

The CLEAR test facility

CERN Linear Electron Accelerator for Research

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The CLEAR test facility

History:

- CTF3 planned for shut-down from 2017 after completing main targets
- Interest from CLIC project and outside to keep an electron test beam facility at CERN
- The test facility will be open to all users, not only CLIC related activities
- Workshop to poll interest form outside community held in September 2016; more than 90 participants from different laboratories and different research fields
- Approved by CERN management for 2+2 years operation
- Currently preparing for first run, starting summer 2017

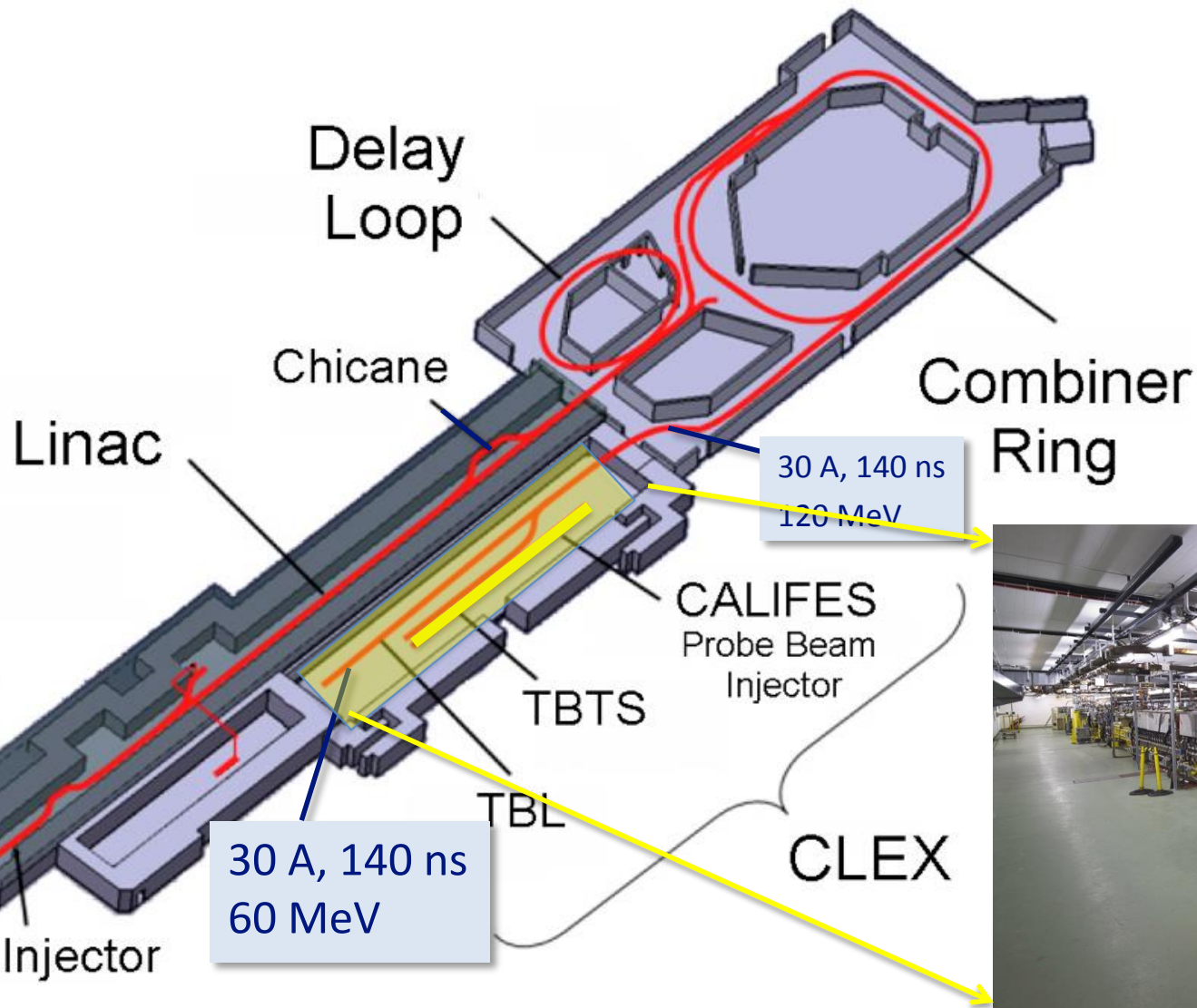


From DG's New Year address January 2017 :

CLEAR start up: CERN Linear Electron Accelerator for Research
A new stand-alone user facility - CLEAR – will be available for users from 2017 onwards.

