Proton Driver Section:

Fermilab has recently completed a design study for a Proton Driver. It describes in detail the design of a new brighter booster, called the Proton Driver, as a complete functional replacement for the present Booster. The design report has been published as a technical memo FERMILAB-TM-2136. It can also be downloaded from the web: *http://www-bd.fnal.gov/pdriver/reports.html.*

The Proton Driver is a rapid-cycling (15 Hz), high-intensity (3×10^{13} protons per pulse), 1 MW 16-GeV synchrotron. It serves a number of purposes in the Fermilab hadron program. In the near term, it replaces the present Booster and increases the proton beam intensity in the Main Injector by a factor of four, thereby providing an upgrade path for NuMI and other 120 GeV fixed target programs. It also opens the avenue for new physics programs based on its stand-alone capabilities as a source of intense proton beams. The beam power of the Proton Driver is a factor of twenty higher than that of the present Booster. It can be employed for the production of high-intensity secondary particle beams of pions, kaons, neutrons and neutrinos. In the long term, the Proton Driver can serve a neutrino factory and a muon collider by generating intense short muon bunches from a target. The design also allows an upgrade path to a 4 MW proton source by adding a 600 MeV linac and a 3 GeV Pre-Booster at some late time (called Phase II). To meet the requirement of a muon collider, such as a Higgs factory, the number of bunches in Phase II will be reduced to four.

The main parameters of the Proton Driver in Phase I and Phase II are listed in Table 1. As a comparison, the parameters of the present proton source are also listed.

Table 1. Parameters of the Proton Driver: Present, Phase I and Phase II

Parameters	Present	Phase I (MI, ν-Fact)	Phase II (μ-Coll)
Linac (operating at 15 Hz)			
Kinetic energy (MeV)	400	400	1000
Peak current (mA)	40	60	80
Pulse length (μs)	25	90	200
H^- per pulse	6.3×10^{12}	3.4×10^{13}	1×10^{14}
Average beam current (μA)	15	81	240
Beam power (kW)	6	32	240
Pre-Booster (operating at 15 Hz)			
Extraction kinetic energy (GeV)			3
Protons per bunch			$2{,}5 \times 10^{13}$
Number of bunches			4
Total number of protons			1×10^{14}
Normalized transverse emittance (mm-mrad)			200 π
Longitudinal emittance (eV-s)			2
RF frequency (MHz)			7.5
Average beam current (μA)			240
Target beam power (MW)			720
Booster (operating at 15 Hz)			
Extraction kinetic energy (GeV)	8	16	16
Protons per bunch	6×10^{10}	1.7×10^{12}	2.5×10^{13}
Number of bunches	84	18	4
Total number of protons	5×10^{12}	3×10^{13}	1×10^{14}
Normalized transverse emittance (mm-mrad)	15 π	60 π	200 π
Longitudinal emittance (eV-s)	0.1	0.4	2
RF frequency (MHz)	53	7.5	7.5
Extracted bunch length σ_t (ns)	0.2	1	1
Average beam current (μA)	12	72	240
Target beam power (MW)	0.1	1.2	4