

### 12th IAEA TM CODAC

# was held in Daejeon, Korea 2019, hosted by the NFRI under the auspicies 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. Labratory

# IAEA TM CODAC 2019 Programme Table

		Monday				Tuesday				Wednesd				Thursday		Friday
		Chair:	Sang-hee Hahn			Chair:				Chair:	Karl Behler			Chair:	Josh Stillerman	
		Welcome					etwork Methods			ary Oral: N				enary Oral		
me	Board	ID	Presenter	Time	Board	ID	Presenter	Time	Board	ID	Presenter	Time	Board	ID	Presenter	
:00	W/1-1		Matteo Barbarino	09:00	0/3-1	513	Ernesto Fabregas Acosta	09:00	0/5-1	529	Basil Duval	09:00	0/8-1	490	Miguel Astrain	
9:05	W/1-2		Sang-hee Hahn	09:20	0/3-2	484	Jesús Vega	09:20	0/5-2	503	Masahiko Emoto	09:20	0/8-2	508	Seung-Ju Lee	
:10	W/1-3		Karl Behler	09:40	0/3-3	456	Wei Zheng	09:40	0/5-3	523	Hideya Nakanishi	09:40	0/8-3	522	Karl Behler	
		Chair:				Chair:		10:00	0/5-4	445	Mykola Dreval			Chair:	Josh Stillerman	
	Plenary Oral: Control Systems				Minioral: KI related Miniorals				10:15 O/5-5 510 Adriano Luchetta			Minioral: DASP			MDSplus Workshop	
ne	Board	ID	Presenter	Time	Board	ID	Presenter					Time	Board	ID	Presenter	
:20	0/1-1	528	Mikyung Park	10:00	P/2-1	543	Fan Xia					10:00	P/4-1	539	Gamal Elaragi	
:40	0/1-2	488	Bingjia Xiao	10:05	P/2-2	582	Rodrigo Castro Rojo					10:05	P/4-2	541	Hanmin Wi	
:00	0/1-3	443	Jasraj DHONGDE	10:10	P/2-3	548	Qiqi Wu					10:10	P/4-3	546	Sergio Esquembri	
:20	0/1-4	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	Taegu Lee					10:20	P/4-5	560	Miguel Astrain	
				10:25	P/2-6	593	Fernando Santoro					10:25	P/4-6	588	Alexandr Chernakov	
								_				10:50	P/4-7	538	Jie Xu	
							Coffee	break								
		01.0			-	Chair:	John Waterhouse		-	Chair:	Adriano Luchetta			- CI -		
		Chair:		-			ma Control 2	-			, MCR & DTI			Chair:	Axel Winter	
			ma Control 1	Time	Board	ID	Presenter	Time	Board	ID	Presenter	-		enary Ora		
ne	Board	ID	Presenter	11:00	0/4-1	459	Zhengping Luo	11:00	0/6-1	441	Pablo Garcia-Martinez	Time	Board	ID	Presenter	
10	0/2-1	511	Sang-hee Hahn	11:20	0/4-2	518	Bernhard Sieglin	11:20	0/6-2	471	Filip Janky	11:05	0/9-1	468	Shinsuke Tokunaga	
30	0/2-2	497	Martin Margo	11:40	0/4-3	527	Keith Erickson	11:40	0/6-3	524	Joshua Stillerman	11:25	0/9-2	483	Igor / Oleg Semenov	
50	0/2-3	466	Qiping Yuan	12:00	0/4-4	530	Muhammad Aqib Javed	12:00	0/6-4	498	Stephen Lane-Walsh			Chair: Minioral:	Axel Winter	
:10	0/2-4	482					Benjamin SANTRAINE									
	5/2 4	702	Gabriele Manduchi	12:20	0/4-3	485	Denjamin SANTRAINE					Time 11:45	Board P/5-1	ID 561	Presenter Ernesto Fabregas	
	5/2 4	700	Gabriele Wariouchi	12.20	0/4-3	403							Board	ID	Presenter	
	0,24			12.20	0/4-3	403	Lunch	Break				11:45 11:50	Board P/5-1 P/5-2	ID 561 567	Presenter Ernesto Fabregas Gabriele Manduchi	
		Cheir:	Bingjis XIAO	12.20	0,4-3	403		Break			Wanderley Pires de Sá	11:45 11:50	Board P/5-1 P/5-2	ID 561 567	Presenter Ernesto Fabregas Gabriele Manduchi	
	Minioral: I	Chair: Plasma Cor	Bingjis XIAO ntrol Miniorels	12.20	0,4-3	403				ry Oral: DA	SP Systems	11:45 11:50	Board P/5-1 P/5-2	ID 561 567	Presenter Ernesto Fabregas Gabriele Manduchi	
	Miniorel: I	Chair: Plasma Cor ID	Bingjis XIAO ntrol Miniorals Presenter	12.20	0,4-3	463		Time	Board	ry Oral: DA	SP Systems Presenter	11:45 11:50	Board P/5-1 P/5-2	ID 561 567	Presenter Ernesto Fabregas Gabriele Manduchi	
	Minioral: I	Chair: Plasma Cor	Bingjis XIAO ntrol Miniorels	12.20	0/4-3	403		Time 14:00	Board 0/7-1	ry Oral: DA ID 457	SP Systems Presenter Yuxing Wang	11:45 11:50	Board P/5-1 P/5-2 P/5-3	ID 561 567 592	Presenter Ernesto Fabregas Gabriele Manduchi Thierry Hutter	
:00	Minioral: Board P/1-1 P/1-2	Chair: Plasma Co ID 535 569	Bingija XIAO ntrol Miniorals Presenter Myungkyu Kim Gimes CAULER	12.20	0/4-3	400		Time	Board	ry Orel: DA ID 457 451	SP Systems Presenter Yuxing Wang Axel Winter	11:45 11:50	Board P/5-1 P/5-2 P/5-3	ID 561 567	Presenter Ernesto Fabregas Gabriele Manduchi Thierry Hutter	
00 05 10	Minioral: I Board P/1-1 P/1-2 P/1-3	Chair: Plasma Co ID 535 569 580	Bingije XIAO ntroi Miniorals Presenter Myungkyu Kim Gires CAULER June-Wo Juhn	12.20	0/4-3	400		Time 14:00	0/7-1 0/7-2	ry Oral: DA ID 457 451 Cheir:	SP Systems Presenter Yuxing Wang Axel Winter Wenderley Pires de Sé	11:45 11:50	Board P/5-1 P/5-2 P/5-3	ID 561 567 592	Presenter Ernesto Fabregas Gabriele Manduchi Thierry Hutter	
00 05 10 15	Minioral: 8 Board P/1-1 P/1-2 P/1-3 P/1-4	Chair: Plasma Cor ID 535 569 580 585	Bingjis XIAO ntrol Miniorals Presenter Myungkyu Kim Gires GAULER June-Woo Juhn Gireok Shin	12.20	0/4-3	483		Time 14:00 14:20	Board 0/7-1 0/7-2 Minis	ry Oral: DA ID 457 451 Chair: oral: FNT, I	SP Systems Presenter Yuxing Wang Axel Winter Wenderley Pires de Sé MCR & DTI	11:45 11:50	Board P/5-1 P/5-2 P/5-3	ID 561 567 592	Presenter Ernesto Fabregas Gabriele Manduchi Thierry Hutter	Excursion
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# **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>(helt on Wednesday)</sup>
- KSTAR PC long-pulse high-performace, 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

