LUCX - THz Program: Overview and Prospects

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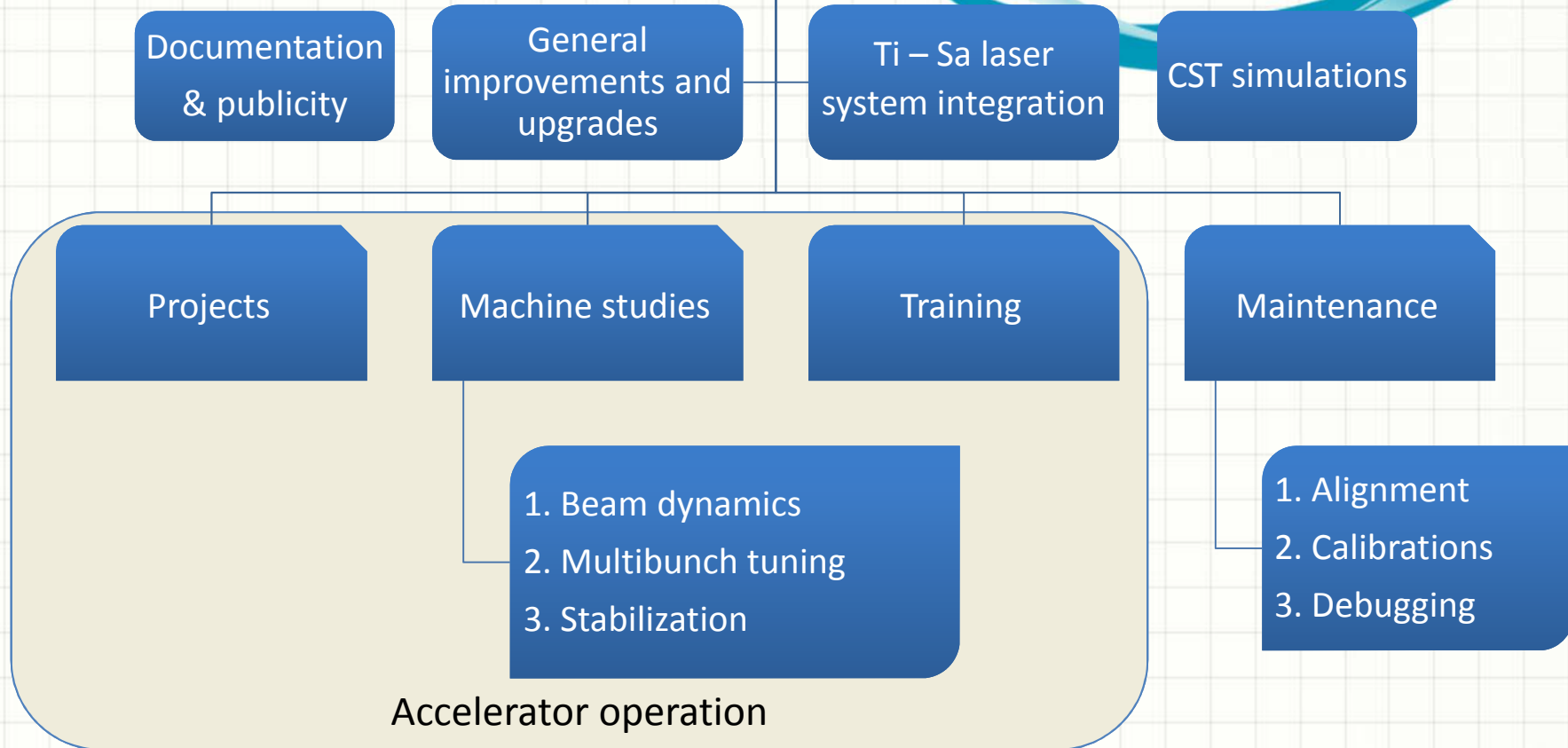On behalf of QB group and
THz collaboration

