STATUS OF CLEAR

A. Curcio

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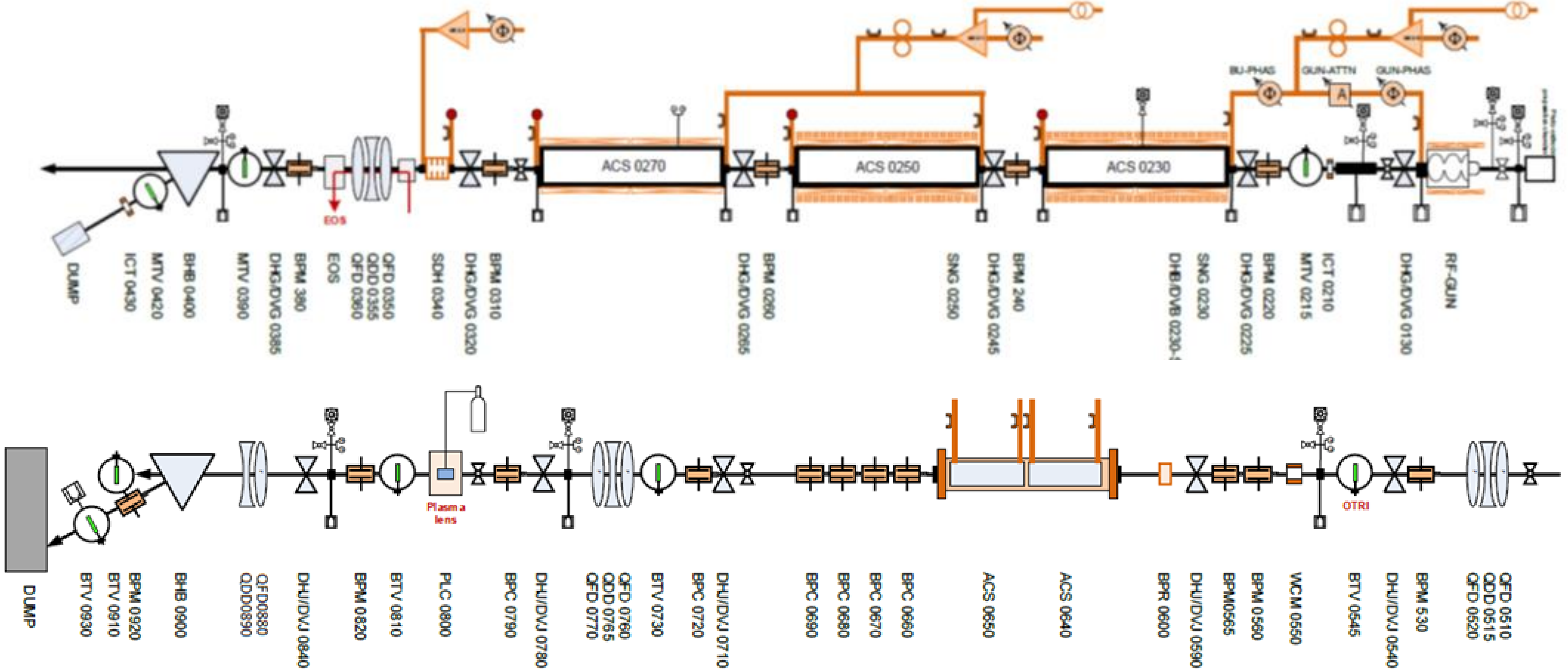
Present layout of CLEAR (2018)

New installations:

1) A quadrupole doublets at the end of the LINAC
2) Pulse compression in the sections ACS0250 and ACS0270
3) Deflector cavity powered by the klystron MKS30



CLEAR performances

Beam parameters	Range	Comments
Energy	60 – 220 MeV	More flexible with 2 klystrons. > 220 MeV with pulse compression.
Energy Spread	< 1 MeV (FWHM)	
Bunch Charge	1 pC – 200 pC	Photocathode changed but limited laser power. Goal: 0.6 nC.
Bunch Length	0.2 ps – 10 ps	0.1 ps with velocity bunching
Normalized emittances	3 μm to 30 μm	Bunch charge dependent
Repetition rate	0.8 to 5 Hz	25 Hz with klystrons and laser upgrade
Number of micro-bunches in train	1 to >150	Single bunch capability assessed
Micro-bunch spacing	1.5 GHz (Laser)	3.0 GHz: Dark current

CLEAR operation in 2018 (from the restart, 19th February)

