MTCA for Optical Links

for the Laser Based Synchronization System at XFEL

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HELMHOLTZ ASSOCIATION

DESY

Overview

- Introduction
  - Laser Based Synchronization System
  - Optical Links at XFEL
- Link Signals and Interfaces
  - MTCA Interfaces
  - Crate Configuration
- Open Questions

Introduction – LBSync System

Provide a global reference for the synchronization of timing-critical subsystems of the accelerator

- Bunch arrival time measurements (BAM)
  - These monitors are used by the beam-based feedback to synchronize (= stabilize) the arrival time of individual bunches to the optical reference
- Laser synchronization (L2L)
  - Injector-, Seed-, and Pump-Probe lasers (their repetition rate and phase of the pulse train) are synchronized to the optical reference.
- RF synchronization for LLRF-reference (L2RF)
  - The 1.3 GHz reference input for LOGM (& Klystron RF) from the main drive line is synchronized to the optical reference in the REFMs

→ Long- and short-term phase-stable optical pulse train has to be distributed along the XFEL (≤ 3.4 km)

Introduction – LBSync System

Provide a global reference for the synchronization of timing-critical subsystems of the accelerator

2 types of pulsed optical links:

- Bunch arrival time measurements (BAM)
  - These monitors are used by the beam-based feedback to synchronize (= stabilize) the arrival time of individual bunches to the optical reference
- Laser synchronization (L2L)
  - Injector-, Seed-, and Pump-Probe lasers (their repetition rate and phase of the pulse train) are synchronized to the optical reference.

Cross-correlator based link stabilization "Link"

- RF synchronization for LLRF-reference (L2RF)
  - The 1.3 GHz reference input for LOGM (& Klystron RF) from the main drive line is synchronized to the optical reference in the REFMs

RF based link stabilization "RF Link"

→ Long- and short-term phase-stable optical pulse train has to be distributed along the XFEL (≤ 3.4 km)

