Future developments for the Plasma Wakefield Acceleration Experiment

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for the E-164X collaboration

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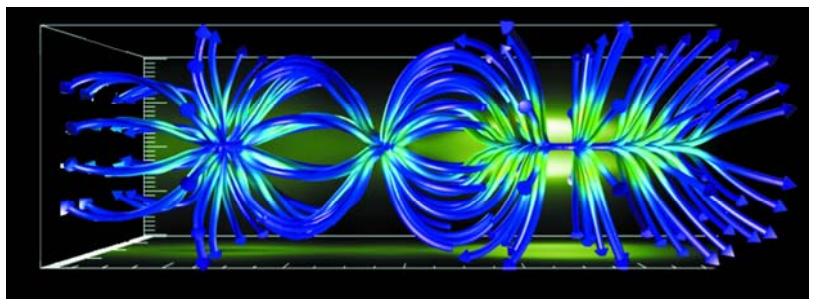
Future developments for the Plasma Wakefield Acceleration Experiment

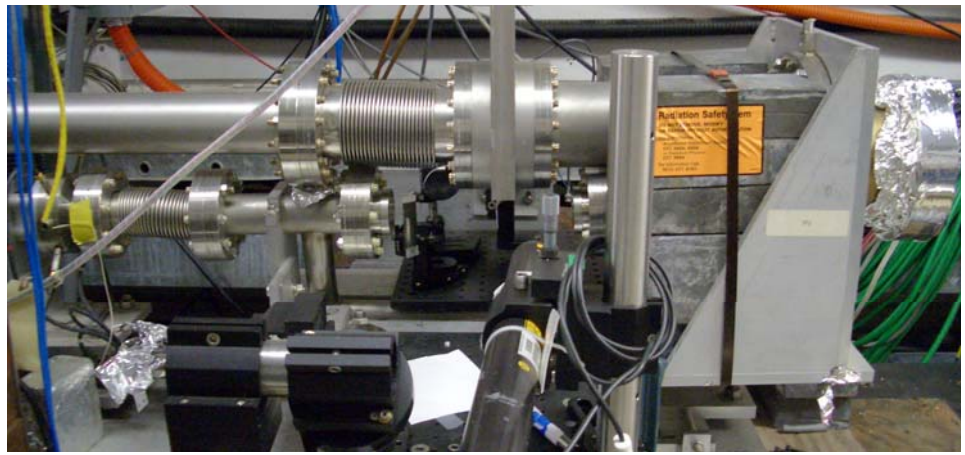
- How can we improve the measurement of the energy gain?
- Larger energy acceptance of the beamline
  - Avoid clipping
  - Allows a longer accelerating section

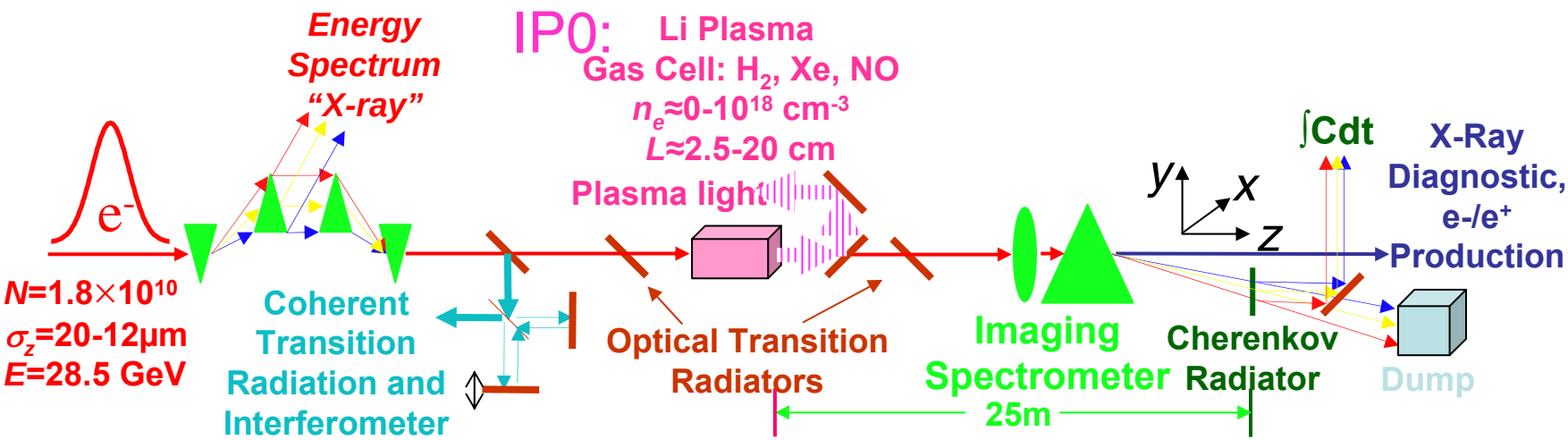
- Create a twin bunch: two bunches, ~1ps apart
  - First bunch creates the wake
  - Witness bunch is accelerated