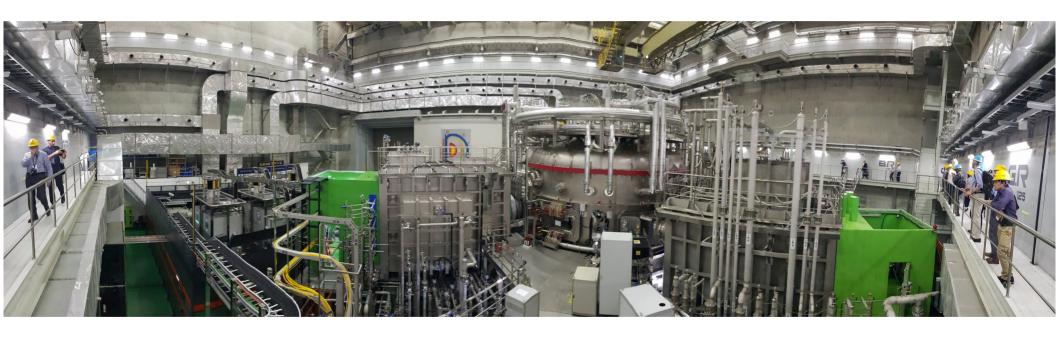
- 3 Orals about Neural Network algorithms
  - To recognize anomalies (Ciemat)
  - For disruption prediction (J-TEXT)
- 3 Minis on "big data", "deep learning", intelligent "decimation"
- 2 Minis on FPGA and GPGPU applications
- 1 Mini on MDSplus custom DAQ and JupyterLab analysis

# **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 glas 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 possibilites for DAG & 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)