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Report

Closure report of 1st Control System TUM

This document is the close-out report of the 1st ITER Control System Technical User Meeting (TUM) held on 09 ~11 Dec 2014 at IO premise for sharing experiences with users at different sites, discussing their works in progress and providing feedback to IO for future plans. This meeting covered conventional control, machine protection and safety.

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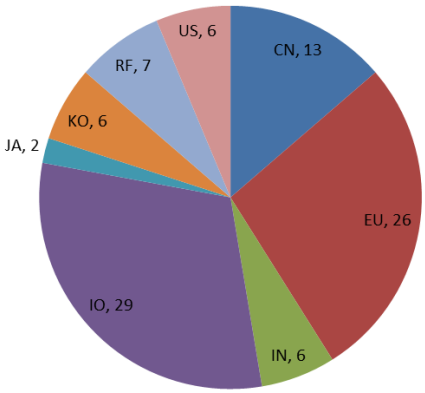
1. Introduction

This document is the close-out report of the 1st ITER Control System Technical User Meeting (TUM) held on 09 ~11 Dec 2014 aiming at following objectives.

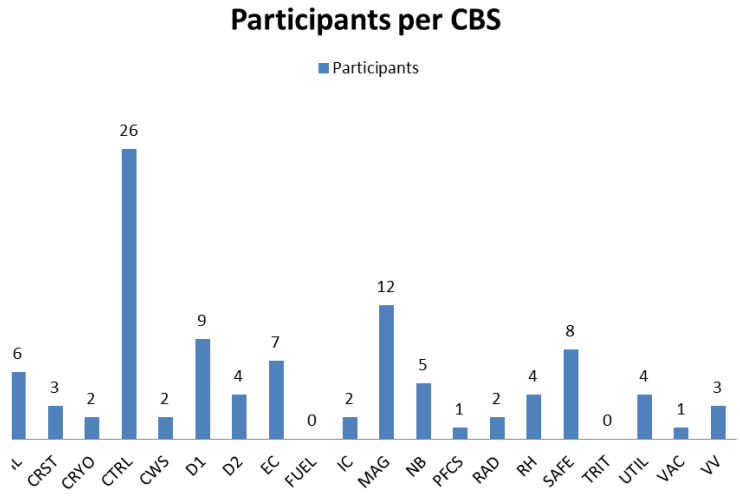
- To share experience in applying PCDH and CODAC Core System in ITER plant system I&C development
- To identify needs and issues not currently addressed by PCDH and CODAC Core System
- To present current status and plans for ITER control system

2. Summary

In the meeting, total 158 peoples including 29 remote participants from all 7 DAs and IO attended and 44 presentations were given. The meeting agenda and participants information are listed in Appendix A & B in this document and the meeting presentations are available in IDM (Q4JRDS). The presentations of designs and progresses were covered by 18 CBS1 systems out of 20 (FUEL and TRIT were missed), and IO-CSD focused on the future support plans of CCS and operation applications, ITER operation concept and HMI style guide, the design of central interlock and central safety, and preparation of FAT/SAT and integration. Additionally, a few small group meetings were made to discuss specific technical subjects and to resolve on-going issues which were highly demanded by plant system I&C developers and CCS users and turned out very effective. A real technical activity like test of TCN was successfully performed at the CODAC technical room under the support by CODAC, which was the useful side benefit of this meeting.



** DA chart: CSD excluded*



** Multidiscipline experts counted in each relevant CBS*

The most of presentations from users were about the progresses in plant I&C design and prototyping's, so their concerns were mainly about the PCDH and CODAC Core System, design of plant interlock and safety system while some plant system showed advanced progresses and expressed more interest in the preparation of FAT/SAT.

In the presentations and separate talks, many questions were asked by users and can be classified in the following categories.

- Detail technical questions in applying PCDH, using CODAC tools and operation tools
  - Backward compatibility of CCS and PLC program
  - Using HPN
  - Data archiving, especially DAN archiving
  - Using SDD and naming convention
  - Alarm handling
- Extension of standard components supported and managements of non-standard components
- How to perform the FAT/SAT and its policy and guideline
- Design of plant interlock system
- Design of plant sadet system
- I&C system working environment : radiation, magnetic field, other harsh condition

The further details and answers by IO are described in the following table.

