

Summary of the 12th MicroTCA Workshop for Industry & Research (2023)

Holger Schlarb, MSK/DESY
USTC, Hefei, China, 19.09.2024

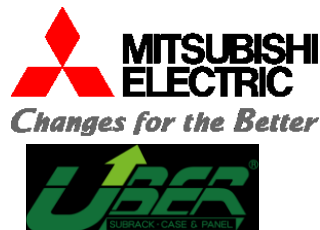
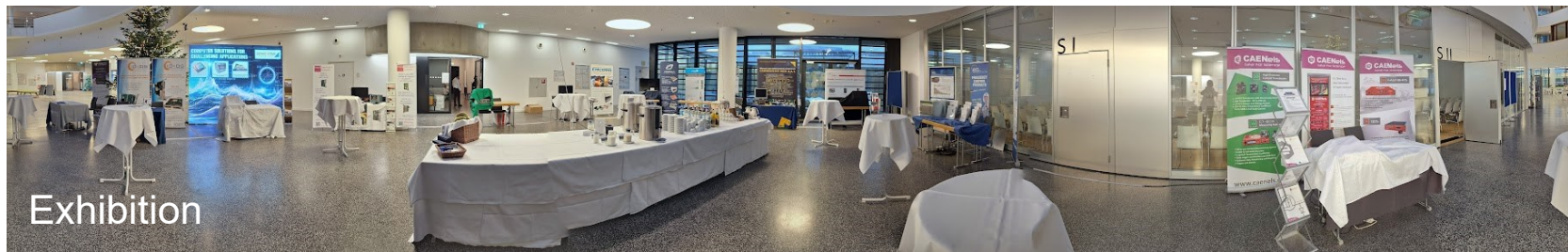
HELMHOLTZ RESEARCH FOR
GRAND CHALLENGES



The image shows the cover of a brochure for the 2024 MicroTCA/ATCA workshop. At the top, there is a row of logos for various institutions including DESY, MSK, and others. The main title is "2024 MicroTCA/ATCA for Large Scientific Facility Control International Workshop". Below the title, it states "Organizer: University of Science and Technology of China (USTC)" and "Sep. 18-Sep. 20, 2024 Hefei, China". The background of the brochure features a photograph of a modern city skyline with several tall skyscrapers and a body of water in the foreground.



Location...



Workshop program Tu / We / Th

Indico page: <https://indico.desy.de/event/41197/timetable/#all.detailed>

Morning: two tutorial tracks ~ 6 + 2 talks, Tu 9 - 12

Firmware & Software Frameworks



Open source FPGA Firmware Framework FWK and the ChimeraTK Software Framework	The Basics <i>Ralf Waldt</i>	09:05 - 09:30
	Q&A	09:30 - 09:35
	MicroTCA Management <i>Heiko Korte</i>	09:35 - 10:00
	Q&A	10:00 - 10:05
	System debugging <i>Thomas Holzapfel</i>	10:05 - 10:25
	Q&A	10:25 - 10:30
Coffee Break	Coffee Break	10:30 - 11:00
Open source FPGA Firmware Framework FWK and the ChimeraTK Software Framework	The MRF timing system <i>Faye Chicken</i>	11:00 - 11:25
	Q&A	11:25 - 11:30
	The White Rabbit based Timing Syst... <i>Dietrich Beck</i>	11:30 - 11:55
	Q&A	11:55 - 12:00
	The XFEL timing system <i>Kay Rehlich</i>	12:00 - 12:25
	Q&A	12:25 - 12:30



MicroTCA Tutorials



Introduction Timing

14.00 →

Tuesday

09:00	Summary on the "2023 MicroTCA/ATCA for Large Scientific Facility Control Workshop" in China	Lei Shi	09:00 - 09:15
	MicroTCA Next Generation Update	Kay Rehlich	09:15 - 09:30
	MicroTCA: Challenges and the value of open standards	Jessica Isquith	09:30 - 09:45
	MTCA.4 Crate - From standard product to custom solution	Christian Garvinger	09:45 - 10:00
10:00	FPGA RF-SoC for MTCA	Lukas Bockmann et al.	10:00 - 10:15
	Discussion		10:15 - 10:30
	Coffee Break		10:30 - 11:00
11:00	NATIVE-Server from Concept to Solution	Heribert End	11:00 - 11:15
14:00	Welcome to DESY		14:00 - 14:15
	Introduction	Dr. Holger Schlarb	14:15 - 14:30
	Modernizing Fermilab's Control Hardware	Jennifer	14:30 - 14:45
	Standard Deployment of MicroTCA at ESS	Faye C	14:45 - 15:00
15:00	Status of MTCA at J-PARC in 2023	Fumihiko Yam	15:00 - 15:15
	CERN High Luminosity LHC LLRF project	Gregoire Hag	15:15 - 15:30
	Coffee Break		15:30 - 15:45
16:00	Keynote PETRA IV		16:00 - 16:15
	Status and commissioning results of the CERN SPS MicroTCA Low Level RF	Arthur S	16:30 - 16:45
	Summary of ongoing MTCA projects at SOLEIL	Mrs Jade Phan	16:45 - 17:00
17:00	Control, Data Acquisition and Communication at W7-X using mTCA for the 2022/23 campaign	Avel	17:00 - 17:15
	Status and Preliminary Testing Results of the MicroTCA based Machine Protection System at the Spallation Neutron Source	Thomas Justice	17:15 - 17:30
	Looking back over 10+ years experience with MTCA LLRF systems at DESY	Julien B	17:30 - 17:45
	Discussion		17:45 - 18:00
17:00	Test campaign at 2k of the BETA 0.35 sp	C. Joly et al.	17:00 - 17:15
	OpenMMC Project Status		17:15 - 17:30
	First Light of the New Modular Controller	Mathias Richerzhagen	17:30 - 17:45
	MTCA Platform		17:45 - 18:00
	Main Oscillator Module with sub-fs Reso	Jiaohi Ba	18:00 - 18:15
	Discussion		18:15 - 18:30
09:00	Application of MTCA in the Hybrid Pixel Detector for the High Energy Photon Source		09:00 - 09:15
	Next gen of AMD Controller and Processor cores	Jen	09:15 - 09:30
	Open-source FPGA Framework for the MicroTCA Ecosystem by DESY	Ca	09:30 - 09:45
	Jump-start control application development with ChimeraTK	D	09:45 - 10:00
10:00	Firmware architecture of ESO's new detector controller (NGCII)	Ma	10:00 - 10:15
	Photonic Boards Boost Computational Power of MicroTCA Based Systems	Fr	10:15 - 10:30
	Coffee Break		10:30 - 11:00
11:00	Development of an Open-Source Synchronous Multi-Axis Motion Controller Solution for Large-Scale Experim	Michael Ranzall	11:00 - 11:15
	Update on the DAMC-X3TIMER Development		11:15 - 11:30
	MicroTCA Module Management with DMCC-STAMP: Overview and recent developments	Patric	11:30 - 11:45
	CW Control System for the KALDERA Laser Plasma Accelerator at DESY	Tomasz J	11:45 - 12:00
12:00	Using high-level synthesis languages to accelerate DAQ and processing applications for AMD-XILINX MPSoC	Mir Alejandro Pitas	12:00 - 12:15
	Python for Firmware Integration Testing on a MTCA system	Chris	12:15 - 12:30
	Closeout		12:30 - 13:00
13:00	Lunch		13:00 - 14:00

42 talks
1 Keynote

← 14.00

12th MicroTCA Workshop for Industry & Research

Statistics

56 new participants!

	2023	2022	2021	2020	2019	2018	2017	2016	2015	2014	2013	2012
Participants	207	190	189	200	198	188	183	159	177	188	191	180
Institutes	30	26	29	37	34	22	27	25	31	30	30	25
Companies	27	23	21	23	25	31	24	28	36	39	39	29
Exhibitors	14	13	9	9	12	14	13	14	14	16	16	12
Talks	42	44	40	44	43	43	38	38	45	44	53	42

- **Face-to-face** (~180) + **virtual** participation (~30)
- **Well prepared & clear talks**
- **Very informative**
- **Lives from the networking**

Newcomers ~ 25 %
High recurrent ~ 35 %

Participating entities...

Institutes:



Universities:



Organization:



CEO: Jessica Isquith

Exhibitors:



Industry:



Further dissemination of MicroTCA...

