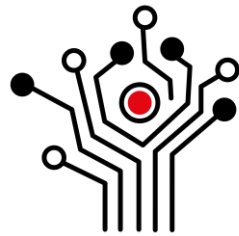


New MTCA solutions for Quantum Technologies and Big Science

Grzegorz Kasprawicz



creo TECH
Instruments S.A.



**European
Funds**
Smart Growth



**Republic
of Poland**

European Union
European Regional
Development Fund



Creotech Instruments S.A.

Key activities

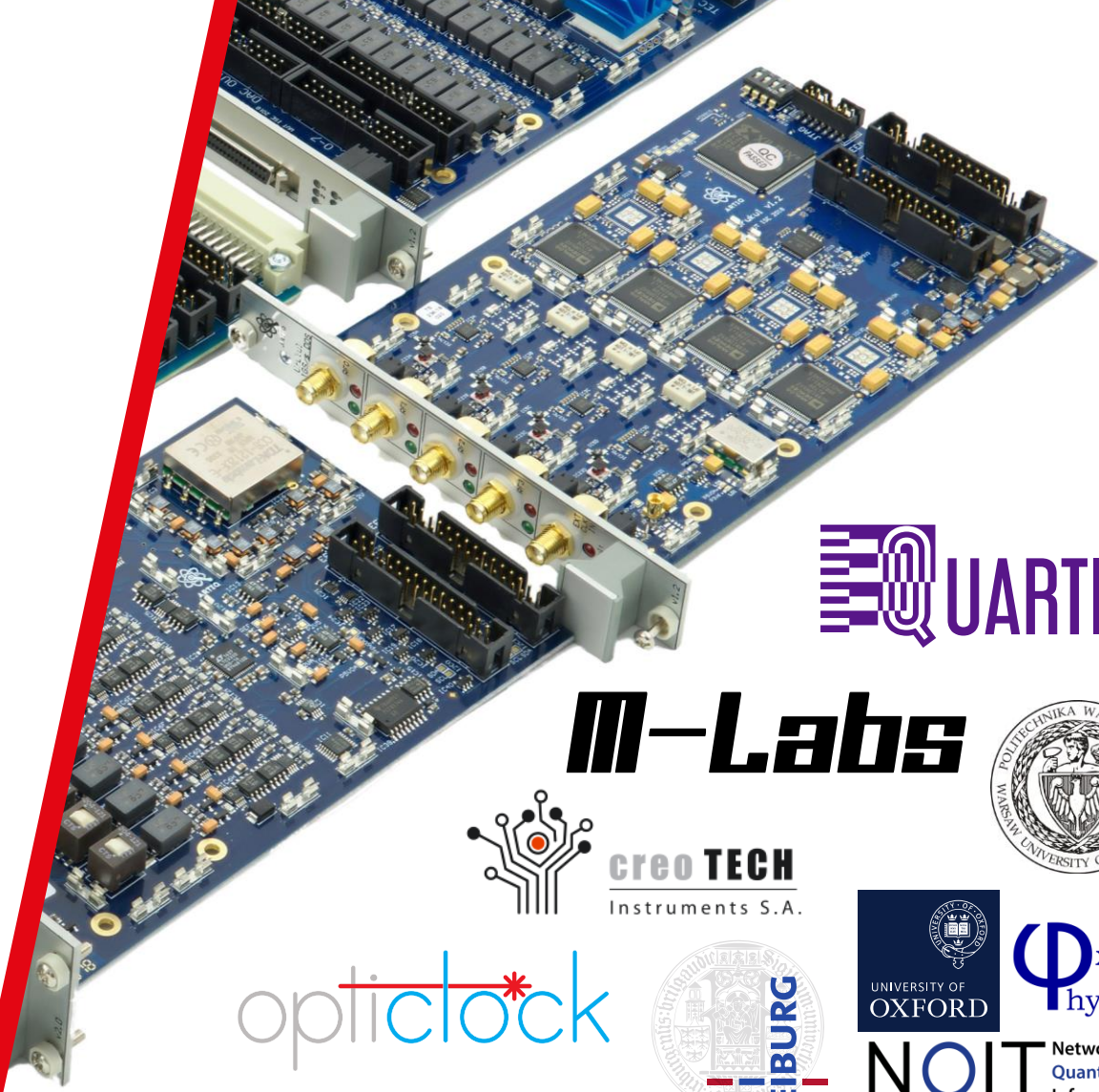
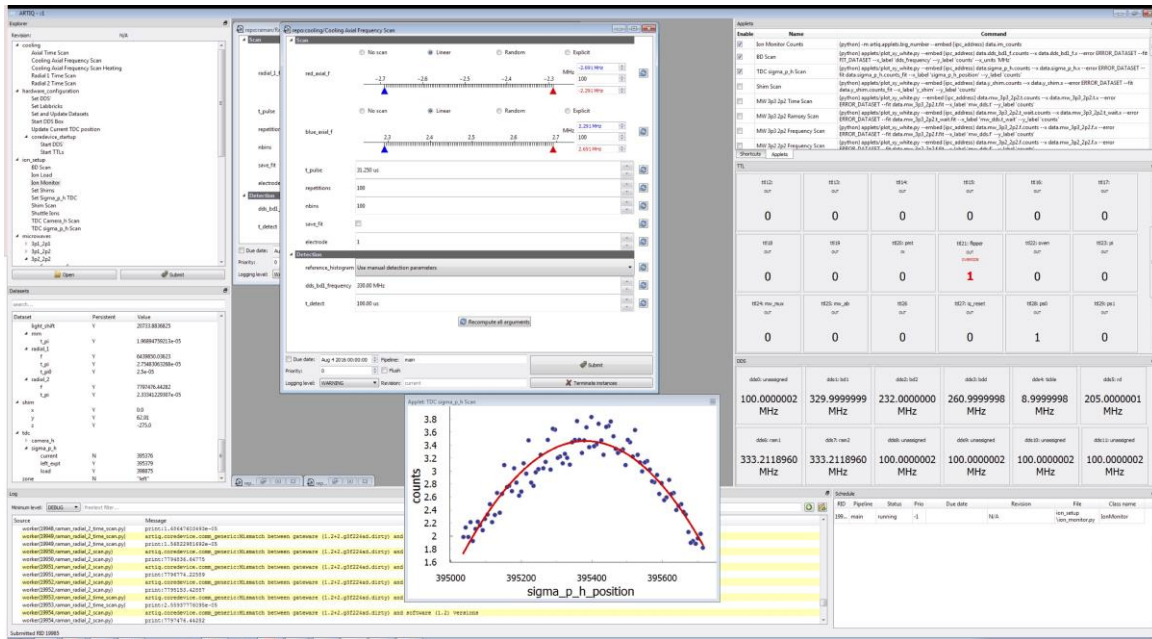
- Certified (automotive, medical, Space) manufacturing services
- Systems for Space
- Hardware and systems for Scientific Instrumentation
- Control systems for Quantum Applications
- R&D, electronics engineering consultancy services



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Sinara project

- Bottom-up initiative of the ion trap community
- Modular control and measurement hardware ecosystem, tailored to the needs of ion-trap experiments
- Open source HW
- Compatibility with ARTIQ open software