Ref.	Questions		Answers/Comments	
	Descriptions		Descriptions	RO
PS1-1	TCN	CN-DA	PXI chassis are used for TCN interface in the current design. With CCS 5.0, provided a recent computer was used (with i350 chipset for PTP), it may not be required. TCN can be connected to an on-board Ethernet interface and system time synchronized with ITER time with a good accuracy.	FDM
			The accuracy achieved for SW scheduling and time-stamping using on-board chipset and CCSv5.0 (beta) is better than 1 micro sec, see PQUH4B V1.0. A new version of the report will be produced with CCS release candidate. The report will be extended as well to list supported chipset exhaustively. Communication is ongoing with the user to collect information about the fast controller architecture (the presentation mentions the reference of the enclosure but not the controller model). From there, we will be able to confirm whether or not the CN-DA CCR can be used without making use of a PXI chassis and NI-SYNC board and rather use a standard 1GbE port equipping the CCR.	BBR
PS1-3	Integrated test for PBS41, FAT		Integration scheme including the scope of individual PA will be discussed during TUM among IO, CN, KO and RF representatives.	IYA
	DAN interface for MRC and CCR and DAN integration	KO-DA	No real details from the presentation but from what we could understand we can say: the developer will have to preserve the timestamp from the source and pass it to DAN. Also as this control unit has an interface with SDN, similar architecture IN-DA HPN use case can be applied (data rate are not too high). On request, we will provide HPN use case (BBR).	LAE
PS1-5	Communication between conventional PLC and interlock PLC	CN-DA	This is not a general issue. ASIPP have made hardware changes after our last visit which has had consequences in the software configuration. We are fixing the errors they made now and problem will be solved before the TUM is finished. TCS and ASIPP CONFIRM THAT PROBLEM WAS SOLVED on 09-DEC-2014.	AVF
PS1-6	I&C naming convention in SDD	RF-DA	In the outside talked, CDC suggested to put some information the users need like "FDU/SDU" difference in the variable name, which is a good option. Also, the difficulty seems to be that users do not have enough information to properly naming signals and, hence, variables. They were only provided with names of cubicles existing for their system, but not with the names of equipment inside the cubicles, so they are trying to name signals/variables after cubicles, which is not good. CDC took an action to see what's currently available in EDB; this will probably need some follow-up with PCI and system TRO.	DSV
			Apparently two problems: what it is very important is. First follow the signal naming scheme which is usually complete, then perform the mapping signal and variable (in SDD this is important for traceability). After what we had put as naming conventions to derive variable names from signal name is a recommendation. so they need to agree with plant system RO and PSEG about a naming scheme strategy (first check with PSEG leader that nothing exists, e.g. interlock signal vs conventional signal, if no then (follow order of signal pieces and use '-' as delimiter e.g. put PBS identifier before TTT if it can help to make the distinction), and respect the max. number of character).	LAE

PS1-8	Connection of LIC to PIC : Profisafe vs. Profinet	US-DA	See answer to PS1-5	AVF
			COS-PSOS mapping and PSOS integration scheme need more consideration. Integration following sub-system; SNU/FDU/PMS/Bus-bar, then integrate into PFCS need to be clarified.	IYA
PS2-3	Need to ensure smooth migration to CCS v5 and later, because already invested in the previous versions	JA-DA	We aims at reducing as far as possible incompatible changes (ex: deprecated features present for few more versions), documenting those and providing support (tools, assistance) for changes at major releases. This appears in the migration guide, in release notes and in the components documentation. Still, at major release, there are changes. We can do more verification before the release on some users' I&C projects to better assess the impact (by us but limited without hardware and/or by users as beta testers) and take some actions. The same can be done after the release for improving 5.1 as an easier version to migrate to in case some migration or backward compatibility issue was remaining. We suggest JA-DA to contact now the support for the migration of some projects they choose so that we do some verification. Short version: We are aim at reducing migration cost as far as possible on 5.0, We can do verifications for the release of 5.0 with your indications. Anyway if backward compatibility issues appear we'll take them as issues to be resolved for 5.1.	FDM
PS2-5	Strict control on naming in SDD	EU-DA	What we warranty is generation of configuration files can be done even if naming convention is not applied. For ITER delivery, naming convention will be followed and it is checked in SDD when doing final validation.	LAE
	SNL ; replication of template as the new release of CCS		Under investigation. To be handled by the CODAC support with IO experts.	FDM
	Alarm and Log handling ; how to manage the alarm and log message generated outside EPICS		Alarms are triggered by Process Variables (PVs) on EPICS IOCs and the alarm system allows the operator to view and handle them. So all alarms are monitored by EPICS even if generated "outside". Regarding the log messages, the ones related to alarms (notification, acknowledgment) are sent using JMS and stored in a message history database. On other sites (FRIB, BNL), other log messages are also sent using JMS in the same database for operation (IOCs log, operator actions…) – to be discussed if we go in this direction. On the other hand, SPLUNK can gather all sort of log format (files, database). Splunk should be the final destination for *all* log information. Systems, servers, IOCs, alarms, services, network devices. It is a "big data" app that gets more powerful with the amount of possibly relevant stuff you feed into it.	NJU RLE
	Archiving ; PON & DAN archiving, Interface with MDS+		DAN interface: we won't push for interface (protocol) because it means that user will have to demonstrate high reliability and high code quality the same as DAN provides. So it means during FAT, we will ask for code review, test plan, demonstration that the quality level, reliability and performance are equal to DAN. Also in all cases, DAN archiver which is a CODAC service will have to be used as DAN-RO don't think it is a good idea to have an archiver implementation per delivery. Now coming back to the slides, he can use MDS+ if he wants as it is not an ITER delivery. Also in next version of CCS, we will add an interface to MDS+.	LAE
			As a long-term plan, CODAC will provide interfaces with as many tools as possible which have been widely used in fusion, and the next release of CCS will have the interface with MDS+, at first. Additionally, CODAC is currently investigating single database for PON data and DAN data together, which reflects that users can access to any data without difference regardless of data type.	MPK
	Real-time framework		If a laboratory is willing to help the CODAC team in evaluating CCS and providing feedback even without having to deliver an in-kind contribution to ITER, this is highly commendable and welcome. In this particular case, a compromise will have to be found between using existing solutions at the laboratory and using solutions provided with CCS. This concerns in particular archiving and fast control frameworks, logging, alarms, etc. which may already exist at the laboratory as a central tool. It may not be reasonable to adopt the solutions delivered with CCS for a particular task under all circumstances, especially if this is a voluntary effort. In this case, interfacing existing solutions to CCS at well-defined interface points is a viable solution in order to benefit from existing expertise and tools which may already be in place. In case for fast control, this is the SDN interface which enables publishing data on a CODAC network is one of those interface points. This approach is limited in its use to the case described above, where CCS is used in an existing environment on a voluntary basis. For any	WRA

