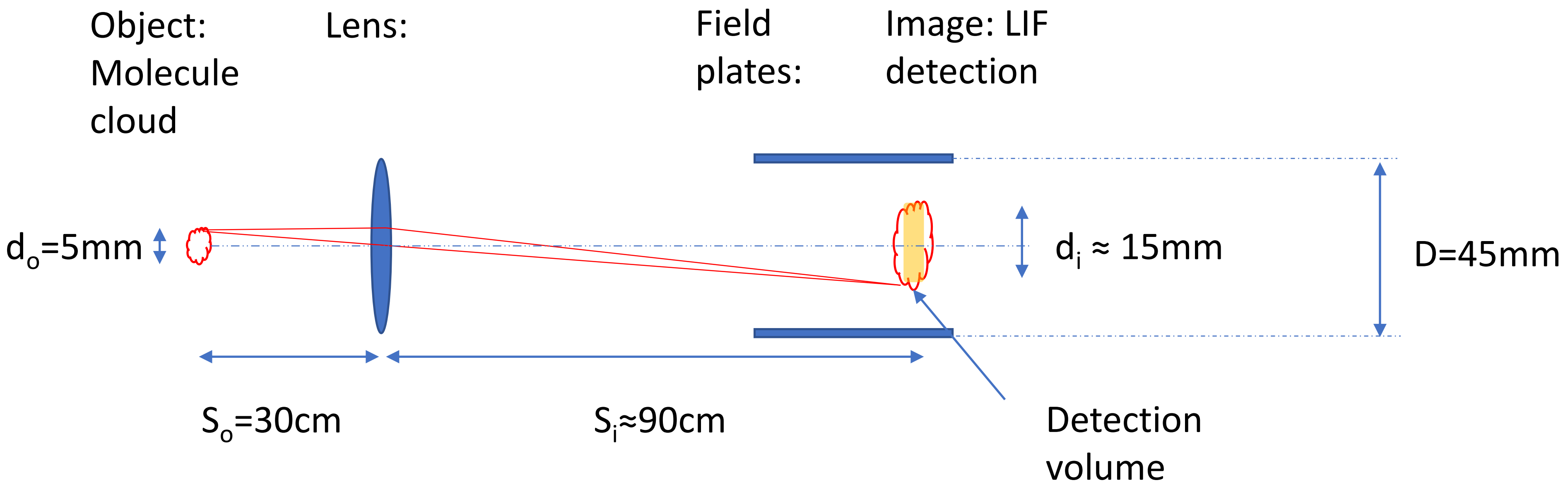
Towards eliminating ThO trajectories which hit the ITO coated Field Plates

Xing Wu

To avoid hitting the extended field plates

- ‘0^{th} order’ approximation:
  - Using ideal lens formula, and object has finite size (no aberration, no fuzziness)
  - Magnification=di/do=Si/So



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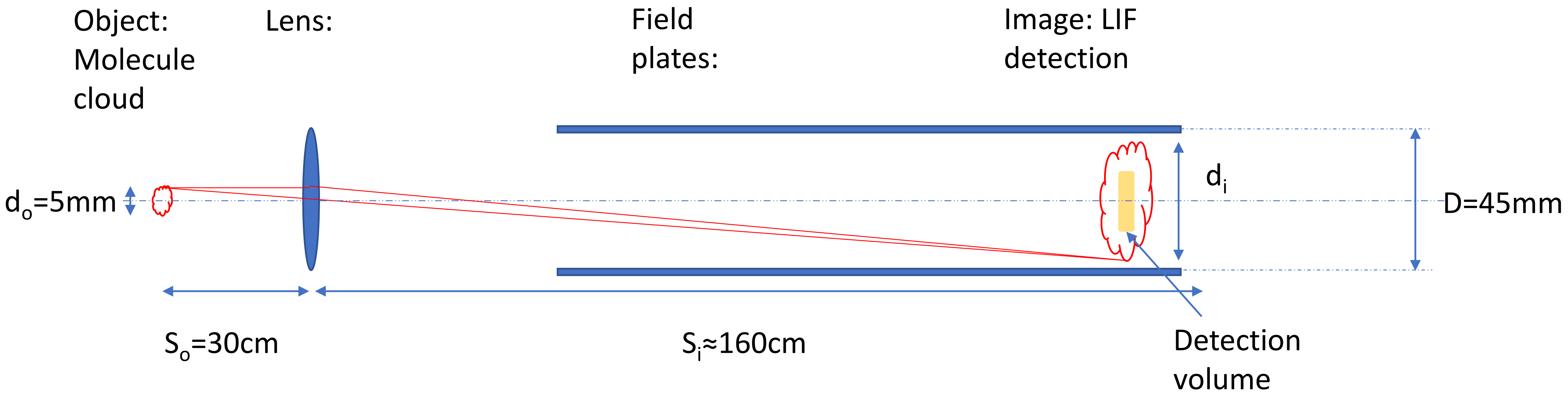
- Longer field plates → larger image. If take aberration (i.e. ‘fuzziness’ of the image) into account:
  - → smaller signal for a given finite detection volume (we already knew)
  - → more likely to hit the field plates



