



***12th IAEA Technical Meeting  
on Control, Data Acquisition  
and Remote Participation  
for Fusion Research***

**NFRI, Daejeon, Korea  
May 13-17, 2019**

**SUMMARY**

# 12th IAEA TM CODAC

was held in Daejeon, Korea 2019, hosted by the NFRI under the auspices of the IAEA

- In total seventy (70) contributions were finally presented
  - 32 oral talks were given on plenary floor
  - 38 concise mini-orals introduced poster contributions in plenary
- Monday: 8 & 11 on „CODAC systems - adaptations & upgrades“
- Tuesday: 8 & 6 on „Recognition & Reaction“
- Wednesday: 11 & 9 on Databases, Machine Control & DAQ Strategy
- Thursday: 5 & 9 on DAQ & Remote Participation / Virt. Laboratory

# IAEA TM CODAC 2019 Programme Table

Monday				Tuesday				Wednesday				Thursday				Friday
Chair: Sang-hee Hahn				Chair: Hideya Nakanishi				Chair: Kerl Behler				Chair: Josh Stillerman				MDSplus Workshop
Welcome				Plenary Oral: Neural Network Methods				Plenary Oral: MCR & DTI				Plenary Oral: DASP				
Time	Board	ID	Presenter	Time	Board	ID	Presenter	Time	Board	ID	Presenter	Time	Board	ID	Presenter	
09:00	W/1-1		Matteo Barbarino	09:00	O/3-1	513	Ernesto Fabregas Acosta	09:00	O/5-1	529	Basil Duval	09:00	O/8-1	490	Miguel Astrain	
09:05	W/1-2		Sang-hee Hahn	09:20	O/3-2	484	Jesús Vega	09:20	O/5-2	503	Masahiko Emoto	09:20	O/8-2	508	Seung-Ju Lee	
09:10	W/1-3		Karl Behler	09:40	O/3-3	456	Wei Zheng	09:40	O/5-3	523	Hideya Nakanishi	09:40	O/8-3	522	Karl Behler	
Chair: Sang-hee Hahn				Chair: Hideya Nakanishi				Chair: Kerl Behler				Chair: Josh Stillerman				
Plenary Oral: Control Systems				Minioral: KI related Miniorals								Minioral: DASP				
Time	Board	ID	Presenter	Time	Board	ID	Presenter					Time	Board	ID	Presenter	
09:20	O/1-1	528	Mikyung Park	10:00	P/2-1	543	Fan Xia					10:00	P/4-1	539	Gamal Elaragi	
09:40	O/1-2	488	Bingjie Xiao	10:05	P/2-2	582	Rodrigo Castro Rojo					10:05	P/4-2	541	Hanmin Wi	
10:00	O/1-3	443	Jasraj DHONGDE	10:10	P/2-3	548	Qiqi Wu					10:10	P/4-3	546	Sergio Esquembri	
10:20	O/1-4	531	John Waterhouse	10:15	P/2-4	572	Miguel Astrain					10:15	P/4-4	553	Biao Shen	
				10:20	P/2-5	579	Taeju Lee	10:00	O/5-4	445	Mykola Dreval	10:20	P/4-5	560	Miguel Astrain	
				10:25	P/2-6	593	Fernando Santoro	10:15	O/5-5	510	Adriano Luchetta	10:25	P/4-6	588	Alexandr Chernakov	
												10:30	P/4-7	538	Jie Xu	
Coffee Break																
Chair: Mikyung Park				Chair: John Waterhouse				Chair: Adriano Luchetta				Chair: Axel Winter				
Plenary Oral: Plasma Control 1				Plenary Oral: Plasma Control 2				Plenary Oral: PCS, MCR & DTI				Plenary Oral: RPVL				
Time	Board	ID	Presenter	Time	Board	ID	Presenter	Time	Board	ID	Presenter	Time	Board	ID	Presenter	
11:10	O/2-1	511	Sang-hee Hahn	11:00	O/4-1	459	Zhenqping Luo	11:00	O/6-1	441	Pablo Garcia-Martinez	11:05	O/9-1	468	Shinsuke Tokunaga	
11:30	O/2-2	497	Martin Margo	11:20	O/4-2	518	Bernhard Sieglin	11:20	O/6-2	471	Filip Janky	11:25	O/9-2	483	Igor / Oleg Semenov	
