INSTRUMENTATION
TECHNOLOGIES

LIBERA

RF Reference Signal Generation and Distribution, Libera Sync Adaptation to Storage Ring Frequencies

Dejan Tinta, May 15th 2023

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Outline

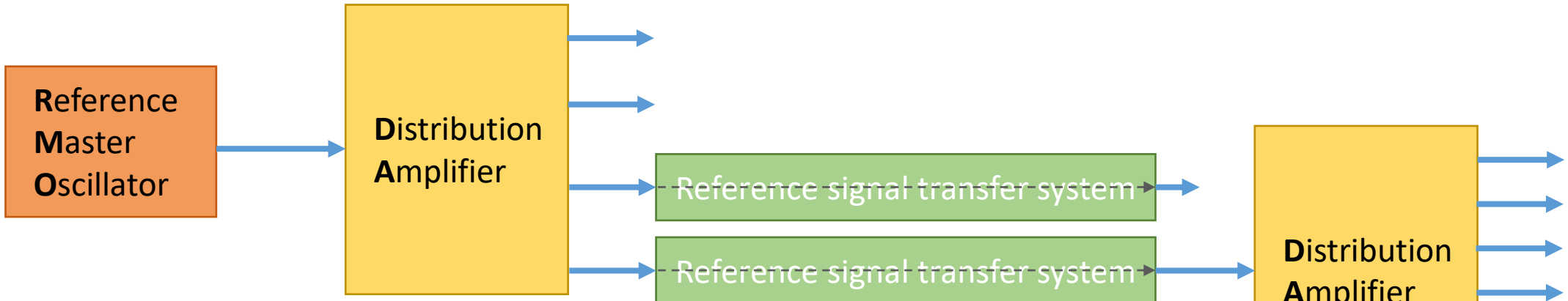
- RF reference signal generation and distribution
  - Reference Master Oscillator – Libera RMO
  - RMO Distribution Amplifiers – Libera RMO DA
  - Reference signa transfer system – Libera Sync
- Libera Sync adaptation to Storage Ring frequencies
- Conclusions

RF Reference Signal Generation and Distribution

Purpose:
Synchronization of devices (e.g. LLRF) along the accelerator machine

Main performance requirements:
- Low jitter
- Long-term stability

General topology



- Fan-out at required output power level
- Generation of higher & sub harmonics

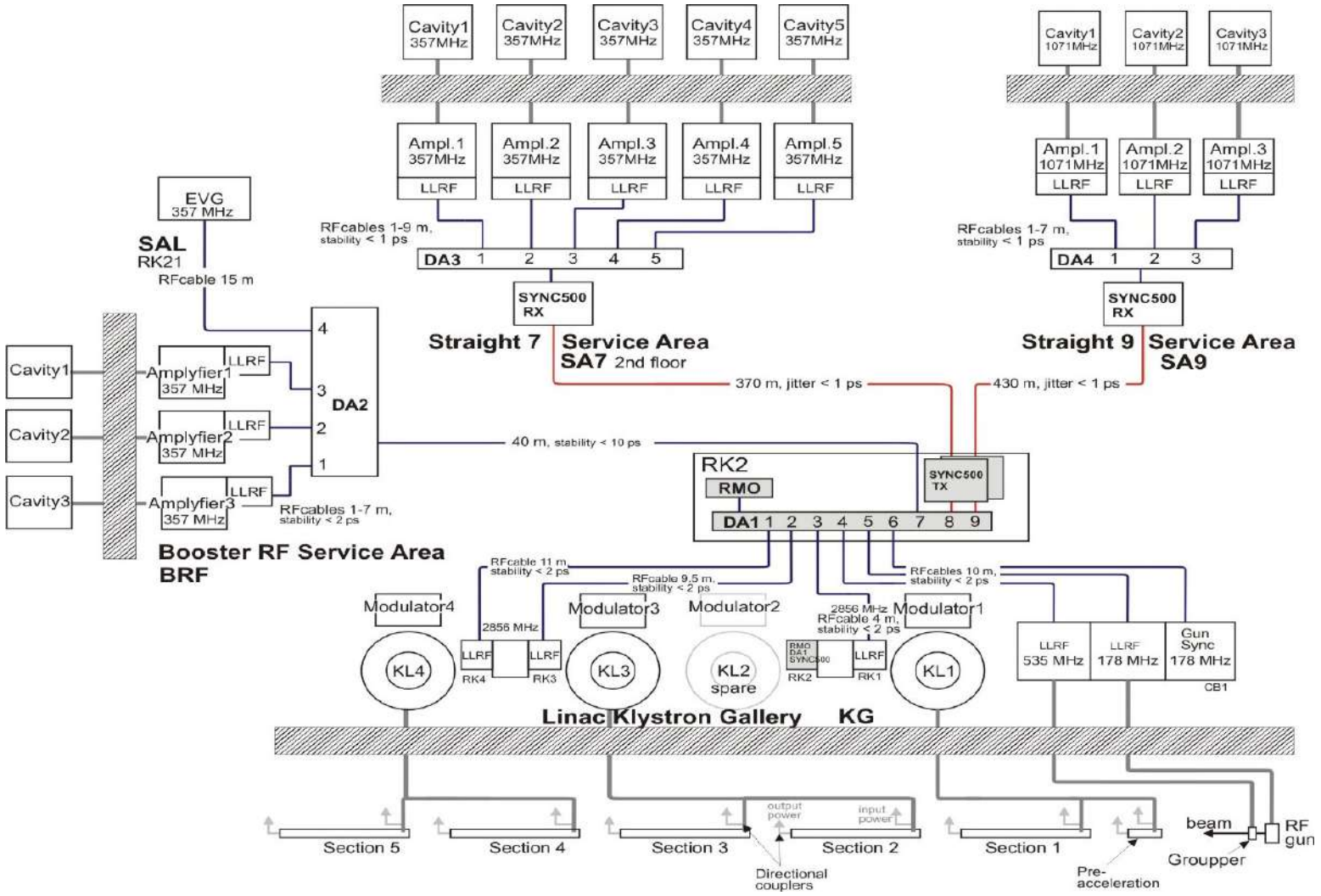
Transfer over longer distances

RF Reference Signal Distribution Topology

User specific – depends on:

