EUROnu meeting Paris 12-15 June

High-Q ion production
Status of Production Ring for 8B and 8Li
Optimization for neutrino flux

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Outline

- Milestones & Deliverables ok!
- Status High-Q ion Production
- Optimizations for higher neutrino fluxes

High-Q ion production, 1

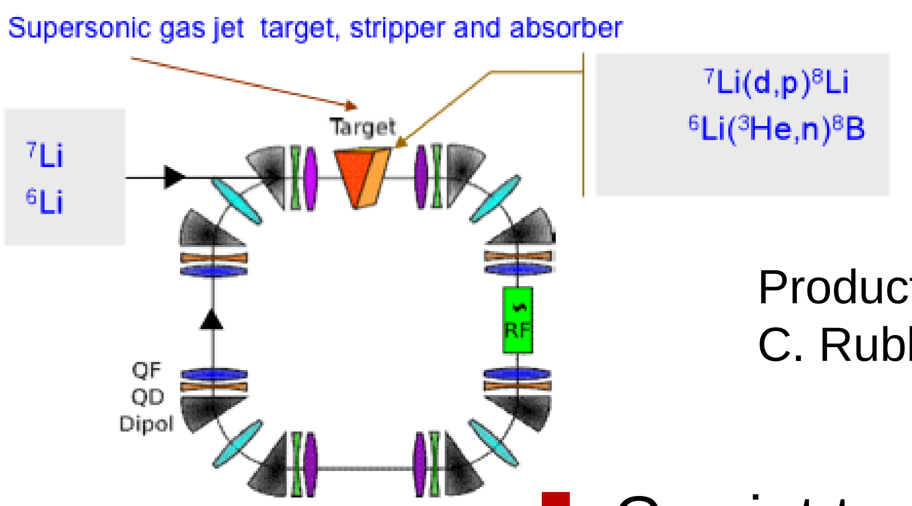
- The studies for the ^{8}Li and ^{8}B Production Ring as proposed by *[C.Rubbia et al.]* are studied within EUROnu
- A preliminary design is available.
- Optics studies done for the ^{7}Li(d,p)^{8}Li inverse kinematics, can be scaled to direct kinematics and B production
- The lattice requires tuning to maximize i-cooling efficiency (e.g. reduce beta at the target).
- 6D tracking tools (based on SixTrack) fully in place, predict what expected from i-cooling analytical estimations.
- The code SixTrack includes also the high order effects, e.g. chromaticity and second order dispersion, which are important.

High-Q ion production, 2

- Progresses in the feasibility studies
- The thickness (10^{19}atoms/cm^2) required for the gas-jet target in a vacuum environment is a major issue.
  - Existing target reach 10^{15}atoms/cm^2
- The direct kinematics approach with a liquid Lithium target looks very promising
- R&D for thin liquid-lithium film used as heavy-ions strippers, we could probably profit from…

The Production Ring (^{8}B and ^{8}Li)

Aachen Univ., GSI, CERN, ANL



Production of 8B and 8Li
C. Rubbia, EUROnu proposal

- Gas jet target:
  - too high density would be needed
  - vacuum problems
- Direct production with liquid Li film targets

High-Q ion production, next ?

- Direct kinematics feasibility:
  - Identify possible show-stoppers
  - Production rates
  - Realistic target thickness (and beam energy)
  - New collection device (or a separator, if feasible/preferred)
- Lattice optimization and injection design (in either direct/reverse)
- Beam-Target interaction w. Monte-Carlo codes:
  - Use correct physics inside tracking simulations (since we are at the limits of ionization cooling capabilities...)
  - Integration of FLUKA in SixTrack (with V. Vlachoudis, D. Sinuela, CERN)
- We maybe still want to look at other types of rings:
  - Existing CERN rings
  - FFAGs

High-Q ions, other rings ?