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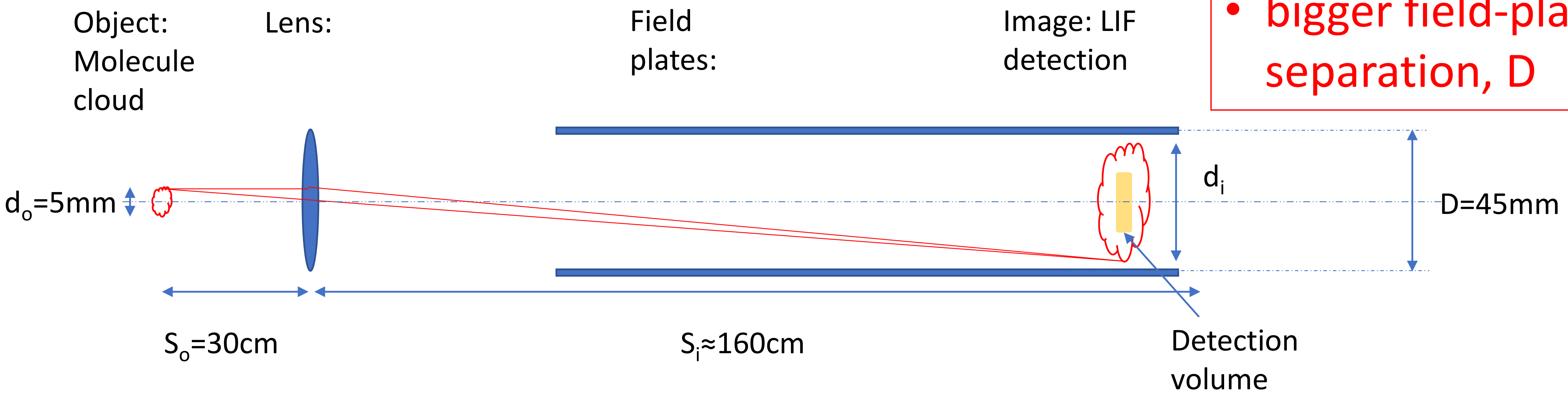
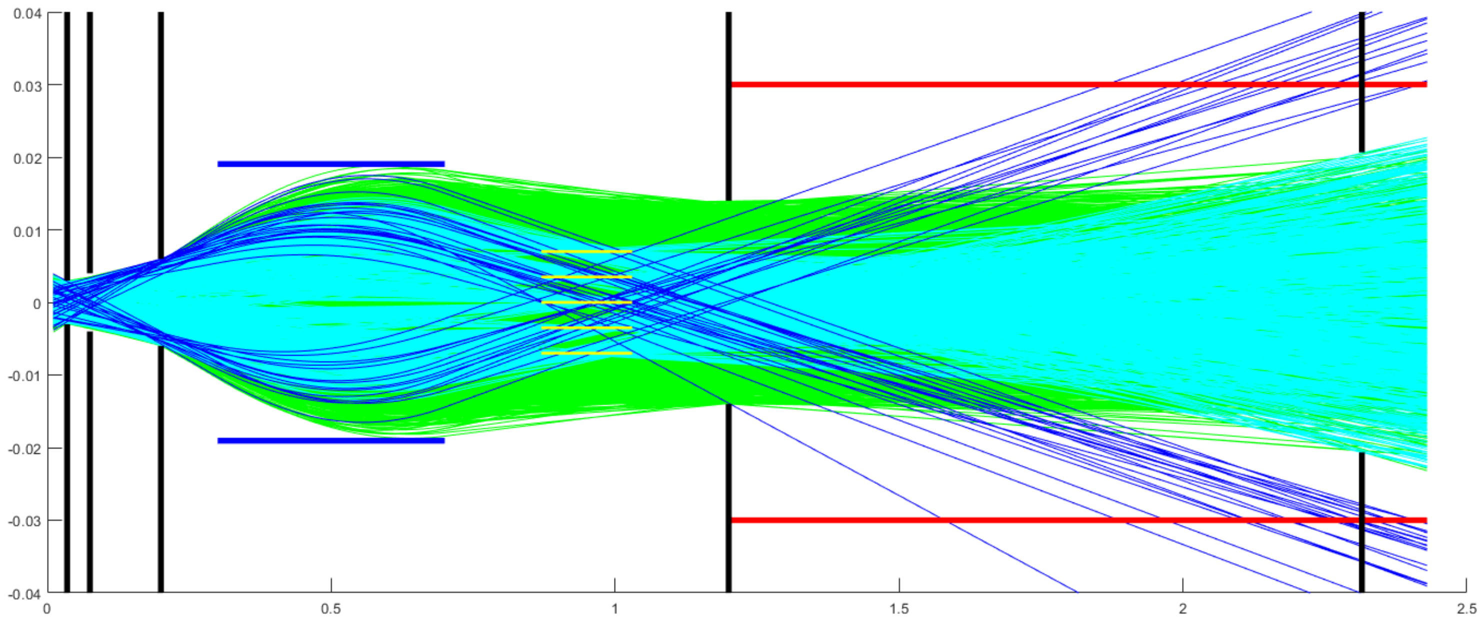
'Desirable' feature:

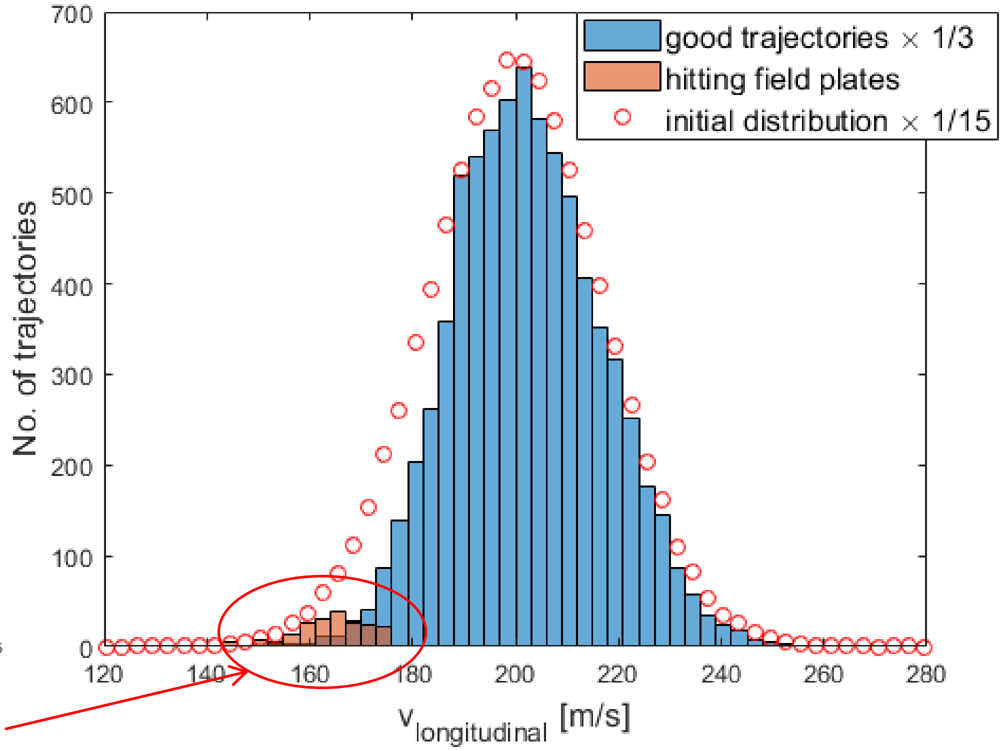
- Lens-to-field-plates distance as short as possible
- bigger field-plates separation, D