Large-scale accelerators:

America

SNS

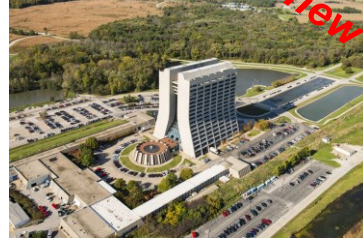


Thomas Justice (ORNL)

APS-U



Fermilab



Jenifer Case (FNAL)

Sirius



Diamond



Alba



MYRRHA *new*



C. Joly (SCK-CEN)

Europe

EuXFEL



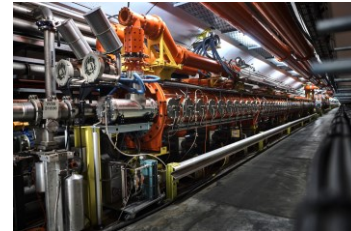
Tim Wilksen/J. Branlard (DESY)

ESS



Chicken Faye (ESS)

CERN



A. Spierer/B. Wooley/
G. Haggmann (CERN)

FAIR - GSI



Rene Geissler (GSI)

Soleil



Bessy



PETRA IV



Asia

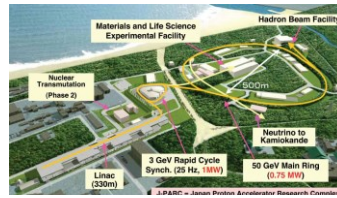
PAL-FEL



Spring 8



J-PARC



Fumihiko Tamura (J-Parc)

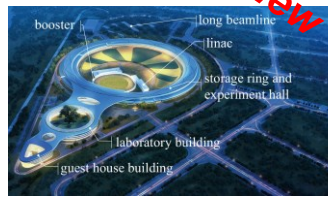
CSNS



SXFEL



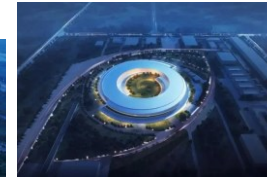
HEPS *new*



BEPC *new*



HALF/HLS-II



S3FEL... *new*



UTF *new*



Ansto



Community is steadily growing...

Looking forward on updates & news from:

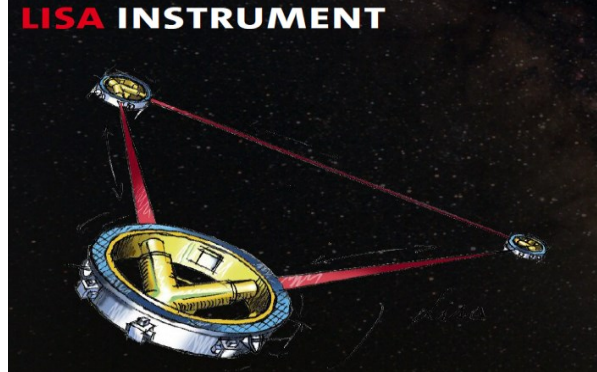
→ Cross discipline synergies

Astrophysics Observatories



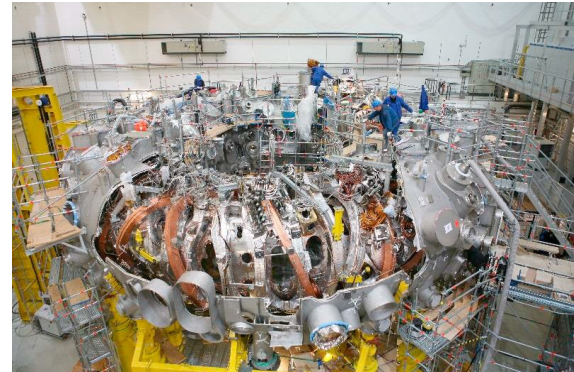
M. Richerzhagen, M. Seidel (ESO)

Gravitational Wave Detection



Ch. Darsow-Fromm (UniHH)

Fusion: W7-X Stellerator

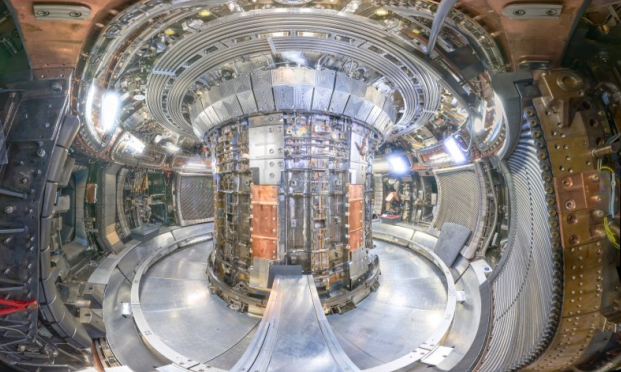


Axel Winter (IPP-MPI)

Fusion: ITER

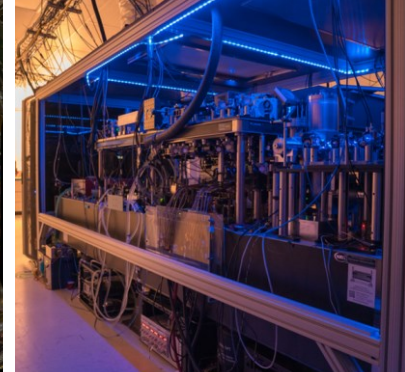


Fusion: ASDEX



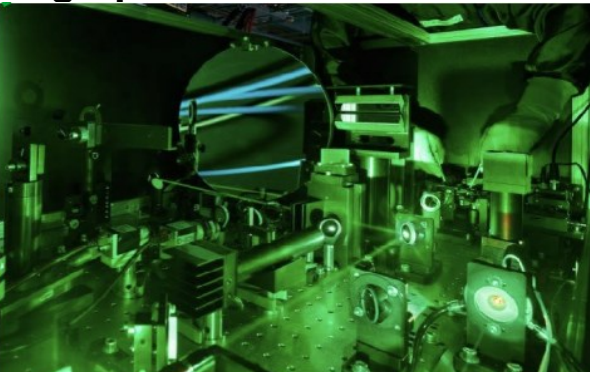
Miguel Astrain (IPP-MPI)

Quantum Comp.



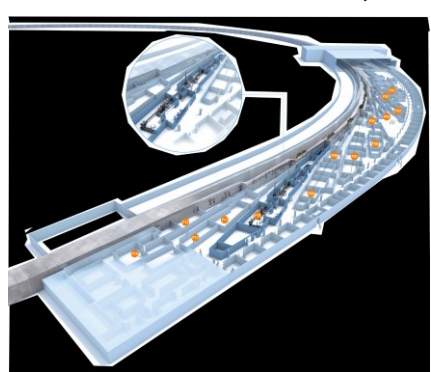
J. Lauigan (Atom Comp.)

High power lasers



T. Jezynski (DESY)

Photon beamline, exp. and detectors



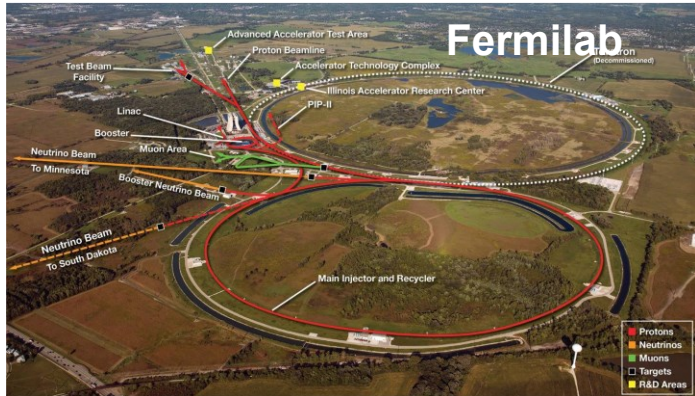
M. Tolkiehn (DESY)







Jie Zhang (IHEP)

Facility updates & plans

FNAL major refurbishment of ACORN control system, CAMAC → uTCA, ... till 2029






Old Hardware

-  2,184 CAMAC Cards
-  257 CAMAC Crates
-  78 Modules
-  208 MADCs



New Hardware

-  >2,000 μ TCA Cards
-  >400 μ TCA Crates
-  ~10 RTMs

Jenifer Case (FNAL)

Functions:

- Power Supply Controller
- Ramping Power Supply Controller
- Clock Generation
- Timing
- Beam Permits
- MDAT Link
- Digital I/O
- Analog Readback Controllers
- Analog Readback
- Gate Generator
- Counters
- Motion Controller
- Specialized Links (Abort or MDAT)
- Multiwire Controller
- Vacuum Interface
- Other

ESS controls ready to go...

