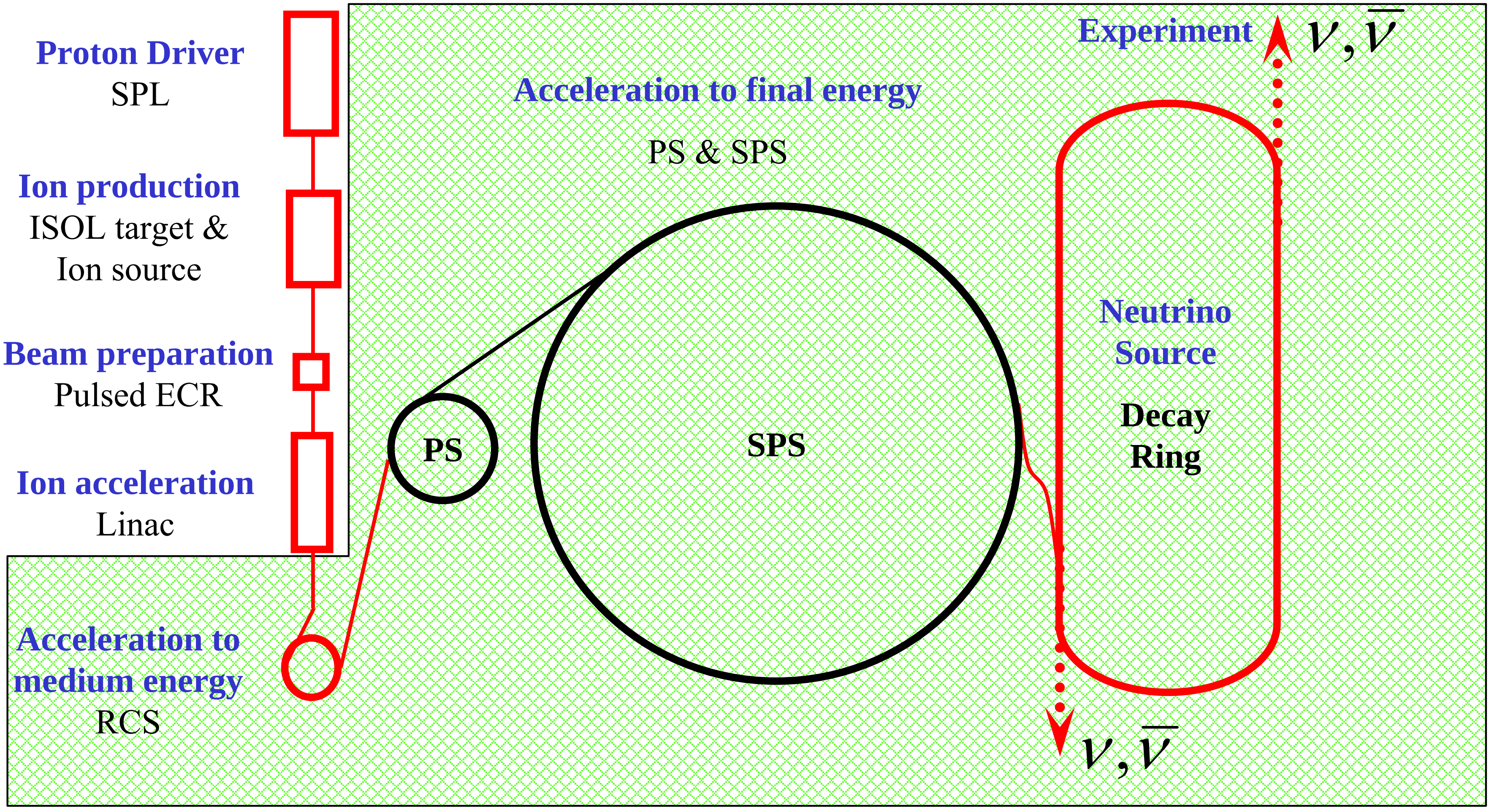
Objectives

The purpose of this presentation is to provide a first overview of emittances along the chain of circular accelerators of the beta-beam. This is a discussion document which aims to identify critical areas for further work.