Larger Energy Acceptance

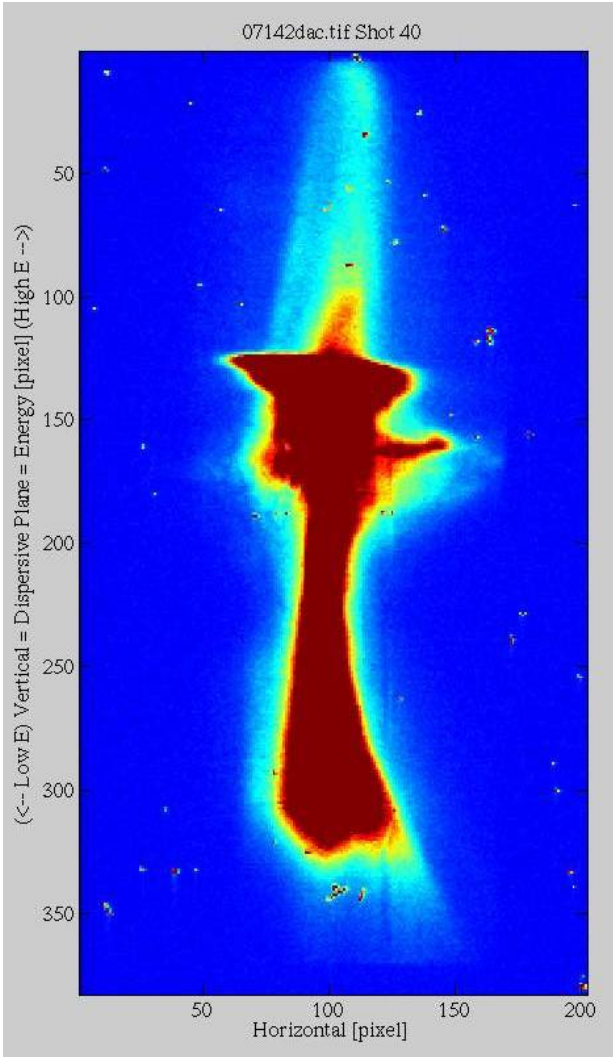
- Limiting element so far: vacuum chamber behind the bending magnet





Larger Energy Acceptance

- Result: even with only 10cm plasma, the beam is clipped



Larger Energy Acceptance

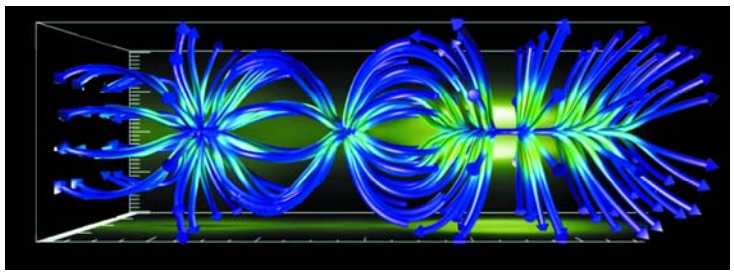
Changes since last run

- Replace vacuum chamber
- Energy acceptance is increased by 50%
  - ⇒ We can now increase the length of the plasma