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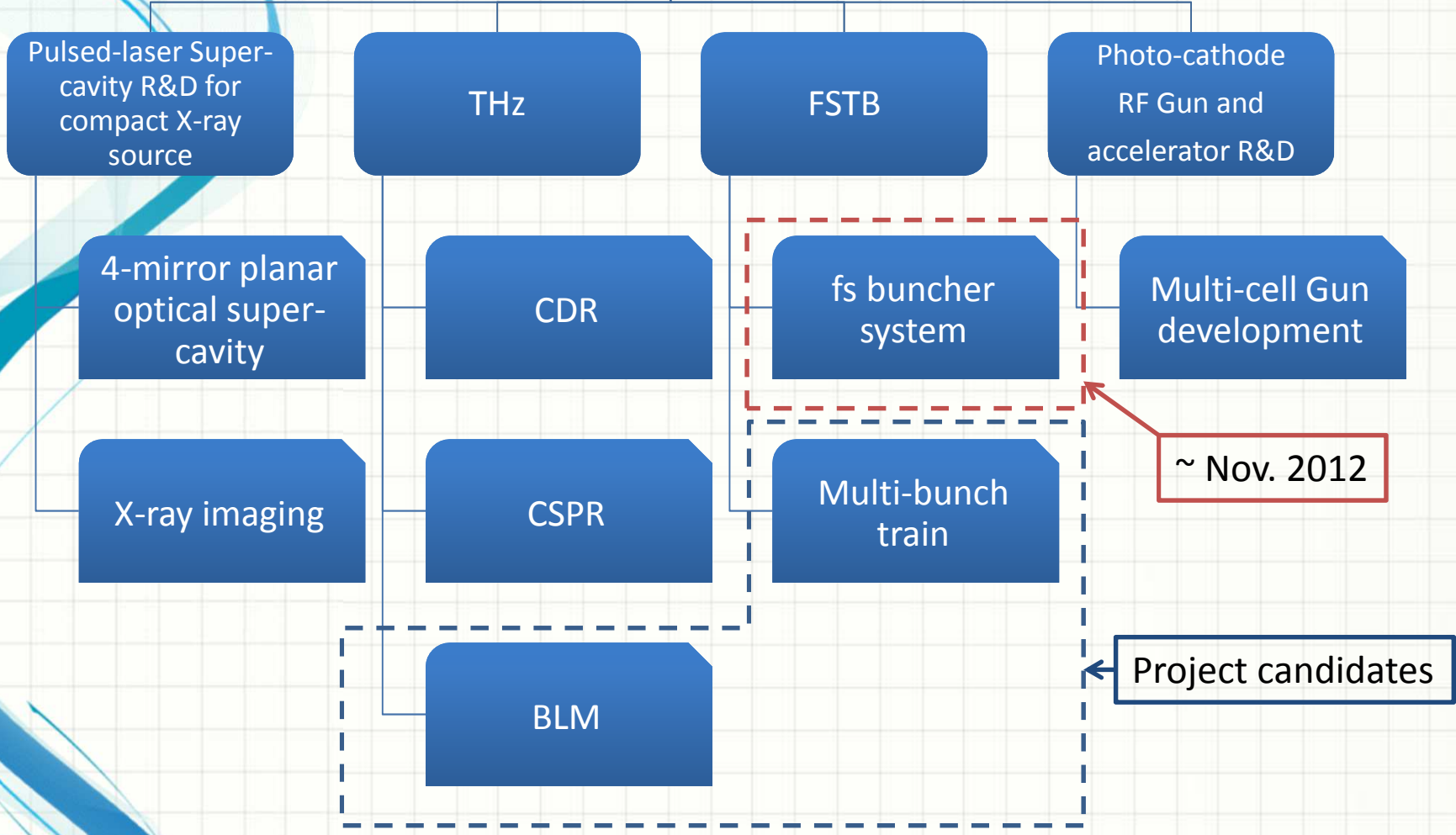
14 – 15 August 2012

