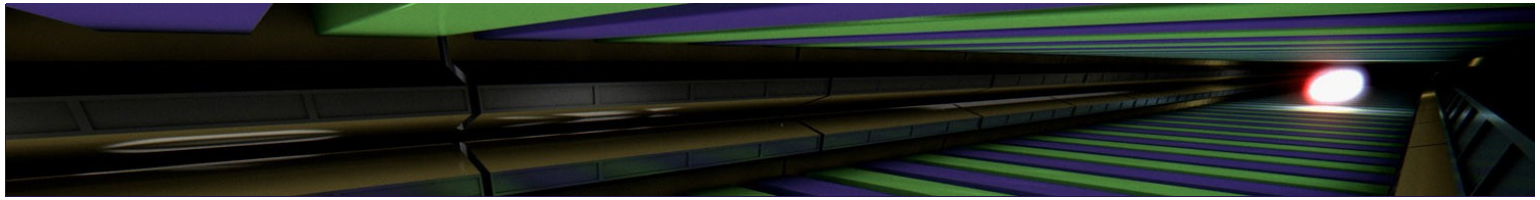
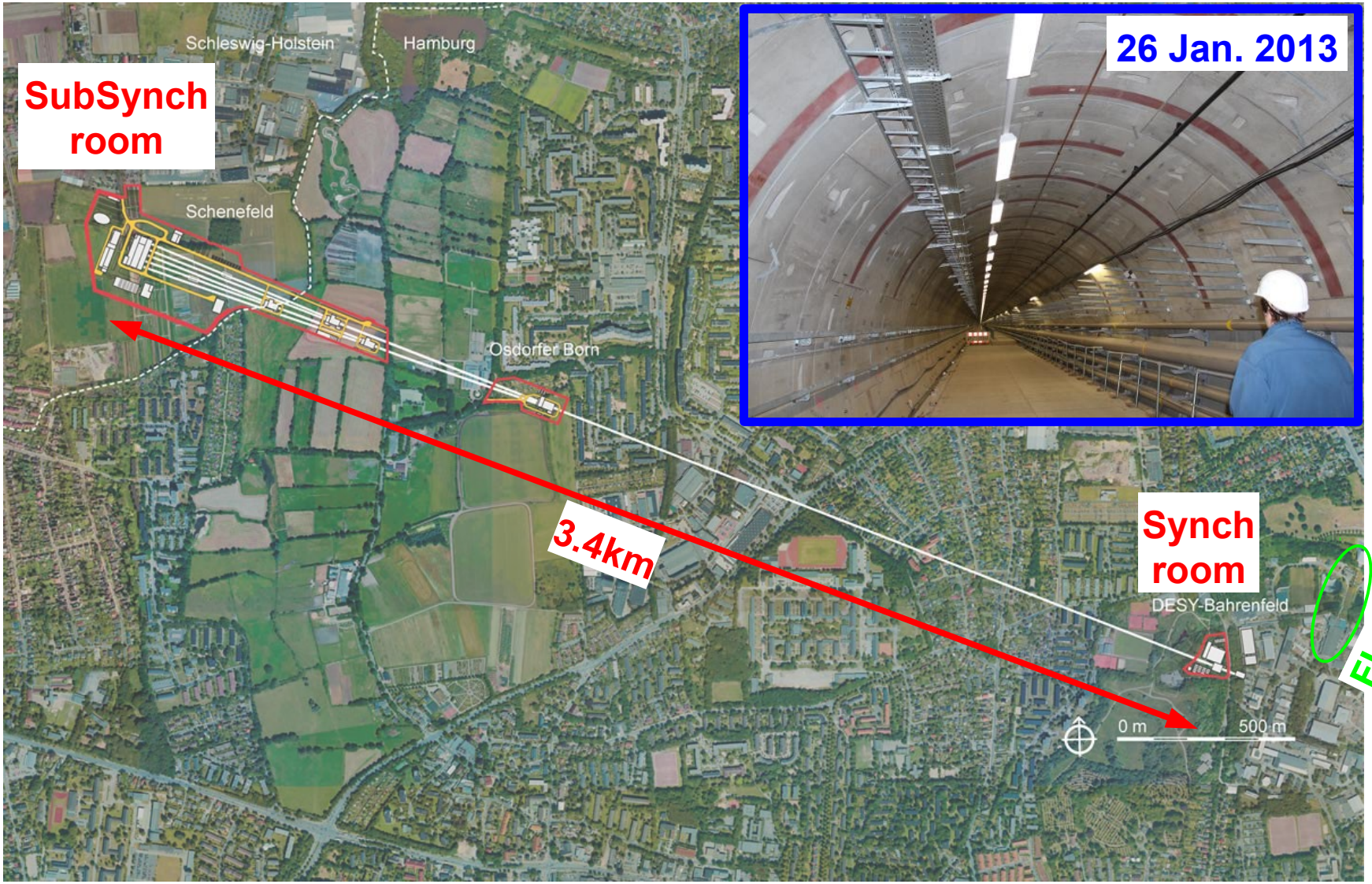