- Large angular spread in particles immediately after the plasma (depending on plasma focusing)
  - ⇒ Require simulation of beam dynamics after the plasma

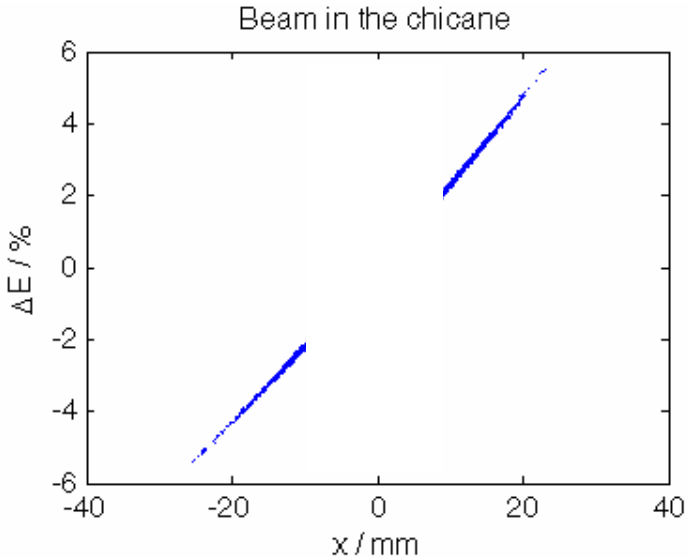
Creation of Twin Bunches

- How can we get a clear sampling of the accelerating field?



- Create a witness bunch at a varying distance to the drive bunch

- Idea: in the chicane, there is a relation between the energy and the transverse position:



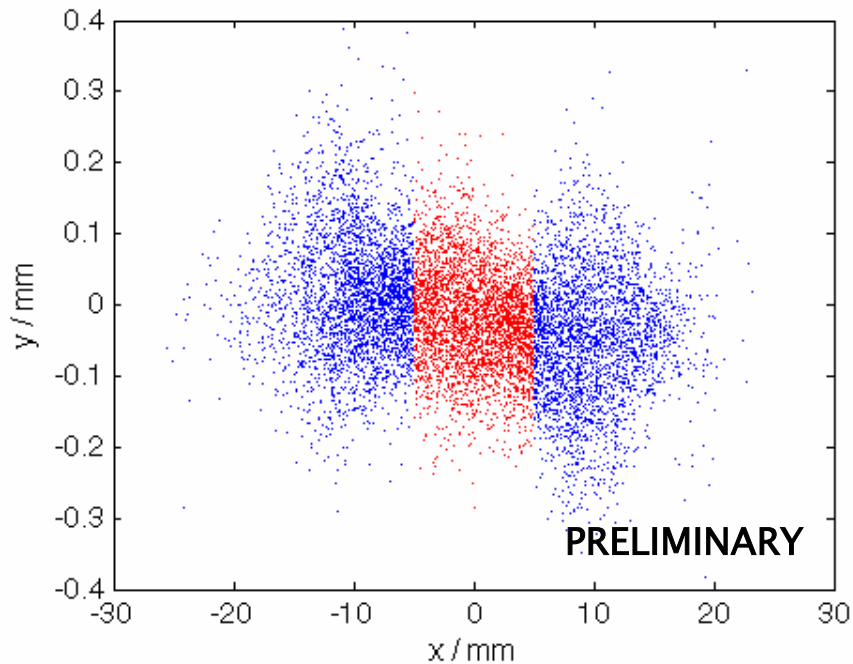
- The middle part of the bunch is removed with a collimator