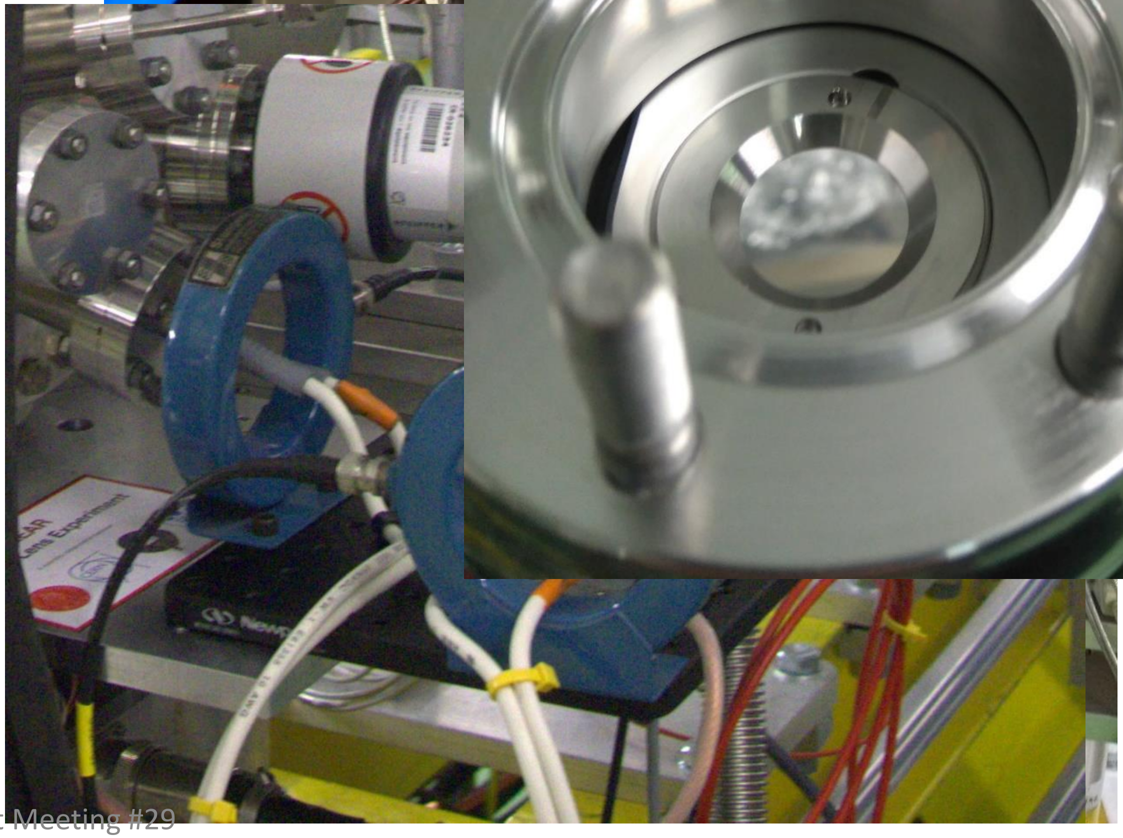
Week			
8 Beam commissioning	9 Beam commissioning and Juas students	10 ESA/IROC users	11 Bunch length studies with LAL people
12 Plasma lens run	13 AWAKE screen calibration	14 Emittance checks with plasma lens	15 Bunch length compression and detection + Cherenkov studies