This new open electron beam facility is an adaptation of the CALIFES electron linac located in the experimental area of the CLIC Test Facility 3 (CTF3) at CERN.

CLIC Test Facility and CLEAR

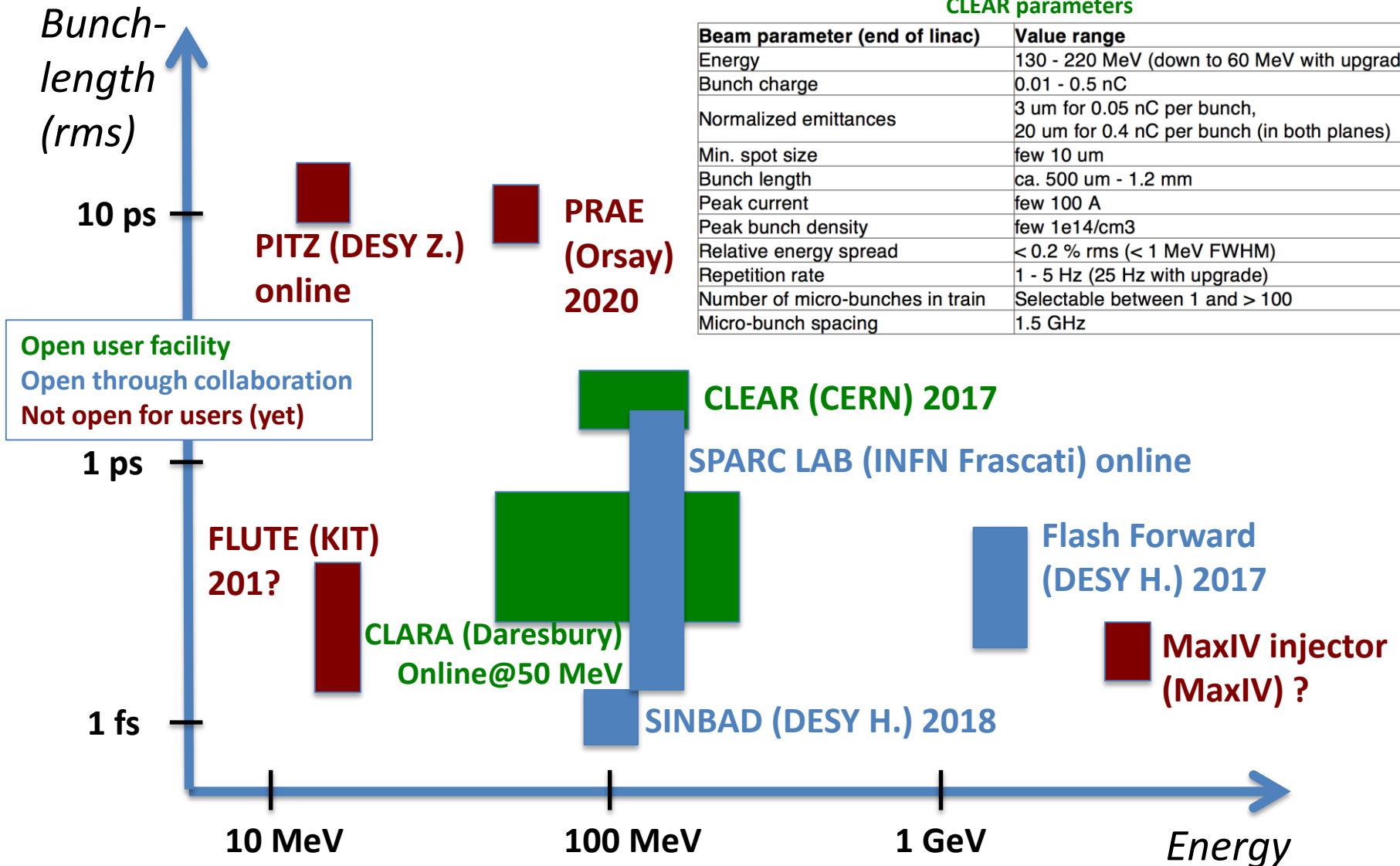


CLEAR consists of the experimental hall, CLEX, housing the 200 MeV S-band electron CALIFES linac.