Optical Synchronization

Cezary Sydlo
on behalf of the
LbSyn Team

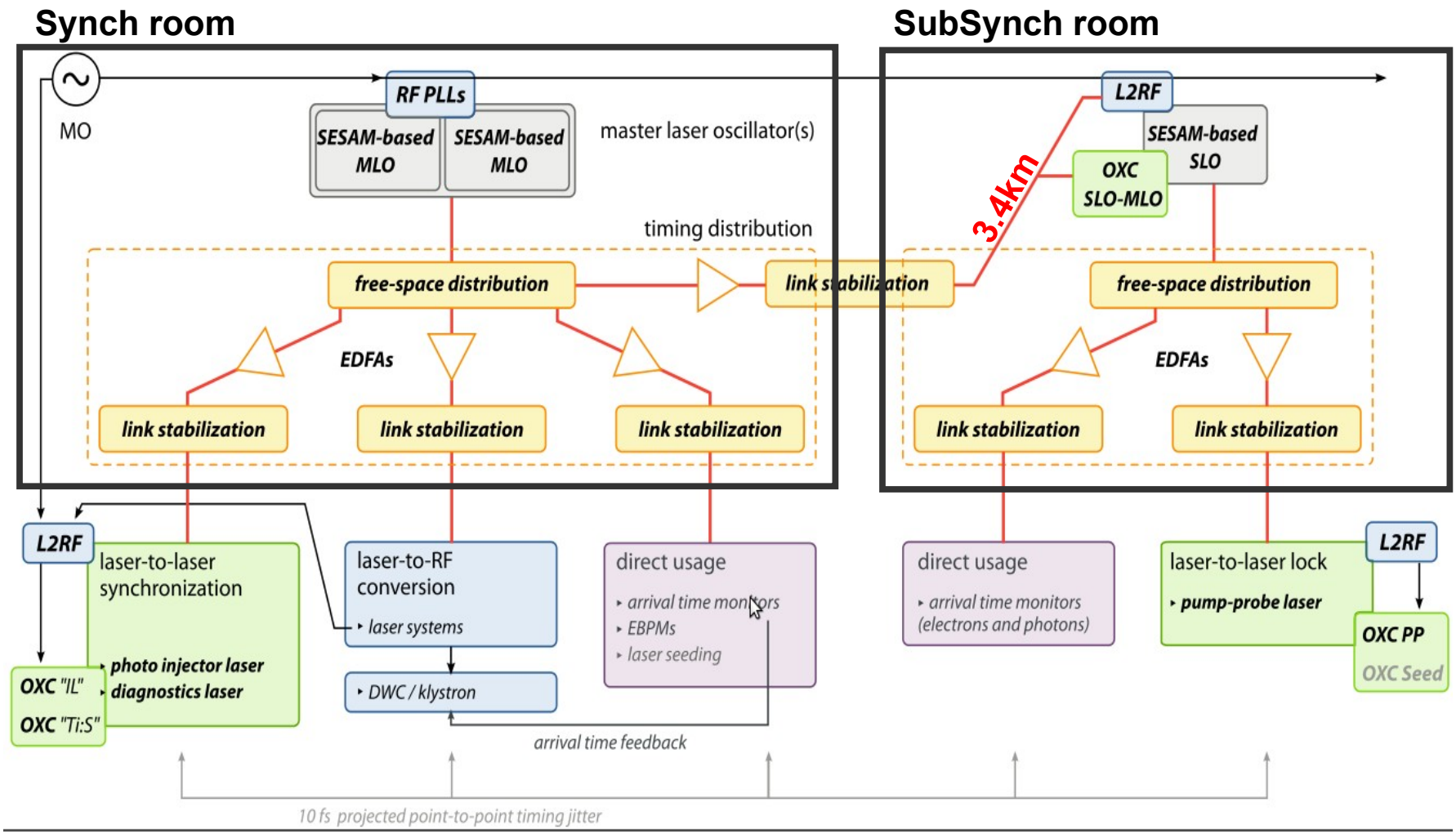
European XFEL

The sheer size ...