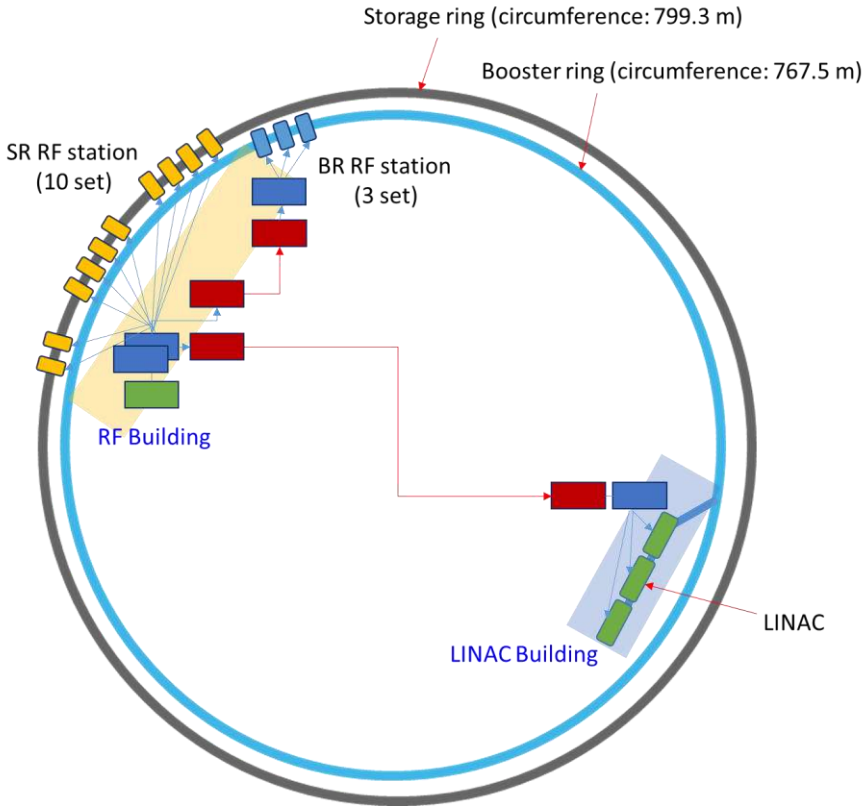
- Devices that need to be synchronized at specific frequencies (basic reference frequency, higher and/or sub harmonics)
- Performance requirements: jitter, long-term stability
- Building layout & geographical positions of the devices
- Environmental conditions

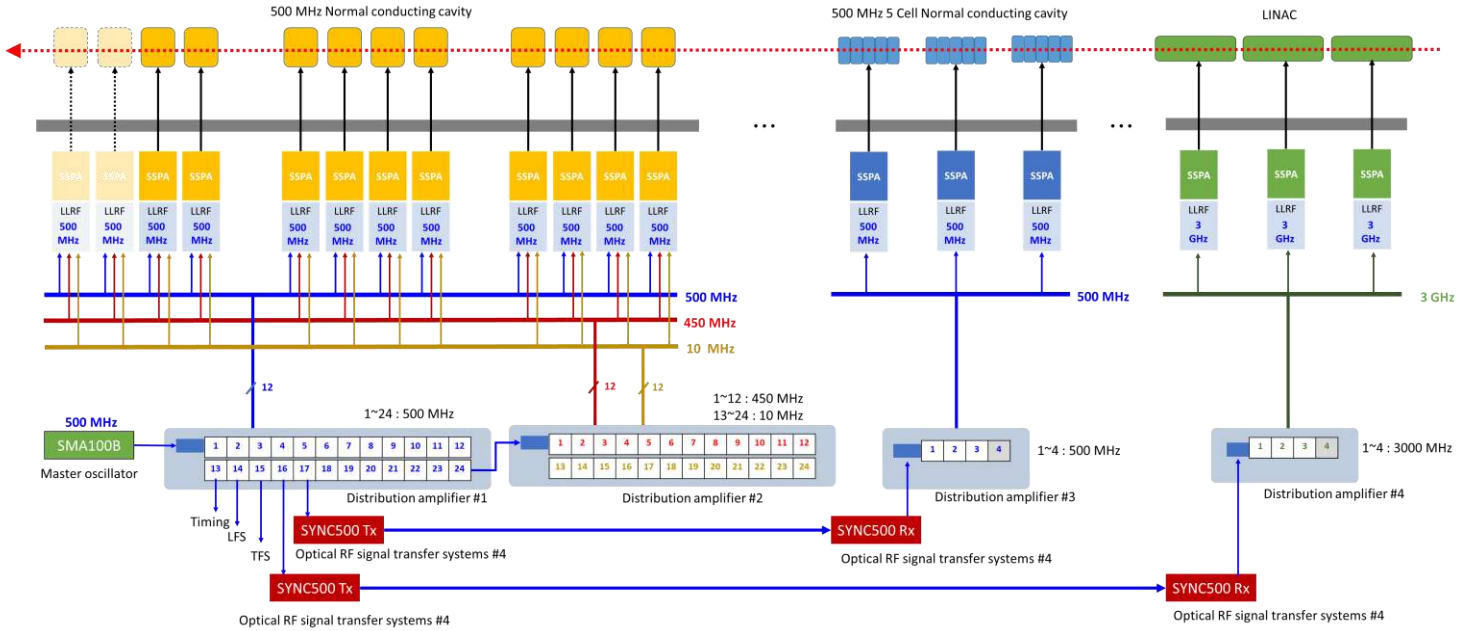
Ref. Signal Distrib. Topology – SKIF example