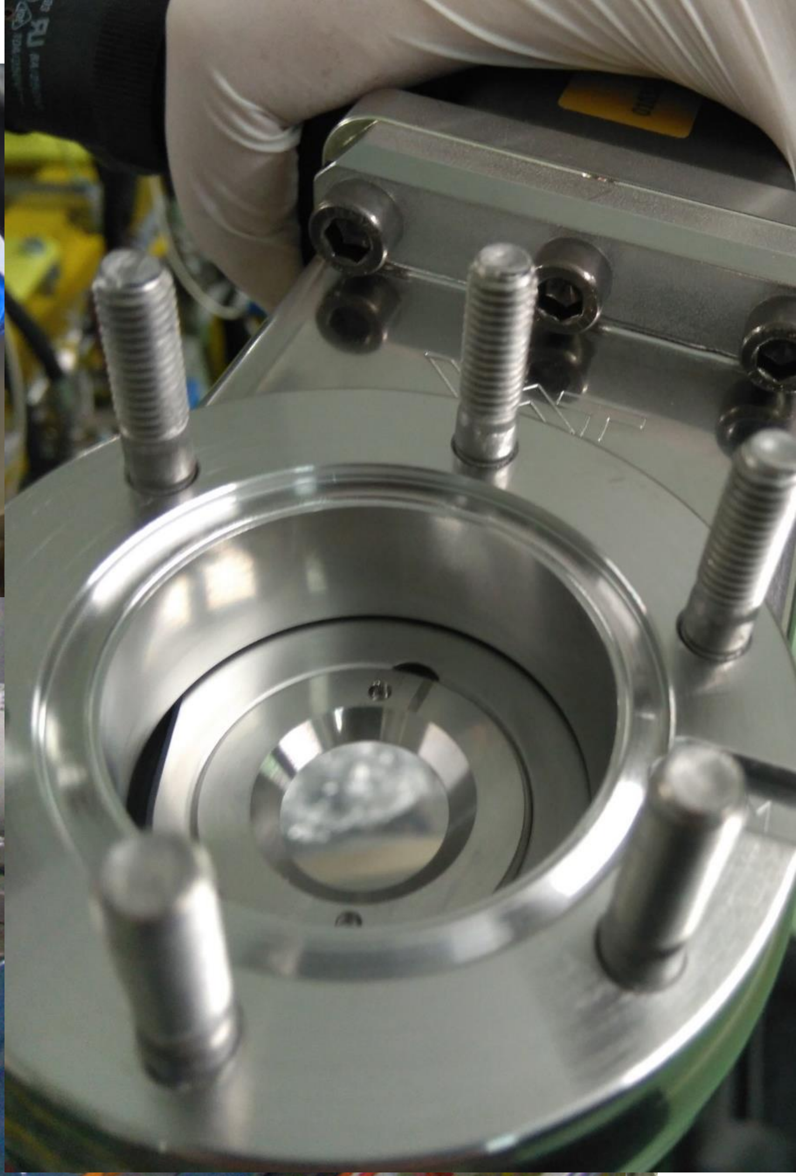
The CLEAR plasma lens experiment

- Compact radial focusing device
  - Passing the beam *inside* the conductor

$$\Rightarrow B_{\phi}(r) = \left({}^{\mu_0 I_z}\!/_{2\pi a^2} \right) r$$

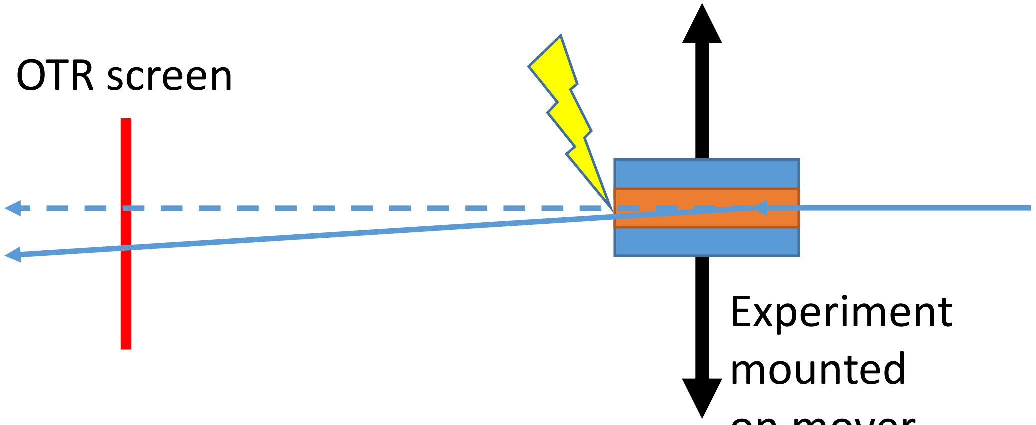
  - Observed gradients > 300 T/m
- Current and beam passed through a gas-filled sapphire capillary
- Gas broken down by a high voltage discharge from a compact Marx Bank
  - Provides a current up to 500A
- Gas flow in the machine is controlled by a 3 µm mylar window

