Laser- and beam-driven plasma-wakefield acceleration studies

Laboratory for laser- and beam-driven plasma acceleration (LAOLA)

LAOLA working-group coordinators:

E. Elsen, K. Flöttmann, B. Foster, F. Grüner, J. Osterhoff, H. Schlarb, B. Schmidt, F. Stephan

People that are doing the actual work:

J. Grebenyuk, A. Martinez de la Ossa, L. Schaper, C. Palmer, M. Schnepp, T. Mehrling, T. Kleinwächter, J.-P. Schwinkendorf, …

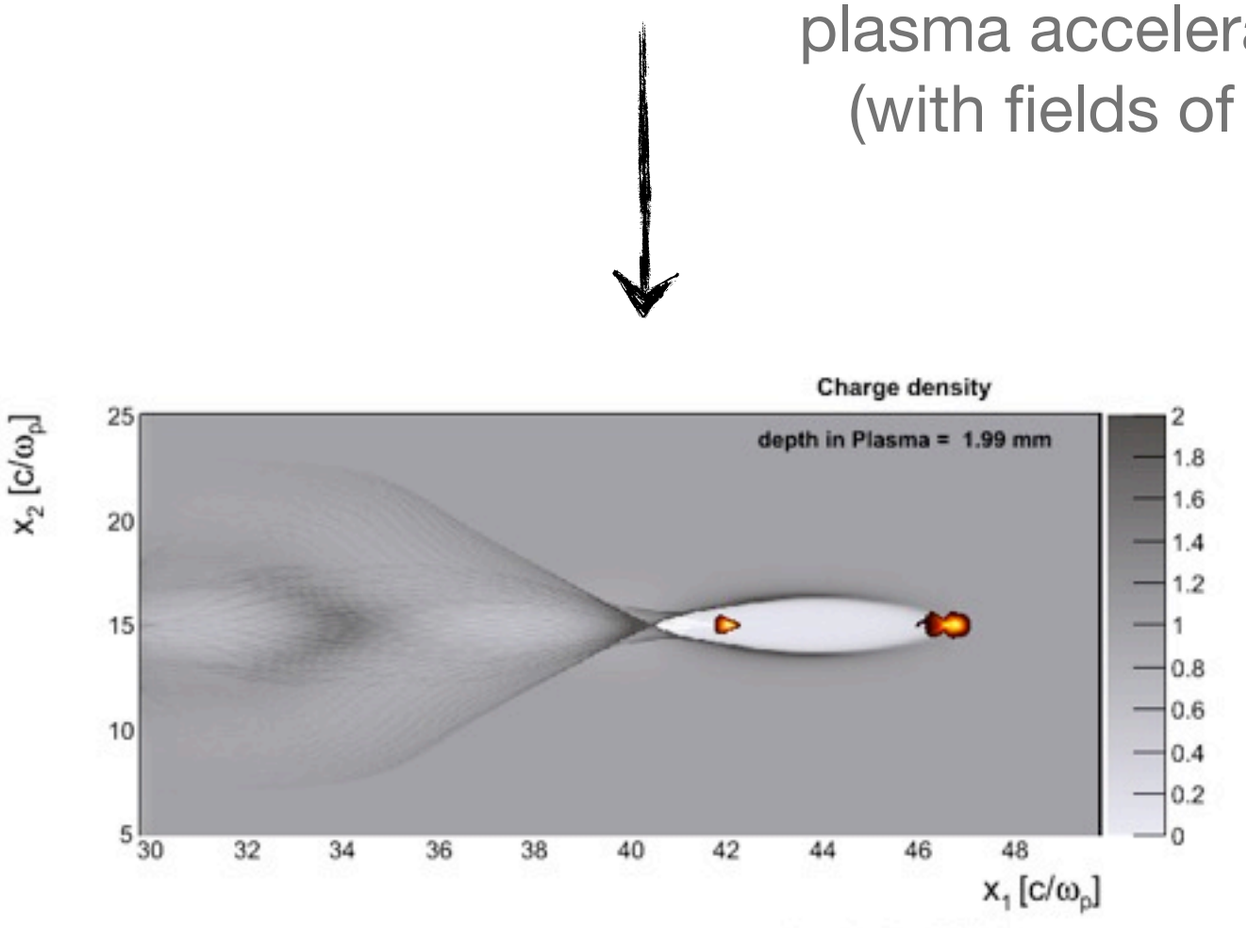
DESY, FLASH Accelerator Workshop, October 4, 2011