Outline

- THz project overview
  - LUCX activity
  - LUCX Projects Overview
  - THz program
- LUCX Laser system
- LUCX 2012 upgrade
  - LUCX operation modes
  - e-beam optics
  - THz program vacuum system, manipulator
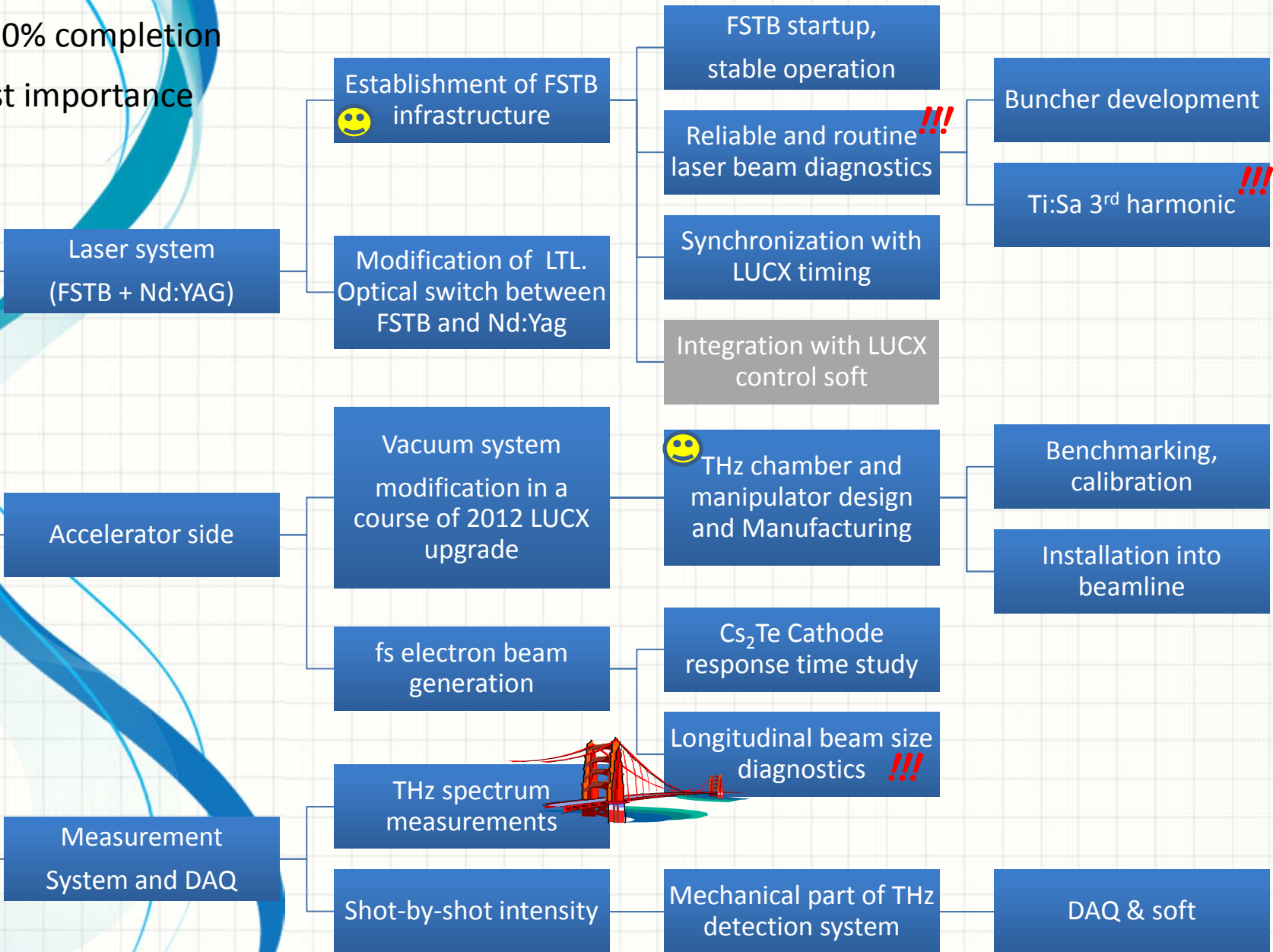- Measurement setup and DAQ
- Schedule & Conclusion
- Resources

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generation

LUCX Activities Overview

Documentation & publicity

General improvements and upgrades

Ti – Sa laser system integration

CST simulations

Projects

Machine studies

1. Beam dynamics
2. Multibunch tuning
3. Stabilization

Training

Maintenance

1. Alignment
2. Calibrations
3. Debugging

Accelerator operation

LUCX Projects Overview

Pulsed-laser Super-cavity R&D for compact X-ray source

THz

FSTB

Photo-cathode RF Gun and accelerator R&D

4-mirror planar optical super-cavity

CDR

fs buncher system

Multi-cell Gun development

X-ray imaging

CSPR

Multi-bunch train

~ Nov. 2012

BLM

Project candidates

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😎 - ≥ 50% completion

!!! – vast importance

THz program

- **Laser system (FSTB + Nd:YAG)**
  - Establishment of FSTB infrastructure 😎
    - FSTB startup, stable operation
    - Reliable and routine laser beam diagnostics *!!!*
      - Buncher development
      - Ti:Sa 3rd harmonic *!!!*
  - Modification of LTL. Optical switch between FSTB and Nd:Yag
    - Synchronization with LUCX timing
    - Integration with LUCX control soft

- **Accelerator side**
  - Vacuum system modification in a course of 2012 LUCX upgrade
    - 😎 THz chamber and manipulator design and Manufacturing
      - Benchmarking, calibration
      - Installation into beamline
  - fs electron beam generation
    - Cs_2Te Cathode response time study
    - Longitudinal beam size diagnostics *!!!*

- **Measurement System and DAQ**
  - THz spectrum measurements
  - Shot-by-shot intensity
    - Mechanical part of THz detection system
      - DAQ & soft