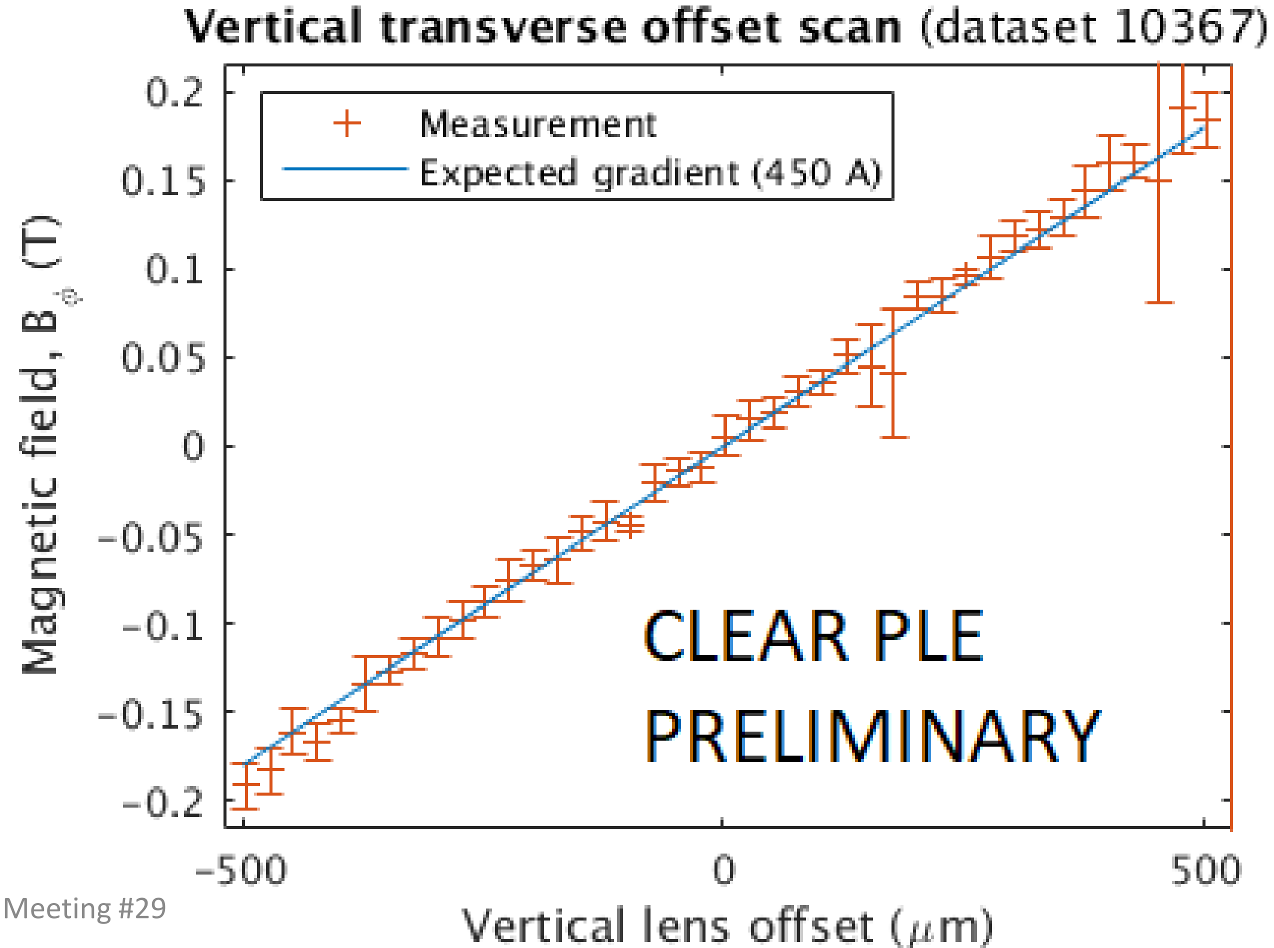




The CLEAR plasma lens experiment

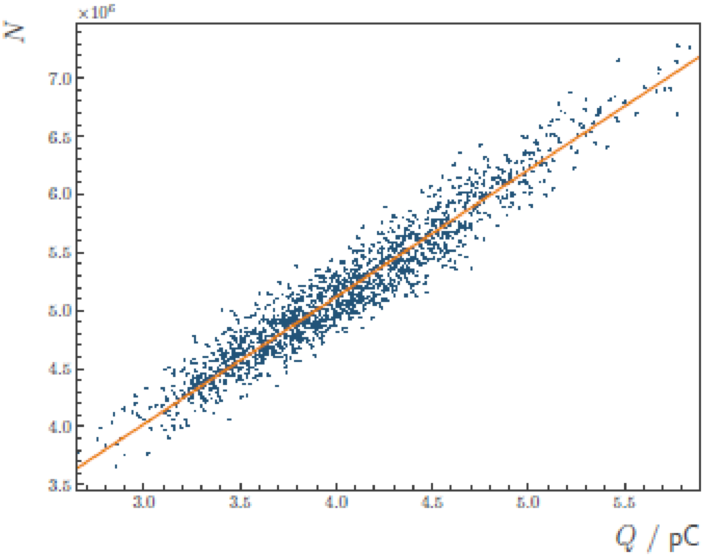
- Direct field measurements
  - Scanned the aperture with a small (ca 50x50 μm) beam
  - Measured the beam centroid displacement on downstream OTR
  - Comparing to current measurements
- Measurements of emittance growth from plasma lens
  - Using the two newly installed quadrupoles downstream of PLE
  - Expect effect from current nonuniformities and scattering processes
- Study of self-focusing due to plasma wakefields
  - Strong and non-uniform focusing fields created by plasma wakefields
  - Important to understand for high-intensity applications

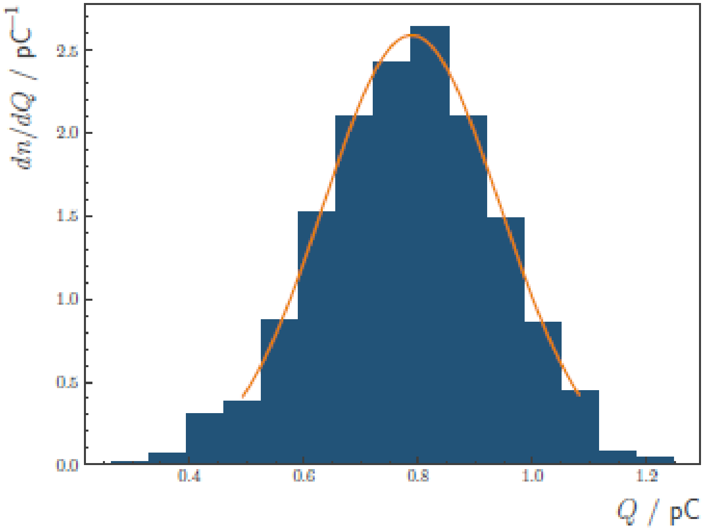




AWAKE screen calibration

We measured the charge response of our scintillator on the CLEAR beamline in late March.
Charges from 1–200 pC were used. We varied the energy and position on the scintillator as well. Analysis is ongoing but the calibration seems to have been a success.