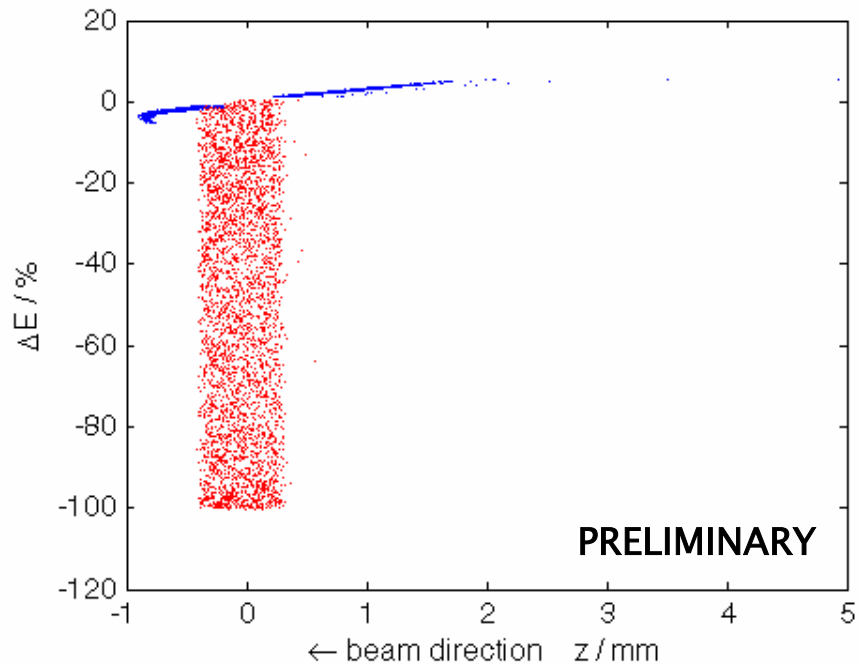
Creation of Twin Bunches

Simulations

- Energy loss by bremsstrahlung
- Beam dynamics

- Directly behind the collimator in the chicane (1cm copper):