Ref. Signal Distrib. Topology – PAL example

Concept under consideration





Reference Master Oscillator

Libera RMO

Reference
Master
Oscillator

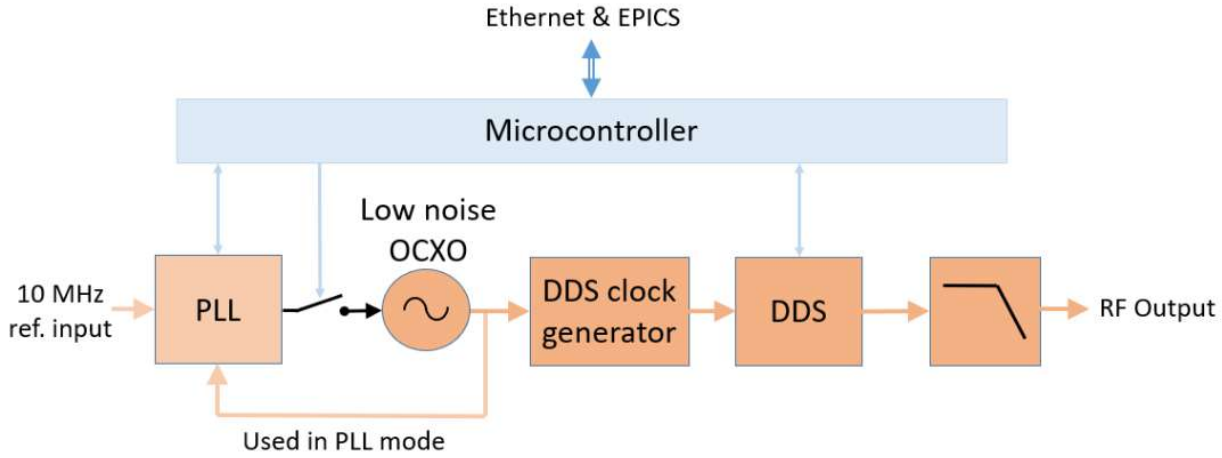
Distribution
Amplifier

Reference signal transfer system

Reference signal transfer system

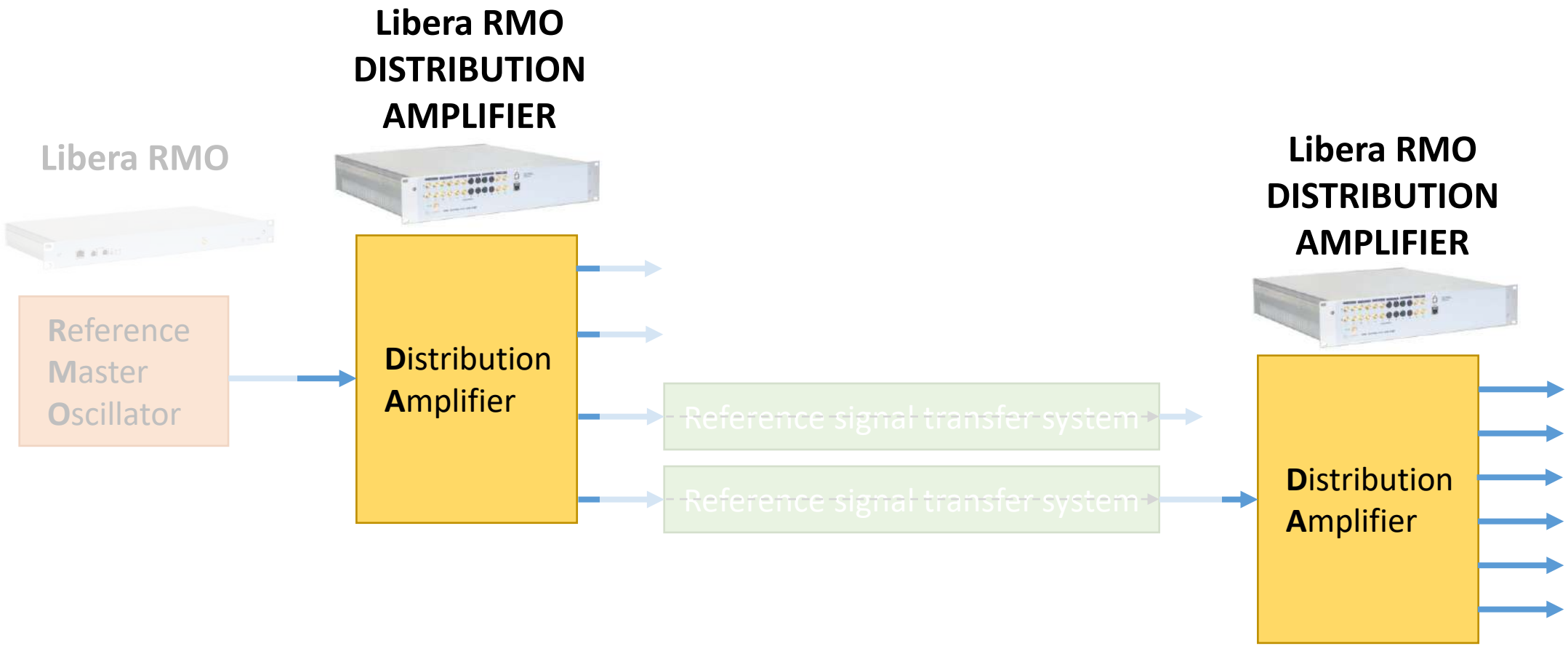
Distribution
Amplifier

Reference Master Oscillator – Libera RMO



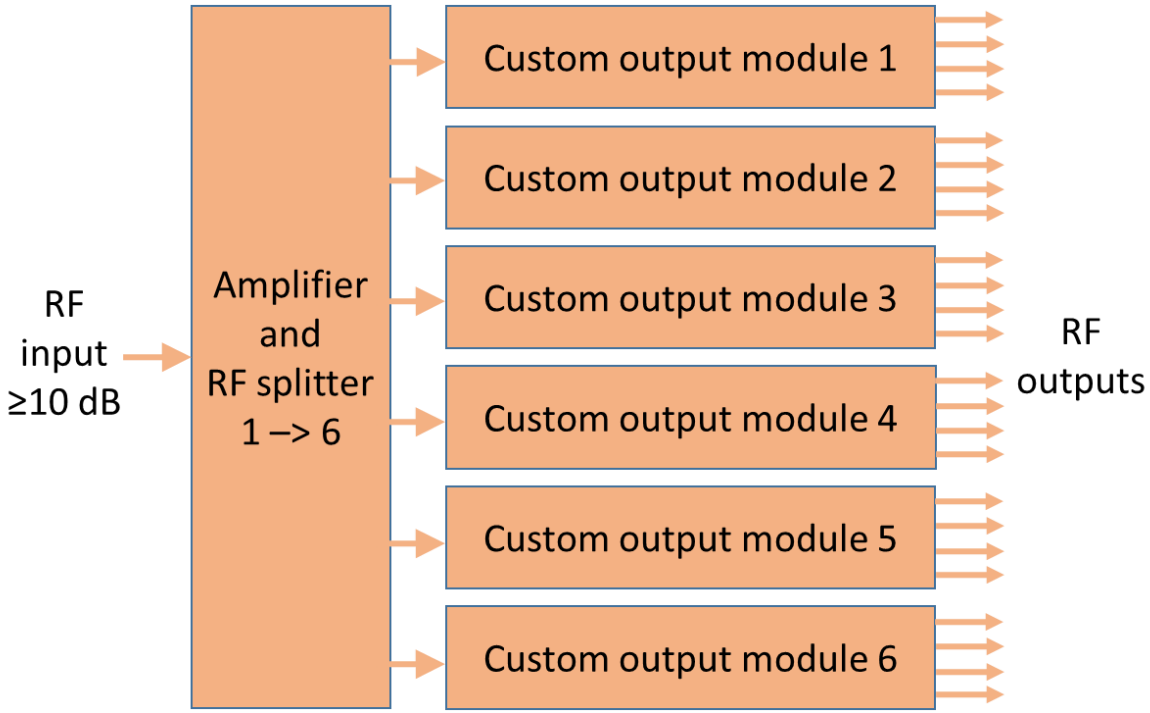
- Typical jitter: **<60 fs** (10 Hz – 10 MHz)
- Harmonic suppression: **<50 dBc** up to 5th harm.