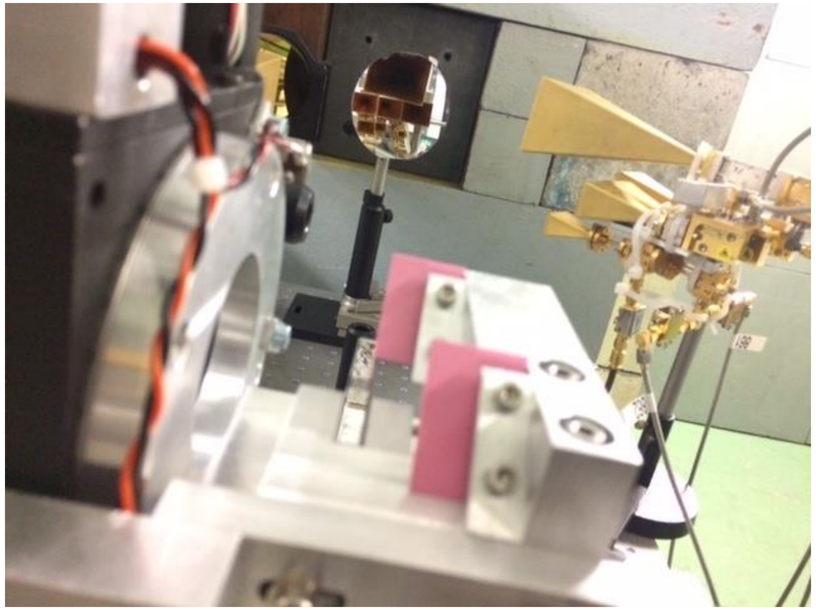




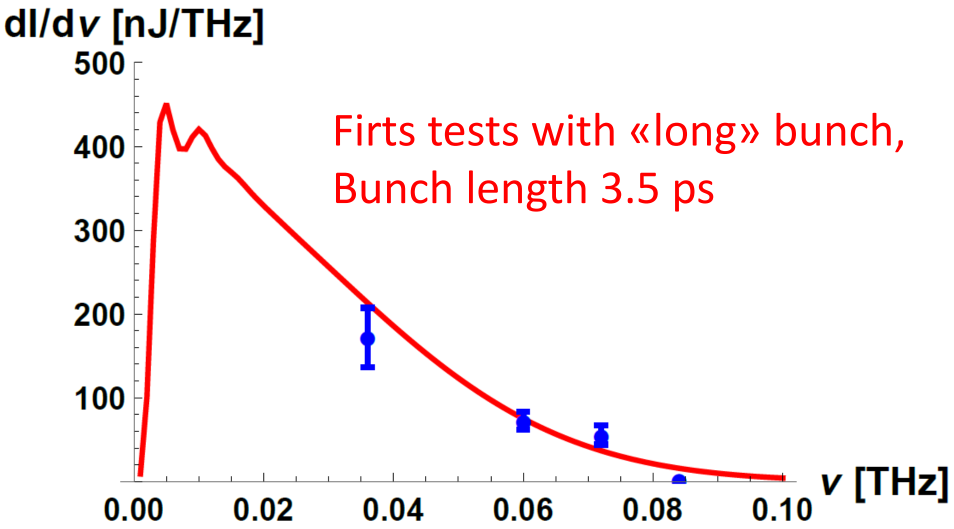
We've measured the offset in your VESPER line charge monitor for you, it's about 0.8 pC—you're welcome!

Thanks to Fearghus Keeble for the slide!

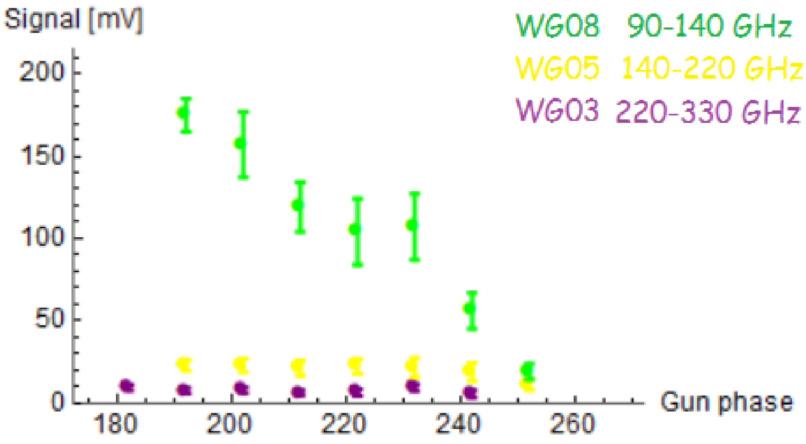
The CLEAR experiment of (sub-)THz generation



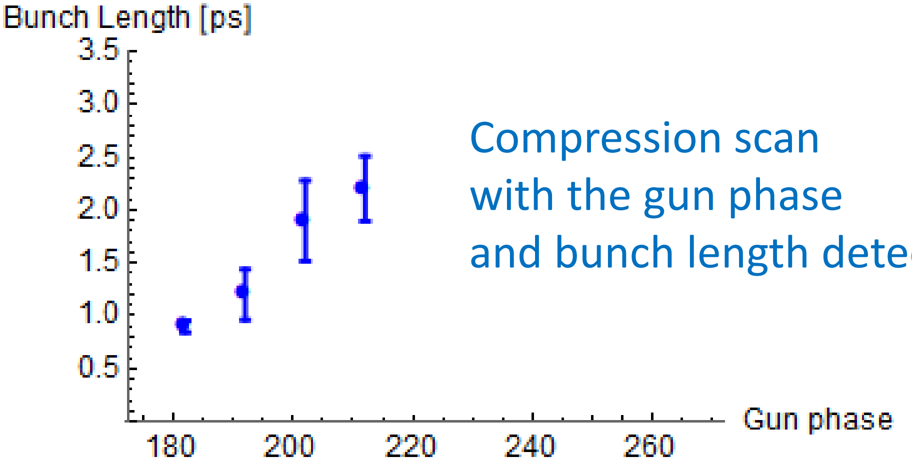
Complete set of Schottky Diodes from 30 to 300 GHz