Present and planned European electron test beams

not complete



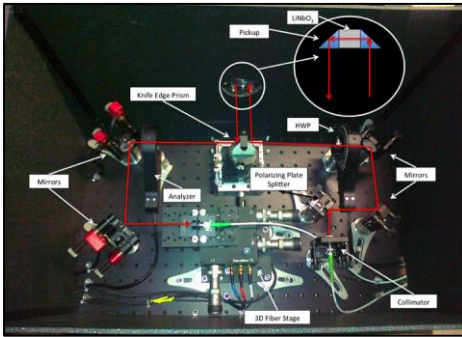
More details can be found at <https://goo.gl/sn4dqP>

CLEAR for CLIC

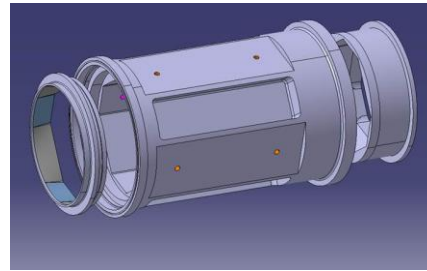
- CLIC collaboration interest: **keep beam test capability** for CLIC (instrumentation, high gradient studies, components...) **locally** at CERN after the CTF3 stop. **A few more detailed example on next slides.**
- Some additional points for a CERN facility:
 - Possibility of beam tests during **long shut-downs**
 - Keep experimental **electron expertise** alive at CERN, including **laser and photo-cathodes** – link with **AWAKE**
 - Complement high-gradient X-band activities for X-FELs, medical...
 - Provide **training ground** for young accelerator physicists
- Interest from external Novel Acceleration Techniques communities (plasma-, THz acceleration...) to use the CLEAR beam. Will increase CERN's competence in these technologies (**next slides**).
- CLIC experimental tests suited for other test facilities should still be performed at those (for example ATF2, EuroFEL, FACET-II etc.)

Beam instrumentation

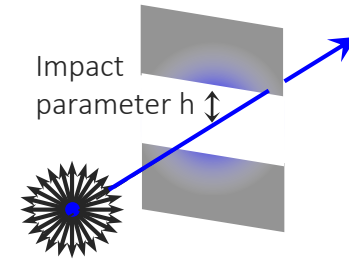
CERN BI (T. Lefevre) : **generic beam instrumentations tests in CLEAR**. Developments useful for both for (HL-)LHC and future colliders. Some examples of on-going and planned studies :



Electro-Optical BPMs



Stripline BPMs

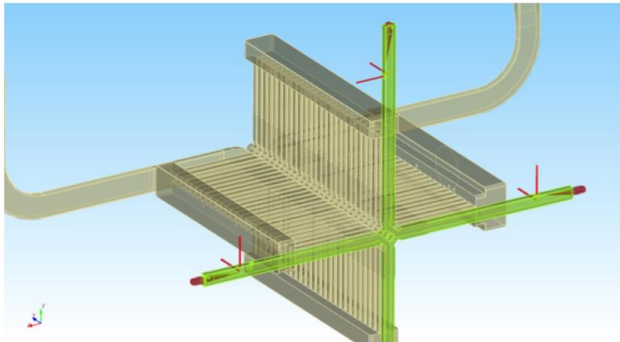


Diffraction Cherenkov radiation studies

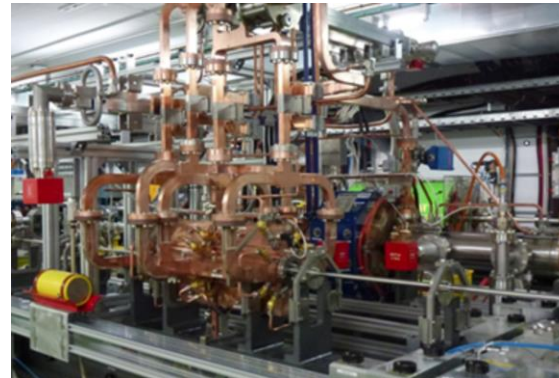
[See talk CLIC workshop 2017 : T. Lefevre](#)

[See talk CLIC workshop 2017 : R. Lillestol](#)

Continued development of essential CLIC diagnostics, **CLIC wake field monitors** :



Accurate (few μm) wake field monitors required to reach the CLIC emittance target.



One of the two accelerator super-structures will be kept in the beam line for further tests.

X-band and high-gradient R&D

CLEAR: will have access to 12 GHz 50 MW RF power supply (X-box 1).
Planned to be connected to CLEAR in 2018.



The collaboration for an **X-band FEL** (part of the CompactLight H2020 Design Study proposal) proposes to test **key X-band components with beam at CLEAR**. Large collaboration with 24 institutes, including CERN.