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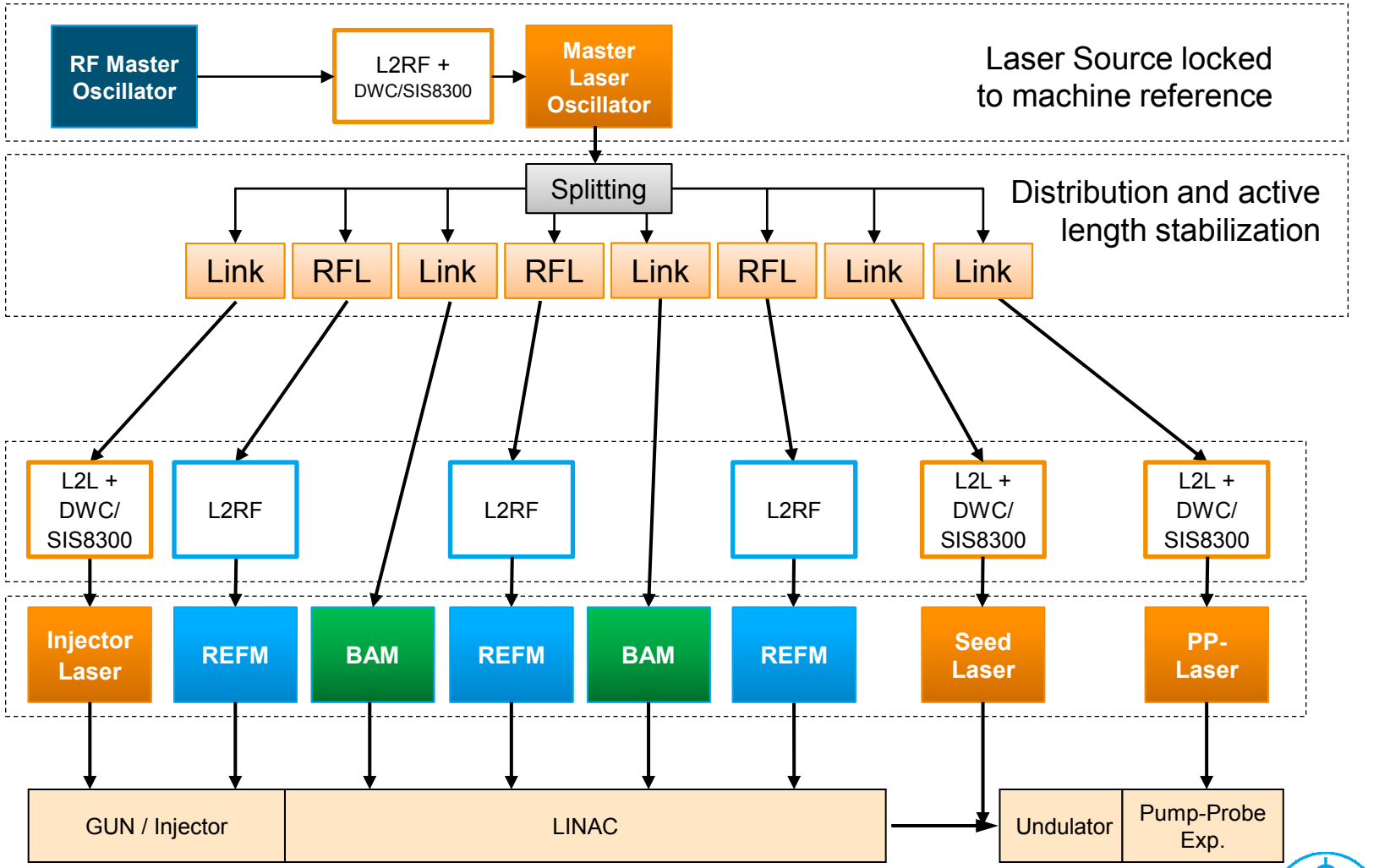