11:50	O/2-3	466	Qiping Yuan	11:40	O/4-3	527	Keith Erickson	11:40	O/6-3	524	Joshua Stillerman	Chair: Axel Winter				
12:10	O/2-4	482	Gabriele Manduchi	12:00	O/4-4	530	Muhammad Aqib Javed	12:00	O/6-4	498	Stephen Lane-Walsh	Minioral: RPVL				
				12:20	O/4-5	485	Benjamin SANTRAIINE					Time	Board	ID	Presenter	
												11:45	P/5-1	561	Ernesto Fabregas	
												11:50	P/5-2	567	Gabriele Manduchi	
												11:55	P/5-3	592	Thierry Hutter	
Lunch Break																
Chair: Bingjie XIAO				KSTAR Visit				Chair: Wanderley Pires de Sá				Poster Session 3				
Minioral: Plasma Control Miniorals								Plenary Oral: DASP Systems								
Time	Board	ID	Presenter					Time	Board	ID	Presenter					
14:00	P/1-1	535	Myungkyu Kim					14:00	O/7-1	457	Yuxing Wang					
14:05	P/1-2	569	Gilles CAULIER					14:20	O/7-2	451	Axel Winter					
14:10	P/1-3	580	June-Woo Juhn					Chair: Wanderley Pires de Sá								
14:15	P/1-4	585	Giwook Shin					Minioral: FNT, MCR & DTI								
14:20	P/1-5	589	Graham McArdle					Time	Board	ID	Presenter					
14:25	P/1-6	605	Arie Tamman					14:40	P/3-1	551	gill kwon					
14:30	P/1-7	599	Alessandro Santos					14:45	P/3-2	559	Hirofumi Yonekawa					
14:35	P/1-8	576	Wanderley Pires de Sá					14:50	P/3-3	571	Jörg Schacht					
14:40	P/1-9	537	B LI					14:55	P/3-4	566	Reinhard Vilbrandt					
14:45	P/1-10	558	Ondrej Kudlacek	15:00	P/3-6	587	Riho Yamazaki									
14:50	P/1-11	573	Siamak Mohammadi	15:05	P/3-7	578	Chungsan Lee									
14:55	P/1-12	598	Gustavo Canal	15:10	P/3-8	590	Michael Grah									
15:00	P/1-13	547	Gediminas Stankunas	15:15	P/3-9	556	Feng WANG									
								15:20	P/3-10	569	Gilles CAULIER					
Coffee service								Coffee service				Coffee service				
Poster Session 1				KSTAR Visit				Poster Session 2				Chair: Matteo Barberino				
												Plenary Summary end Closing				
												Time	Board	ID	Presenter	
												16:00	S/1-1		Summary	Karl Behler
16:30	S/1-2		Outlook	Matteo Barberino												
16:50	S/1-3		Farewell	Sang-hee Hahn												

# Monday: Research on CODAC Systems

8 orals, 11 minis about CODAC system adaptations & upgrades

- ITER Operation Application System (commissioning)
- JET & MAST research for ITER and MAST Plasma Control System Upgrade plans
- EAST research for CEFTR and more about heat-flux PC in EAST
- WEST CODAC evolution<sup>(Tuesday)</sup> and more about WEST-Box<sup>(held on Wednesday)</sup>
- KSTAR PC long-pulse high-performance, FIS, L&H and ELM classific.
- DIII-D PCS state
- HL-2M first plasma campaign preparation to be happen in middle of 2020
- TCABR<sup>(three contributions)</sup> and TT1 developments for small Tokamaks
- JET Bolometer Tomographie for DT Baseline
- ASDEX Upgrade effective management of actuators for various control purpose

# Trends in Plasma Control ???

Control Systems are mostly LINUX based real-time systems using fast & up-to-date commodity networks (10 Gbps, 40 Gbps; eXtreme or InfiniBand)

Hardware goes NI-PXI or FPGA of the shelf, sometimes DTACQ.

