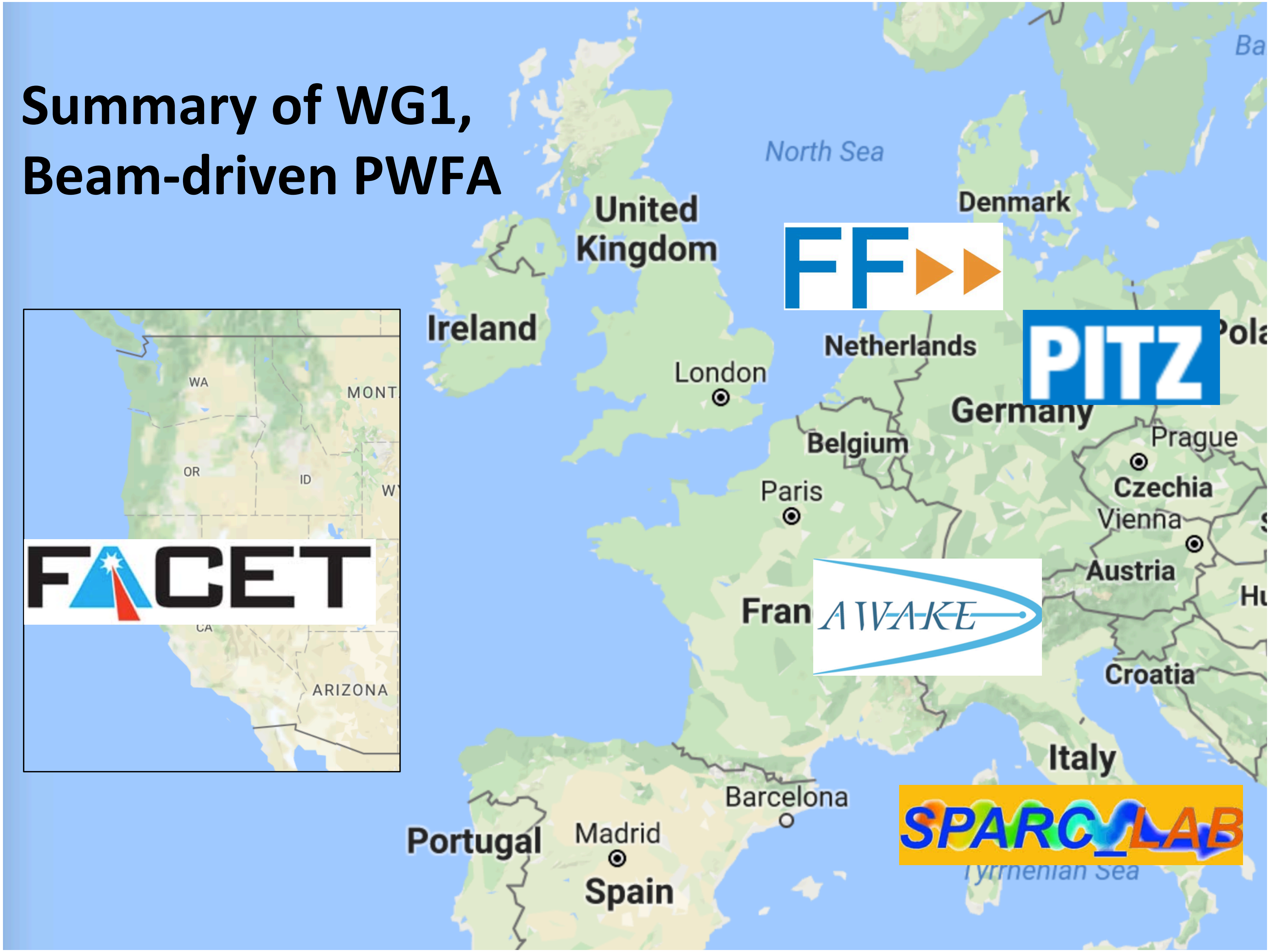
Summary of WG1, Beam-driven PWFA



Carl A. Lindstrøm, University of Oslo and FACET, SLAC

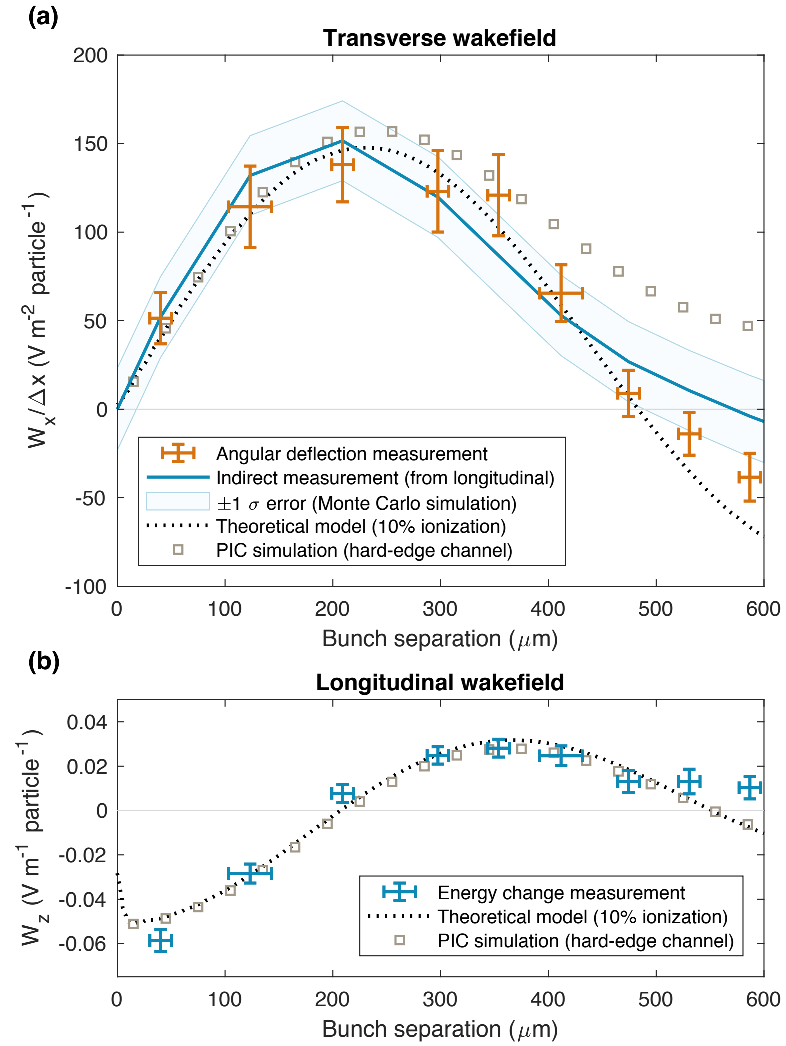
Measurement of transverse wakefields in a positron-driven hollow channel