The proposal

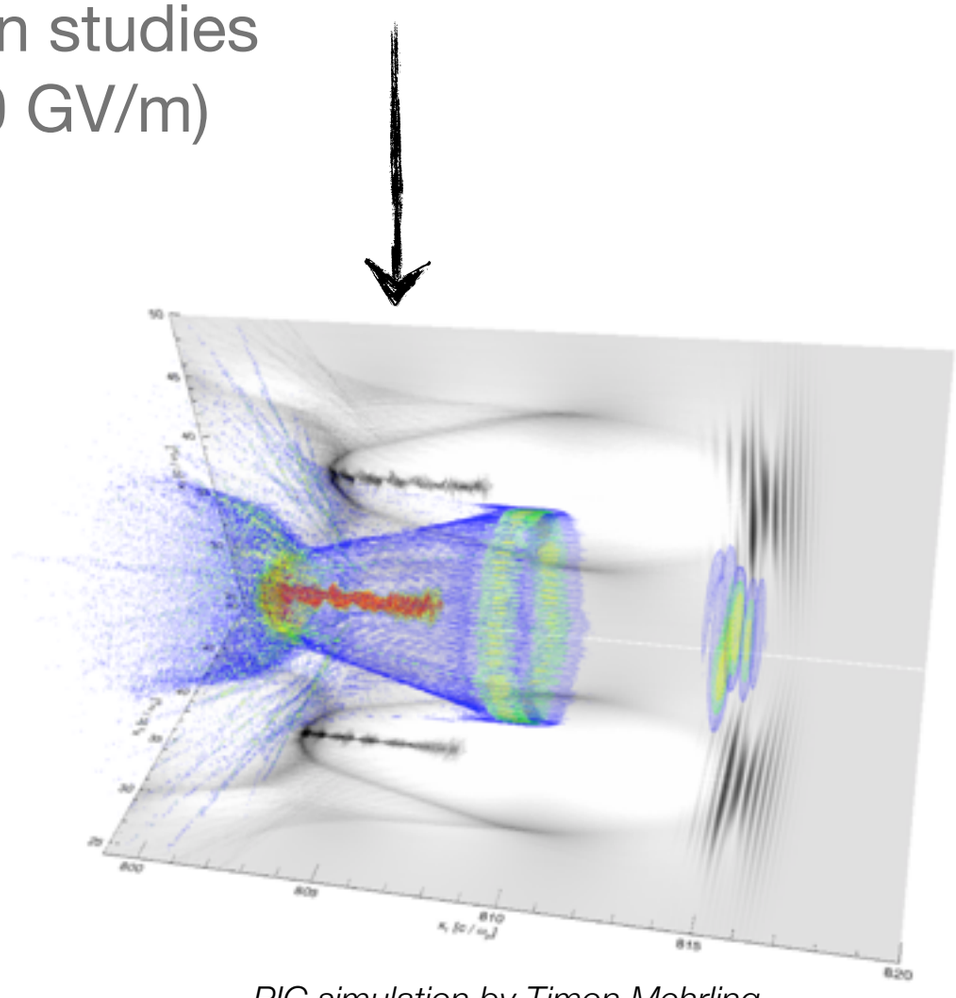
Beam-driven

Laser-driven

plasma acceleration studies
(with fields of ≳10 GV/m)



PIC simulation by Alberto Martinez de la Ossa



PIC simulation by Timon Mehrling

Why at FLASH? Scientific motivation…

- FLASH offers unique electron-bunch shaping capabilities
  - triangular beams
    → *P. Piot's talk*
  - tailored bunch trains
    (e.g. with the addition of a PITZ-like gun-laser system)

- GeV beam energy
  - stiff beams (compared to e.g. PITZ and REGAE)
  - beam gamma ≧ wake gamma for LPA case

