Stack Halo due to Merging

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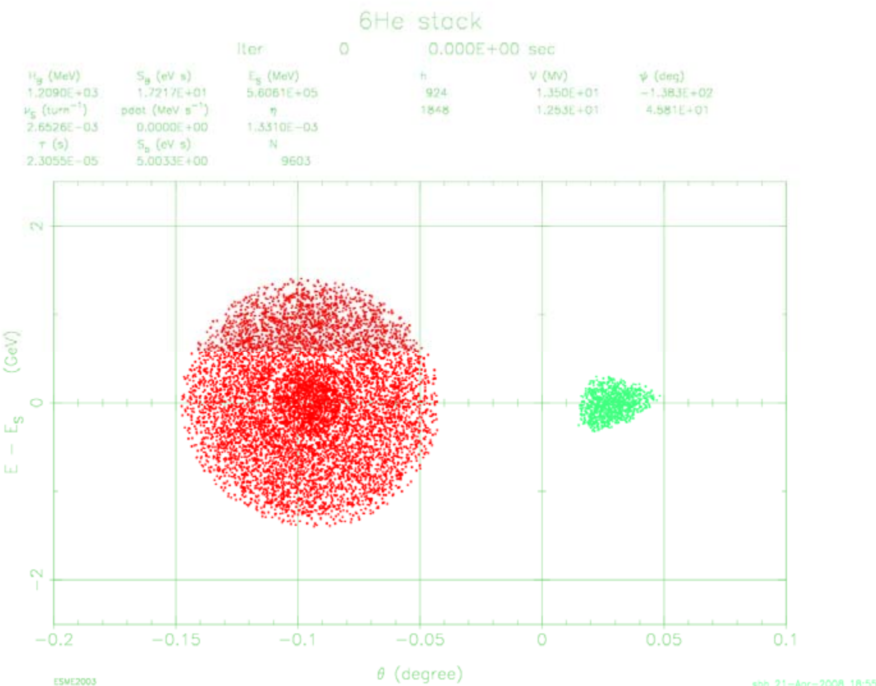
Overview

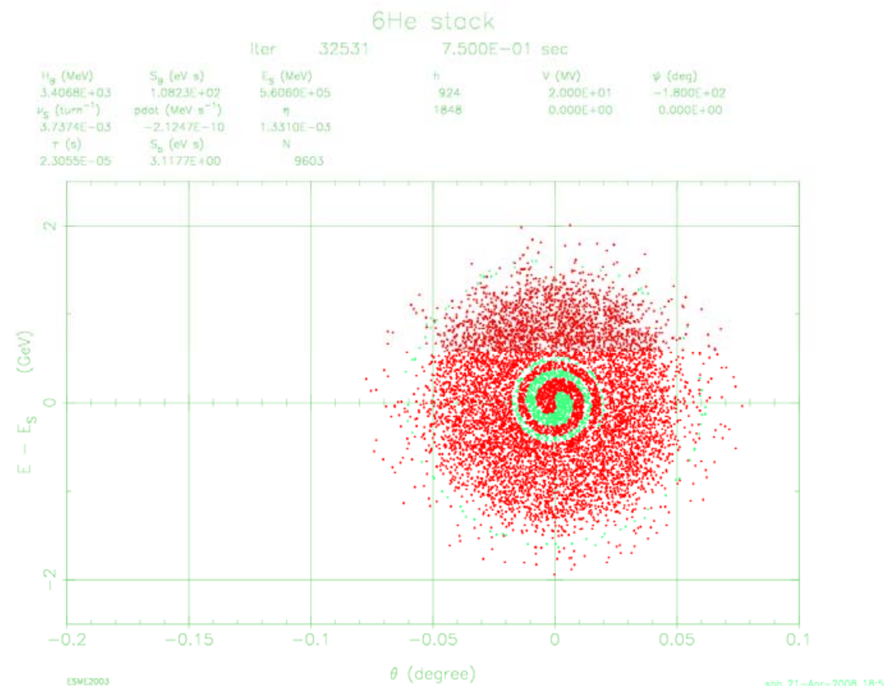
Studies of stacking efficiency have been presented at the 3rd Task Meeting and at EPAC in Edinburgh. Survival profiles were generated versus the number of stacking steps noting that the beta-decay-corrected survival profile of the first bunch is the increment in the total number of particles at each step. Beta-decay was put in by hand. Momentum collimation at a relative momentum offset of 2.5‰ (corresponding to the 15×1eVs stack size of the helium case in a 40MHz bucket at full 20MV rf voltage) was achieved by specifying a beam pipe of the equivalent radius in ESME.

