Institute of Electronic System WUT

involvement in studies of plasma physics and fusion research programme

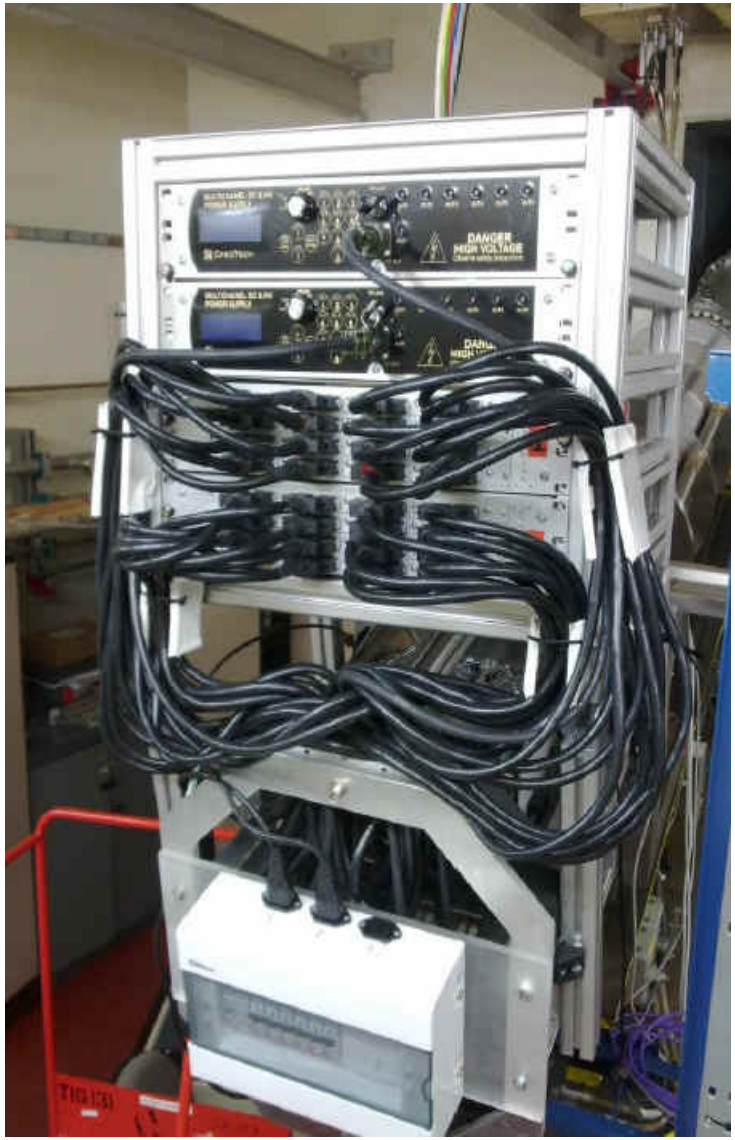
- ELHEP laboratory activities:
  - EFDA, JET Tokamak, Culham - plasma inpurity measurement system – X-ray spectrometer at KX1 for W(Tungsten) and Ni (Nickel) based on GEM detectors
  - CCFE, MAST tokamak, Culham – control and monitoring upgrade for superconductor magnets
  - CEA, WEST tokamak, Cadarache - Development of soft X-ray GEM based detecting system for tomographic tungsten focused transport monitoring