Latency is still an issue as requirements rise – FPGAs as solution?

Timing goes IEEE 1588 PTP (beside many other legacy solutions)

Integration of Control & DAQ

(MARTe2 & MDSplus, EAST, WEST, ITER, ASDEX Upgrade)

# Tuesday: Recognition and Reaction

3 Orals about Neural Network algorithms

- To recognize anomalies (Ciemat)
- For disruption prediction (J-TEXT)

3 Minis on „big data“, „deep learning“, intelligent „decimation“

2 Minis on FPGA and GPGPU applications

1 Mini on MDSplus custom DAQ and JupyterLab analysis

# Tuesday: specific solutions for PCS

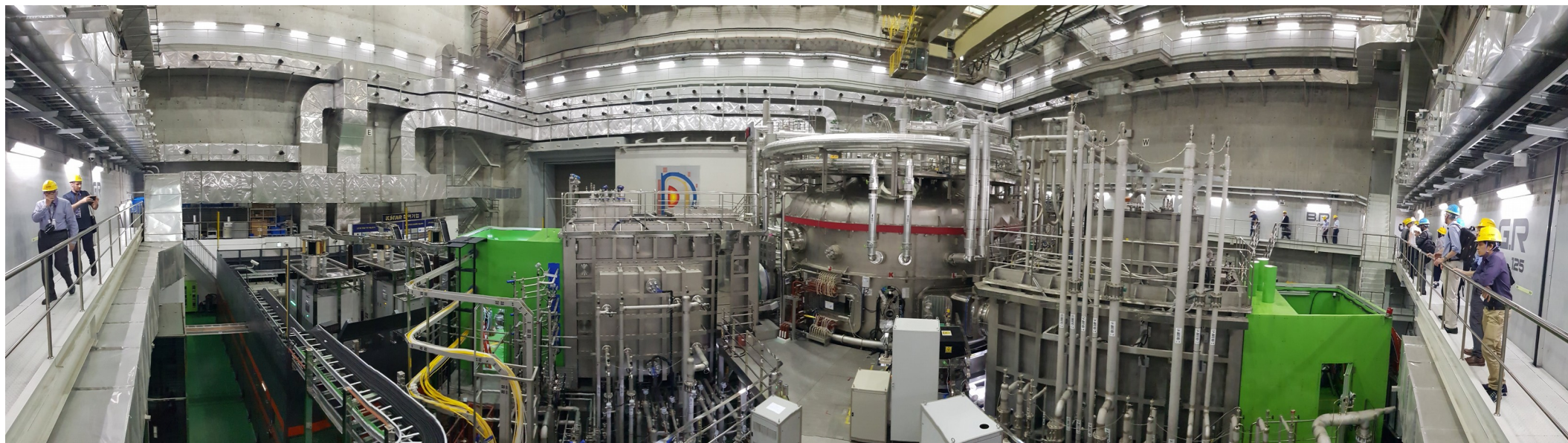
3 more orals on

- Fast Scenario Design for QSF divertor configuration (EAST)
- Rapid Prototyping of DCS Algorithms (Asdex Upgrade)
- FPGA based low latency DAQ and data processing (PPPL)

2 more orals for specific situations

- A Start-Up CODAC system for GLAST
- Cost Optimized Timing for SST1<sup>(Monday)</sup>

# KSTAR Visit





# Wednesday: Databases, Archives, Control, Monitoring, Safety

## 9 orals in the morning (summary after a glass of wine or two)

- ¿ Asynchronous event driven state machines / state driven event machines ?
- Adaptation of post # analysis from LHD to KSTAR
- „Ping“ the network distance for multi-site data repositories
- Control/interlock development dedicated to special purposes (NPA, MITICA)
- YAES – yet another equilibrium solver (sophisticated MHD)
- Fenix tries flying out of the ashes of discharge design
- It's hopeless to navigate metadata – but never stop trying
- Put MDSplus into a container to ship it anywhere

