Studies for Particle Driven Plasma Acceleration at PITZ

Current Activities

Matthias Gross
PITZ Physics Seminar
Zeuthen, 1. November 2012

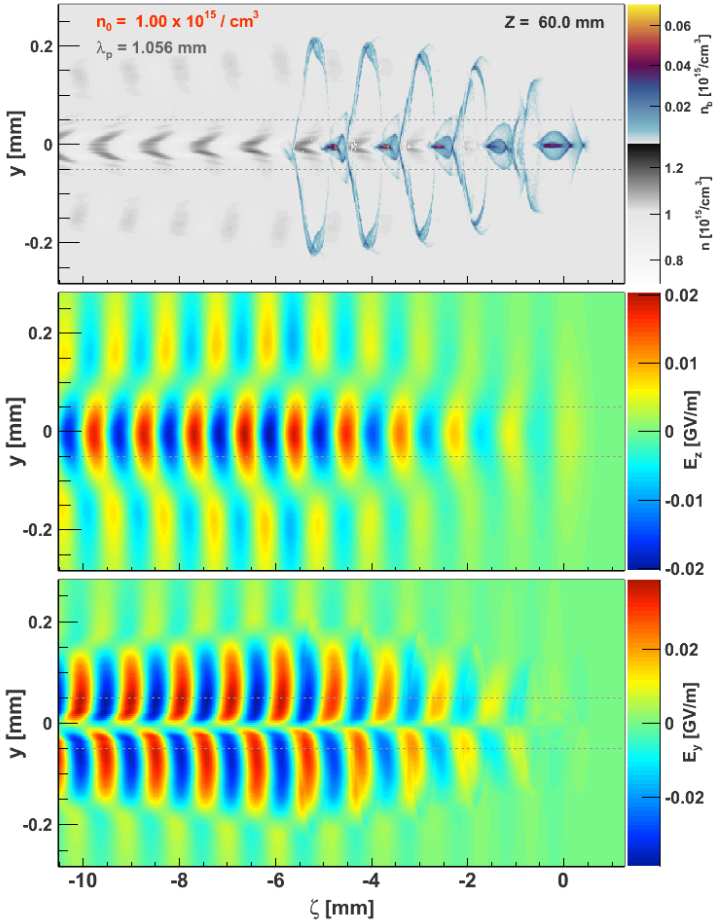
HELMHOLTZ ASSOCIATION

PITZ Photo Injector Test Facility Zeuthen

DESY

PIC (Particle in Cell) Simulation of PITZ Experiment

Beam parameters	Setup 1
Total charge, pC	100
Longitudinal beam position, m	6.35
Horizontal rms beam size, um	49.8
Vertical rms beam size, mm	51.2
Bunch length in FWHM, mm	5.92
Average kinetic energy, MeV	24.55
Rms energy spread, keV	27.5
Peak slice current, A	5.2
Horizontal rms emittance, mm mrad	0.37
Horizontal beam divergence, mrad	0.008
Vertical rms emittance, mm mrad	0.38
Vertical beam divergence, mrad	0.002
Longitudinal rms emittance, keV mm	42.4
Peak beam density, 10^12 e / cm^3	9.1



> Expected energy modulation ≈600 keV. PITZ beam energy spread as low as ≈60keV. Resolution of TDS/HEDA2: 10keV and 100μm (Malyutin et al. "Simulation of the Longitudinal Phase Space Measurements With the Transverse Deflecting Structure at PITZ", *Proc. of IPAC 2012, MOPPP034* → Measurable

Simulations:
Alberto Martinez de la Ossa

DESY

Lithium Plasma Cell

> Principle:

- Evaporate Lithium in central pipe (700°C)
- Define beginning and end of Lithium zone with steep temperature gradient and Helium buffer gas
- Once pressure regions have stabilized:
  - Ionize Lithium gas with laser
  - Inject particle beam for PWA experiment