- Use existing CERN rings
  - e.g. AD, LEIR or ELENA(proposed)
  - stochastic and/or electron cooling available
  - larger circumference, less constrains?
  - reduce costings, have sinergies w. other CERN projects
- FFAGs
  - *see Y.Mori, NIM A 562 (2006) 591; K.Okabe et al, IPAC10, EPAC08,…*
  - Proton FFAG with internal Be target to produce neutron for BNCT.
  - ERIT: Emittance Recovery Internal Target
  - Large acceptance for both horiz.(10^3 mm mrad) and longit.(10%)
  - no need of (dp/p) cooling
  - Scaling FFAG (Q'~0)
  - They have a running machine! With similar parameters to ours

Optimization for neutrino flux

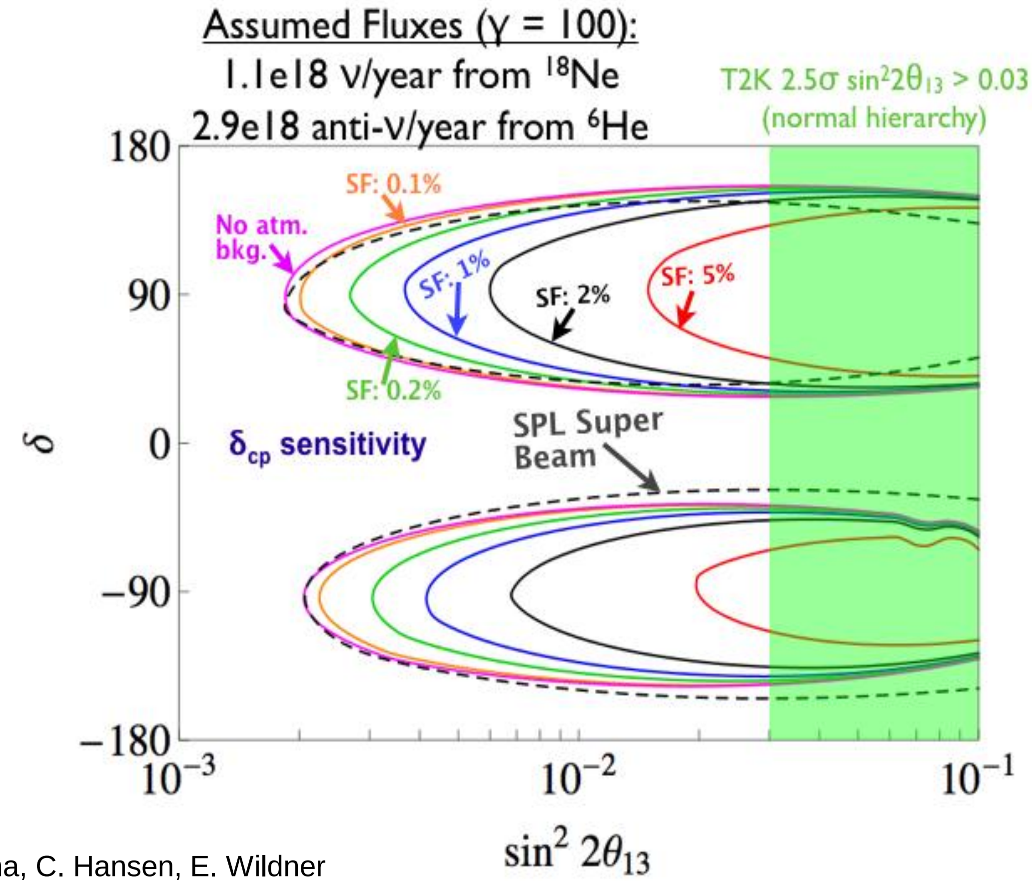
- Do we need higher fluxes, and how much ?
- Where are the limitations ?
  - Production
  - Acceleration, losses
  - Injection, Decay Ring (intrinsic, longitudinal merging)
  - Storage
  - Radiological issues
  - Shielding of equipment

Optimization for neutrino flux

- Do we need higher fluxes, and how much ?
  - To be discussed by WP6
    - What do we gain by putting more ions?
    - What do we loose by relaxing the SF?
  - Much has already been done
  - WP4 has been able to find directions of research

CPV dependence on SF (Fréjus option)

SF 2% seems sufficient for larger $\sin^2 2\theta_{13}$ (0.6% used up till now)
Permits higher fluxes and reach will increase (needs optimization)