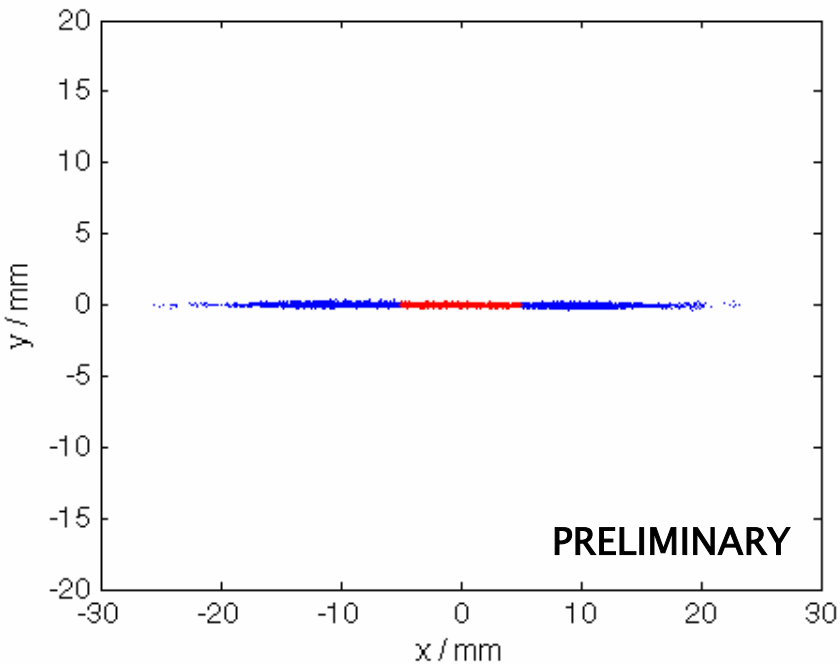


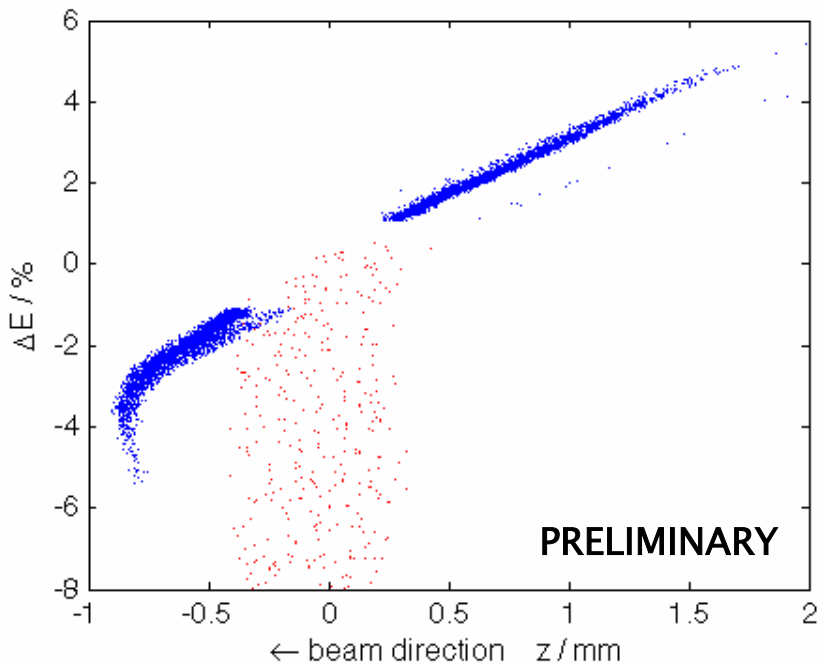
Creation of Twin Bunches

Simulations

- Energy loss by bremsstrahlung
- Beam dynamics

- Development in the chicane



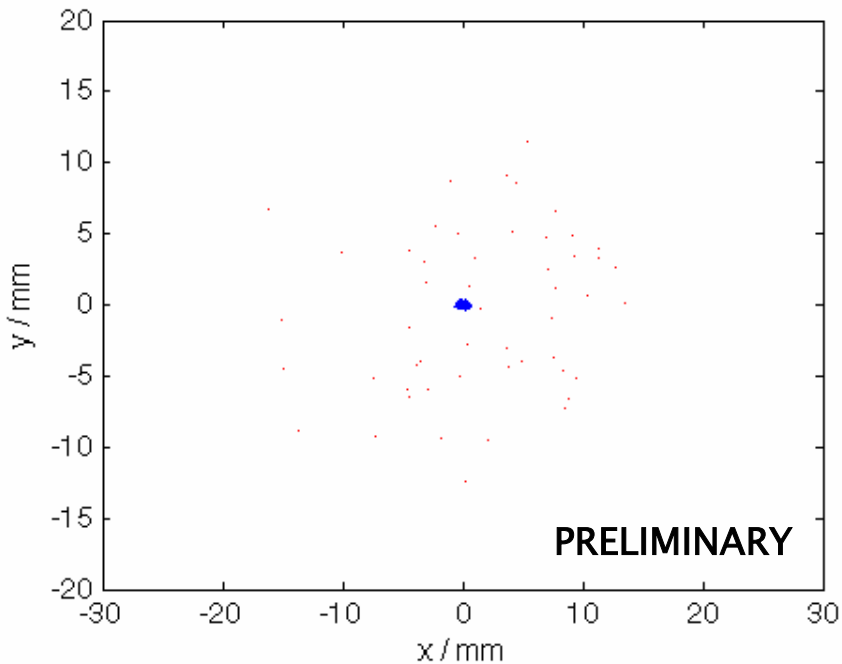


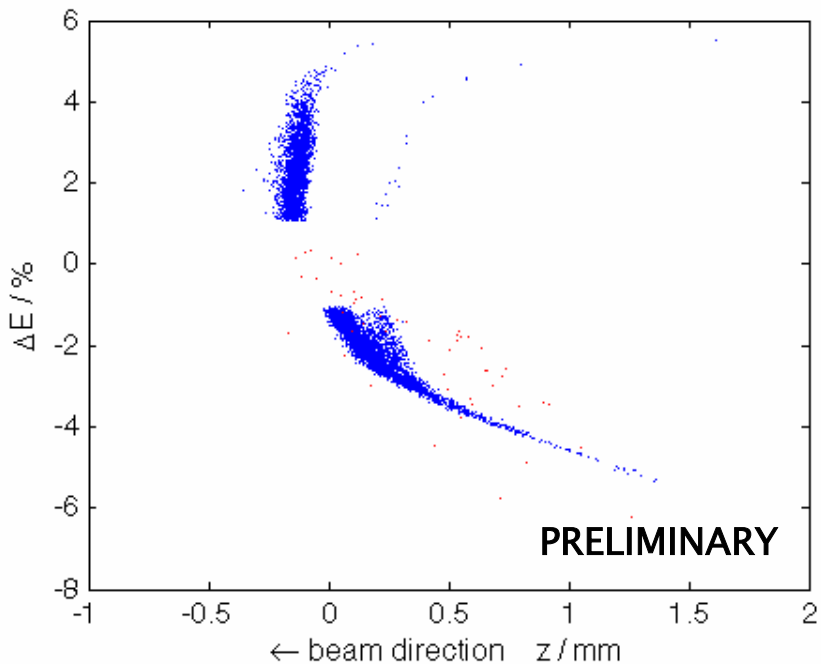
Creation of Twin Bunches

Simulations

- Energy loss by bremsstrahlung
- Beam dynamics

- Development in the following linac sections

