Federal Ministry
of Education
and Research

Status Report on the Magnetohydrodynamic Simulations of a Tapered Plasma Lens for Optical Matching at the ILC e^+ Source

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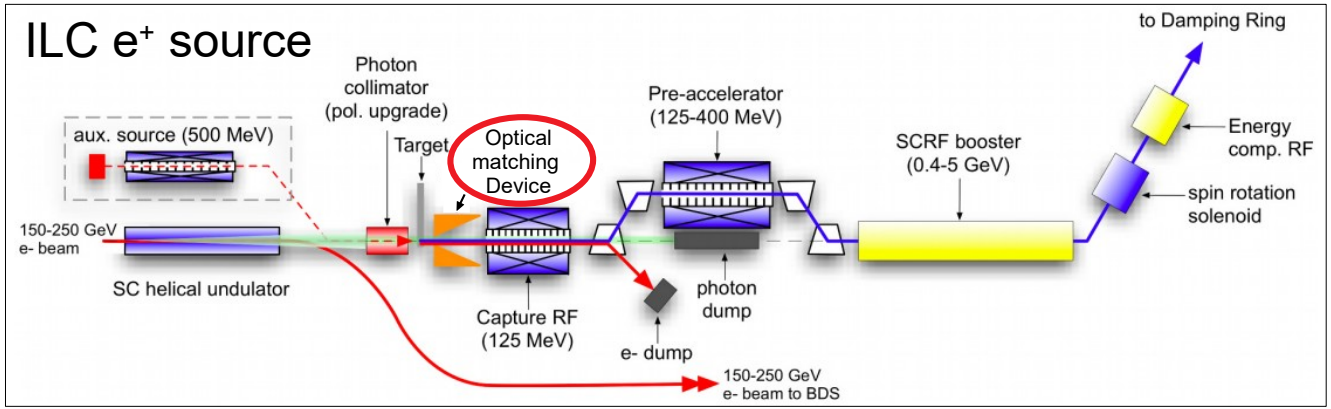
Motivation

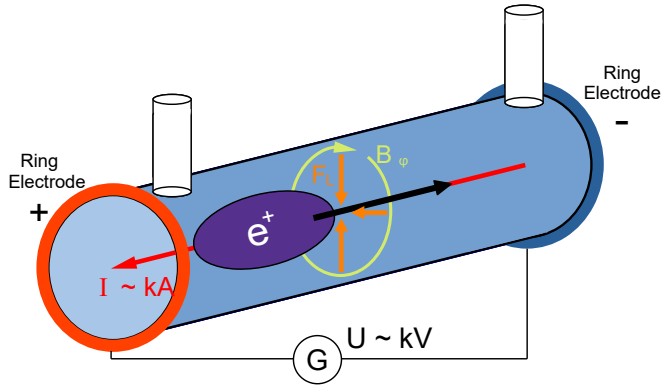
- Need to collimate divergent e+

  ➔ Optical Matching Device



- Principle of Plasma Lens:

  1) Inlets fill capillary with gas (e.g. H2, Ar)
  2) Voltage on electrodes ignites plasma
  3) Electrons are accelerated (Electric current)
  4) Current induces azimuthal magnetic field B_φ
  5) Magnetic field focuses incoming charged particle beam

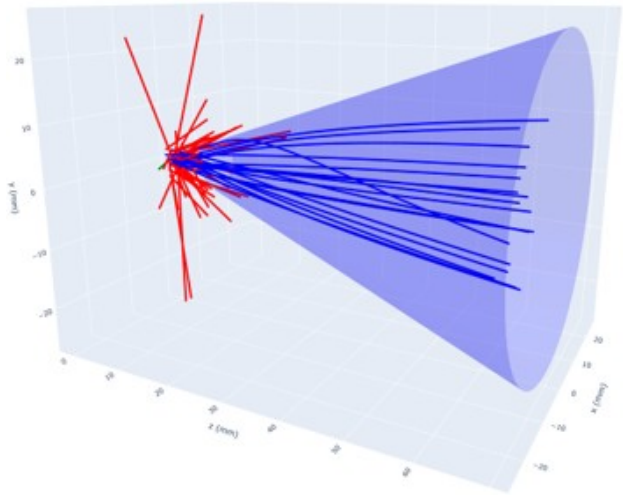


Source: Adolphsen, Chris, et al. “The International Linear Collider Technical Design Report-Volume 3. II: Accelerator Baseline Design.“, No. arXiv: 1306.6328. CERN, 2013.

Optmization of PL Design

Particle Tracking Simulations

- Goal: find optimized PL design
- Conditions:
  1) ILC e+ distribution
  2) No Beam self-interaction
  3) Idealised plasma lens:
     - ➔ No Plasma dynamics
     - ➔ Ideal magnetic field (from $j(x,y,z,t) = j_z(z)$)



➔ Result: ~43% captured e+ with Tapered capillary profile!