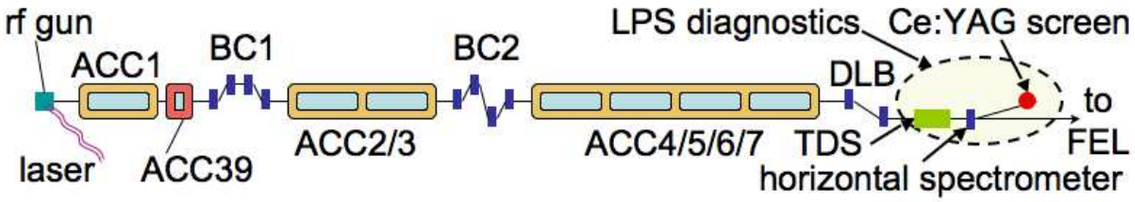
DESY TESLA-FEL 11-02 and FERMILAB-PUB 11-339-APC

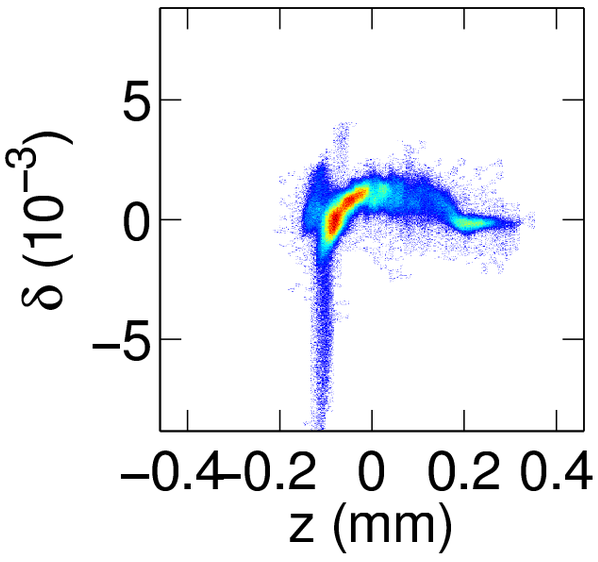
Generation and Characterization of Electron Bunches with Ramped Current Profiles in a Dual-Frequency Superconducting Linear Accelerator

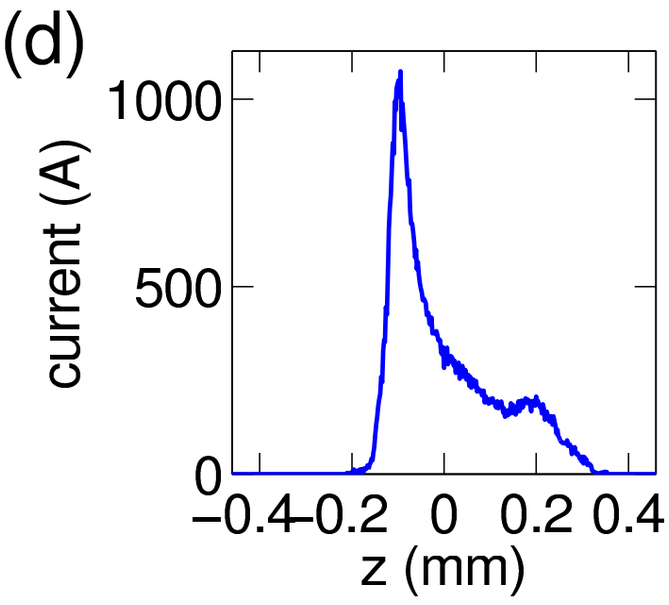
P. Piot,[1,2] C. Behrens,[3] C. Gerth,[3] M. Dohlus,[3] F. Lemery,[1] D. Mihalcea,[1] P. Stoltz,[4] and M. Vogt[3]

[1] *Northern Illinois Center for Accelerator & Detector Development and Department of Physics, Northern Illinois University, DeKalb IL 60115, USA*
[2] *Accelerator Physics Center, Fermi National Accelerator Laboratory, Batavia, IL 60510, USA*
[3] *Deutsches Elektronen-Synchrotron DESY, Notkestraße 85 D-22607 Hamburg, Germany*
[4] *Tech-X Corporation, Boulder, CO 80303, USA*

(Dated: September 8, 2011)