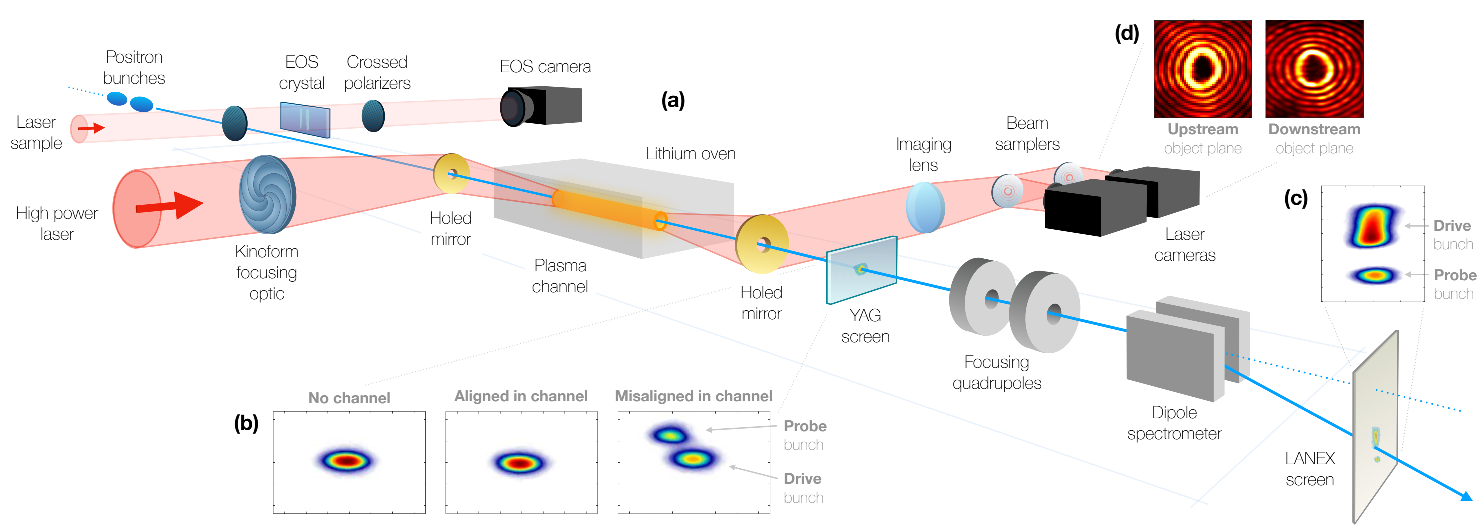
- **Hollow plasma channels**: a proposed method to accelerate low emittance positrons with high gradient (key to a complete plasma linear collider concept). Challenge: **Strong deflecting transverse wakefields** for misaligned beams.

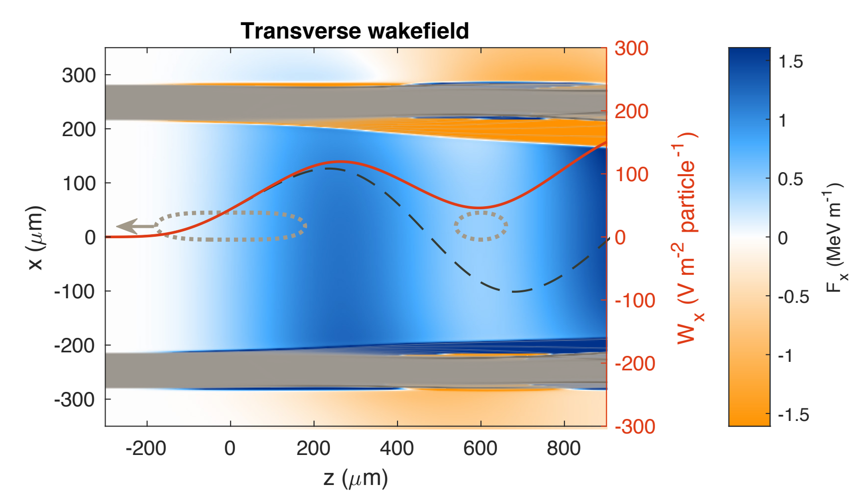
- **E225** Hollow Channel experiment at **FACET at SLAC**:
  – Two-bunch 20 GeV positron beam (0.5 nC drive bunch + 0.1 nC probe bunch)
  – 25 cm long, 500 μm diameter hollow channel using a high-order Bessel kinoform

- **Transverse offset of channel was scanned for many probe positions behind the drive bunch.**
  – Transverse wakefield measured directly via the kick of the probe bunch.
  – Extra independent measurement: Indirect estimate of transverse wakefield from the measured longitudinal wakefield via the Panofsky-Wenzel theorem.

