



Update on *AWAKE* Run 1 data analysis

M. Turner and the *AWAKE* experimental team

Summary

My 'obvious' findings:

the **accelerated electron energy** is determined by:

- wakefield amplitude along the plasma ← defines the observed trends
- at which phase electrons are (longitudinally) ← make the trend less clear
- how long they stay in the accelerating wakefield phase ← make the trend less clear

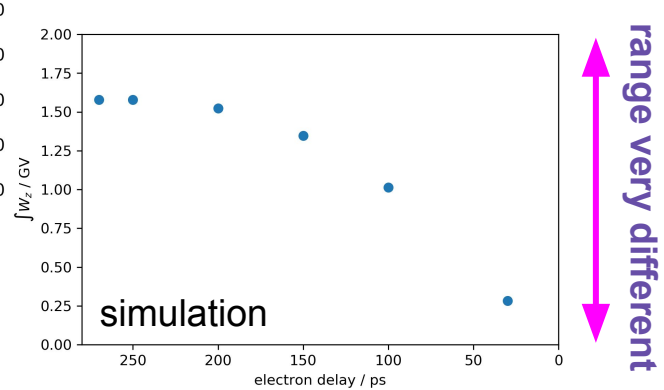
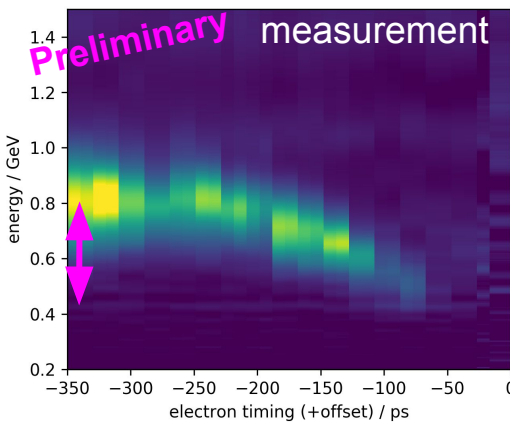
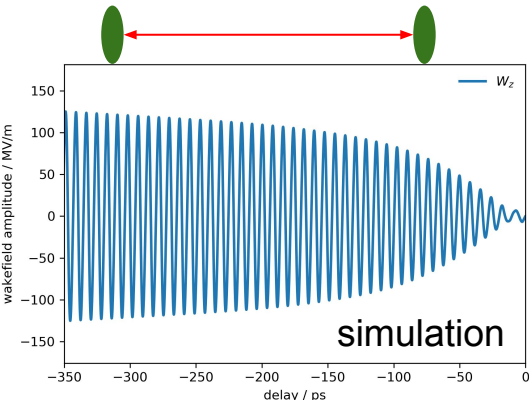
the radius of the **maximum defocused protons** is defined by:

- the integral of the radial wakefield amplitude ← defines the observed trends
- until the protons exit the plasma ← not always the same location

Electron Delay Scan

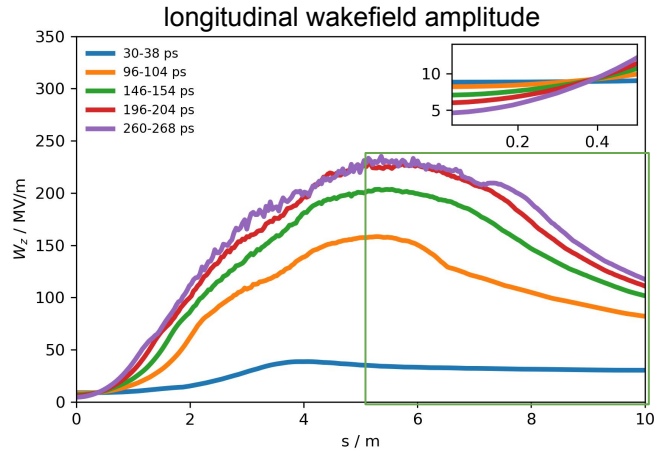
longitudinal wakefields

change the delay (0-350 ps) between the electron bunch and the laser pulse:

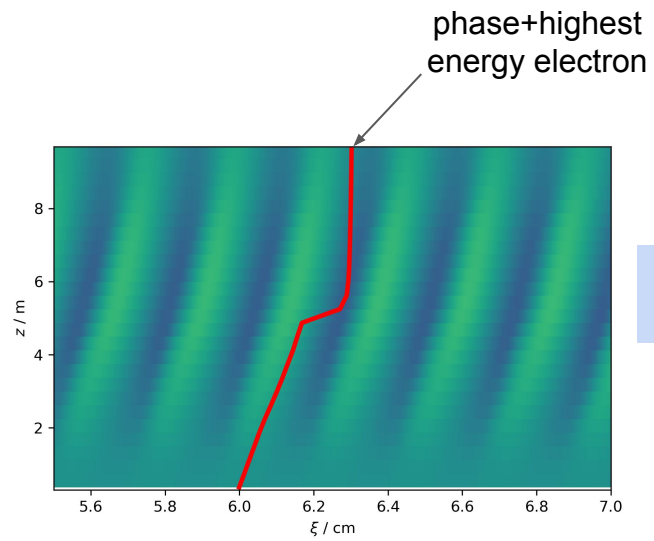


Simulations

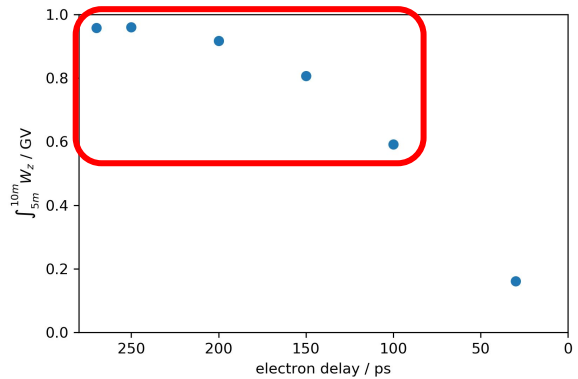
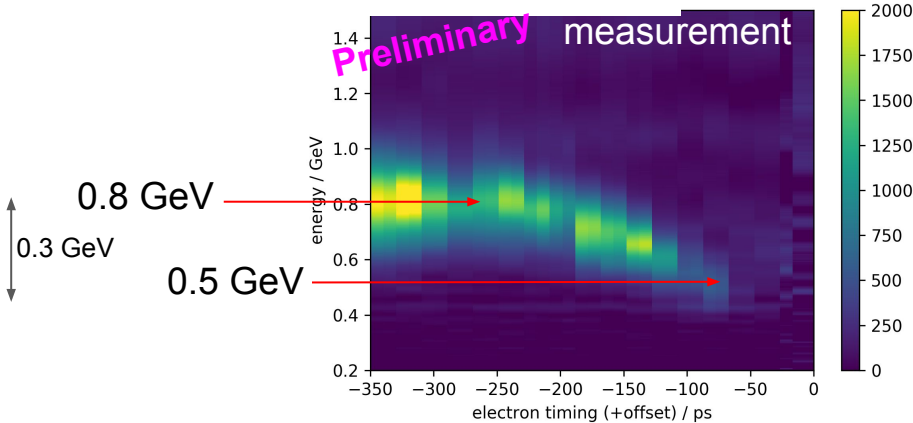
electron delay scan