European XFEL

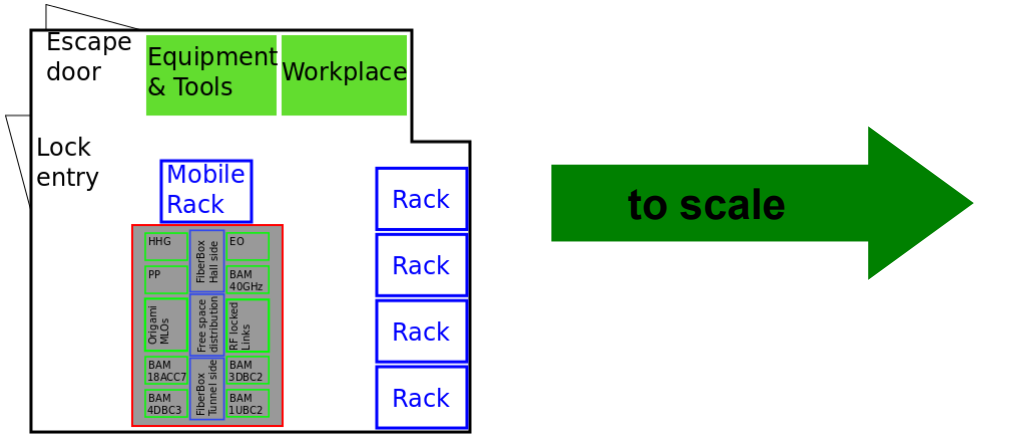
XFEL Optical Synchronization System



Courtesy: S. Schultz

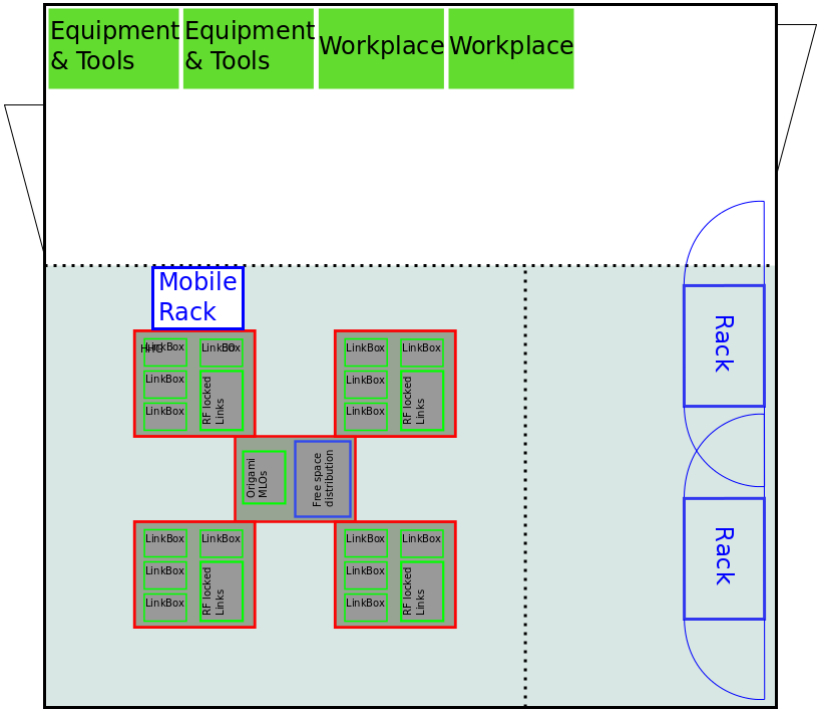
XFEL Synch room

- Strong temperature and humidity requirements
  - Own independent climatisation
  - Additional thermal isolation of sensitive installations
- Sensitive signals
  - Shielding concept in progress
- Acoustic noise reduction
- Clean room installation



