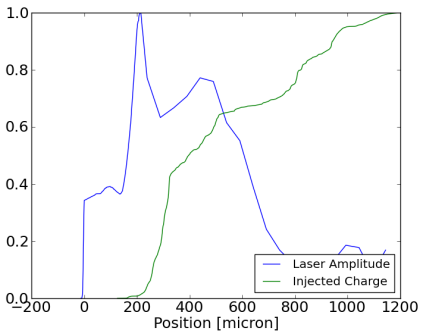
Laser Wakefield Electron Acceleration at U=15J and τ = 15 fs

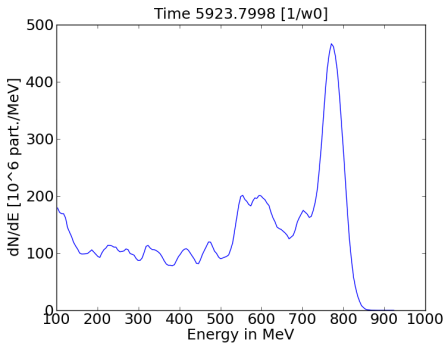
Parameters

$a_0 = 20$, $r_0 = 8.5\ \mu m$, $P = 1PW$,
$n_e = 3.13 \times 10^{19} cm^{-3}$

Pulse is matched to bubble size

$$r_{\text{bubble}} \simeq \frac{2\sqrt{a_0}c}{\omega_p} \simeq r_0$$





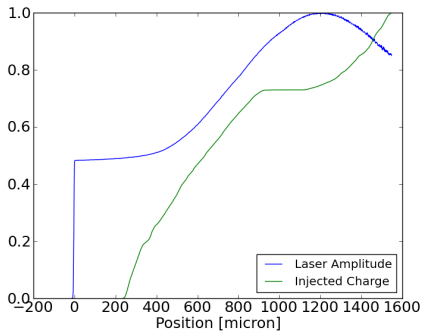
Injection starts only at laser defocusing phase and never stops.

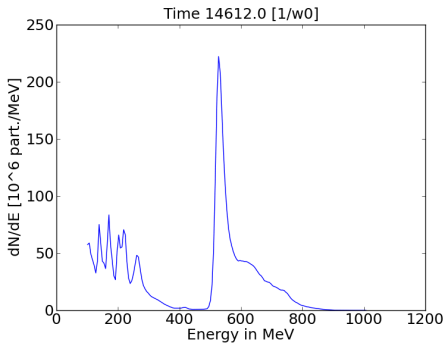
Parameters

$a_0 = 8.49$, $r_0 = 20\ \mu m$, $P = 1PW$,
$n_e = 2.4 \times 10^{18} cm^{-3}$

Pulse is matched to bubble size

$$r_{\text{bubble}} \simeq \frac{2\sqrt{a_0}c}{\omega_p} \simeq r_0$$





First injection phase during laser self-focusing. Then injection starts again during laser defocusing like in the high density case.

Conclusions

- There is a correlation between injection and bubble evolution
- Injection happening in later stages, after laser compression has started, looks hectic.
- Early injection is smoother and closer to axis.
- **The high intensity, high density does not look promising in terms of beam quality for high power, short (15fs) pulses, and especially for high P/P_{crit}. The laser evolves too quickly and there are no clean injection phase.**
- **You need lower densites, longer propagations or other beam/plasma manipulations to mitigate dark current if you want short distance acceleration (See S. Kalmykov presentation)**