

CLEAR Summary Autumn 2020

Luke Aidan Dyks

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CLIC Project Meeting #38

10th December 2020

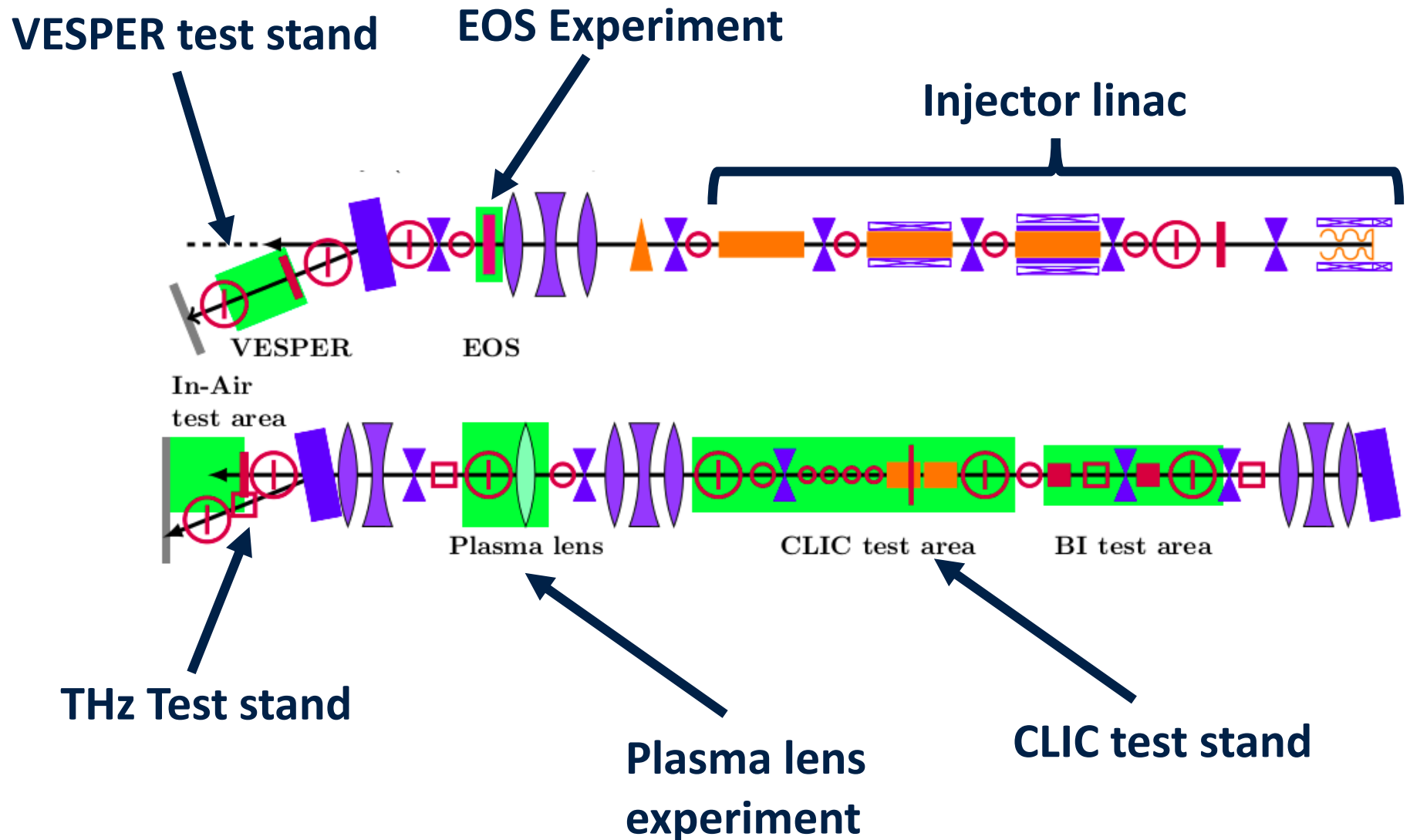
With thanks to the whole CLEAR team



Introduction

- Current status of CLEAR
- Summary of autumn experiments
 - CLIC related research
 - Medical applications
 - User experiments
- Machine development
- Outlook for 2021 and beyond!

CLEAR Beamline



CLEAR Beam Parameters

Parameter	Value
Energy	60 – 220 MeV
Energy spread	< 0.2 % rms (< 1 MeV FWHM)
Bunch length	0.1 – 10 ps rms
Bunch charge	5 pC – 3 nC
Normalised emittance	3 – 30 μm (charge & length dependent)
Bunches per pulse	1 – ~150
Max. charge per pulse	30 nC
Repetition rate	0.833 – 10 Hz
Bunch spacing	1.5 GHz

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Bunch compression work: [CLIC Mini Week 2020](#)

Status of CLEAR

- Planned operation until 2025
 - Operational budget, independent from CLIC, 800 kCHF/year (material)
- 2020 operation effected by lockdown
 - Two months out
 - 31 weeks operation (38 in 2019, 36 in 2018)
 - Cancelled summer shutdown
- External user access restricted
 - Lots of CERN users!
- Due to shutdown on December 16
- Two-month shutdown after break
 - Plan for shutdown being finalised