longitudinal wakefield phase along the the plasma, ~6 cm behind the seed



energy gain only for $s > 5$ m

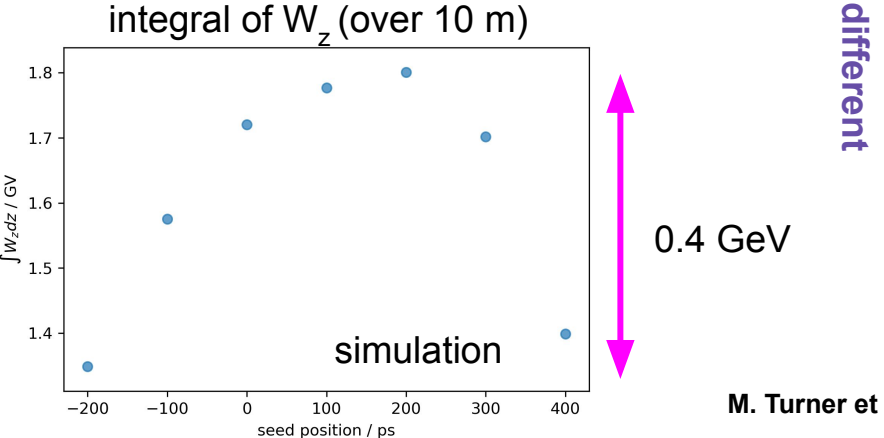
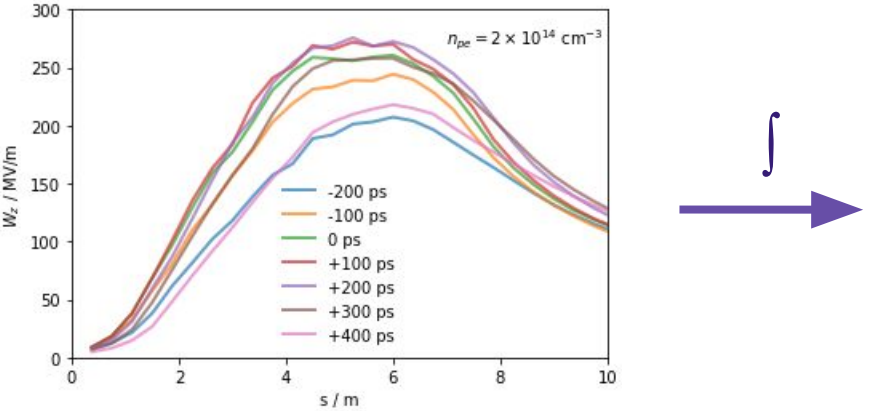
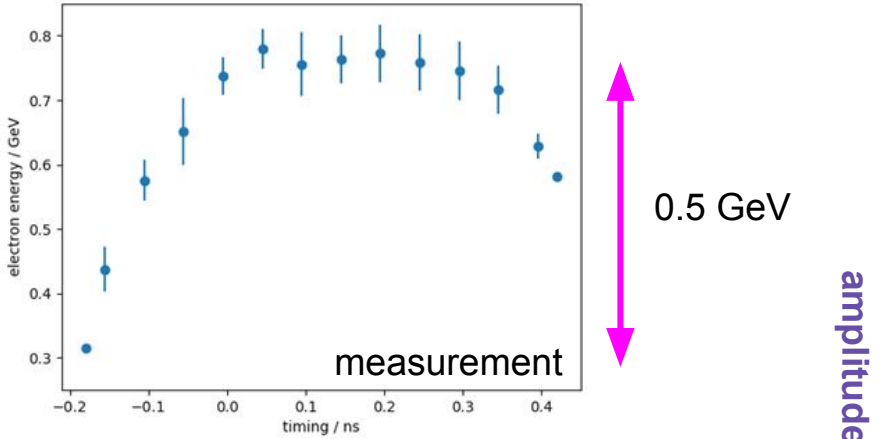
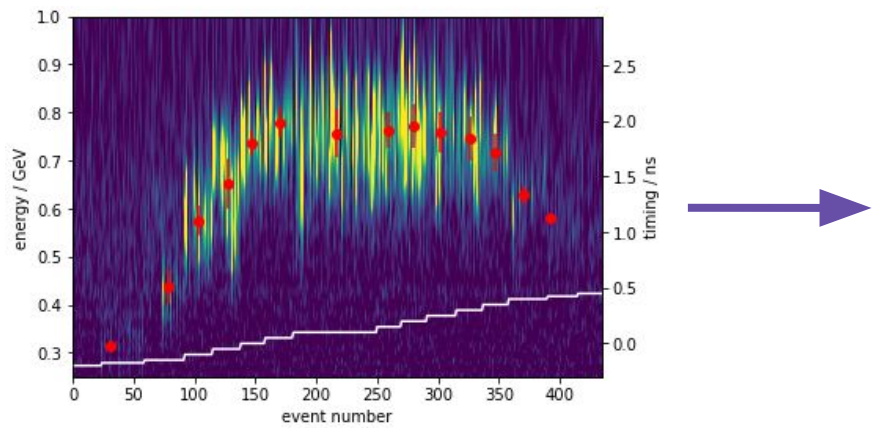