ELHEP staff & area of interest

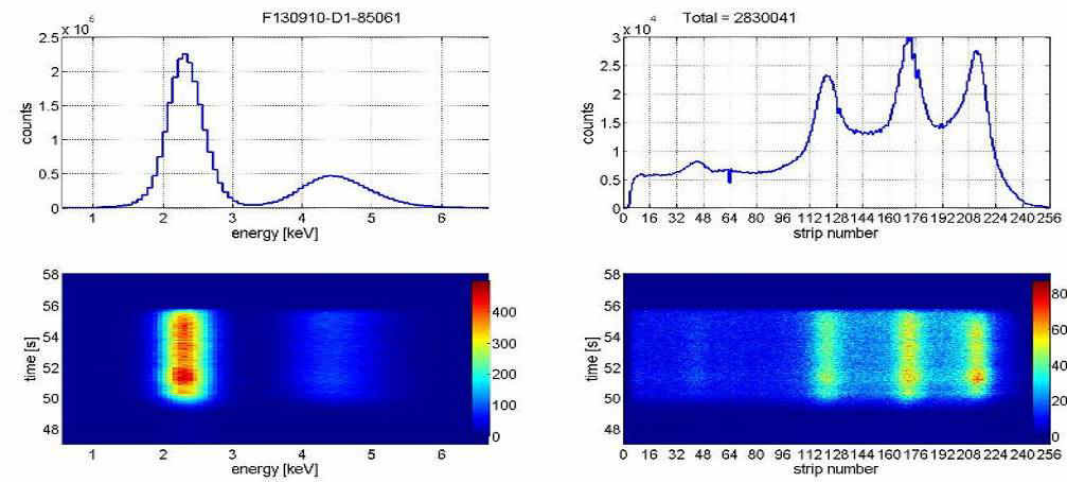
- Krzysztof Poźniak, DsC, PhD, Head – FPGA firmware, HEP metrology
- Wojciech Zabołotny, PhD – FPGA & DSP implementation
- Grzegorz Kasprowicz, PhD – fast & multichannel hardware designer
- Andrzej Wojeński, PhD – FPGA & embedded systems specialist
- Rafał Krawczyk, PhD – uP & DSP high performance computing
- Maciej Linczuk, PhD – DSP algorithms
- Paweł Linczuk, PhD stud. – uP high performance systems & interfaces
- Michał Gąska, PhD stud. – control & monitoring system
- Piotr Kolasiński, PhD stud. – FPGA firmware
- Radosław Cieszewski, PhD stud. – HLS for FPGA, C/C++ specialist
- >10 BSc and MSc students

- *FPGA technologies* – hardware & firmware design, multi-FPGA systems
- *DSP technologies* – uP-DSP & FPGA-DSP designs, real-time algorithms
- *Optoelectronic* – multi Tbps synchronous data transmission
- *PCB design* (multi GHz) – multilayer EMC/SI verified and tested
- *Hardware testing* – EMC/SI simulation and measurements