Generic high-gradient studies, beneficial for CLIC, FEL, medical etc :

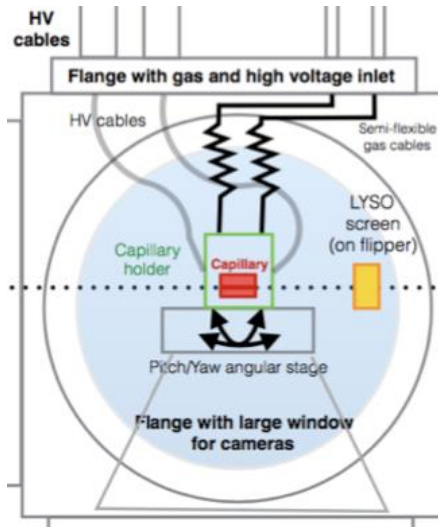
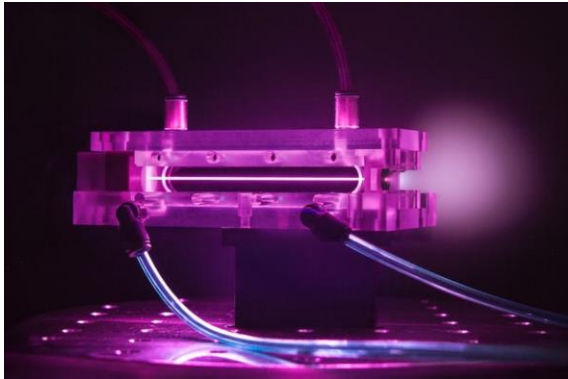
- 1. The effect of a beam on the high-gradient behavior of a structure** : Example: beam loading effect on gradient (17% less output field with beam). A CLEAR program allows new studies such as effect of controlled beam loss on gradient, as well as continuation of tests of beam loading.
- 2. The effect of high-gradient acceleration on the beam.** Example: further understand effect of break down and dark current on beam quality and luminosity.
- 3. Wake-fields and structure-based beam measurements.** Example: CLEAR offers ability to further study the X-band wake fields, as well as how to use the wake field as a precise beam position monitor (wake field monitors).

Novel accelerator techniques: plasma

Reminder: New CLIC working group on novel acceleration techniques.

<https://indico.cern.ch/category/8905/>

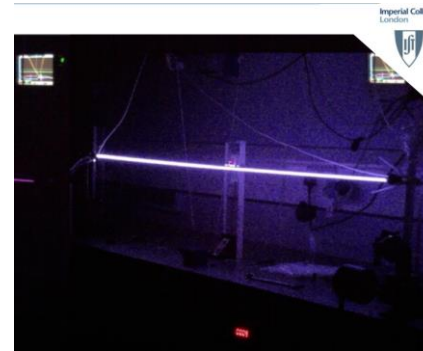
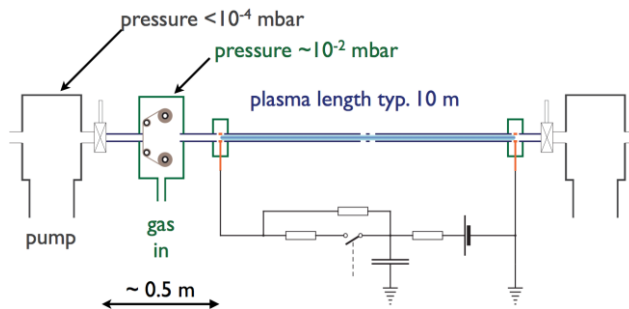
Plasma lens experiments (suggested by U. Oslo) :



These experiments involves gas flows, high voltage (tens kV), eventually high-power lasers : new challenges at CLIC/CTF3.

CLEAR thus needs to build up this competence. Potentially useful knowledge for studies of novel accelerator techniques for linear colliders.

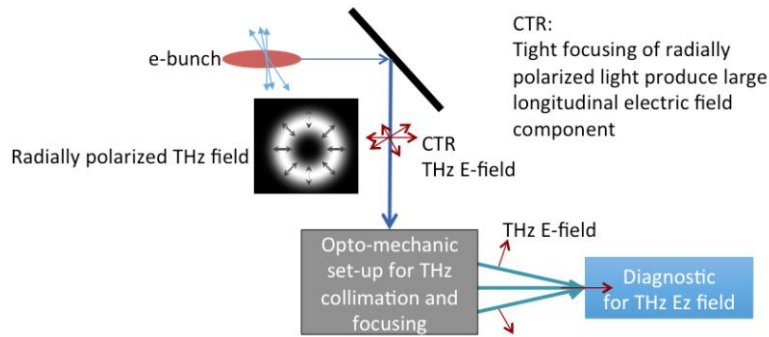
Plasma source tests (suggested by Imperial College/IST) :
also of interest for AWAKE (source development for **Run 2**)



