Preliminary Studies on Injection Optimisation

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    2. Line density
    3. Energy spread
    4. Longitudinal emittance (matched, RMS, 90%)
    5. Filamentation
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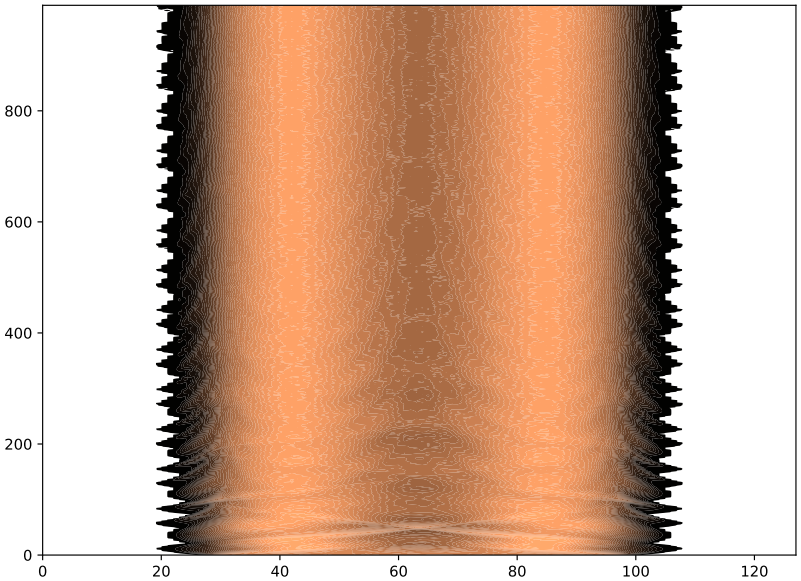
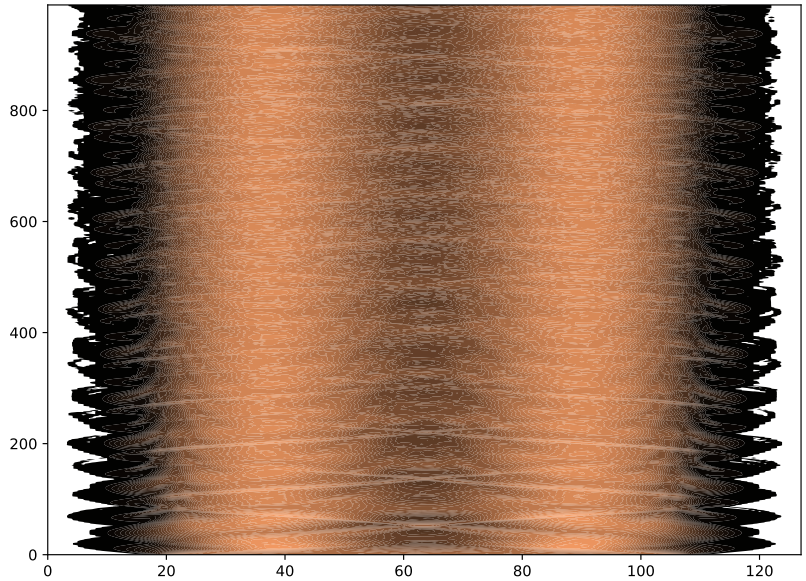
- What factor, or combination of factors (in which case with what weighting), matters most?
- Does "optimum" depend on beam type?

Very different parameters and results, but which is better?



- Injected length: 700 ns
- Energy Spread: 850 keV
- $V_{h=1}$: 9.3 kV
- $V_{h=2}$: 7.6 kV
- Result: Fairly smooth, but quite small



- Injected length: 700 ns
- Energy Spread: 1050 keV
- $V_{h=1}$: 6.7 kV
- $V_{h=2}$: 10.2 kV
- Result: Lots of filamentation, but large