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LUCX Facility, FSTB

LUCX accelerator tunnel

Nd:YAG

KLY#0

KLY#1

FSTB

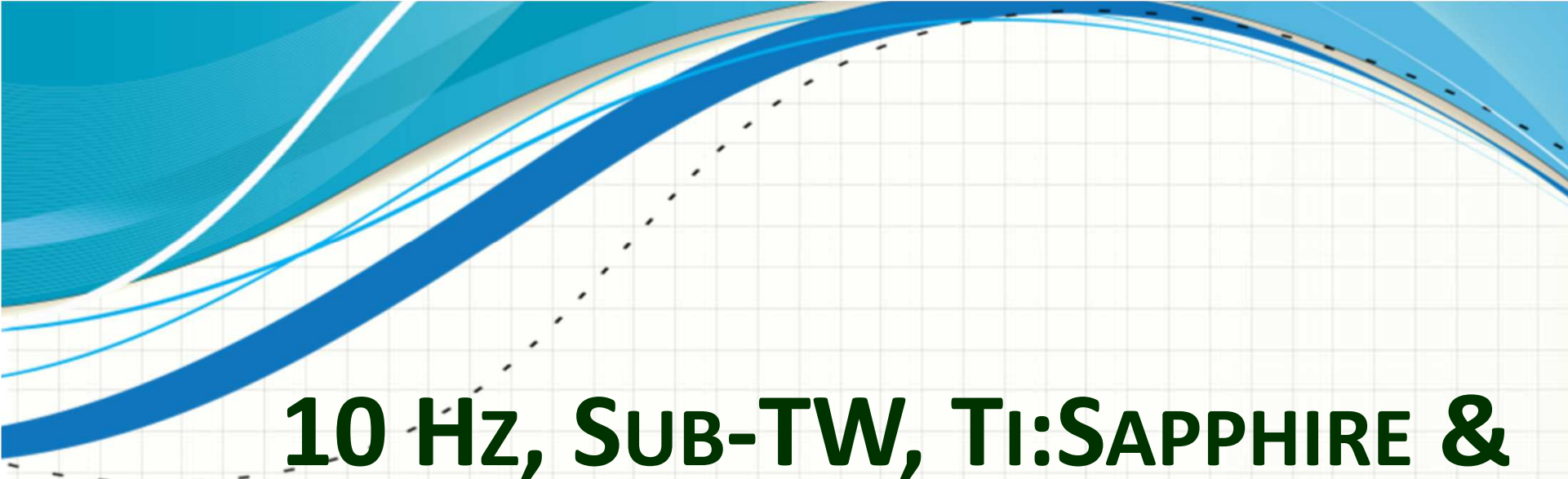LUCX control room

Modulator #0

Modulator #1

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THz program key points

- **Laser system**
  - Stable operation and diagnostics
  - Generation of Ti:Sa 3rd harmonic (265nm) fs laser beam
  - Pointing, energy, mode stability @ 265nm
  - Micro-bunching
- **Accelerator**
  - Generation of fs electron beam
  - Ability to measure longitudinal beam profile
  - Vacuum chamber with multi-axis manipulator system
- **THz Measurement system**
  - Reliable measurements of THz radiation spectrum and angular distribution.
  - Radiation intensity, Pulse duration, Shot-to-shot and Long-term stabilities.

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10 Hz, Sub-TW, Ti:Sapphire & 3 Hz, MW, Q-switch Nd:YAG Laser systems

Q-switch Nd:YAG laser system

to FSTB

1000×2000
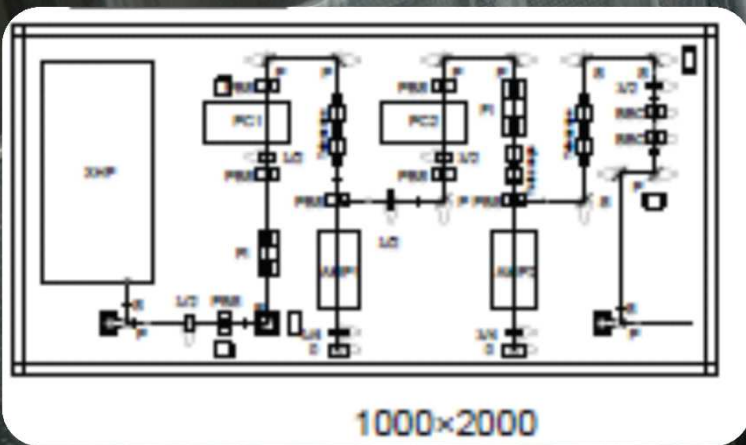
Measurement results	
Repetition rate, typ.	3Hz
Central wavelength	266nm
Pulse energy @ 266nm, typ	10μJ
Pulse duration	~10ps
Energy stability 10μJ @ 266nm	~1%