- Frequency stability: **5*10^-11** (Allan Deviation)
- Output power: **>15 dBm**
- Different output stages and freq. ranges: **from 50 to 3120 MHz**
- Freq. sweep capability and continuous phase transition
- External trigger

RMO Distribution Amplifier

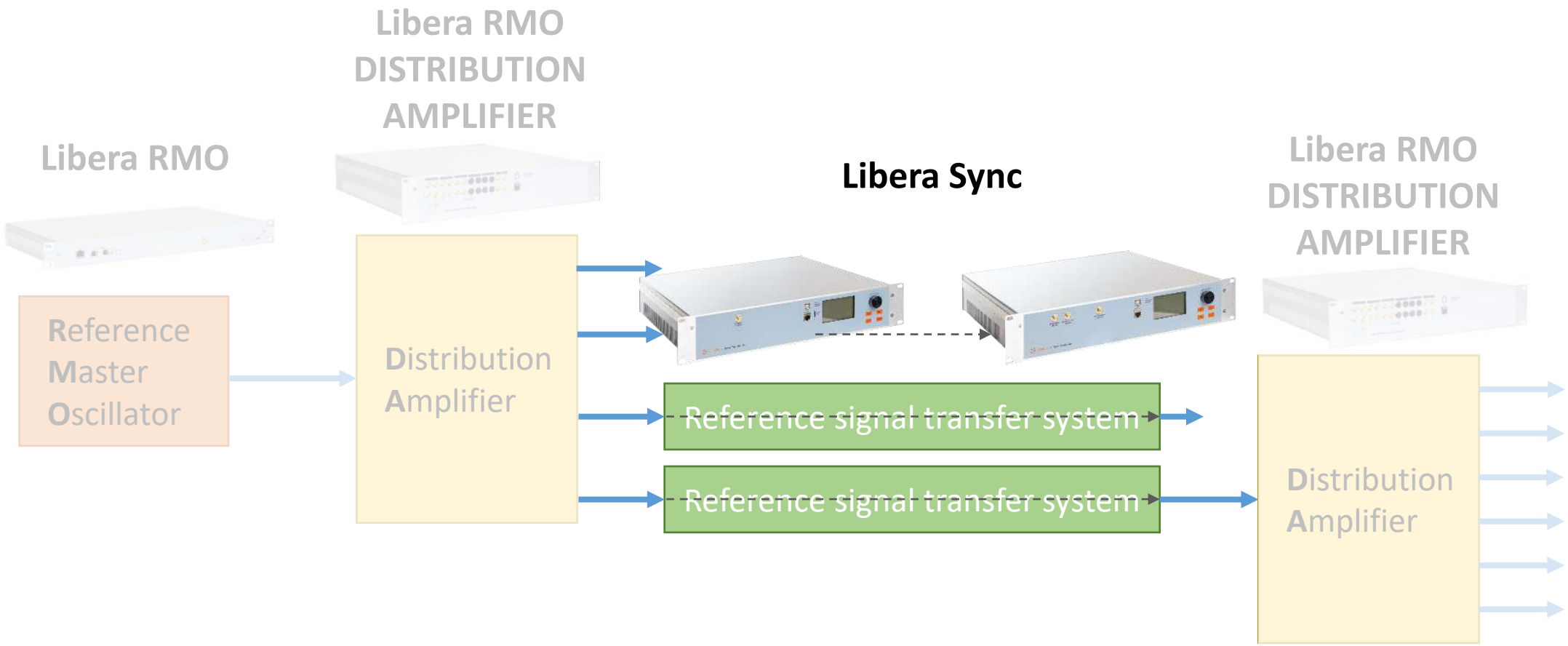


Libera RMO Distribution Amplifier

- Temperature stabilized platform -> long-term stability
- Low jitter design
- **Modular design** – up to 24 RF outputs at different frequencies: input freq., higher and sub harmonics