CLEAR Operational Team



- Two new operators
 - Gabriel and Pierre
- Many others in the CLEAR team

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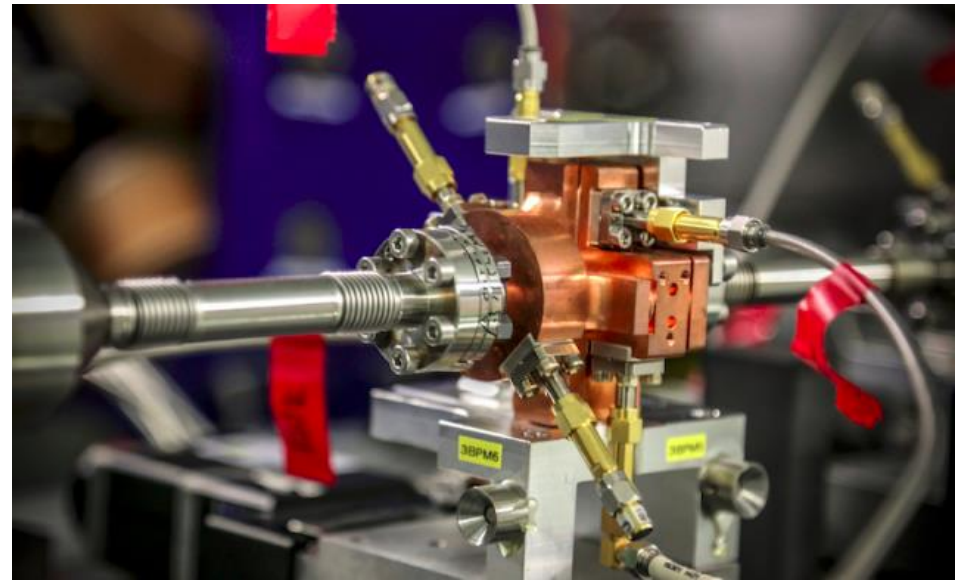
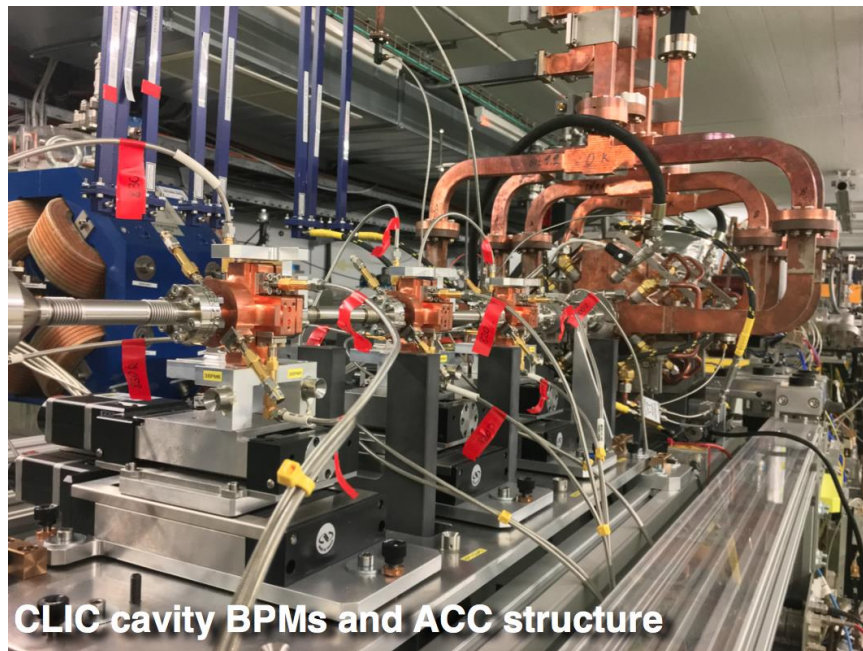
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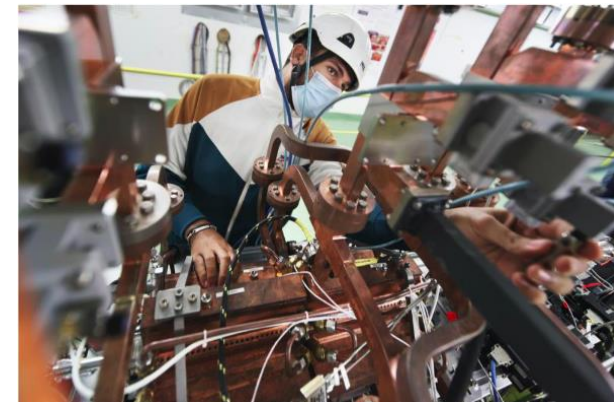
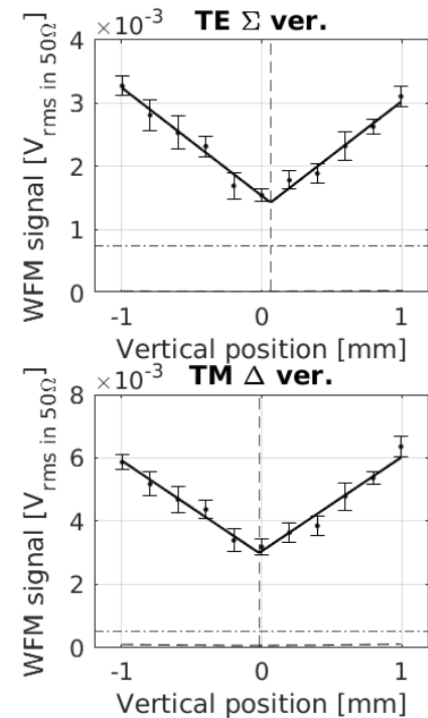
CLIC Related Research – Cavity BPMs