E. Fernandez, P. Coloma, C. Hansen, E. Wildner

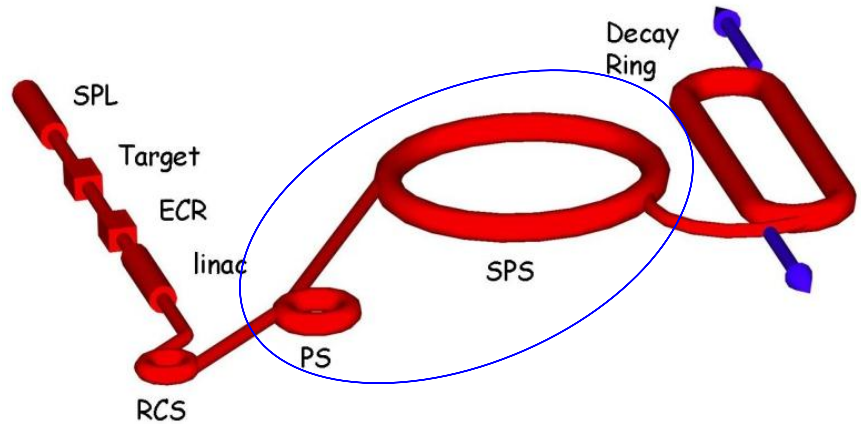
Optimization for neutrino flux

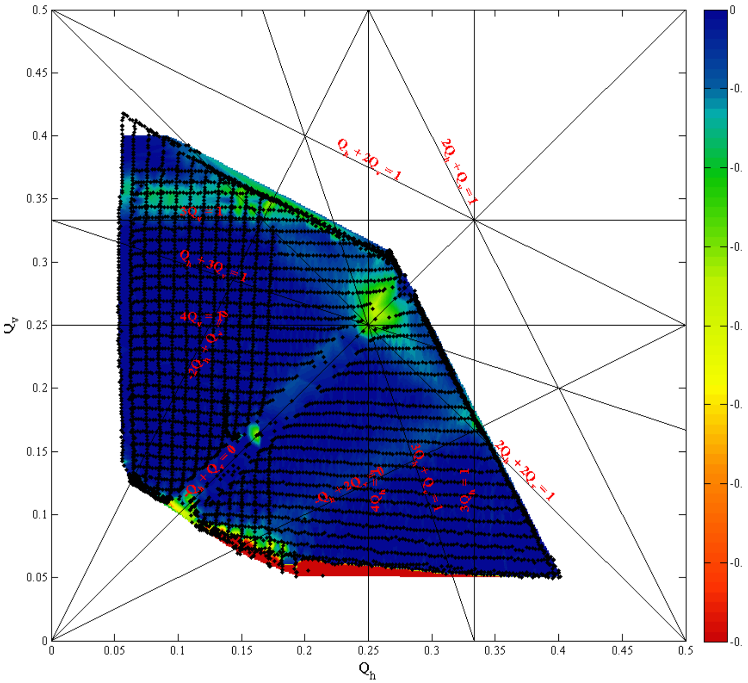
- Production:
  - The main focus of EUROnu WP4 is isotope production
  - 8B and 8Li production is the central research
  - Difficult technical obstacles for 8B and 8Li
  - Switch of focus: 18Ne (6He already in good shape)
  - Good progress
  - Production of 6He and 18Ne is our baseline

Optimization for neutrino flux

- Acceleration, losses:
  - In all machines we have intense ion beams
  - We do not yet know the limits of what is possible
  - What can be improved in the machines? Cost ?

Intensity Limits: PS & SPS





- Tune scans in PS
- 6He will survive, 18Ne needs resonance compensation (PS)
- Beam stability in the PS and the SPS still needs studies

Optimization for neutrino flux

- Injection, Decay Ring (intrinsic, longitudinal merging)
  - To what extent can we profit of relaxed duty factors ?
  - Study of all machines, RF Bunching…
  - To what extent can this help the acceleration ?