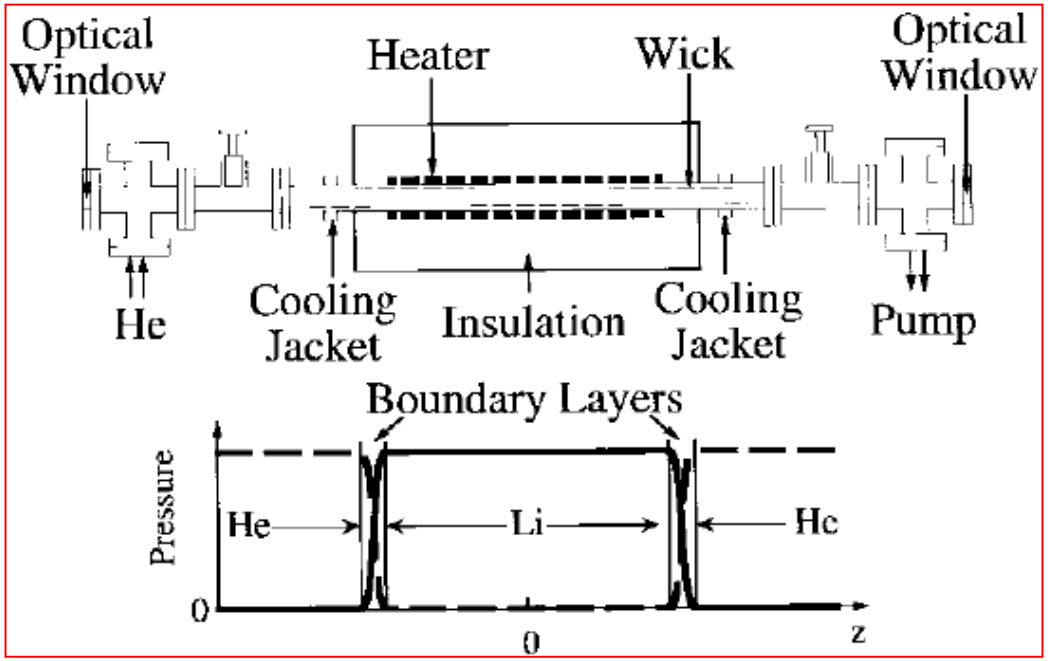
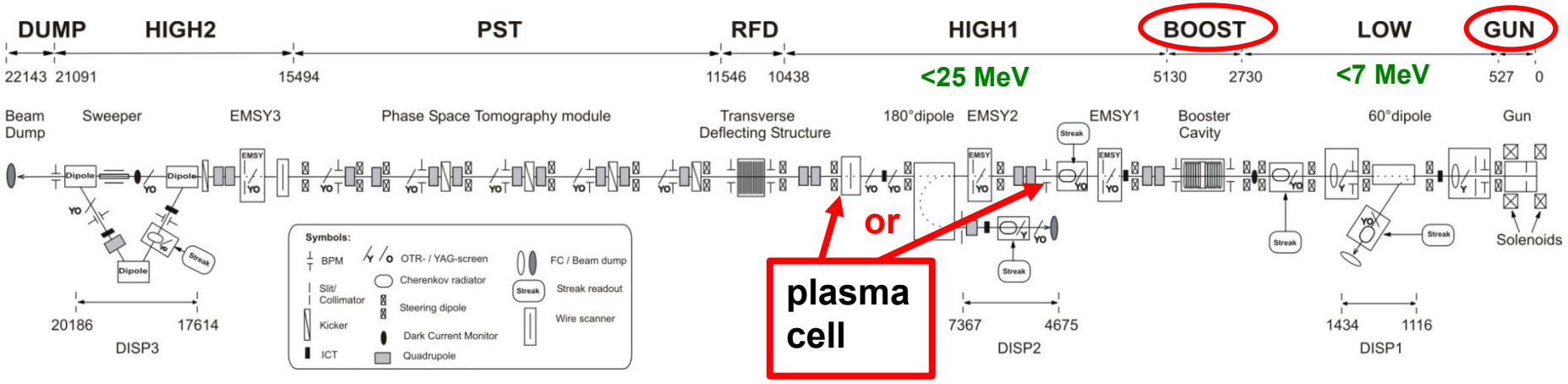


Figure from: P. Muggli et al. “Photo-Ionized Lithium Source for Plasma Accelerator Applications”, *IEEE Trans. Plasma Science* **27** (1999), pp. 791-799