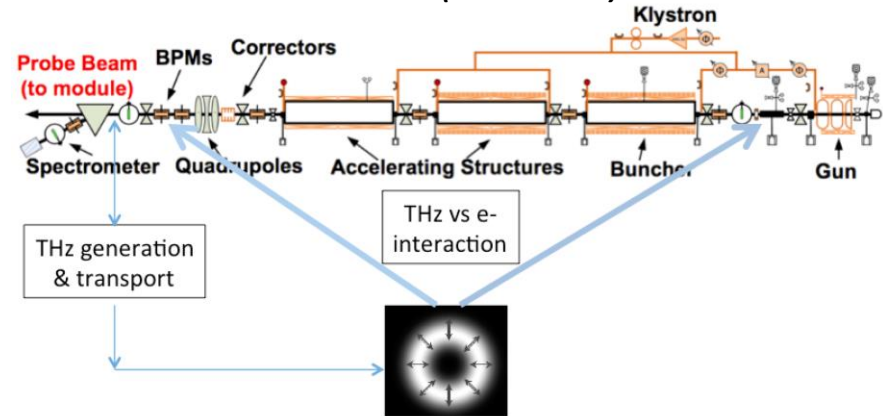
Novel accelerator techniques: THz

M. Petrarca, CLIC Workshop, CERN, March 2017 :

Study of THz generation (2017+) :



THz acceleration (2018+ ?) :



Steve Jamison, CLIC Workshop, CERN, March 2017 :

A potential CLEAR programme

Demonstration of high gradient Dielectric and THz acceleration & deflection

Includes both THz and dielectric laser acceleration schemes

Programme goals: Demonstration of MeV acceleration & > 10 MeV/m gradients
Wakefield measurement / benchmarking & mitigation
Understanding beam-loading in the new regime of few-cycle acceleration

Collaboration across Cockcroft Institute (STFC, Lancaster, Manchester, Liverpool Universities) & with University of Rome/ INFN and Paul Scherer Institute

2017/2018: THz driven deflector for ultrafast beam diagnostics

Experiment specific hardware

- design/build/test in UK, install for experimental runs
- additional diagnostics with potential use in wider wakefield projects

Immediate challenges: Establishing the few-mJ class laser at CLEAR

2017: collaboration with M Petrarca Uni Rome for THz CTR electro-optic characterisation (establishing synchronisation and THz detection systems)

2018: ready to install THz deflection experiment at CLEAR (*dependent on laser availability*)

Collaboration CLEAR – STFC/U. Rome being discussed. If moving forward: significant amount of resources (manpower, hardware, diagnostics) to CLEAR starting from ~ 2018.

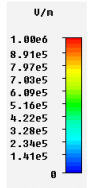
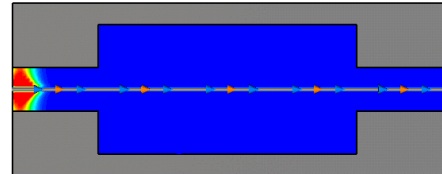
This effort would also profit other CLEAR experiments.

Other interests in CLEAR

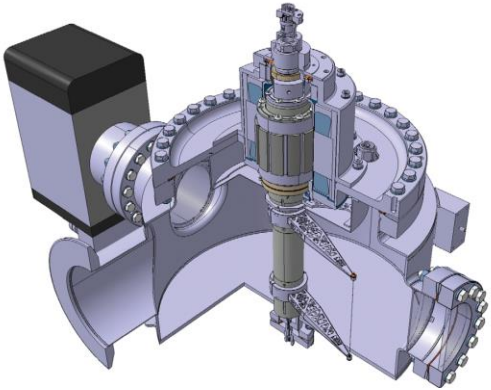
CLEAR: open facility, all user/communities welcome to propose experiments.