1σ Physical Emittances at Injection

Scaling from the normalized rms values (15μm, 8μm) at PS injection for the high-intensity proton fixed-target physics beam, then

$$\varepsilon(ion, machine) = \varepsilon(ref, PSinj)\frac{\beta\gamma(^{6}He, PSinj)}{\beta\gamma(ion, machine)}$$

H,V [μm]	^{6}He	^{18}Ne
RCS	12., 6.4	12., 6.4
PS	6.7, 3.6	4.0, 2.1
SPS	0.62, 0.33	0.37, 0.20
Decay Ring	0.057, 0.030	0.057, 0.030

We assume the ^{18}Ne has the same normalized emittance as the ^{6}He because it comes from the Linac with identical βγ and is multi-turn injected into the RCS with the same geometrical set-up.

Tune Shift at Injection

Considering for simplicity a round Gaussian beam of fully stripped ions, the self-field incoherent (“Laslett”) tune shift is

$$\Delta Q_V = -\frac{Z^2}{A_p}\frac{3r_p}{4(\beta\gamma)^3 c}\frac{R}{\tau_b}\frac{N_b}{\varepsilon_V}$$

	^{6}He	^{18}Ne	
RCS (1 bunch, T=100MeV/n)	-0.056	-0.0057	Cf., PSB
PS (16 bunches, Bρ=8Tm)	-0.30	-0.017	
SPS (8 bunches, Bρ=86.7Tm)	-0.39	-0.019	40MHz

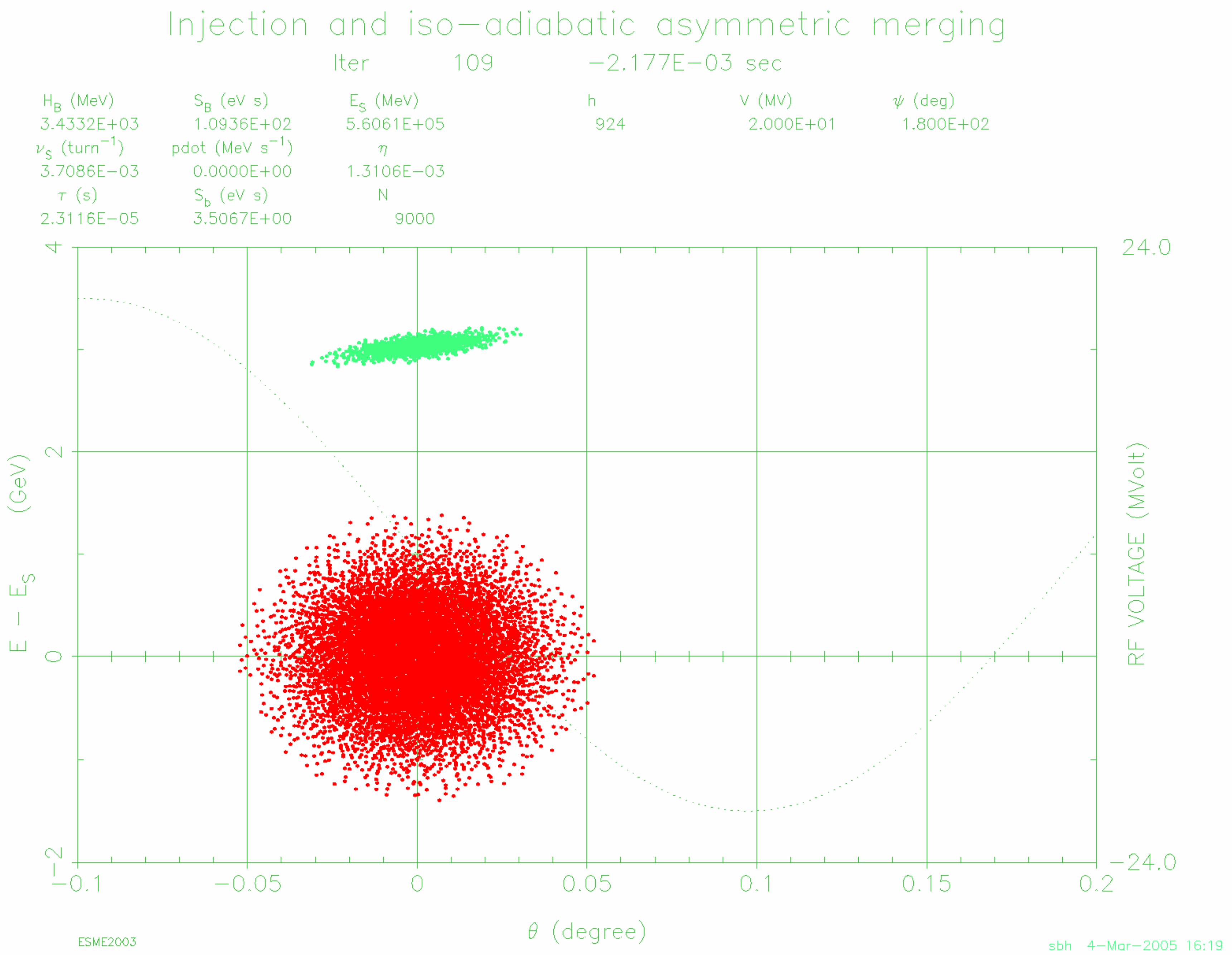
We assume τ_b = 80% of the rf bucket duration in all cases.