Insertion of Plasma Cell into PITZ Setup

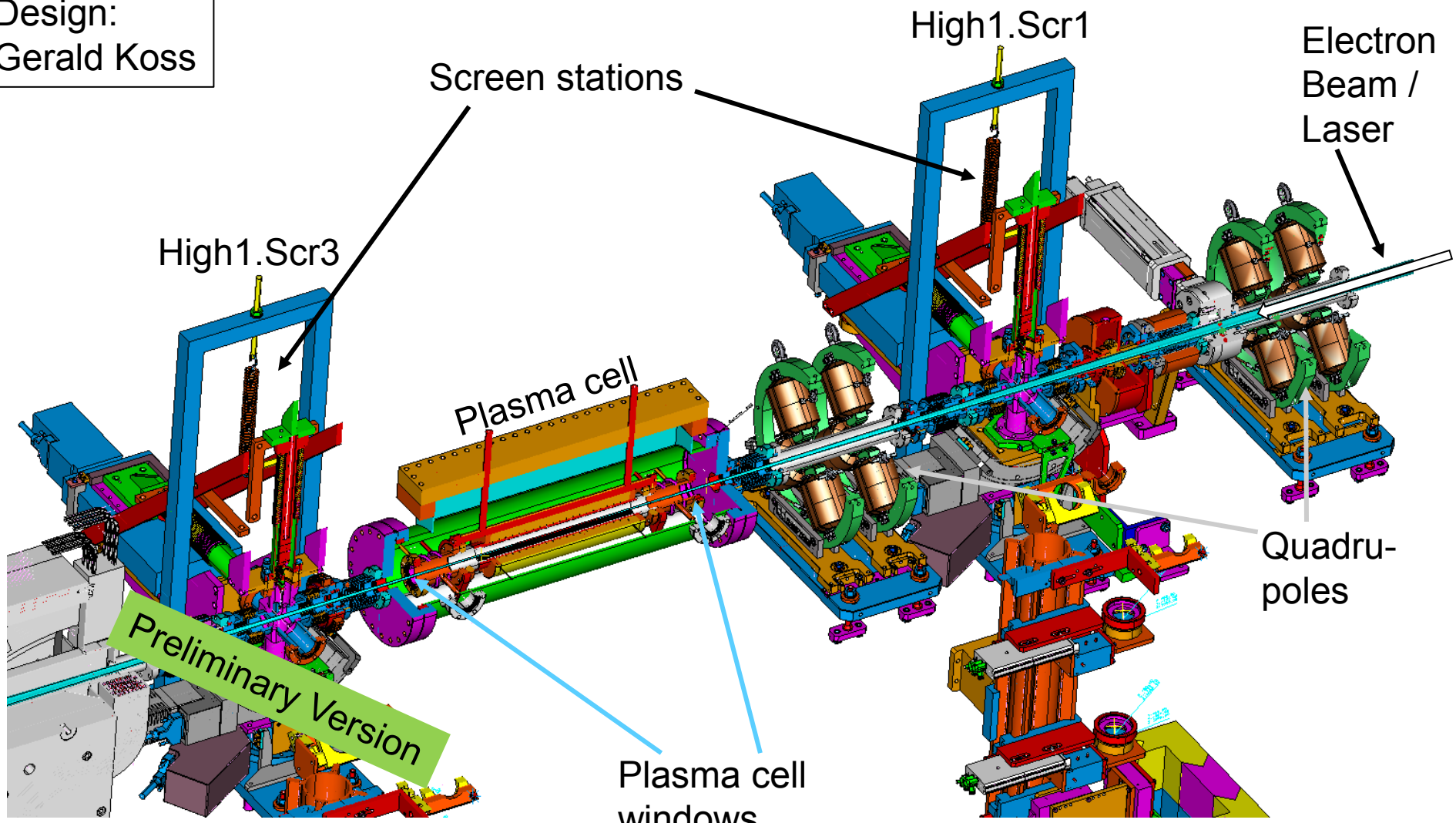
- PITZ 2 setup to be used for first plasma experiments



- Plasma cell has to be between booster and TDS
- Two possible positions, both with a length of about 1m
- Beam dynamics simulations to determine which position is more favorable → Before dipole

Plasma Cell Assembly: Sketch

Design:
Gerald Koss



Plasma Cell Window: On Axis Window to Contain Gas in Plasma Cell

- Has to let 25 MeV electrons pass
  - GEANT simulations (conducted by Dieter Richter, HZB)
  - → Polymer windows show low scattering
- Withstand pressure difference (10^{-4} mbar inside; 10^{-9} mbar outside)
  - Calculation of tear resistance (conducted by Dieter Richter, HZB)
  - → Thickness of 25 μm is sufficient
- Transparent enough to let ionization laser pass without damage
  - Experiments at MBI with Ti:Sa Laser (conducted with help from Gerd Priebe, MBI)
  - → Kapton (polyimide) shows high damage threshold ($2*10^{12}$ W/cm^2) – with safety margin: 8mm diameter spot size of laser on window is tolerable
- Selected window material: 25μm thick Kapton foil (continue to look for even better material)

Experiments have started with Plasma Cell Prototype

- First: Measurement of temperature profile with air in plasma cell tube