Integral from 5-10m

amplitude: not too far

Simulations

seed position scan



amplitude different

Simulations

seed position scan

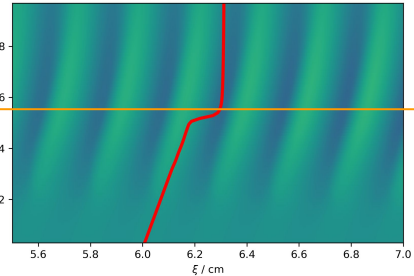
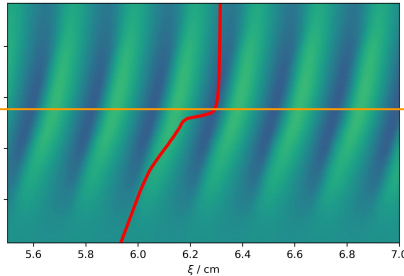
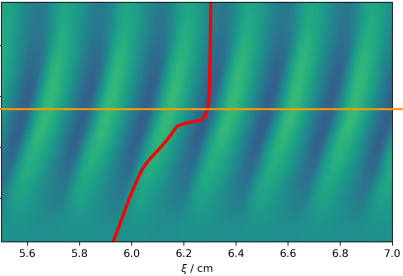
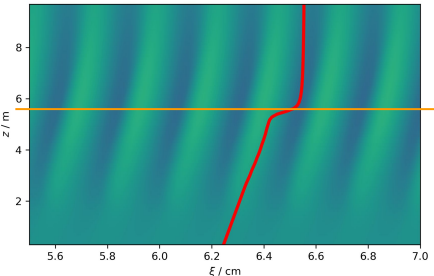
phase + highest electron energy

-200 ps

0 ps

+200 ps

+400 ps

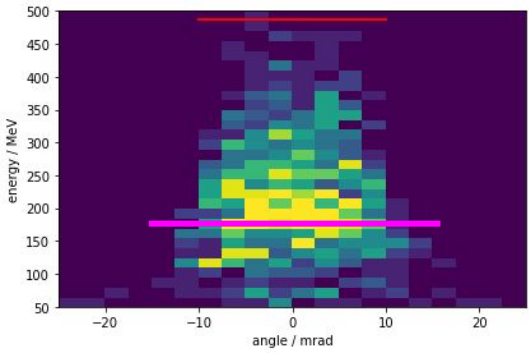
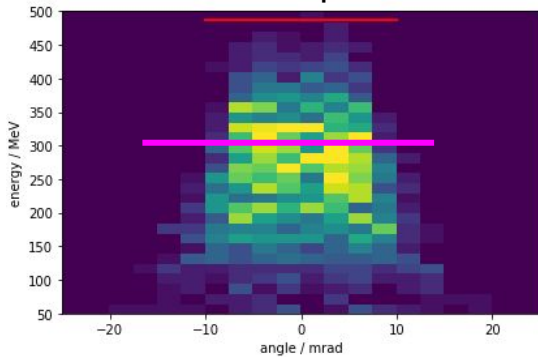
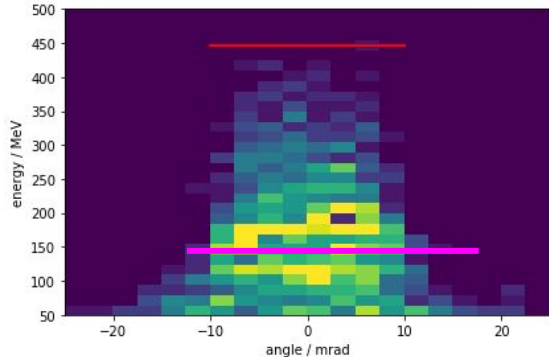