T-GEM system on KX1 at JET tokamak



2 GEM system installation

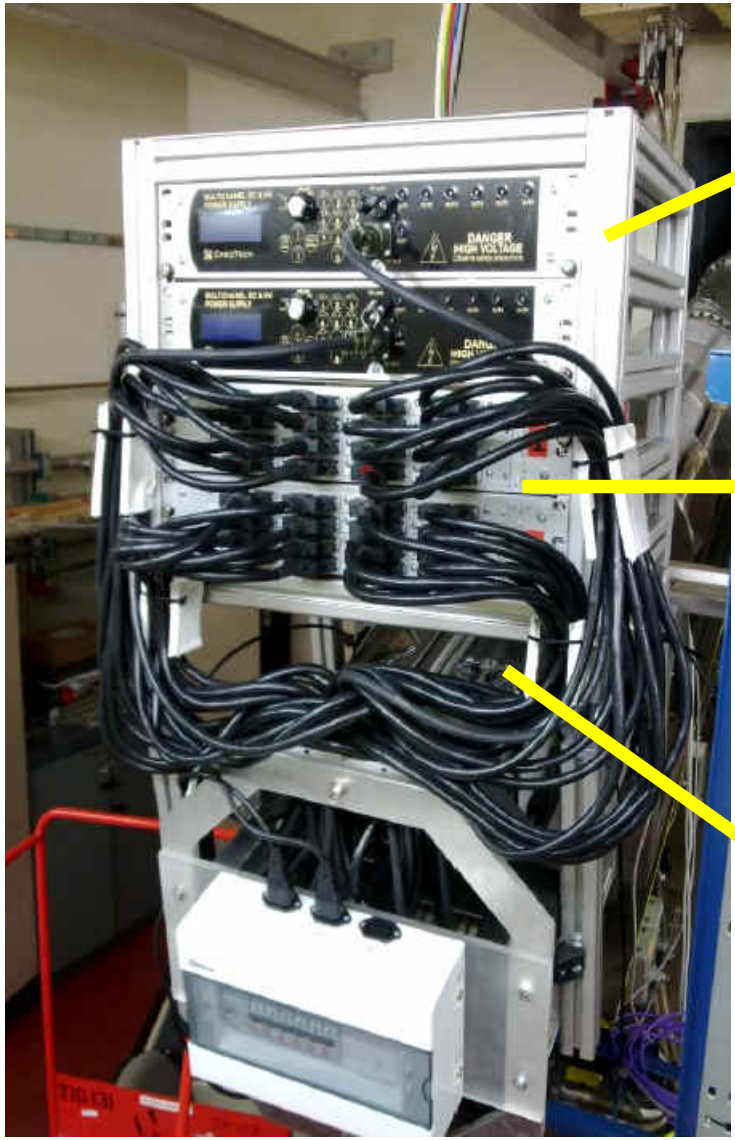


Exemple of result -Tungsten spectrum evolution in time (resolusion 10 ms)

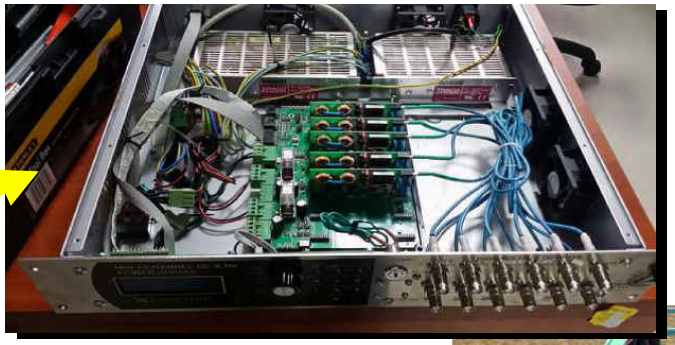
Parameter name	Unit	Count
Channel number	#	256
Analog signal probe frequency	MHz	77.78
Digital signal size	bits	10
Minimum histogramming time	s	0.01
Maximum histogram measures (for 512 charge levels)	#	2000
Maximum histogram measures (for 256 charge levels)	#	4000
Maximum histogram measures (for 128 charge levels)	#	8000