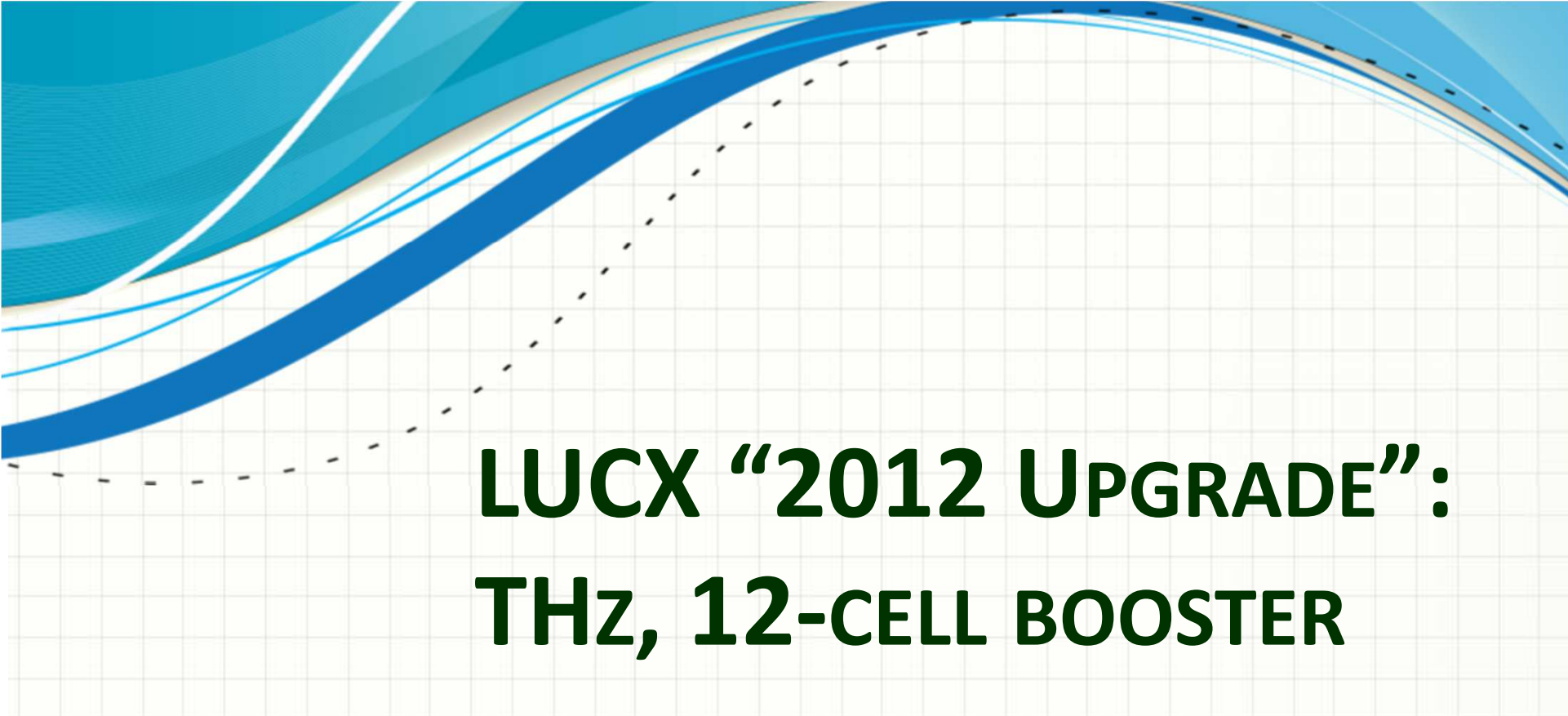TPU-KEK-RHUL Workshop on THz radiation generation

LUCX operation modes

"Femtosecond mode"

- Ti:Sa laser
- e-bunch length ~
- e-bunch charge ~
- Single bunch train
- Micro-bunching 4 – 16
- Rep. rate 3.13 Hz
- Experiments: THz program

"Picosecond mode"