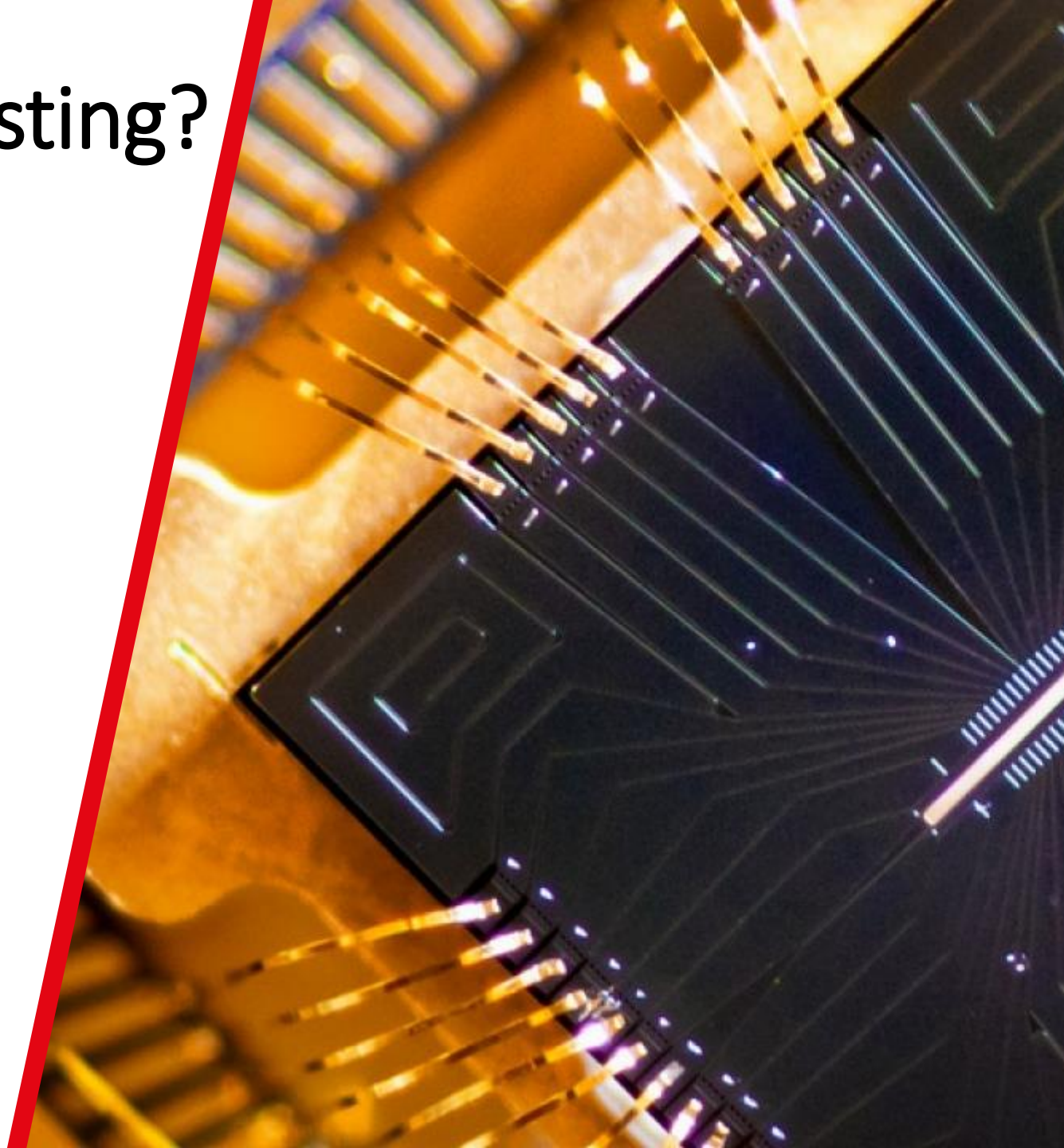


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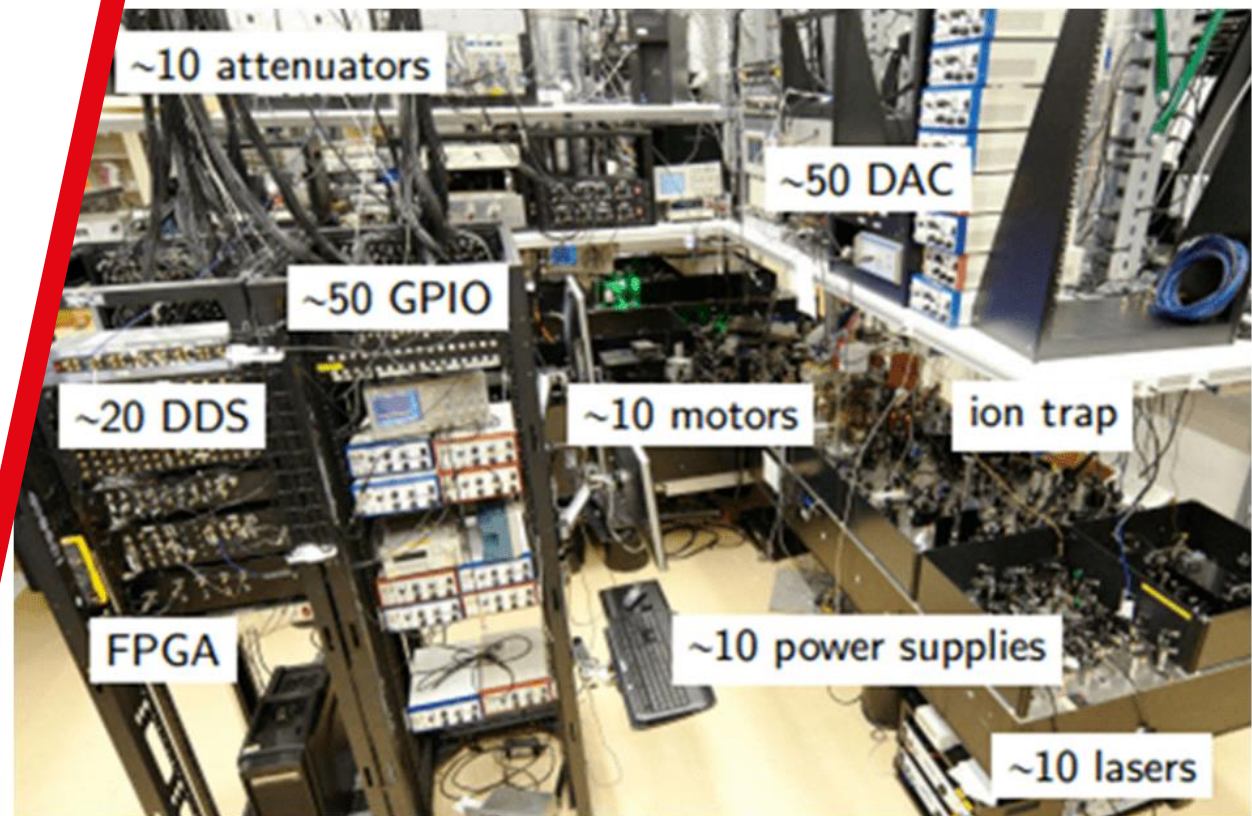
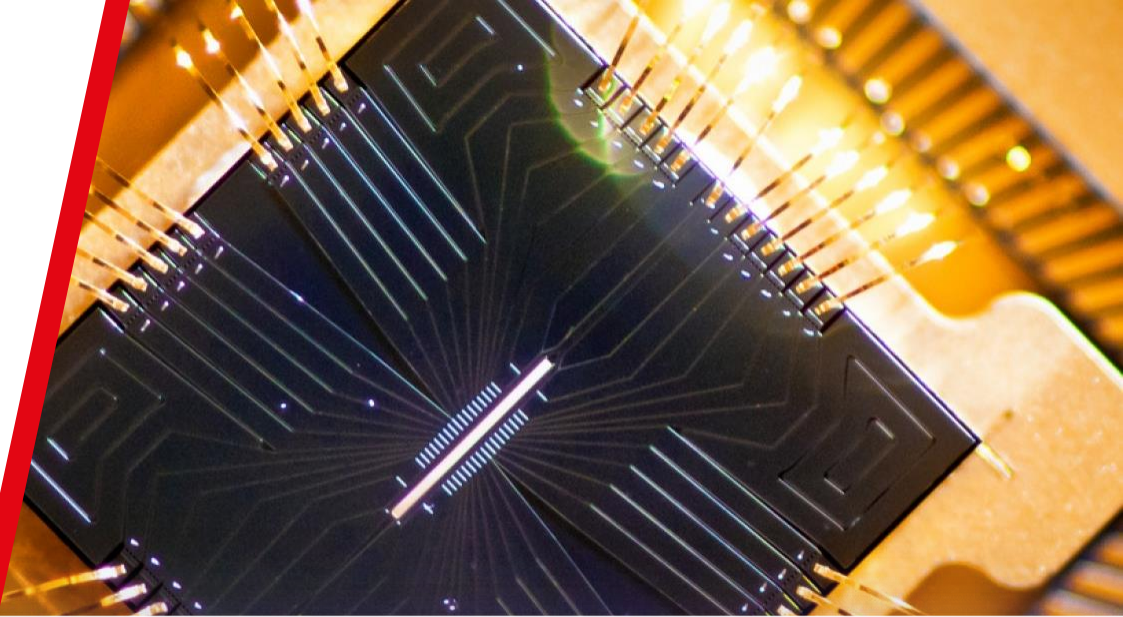
Why are ion traps interesting?

