THz R&D with CLEAR for THz-driven acceleration

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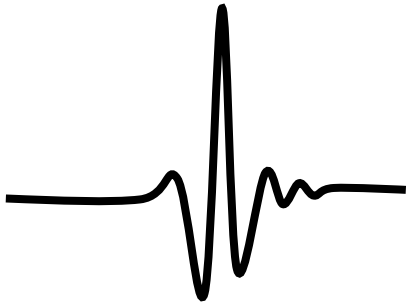
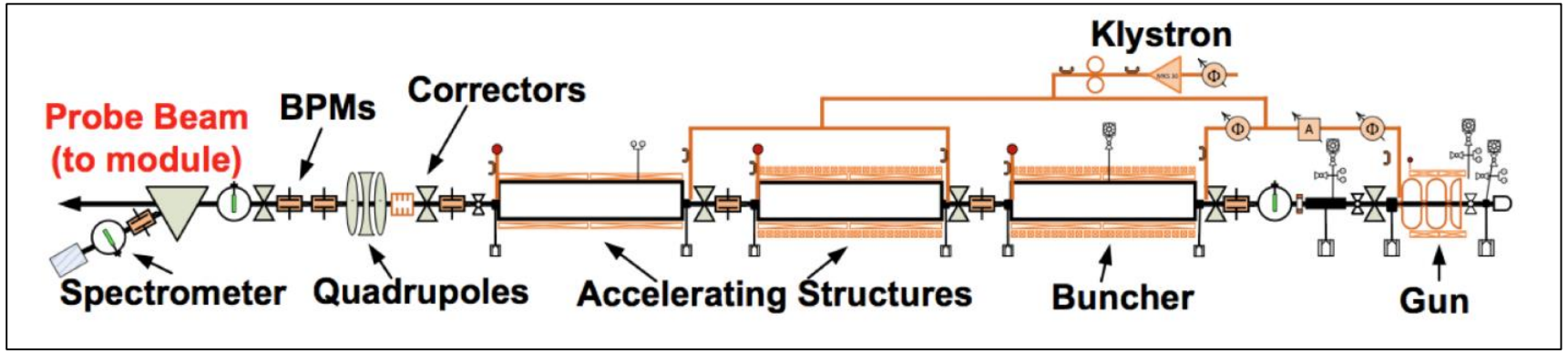
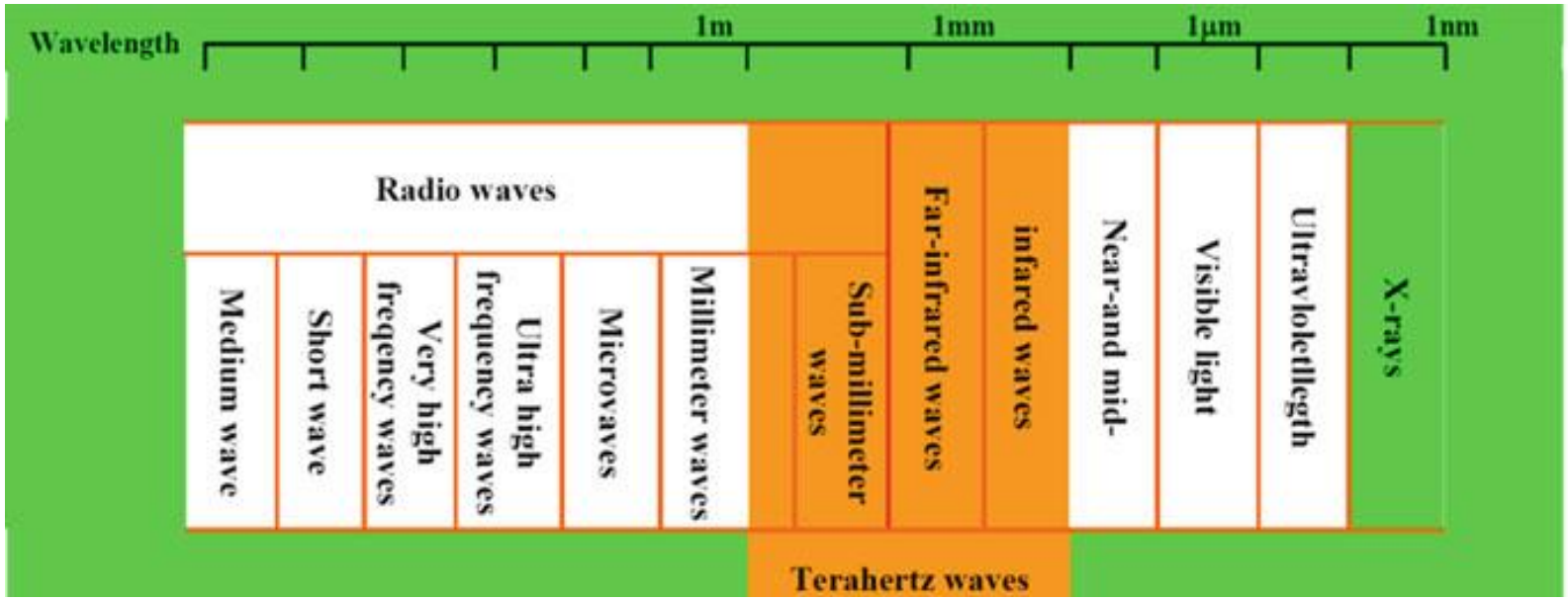




