Infrastructure requirements for an optical synchronization system

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(DESY up to January 2009, now ITER)

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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

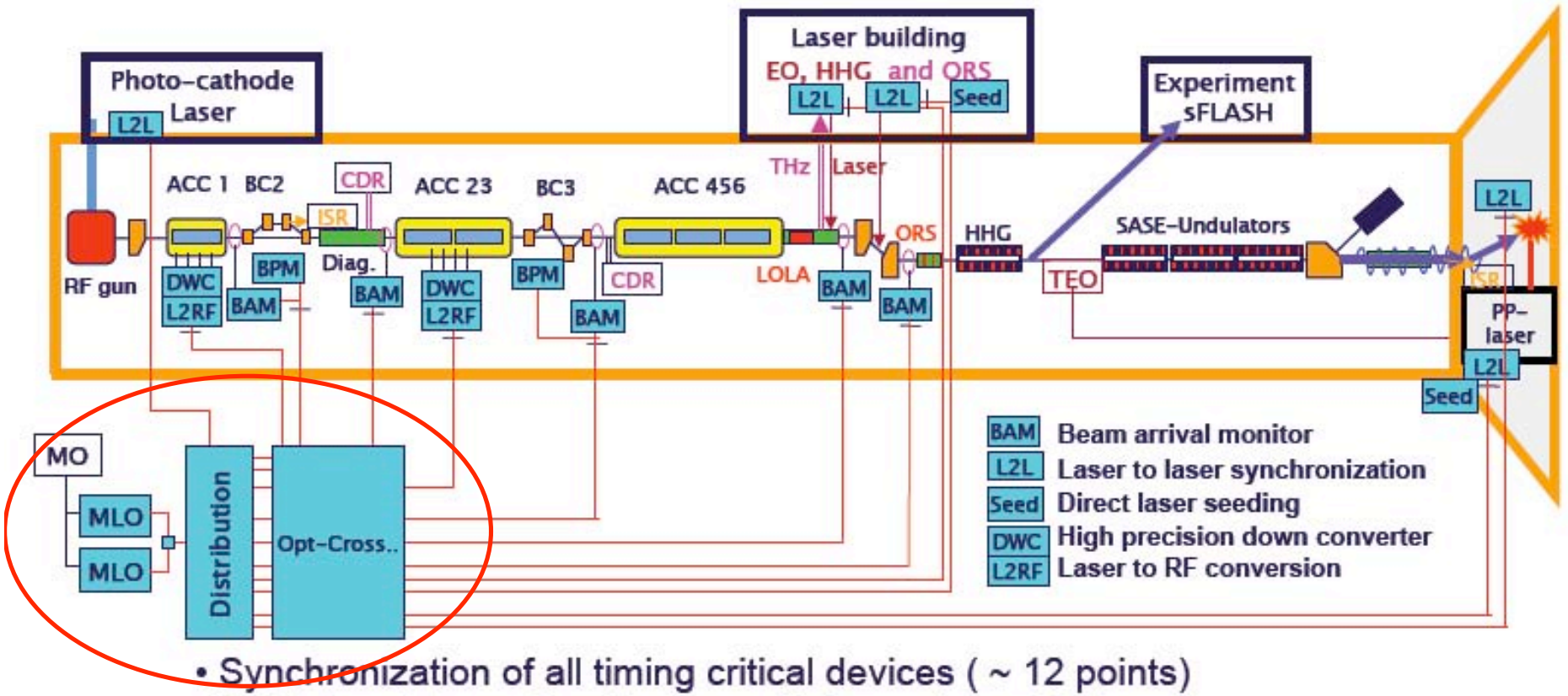
- Optical spectrum analyzer
- autocorrelator

- Phase noise measurement system

- Fast Scopes, spectrum analyzers, signal analyzers
- And a whole lot of small stuff