- CLIC cavity BPM studies
 - Testing of one cavity BPM underway this week!
 - Further tests could happen in 2021



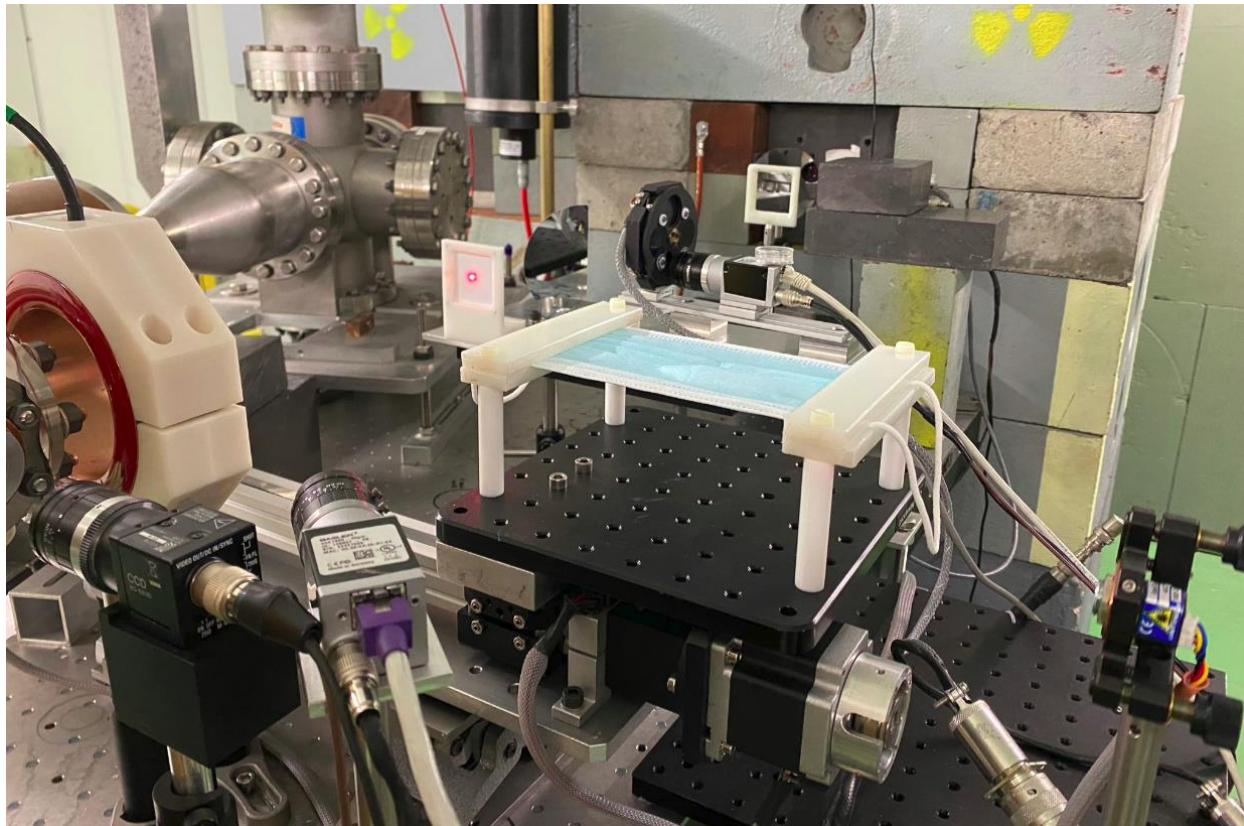
CLIC Related Research - Wakefields

- CLIC Cavity wakefield studies ongoing
- Trying to understand cause of 100 μm difference in central position of two frequency bands
 - Not dependent on beam angle
- Measurement of short range kicks
 - Promising results – improvement welcome!
 - Start using iBPMs in measurement
- Current work centred on comparing centre as measured with kick and with WFM
- Developed method of measuring and applying initial beam orbit



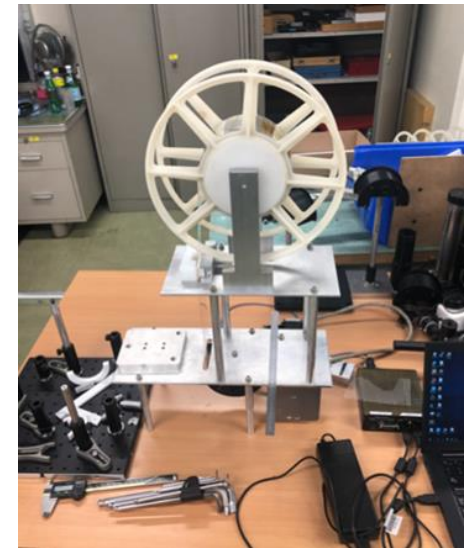
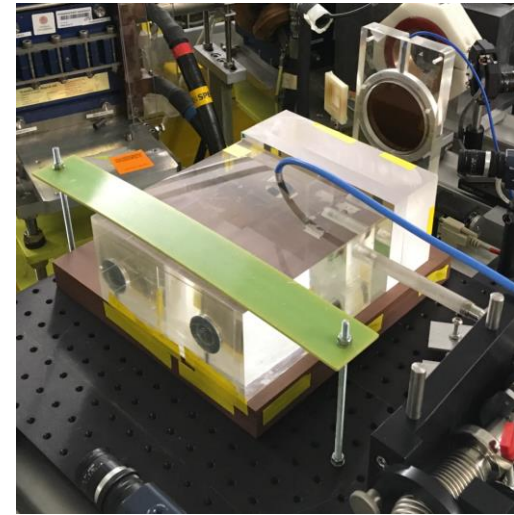
Covid Response