FLASH Synch hutch 17m², Hall 3

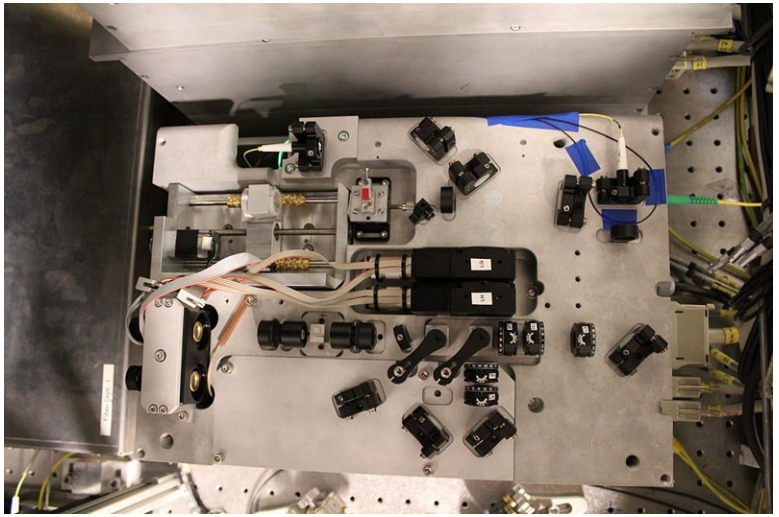
to scale



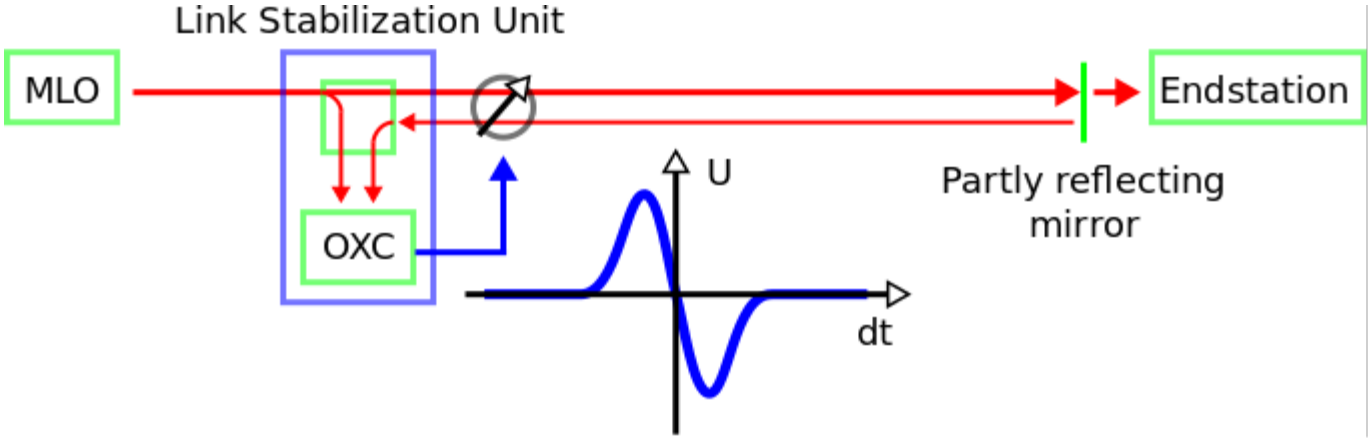
XFEL Synch room 51m², UG5 Room25

Link Stabilization Units

- Mode locked (pulsed) laser
- Partial reflection at link end
- Round trip time detection in OXC
- Around 5mV/fs (FLASH)



LinkBox V3.2



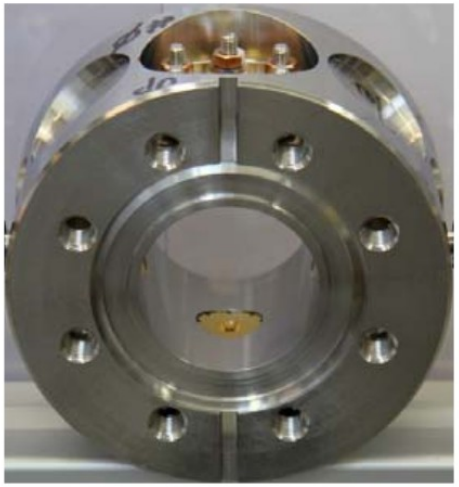
Challenges in Link Stabilization Units