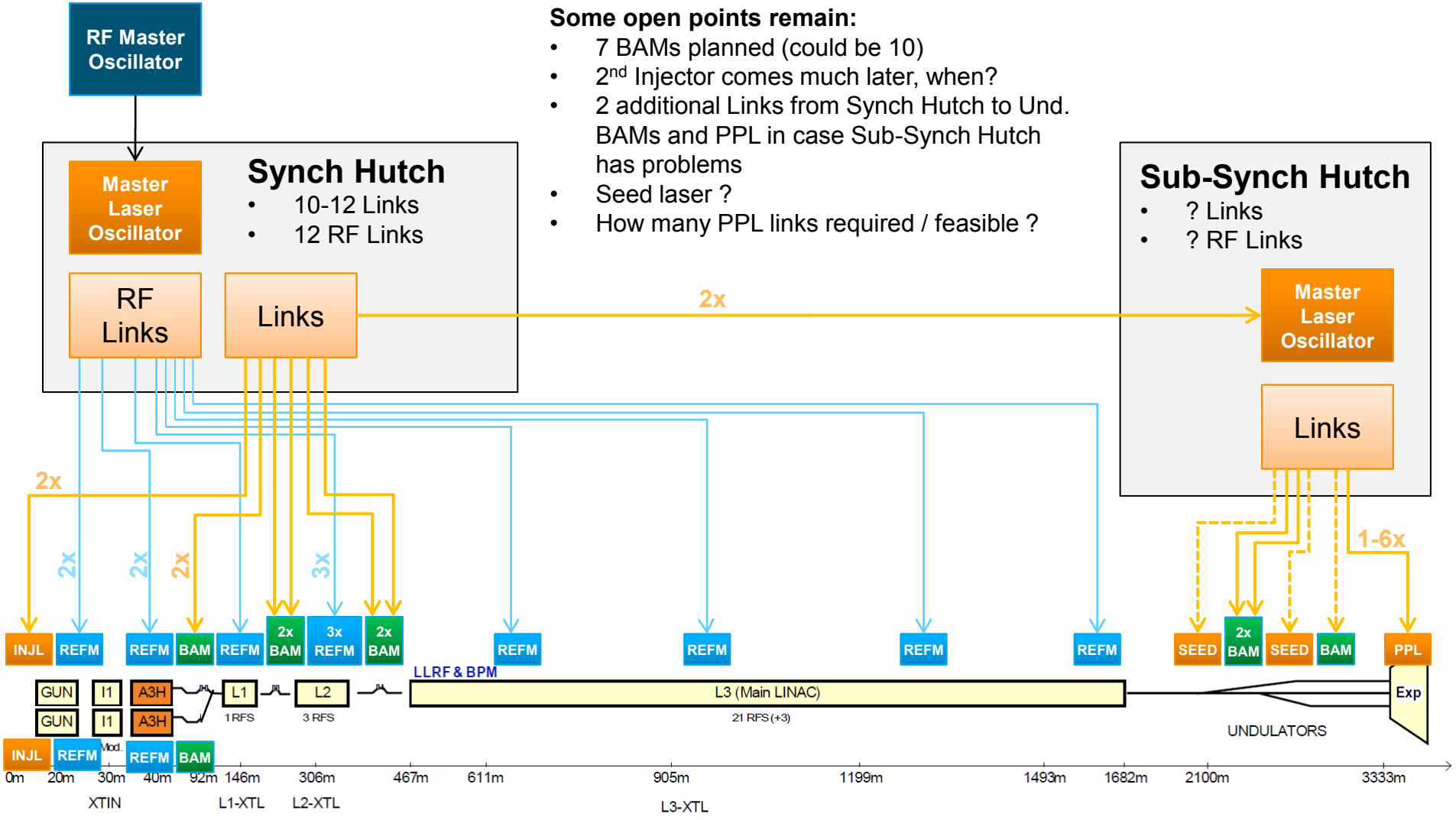
Principle Layout of the Synchronization System