The activity is presented in collaboration with S.P. Jamison-Cockcroft Institute, UK
and has strong synergies with others groups e.g. T. Lefevre CERN; V. Goryashko -Uppsala University..



THz gap ⟷

THz

Frequency: 0.1 – 10 THz

Wavelength: 3 mm – 30 µm

Energy: 0.4 – 4 meV

Wavenumber: 3 – 300 cm^{-1}

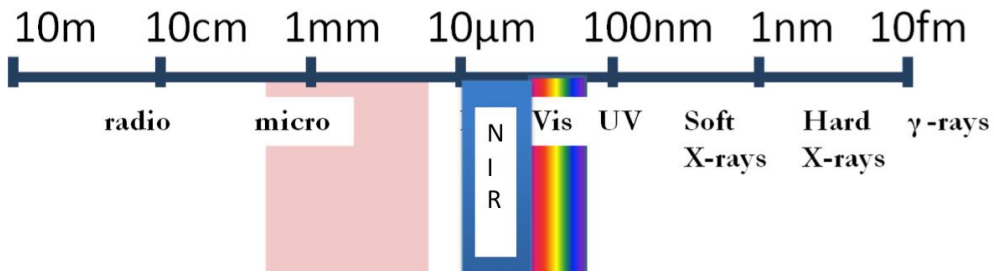
NIR

Frequency: 150- 500 THz

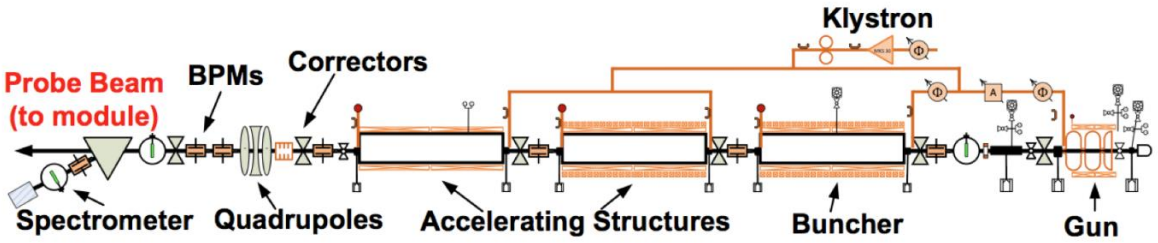
Wavelength: 700 nm – 2 µm

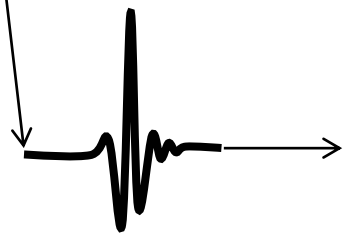
Energy: 0.6 – 2 eV

Wavenumber: 5000 – 16000 cm^{-1}



THz impact





1) **Novel acceleration concept**
2) **Study of material response in non-linear regime**
3) **Bio/Medical application**
4) **Security application**

Some bibliography:

THz driven acceleration:

- E. A. Nanni et al, NATURE COMMUNICATIONS | DOI: 10.1038/ncomms9486
- L. Wimmer et al, NATURE PHYSICS | VOL 10 | JUNE 2014 | DOI: 10.1038/NPHYS2974

Area of interest. Need to go for high energy e-

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THz driven non-linear material response:

- F. Giorgianni et al, NATURE COMMUNICATIONS | 7:11421 | DOI: 10.1038/ncomms11421
- M. Liu et al, NATURE LETT, VOL 0, 2012

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THz for Bio/Medical application

- B.S. Alexandrov et al, Scientific Report **3**, 1184 (2013): *Specificity and Heterogeneity of Terahertz Radiation Effect on Gene Expression in Mouse Mesenchymal Stem Cells*
- P. Weightman, Phys. Biol. **9** 053001 (2012)*: Prospects for the study of biological systems with high power sources of terahertz radiation*