- **Good agreement between theory and experimental measurements!** Some discrepancy further behind the drive bunch, likely due to imperfect knowledge of radial plasma profile.



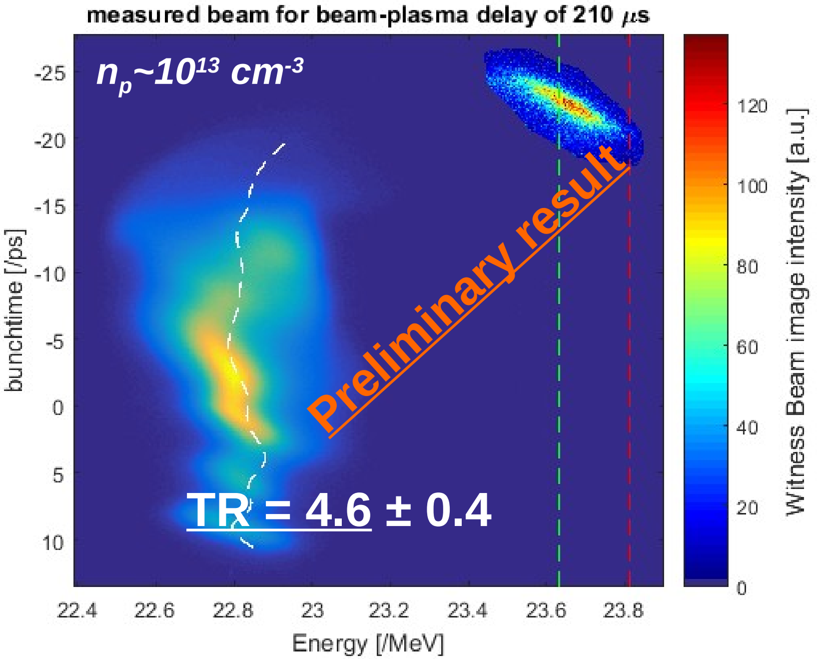




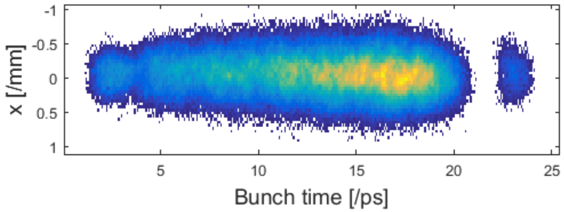
High Transformer Ratio PWFA demonstration @ PITZ

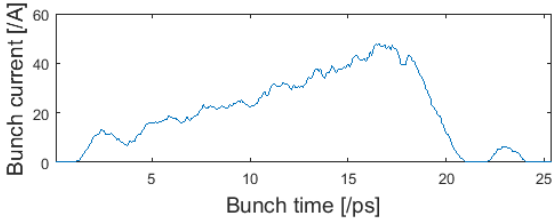
Gregor Loisch (DESY, Zeuthen)

- Photocathode laser based shaping of (double) triangular electron bunches was achieved
- Measured Transformer Ratios up to ~4.9 +- 0.6 (detailed analysis ongoing)
- Stable Driver (L~λ_p) transport over 100 mm Plasma (Gradient ≤ 10 MV/m)
- Improved bunch shaping capabilities under assembly



Driver ~715 pC, Witness ~15pC
Energy gain ~0.7 MeV





Bunch Shape Measurement 700 pC

Alexander Knetsch (DESY, Hamburg)

FLASHForward X-1

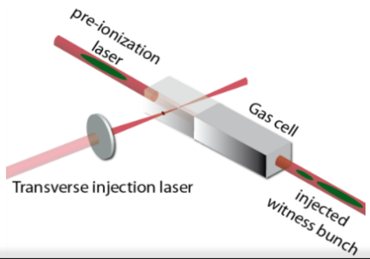
High-quality electron beams from a plasma cathode

A. Knetsch, S. Bohlen,J. Dale, R. D'Arcy, J.-H. Röckemann, B. Hidding, Z. Hu, V. Libov, T. Mehrling, P. Niknejadi, A. M. de la Ossa , K. Poder , L. Schaper, B. Sheeran, M. Streeter, G.Tauscher, M. Quast , J. Zemella, J. Osterhoff

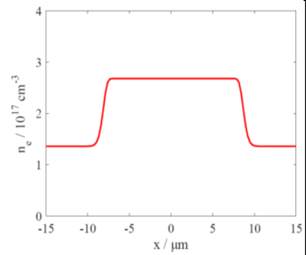
X-1 is the internal injection PWFA experiment at FLASHForward.

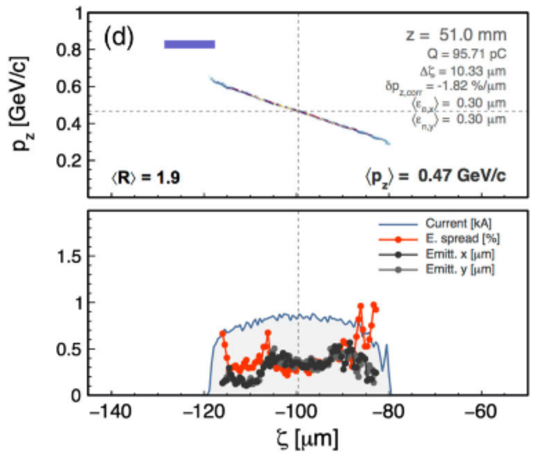
It aims at generating high-brightness electron bunches for FEL applications.