System basic specification

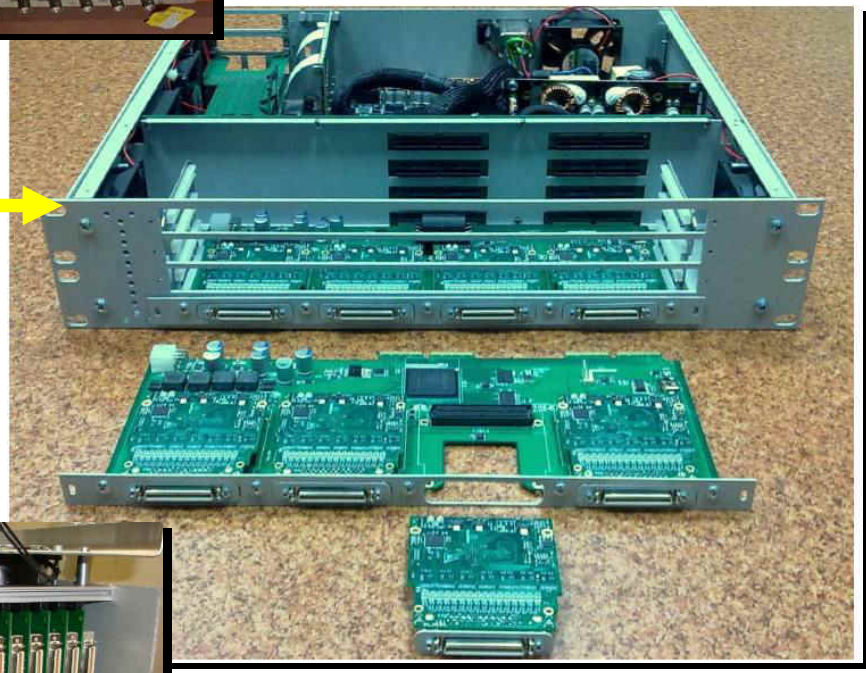
T-GEM system on KX1 at JET tokamak



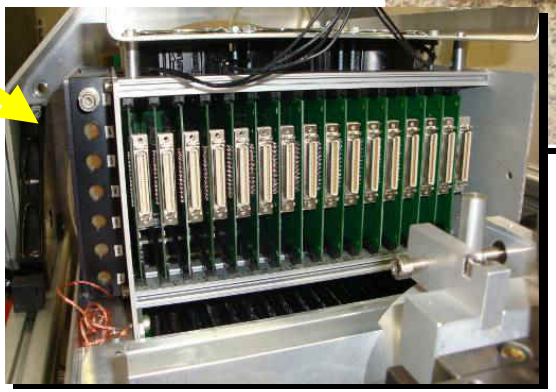
2 GEM system installation



7-ch. programmable HV
& ±5V power supply

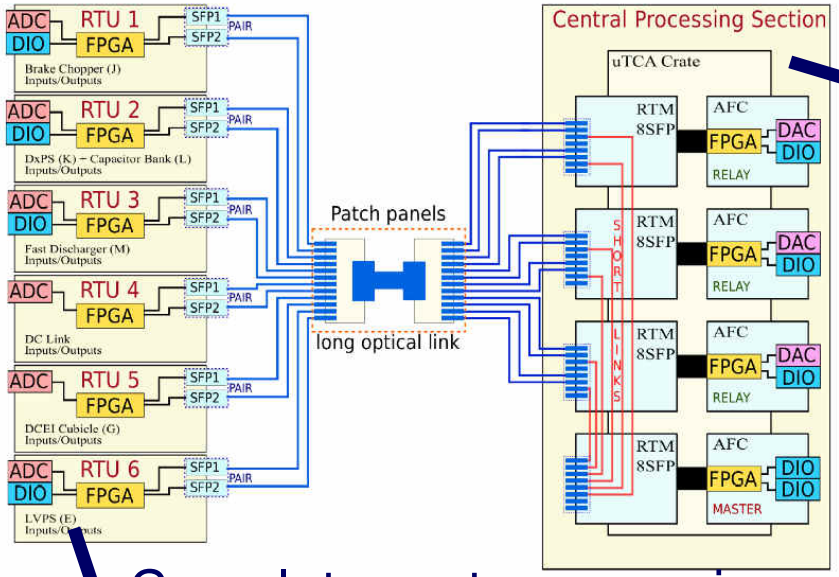


FPGA based modular
digital system

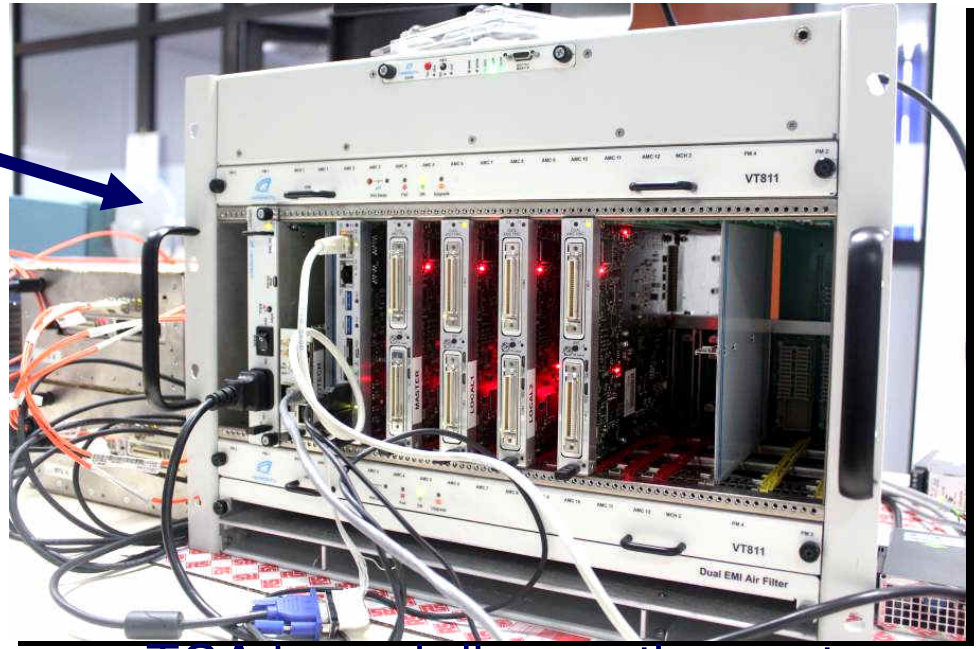


T-GEM & analog FEBs

Diagnostic system for MAST tokamak



Complete system overview



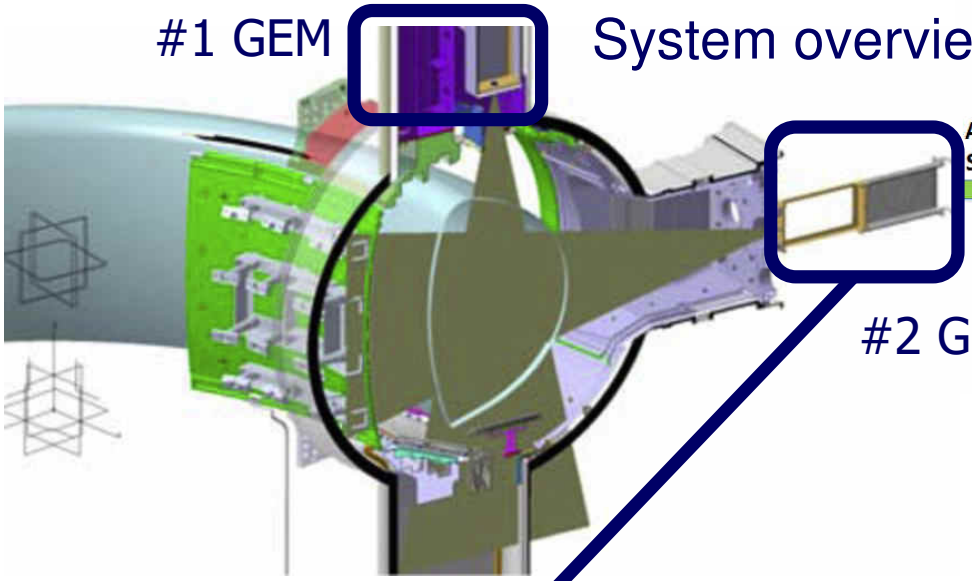
uTCA based diagnostics system

High voltage diagnostic system

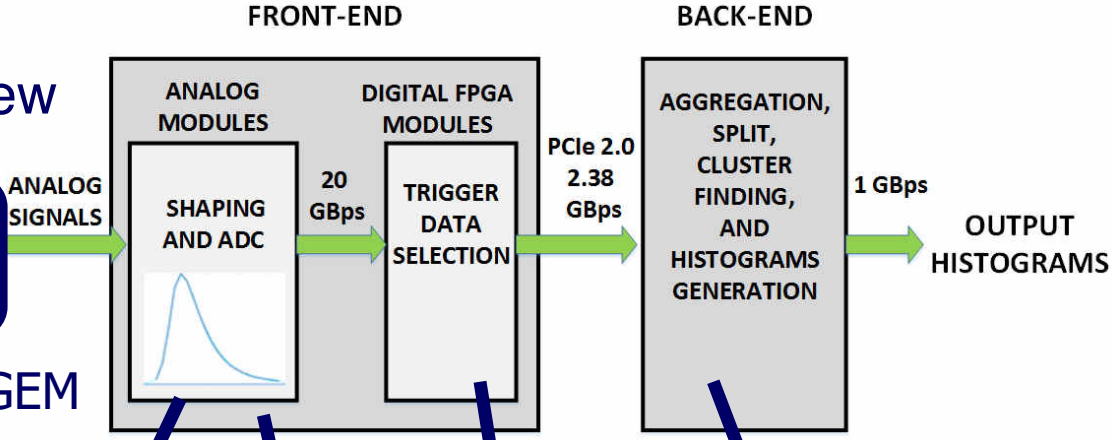
Tungsten topographic for WEST tokamak

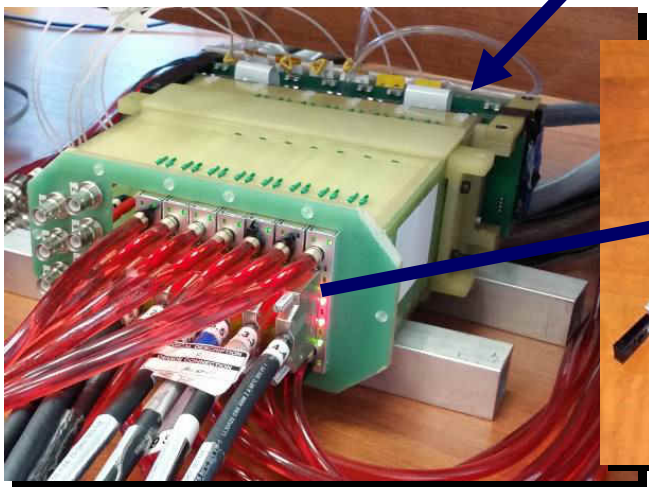
