The Beta-Beam Task in the EURISOL Design Study

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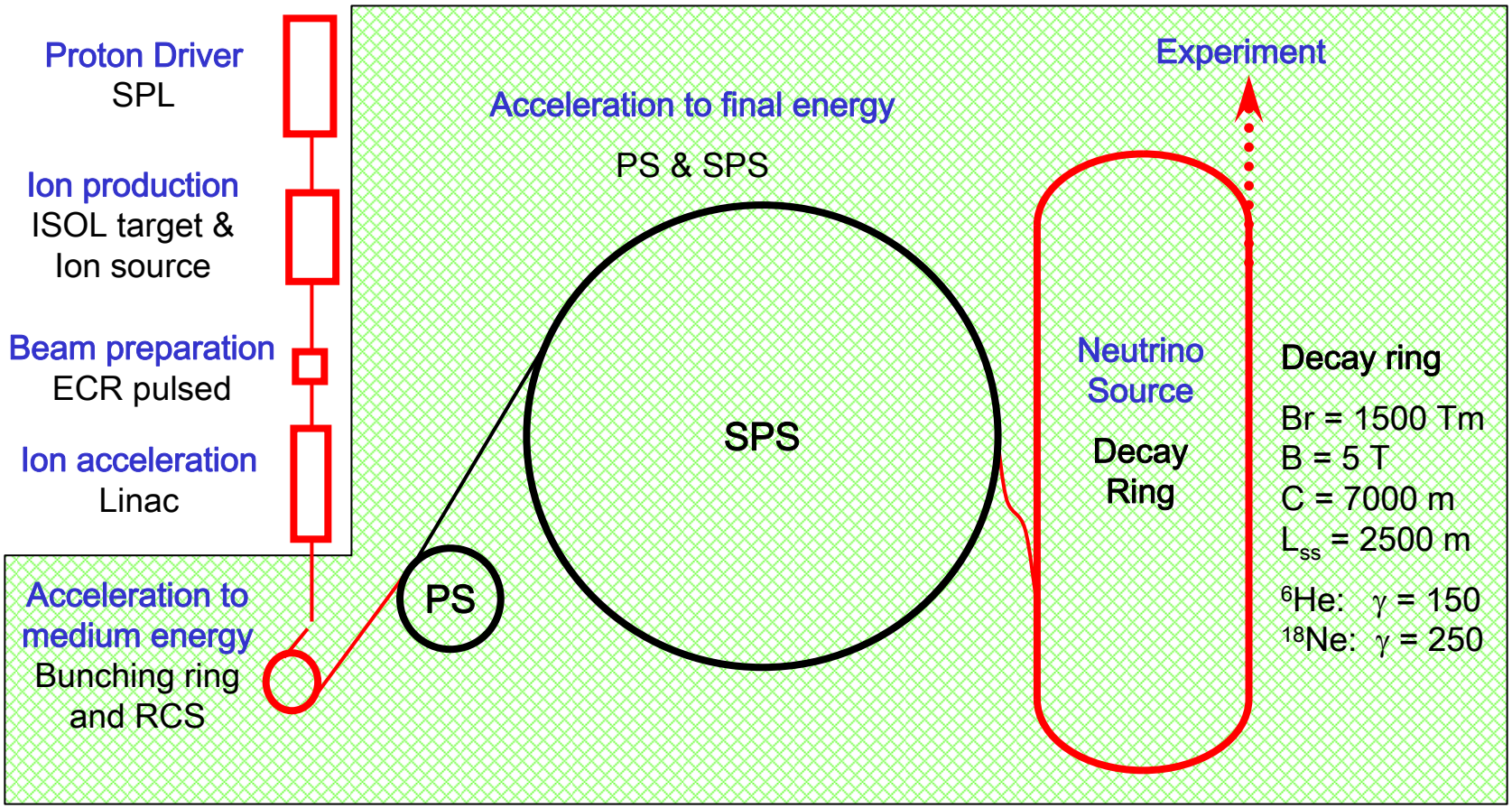
Task: Beta Beam Aspects

Starts at exit of heavy ion LINAC (~100 MeV/u) to Decay Ring (~100 GeV/u).



Strongly linked Tasks in EURISOL

1) Ion production (Ne) ⇒ TASK: Direct Target & Ion Source.
   - 100 kW target station.
2) Ion production (He) ⇒ TASK: Solid Converter-Target/Ion Source.
   - 100 kW target station.
3) Pulsed ECR source ⇒ TASK: Beam Preparation.
   - 60 GHz pulsed source to give time structure.
4) Ion acceleration ⇒ TASK: Heavy Ion Accelerator.
   - Acceleration to ~100 MeV/u
5) High power proton driver ⇒ TASK: Proton Accelerator.
   - 5 MW – 5mA CW superconducting proton linac.
6) Radiation aspects ⇒ TASK: Safety & Radioprotection.
   - General radioprotection aspects, (collimation systems not included).
7) Physics case ⇒ TASK: Physics & Instrumentation.
   - Low energy Beta Beam physics case and potential use of (parts of) beta beam complex for nuclear physics.
   - Base line and high energy beta-beam physics cases are not included!

The Beta-Beam Task – Participants

	PARTICIPANTS	PERSON IN CHARGE
1	GANIL (F)	D. GOUTTE
2	IN2P3 (F)	D. GUERREAU
3	INFN-LNL (I)	G. FORTUNA
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7	Stockholm University (S)	A. KJÄLLBERG
8	CEA (F)	N. ALAMANOS
9	UNIV. FRANKFURT (G)	?
10	NIPNE (RO)	D. BUCURESCU
11	JYVASKYLA (FI)	R. JULIN
12	UNIV.MUECHEN (G)	AUMULLER

	PARTICIPANTS	PERSON IN CHARGE
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15	IOP (LI)	?
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17	IOP (SK)	E. BETAK
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20	GSI (G)	W. HENNING
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23	PSI (CH)	W. FISCHER
24	UNIVERSITY HOSPITAL OF GENEVE	?