Firts tests with «long» bunch,
Bunch length 3.5 ps

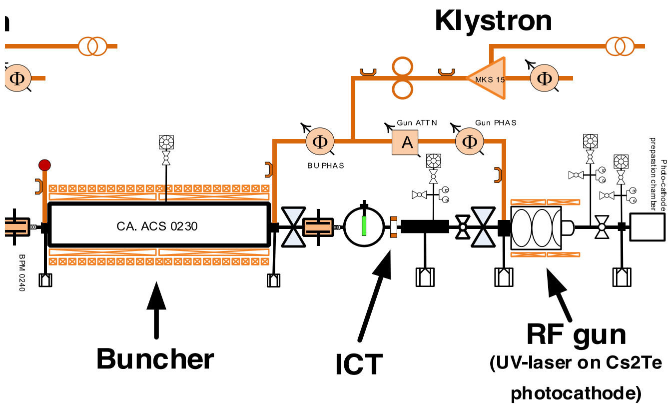


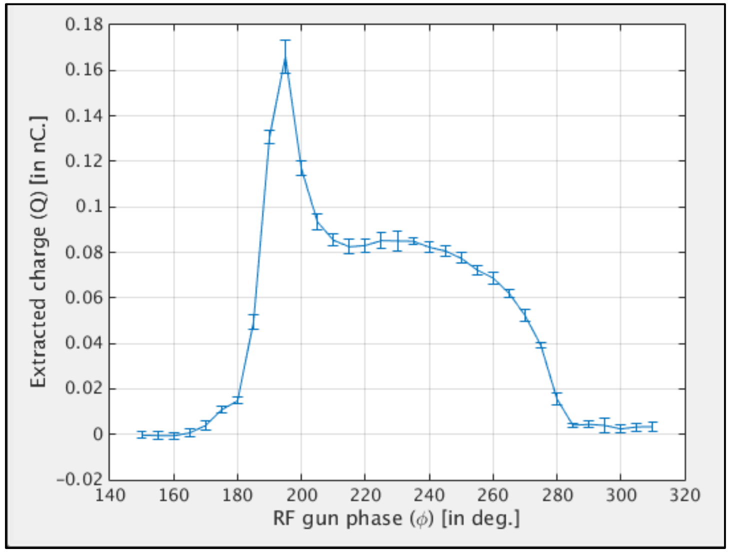
Signature of the bunch compression

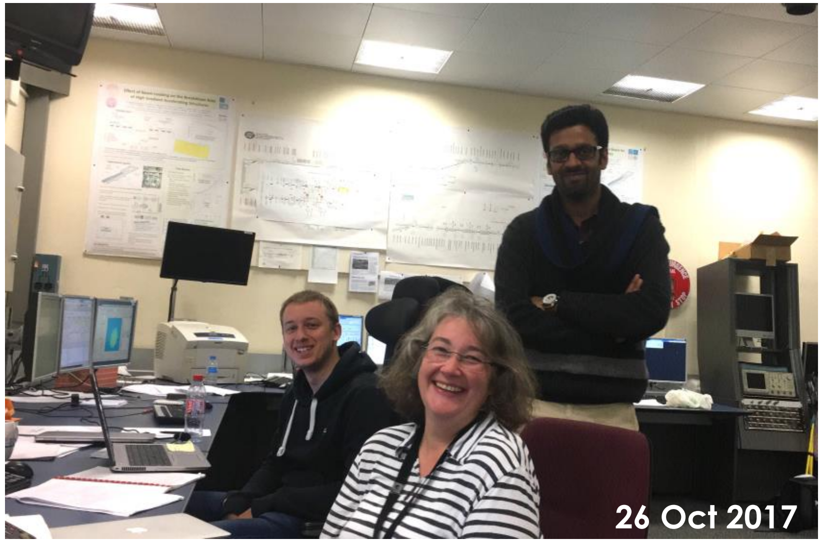


Compression scan
with the gun phase
and bunch length detection

Injector optimisation for shorter bunch length

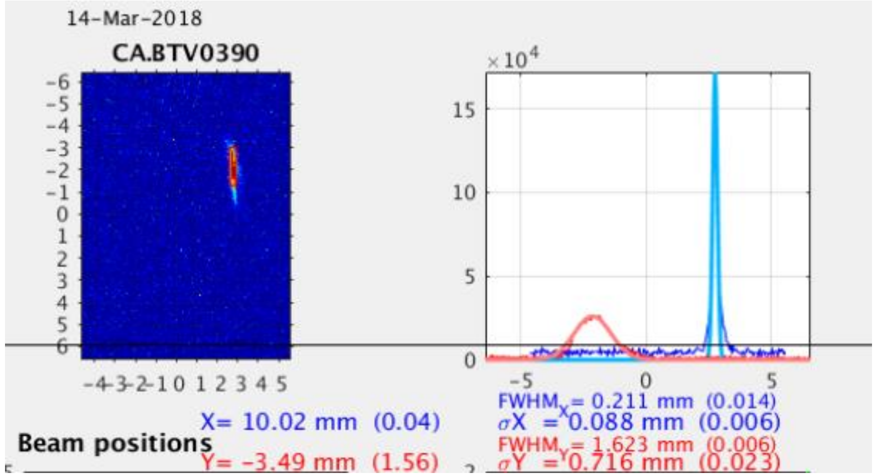