	Electric Current	Taper Type	Opening Radius	Exit Radius	Capillary Length
Full Scale:	9000 A	linear	4.30 mm	25.5 mm	60 mm
Prototype:	350 A		0.85 mm	5.0 mm	12 mm

Downscaled by factor ~5

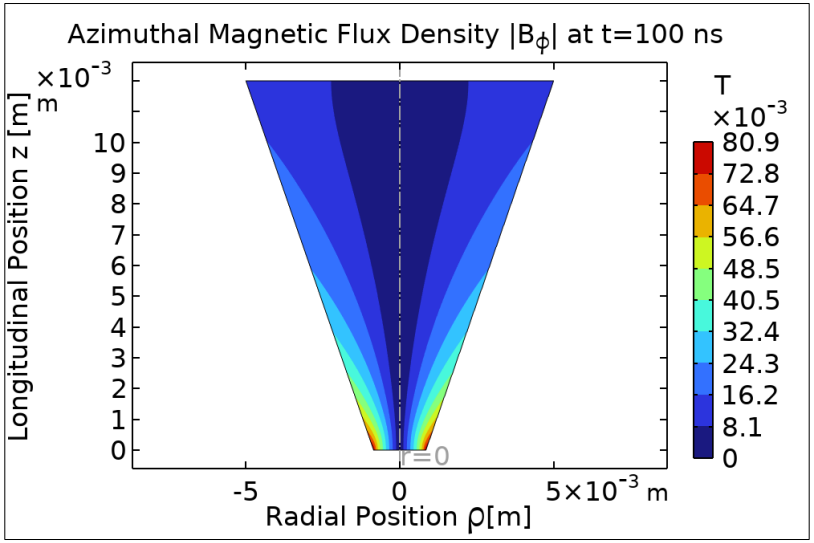
Large dimensions!

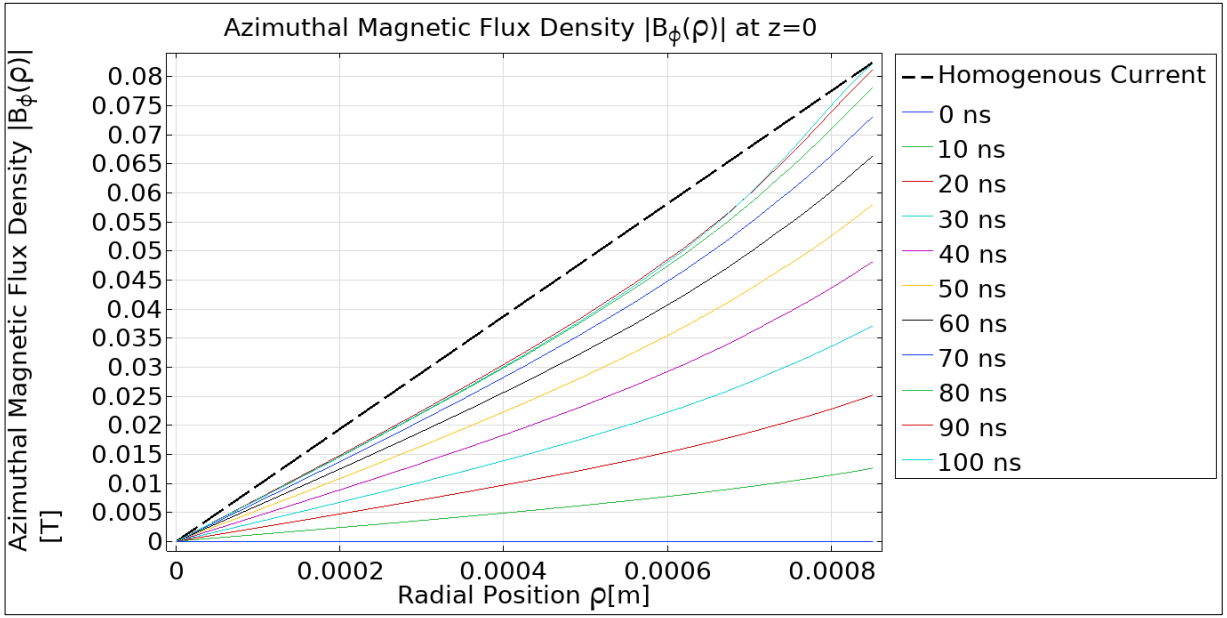
Preliminary (M)HD Results

Model by M. Mewes

- Simulations in COMSOL
- Effective 3D Model (2D with axial sym.)

- Simulated Field underperformes!
  - ➔ Probably no problem
    1) Large overhead
    2) More realistic simulation needed





Outlook

- Implementations needed:
  1) Argon reactions (instead of H2)
  2) More realistic electrode geometry
  3) Angled Inlets
  4) Realistic materials of components
  5) Rotating target

- To study:
  1) Plasma response to multi-pulse discharges
     ➔ Demanding e+ beam time structure
  2) Gas flow into downstream accelerator
     ➔ Discharges in cavity possible (no acceleration)
  3) Heat load on geometries

	Repetition rate	Duration	Spacing
Pulse	5 Hz	727 μs	199 ms
Bunch	1.8 MHz	538 ps	554 ns

- Compare with prototype experiments by Niclas Hamann (next talk)

Thank you
for listening!