- metrology
- mass spectroscopy
- quantum simulation and sensing
- quantum computing
- qubits are manifested in the internal energy levels of ions and are manipulated through laser and microwave radiation
- long coherence times
- scalability
- e.g. ION Q commercial quantum computer with 11 fully connected qubits, 55 addressable pairs, qubit gate error $< 0.03\%$

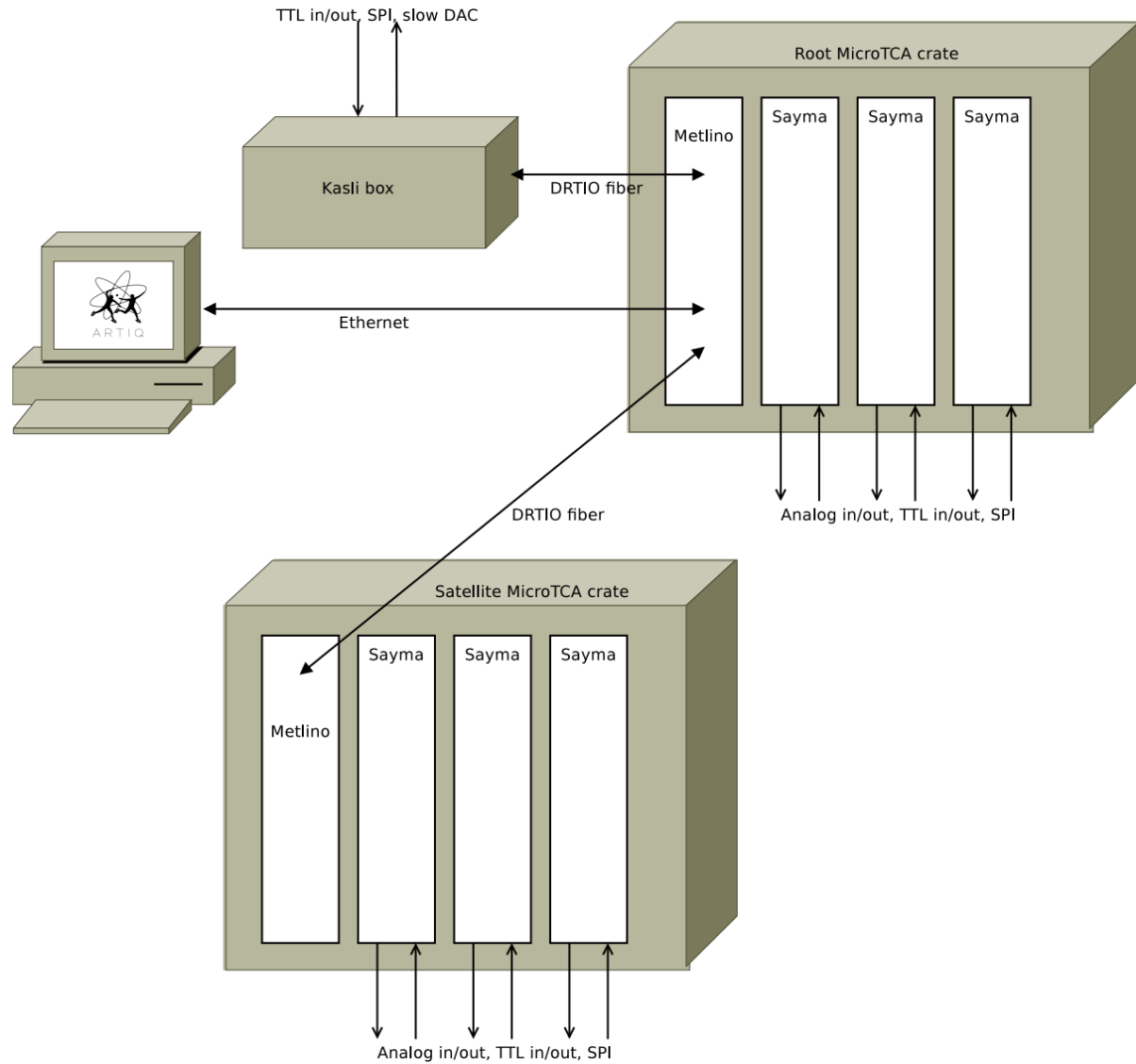


Ion trap experiments - needs

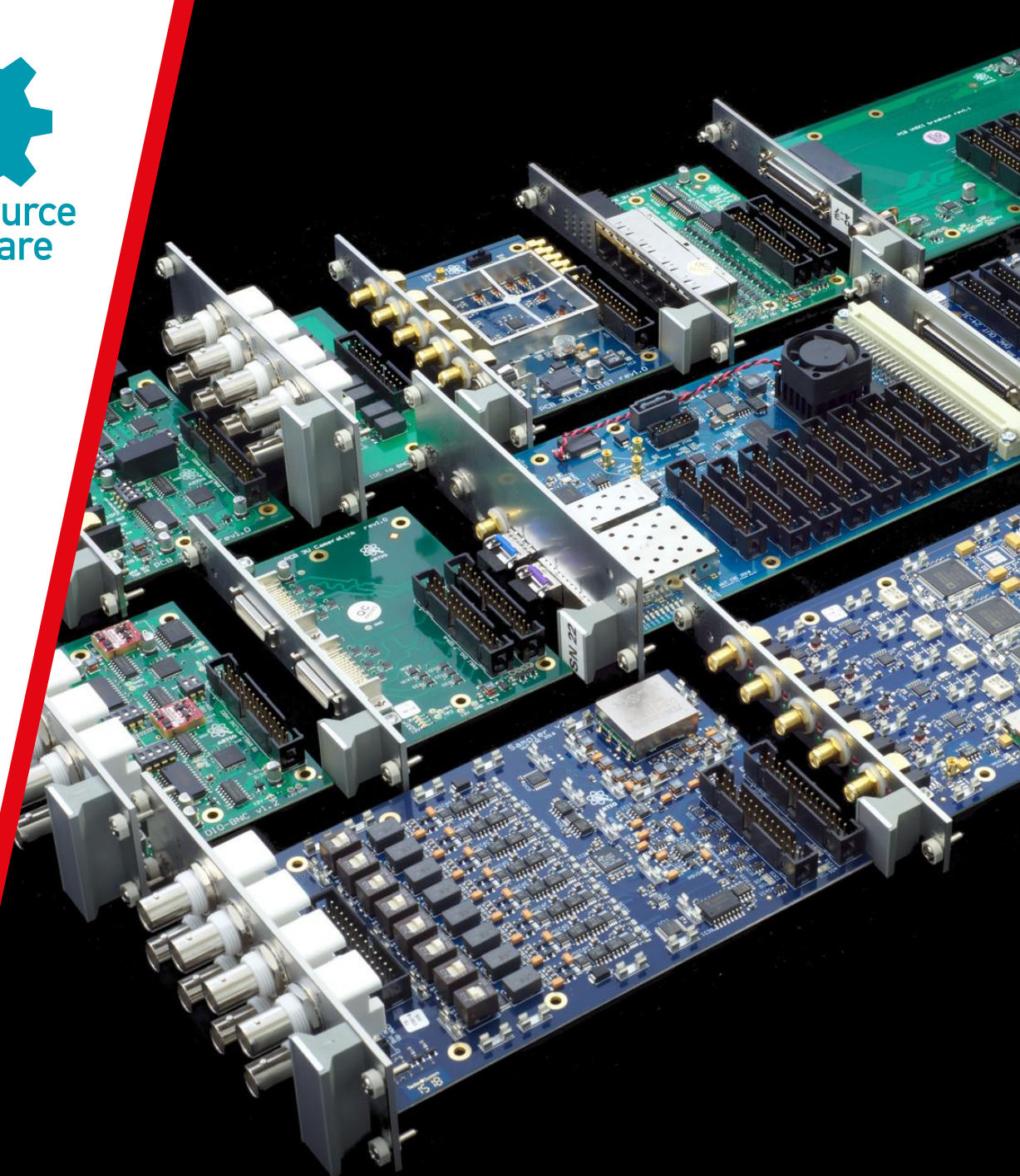
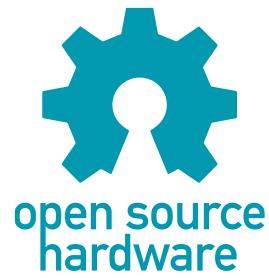
- **microsecond** response times, **sub-ns** synchronization
- control system:
 - flexible and modular
 - well tested
 - easy to build and reproduce
- multi-channel processing
- ultra-low noise (order of nV) DAC
- laser intensity servos
- laser frequency stabilization
- fast ion state readout and modification