Deployed with combinations of:

- 6 x AMC
- 7 x RTM
- 12 x FMC

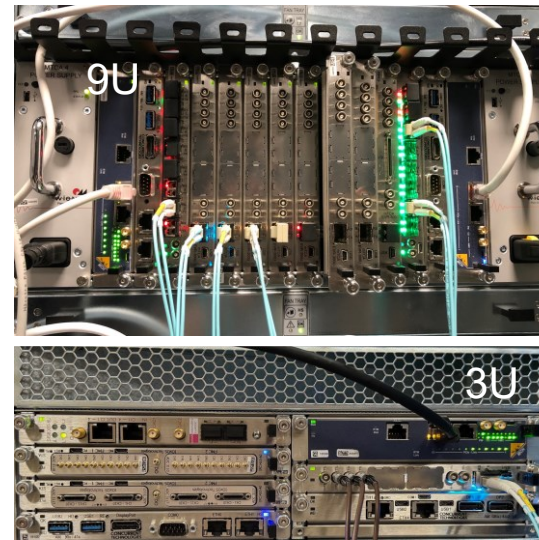
Timing: MRF

Deployment process:

- Linux OS via Network boot installer
- Jupiter Notebook



Chicken Faye (ESS)



ESS ~ 300			
RF	BI	TD	MP
175 x 9U	70 x 3U 15 x 9U	35 x 9U	10 x 3U

Take away message:

- Early system assemblies were all individual setups
- Need to have a basic “vanilla” system setup for easy maintenance and system reliability

Facility updates & plans

J-PARC expands MicroTCA... Fumihiko Tamura



Stable LLRF System



Beam Long. Diag.:

Osc. → MicroTCA crate

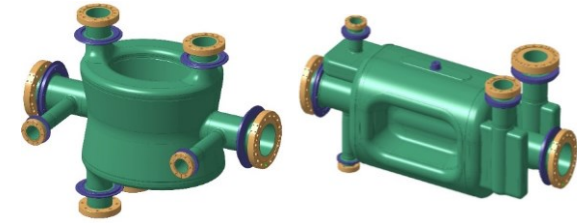


COTS: TeledyneSP ADQ14 +Vadatech VT816

➤ **Dedicated timing system (not WR)**

CERN: HL Crab-Cav. LLRF G. Hagemann (CERN)

DQW (V) or RFD (H) resonators @400MHz



Tight tolerances

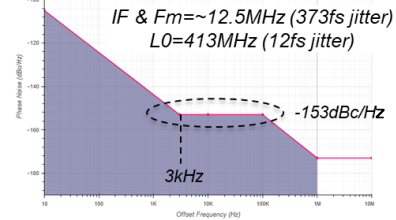
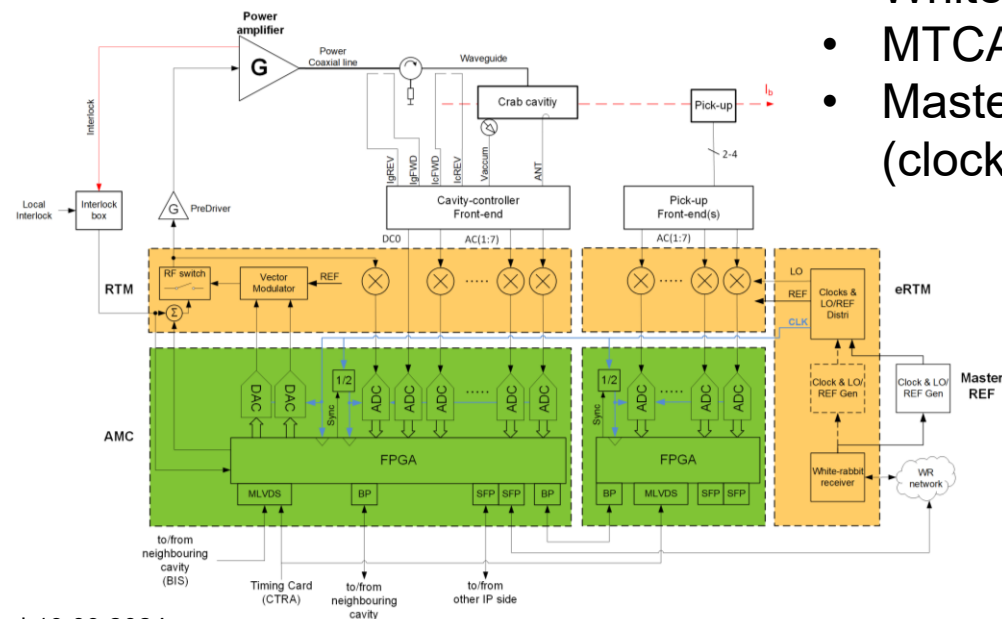


Fig - LO & IF Phase noise requirement



Architecture

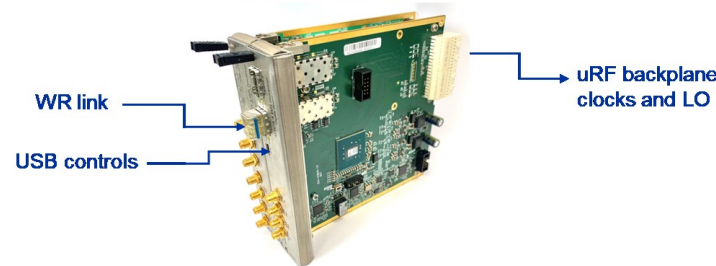
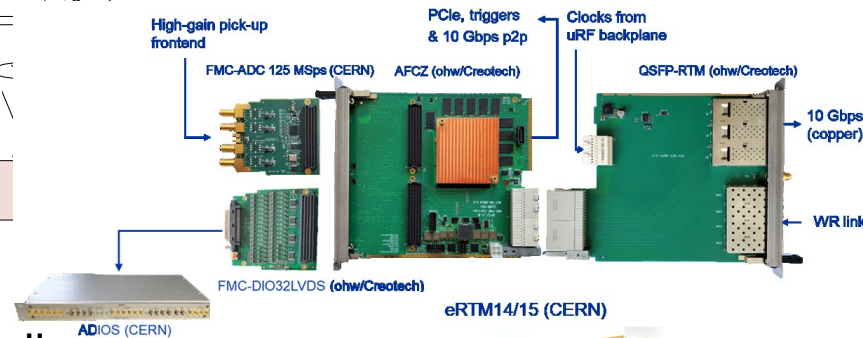
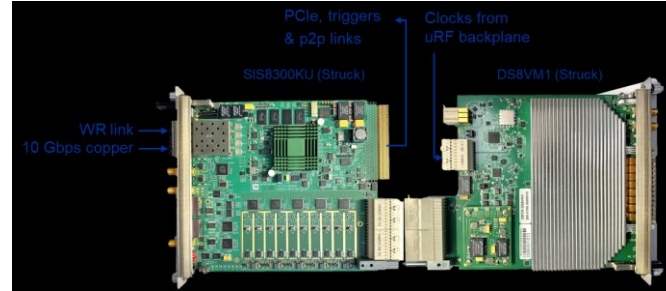
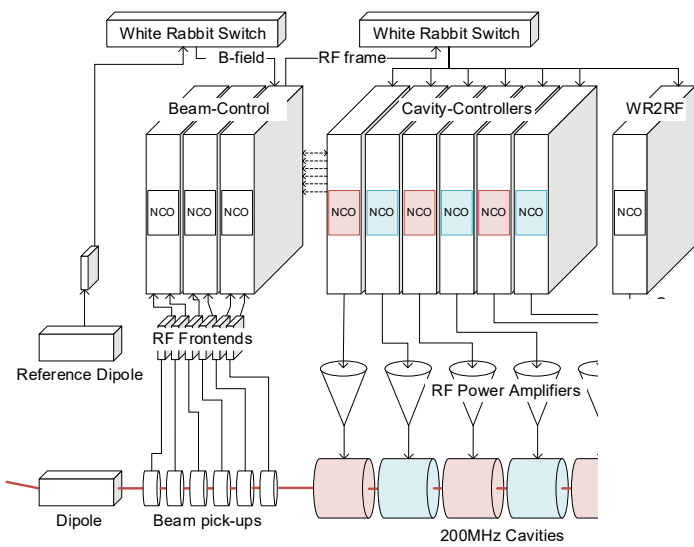
- White-Rabbit based
- MTCA platform
- Master Reference (clock, LO) → eRTM

Low Level RF Systems at CERN ...