First planned internal injection method: Laser-triggered density downramp injection



Sharp on-axis plasma density gradients from distinct H_2 and He ionization



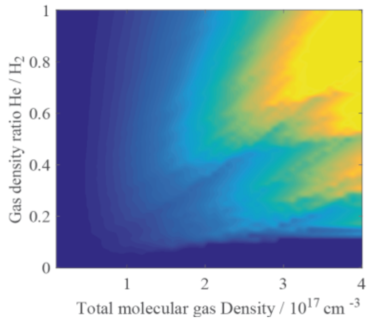


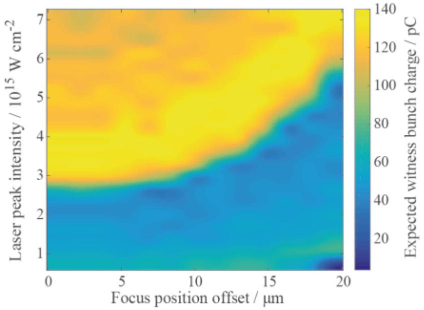
Density-Dowramp injection in PWFA with steep density ramps allows for generating electron bunches with

- < 1 % energy spread
- < 1 µm emittance
- > 1 kA peak current
- ~ 100 pC charge

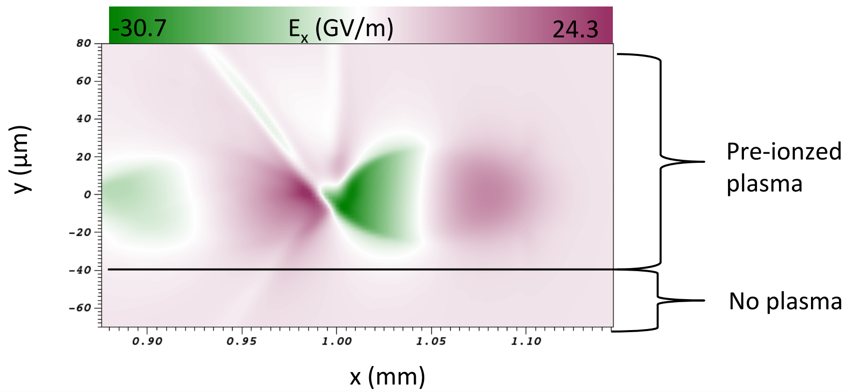
AM de la Ossa et al., PRAB 2017

Stable injected charge of 80-100 pC expected for experimental parameters





Supress low-quality dark current from deformed plasma wake due to misalignment

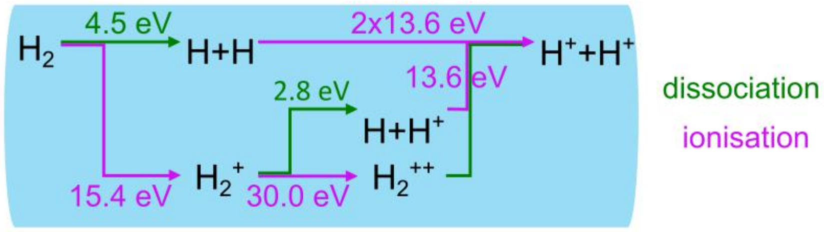


HELMHOLTZ ASSOCIATION
MT ARD MATTER AND TECHNOLOGIES ACCELERATOR RESEARCH AND DEVELOPMENT
FLASHForward
DESY

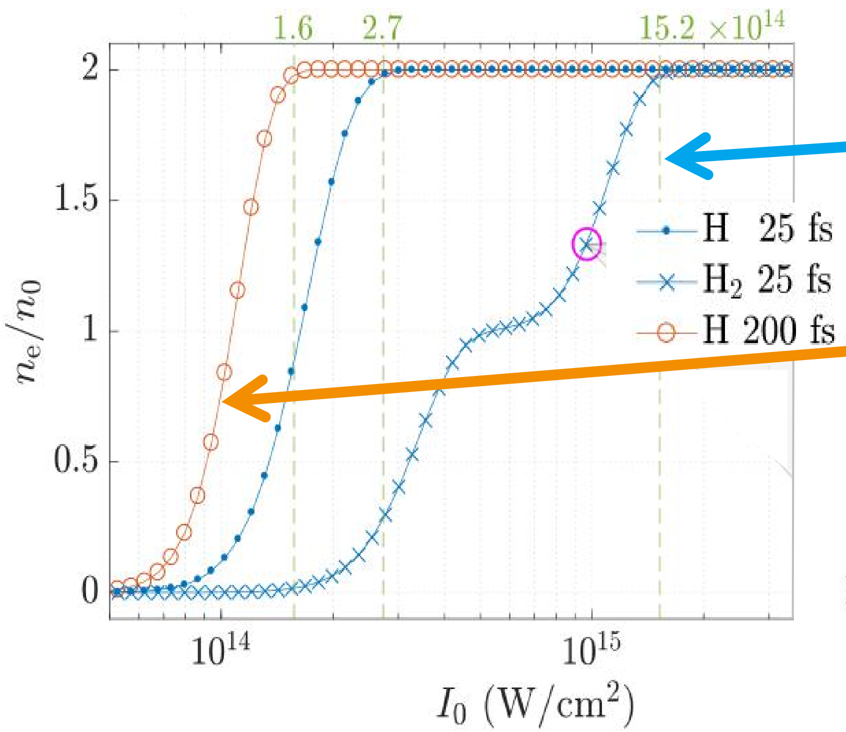
Theoretical and experimental studies on plasma generation.

