Laser-based Synchronization System Installation

Cezary Sydlo
on behalf of the LbSync Team

24th April 2015
DESY

Optical Synchronization Team within MSK

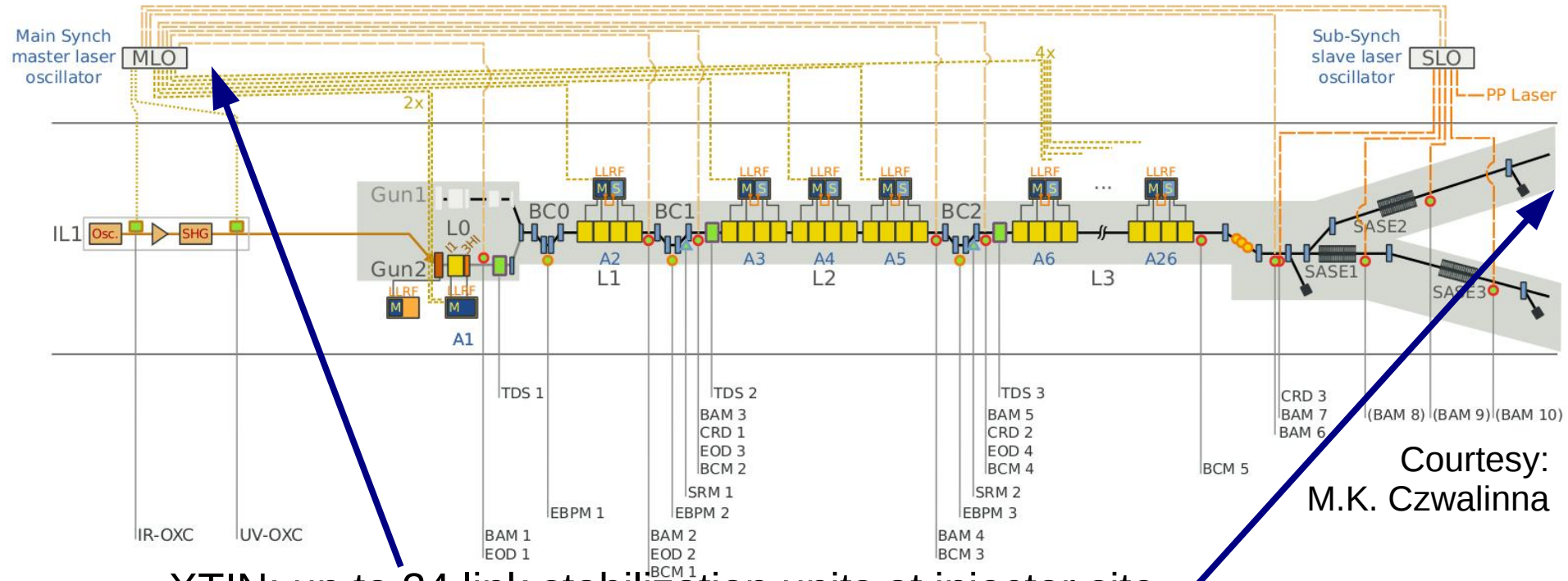
		Now @ FLASH		+ FLASH2 & XFEL
Bunch Arrival Monitor	Marie Kristin Czwalinna	3	=>	18
Hardware & Electronics	Matthias Felber	a lot	=>	even more
RF to laser locking	(Thorsten Lamb)	0	=>	14
Laser to laser locking	Jost Müller	3	=>	16
Coordination	Cezary Sydlo			
Fiber Link Stabilization	Falco Zummack	10	=>	42

5-6 times increased!

Laser to RF (REGAE/ANGUS)	Mikheil Titberidze (PhD student)
CW Fiber Link Stabilization	Szymon Jablonski (PhD student)
Control Theory	Michael Heuer (PhD student)
Dedicated electronics	Ewa Janas (PhD student)
Software	Pawel Predki (PhD student)
	Tomasz Kozak (PhD student)
	Dependent on strong interaction with LLRF

LbSync at the European XFEL

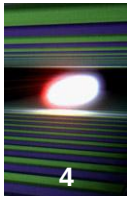
European X-Ray Free-Electron Laser



Courtesy:
M.K. Czwalinna

- XTIN: up to 24 link stabilization units at injector site
  - 2 links for experimental hall (continuous out-of-loop check)
- XHEXP: 2nd synchronization room in the experimental hall
  - Slave laser oscillators
  - 8 link stabilization units (space for up to 20)