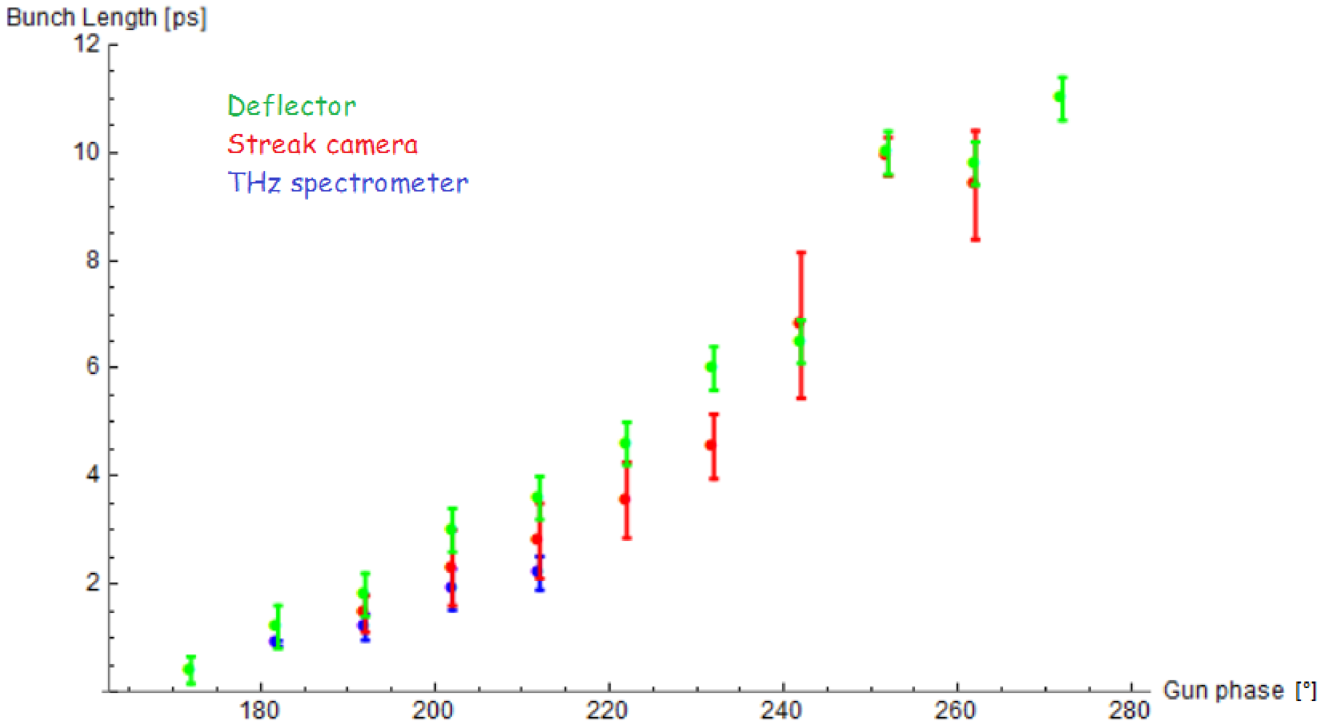


- Collaboration with **LAL** colleagues.
- Results and aims:
  - Minimum bunch length detected 0.2 ps rms!
  - Crosscheck of **ASTRA** simulations.
  - Guide the optimisation of our injector.

C. Bruni and al.



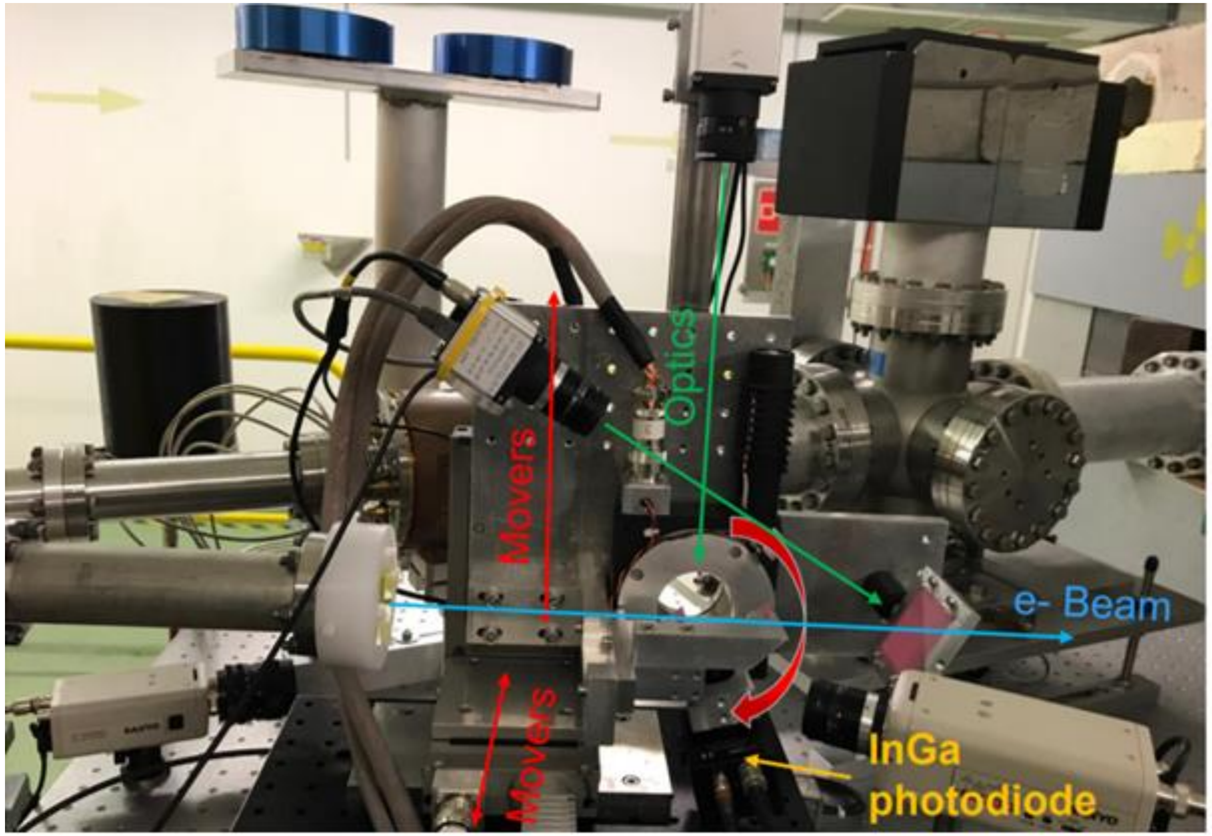
Full set of diagnostics for bunch length measurement