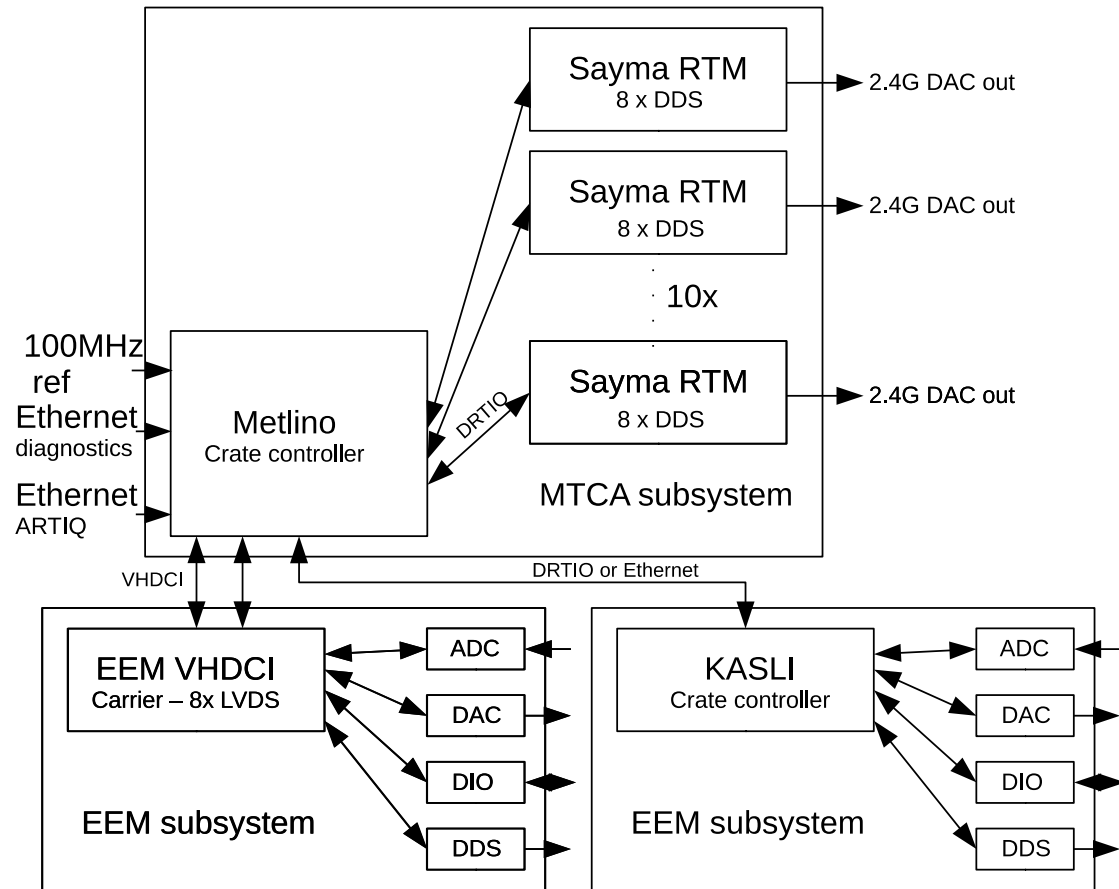
Sinara control system



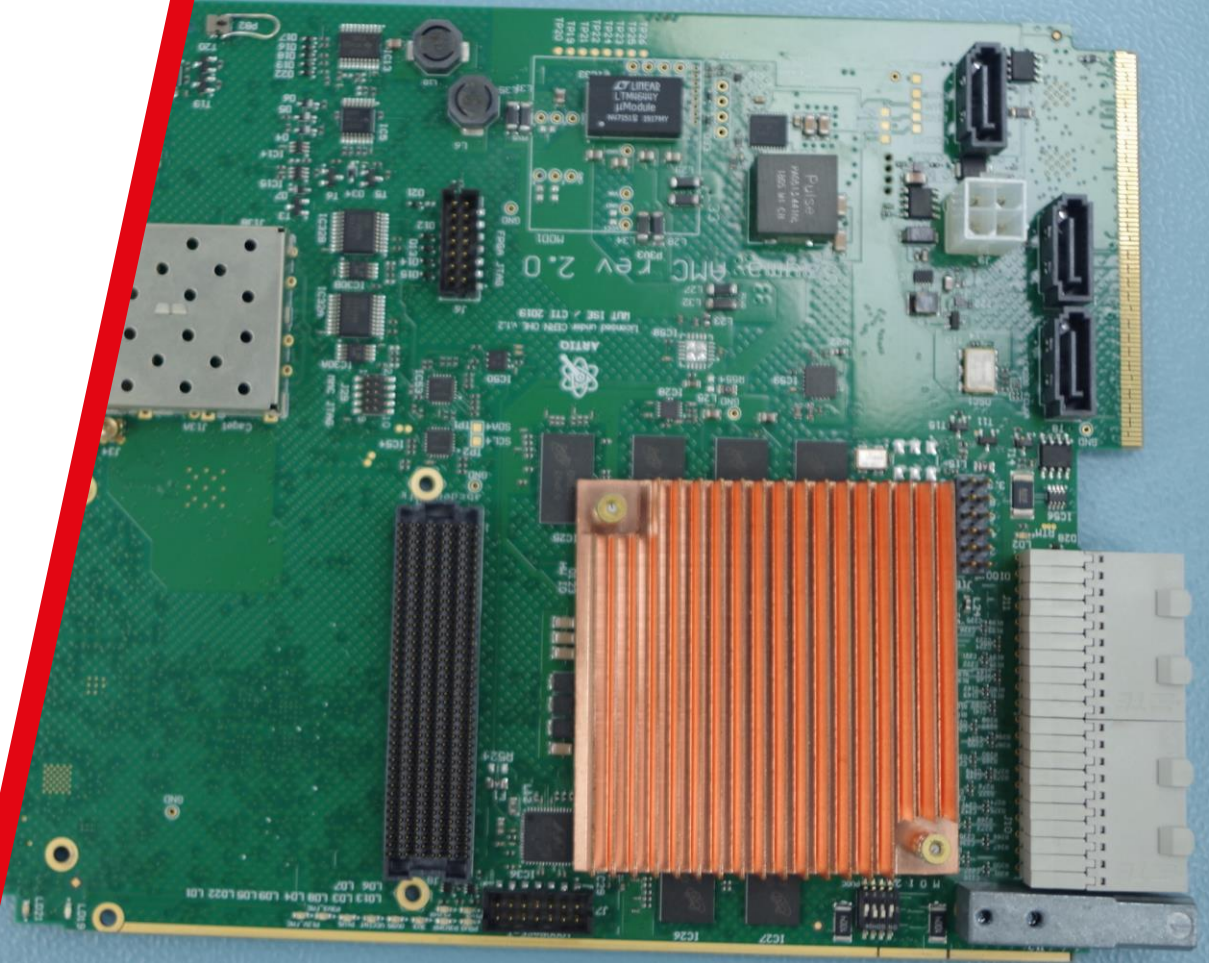
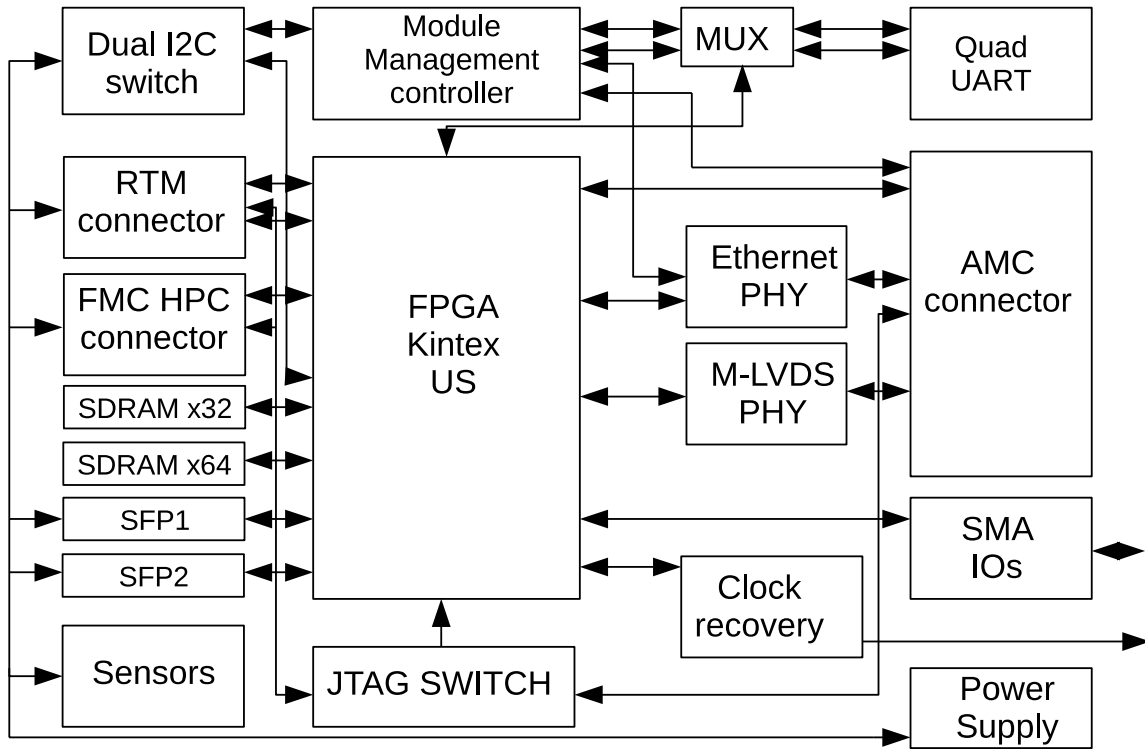
- **Kasli** Artix-7 100T FPGA deterministic real time controller (sub-ns precision)
- TTL or LVDS I/O EEMs
- **Urukul** DDS-based frequency synthesizer with sub-Hz resolution, phase steps and amplitude control
- **Sampler** low-noise ADC with 1.5MSPS sample rate and +/-10mV to +/-10V input range
- **Zotino** DAC with ultra-low noise and good stability
- **Grabber** camera interface
- **Clocker** clock distribution with low jitter <100fs
- **Thermostat** temperature controller
- **Booster** 8 channel RF amplifier for AOM
- **Sayma** AMC and RTM SAWG in MTCA format
- 56 modules and growing...