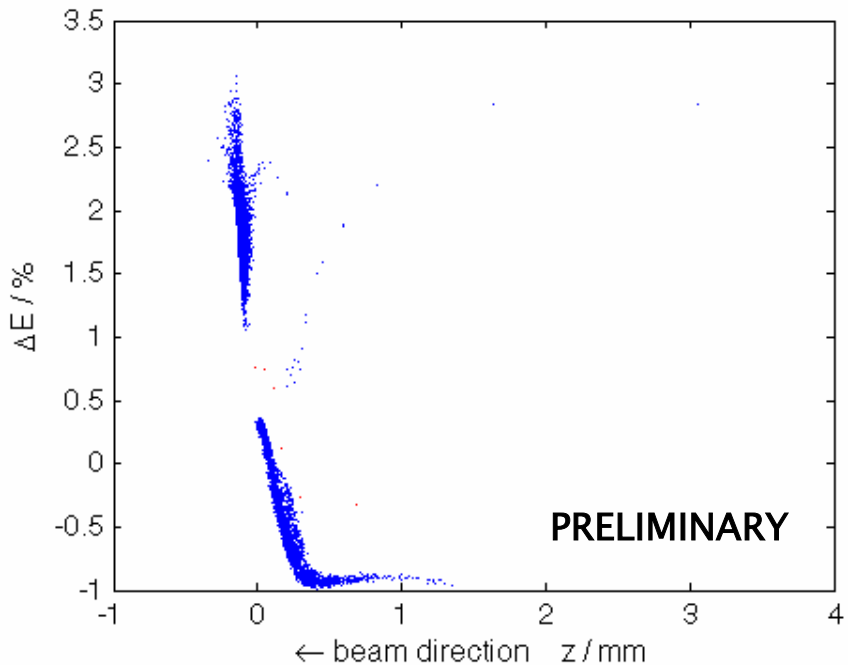


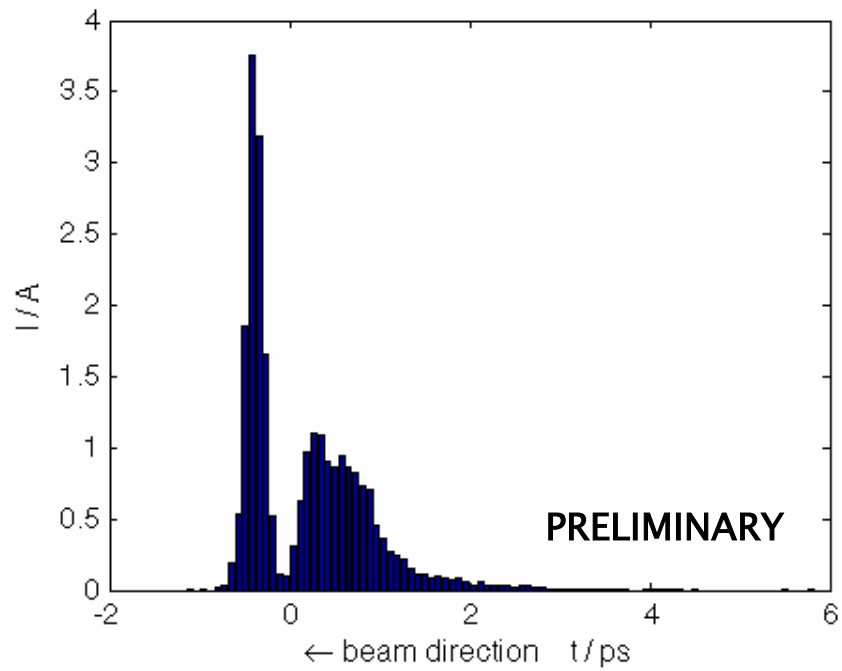


Creation of Twin Bunches

Simulations

- As there is an inherent E-z dependency at the position of the plasma, the two bunches will be separated in time
- Situation at the entrance of the plasma chamber





Creation of Twin Bunches

Practical Considerations

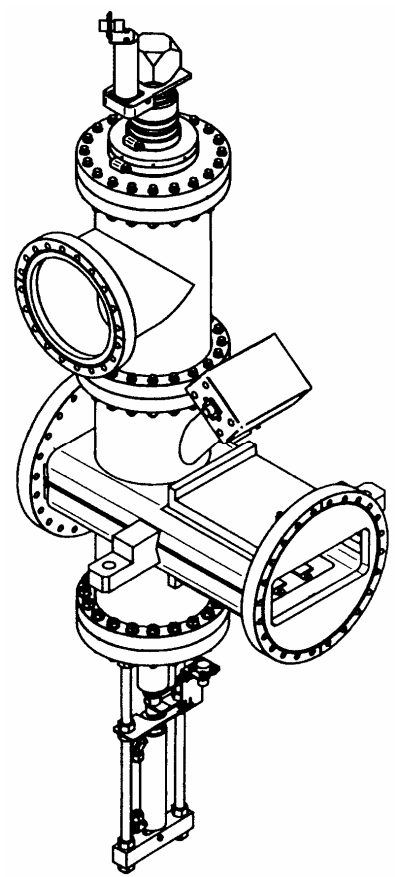
- Thickness of the absorber
- Cooling