CERN, HL-LHC, SPS LLRF System

Arthur Spierer (CERN), 200 MHz

Use SIS8300KU and DWC8VM1 AMC+RTM.



6x 200 MHz Cavity controllers

125 Msps ADCs

2x Beam-based measurements

5 Gbps & 125 Msps ADCs

1x Beam control

125 Msps ADCs

➤ eRTM 15 cooling needed spec. solution

CERN, Awake Photoinjector LLRF

Ben Woolley (CERN), S & X-Band

Use SIS8300KU and DWC8VM1 AMC+RTM.

WR receiver

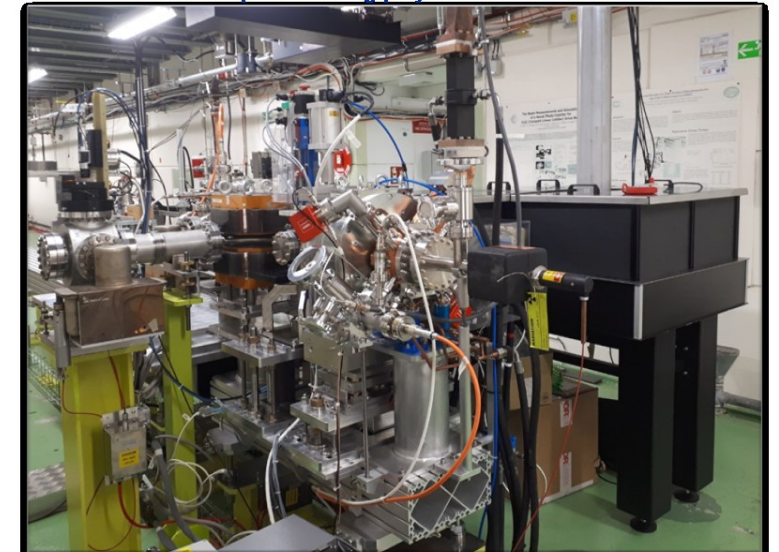


DeRTM-LOG3000



AFC FMC carrier: <https://ohw.org/project/afc>

DeRTM-LOG



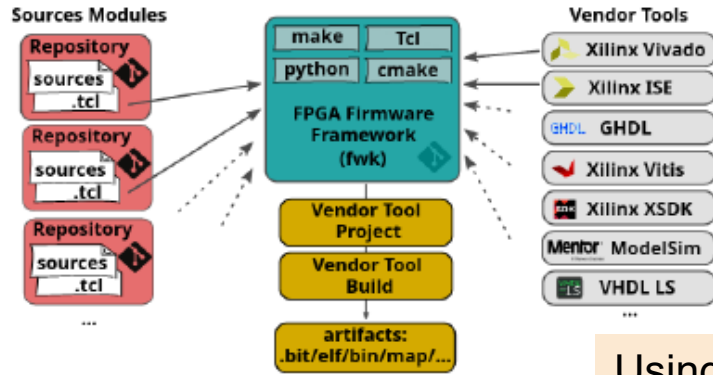
AWAKE Run 2c photocathode gun installed in former CLIC Test Facility

Feedbacks for Synchrotron Radiation Sources...



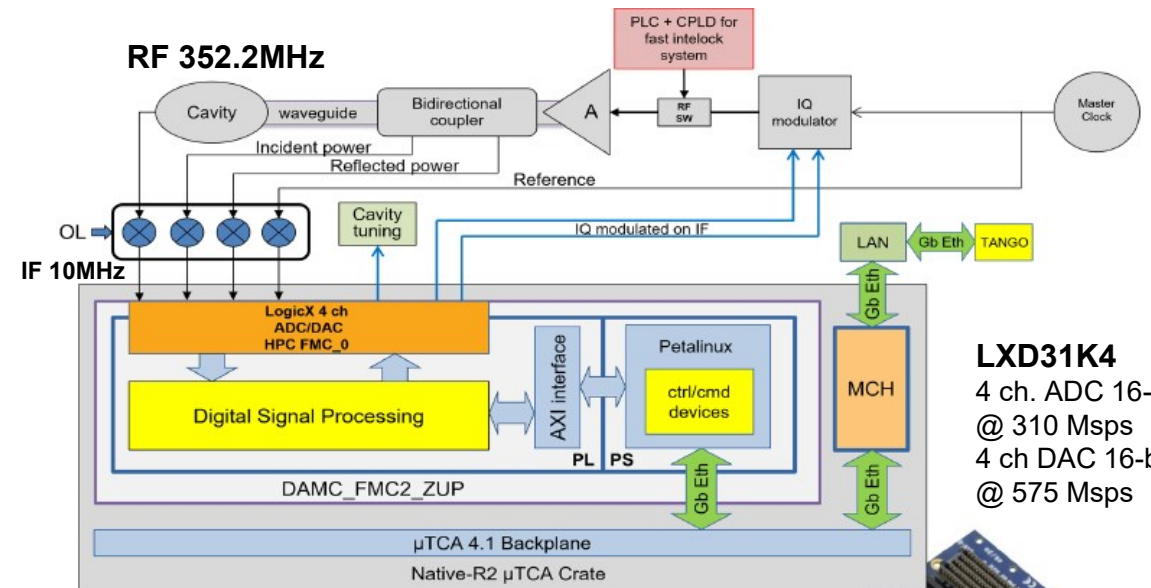
Synchr. in France Jade PHAM, Romain BRONÈS

Fast Orbit Feedback (in operation)

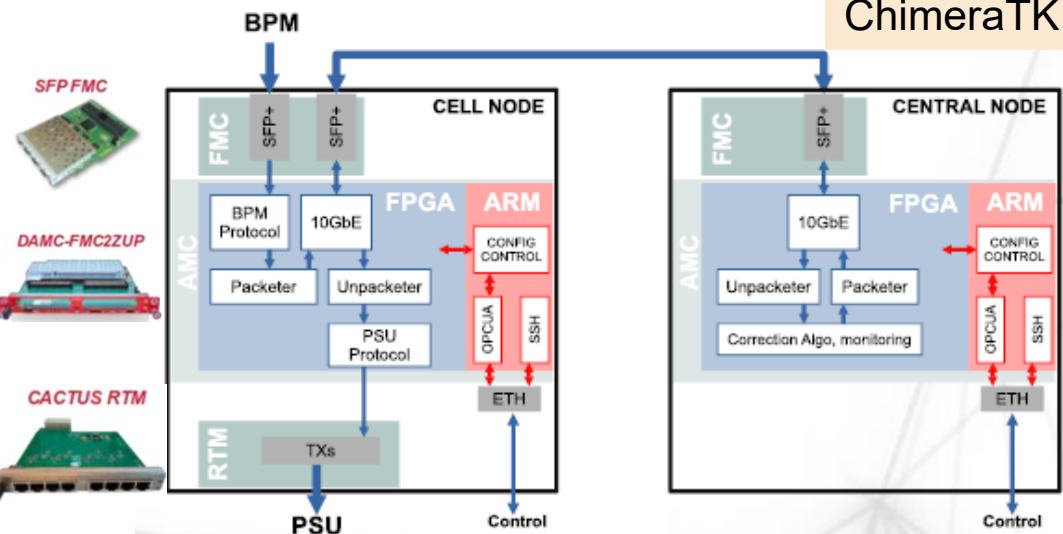


Using FWK & ChimeraTK

LLRF system (first successful tests)