Gabriele Tauscher (DESY, Hamburg)

Molecular gases show complex fragmentation dynamics



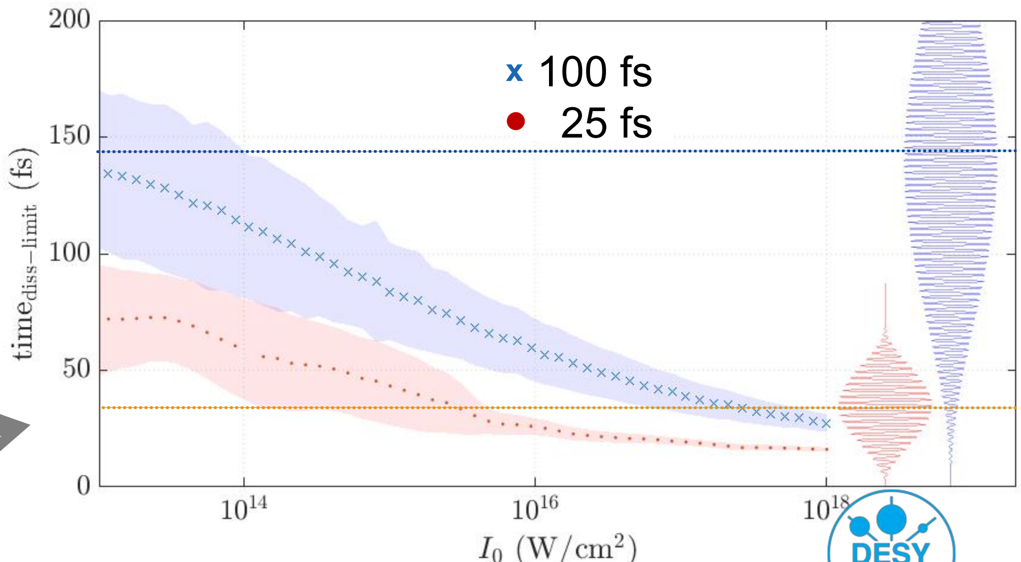
Most important here: Duration of interacting pulse



Short pulse regime *(up to few 10fs)*: molecular ionisation path, modified ADK theory applicable

Long pulse regime *(from few 100fs)*: sufficient time for dissociation before ionisation, standard ADK theory works

Intermediate regime: full simulation of fragmentation dynamics needed! Example: Hydrogen molecule dissociation

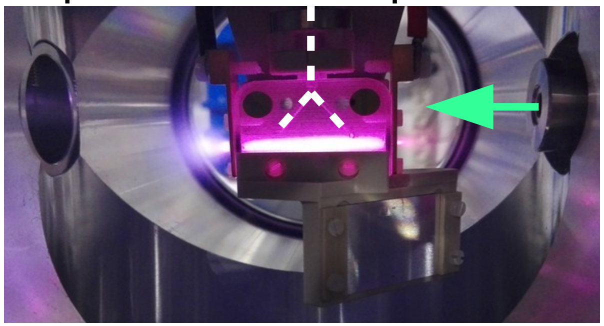


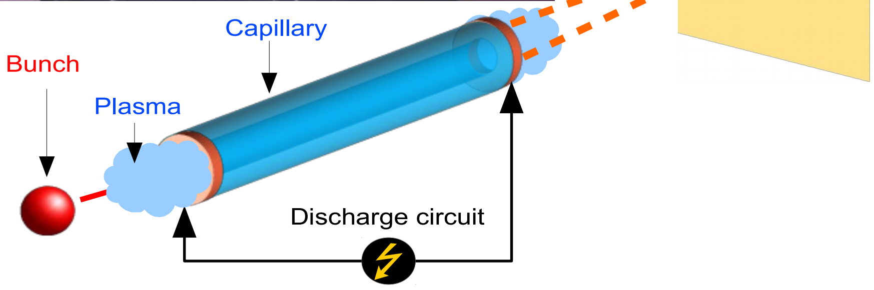
Riccardo Pompili (INFN, Frascati)