# A more serious view onto the morning session

## Heterogeneous session including four papers: 1xPC, 1xMCR, 2xDTI

- O/6-1 Garcia – Martinez: A new algorithm to include the equilibrium condition in control oriented transport simulations has been developed, which is robust and reasonable efficient. The paper contributes to modelling activity for large tokamaks.
- O6/2 Janky: The work presented in the paper is an effective step forward in fast simulation of tokamak discharges. It implements a wide variety of control models and the realization of many others is planned for the near future. Validation of results is very promising. The system is a perfect candidate for both for pre-pulse simulation and for pulse set-up support.
- O6/3 Stillerman: Personal and interesting view on how relationships between data and metadata can be described, captured and navigated. The speaker presented an implementation currently used at MIT PSFC. The tool is continuously improving thanks to user feedback. It aims to provide a set of general guidelines for describing metadata relationships and help scientists optimize their conceptual work.
- O/6-4 Lane-Walsh: The speaker proposes splitting MDSplus components into separate dockerized ones. The advantage of the approach is that no preparation and installation is required to run the MDSplus components because the docker image already contains all libraries and settings that are required to run the components. Such an approach may provide a significant boost in the usability of MDSplus.

# Wednesday: DAQ Strategies & various miniorals

## **2 more orals in the afternoon**

- Web-technologies All-In-One for J-TEXT
- Strategies to standardize Diagnostics under CoDaC architecture W7-X

## **and 9 miniorals**

- 2x KSTAR real-time & security processing systems
- 3x W7-X on Safe Operation, Fast Interlock, & Logbook
- Experiment Database for JT-60SA
- Local power supply controller for ITER
- EAST MDSplus log data
- WEST-Box

# Thursday: more about DAQ & Signal Processing

## 3 orals

- A crash course on FPGA possibilities for DAQ & Processing
- ADC & GPU architecture for Thomson Scattering DAQ & Analysis  
(including a 5 GHz ADC concept for Thomson Scattering)
- A universal FPGA based DAQ concept for diagnostics at AUG  
(including a 1 GHz ADC concept for Thomson Scattering)

## 7 miniorals

- 2x DAQ with nominal device support (Spain)
- R-T MSE diagnostic @KSTAR
- Video plasma boundary reconstruction @EAST
- LabBot framework & another 5 GHz ADC for Thomson Scattering

# Thursday: Remote Participations Centres & Tools

## 2 orals

- Rokkasho experimenting at WEST with 200ms latency / 3 firewalls
- A large video wall to look at ITER from Russia

## 3 miniorals

- Web-Socket based interactive remote data analysis & visualization
- Web-Based waveform display with MDSplus & Node.js
- Tools provided by WEST for remote experiment control

# Outcome of the IPAC Meeting

- FPGA and GPU methods widely adopted
- Neural Network, Deep Learning materializing
- Small devices presenting their efforts expands community & and fosters newcomers in the field

# Publication in FusEngDes

- A selection of papers from this meeting will be published as a Virtual Special Issue (VSI) in the Elsevier Journal „Fusion, Engineering, and Design“
- They will be peer reviewed by experts from our meeting and others.
- Contact with Elsevier was already made and the editor in chief Mohamed Abdou agreed to publish our VSI. A board of 3-5 members out of our IPAC will act as guest editors for this VSI.
- Expect an announcement shortly after this meeting by email. The submission deadline will at least allow six weeks to finish papers.
- **Please refer to prior work carefully. A long row of FusEngDes Special Issues from our former meetings is available to draw from.**

# Farewell, Thank You, & CU in Two Years

in Culham, UK

as UKAEA opted for hosting the next meeting

Matteo Barbarino (IAEA)

Sang-hee Hahn (NFRI)