- Q-switch Nd:YAG laser
- e-bunch length ~ 10 ps
- e-bunch charge ~ 0.5 nC
- Multi-bunch train 2 – few 10^3
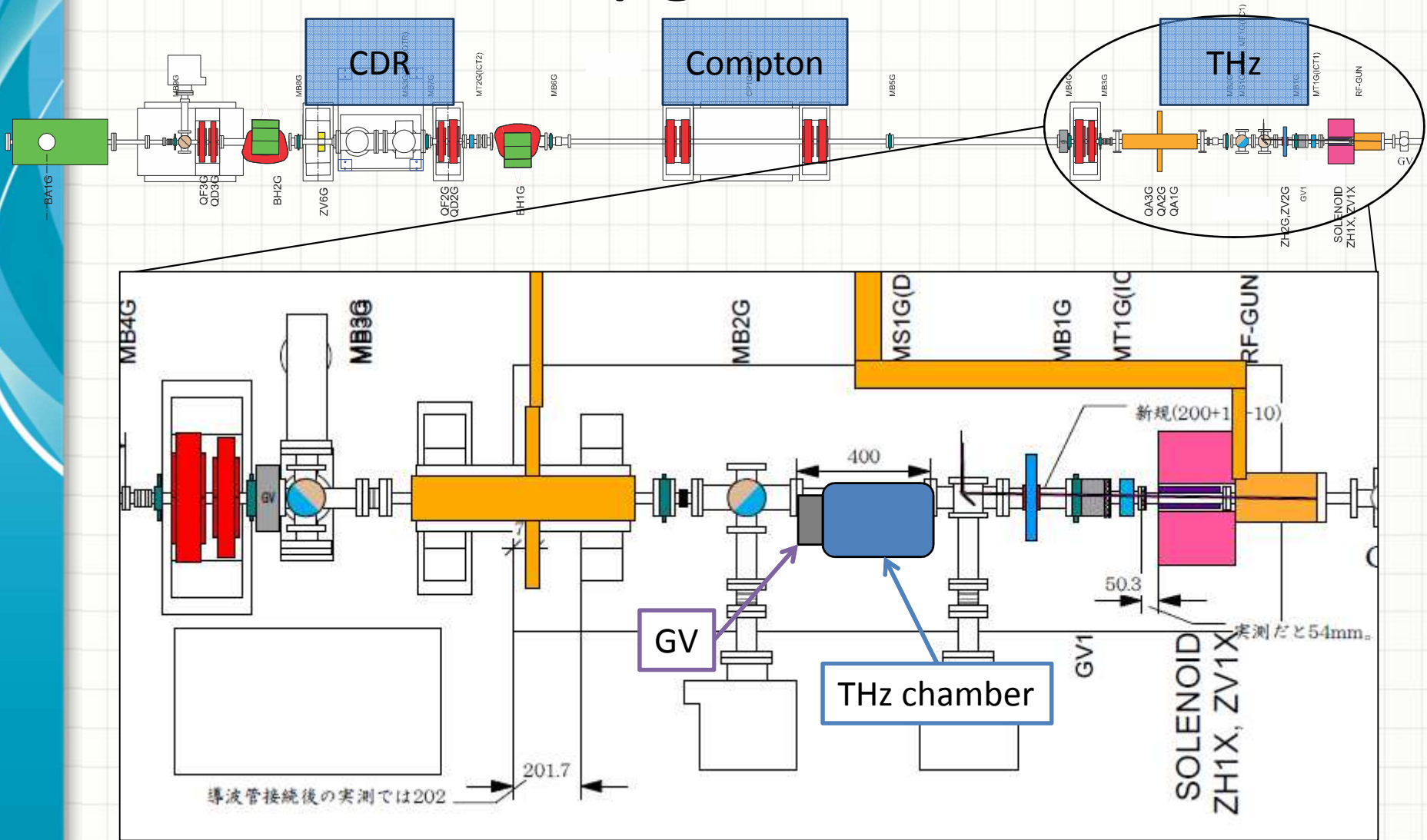- Rep. rate 3.13 Hz
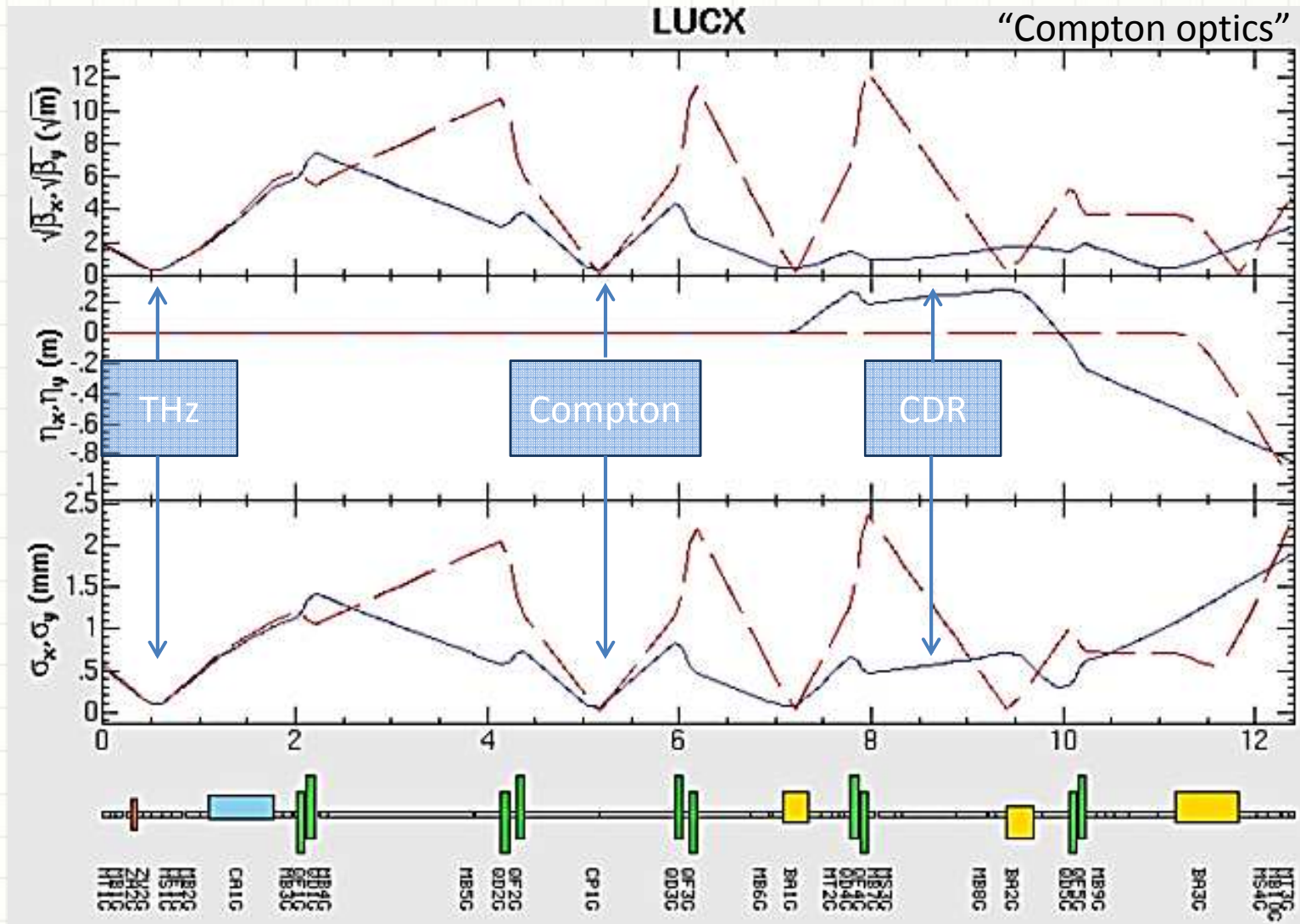- Experiments: Compton, CDR

