per year per baseline	$5*10^{20}$

Proton driver

R&D for the proton driver is decoupled from IDS as a hosting lab specific solution is assumed. The proton driver work within EUROν is performed in the superbeam WP as well as work on target……..but required beam parameters on target have been defined for the IDS-NF.

Main Proton driver projects relevant for NF:

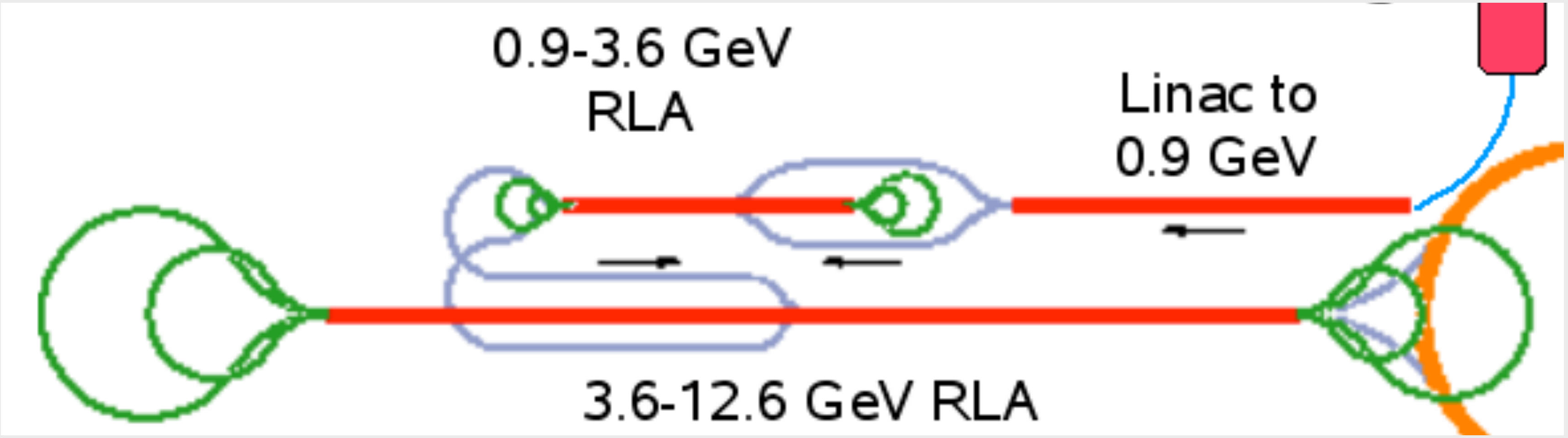
1. CERN LINAC 4 / SPL
2. Fermilab Project X
3. RAL - ISIS upgrade
4. (Green field solution)

μ front end

1. Determination of usable yield — done
2. revision of yield using HARP data — 24 month
3. Lattice design — done
4. Particle Tracking 1 — done
5. Particle Tracking 2 — started — 9 month
6. Pre engineering of RF and magnets — 19 month
7. End to end simulation — 34 month
8. Costing of components — 24/42 month

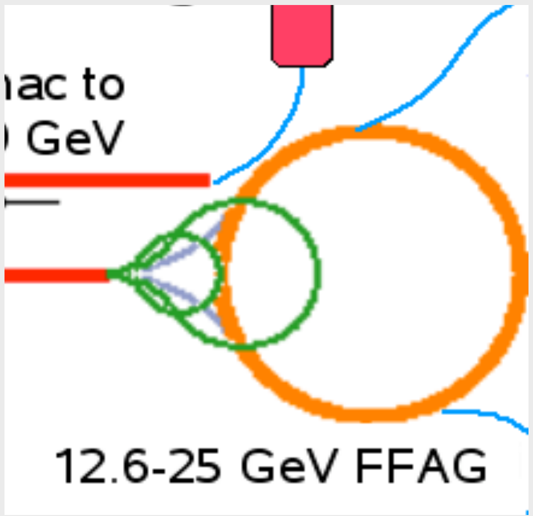
Problem : The baseline setup of the muon front end requires a field gradient in the cavities of ~ 15 MV/m in presence of high magnetic fields (2-3 T). Experiments show that high magnetic fields degrades the available accelerating voltage to below ~10 MV/m. An extensive experimental programme underway to investigate this problem. => Achievable gradient will strongly influence the design of muon front end.

Fast acceleration – Linac / RLA



1. Lattice design		done
2. Particle Tracking 1		done
3. Particle Tracking 2	started	12 month
4. Pre engineering of modules and magnets		19 month
5. Costing of components		24/42 month

Fast acceleration - FFAG



1. Lattice design		mainly done
2. Injection & extraction	started	12 month
3. Particle Tracking 1		24 month
4. Particle Tracking 2		24 month
5. Pre engineering of RF and magnets		19 month
6. Costing of components		24/42 month

Decay rings

1. Lattice design		done
2. Particle Tracking 1	started	9 month
3. Particle Tracking 2	started	9 month
4. Pre engineering of magnets		19 month
5. Definition of beam diagnostics		24 month
6. End to end simulation		34 month
7. Costing of components & rings		24/42 month
8. Scaling and costing for LENF		36 month

Summary

- Recruitment of new personnel (EUROν) and coordination with IDS-NF finished
- Tasks, partners and responsibilities identified
- Main critical issues identified and work started
- Work focuses on problems to be solved for a design report in 2010 / 2012 rather than on implementation of new ideas
- In person WG3 meetings aligned with IDS-NF
- Detailed work plan under : https://www.ids-nf.org/wiki/FrontPage/Accelerator/Workplan