The reference timing information is encoded in the precise repetition rate of an optical pulse train



Optical Links at the European XFEL



Some open points remain:

- 7 BAMs planned (could be 10)
- 2nd Injector comes much later, when?
- 2 additional Links from Synch Hutch to Und. BAMs and PPL in case Sub-Synch Hutch has problems
- Seed laser ?
- How many PPL links required / feasible ?

Link Setups - Interfaces to MTCA Units

Signals per Link Box

- Inputs:
  - Piezo: ± 100 (± 85) V
  - Stepper Motor
- Outputs:
  - OXC Signal
  - Phase Detector
  - 2 x Power Monitor
  - 2 x Balanced Detector individual channels

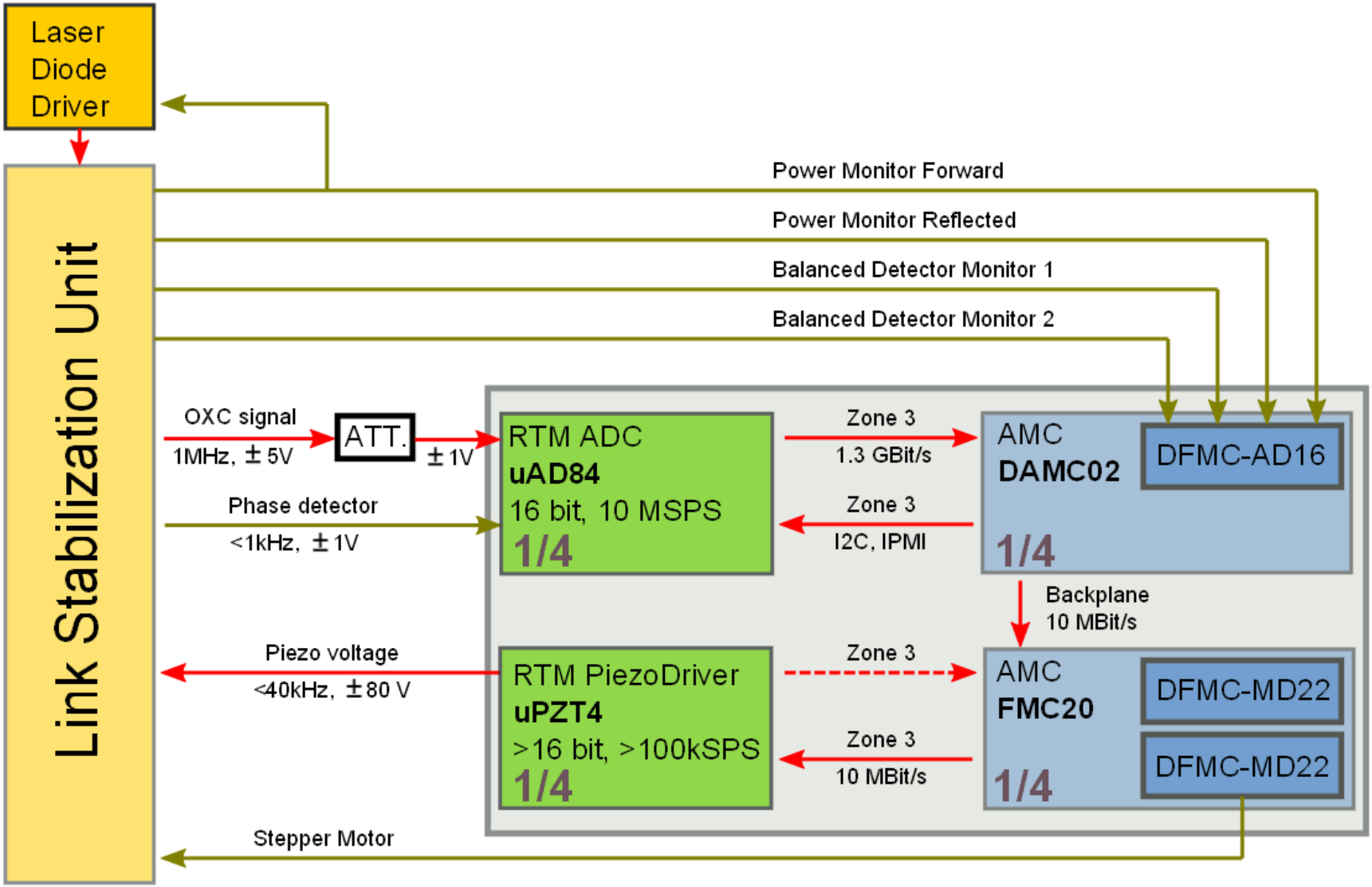
Additionally: 2 x Laser Diode Driver with CAN-Bus interface