- Participated in the “CERN against COVID-19” taskforce
- Performed irradiation of masks
 - Test of activation and robustness to radiation



VHEE Radiotherapy at CLEAR

- Ban on external users has postponed some work
- VHEE work from CLEAR was presented at VHEE2020
 - CLEAR remains unique for High charge and high energy
 - Details can be found here: [VHEE2020 Indico](#)
- Big push to improve stability
 - Achieved ~2.4 % laser jitter, ~1.7 % charge jitter
- Motorised iris fitted to laser system
 - Reduced laser position jitter by factor 5!
- Dosimetry tests have been carried out
 - Relating current beam diagnostics to dosimetric films
- Commissioning of robot arm ongoing
- Papers accepted for publication ([CLEAR Publications](#))



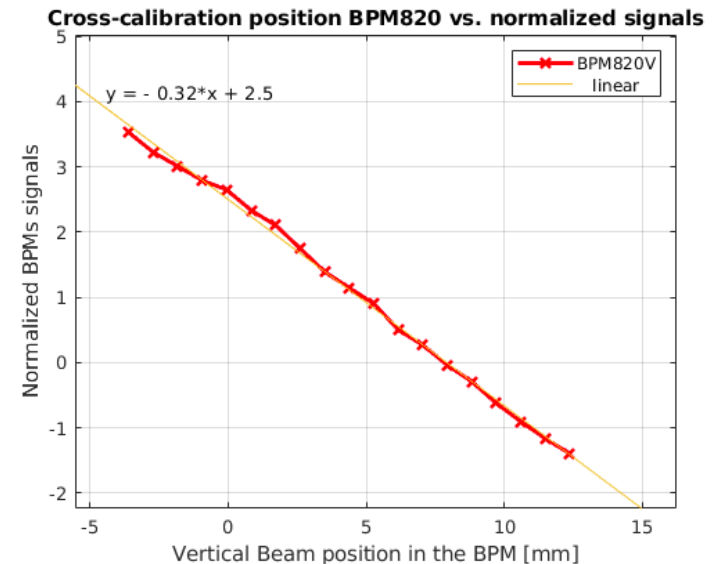
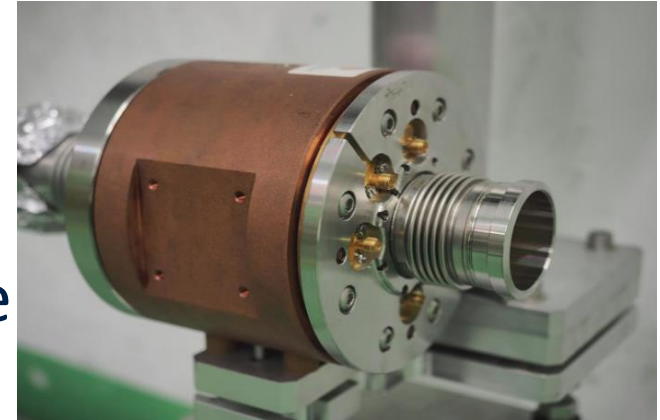
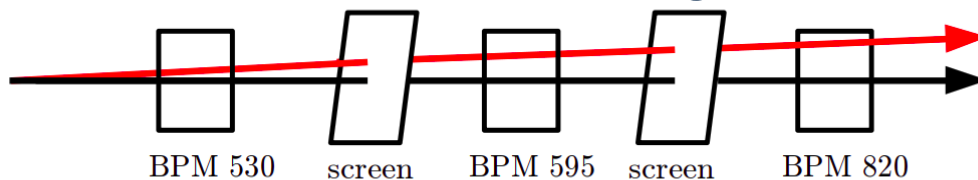
User Experiments

- AWAKE
 - Tested light output of YAG and OTR screens under heating in rubidium vapour tank
- Beam instrumentation
 - Continued work on EOS and Plasmonic wave experiments
- Micro BPMs
 - Tested several iterations of setup
- Glass fibre beam loss monitors
 - Irradiated and rotated on new revolving stage

Light emitted measured and analysed

Inductive BPM Calibration

- Calibration of inductive BPMs in experimental line
- Calibration done with screens
- Good position resolution over a large enough parameter range
- Implemented into control systems
- Further work needed:
 - Calculation of absolute resolution
 - Dispersion free steering
 - Wakefield free steering