Impedance studies

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Clamp to range: (Min: 0/ Max: 1e+006)

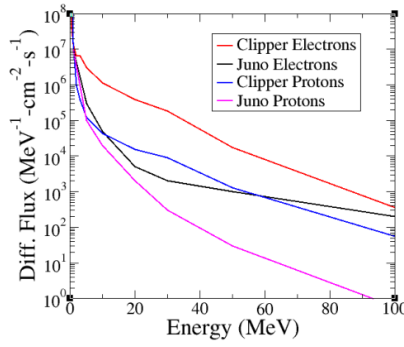


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Monitor: e-Field (t=0..3(0.01);x=0) [pb]
Component: abs
Plane at x: 0
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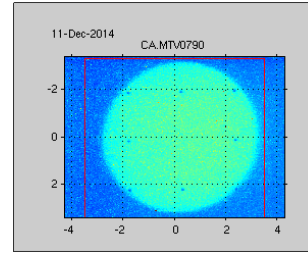
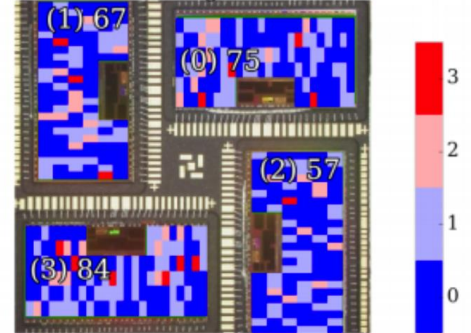
CERN ABP Impedance studies. first candidate: study of SPS wire scanner heating. Complexity of problem makes numerical studies and bench measurements. possibilities for CLEAR tests in 2017-2018.

Electron irradiation studies

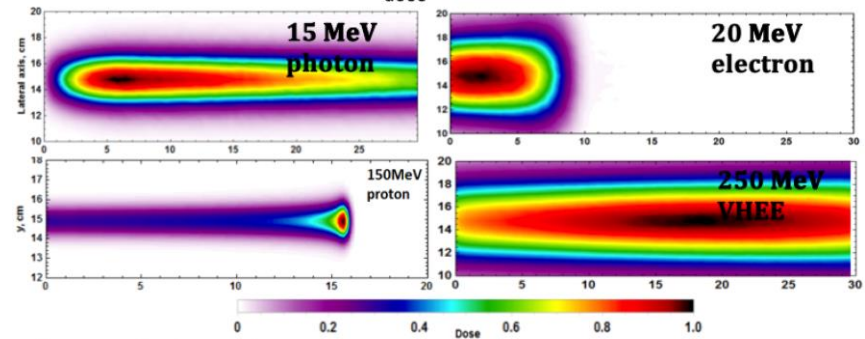


R2E: Tests for ESA space missions (Juice) (ESA, Jyvaskyla and others)
well-centered/homogeneous beam

ESA monitor reading 2016-09-16 01:44:00



Tests for VHEE radiation therapy (Cockcroft)



Dose maps of various particle beams in water



For post 2017 Run.

Organizational Matters

- We propose to organize CLEAR along the same lines as other user facilities already operating at CERN, e.g., HiRadMat:

<https://espace.cern.ch/hiradmat-sps/Wiki%20Pages/Home.aspx>

- The main bodies will be a **Scientific Board** and a **Technical Board**
- The **Scientific Board** will meet 2-3 times per year to assess the requests of the experimental teams on the basis of their physics interest and of the availability of the facility.
- The recommended experiments will then be reviewed by the **Technical Board** where the technical, safety and radiation-protection issues are addressed. The **Technical Board** gives the final authorization for the installation of the experiment and operation.
- Guidelines & a detailed description of the **experiment approval procedures** will be ready soon. In the meantime, if you want to propose an experiment:
 - 1) contact me directly to get some initial info.
 - 2) eventually apply using the **Experiment Request Form** (see next slide).

From R. Corsini :

4.1.2 Tentative running schedule 2017

The modifications above can take place during the winter shut-down 2016/17, and operation should be possible from the beginning of May. About one month would be needed to re-commission the CLEAR beam. A few operation periods interleaved with short installation stops are foreseen, and the mode of operation is supposed to be similar to the one of CTF3 and CALIFES, with two daily shifts during working hours. However, radiation tests in the VESPER beam line will be mainly carried out with remote supervision during night and weekends,