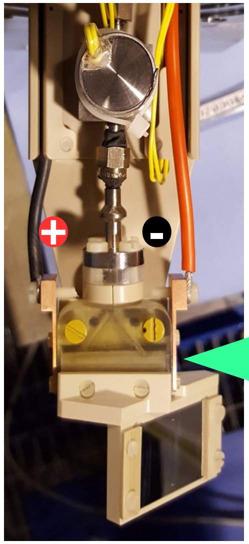
Summary

Recent results SPARC_LAB

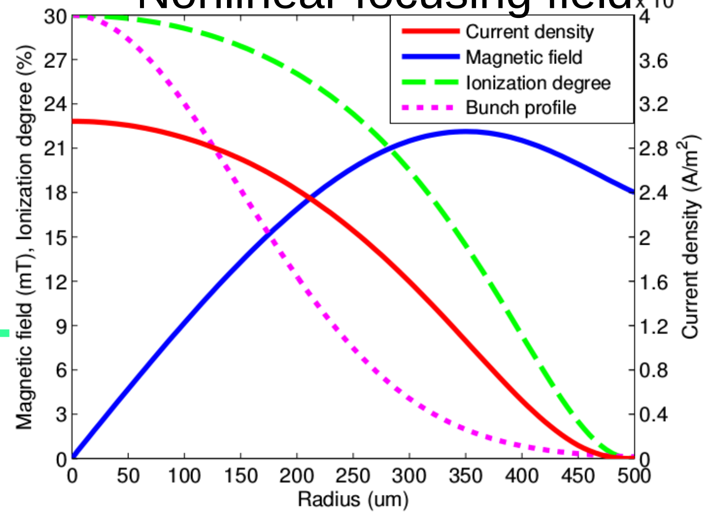
Experimental setup



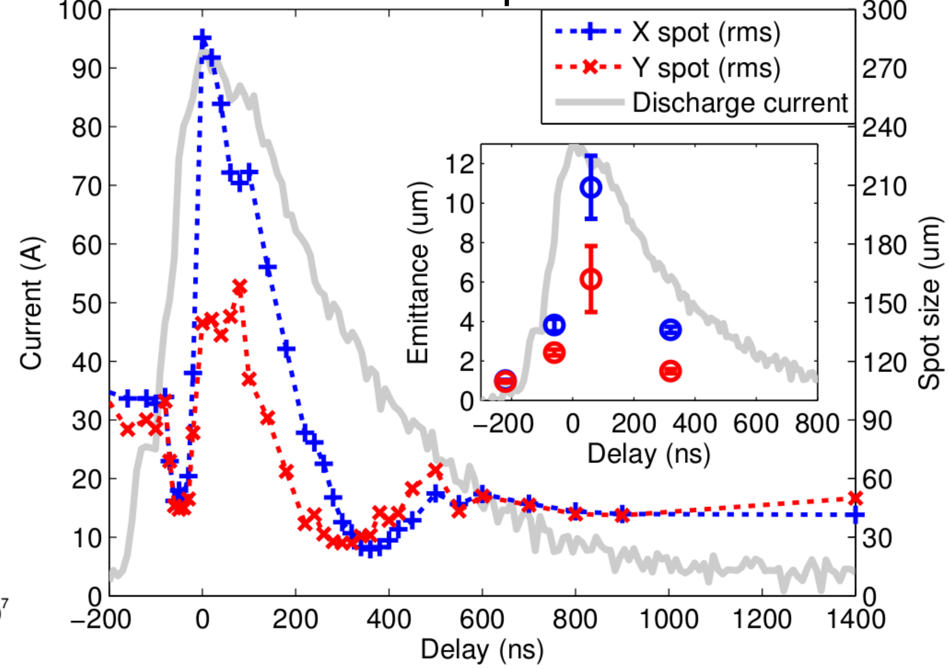


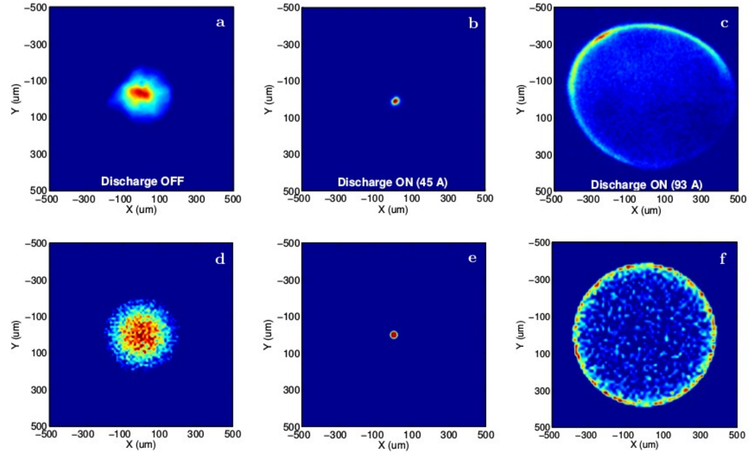


Nonlinear focusing field



Envelope scan



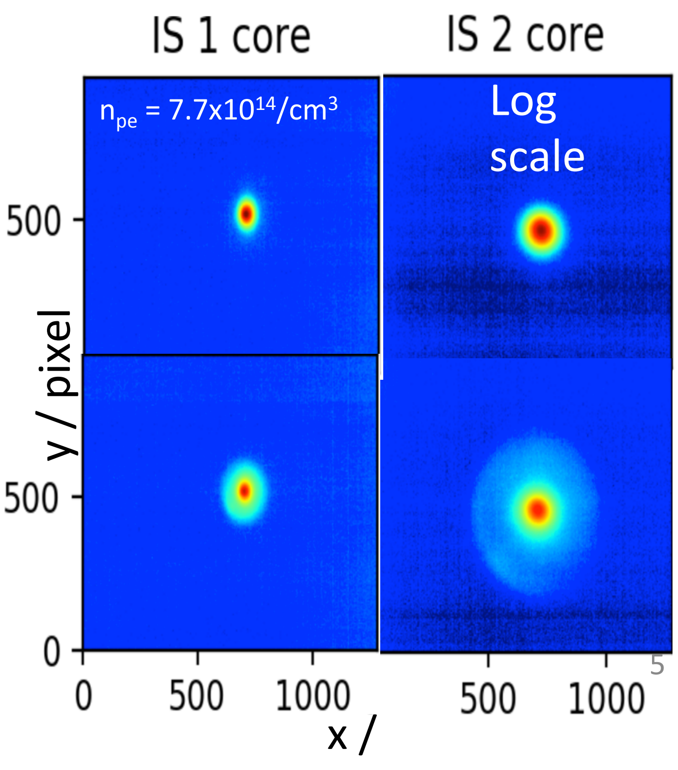


Marlene Turner (CERN and TU Graz)