Longitudinal Emittance

In the same way that transverse emittance was pegged at injection into the PS, we identify a 2eVs longitudinal acceptance limit for ^{6}He during acceleration in the SPS. In addition, the escalating cost in the decay ring of rf voltage and aperture for increasing stack size led us to consider 1eVs delivered by the SPS and 15eVs stored in the decay ring for ^{6}He.

The situation for 18Ne is made easier by some simple scaling rules: at the same γ and rf voltage, the bucket acceptance and relative momentum half-height scale as $\sqrt{(Z\ A)}$ and $\sqrt{(Z/A)}$, respectively. This means that the same $\Delta p/p$ can be achieved at lower voltage without compromising the acceptance.

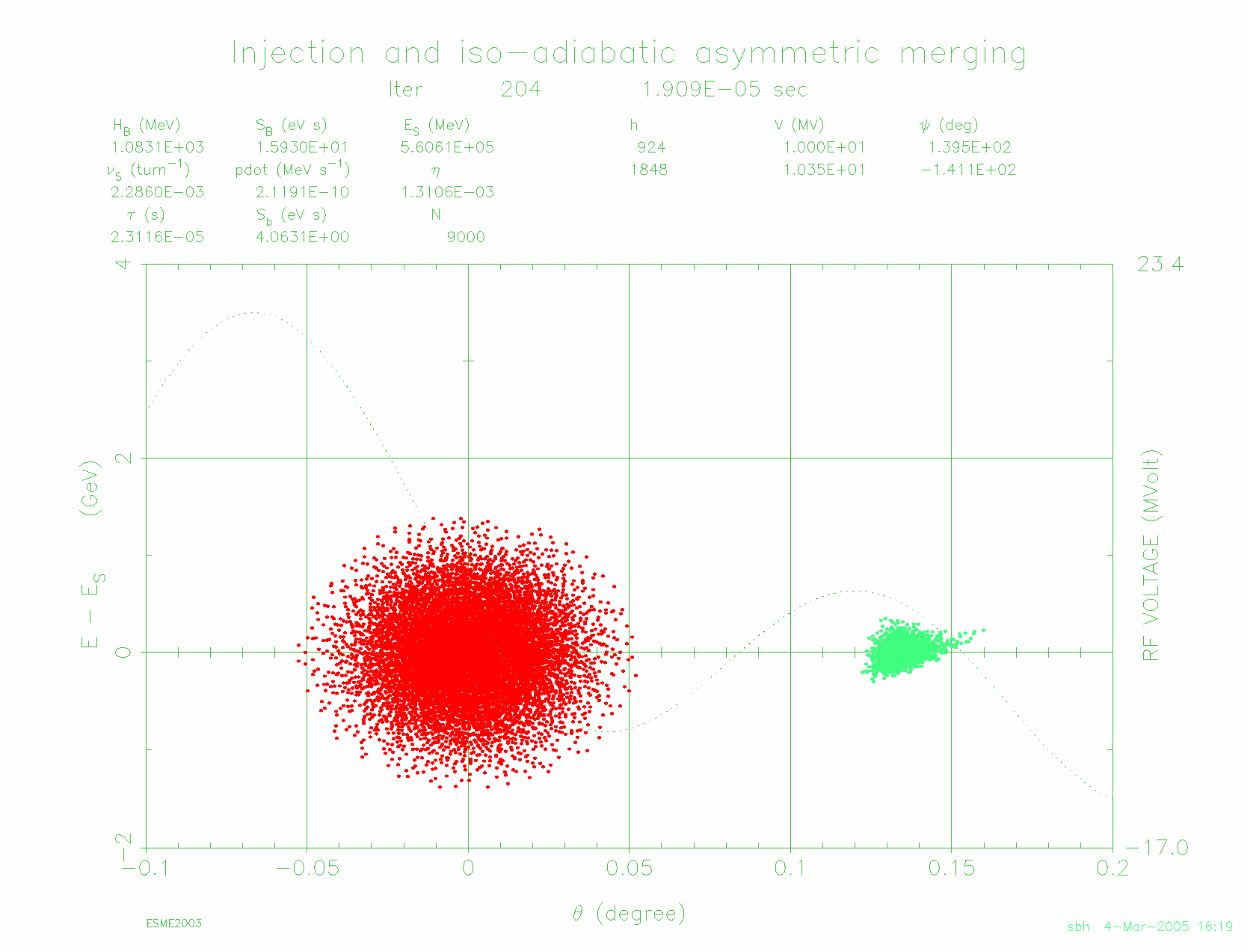
So far, simulations have only been performed for ^{6}He, but this work needs to be reviewed in the light of the most recent transverse emittance figures before going on to consider ^{18}Ne.



Injection and iso-adiabatic asymmetric merging

Iter 109 −2.177E−03 sec

H_B (MeV)	S_B (eV s)	E_S (MeV)	h	V (MV)	ψ (deg)