- Positioning of the notch collimator

- Beam losses
- Development of the two bunches in the following accelerator
  - Wake fields
  - Coherent synchrotron radiation
- Stability of the bunch separation
- Preservation of the peak current of the drive pulse

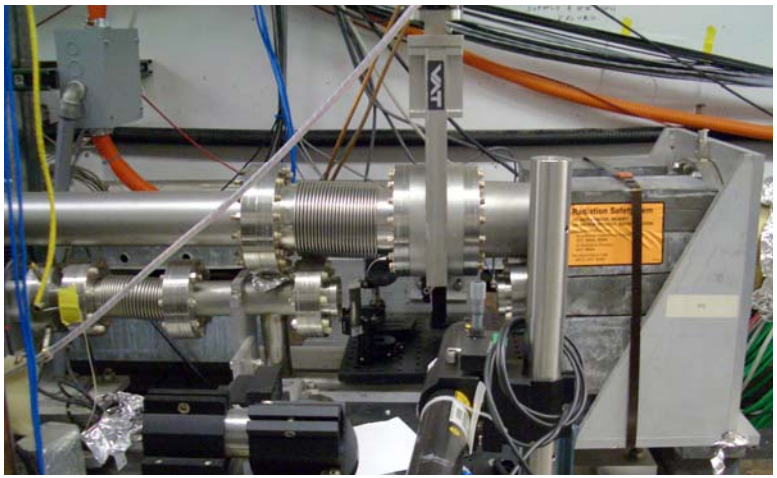
- Optimum distance and length of the witness pulse?
- Energy of the witness pulse is lower; how does this affect the measurements?