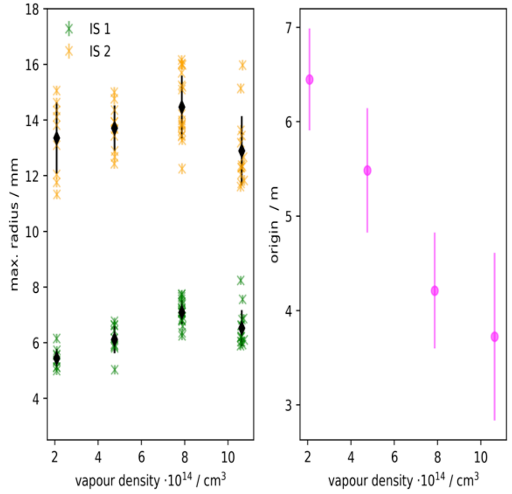
Indirect Measurement of the Seeded Self-Modulation in the AWAKE Experiment at CERN

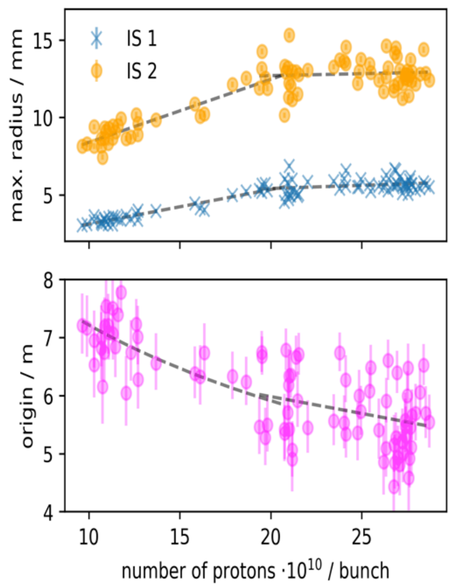
Plasma off:

Plasma on:



- Observation of protons at **large radial positions** (protons defocused by the transverse plasma wakefields).
- Measured transverse momentum larger than initial momentum plus the seed wakefields ⇒ **wakefield growth.**





M. Turner and the AWAKE collaboartion

Maximum defocused protons **exit the wakefiedls earlier** for higher plasma densities and larger proton bunch populations

suggesting a **faster growth** of the SSM.

Falk Braunmueller (MPP, Munich)

S_{eeded} S_{elf} $M_{odulation}$-Diagnostics via CTR

- **Waveguide-based heterodyne receivers for CTR:**
  - **90-140GHz-system + 170-260GHz system** new
- **Can detect 2^{nd} harmonics of $f_{modulation}$**

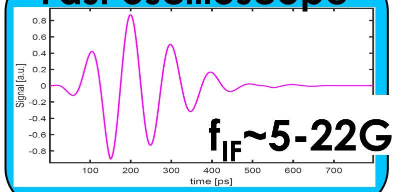
Signal: **e.g. f_{CTR} ~260GHz**

Reference: **f_{ref}~270GHz**

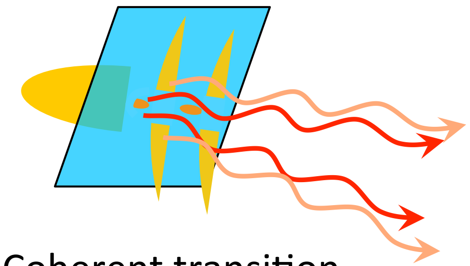
Mixer

Intermediate frequency:

Fast oscilloscope



f_{IF}~5-22GHz



Coherent transition radiation @ $f_{modulation}$ (90-280GHz)

Main result: $f_{CTR} = f_{plasma}(n_{Rb})$ ← vapour

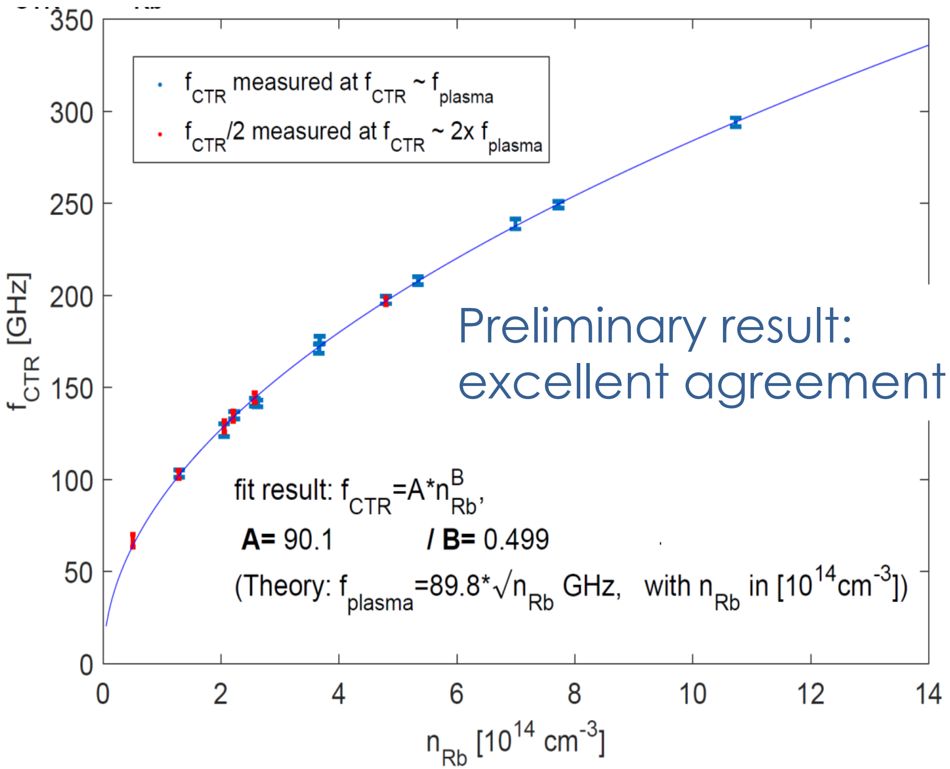
➔ **SSM with $f_{CTR}=f_{plasma}$ as predicted**