Motivation



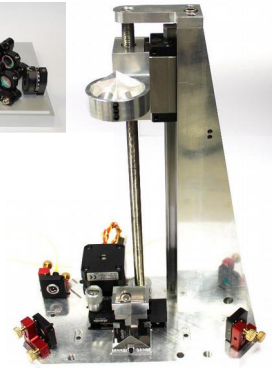
- **Huge development effort for the European XFEL**
  - Learn from FLASH
  - Exploit gathered experience for European XFEL developments
  - Test new developments at FLASH
  - Allow reflow of improvements to FLASH, keep systems identical

- **The number of installations and its locations is significantly increasing, but personnel is limited**
  - Simplify commissioning and maintenance
  - Unify and standardize systems
  - Stay modular

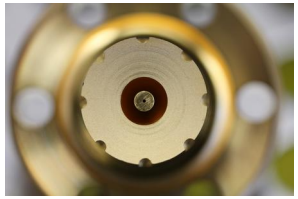
Developments for LbSync (1/2)

- **Link Stabilization Unit: Tested and in production**
  - LSU V3.2 (SMF only) => V4.0 (PMF)
  - Long Delay-stage
  - Balanced photodetector: Improved performance
  - Link electronics: Integrated and improved
- **Bunch Arrival Monitor: In progress**
  - 40GHz Pickups: Improved performance
  - Frontend
- **RF-to-laser lock (REFM-OPT): More testing**
  - New development
- **Laser-to-laser (L2L): In testing phase**
  - New set-up for all laser system

LSU V4.0

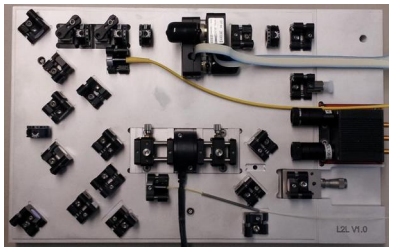


4ns Delay stage



40GHz pickup

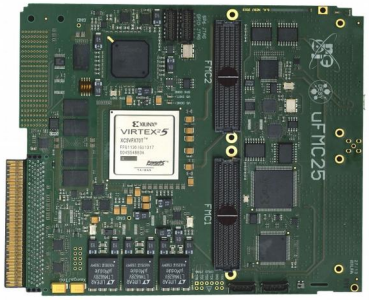
REFM-OPT: 3HE 19”



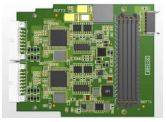
L2L setup

Developments for LbSync (2/2)

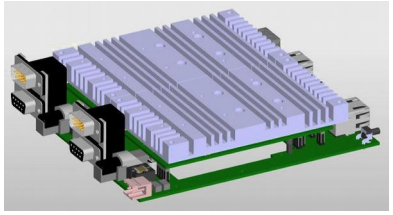
- **MTCA cards**
  - AD84, FMC25, FMC20, PZT4, MD22, AD16 (for link locking): Testing
  - LASY, LASIO (dedicated laser locking cards): In progress