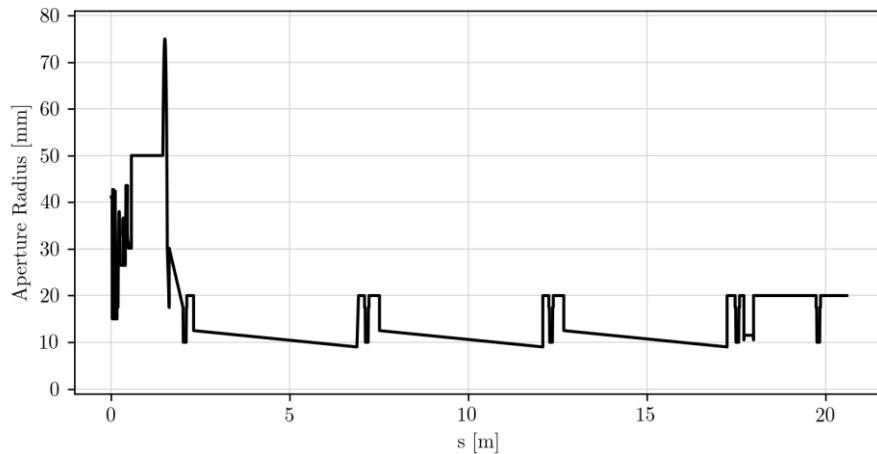


Beam Transport Studies

- Typical beam transport $\sim 80\%$
- Close to max. Achievable
 - low charge $\sim 90\%$
 - High charge $\sim 80\%$
- Location of losses not known well
- Can transport be improved?

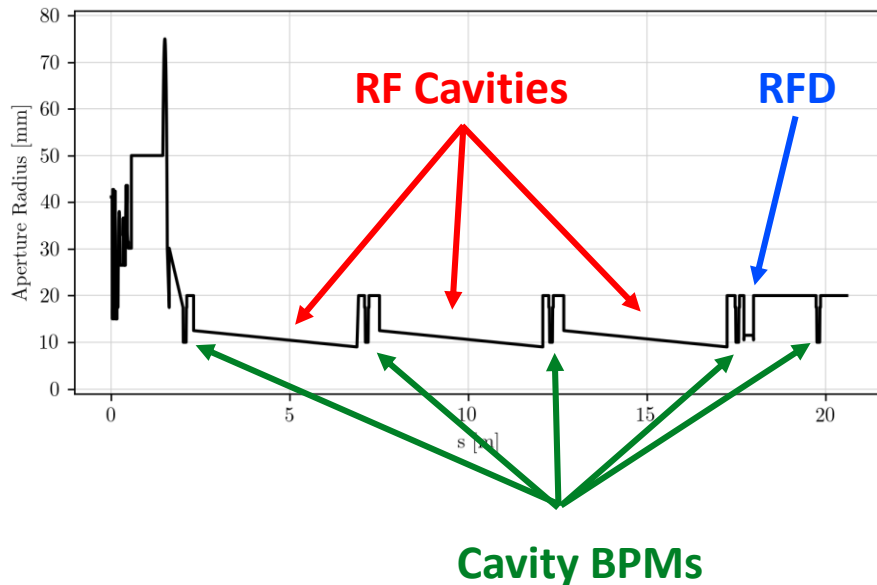
Beam Transport Studies

- Built a model of CLEAR to simulate losses in ASTRA
- Realistic approx. of aperture
- Solenoid magnets modelled as coils
 - 0 – 0.1 T (0 – 200 A current)



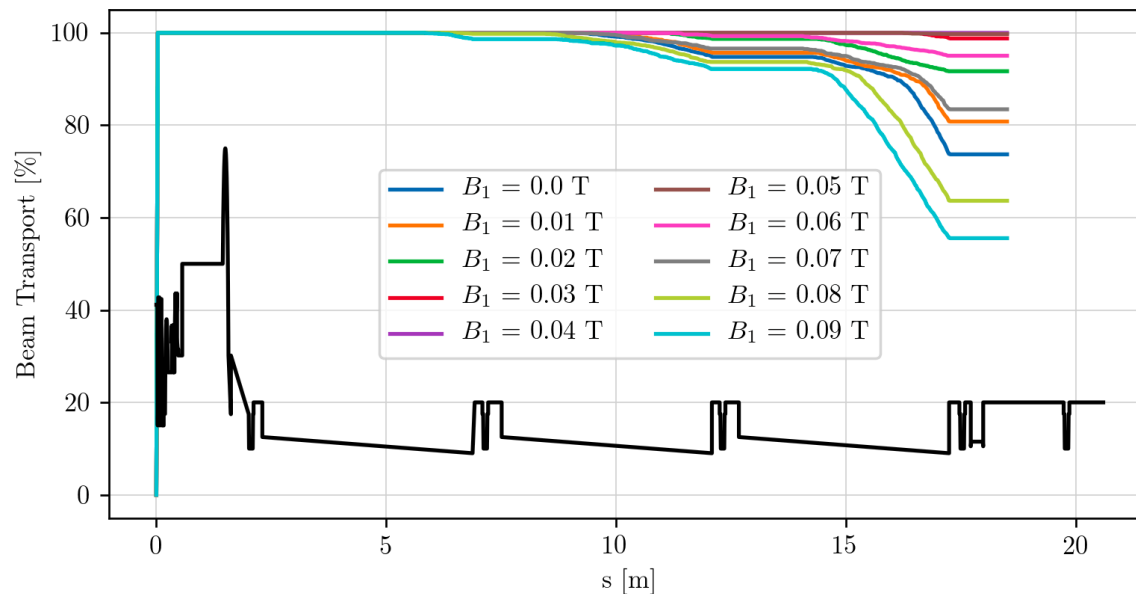
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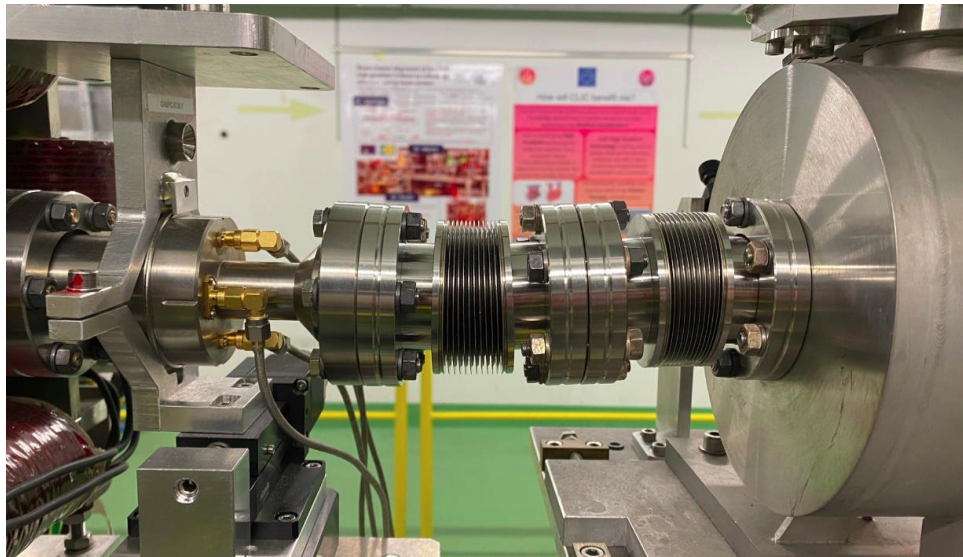
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- Up to 100 % transport in perfect machine
 - Solenoid strength important