Comparative study among three different longitudinal diagnostic techniques:

1) Deflector cavity
2) OTR streak camera measurements
3) THz spectrometry
4) OTR shot noise study (still under test, but already promising results)
5) Electro-optical sampling (BI plan for EOS revival)

Experiment of ChDR at CLEAR

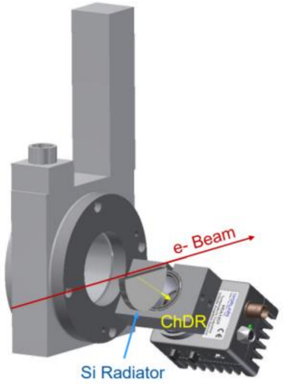


Studies on the angular distribution of Diffraction Cherenkov Radiation (thanks to Michele Bergamaschi), measurements in last two weeks

In-air spectral-angular measurement of ChDR in an half silicon wafer radiator.

Detector: PDA10 InGaAs (0.9-2.6um) single pixel photodiode mounted on a motorized Goniometer.

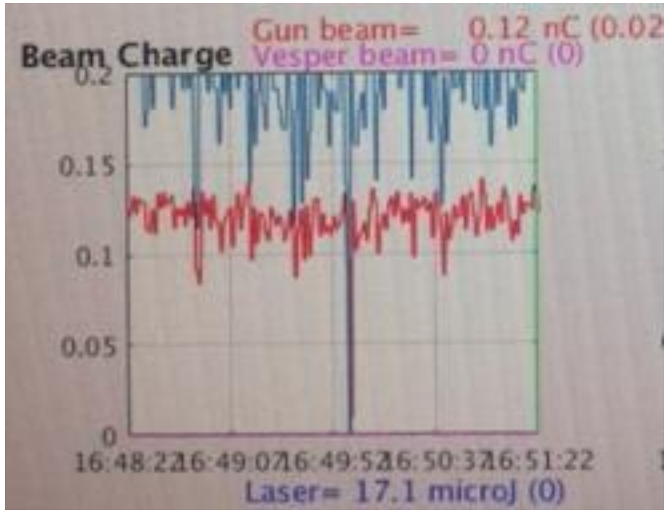
Set of bandpass filters used to select wavelength (BW 30nm).



Recycle of the same setup for Smith Purcell studies planned for next week!

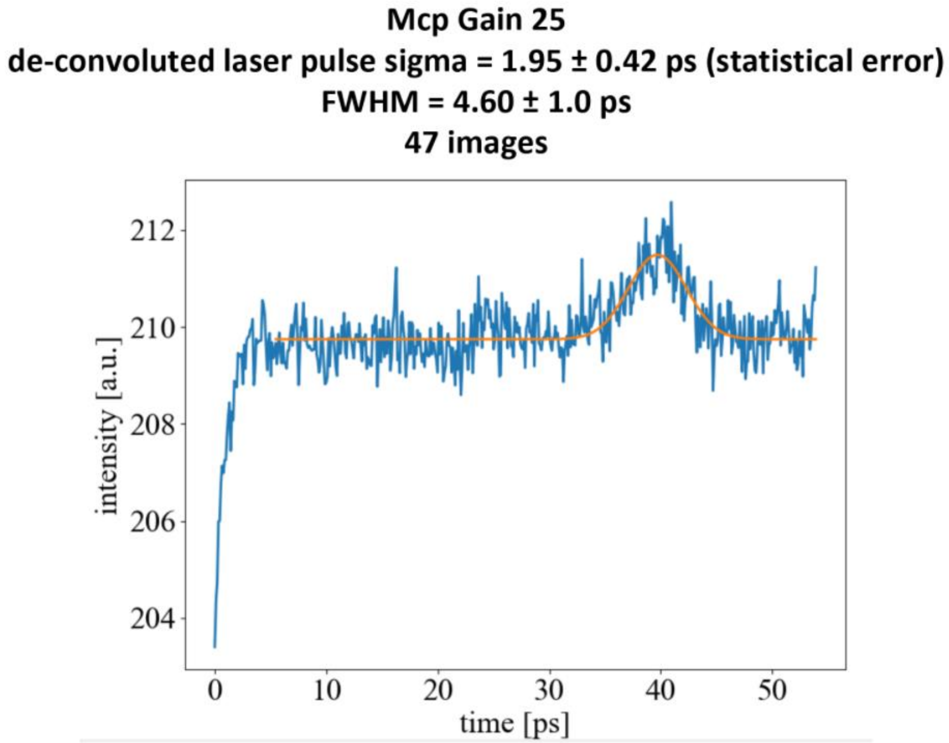
100 mm, $N =$ 100 periods

Laser characterization and improvements



- Improvements of beam shape on the cathode
- Improvement of laser energy per pulse around a factor 2
- Improvement of temporal stability
- Measurement of laser pulse length
- Minimize pulse picker leakage still to be solved

Beam charge at the gun,
value (120 pC) and stability (few %).
Also laser energy per pulse improved around a factor 2.



Conclusion

- CLEAR has successfully restarted on the 19th February 2018, already delivering beam to many experiments (irradiation, plasma lens, AWAKE screen calibration, THz generation…).
- New powerful installations (doublet, pulse compression, RF power to the deflector cavity) useful for experiments and beam optimization.
- Main achievements for the machine like bunch compression well below 1 ps rms obtained .
- Successful and promising experiments ongoing (plasma lens, THz, Cherenkov…).