➔ **Rb fully ionized**

Further: result: **preliminary**

~5% n_{Rb}-gradient : $f_{modulation}$ ~ f_{plasma}(end)
+ more microbunches visible

➔ **longer SSM-interaction (?)**



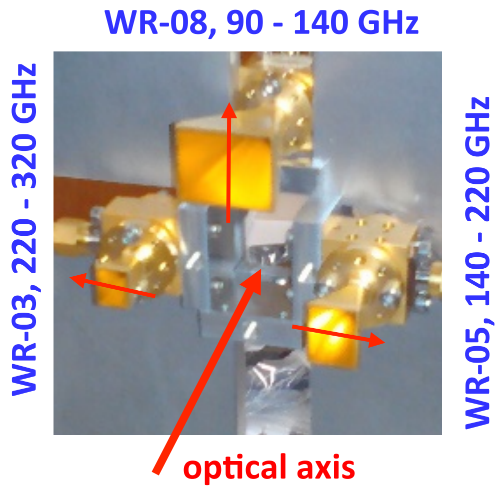
AWAKE

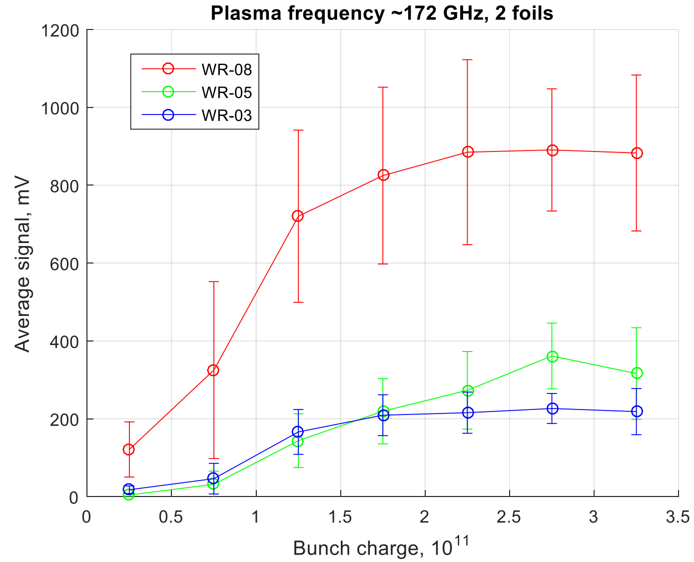
Max-Planck-Institut für Physik (Werner-Heisenberg-Institut)

Mikhail Martyanov (MPP, Munich)

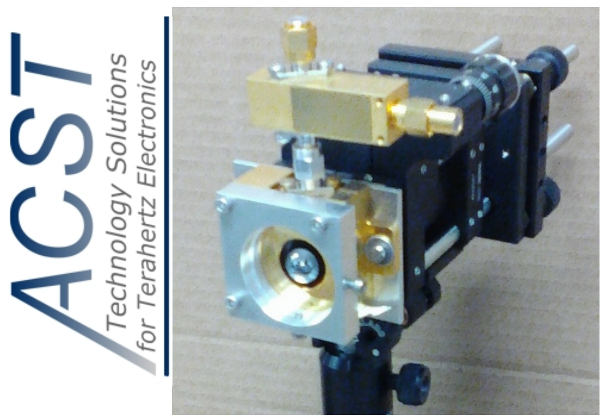
Preliminary CTR results

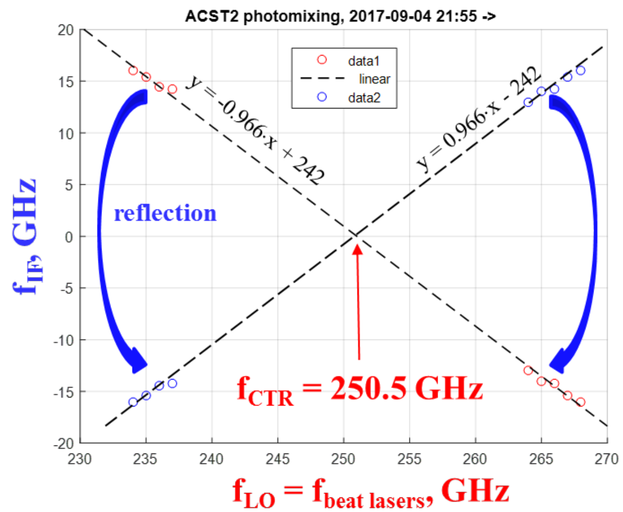
- Three wide-band Schottky diodes see a strong CTR signal from modulated bunch





- Successful CTR frequency measurement with a Schottky photo-mixer prototype





Kevin Pepitone (CERN)

Awake electron line

Electron beam ready for global AWAKE experimental commissioning by December 2017

Studies of an ultra-short bunch injector for AWAKE RUN 2

Obtained Parameter	Size
Total Length	4.2 m
Beam Energy	85 MeV
Energy Spread	0.52%
Bunch Charge	0.1 nC
RMS Bunch Length	53 fs
RMS Beam Size	0.2 mm
Normalized Emittance	0.7 $mm.mrad$