ADVANCED GENERATION OF THz AND X-RAY BEAMS USING COMPACT ELECTRON ACCELERATOR


(“Advanced Generation of THz and X-ray” AGTaX collaboration)

a KEK: High Energy Accelerator Research Organization, Japan
b Inter University Accelerator Centre (IUAC), New Delhi, India
c Society for Applied Microwave Electronics Engineering and Research, Mumbai, India
d The John Adams Institute, Department of Physics, University of Oxford, UK
e John Adams Institute at Royal Holloway, University of London, UK
f Tomsk Polytechnic University, Institute of Physics and Technology, Russian Federation
g# National Research Nuclear University (MEPhI), Moscow, Russia
h SOKENDAI: The Graduate University for Advanced Studies, Japan

Channeling 2016, VIII AGTaX, 30 September, 2016
Outline

• FEL introduction
• THz FEL RF Gun laser system
• Pre-bunched beam dynamics
• Pre-bunched beam diagnostics
• THz resonator
• Conclusion, Plans, Schedule
Additional motivation

\[ \frac{d^2 W_{tot}^s}{d\omega d\Omega} = \frac{d^2 W_{sing}}{d\omega d\Omega} N_e \left( 1 + (N_e - 1) |f_i(\omega)|^2 \right) \]

\[ \frac{d^2 W_{tot}^s}{d\omega d\Omega} = \frac{d^2 W_{sing}}{d\omega d\Omega} N_e \left( 1 + (N_e - 1) \frac{\sin^2 \left[ \frac{N_b \omega \lambda_{RF}}{2\beta c} \right]}{\sin^2 \left[ \frac{\omega \lambda_{RF}}{2\beta c} \right]} |f_i(\omega)|^2 \right) \]
“Advanced Generation of THz and X-ray” collaboration started in 2013.
It brings together different communities working on the simulation, generation and experimental investigation of high-brightness THz and Compton X-ray beams.
Based on several MoUs the following research strategy was agreed:
– Construction of a stable and tunable laser system for RF gun development and THz radiation sources tests based on modern technology.
– Build a broad collaborative network among leading institutions worldwide.
– Develop state-of-the-art tunable coherent THz radiation sources on the basis of a compact (preferably table-top) accelerator.
Collaboration experiments were started in 2015 at KEK LUCX.
Seven collaboration meetings were held 2 times a year at almost every collaborator’s institutions: KEK – 2013.03, RREPS13 (conference session) – 2013.09, MEPhI – 2014.05, SPbSU – 2014.10, Oxford – 2015.03, RREPS15 (conference session) – 2015.09 and KEK – 2016.03.
Future meetings are considered as follows: 2016.09 – Channeling2016 (conference session), 2017.02 – IUAC, 2017.09 – Wuhan University.
Collaboration supported by:
– Leverhulme Trust Network “Advanced Research on Generation of THz and X-ray Radiation” (IN 2015 012)
– JSPS KAKENHI grant numbers 23226020 and 24654076 (Finished April 2016)
– JSPS – RFBS bi-lateral research program
Pre-bunched THz FEL introduction


Simulation of Henry Freund
“Femtosecond mode”
- Ti:Sa laser
- e-bunch rms length ~100fs
- e-bunch charge < 100pC
- Single bunch train, Micro-bunching 4-16 (4 is confirmed)
- Typical Rep. rate 3.13 Hz
- Experiments: THz program

- Ce₂Te cathode Q.E. measurements
  - Confirmed to be same as of ps and fs laser – 0.4%
- Ce₂Te cathode response time
  - First step experiment to confirm < 250fs response
  - Present measurements shows ~ 160fs response

“Picosecond mode”
- Q-switch Nd:YAG laser
- e-bunch rms length ~10ps
- e-bunch charge < 0.5 nC
- Multi-bunch train 2- few 10³
- Max Rep. rate 12.5 Hz
- Experiments: Compton, CDR
THz-related activity

e-beam generation

Diagnostics

Beam dynamics

THz generation

CDR/CTR

Undulator

Simulation

3D Periodical structures

Experimental studies

Smith-Purcell

Beamline construction

Experimental studies

THz cavity

Simulation

Optical constants

THz imaging

THz test bench

New laser system

VII Mini-workshop for Advanced Generation of THz and Compton X-ray beams

“AGTaX” using compact electron accelerator at KEK

3rd March, 2016
Conclusion & Summary

• Following electron beam parameters @ THz station were confirmed:
  – Energy ~ 8.5 MeV
  – Energy spread < 1 % rms
  – Transverse rms beam size @ THz station ~ 500x500 um
  – Bunch length ~ 250 fs (4 micro-bunch average)
  – Number of micro-bunches – 4
  – Minimum micro-bunch time separation ~ 250 fs
  – Micro-train charge (4 micro-bunches) ~ 100 pC
Resources

• **Skype**
  – Aryshev Alexander : alarkek

• **E-mails**
  – Aryshev Alexander : alar@post.kek.jp
Thank you for your attention