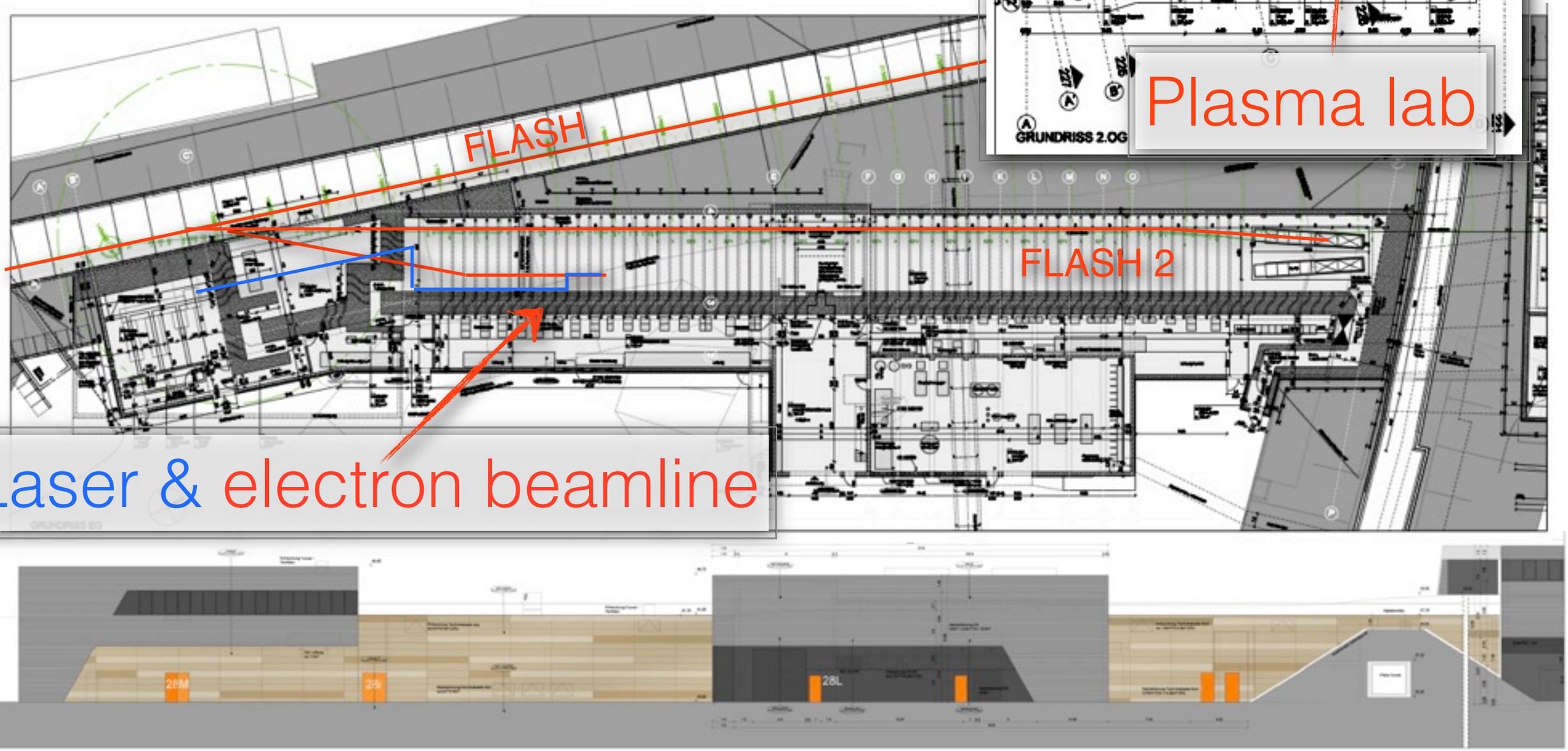




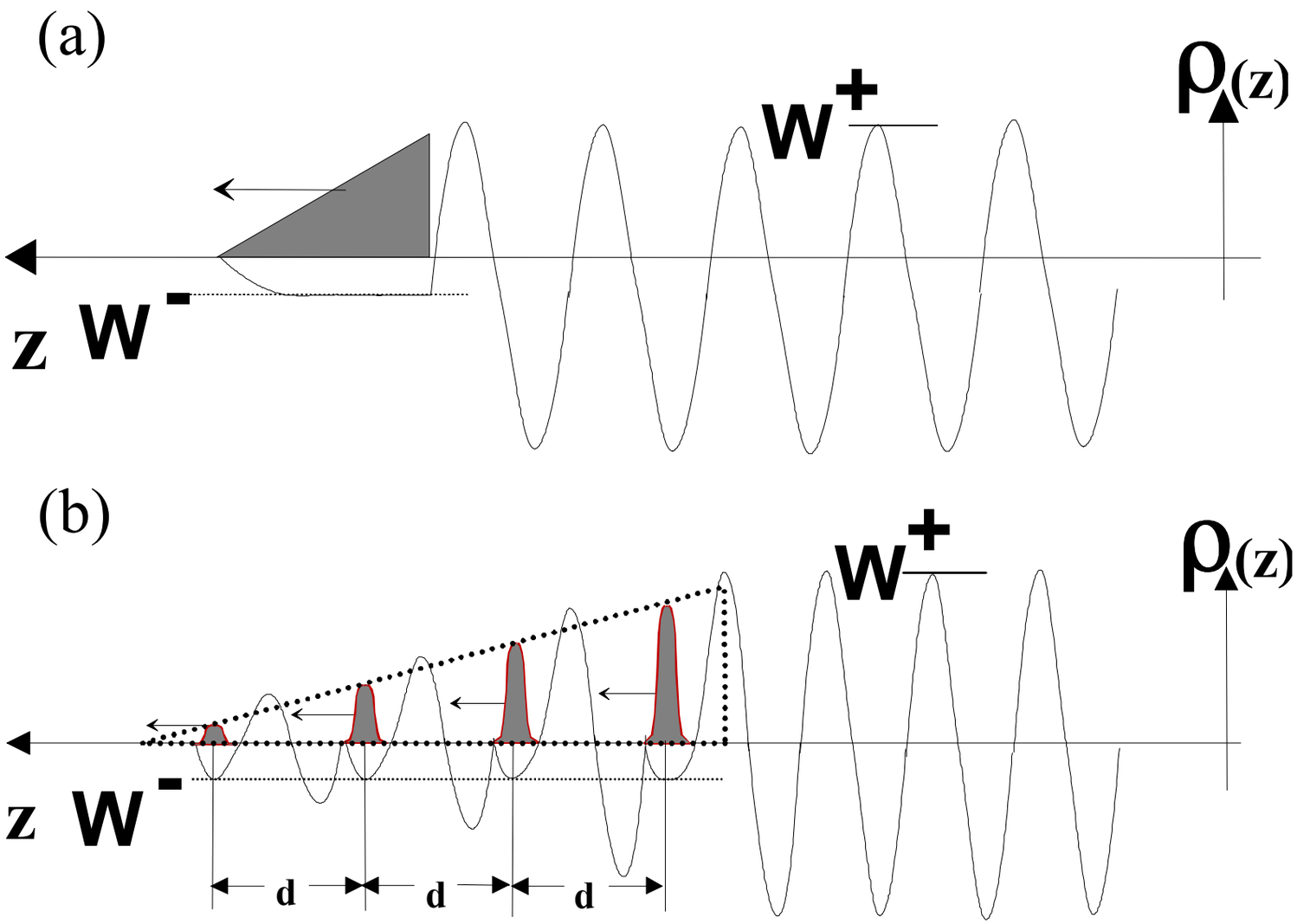


Location of the experiments

- Dedicated plasma and preparation lab
- Plasma beam line parallel to FLASH 2



Multi-bunch driver for increased transformer ratio



from J.G.Power *et al.*,
PAC Proceedings 115 (2001)

- Charge density increases linearly to cancel field (under each bunch and excite the wake resonantly)

Challenges of PWA studies at FLASH

- Generate
  - short bunches for LPA → FLASH fs-bunch operation, J. Roensch-Schulenburg
  - charge ramps → studies led by P. Piot, C. Behrens
  - bunch trains → requires work on gun laser-system

- Transport bunch into FLASH II tunnel
  - maintain beam properties (short pulse duration, beam shape, ok emittance)
  - synchronize with laser to within a few 10 fs rms

- Conduct studies (beam-driven after 2013, laser-driven after 2015)
  - get sufficient beam time, possibly symbiotic (or parasitic) operation
  - explore fully remote operation of plasma experiments

Conclusions

- FLASH provides ample opportunities and could become a unique facility for plasma-wakefield experiments
  - Multi-bunch patterns
  - Controlled bunch charge distribution
  - Synchronized to multi-hundred TW system

Numerous novel beam- and laser-induced plasma experiments will become possible

...setup also compatible with wakefield experiments in dielectric structures → P. Piot's talk, up next

Thanks for your attention!