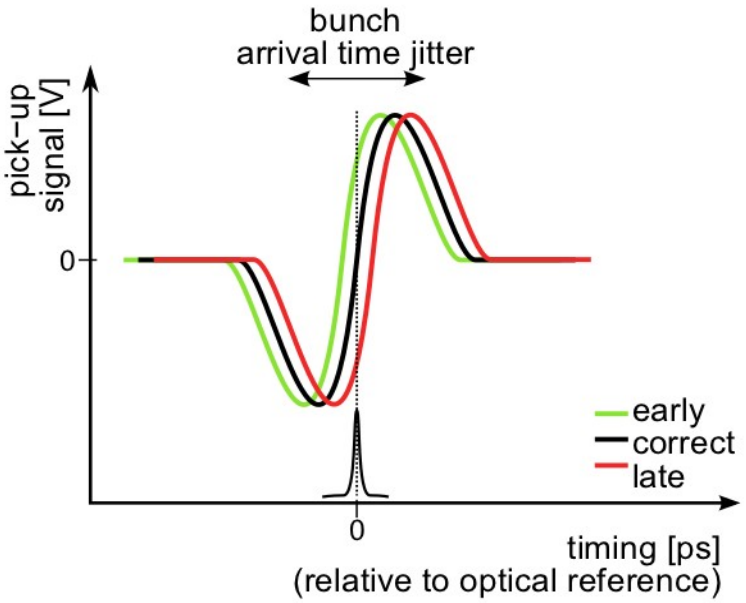
Stabilized link lengths up to 4km => up 40µs delay

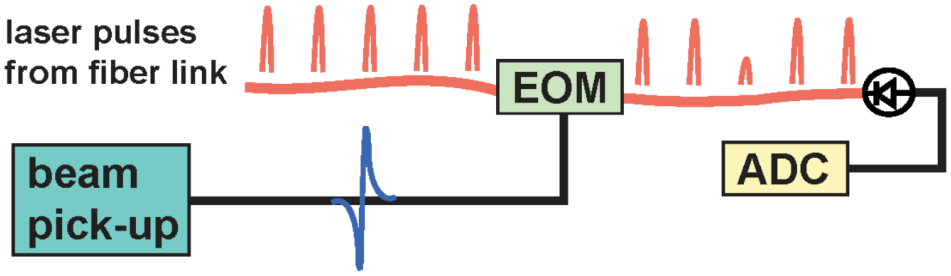
- <10fs point-to-point stability
  - Frequency stability >10^{10} required!
- Significantly reduced phase margin
  - PID controller sufficient? Other ways of controlling?
- Calculation power and memory consumption?
  - An elaborated controller necessary!