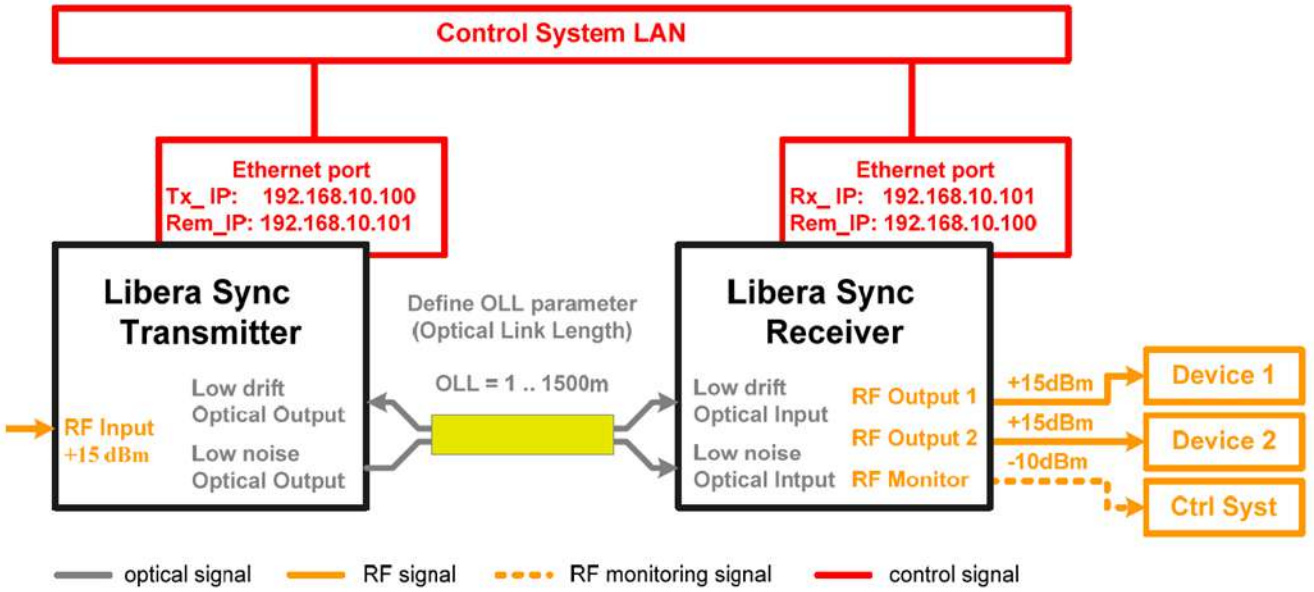


Reference signa transfer system



Reference signa transfer system – Libera Sync

Developed in collaboration with **PSI** for **SwissFEL**



- RF frequency: **~3 GHz**
- Integrated added jitter: **<10 fs RMS**
- Long-term stability: **<40 fs pp in 24 h**
- Drift compensation capability: **500 ps**
- Link length: **up to 1.5 km**
- Based on RFoF technology
- Fully automated start-up and tuning procedure

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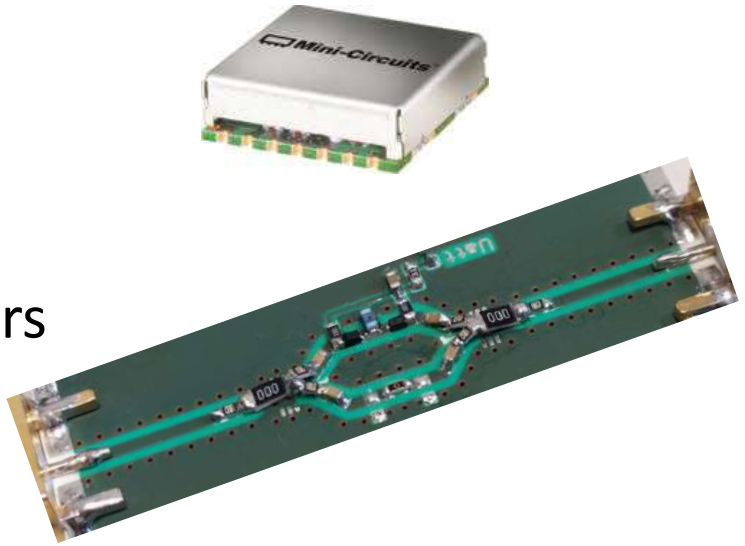
Libera Sync 178 MHz

Same working principle like in the case of Libera Sync 3 GHz

Required adaptations:

- RF amplifiers
- RF filters
- Phase shifters
- RF splitters
- RF variable attenuators
- FW adaptations