-100 ps

+100 ps

+300 ps

resulting electron energy spectrum

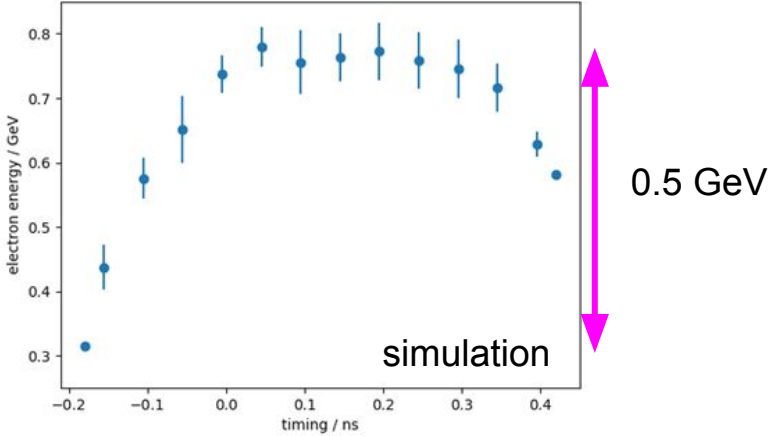
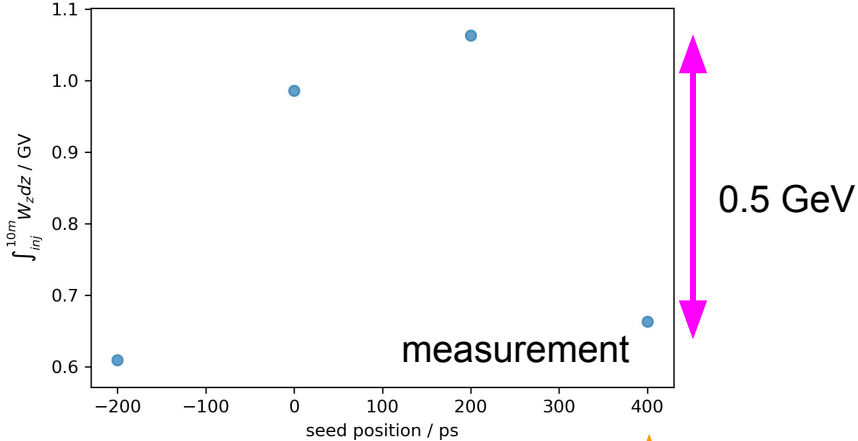


electron energy lower than measured; energy trend is there

Seed Position Scan

longitudinal wakefields

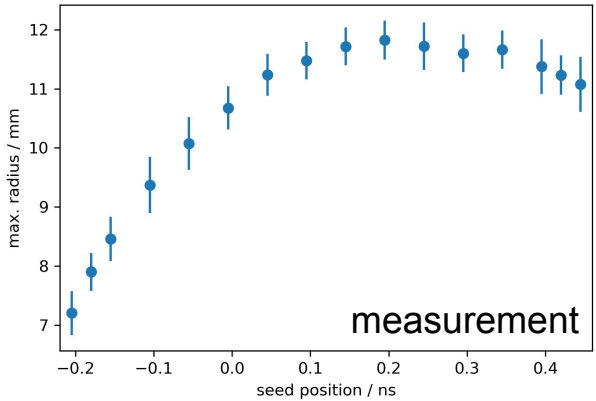
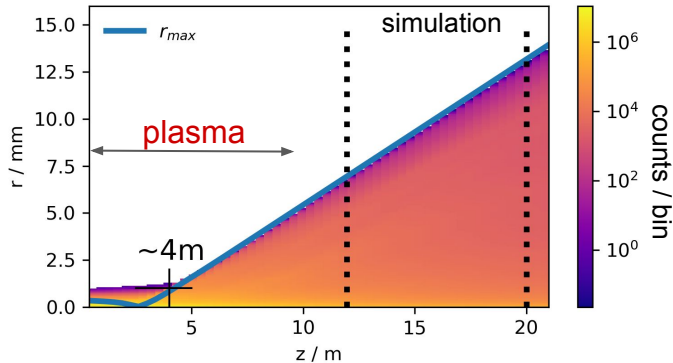
after adjustments...
(field integration from the injection position onwards)



better agreement;
300 MeV offset

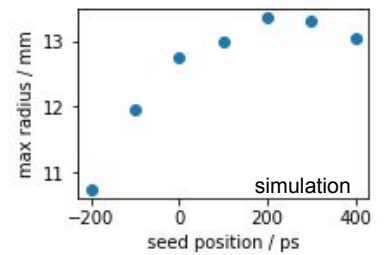
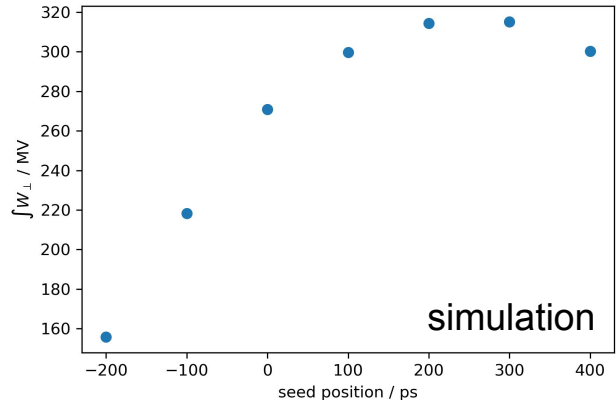
Seed Position Scan