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THz R&D with CALIFES

CLEAR can be used as THz source and as e-bunch generator. The CLEAR-produced THz can be feedback into the beam line to interact with CLEAR produced e-bunches for different purposes: THz-driven acceleration; THz-driven deflector etc..
THz pulses must be characterized to configure THz-electron interaction as well as laser pulse shaping required to perform the interaction

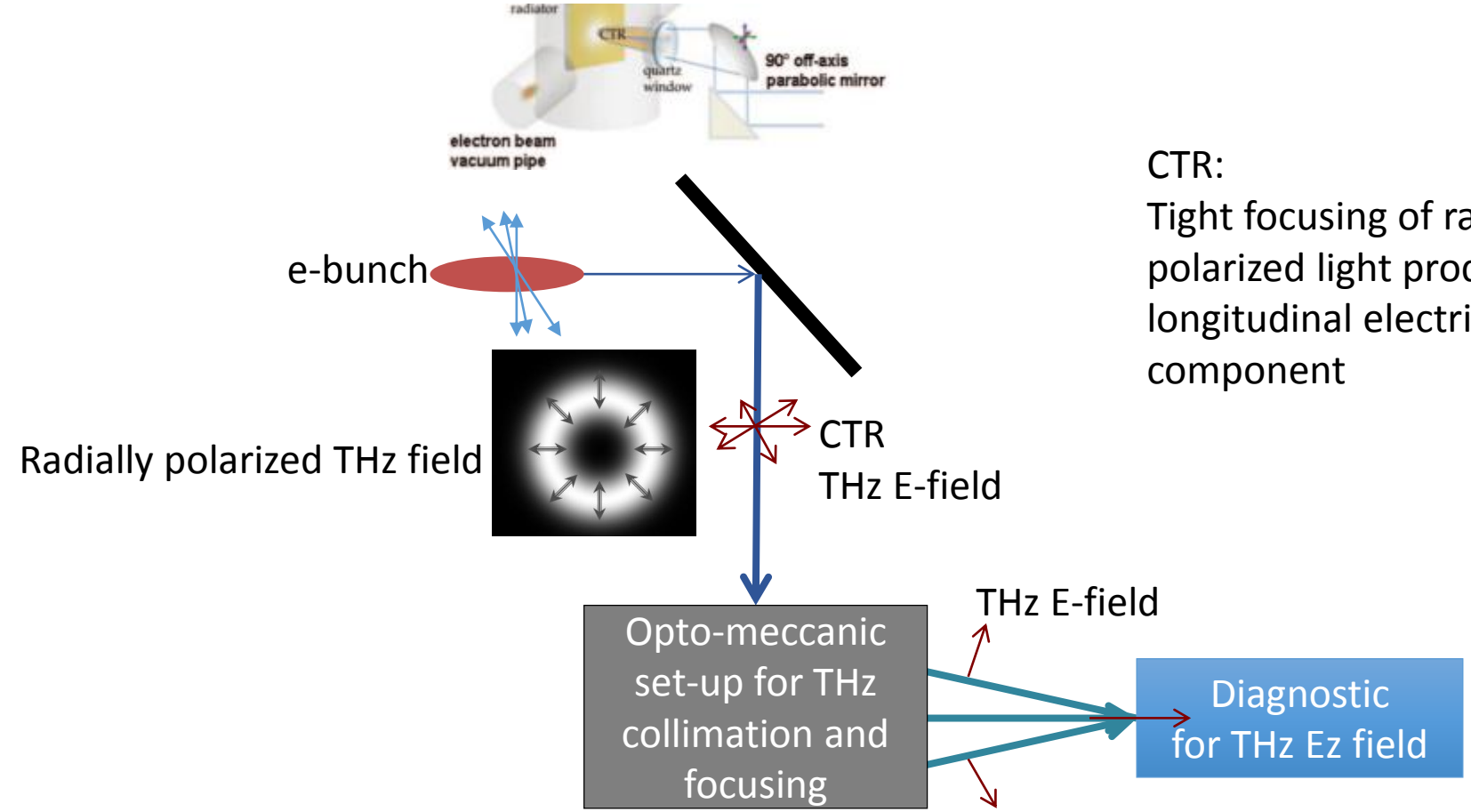
Idea of schedule for THz activity	
Short term (2017)	THz characterization (time/spectral profile, spatial profile and energy) & shaping. THz Longitudinal field generation and characterization. **= Hands on CLEAR as THz source**
	Laser pulse shaping to produce two pulses (THz-driver and THz-probe) with variable delays and different charge. Design and testing.
Medium and Long term (2017-2018)	First THz interaction with e-bunch (acceleration/deflection)