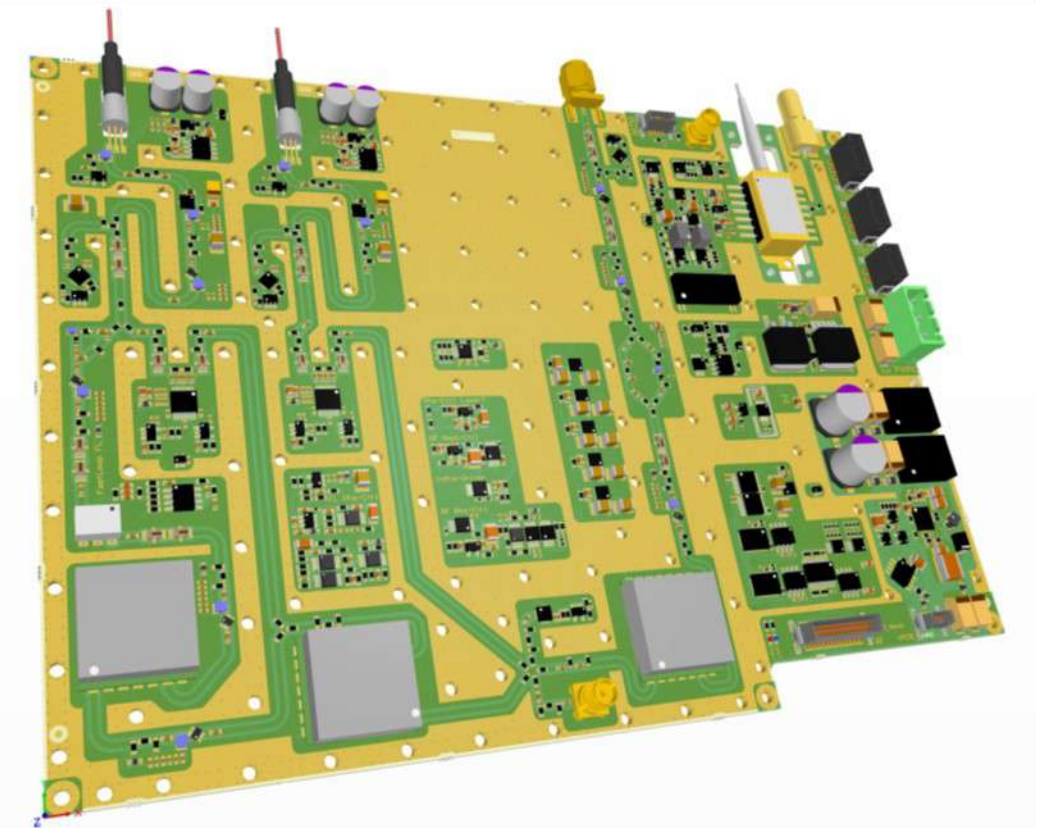


Expected performances:

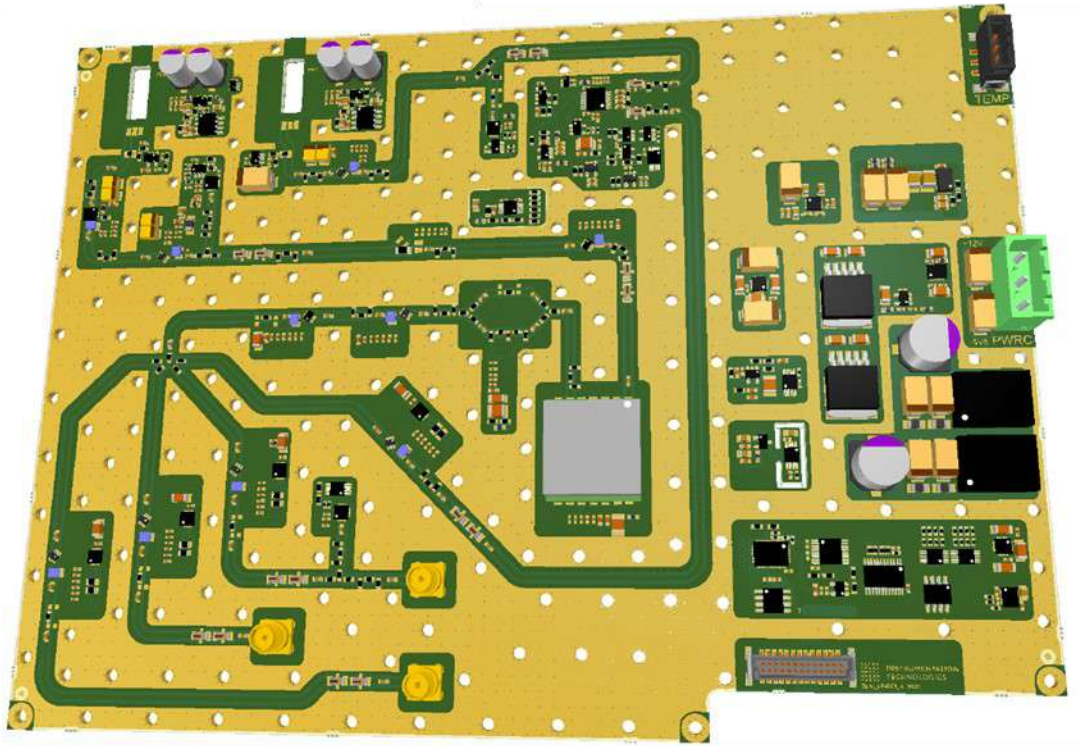
- Integrated added jitter: **300 fs RMS** (from 10 Hz to 10 MHz)
- Long-term stability: **700 fs pp in 24 h**