€ 300.000

Layout of the FLASH Synchronization System



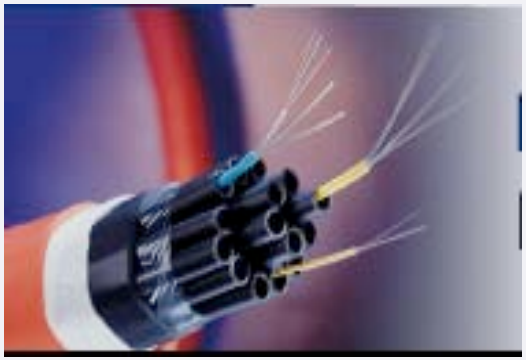
- Synchronization of all timing critical devices (~ 12 points)
- Point-to-point synchronization ~ 10 fs rms (e- < 30 fs rms)
- Permanent operation and long term stability /availability investigation

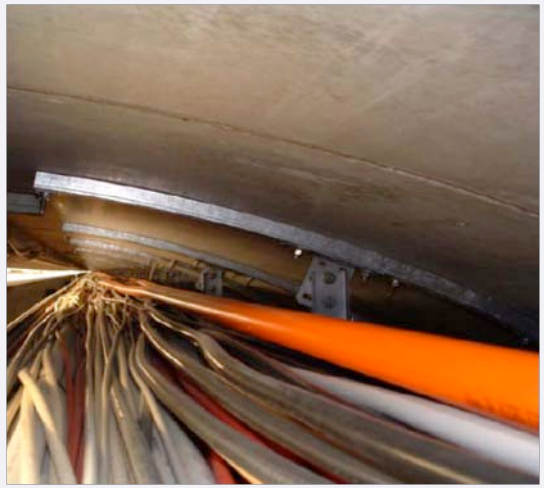
One central point for lasers & link stabilization

- 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 requried

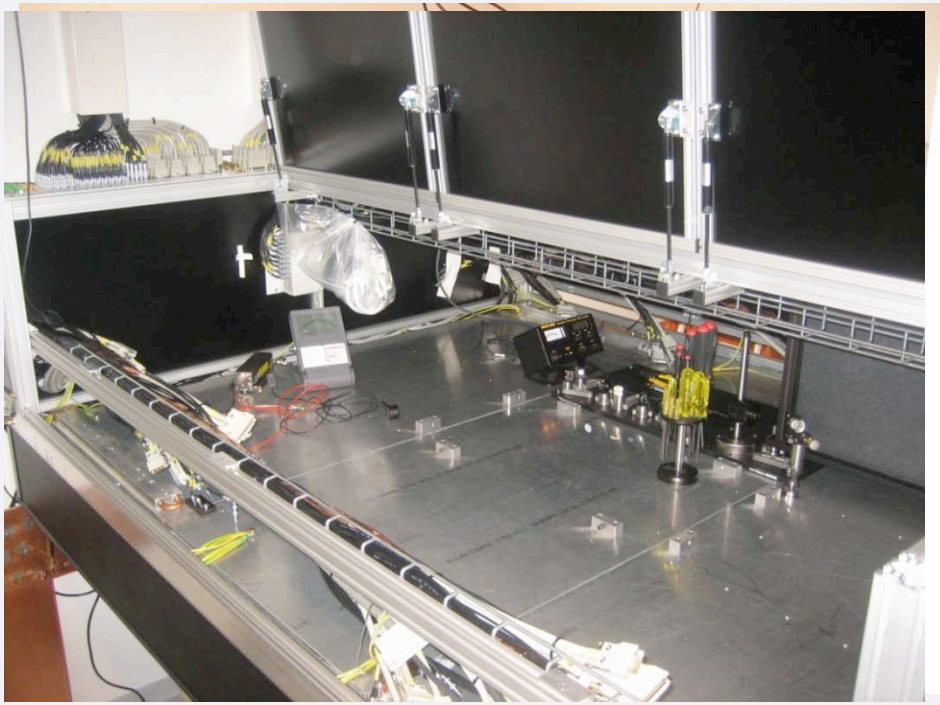




Stabilizing the environment

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

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

electronics & software development needed:

- Laser diode drivers
- fast ADC‘s (130 MHz 16 bit)
- low noise piezo drivers
- slow ADC‘s & DAC‘s

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!