Optimization for neutrino flux

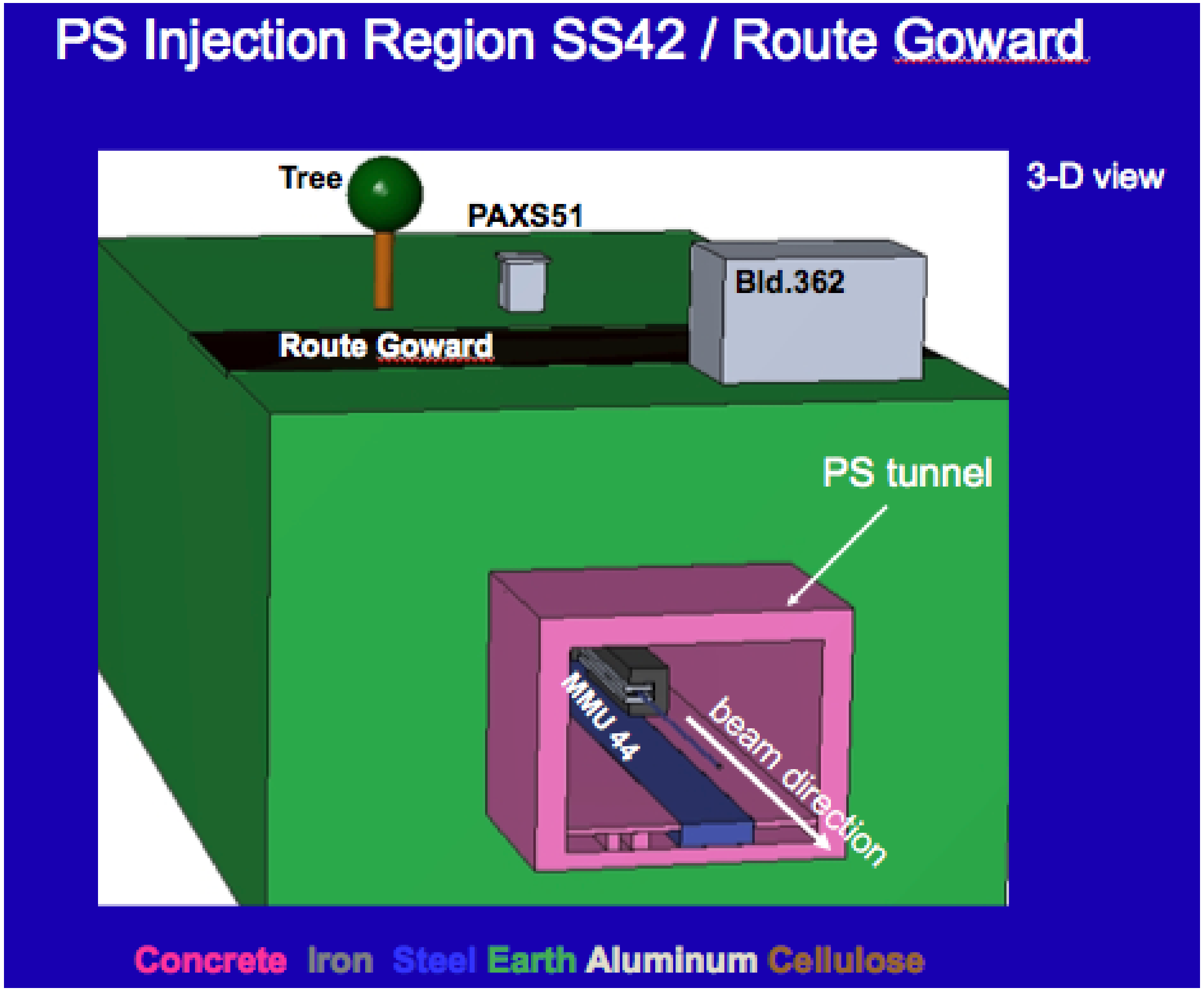
- Storage
  - How much can we store in the Decay Ring?
  - Magnets, dumps, shielding