Signals per 4 RF Links (in one box)

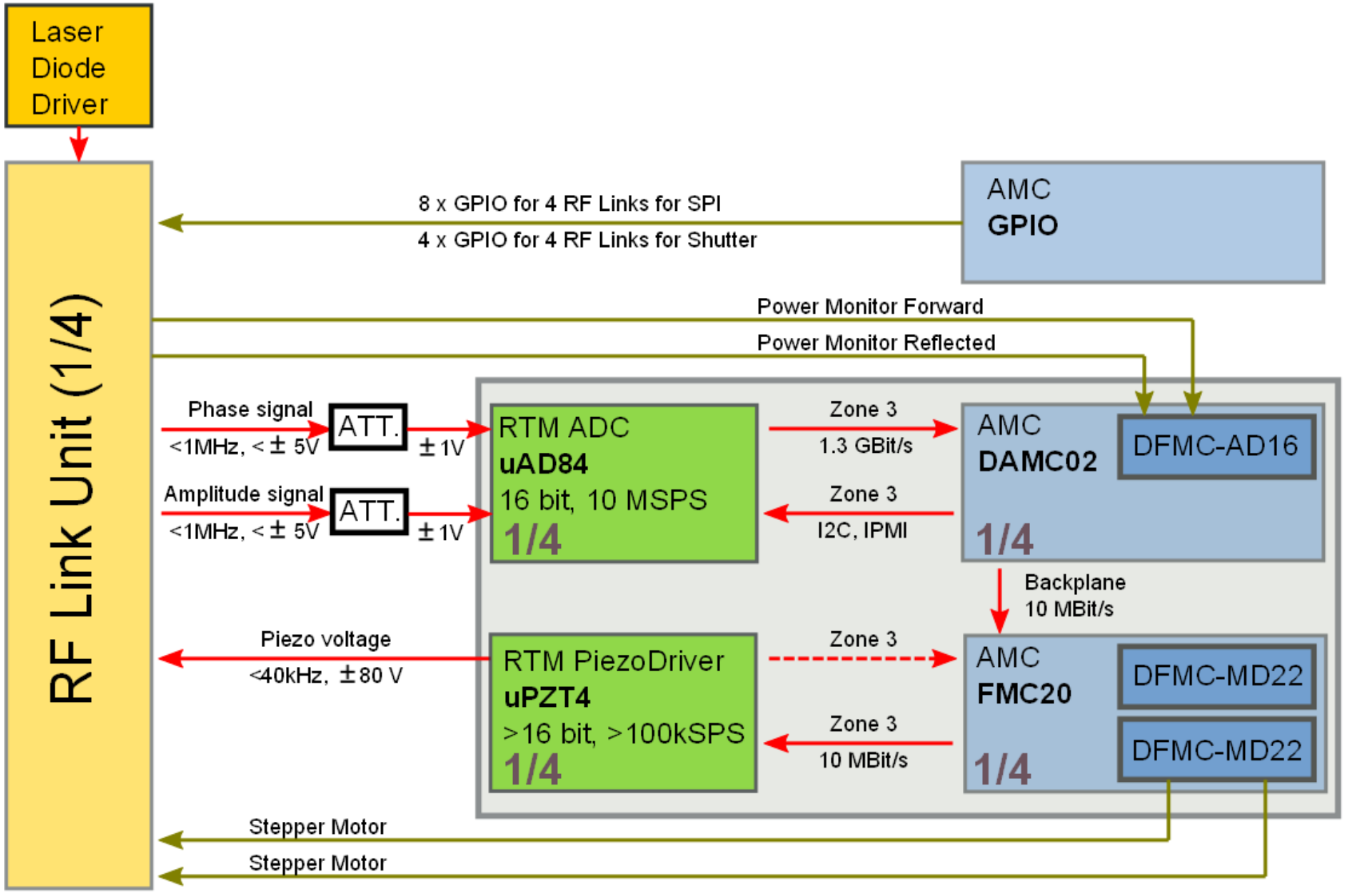
- Inputs:
  - 4 x Piezo: ± 100 (± 85) V
  - 8 x Stepper Motor
  - 8 x GPIO for SPI interface
  - (4 x GPIO for shutter)
- Outputs:
  - 4 x Phase Signal
  - 4 x Amplitude Signal
  - 8 x Power Monitor