- For different beam types a longitudinal figure of merit that maps onto important beam parameters (e.g. blow-up) is needed
  - Is it better to have smaller with less filamentation, or larger with more filamentation?
  - Should a small longitudinal loss be accepted?
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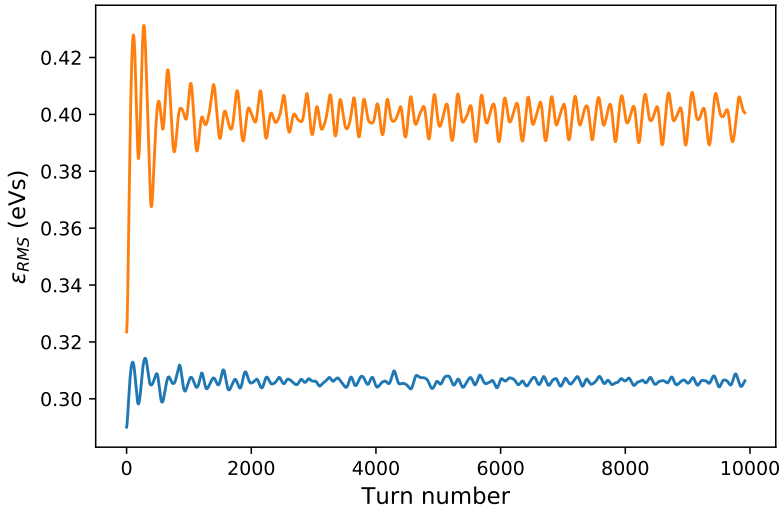
- Large parameter scan with BLonD used to investigate possible figures of merit for HL-LHC type beam:
  - Length: 500 ns $\rightarrow$ 750 ns
  - Energy spread: 500 keV $\rightarrow$ 1100keV
  - $V_{h=1} + V_{h=2}$: 10 kV $\rightarrow$ 20 kV
  - $V_{h=1}/(V_{h=1} + V_{h=2})$: 0.3 $\rightarrow$ 0.6
  - $\approx$ 11k simulations of 10 ms on a 160 MeV flat bottom with space charge (run time $\approx$ 20 minutes each)

An example using ε_{RMS}



- Two parameters of interest:
  1. Level of filamentation: Measured by standard deviation of ε_{RMS} over first 1k turns
  2. Longitudinal size: Measured by average ε_{RMS} over last 1k turns

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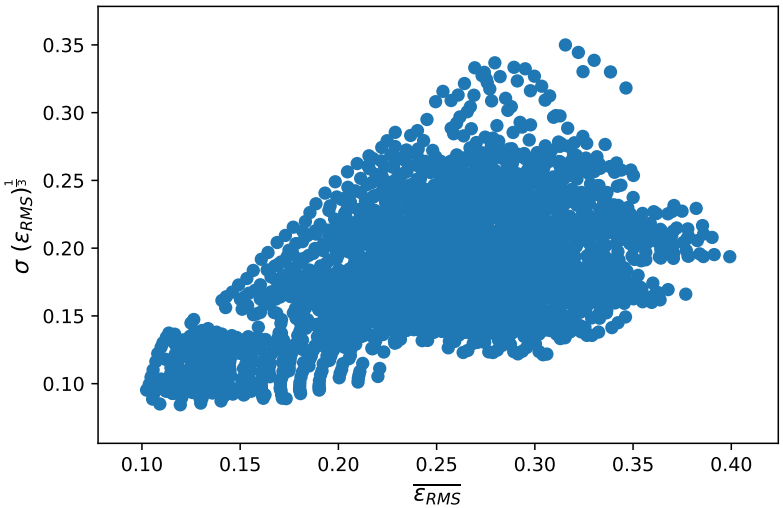

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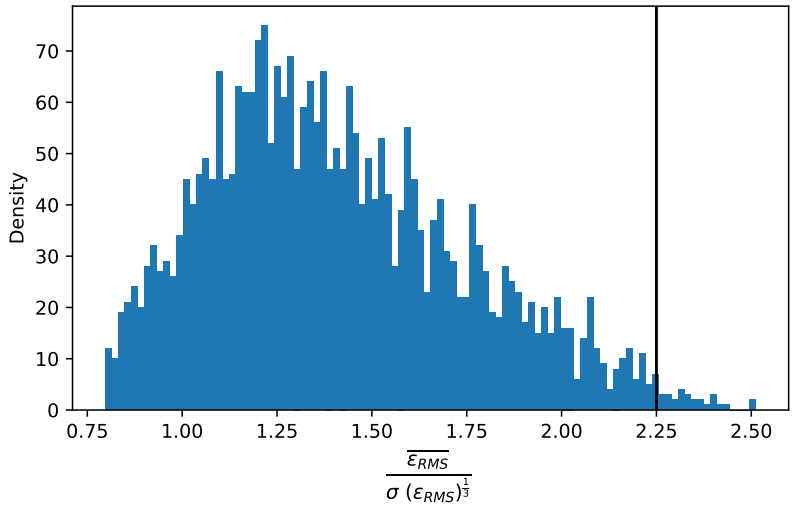