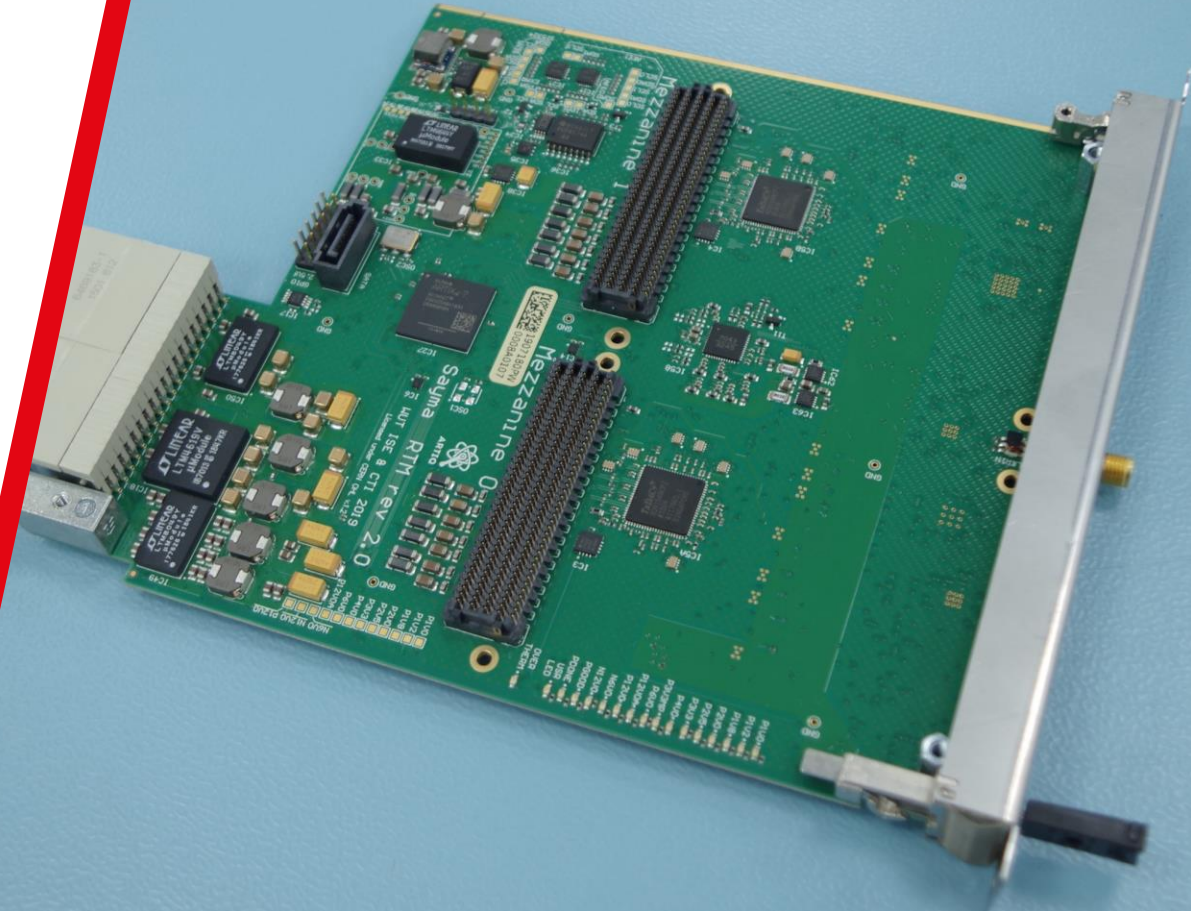
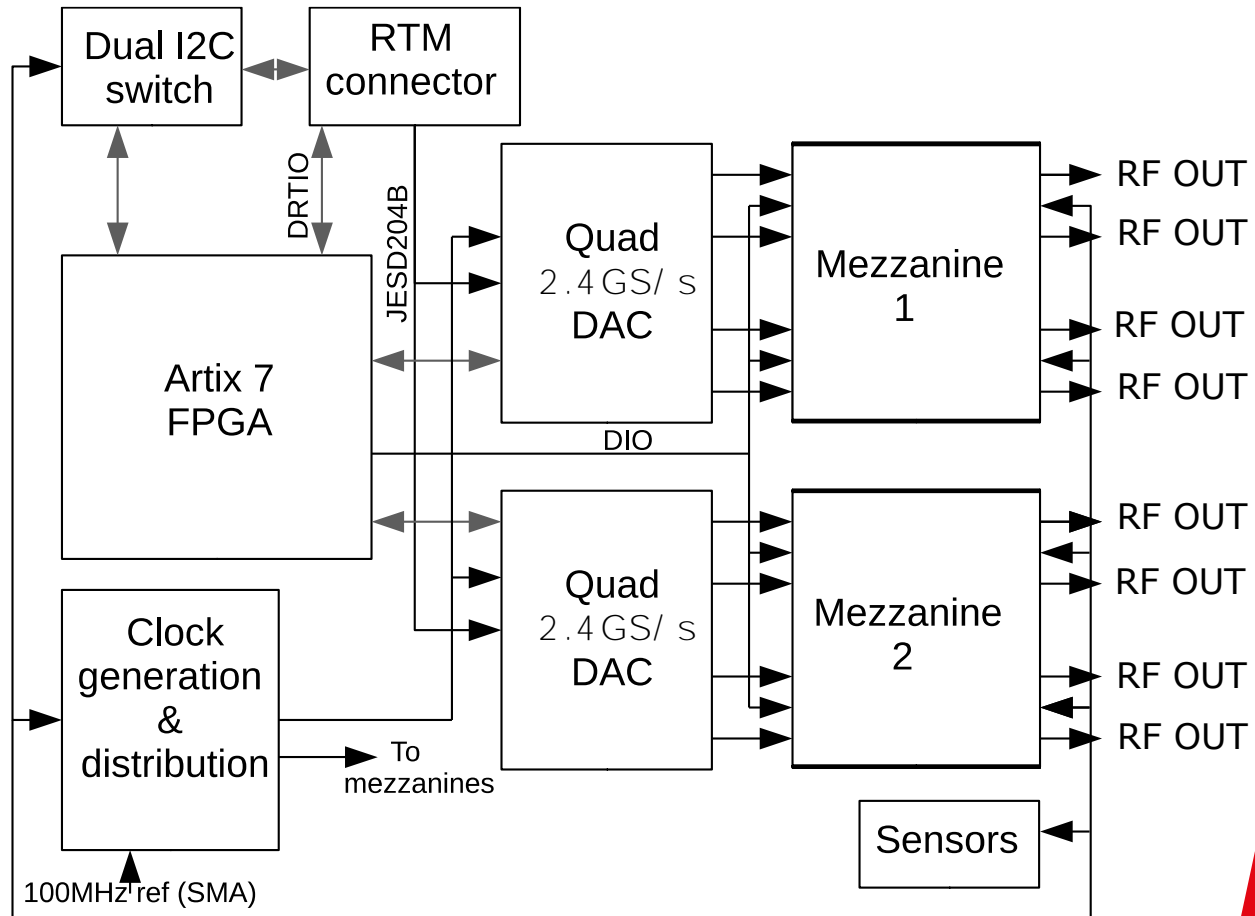
Sinara Ecosystem