Additionally: 1 x Laser Diode Driver with CAN-Bus interface

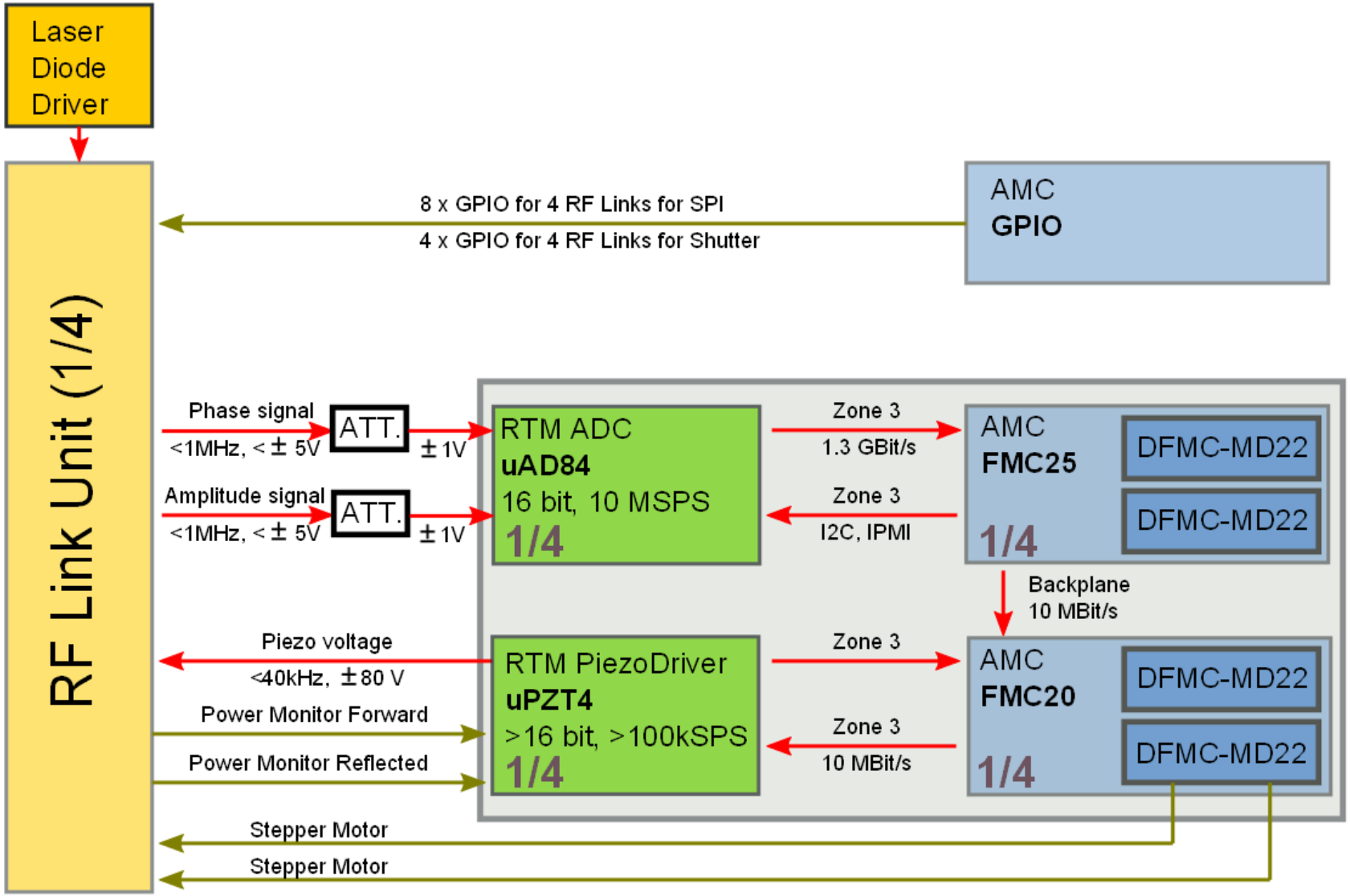
Link Setup – MTCA Signals



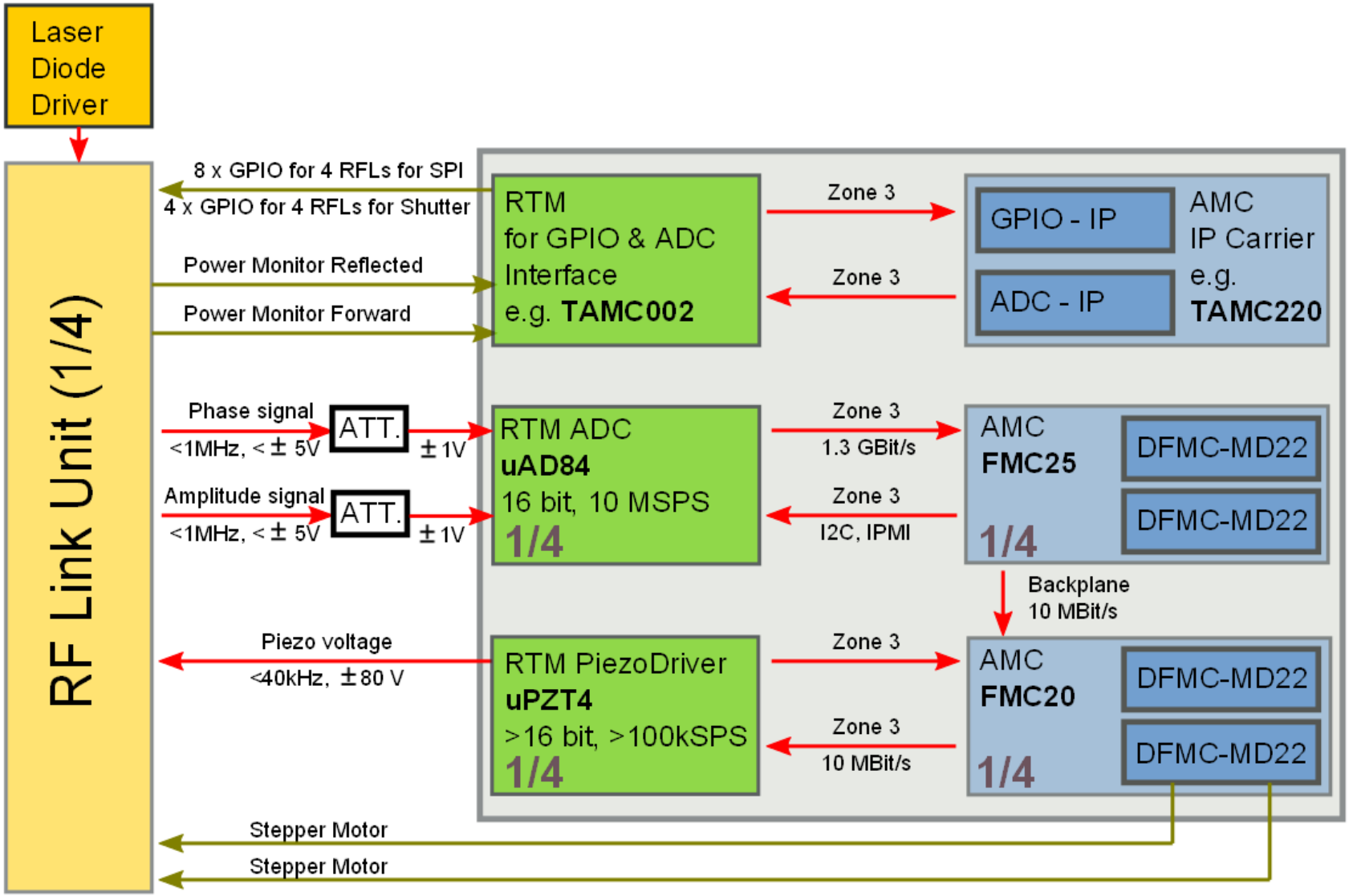
RF Link Setup – MTCA Signals



RF Link Setup – MTCA Signals – alternative configuration

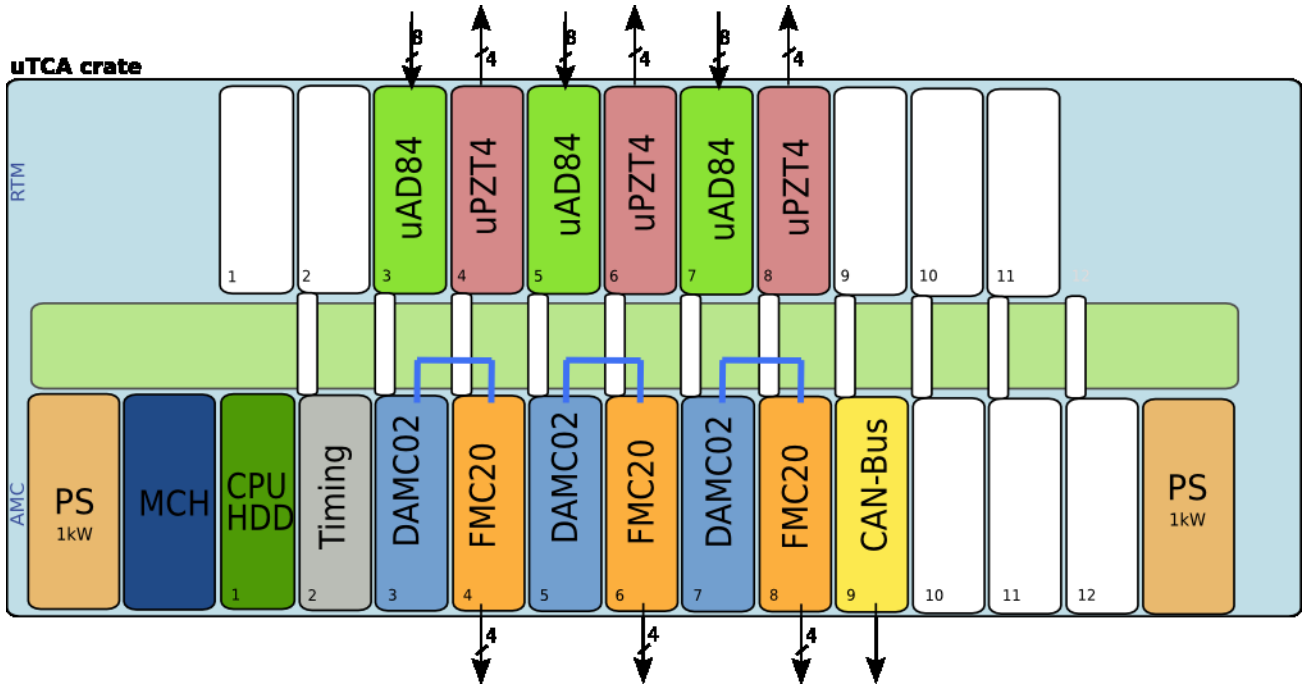


RF Link Setup – MTCA Signals – alternative 2



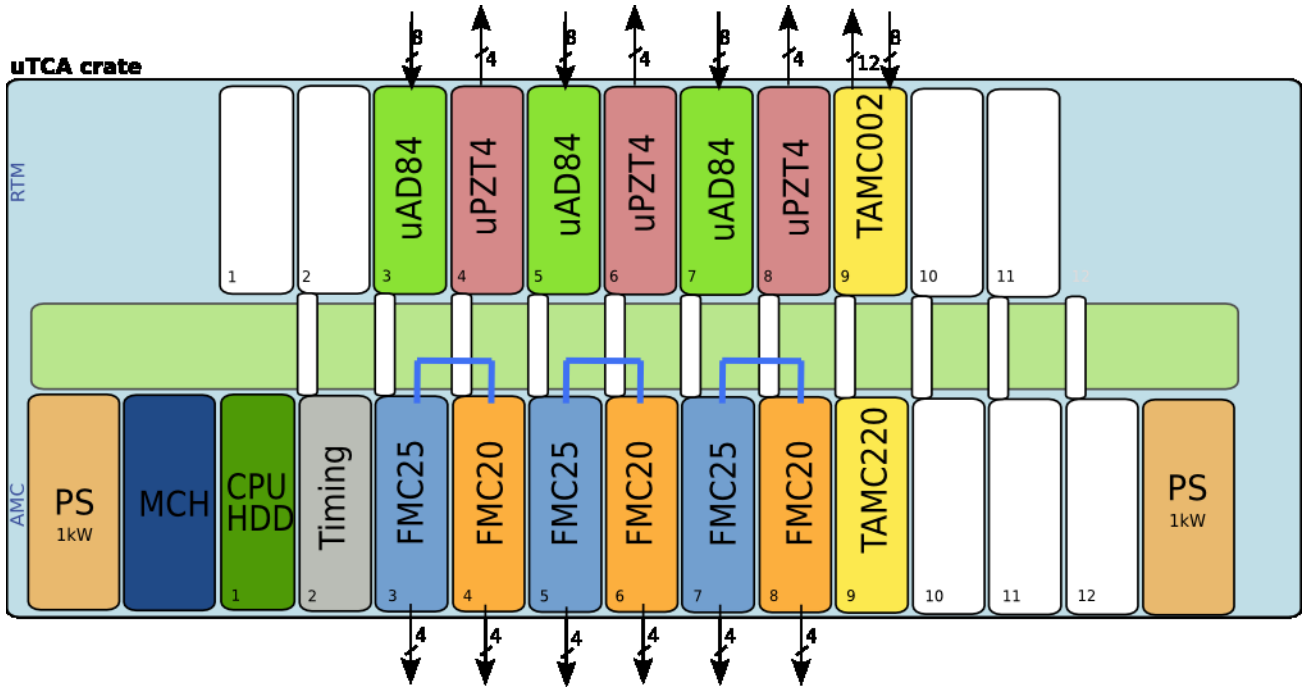
MTCA crate configuration

- On the optical table, 4 Links and 4 RF Links are grouped together
- uTCA hardware fits very well for controlling 4 Links with just 2 slots



MTCA crate configuration

- For the RF Links the situation is similar but a little more complicated due to the 2nd motor and the additional GPIO signals. With an TAMC board it could work…



Open Questions

- Crate
  - Redundancy
  - Cable Management
  - PS 1 kW or 600 W?
- Piezo Driver
  - Power supply extern or intern – RF backplane?
  - Heat load
  - Bandwidth → worst case: 5V / 100 nF / 40 kHz → 100 mA
- DAMC02 Communications
  - Communication bandwidth sufficient?
  - Latency
  - Calculation power sufficient? (How many FIR coefficients?)
- Action plan
  - Timeline: Availability of boards?
  - Timeline: Software status?
  - Test-system until Summer 2013

Thank You