LUCX "2012 Upgrade": THz, 12-cell booster

LUCX "2012 upgrade"

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LUCX "2012 upgrade", e-optics
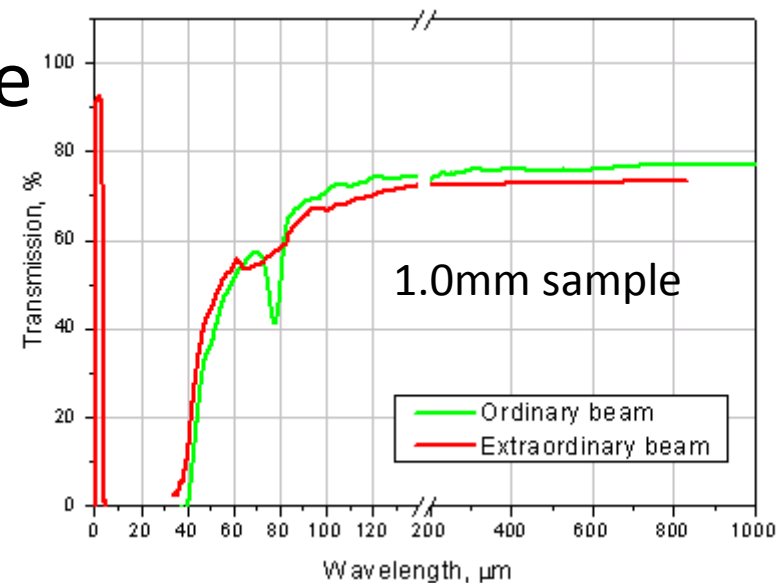
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Vacuum window