Q = 500 pC

Beam Transport Studies

- Simulations suggest transport could be improved
- Up to 100 % transport in perfect machine
 - Solenoid strength important



N.B. this is next to a mover, illustrative only!

- BUT we have misalignments!
- 2nd solenoid VERY difficult to use because of this!

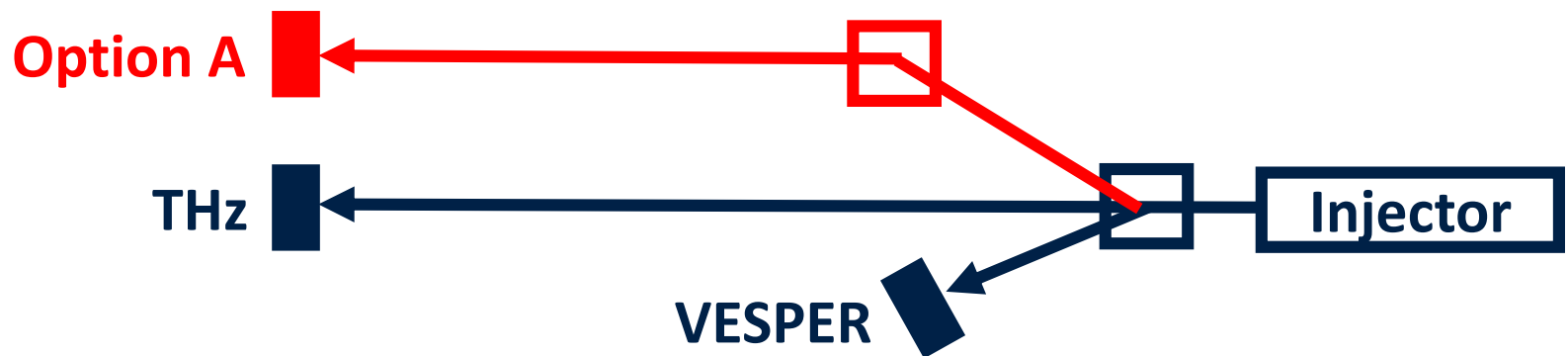
Second Beamline

- Long awaited second beamline is being designed!
- For compression, larger aperture quadrupoles for VHEE...
- Short dogleg utilising existing dipoles and quads
 - Likely existing VESPER Dipole (MDX type)
- Two options