The Beta-Beam Task: Boundary Conditions

- Beta Beam task starts at exit of the EURISOL post accelerator.
- Comprises the design of the complete accelerator chain up to the decay ring.

Assumed starting conditions – incoming ion beam:

Fully stripped beam (6He or 18Ne) with several 10 μs pulse length.
Beam energy of around 100 MeV/u.
Repetition rate around 15 Hz during ~1 second
No beam during following ~7 seconds (total cycling time ~8 s).

What are we aiming at in the Decay Ring:

Very few, very intense bunches, as short as possible (4 bunches,<10 ns)
Stacking of the “fresh” ions with the already circulating bunches.

Beta-Beam work packages

The present base line scenario features a three stage accelerator chain:

1. One or more low energy machines for bunching of the (long) beam and fast acceleration to higher energies to increase lifetime.
2. The existing PS and SPS machines for further acceleration to the required top energies.
3. A high energy Decay Ring to accumulate the ions and to act as neutrino source.

This suggests to define sub-tasks in the way the accelerator chain is structured:

WP 1: Design of the low energy ring(s).

WP 2: Ion acceleration in PS and SPS and required upgrades of the existing machines including new designs to eventually replace PS and/or SPS.

WP 3: Design of the high energy Decay Ring.

In addition there will be a beta-beam task steering group.

Beta-Beam Steering group

Goal

- Management of the Beta Beam Task in EURISOL.

Major Activities

- Act as “parameter” and steering group for the beta beam sub tasks.
- Review and confirmation of the base line design.
- Close contacts to the neutrino physics community to guide the accelerator complex design according to requirements and evolution of the physics case.
- Ensure the links to other related EURISOL tasks to clearly define the needs, expectations and “hand over” points.

Time aspects / manpower estimate

- During the complete duration of the design study (48 months).
- One member from each of the participating institutes, task leader and work package leaders.
- Manpower requirements: 4 man-years.

WP 1: Design of low energy ring(s)

Goal

- Conceptual design of low energy ring(s) demonstrating basic feasibility.
- First order cost estimate.
- Identification of critical hardware issues to be addressed in further studies (FP 7).

Major Activities

- Optics design and beam dynamic simulations for low energy ring(s).
- First technical designs demonstrating the feasibility of critical hardware.

Specific Aspects

- Accumulation of the relatively long linac beam (multi turn injection, etc.)
- Aspects related to fast acceleration (RCS?) magnets, power converters, RF, etc.
- Machine protection and collimation issues.

Time aspects / manpower estimate

- Starts after three months with total duration of 36 months.
- Participants: CERN, IN2P3, Stockholm University, TRIUMF (Ca)
- Manpower requirement: 10 man-years (theoretical design ~6 and technical ~4)

WP 2: Acceleration in PS and SPS Upgrades and new Designs

Goal

- Proof feasibility of ion acceleration in PS and SPS.
- Conceptual design of medium/high energy machine(s) to replace PS and/or SPS.
- First order cost estimate.
- Identification of critical hardware issues to be addressed in further studies (FP 7).

Major Activities

- Beam dynamic simulations for ion acceleration in PS/SPS.
- Optics design and beam dynamic simulations for new machines.

Specific Aspects

- High intensity ion operation in PS/SPS (space charge issues, etc., cf. LHC ions)
- Machine protection and collimation issues (existing machines).

Time aspects / manpower estimate

- Starts after three months with total duration of 36 months.
- Participants: CCLRC RAL, CERN, GSI, FNAL (USA).
- Manpower requirement: 12 man-years (theoretical design ~8 and technical ~4)

WP 3: Design of Decay Ring

Goal

- Conceptual design of the ion Decay Ring.
- Identification of critical hardware issues to be addressed in further studies (FP 7).
- First order cost estimate.

Major Activities

- Optics design with beam dynamic simulations for the ion Decay Ring.
- First technical designs demonstrating the feasibility of critical hardware.

Specific Aspects

- Highest intensity ion operation (space charge issues, etc.)
- Injection, accumulation and stacking of ions at high energy.
- Machine protection and collimation issues.
- Superconducting magnets in high radiation environment

Time aspects / manpower estimate

- Starts after three months with total duration of 36 months.
- Participants: CEA-Saclay, CERN.
- Manpower requirement: 12 man-years (theoretical design ~7 and technical ~5).

Work Organization

- First 18 months to produce optics designs for all machines. Analyze different options (e.g. FFAG vs. RCS, etc.)
- Afterwards linking of all machine designs and converging towards an optimized accelerator complex (18-24 months). Freeze all parameters.
- 24-36 improve optics design, work on more technical design aspects of critical elements (rf, collimators, etc…)
- 36-42 review of overall design, check for consistency, corrections.
- 42-48 produce final report.

Conclusions

- Beta-Beam Task is well integrated in the EURISOL DS.
- Strong synergies between Beta Beam and several other EURISOL tasks.
- Physics case not covered within EURISOL DS (->BENE).

- Well established base-line design as starting point.
- Total integrated man-power in Beta-Beam task is 38 man-years out of which 13 are financed the EU.
- Total budget: ~3.000 k€ with ~1.000 k€ from EU.
- Ready to go.