#1 GEM

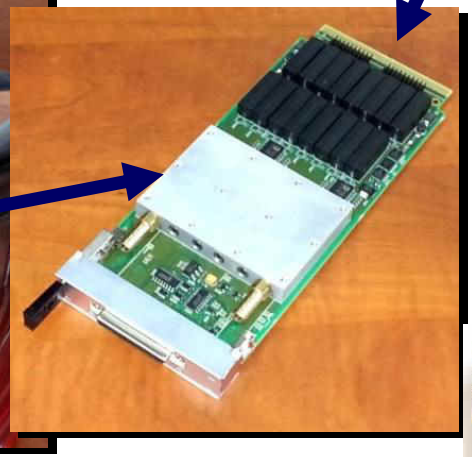
System overview



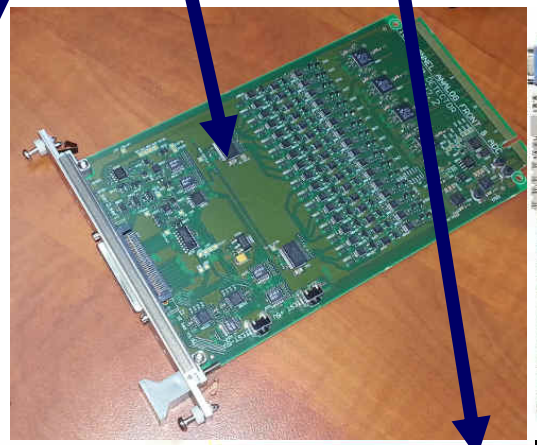
#2 GEM

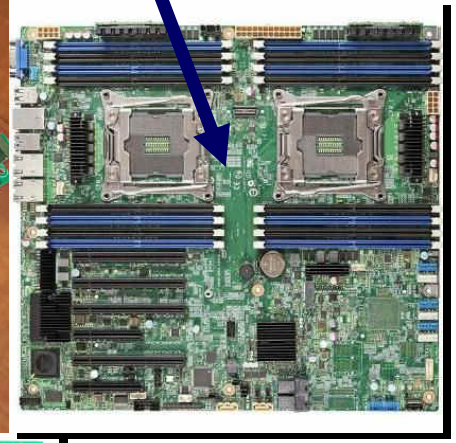


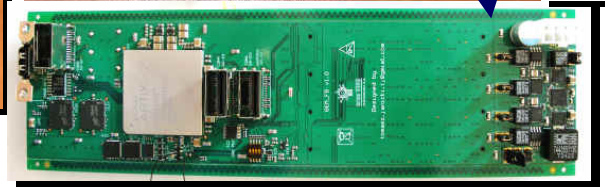




T-GEM & analog FEBs







FPGA & PC based digital system

Tungsten topographic for WEST tokamak

Parameter	Hardware histogramming system	Serial acquisition system (new system, under design)
# channels	256	**Up to 2048 (512 per one PCI-E switch per one PCIe slot)**
Sampling freq.	77.78 MHz	**50.0 - 125.0 MHz**
Samples resolution	10 bits	**14 bits**
Min. time of histrogramming	10 ms	**1 ms** or **continuous-time acquisition mode**
Strip charge rate	About 2 MHz	**About 5 MHz**
Used FPGA	21 Xilinx Spartan6	**4 newest Xilinx Artix7 (256 ch)**
Type of GEM detector	1 dimensional, based on stripes	1D, 2D, **different readout structures** (XY, YUV)
Measurement mode	Analog current-to-voltage mode	**Fast hybrid integrator, direct sampling or fast discriminator**
System control	Software based on C/Python	**FCS + C++ readout software**
Data channels	PCI-Express, fast serial links	**PCI-Express, Gigabit transcievers**
Other features	Modular, flexible construction	**Synchronization interface**
	FMC standard	**Tree structure, easy to extend**