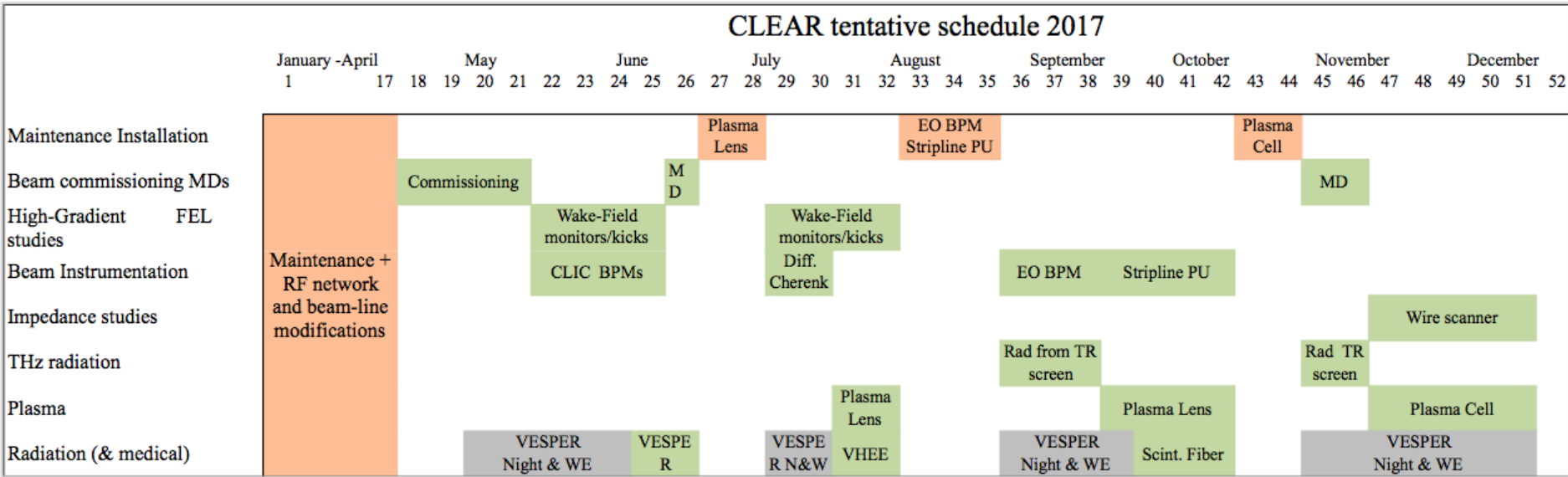
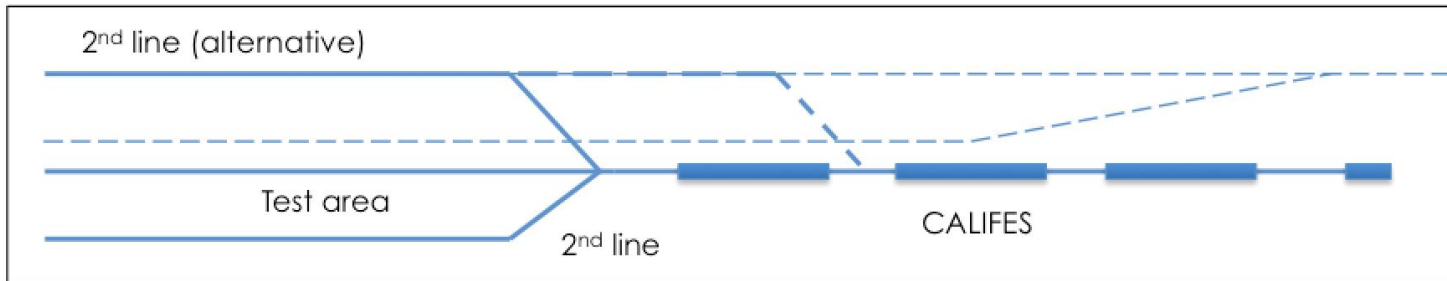


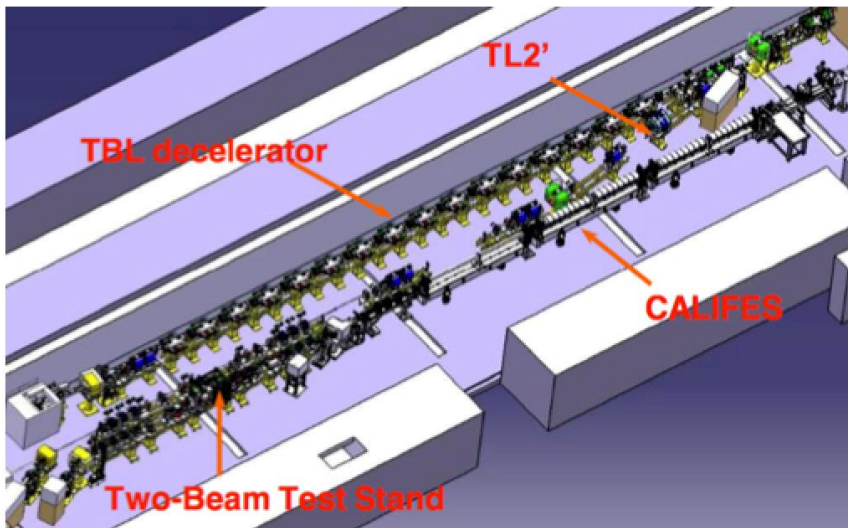
Figure 2 - Tentative experimental program and schedule of the CLEAR test facility in 2017.