Looking at the trajectories

- Major difference between good & bad: longitudinal velocities

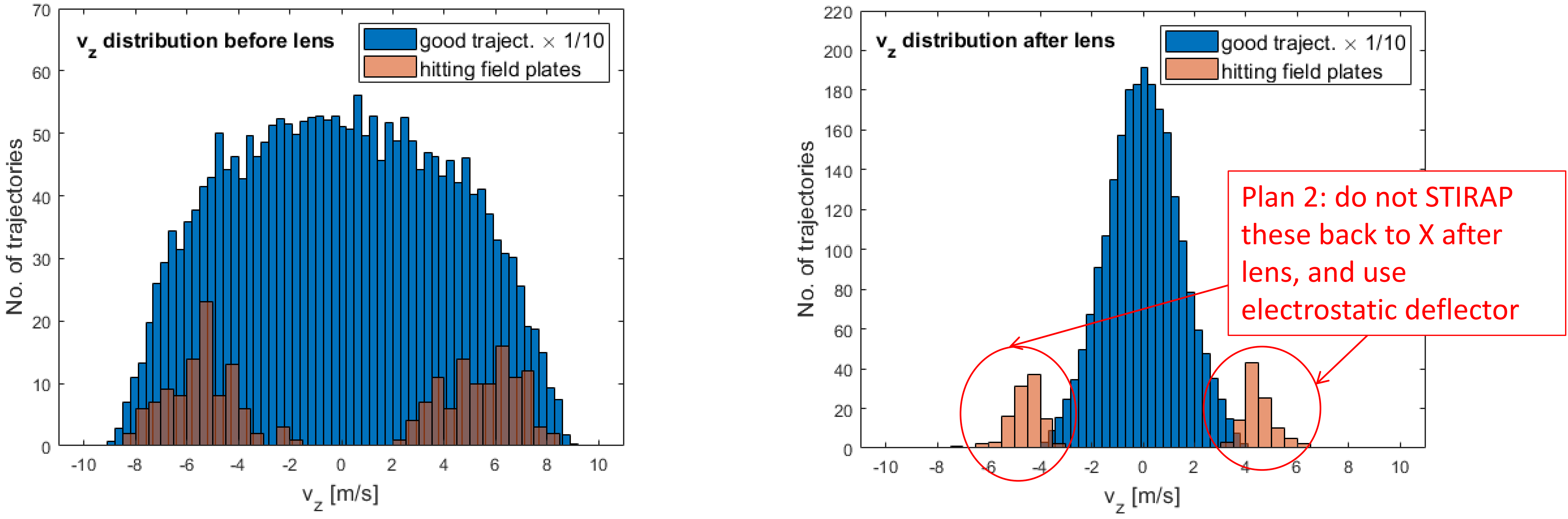




Plan 1: pump them out of the X-C-Q STIRAP ground state after rotational cooling & before STIRAP takes place

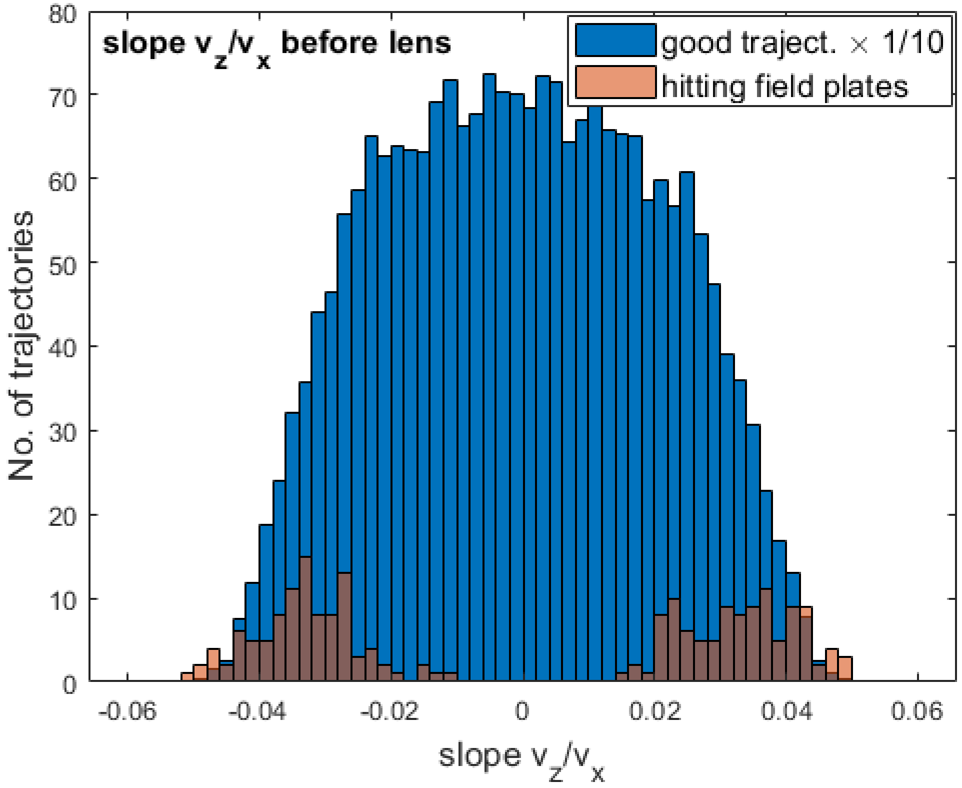
Transverse velocity (v_z) (z is the same as defined in ACME II)