Sayma AMC – AWG controller



Sayma RTM – 8 CH 2.4GS/s AWG



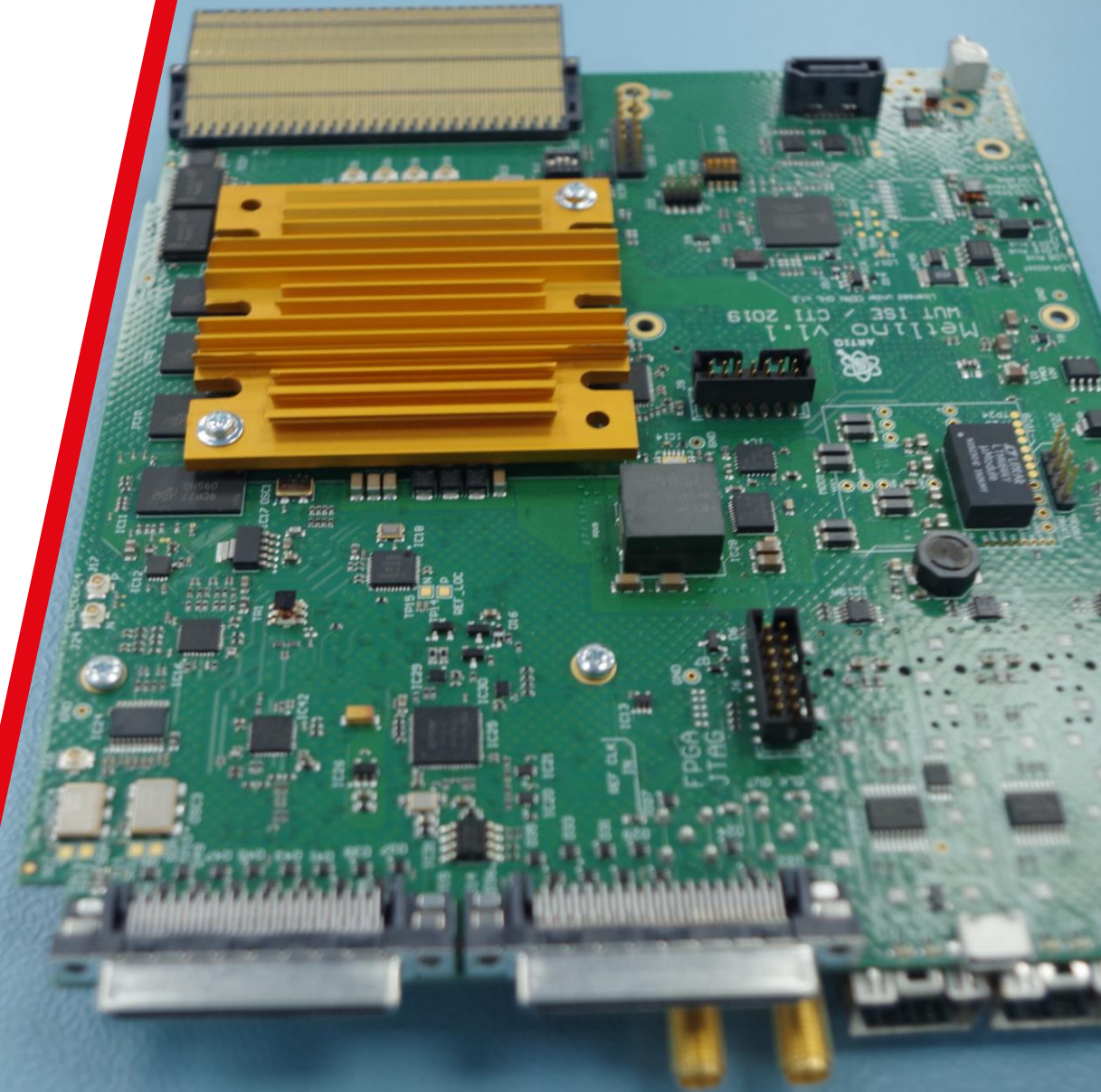
Metlino

Sits on top of standard NAT MCH
DRTIO master/slave

Controls:

- other MTCA crates using DRTIO
- EEM boards using LVDS links

FMC connector for future extensions



RF-SoC

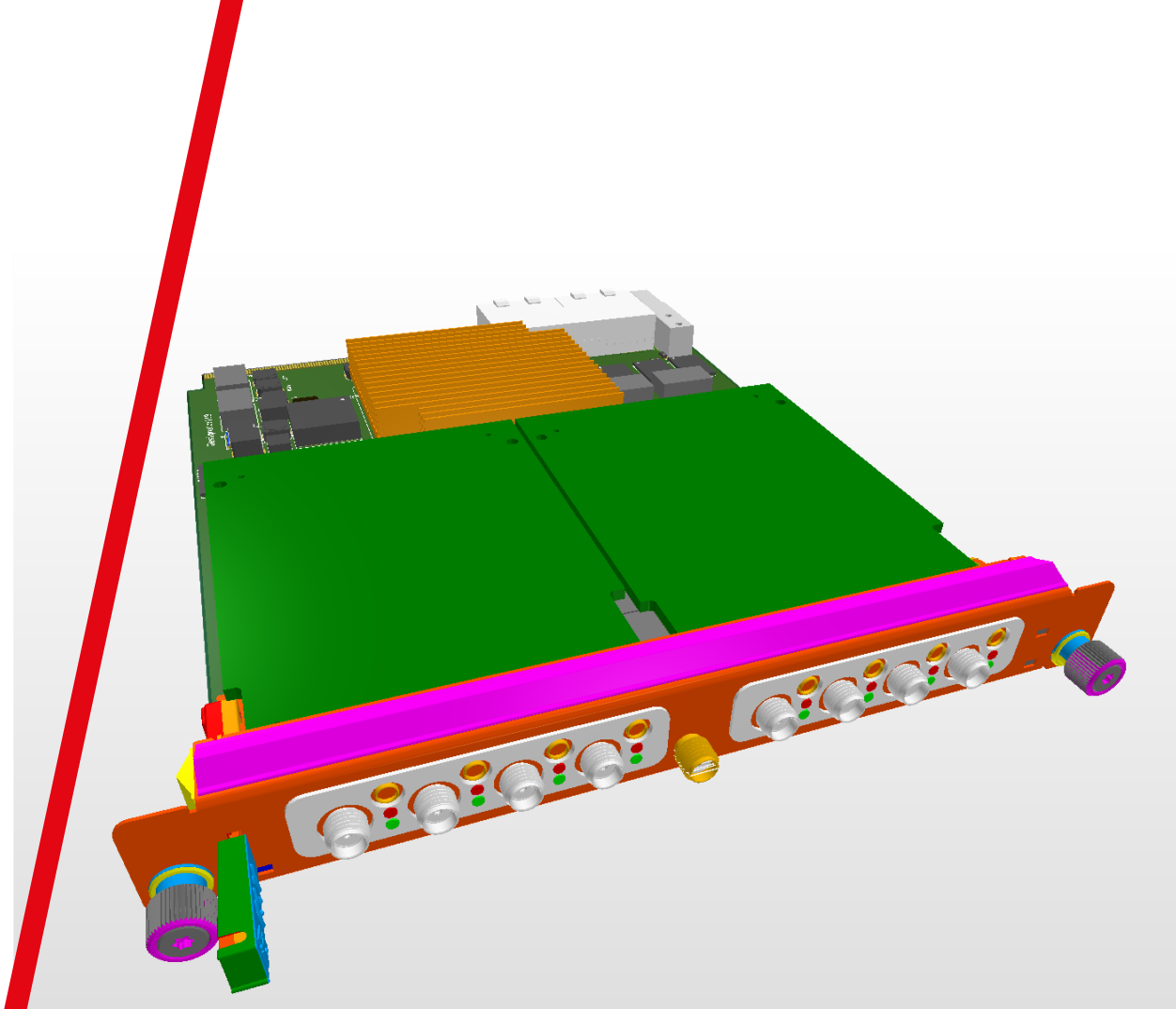
8 channel complete readout system for
SC qubits / AWG

Universal AFE module for various
physics (ion-traps, SC qubits)