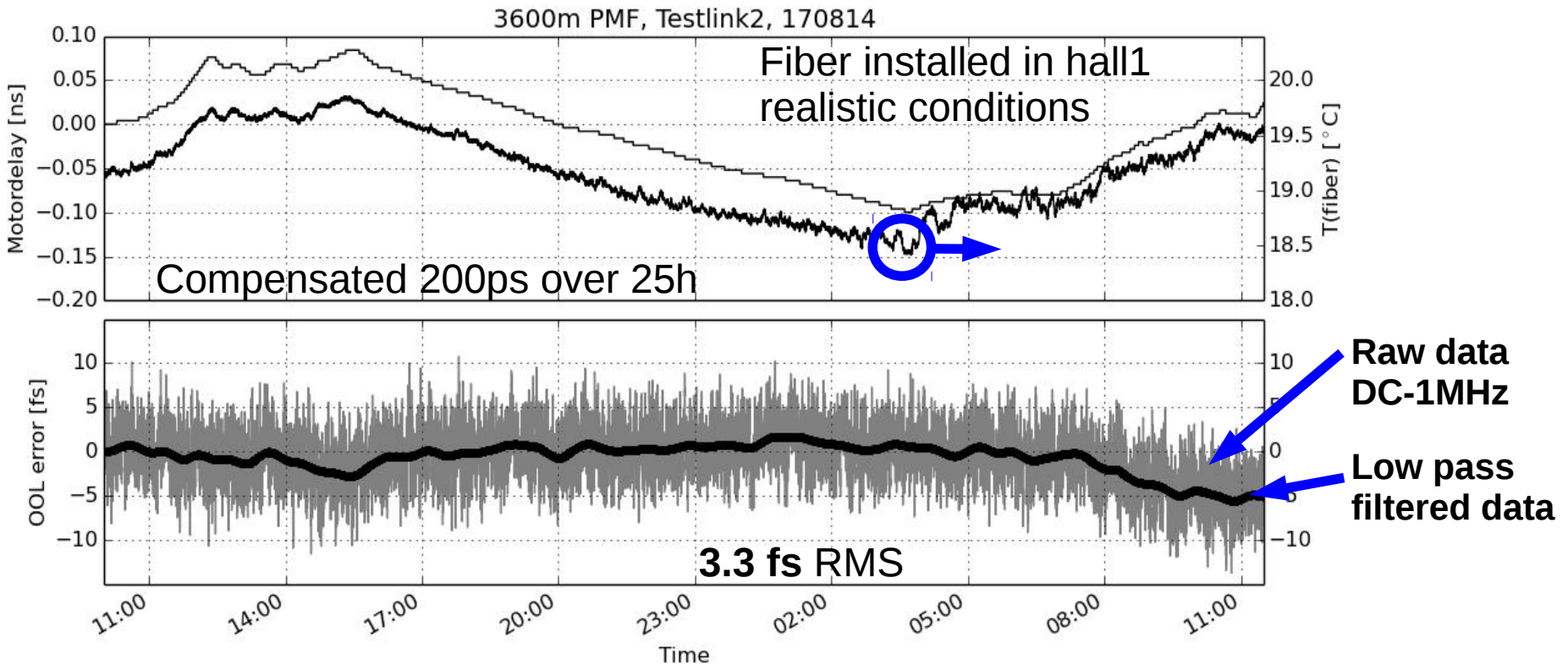



- **Electronics**
  - Laser diode driver: Tested and in production
  - Laser to RF lock modules: Tested and available
    - (with Laurin AG)
  - Specialized electronics: Tested and in production
    - FRED (with LLRF/WP02)
    - TMCB (with LLRF/WP02)
    - **...**



European XFEL

Link Stabilization results



- **Prototype tested in lab 26a with 3.6km PM fiber installed in hall1**
  - **Realistic, uncontrolled ambient conditions for meaningful results**

C. Sydlo et. al. “Femtosecond timing distribution for the European XFEL”, Proceedings of the 36th International Free Electron Laser Conference FEL 2014, August 25-29, 2014, Basel, Switzerland

Critical points

DONE!

- Most developments finished successful
- Received 21km PMF cable for XFEL
- Synchronization room “Laserraum1” mostly finished
- Optics installation on superinvar optical table started

- Progress on L2RF & BAM is limited by personnel
  - Relocate workforce from finished developments
- Software (it works, but is far from final state)
- PMF cable installation: “blowing in fibers” must work!
- Operation and maintenance of synchronization in the future.
  A lot of additional systems with FLASH II and XFEL!

Next steps

- **ASAP**
  - Install 4.2km PMF loop over Osdorfer Born (reused later for XHEXP)
  - Commission and check Synchronization system
- **Till end of 2015**
  - Finish all tunnel installations (REFM-OPT and BAM Frontend)
  - Install all stabilized links in XTIN “Laserraum1”
  - Collision with FLASH II work?
  - Ready for installations and comissioning in Subsync-Hutch/XHEXP
- **From April 2016**
  - Build up Subsynch-Hutch
  - Use gathered experience for commission of links in HEXP
  - Use laser-to-laser locking as soon as experimental laser operate

About 30 mirrors set, more than 200 still to come

XTIN UG5 “Laserraum1” (17. April 2015)