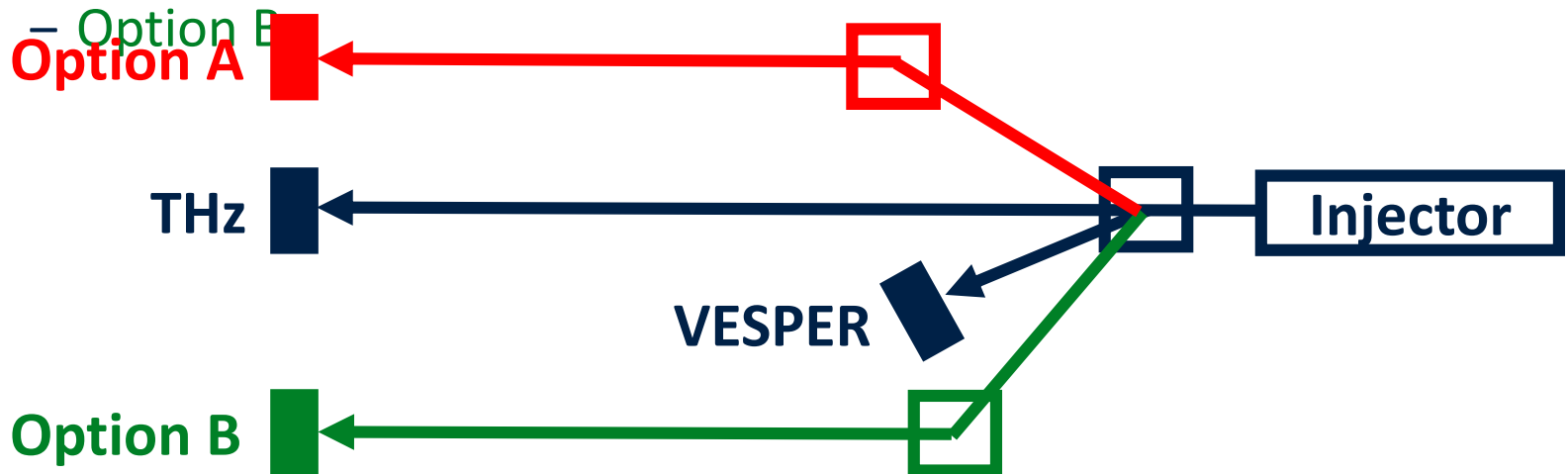
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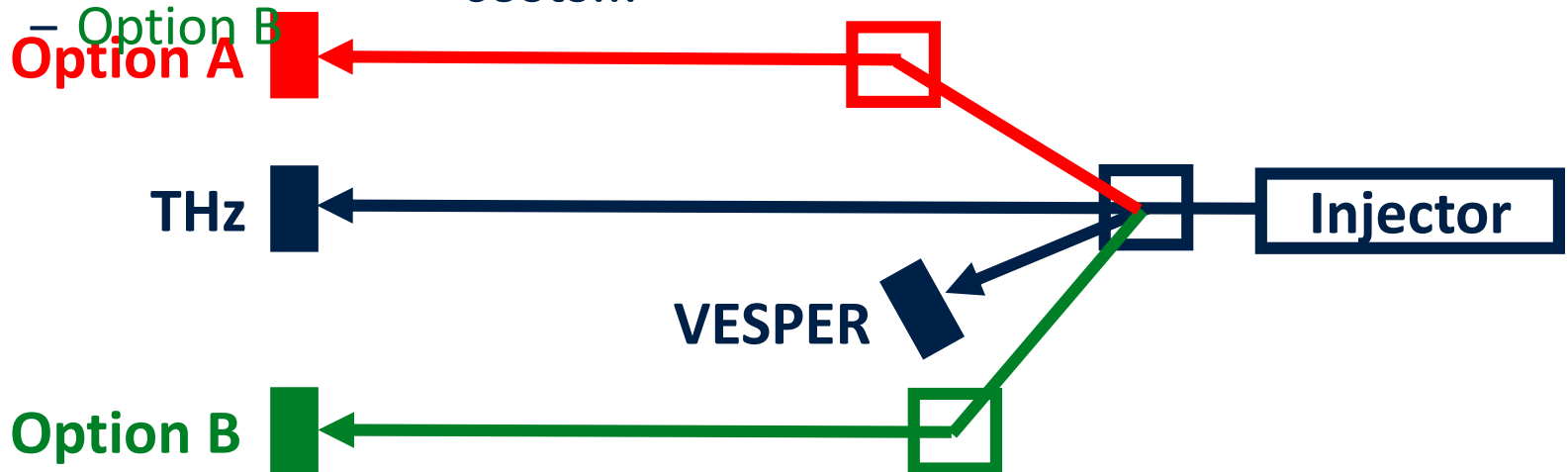
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 - Option A
 - Option B



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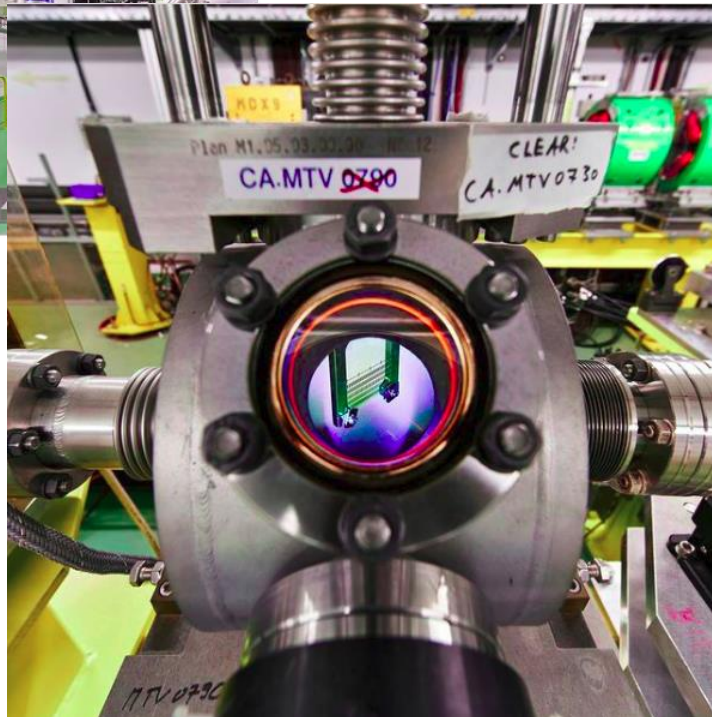
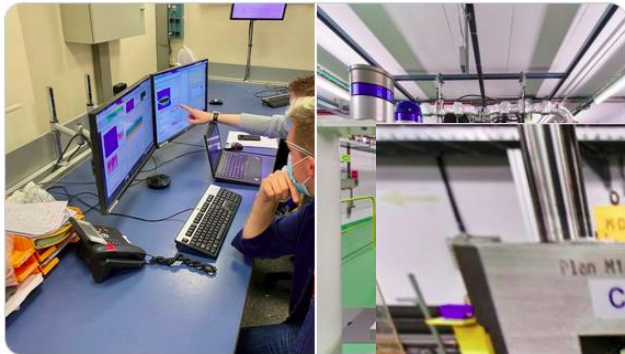
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 - Option A
 - Option B
- Work ongoing to optimise**
Physical space, bunch compression, equipment costs...