LXD31K4
 4 ch. ADC 16-bits @ 310 Msps
 4 ch DAC 16-bits @ 575 Msps



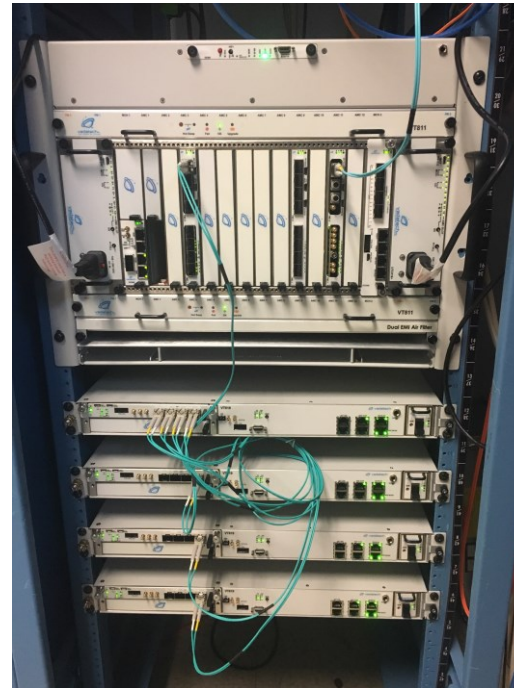
Experience and improving reliability



Spallation Neutron Source (SNS),
Machine Protection System

@Alan Justice

- **VME to MicroTCA upgrades** are part of the Integrated Controls Section modernization strategy at SNS
- **6 years of production** at SNS for MicroTCA
- **Extensive in-house** hardware & firmware **expertise**
- **Improving the reliability** through extensive component health monitoring (IPMI)



SNS MPS Master, Trigger Control and Field Nodes



Vadatech AMC523 and SNS MPS RTM

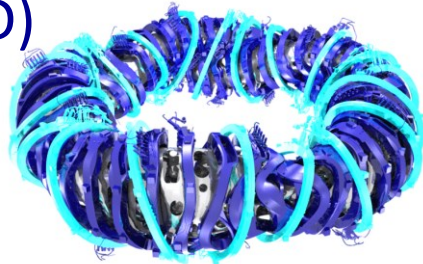
Plasma fusion

MAX-PLANCK-INSTITUT
FÜR PLASMAPHYSIK

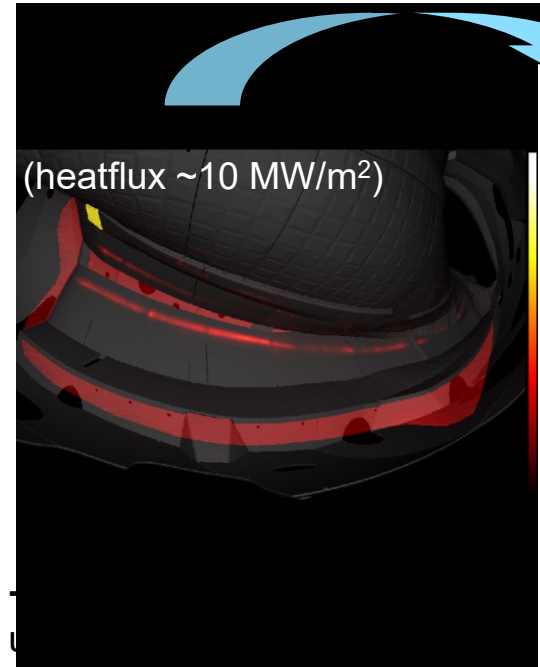
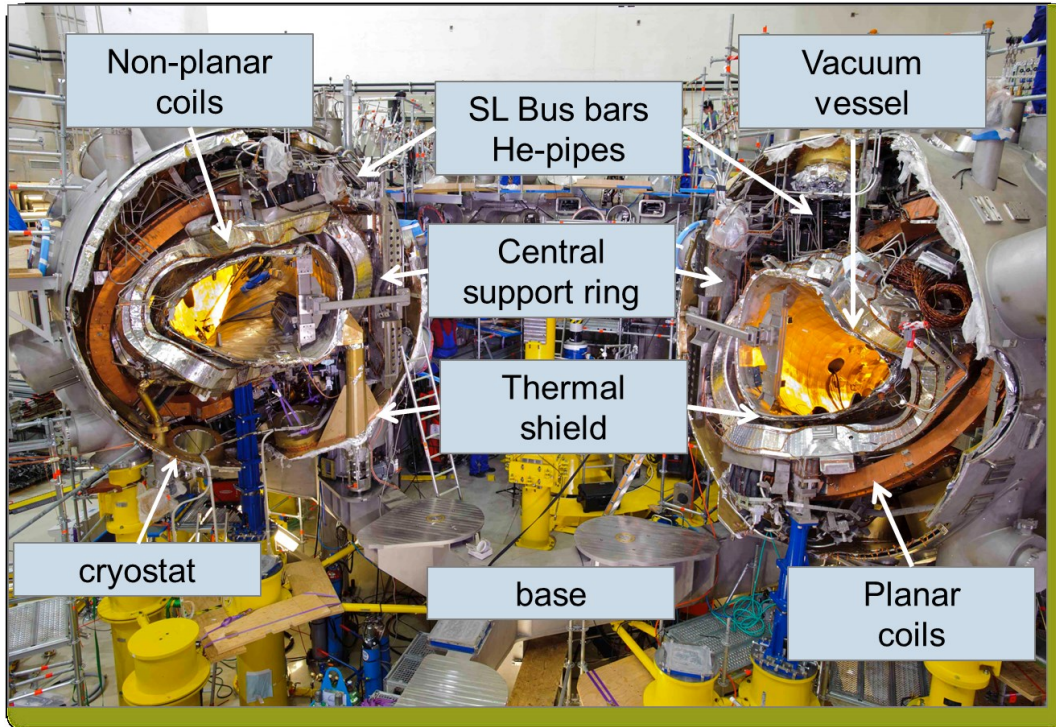


Lodz University
of Technology

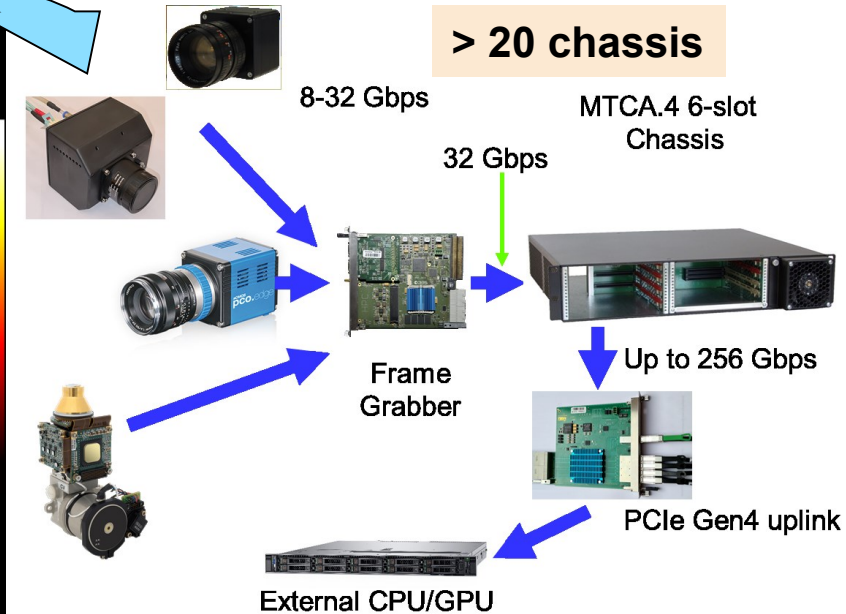
W7-X Control (north of Germany) Axel Winter MPI, D.Makowski DMCS, Lodz
Stellarator (3D)