Optimization for neutrino flux

- Radiological issues
  - So far no show stoppers have been seen

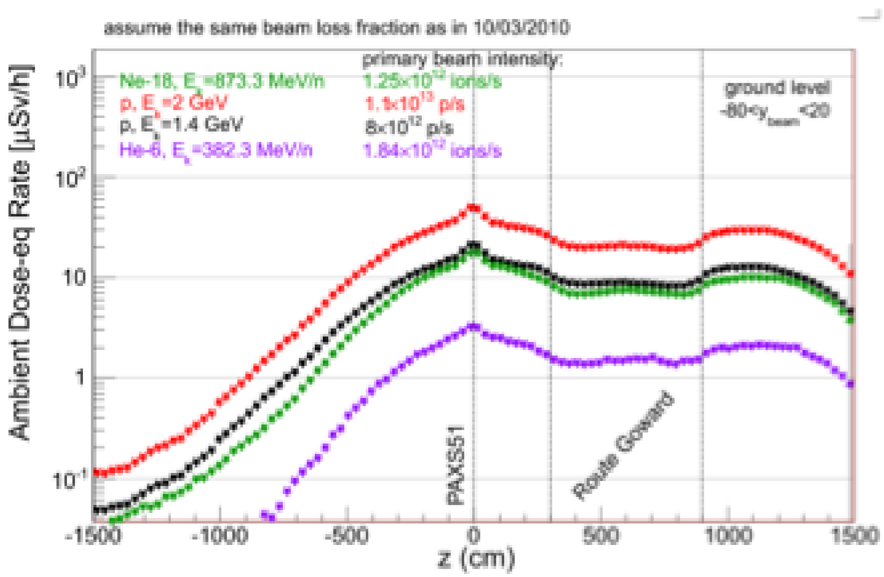
Integration: PS, radiation studies (1)

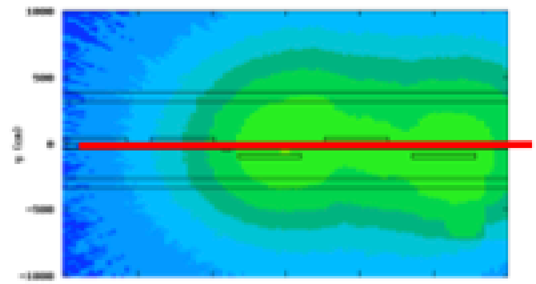
S. Damjanovic
DGS-RP, CERN



Integration: PS, radiation studies (2)

Ambient Dose-Eq Rate [μSv/h] above the Ground Level





Dose Rates extracted assuming the same relative beam loss as of 10/03/2010 when 6μSv/h was measured by PAXS51

values at PAXS51:

Ne-18, Ek=873.3 MeV/n:	17 μSv/h
He-6, Ek=382.3 MeV/n :	3 μSv/h
p, E_k=2 GeV:	49 μSv/h
p, E_k=1.4 GeV:	21 μSv/h

for the full proton beam intensities of 8×10^{12}p/s (E_k=1.4 GeV) and 1.1×10^{13}p/s (E_k=2 GeV) Dose Rates highest for the proton beams than for the beta beams.

Dose Rates higher by factors of 2.3, 3, 16 for p E_k=2 GeV beam losses compared to H-proton E_k=1.4 GeV, Ne-18 and He-6, resp.