CLEAR on Social Media

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#ThisWeek @CERN - @LukeDyks and Pierre Korysko @oxfordphysics analyse performance of the CLEAR electron gun, tech for future particle accelerators 🙌
home.cern/news/news/acce... #UKatCERN
#InspiringScience



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This week @CERN: @CLIC_study @OxfordPhysics have been calibrating beam diagnostics and performing radiation studies 🙌

#FutureAccelerators #InspiringScience
#AwesomeEngineering #UKatCERN @LukeDyks



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cern All CLEAR for accelerator research 🙌

The CERN Linear Electron Accelerator for Research (CLEAR) started three years ago, with the primary goal of enhancing and complementing existing accelerator R&D programmes at CERN. It also offers a training infrastructure for future accelerator physicists and engineers.

CLEAR's focus includes studying high-gradient acceleration methods, such as CLIC X-band and plasma technologies, as well as prototyping and validation of accelerator components for the #HiLumiLHC upgrade.

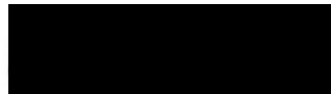
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CLEAR on Social Media

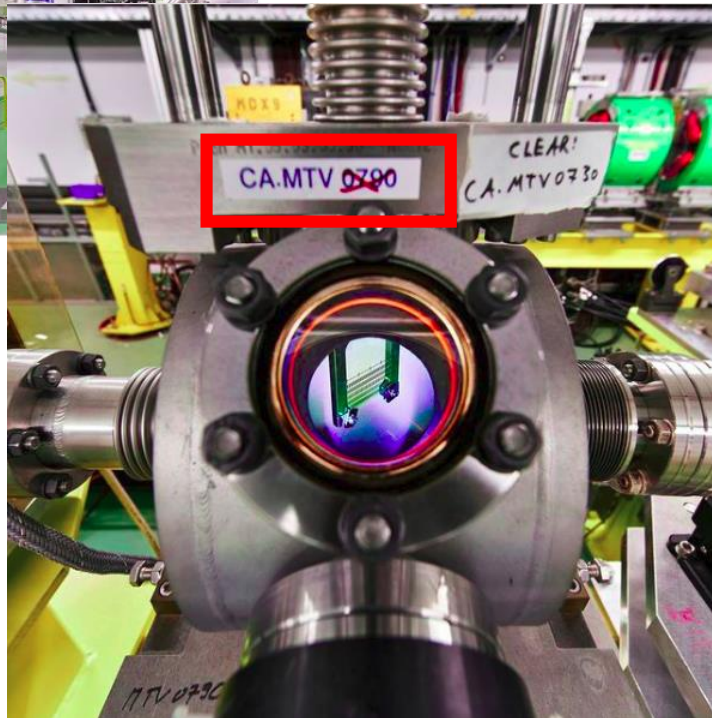
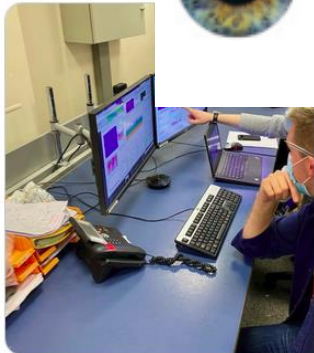
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#ThisWeek @CFRN - @LukeDyks and Pierre Korvskn
@oxfordphysi
electron gun,
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Its definitely not CA.MTV.0790!

32m 3 likes Reply



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... physics have
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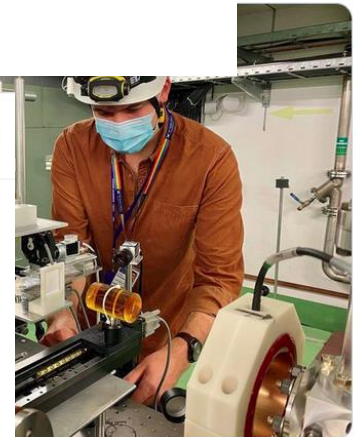
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Plans for future

- 5 year (possibly more) program provides stability
- Re-evaluate experimental program and available resources:
 - Will held a CLEAR advisory committee meeting before the end of the year

Short term → (winter shut-down 2020/2021 and during 2021)

- Consolidation for extended running (5y or more) – laser, RF, controls, ...
- Repair, conditioning and connection of X-box1
- Second beam line

Long term → Beyond 2021

- New source – it will be developed, tested and commissioned in CTF2 hall
 - May be installed in CLEAR from 2022
- New AWAKE timeline requires new source in 2026 – no potential conflict
- X-Band technology – Carlo will likely mention next!

Conclusions

- Despite Covid-chaos CLEAR continues to operate
 - Nearly as many weeks as last year
- Many user experiments have taken place
 - EOS, Micro BPM, plasmonic, AWAKE...
- CLIC and Medical studies look very promising
 - Unique VHEE facility
- Extended operational period gives good chance for MD
 - Improve diagnostics and beam quality
 - Provide a second beamline
- We look to improve the facility for future users

Merry Christmas!



clear