Having established that the overall stacking efficiency is better than 80% for both ion species, we now turn our attention to the energy distribution of the particles that end up outside the 2.5‰ limit as the result of a single merging step.

$^{6}He^{2+}$ Case (1)

I take the "steady-state" distribution after 20 injections and, after beta-decay correction, I add one more fresh bunch in the absence of further collimation.

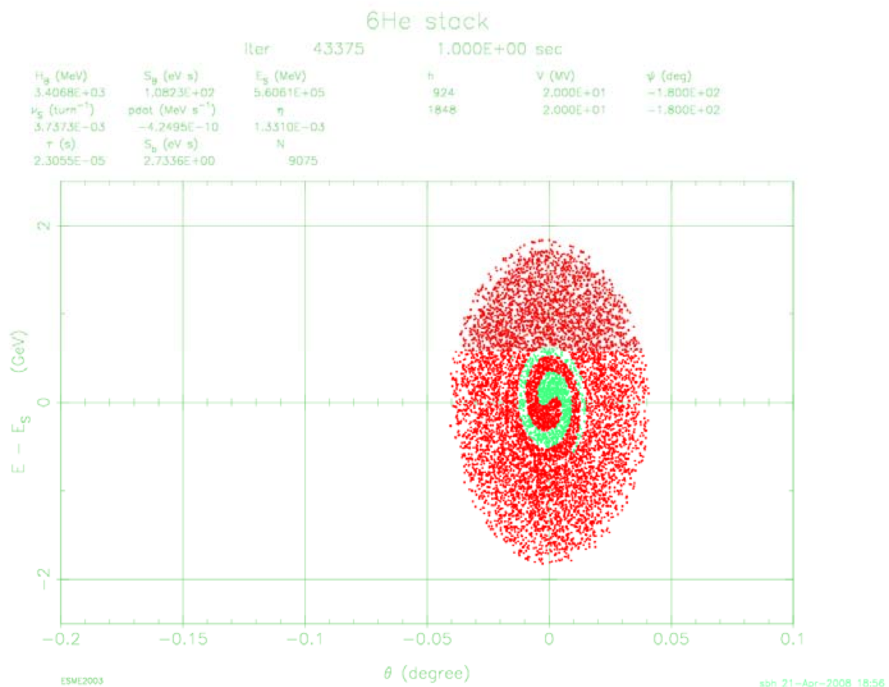


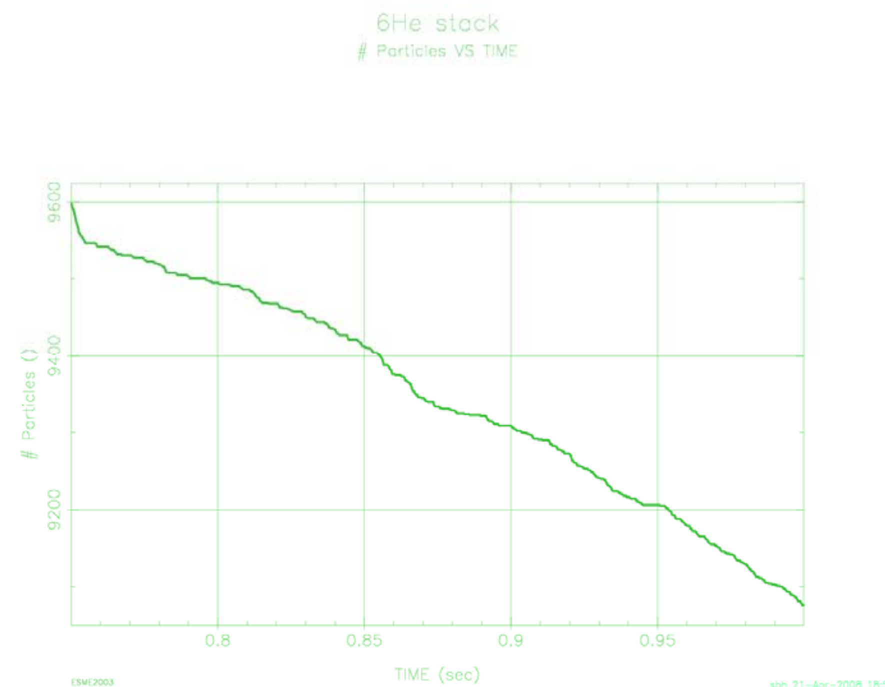


I ignore beta-decay in the short time it took to merge once.

$^{6}He^{2+}$ Case (2)

Next, I raise the 80MHz component linearly from zero to the 20MV maximum with an aperture restriction at 3.293‰ to shave the distribution back to 15eVs.

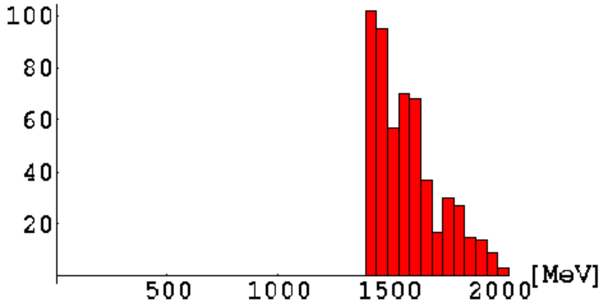




The loss rate is fairly steady even with this simple bunch shortening approach.

$^6He^{2+}$ Case (3)

Returning to the uncollimated distribution, I remove particles inside the limiting synchrotron amplitude of the stack and histogram the remainder as an azimuthal projection onto the energy axis.



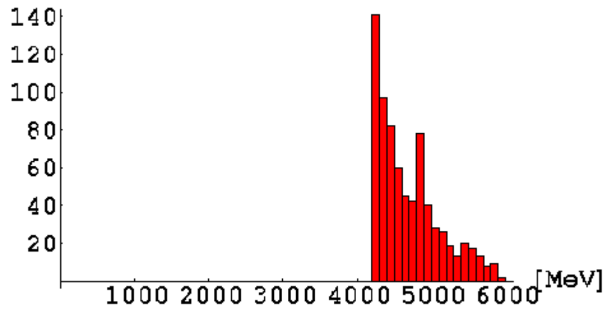
These collimated particles amount to ~6.3% of the original stack. This is entirely consistent with the earlier high-statistics study which found that the steady-state stack amounts to 8.9 effective shots accumulated.

```
topgamma=100; thalf=0.81; spsrepetitiontime=6.0;
tratio = spsrepetitiontime/(topgamma thalf/Log[2]);
(1 - 8.9 (1 - Exp[-tratio])) / 8.9
```

0.0623112

$^{18}Ne^{10+}$ Case

The size of the 20×2.2eVs neon stack is determined by the helium case. Repeating the whole exercise for the distribution obtained after 25 injections yields unsurprisingly similar results.



These collimated particles amount to ~5.4% of the original stack. This is entirely consistent with the earlier high-statistics study which found that the steady-state stack amounts to 14.0 effective shots accumulated.

```
topgamma=100; thalf=1.67; spsrepetitiontime=3.6;
tratio = spsrepetitiontime/(topgamma thalf/Log[2]);
(1 - 14.0 (1 - Exp[-tratio])) / 14.0
```

0.0565976

Concluding Remarks

Hopefully, these results can be input into ACCSIM/FLUKA to convert particles lost per second into W/m.

It should thus be possible to determine the maximum rate at which bunch shortening can proceed.