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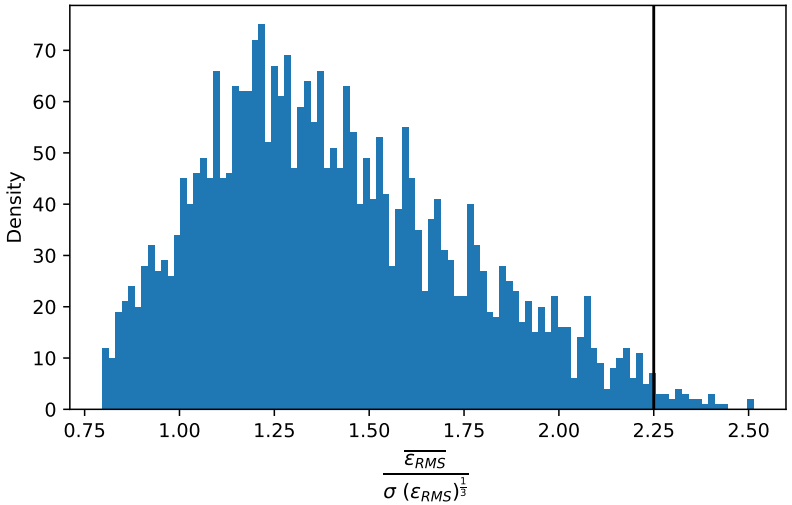

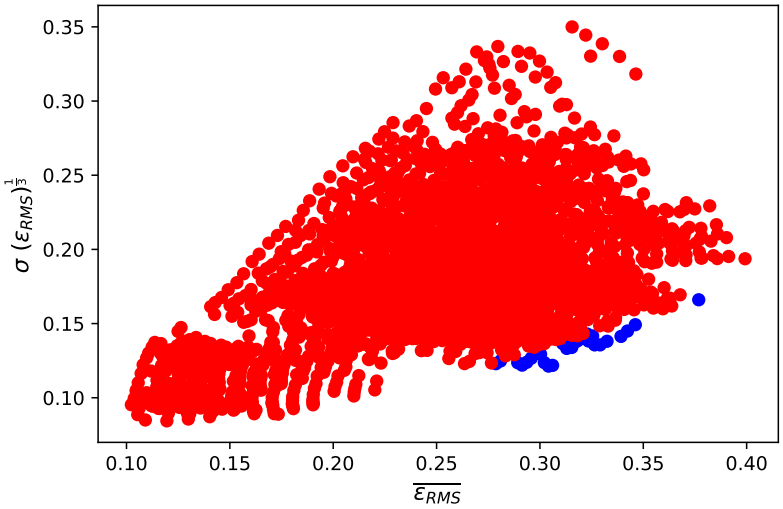

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- Red points are “bad”, blue points are “good”

- Simulation results in a SWAN project (if you want access let me know)
- Selection of possible parameters based on different figures of merits identified for simulation in 6D, preliminary combinations:
  - $V_{h=1}$ = 9.5 kV, $V_{h=2}$ = 9.5 kV, 600 ns, 1.1 MeV
  - $V_{h=1}$ = 3.0 kV, $V_{h=2}$ = 7.0 kV, 625 ns, 1.1 MeV
  - $V_{h=1}$ = 8.0 kV, $V_{h=2}$ = 8.0 kV, 600 ns, 1.0 MeV
  - $V_{h=1}$ = 7.0 kV, $V_{h=2}$ = 13.0 kV, 625 ns, 1.1 MeV
  - $V_{h=1}$ = 12.0 kV, $V_{h=2}$ = 8.0 kV, 525 ns, 1.1 MeV
- Relationship between longitudinal measureables and transverse parameters to be used as feedback for defining “optimal” conditions
- After identifying optimum on a flat bottom the question becomes how to get it up the ramp

Any suggestions/ideas/thoughts/proposals/etc welcome and appreciated