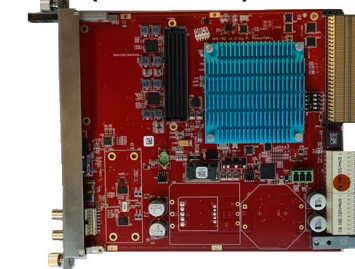
Wendelstein 7-X



**Diverter Bolometer
+ 100 ch**



**Artix 7 FPGA
(<6.5 Gb/s)**



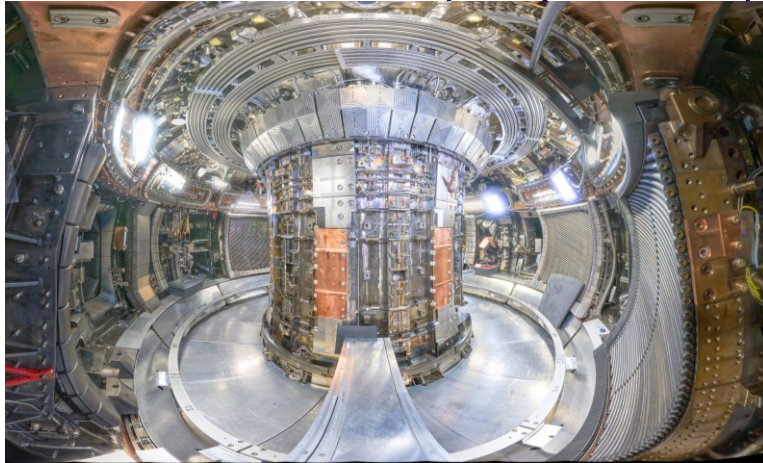
**Kintex UltraScale
(>6.5 Gb/s)**



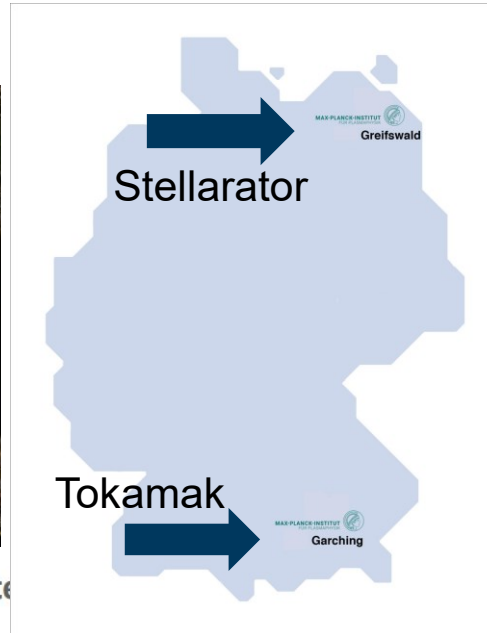
Plasma fusion

ASEX upgrade (south of Germany) M. Astrain (MPG)

ASDEX Tokamak (axisymmetric)



Typical MTCA.4 Crate



MAX PLANCK
GESELLSCHAFT



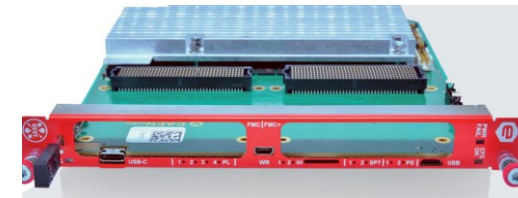
EPICS

STANDARDIZATION

Embedded Linux

DESY FWK BSP

Use Frameworks From ITER & DESY



FMC2ZUP



FMC1Z7IO

12 slot chassis

AI 768ch @1MSPS

AI 384 @2MSPS

AI 192 @4MSPS



2:1



2:1?



• LPC SLOT

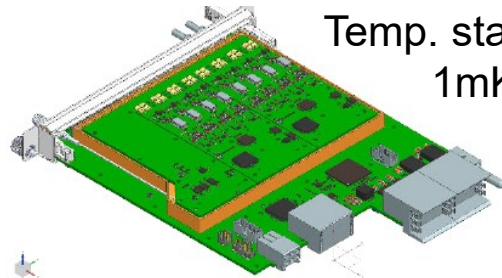
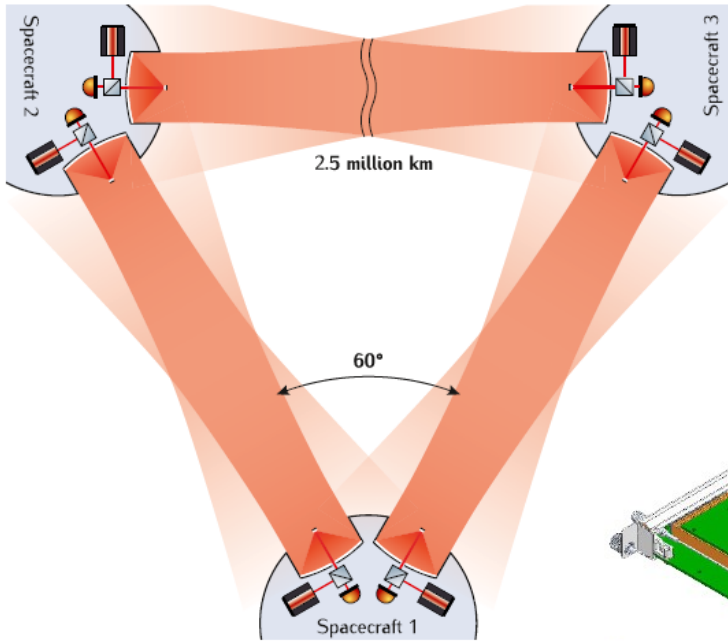


• HPC SLOT

LISA Ground-support equipment phasemeter

Interferometer multi-channel readout ...

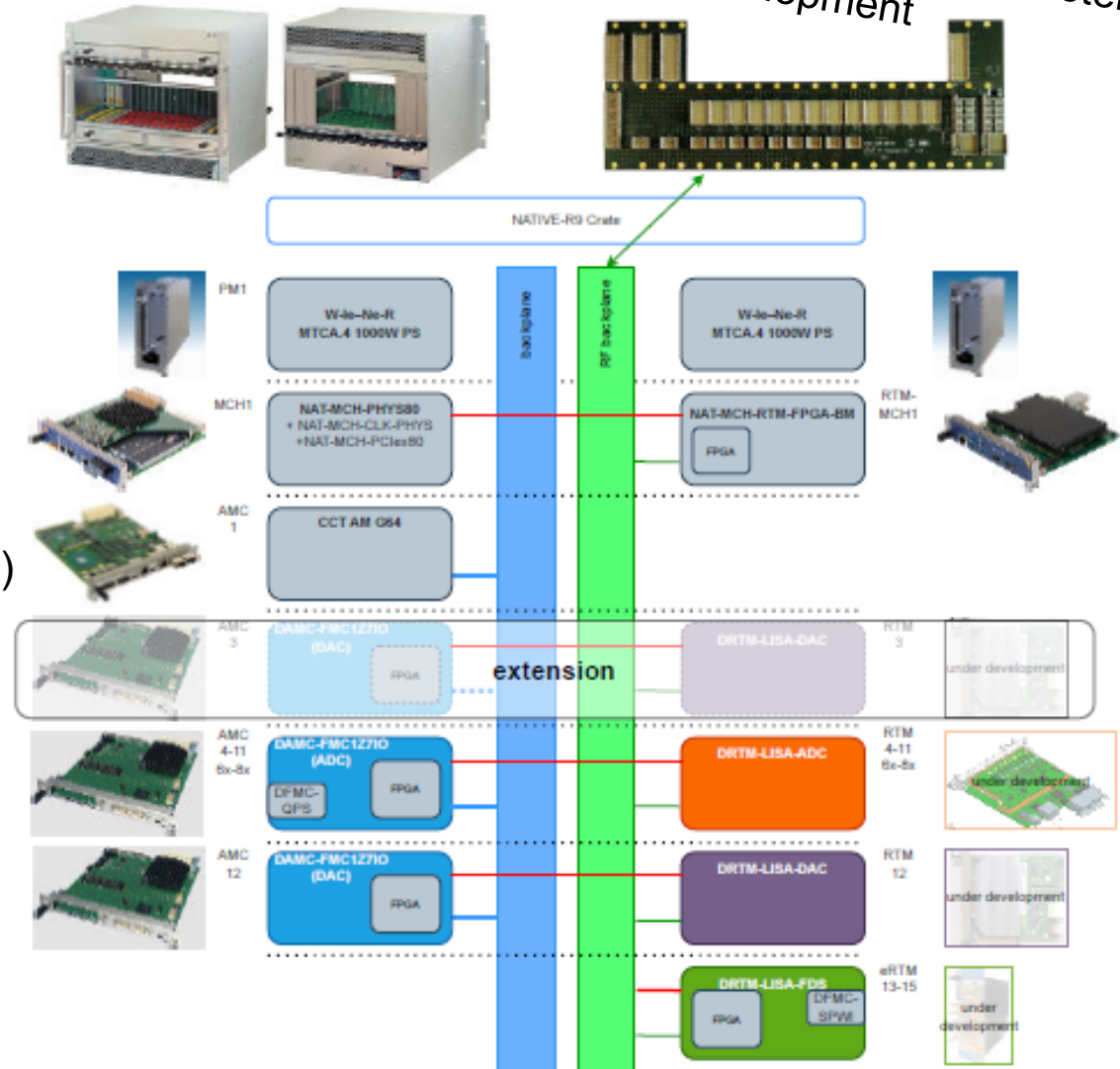
O. Geberding



Precision ADC
Temp. stab.
1mK/sq(Hz)

- AMC mainly COTS components (base FMC1Z7IO)
- RTM high performant, application specific
- Uses RF-backplane & eRTM

Not the flight hardware
Platform for phasemeter
development

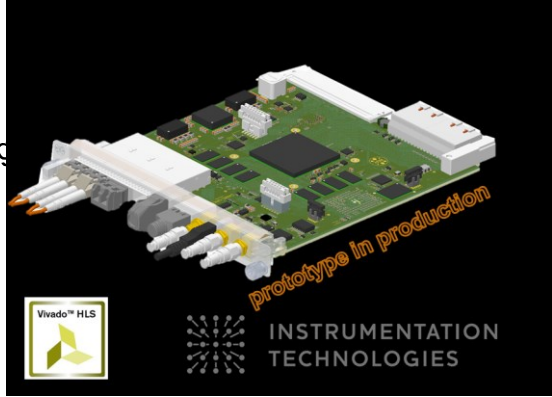


New board devel. from institutes...