New RF PCBs

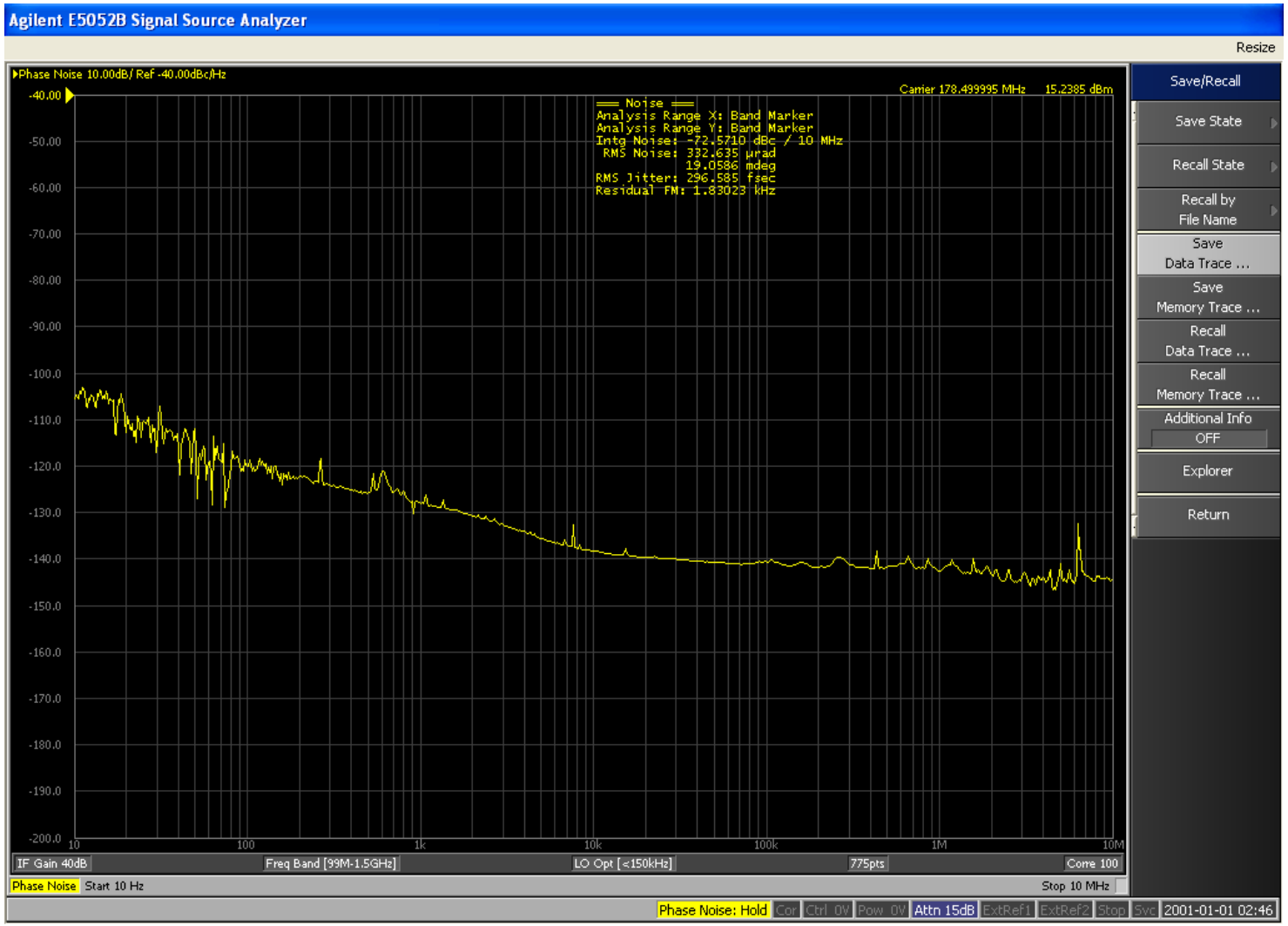
Transmitter



Receiver



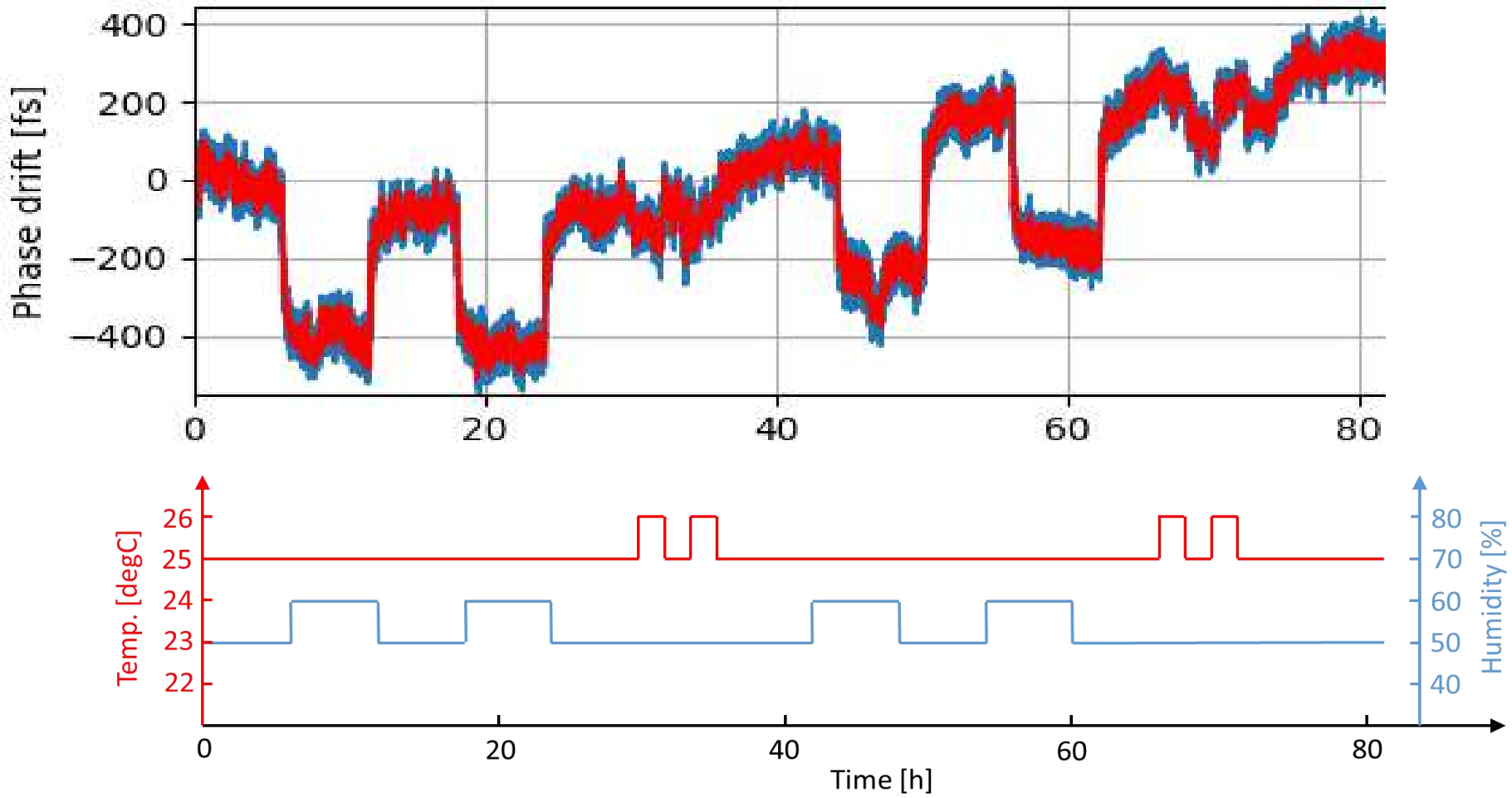
Added jitter – measurements on prototype