- THz grade crystal quartz (z-cut)
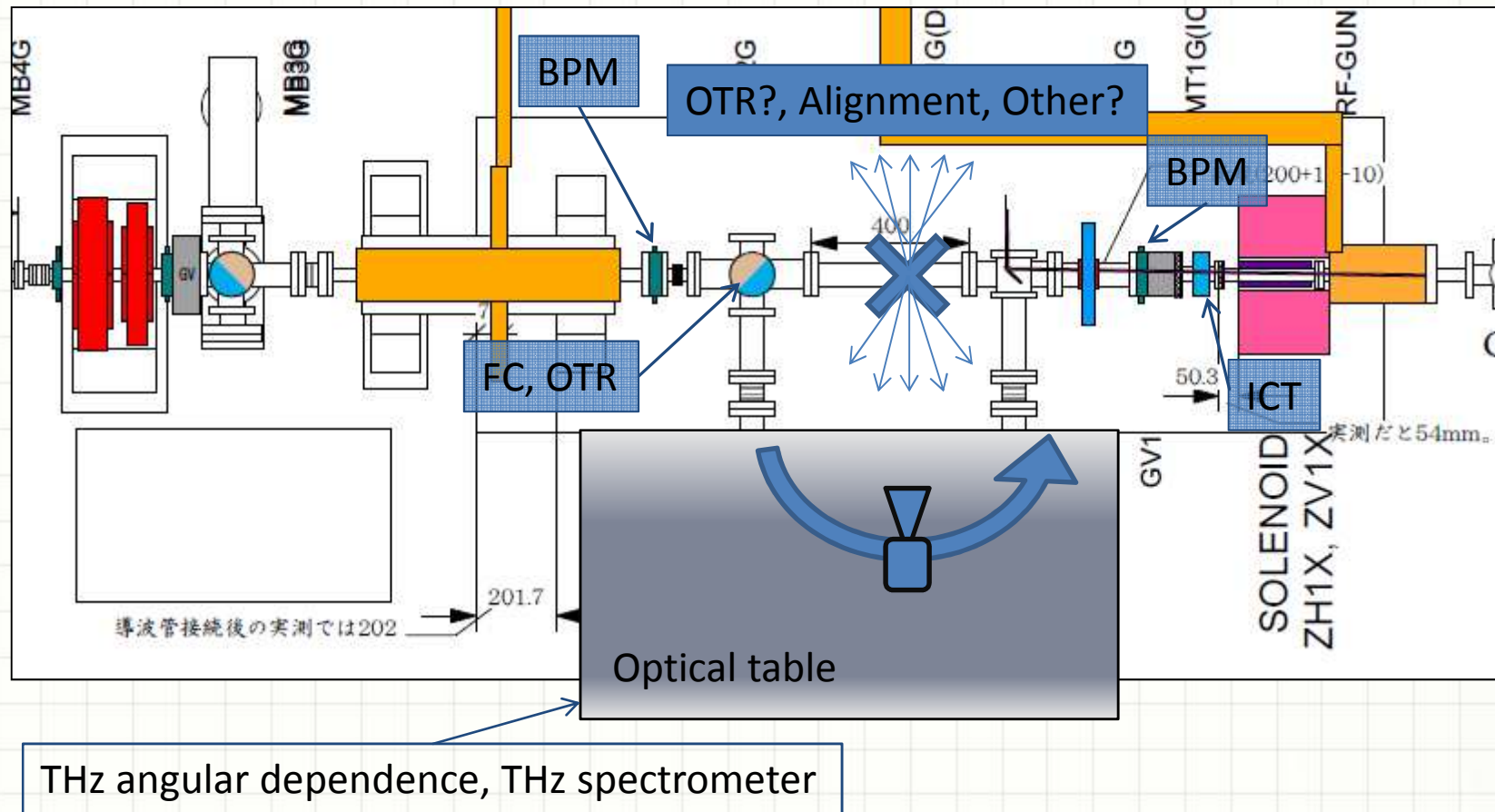- Spectral transmission ?
- ICF203 flange
- Window size – aperture

max 150 mm

1.0mm sample

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Measurement setup and DAQ

Measurement setup and DAQ

- Detectors
  - SBD 60 – 90 GHz
  - SBD 90 – 140 GHz
  - Gamma detector
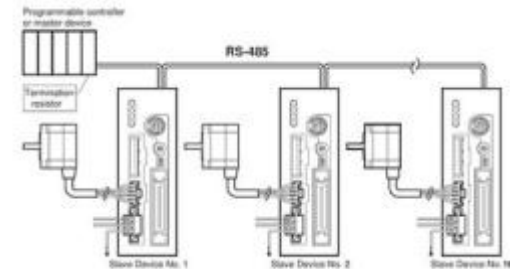 - Quasi-Optical Detector Frequency Range 0.1-1 THz
- DAQ
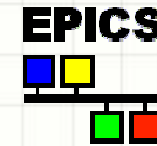 - Oscilloscope 1GHz, 5GS/s
  - Fast digitizer ?
- Motorization
  - Similar to CDR (Oriental motors + controllers)
  - PLC ?
- Soft
  - Qt GUI, EPICS, python scripts
  - Data format

Schedule & Conclusion

- Work in every direction is ongoing
- FSTB
  - startup: from 22 August 2012
- THz chamber
  - Right now at Design stage
  - Preliminary Installation schedule – December 2012
- LUCX diagnostics
  - BPMs, ICT, OTR – have to be checked
  - BLM – has to be developed
- Measurement setup and DAQ
  - Right now at Design stage
  - More discussion is required

Resources

- THz program web:
  http://www-atf.kek.jp/thz/index.html

- LUCX wiki (documentation, e-log, etc.):
  http://atf.kek.jp/twiki/bin/view/LUCX/WebHome

- QB program web:
  http://kocbeam.kek.jp/