transverse wakefields



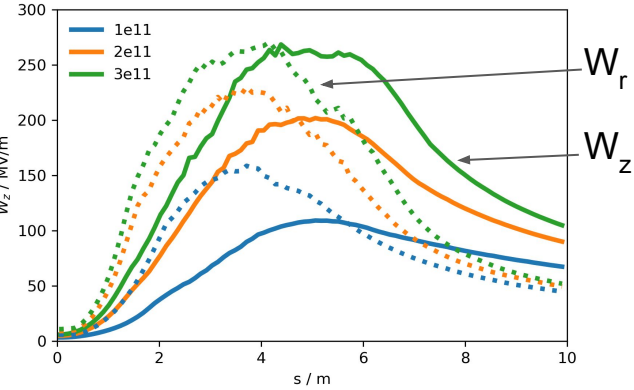
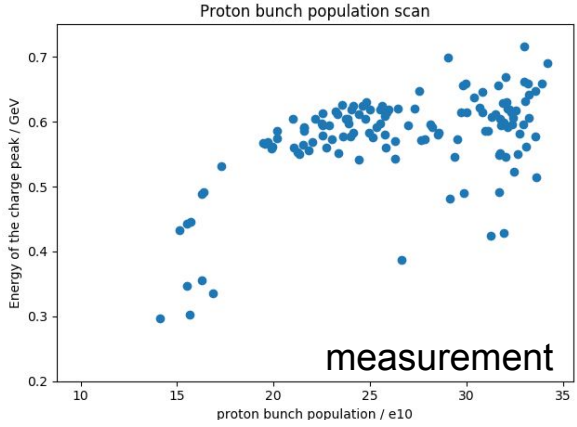
Beautiful agreement of trend; measured maximum radius lower

$$\int_{0m}^{4m} W_r dz$$

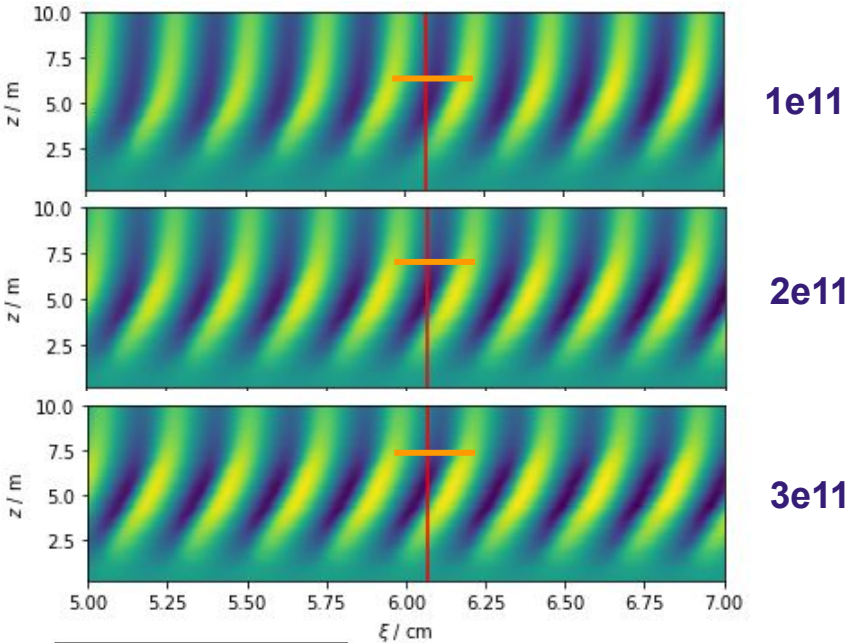


Max. radius and integral of fields follow the same trend

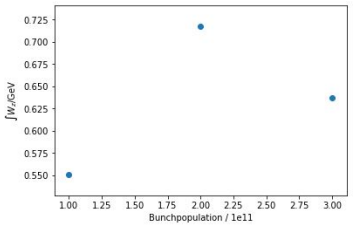
Proton Bunch Population



Wakefield phase



Phase stabilizes later for higher proton bunch population



When combining wakefield amplitudes and phase; closer to the measured trend than naive expectations

Summary & Conclusions

- When taking into account particle trajectories:
 - the observed energies are on the order of the expectations from the field amplitudes.
 - what we measured does make sense
- It will be possible to write a paper discussing our observations and show consistency.
 - not sure that we will be able to ‘prove’ any physics as there is many different unknown influences