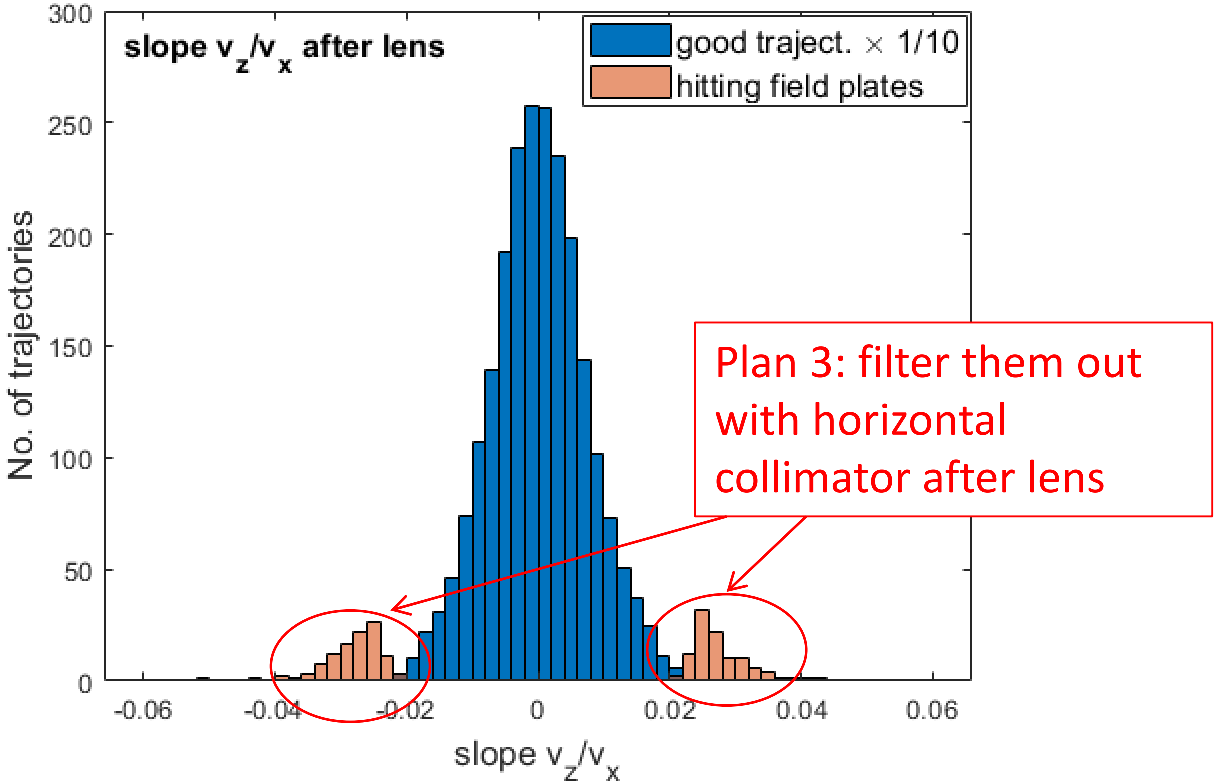
- Cannot differentiate good & bad trajectories in v_z before lens. But they get separated after lens because the bad ones are all slower in v_x and hence spend longer time in lens→ over-focused



Trajectory slope (v_z/v_x)

- The differentiation gets 'doubly' enhanced by looking at the slope (v_z/v_x). This is what the horizontal collimator tries to filter out. However, because of convolution between spatial distribution and slope of the trajectories, about x20 times more good trajectories (about 17% of all the good trajectories) are blocked than the bad ones (100% of the bad ones). Scatter from the collimator surfaces are not included yet





Proposed sensitivity gain for ACME III

extending Field Plates: from 43cm (2x11.5cm for fringing Fields + 20cm for spin precession) to 123cm

Also need to avoid ‘direct’ coating of ThO on Field Plates

Improvement	Signal Gain	EDM Sensitivity Gain
Increased Precession Time	0.20	2.3
Electrostatic Lens	16	4
SiPM Detector Upgrade	2.3	1.5
Timing Jitter Noise Reduction	1	1.7
Total	7.4	23.5

$$\delta d_e = \frac{1}{2T\mathcal{E}_{eff}\sqrt{N}}$$