ELT (astrophysics)



@Michael Fenner (DESY) [see talk](#)

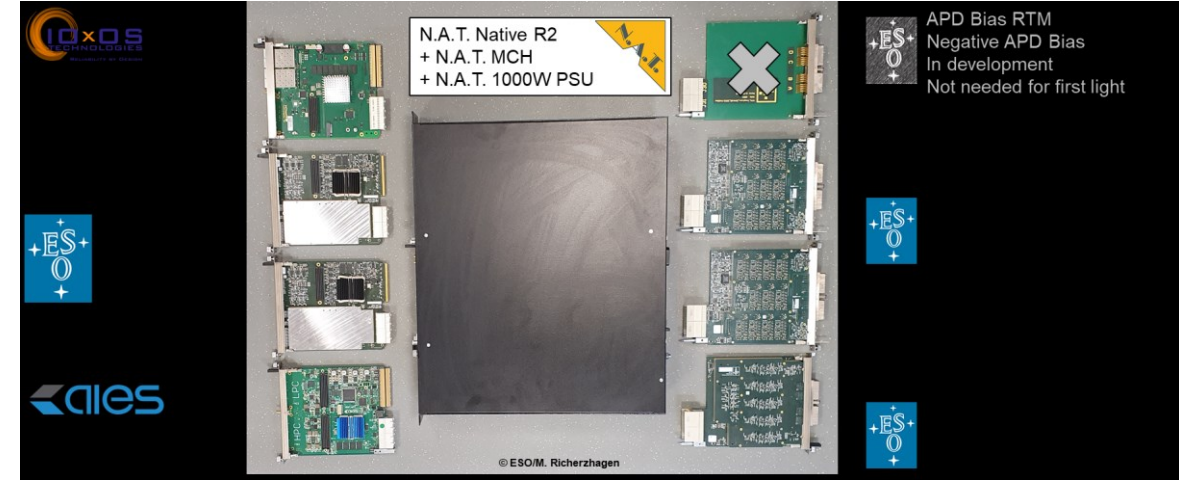


@Rene Gessler (GSI)



Current to freq. converter

@Mathias Richerzhagen (ESO)



@M. Tolkiehn (DESY) [see talk](#)



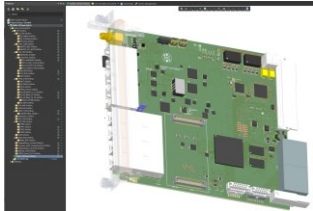
Energy dispersive X-ray detectors

@Jie Zhang (IHEP) [see on talk Friday](#)

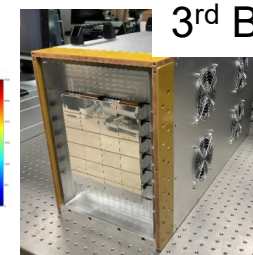
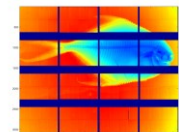


HEP/HEPS experiments

@H. Lippek (DESY)



[See talk Randall \(DESY\)](#)



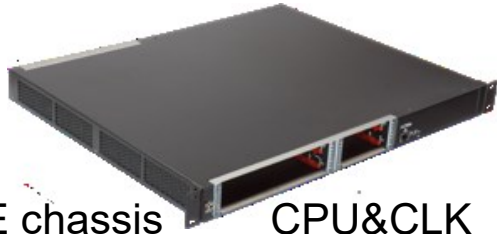
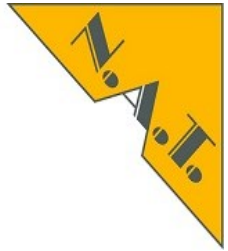
3rd BRIX → 4th BRIX



Front-end for detectors

New products from companies...

NATIVE Server-R1

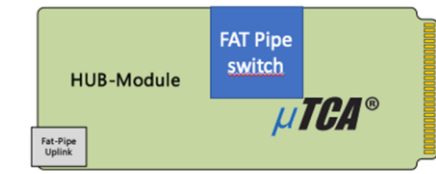


1HE chassis CPU&CLK
(4 AMC/2 RTM, 40GT/sec)

NAT-MCH-Gen4

Fat-Pipe HUB Modules

- 1/10/40 GbE
- PCIe x48/x80 Gen 3-5
- Fat-Pipe Uplink options



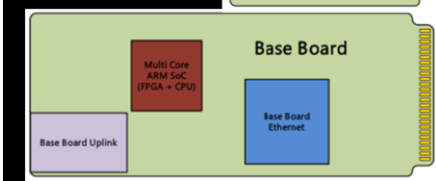
Clock-Module (IEEE 1588)

- With /without OXCO



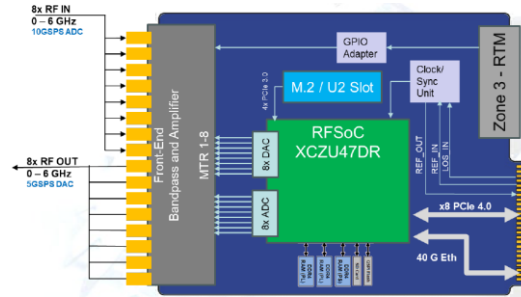
Base Board

- Multi Core ARM SoC
- Base Board Ethernet
- Base Board Uplink



→ See talk from Alex Mao

See talk from Jiaoni Bai ←



RFSoc AMC



IFC



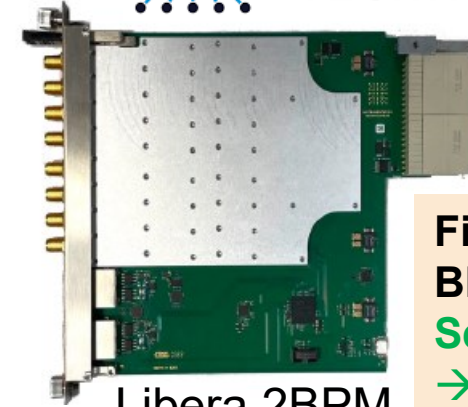
Xilinx WR support



ORCA-Quest qCMOS camera C-15550-20UP



INSTRUMENTATION TECHNOLOGIES

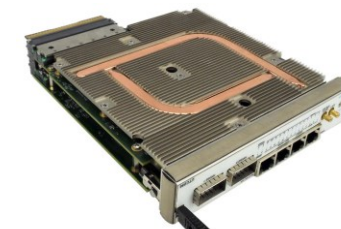


Libera 2BPM

First MicroTCA BPM for SR rings
See talk
→ M. Cargnelutti



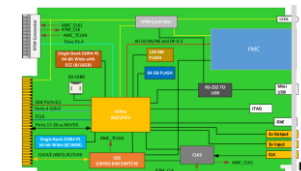
MCH Gen5



RFSoc AMC



Next gen. Chassis



AMD XCZU7EV D1.4
+ div. FMC

Update from PICMG



Open Modular
Computing
Standards



Founded 1994 as a non-profit consortium

- Focus on open standards for embedded computing
- ~ 140 members companies



Open Standards encourage innovation and differentiation amongst multiple vendors
– interoperability is key

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PICMG* [PCI INDUSTRIAL COMPUTER MANUFACTURER'S GROUP]

MICROTCA NEXT GENERATION

Potential elements:

- 100Gb Ethernet
- PCIe GEN5
- Overcome 80 W AMC limitation
- Increase power / slot
- Backward compatibility

Technical working group members

Amphenol
Atom Computing*
BAE
Comtel
DESY
Embeck
ept
ESS
MicroLab*
N.A.T.
nVent
powerBridge
Samtec
University of Lodz
VadaTech
W-IE-NE-R Power

Jess Isquith

PICMG, President

jess@picmg.org



Chinese Inst. missing...!!!