Based on RFSOC

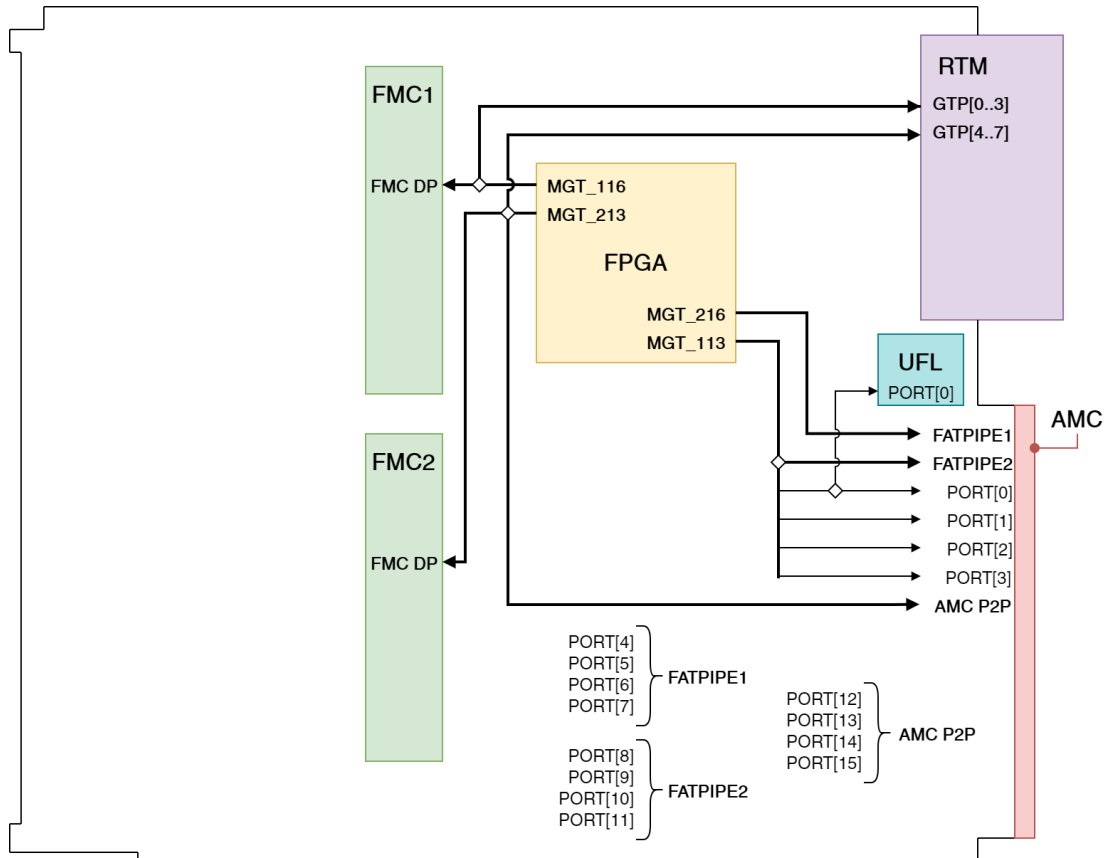
Currently under design review

Developed at the WUT within NCBIR
project



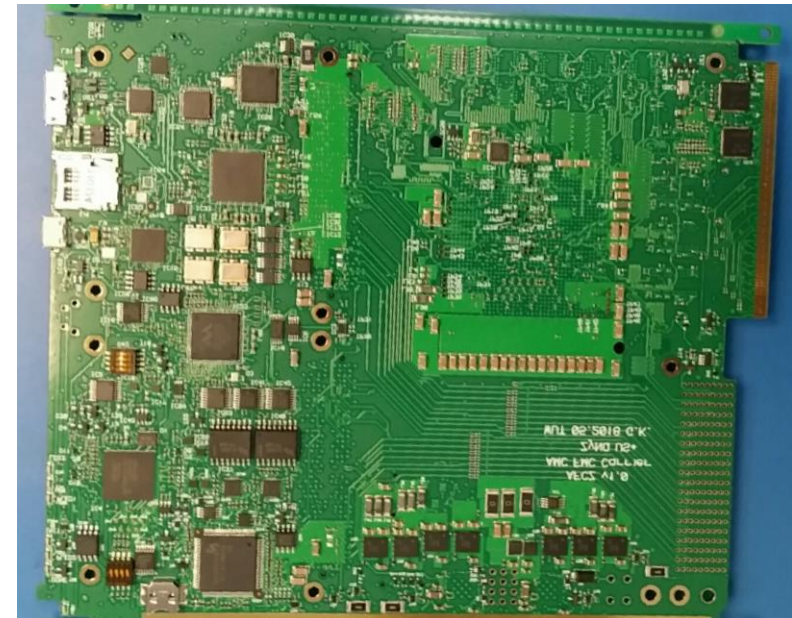
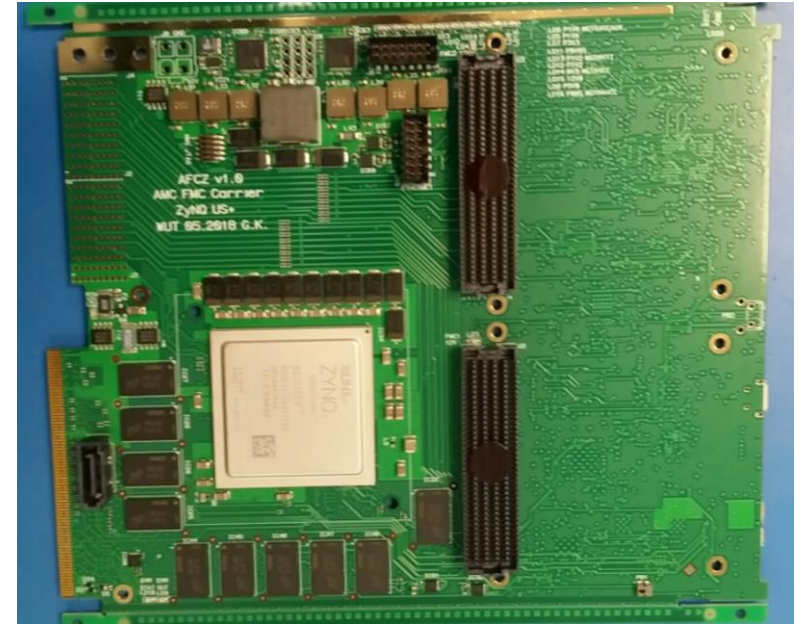
AMC FMC CARRIER - AFC

New revision of well known AFC
Multi channel TDC and readout
system for QC
Common development between
LNLS, WUT and CTI



AFCZ

AMC FMC Carrier with ZynQ US+
Optimized for high speed serial converters
2-nd revision developed together with
CERN for LLRF / WR applications



- **48 channel 2.4GS/s AWG**
 - Dedicated to ion-trap applications
 - AFE boards with RF gain control and precise ADC
 - All channels synced within a fraction of ns using DRTIO
 - Developed for US Army Research Lab/Oxford by WUT, CTI and Mlabs
-
- Ongoing integration effort of Sinara ecosystem and CERN Distributed IO Tier – CPCIS backplane instead of ribbon cables
 - Sinara is used in over 100 Q experiments around the world, over 2k units sold
 - Sinara is currently applied to control CERN AEGIS experiment (anti-matter trap)