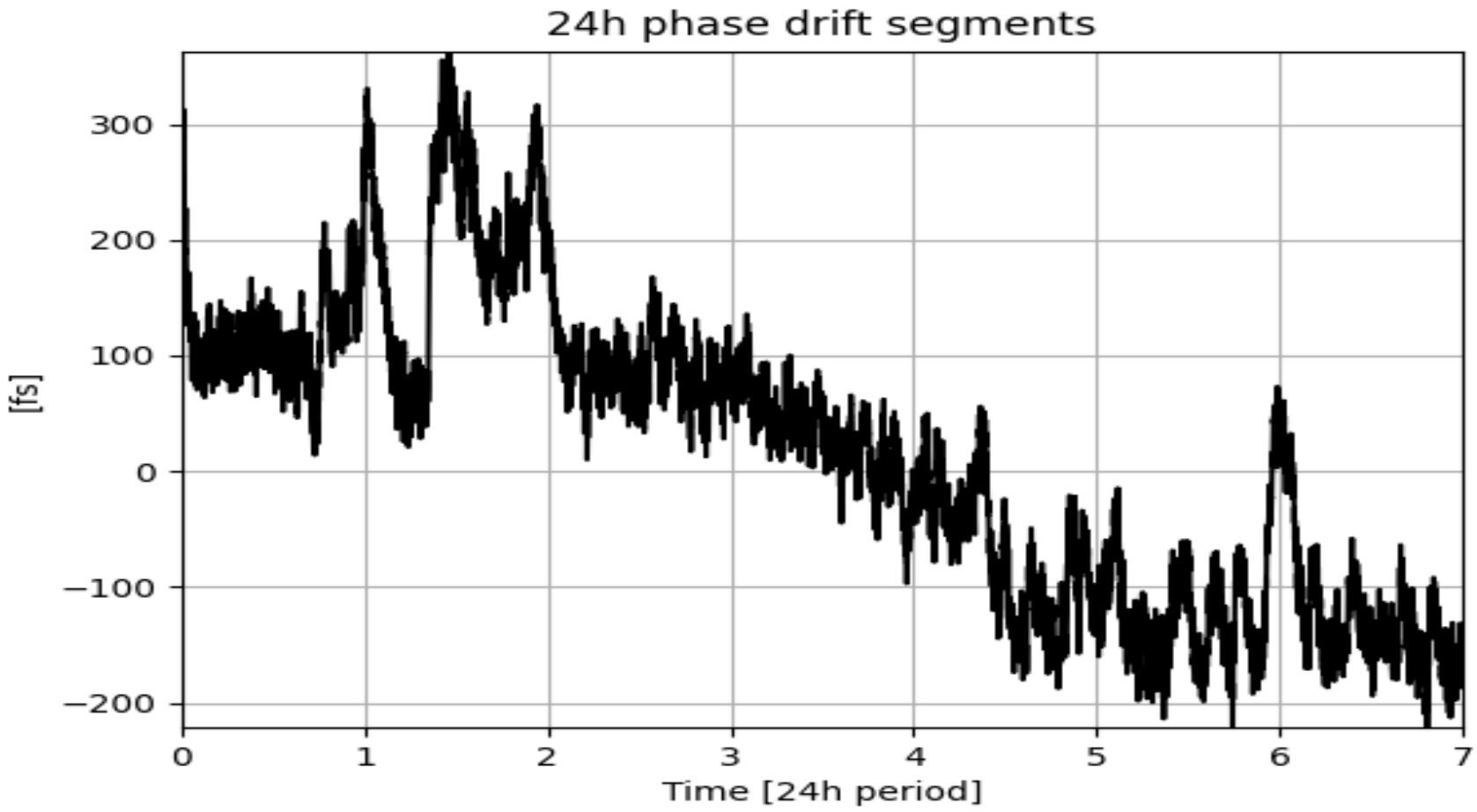
Integrated added jitter (from 10 Hz to 10 MHz): **300 fs RMS**

Even better results are expected after improvements in respin i.e. **<200 fs RMS**

Temperature & humidity dependence



Long-term stability



<400 fs pp in 24 h

Conclusions

- RF reference signal generation and distribution systems are user specific
- Their building blocks need to be adapted in terms of topology and frequencies
- Development of the Libera Sync 178 MHz will enable easier adaptation also to other frequencies up to 500 MHz.

Thanks for your attention!

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