3.4332E+03	1.0936E+02	5.6061E+05	924	2.000E+01	1.800E+02
ν_S (turn^{-1})	pdot (MeV s^{-1})	η			
3.7086E−03	0.0000E+00	1.3106E−03			
τ (s)	S_b (eV s)	N			
2.3116E−05	3.5067E+00	9000			



Injection and iso−adiabatic asymmetric merging

Iter 204 1.909E−05 sec

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H_B (MeV)        S_B (eV s)        E_S (MeV)        h        V (MV)        ψ (deg)
1.0831E+03       1.5930E+01        5.6061E+05       924      1.000E+01     1.395E+02
ν_S (turn^-1)    pdot (MeV s^-1)   η                1848     1.035E+01     −1.411E+02
2.2860E−03       2.1191E−10        1.3106E−03
τ (s)            S_b (eV s)        N
2.3116E−05       4.0631E+00        9000
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Injection and iso−adiabatic asymmetric merging

Iter 21630 4.953E−01 sec

H_B (MeV)	S_B (eV s)	E_S (MeV)	h	V (MV)	ψ (deg)
1.2805E+03	2.1775E+01	5.6060E+05	924	1.000E+01	1.460E+02
ν_S (turn^{-1})	pdot (MeV s^{-1})	η	1848	6.031E+00	−6.822E+01
2.3873E−03	−3.8881E+02	1.3106E−03			
τ (s)	S_b (eV s)	N			
2.3116E−05	2.1021E+00	9000