Previously IHEP was
working group member
(member of PICMG?)

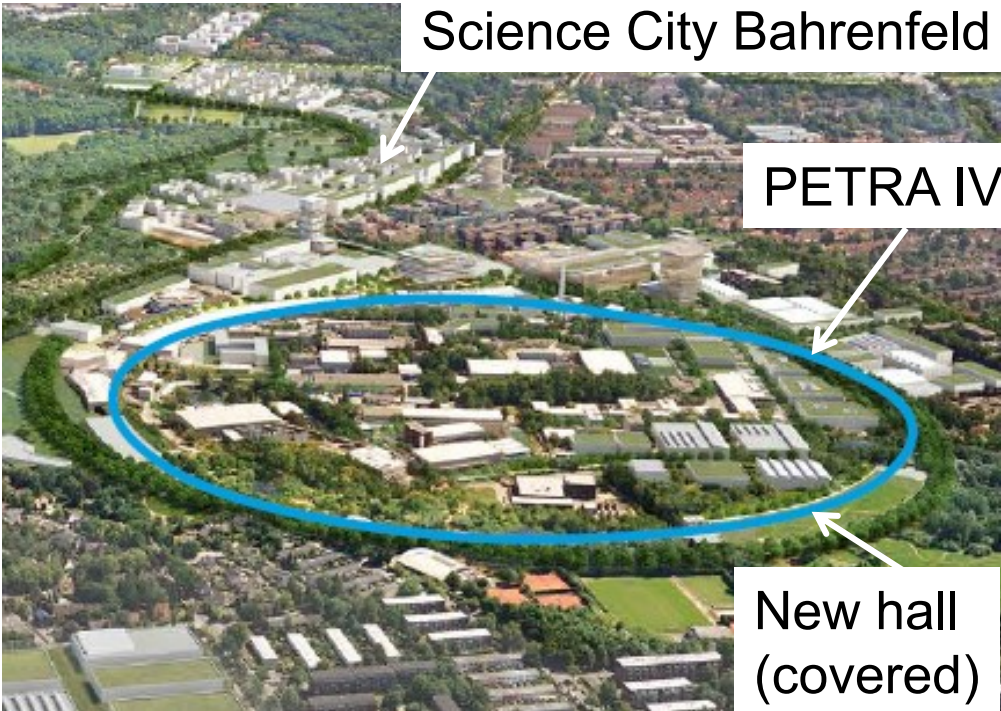
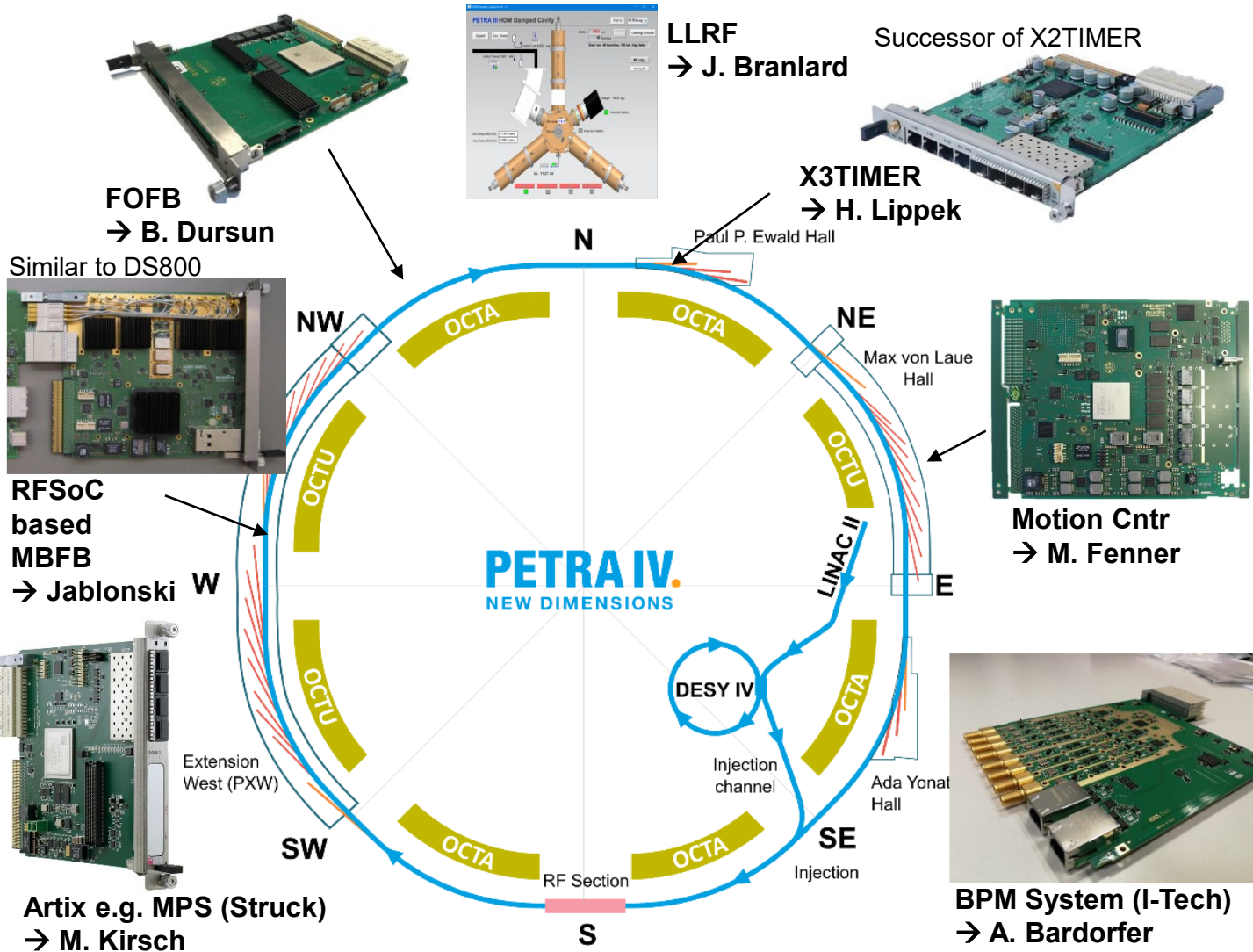
Accelerator and Project at DESY @ Tim Wilksen (Controls)

User Facilities FELs and Synchrotron + Test Facilities and ARD Projects



Quick overview of MicroTCA Modules for PETRAIV

Hardware portfolio PETRAIV (incomplete)



Take away from 12th MicroTCA Workshop

➤ Indispensable for building network:

- Get known to each others... who is who
- Exchange solutions and idea's
- Innovative space ...

Almost familiar atmosphere

➔ **Cross-discipline synergies**

➤ Keep format (~ 2 keynotes / short compact talks but many ~40)

➤ Tutorial tracks & special session $\Sigma \sim 80$

➤ Increasing attention to

- *SW/FW frameworks*
- *Deployments & maintenance tools*

➔ *Becomes new bond*

➤ Education of young engineers & scientists

➤ Unique interplay between research & industry

➤ Next generation MicroTCA

x4 ↻

Chair: Kai Rehlich



PCI Express version	Introduced	Line code	Transfer rate	Throughput (simplex)		
				x1	x2	x4
1.0	2003		2.5 GT/s	250 MB/s	0.50 GB/s	1.0 GB/s
2.0	2007	8b/10b	5.0 GT/s	500 MB/s	1.0 GB/s	2.0 GB/s
3.0	2010		8.0 GT/s	985 MB/s	1.97 GB/s	3.9 GB/s
4.0	2017	128b/130b	16.0 GT/s	1969 MB/s	3.94 GB/s	7.9 GB/s
5.0	2019	128b/130b	32.0 GT/s	3938 MB/s	7.88 GB/s	15.8 GB/s
6.0	In preparation	PAM4	64.0 GT/s	~7800 MB/s	~15.7 MB/s	~31.4.8 GB/s

+ 110/200 W per slot and 100Gb Ethernet



Next workshop date:

10-12.12.2024

(Tu-Th)

Thank you for your attention