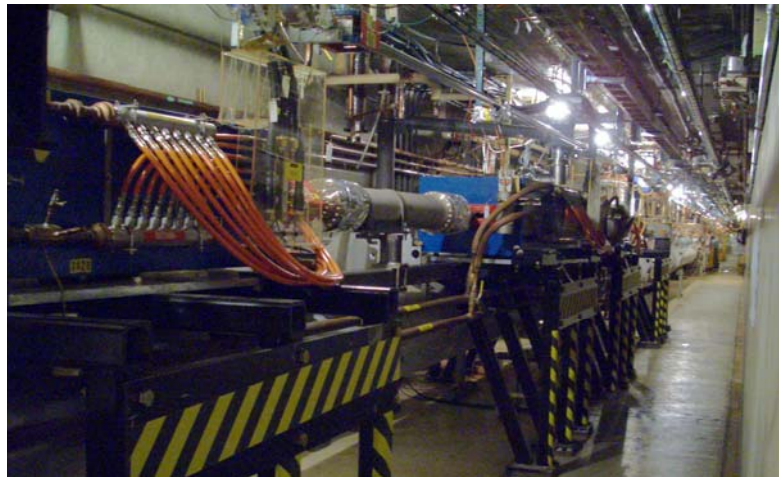
Diagnostics

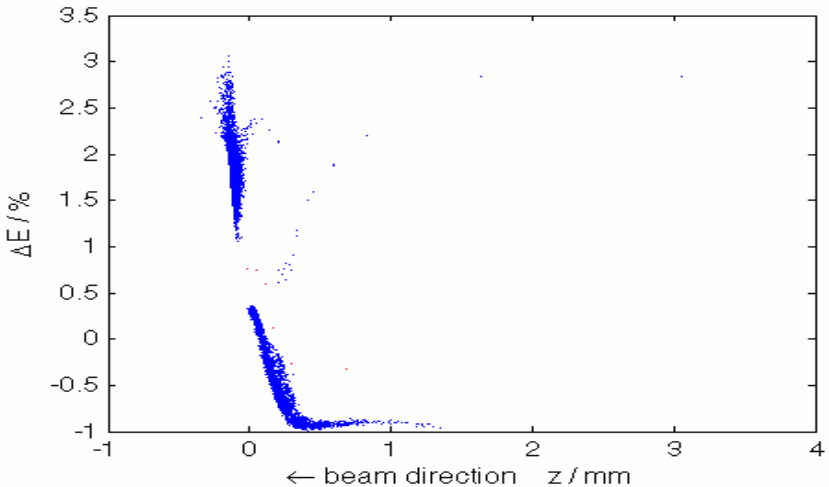
- Profile monitor in the chicane

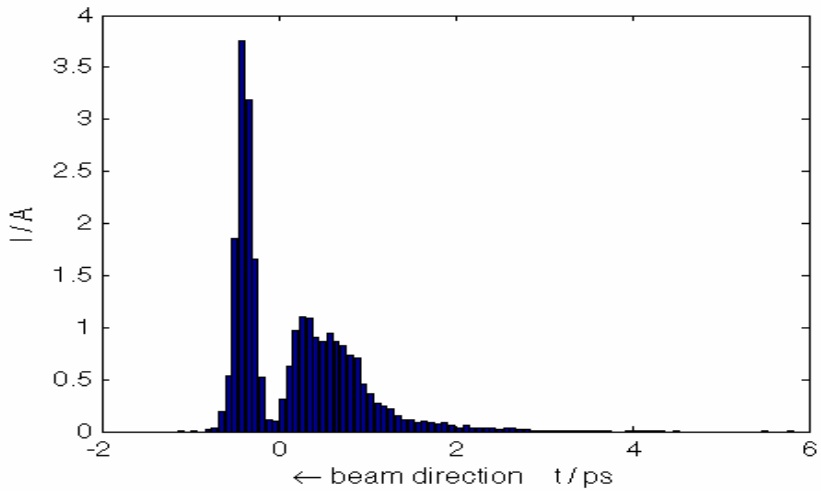


Conclusion






3.5
3
2.5
2
1.5
1
0.5
0
-0.5
-1
ΔE / %
-1
0
1
2
3
4
← beam direction z / mm


4
3.5
3
2.5
2
1.5
1
0.5
0
I / A
-2
0
2
4
6
← beam direction t / ps