Options for a second beam line

From R. Corsini :

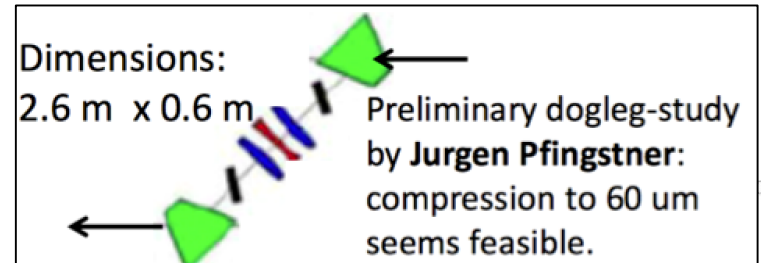


CLEX



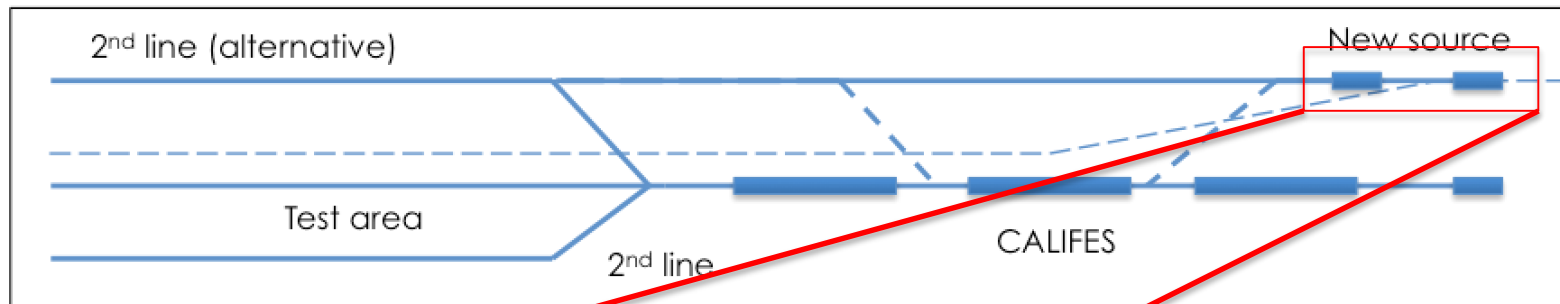
To fit all proposed experiments, both space and downstream compability may be very challenging to handle with a single beam line. Space and hardware exists for **a second beam line**. Probable push to prepare the second line sometime in 2018 (but pending review of all requests).

Several users also ask for shorter bunches (fraction of a ps). Bunch compressions could be built into dogleg (studies have started).

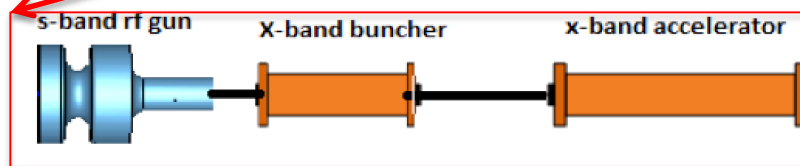


Options for a second beam line + source

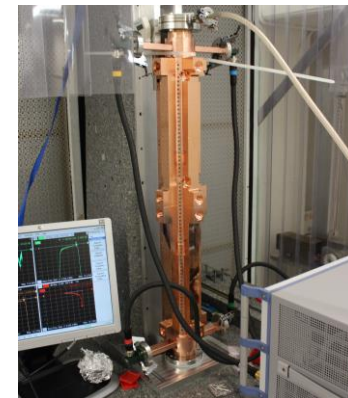
From R. Corsini :



A possible injector for AWAKE and CLEAR



S, Doebert



S-band gun + 12GHz bunching structure,

22 MV/m buncher, 80 MV/m X-band accelerator to keep bunching

- Interesting option for AWAKE 2nd run and CLEAR upgrade, using x-band technology for a compact injector
- In particular since a lot of the **hardware** might be **available** or at least expertise exists.
- The possibility of ultra short bunches could be a big asset for the future test facility
- General interest in developing novel and compact accelerators for research, medical or industry

Conclusions

- CLEAR approved for 2+2 years: a new, open 200 MeV electron beam test facility at CERN starting operation this summer
- A mix of existing users - including CLIC - and new users - including novel technology communities
- New users will ideally bring more manpower, resources and competences to CERN and CLEAR
- Interested users are encouraged to take contact with the CLEAR team