Beam parameter (end of linac)	Value range
Energy	80 - 220 MeV
Bunch charge	0.01 - 1.5 nC
Normalized emittances	2 um in both planes
Bunch length	300 um -1.2 mm

Relative energy spread	1 %
Repetition rate	1 - 5 Hz
Number of micro-bunches in train	Selectable between 1 and >100
Micro-bunch spacing	1.5 GHz

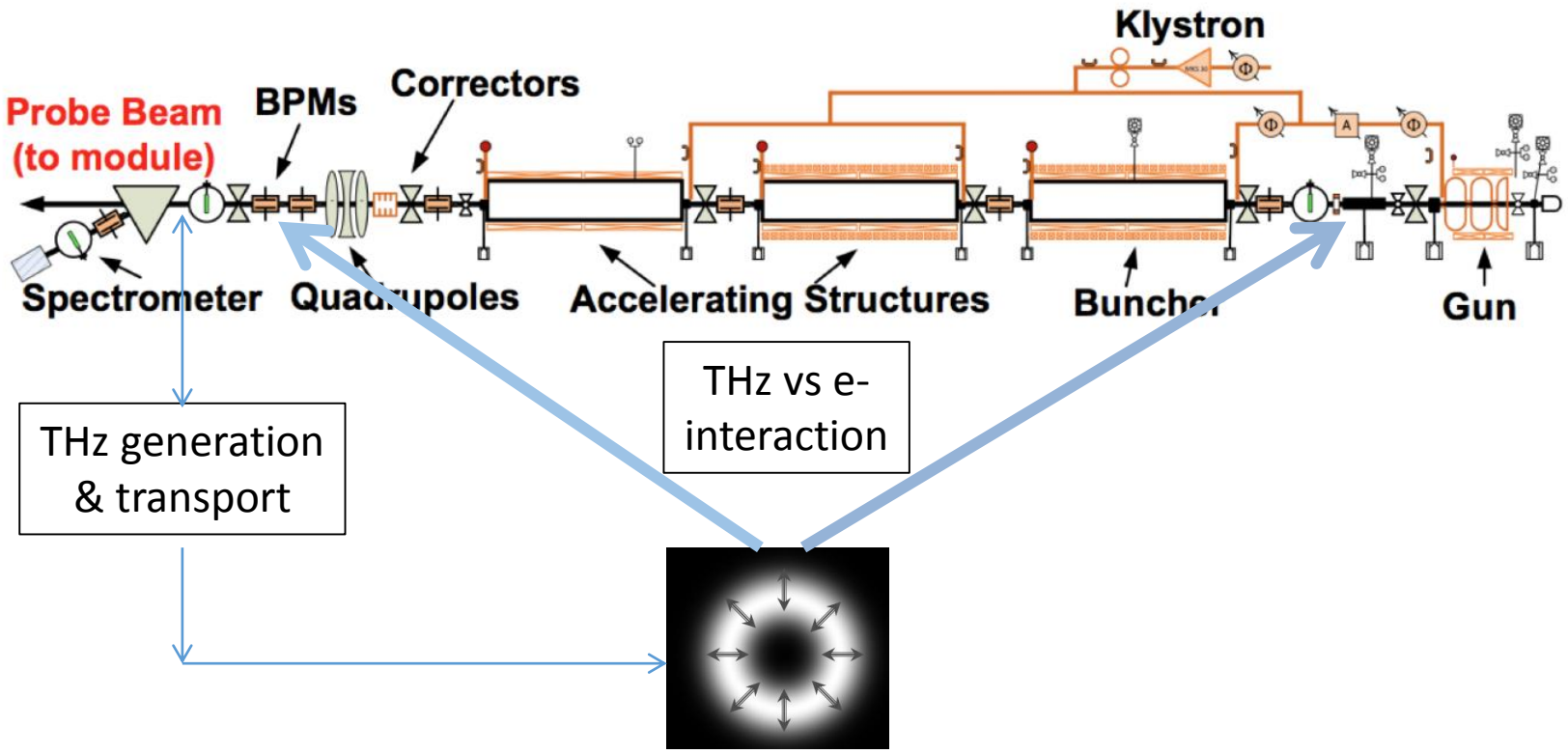
THz R&D (short term 2017)

Characterization (time/spectral profile, spatial profile and energy) of THz pulses produced by CLEAR in its actual configuration.
The processes to produce THz: CTR,CDR, CCR
Characterization of longitudinal component (Ez) of THz field
THz pulse shaping (two THz sources along the beam line)



CTR:
Tight focusing of radially polarized light produce large longitudinal electric field component

THz vs e- interaction (medium-long term 2017-2018)



THz-electron interaction can take place at different position along the beam line.