Infrastructure requirements for an optical synchronization system

Axel Winter
(DESY up to January 2009, now ITER)

(Deutsches Elektronen-Synchrotron)

C. Behrens, S. Schulz, S. Wesch, J. Zemella,
(Universität Hamburg)

J. Szewinski
(Warsaw University of Technology Institute of Electronic Systems)

W. Jalmuzna
(Technical University of Lodz)
Overview

• The essentials to start the lab
• Requirements for the installation of a typical system
  – Fiber Installations
  – Electronics, climate, vibrations
• Infrastructure at FLASH
• Conclusion
Basic necessities to get the lab going

- Working with fibers: PM-splicer

€ 40.000
Basic necessities to get the lab going

- Working with fibers: PM-splicer
- And to make it work with non-standard PM fibers

€ 60,000
Diagnostics for fiber lasers

- Optical spectrum analyzer

€ 100,000
Diagnostics for fiber lasers

- Optical spectrum analyzer
- Autocorrelator

€ 120,000
Diagnostics for fiber lasers

- Optical spectrum analyzer
- Autocorrelator
- Phase noise measurement system

€ 180,000
Diagnostics for fiber lasers

- Optical spectrum analyzer
- Autocorrelator
- Phase noise measurement system
- Fast Scopes, spectrum analyzers, signal analyzers
- And a whole lot of small stuff

€ 500,000
Layout of the FLASH Synchronization System

- Synchronization of all timing critical devices (~ 12 points)
- Point-to-point synchronization ~ 10 fs rms (e- < 30 fs rms)
- Permanent operation and long term stability/availability investigation
One central point for lasers & link stabilization

- Very well (!!!) temperature stabilized area (~0.01° in critical areas)
- Good grounding to minimize EMI
Distributing fibers

- Use blow-in technique
  - Well established, industry standard (used for airports, universities, hospitals)
  - Flexible, allowing for later upgrades
  - Needs special fiber coating, but companies provide that
  - Breakout boxes can be installed where required
Stabilizing the environment

Approach: many layers of isolation: the „onion strategy“

• Vibrations
  • Optical table isolated wrt. floor
  • Heavy metal plates on leadfoam

• Temperature
  • Dedicated room with AC
  • Cover around optical table
  • Modules encapsuled independently
  • Needed: 0.01° at critical positions
A „standard“ system (again FLASH example)...

- 2 MLO’s with distribution and ~16 fiber links
  - 300 cables (~150 signal cables)
  - 58 motors
  - 20-25 laser pump diodes
  - 16-20 peizo stretchers
  - 42 temperature sensors
  - 4 VME crates
  - ~100 medium and fast ADC channels
  - ~150 control loops

- electronics & software development needed:
  - Laser diode drivers
  - fast ADC’s (130 MHz 16 bit)
  - low noise piezo drivers
  - slow ADC’s & DAC’s

- So by no means a simple system, but extremely complex
Conclusion

• Optical Synchronization systems are very complex systems with extremely tight constraints on:
  • Temperature stability
  • EMI
  • Vibrations

• but also require state of the art electronics:
  • High dynamic range fast ADC’s (12 bit, ~500 MSPS)
  • High performance digital regulation systems

• State of the art Test & Measurement equipment required (~500 kEUR)
Thanks for your attention!