Bunch Arrival monitor

- Electron bunch induces monocycle
- Monocycle modulates laser pulse train
- Direct sampling with photodiode
- <10fs sensitivity @ >300pC
- Slow & fast intra-bunch train feedback



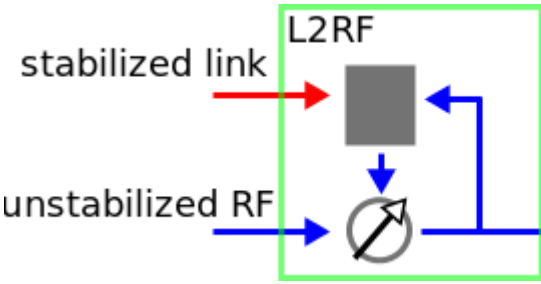


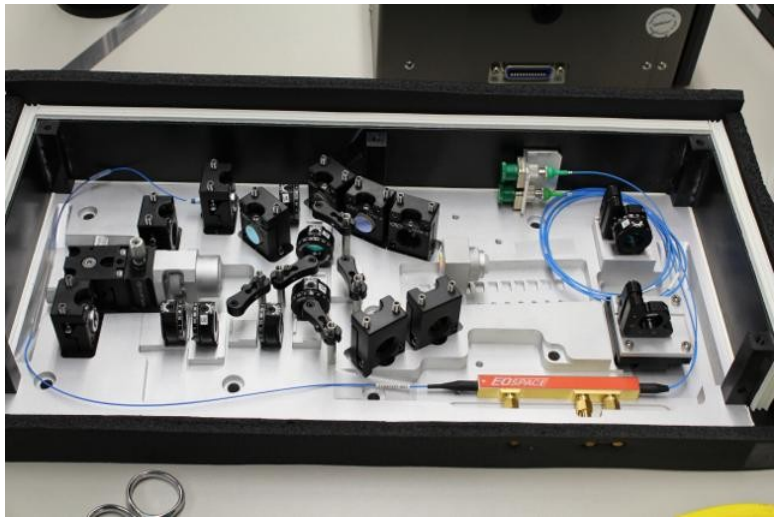


Courtesy: M.K. Czwalinna, A. Angelovski, A. Penirschke

Laser to RF conversion

- Long RF links are difficult
- Long distances are stabilized optically
  - Low loss
  - Low drift
  - No EMI
- RF signal stabilization by optical stabilized link





Courtesy: T. Lamb

MTCA boards: first rough estimation

Synch room

- 6x uAD48 3x DAMC02 3xFMC25
- 6x FMC20 6x uPZT4
  - 18x MD22
- 1x DWC/SiS8300
- 72 channels 16bit slow ADCs

Split over 2 Crates

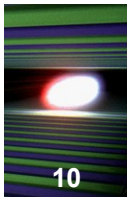
Sub Synch room

- 4x uAD48 4x DAMC02
- 4x FMC20 4x uPZT4
  - 8x MD22
- 1x DWC/SiS8300
- 64 channels 16bit slow ADCs

Split over 2 Crates

Additional: CAN bus, GPIO, etc.

Dedicated Sessions



Link stabilization

- "System overview: MTCA for optical links"
  Matthias Felber, Wed. 20.2. 9h00

Laser locking

- "Laser synchronization"
  Holger Schlarb, Wed. 20.2. 13h00

Direct usage

- "BAM system overview"
  Marie Kristin Czwalinna, Wed. 20.2. 15h00

Laser to RF

- "REFM"
  Thorsten Lamb, Wed. 20.2. 16h45

Challenges in Link Stabilization Units

3.5km links => up to 40µs dead time

- "pure" PID controller insufficient
- Other ways of controlling?
- Smith-predictor?
- Calculation power and memory consumption?
- A controlling scheme needs to be elaborated!