WP3 Tentative Parameters

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Tasks

Task 3.2 – High power linac (**CERN** and ESS)

The goal of this task is to collect the parameters that can be use for a future design of a high-power H- linac to be used as the driver of the proton complex. This collection will be based on inputs from ESS and the SPL /LINAC4 designs and will include: source type, preliminary acceleration layout, beam dynamics and stability considerations and chopping schemes . Consideration will be given of the need for an additional accelerator ring to reach the required beam power. The parameters will be used to provide input on final beam parameters for task 3.3.

- **Task 3.3** – Compressor ring design (**ESS**, UU and CERN and more)
- The goal of this task is to provide a self-consistent collection of parameters to be used in the design of a future compressor ring. The ring will create the high intensity short bunches that will be delivered to the target for muon production. With the input of WP4 (target and cooling) and task 3.2 participants a set of beam parameters will be defined. A preliminary design of the ring will be developed including accumulation and compression strategy, preliminary lattice and injection and extraction considerations. Further R&D needs will be outlined. Preliminary study of intensity-based effects such as space charge and single and multi-bunch effects will be carried out for the compressor ring.

Linac Tentative Parameters

- Linac :
  - 2 scenarios: What is possible now and identify R&D? In 20 years?
  - Doesn't make sense to put too much pressure on the Linac side right now since the proton complex depends also a lot on target parameters
  - Design exists from past nufact studies and can use ESS one also for technical challenges

  - Final Energy → 5 GeV (SPL based)
  - Baseline power 2 MW (study upgrades to 4 MW if possible/needed)
  - 2 ms pulse length@accumulator injection and 40 mA current (not far from SNS parameters, current withing new LINAC4 source development)

  - H- source
  - H- stripping for injection/transport - foil based for the moment – painting in 3 planes
  - Chopper patterns for accumulation

Linac Tentative Parameters

Max energy but depending on the work on the Accumulator we can stop before

Table 11.1: Tentative Parameters H^- Linac.

Linac Parameters	Symbol	Unit	Value
Final energy	E_L	GeV	5.0
Repetition rate	-	Hz	≥ 5
Max. pulse length	-	ms	2.0
Max. pulse current	I_L	mA	40.0
Norm. rms emittance	ε_L	mm.mrad	2.5
Power	P	MW	2.0
RF Frequency	f_{RF}	MHz	352 and 704

The linac can be used for other purposes

Linac4 new source is able to reach 50 mA. Continuous R&D can bring us closer to this goals. Or we can use more than a single pulse for the Muon Collider.

Now a big issue for the linac (SNS, JPARC and ESS) but can be very challenging to the rings. So we would rather first have a working solution and only then jump into higher power options.

Compressor Tentative Parameters

- Compressor (5-10 GeV):
  - For 5 GeV -> 5 x 10^{14} particles in total
  - Define number of bunches needed (this will drive chopping scheme and accumulator design)
  - RF rotation scheme/ Isochronous option.
  - Check tune shifts and instability onsets (mainly space charge related)
  - How to merge the bunches onto the target/before target
  - How to preserve bunch length from rotation to target.
  - Check 4 MW upgrade if possible

Compressor Tentative Parameters

Table 11.2: Tentative Parameters Compressor.

Parameters	**Symbol**	**Unit**	**Option 1**	**Option 2**
Energy	E_R	GeV	5	10
Circumference	C	m	between 300 to 900	
Protons on target	n_p	-	5×10^{14}	2.5×10^{14}
Final rms Bunch ngth	σ_z	ns	2	
Final rms emittance	ε_L	mm mrad	> 5	
Max. turn for full rotation	N_{rot}	-	50	

Lower energy : Target and existing design
Higher energy: MAPS study

Green field solution, i.e. we will
Not try to fit the ring in any available tunnel

Laslett tune shift (free space)

$$\Delta\nu = -\frac{n_b r_p}{4\pi\varepsilon\beta^2\gamma^3}$$

$$\eta = \frac{1}{\gamma_{tr}^{\ 2}} - \frac{1}{\gamma^2} \quad ,$$

$$\frac{1}{\gamma_{tr}^{\ 2}} = \alpha_p = \frac{1}{C}\int_0^C \frac{D(s)}{\rho(s)} ds$$

The max number of turns before extraction (turn to rotate the bunch) will drive:

1. Ring optics (phase slip factor)
2. RF Amplitude and phase (for rotation)
3. Ring dispersion control (because of the increasing energy spread of the bunch)
4. Amount of tune spread that can be handled