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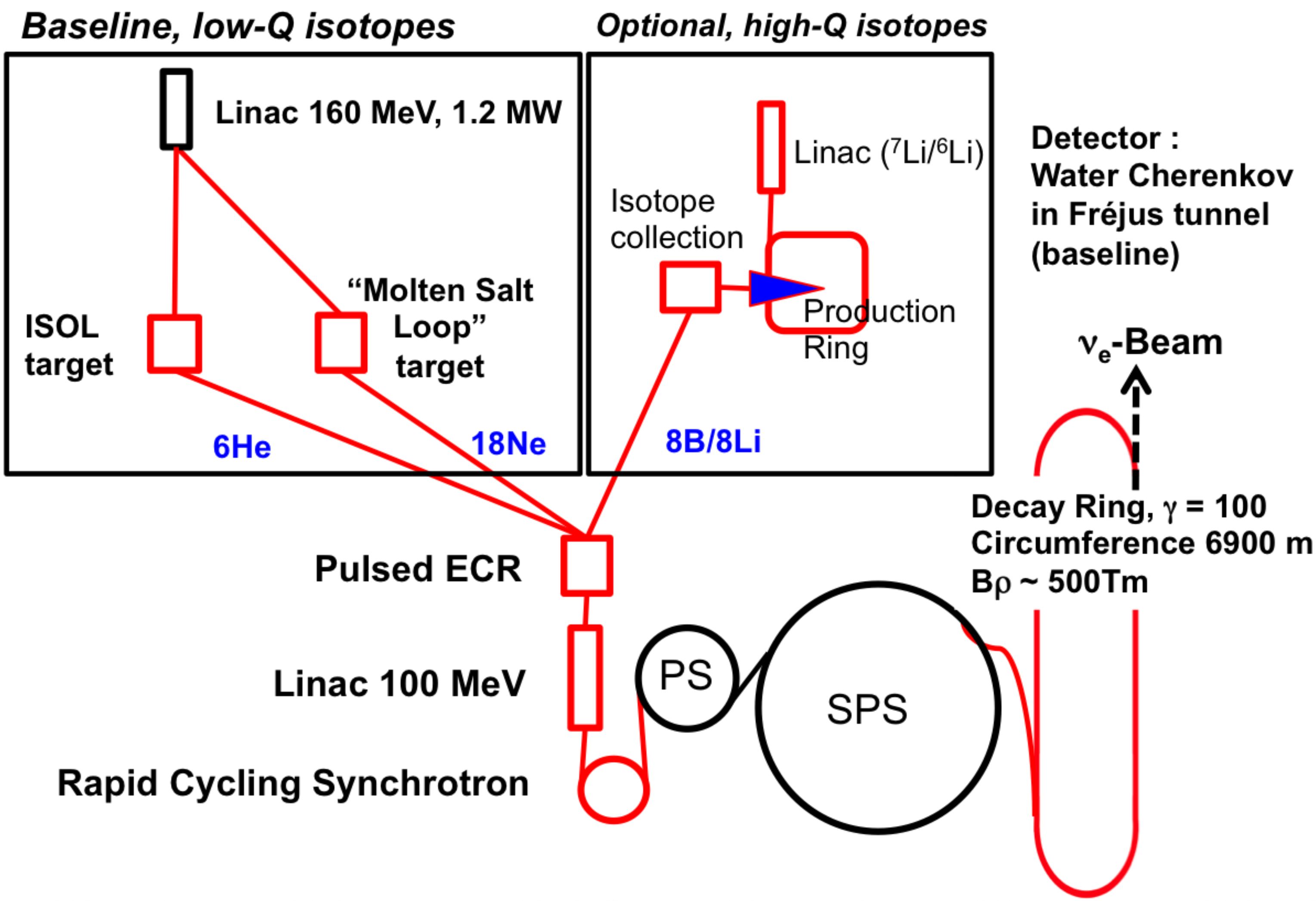
Optimization for neutrino flux

- Shielding of equipment
  - Needs studies in all machines
  - No evident show stoppers have been found

The CERN Beta Beam, now



Decay Ring: $B\rho \sim 500$ Tm, B = ~7 T, C = ~6900 m, L_{ss}= ~2500 m, γ = 100, all ions

Production of β-active isotopes

Aim ^{6}He and ^{18}Ne: 2 10^{13}/s **Targets below MWatt is a considerable advantage!**

Isotope	^{6}He	^{18}Ne	^{8}Li	^{8}B
Prod.	ISOL(n)	ISOL	P-Ring	P-Ring
Beam	SPL(p)	Linac4(p)	d	^{3}He
I [mA]	0.07	6	0.160	0.160
E [MeV]	2000	160	25	25
P [kW]	140	960	4	4
Target	W/BeO	^{23}Na, ^{19}F	^{7}Li	^{6}Li
r [10^{13}/s]	5	0.9	0.1	0.08

^{6}He production exp. T. Stora, CERN-2010-003, pp. 110-117

Templates PRSTAB (Latex)

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