			development which is eventually delivered to ITER and integrated into the control system, CODAC strongly encourages the use of solutions provided in CCS. This will facilitate integration later on. Otherwise, maintenance is a major issue as outside solutions can only be treated as black boxes and this is not desirable and only acceptable in well-justified individual cases.	
	Documentations for people with poor knowledge of EPICS		The issue is orientation in ITER documentation for people who are looking for short concise recipes how to solve this or that I&C problem. The best way to address this is via FAQ/How-to (wiki style), which gives one page solution and links for further reading. Topics to be elaborated on the basis of support questions.	DSV
			In addition, on-line training may be a way for reducing the learning time. It would be good to have some training objectives (task to be accomplished, assumptions on the people knowledge) to align the on-line training to these users. (On-line training)	FDM
	Evaluation of supporting S7-1500		Regarding this issue, IO already gave the answer (to Filippo) as follows. Dear Filippo, The s7-300 is by far the best selling PLC of their catalogue, and I have confirmation that its phase-out is not programmed, and will not be before a long time. And should it be phased out, it will still be supported for an even bigger time. And according to the experience with s5-s7 migration we can trust them. TIA Portal and s7-1500 are linked together, in the sense that S7-1500 can be programmed with TIA portal only. So if I introduce s5-1500, it means that I have to force people to use TIA portal. TIA Portal is actually not supporting all features supported by Step 7 V5.5. The Siemens strategy is to merge all of them gradually. (I think CFC has been merged last week or something like that). Redundant PLCs and Safety features are still to be merged. And I want to strongly test Communication with PLCs programmed with TIA portal, before integrating TIA portal in the catalogue. Technically speaking, the only reason for which you should use TIA Portal is if you use Siemens local panels, not supported any more by any other Development environment. Last, I don't have concrete argument on this, but return of experience from users on TIA portal is actually not very good. But anyway, as soon as I will find it reasonable, I will put TIA portal and s7-1500 in the catalogue. At least to avoid you (our collaborators) buying 2 licences. ---- Since That, here are some lesson-learnt. - IO learned that some communication channels will be encrypted in new generation, and some communication channels will disappear. IO is not ready for that. - The s7-414-5H of our catalogue is not supported.	BED
			From the understanding, no real impact in SDD, what IO can add in SDD is an attribute which indicates the model of PLC.	LAE
PS2-7	(Experience in Slow Controller Integration with CODAC (3ES6HE v1.1), there seems to be a mixing of interlock and conventional control. - ??	IN-DA	Satellite PCDH documents related to the interlocks clearly explains how to segregate interlocks and conventional functionalities inside PIS. In some exceptional cases the conventional PLC of a plant system can provide input data to the PIS. This is clearly an exception but for some industrial plant systems such as cryogenics we have to live with it. The PCDH documents also explain how to do this.	BED/ AVF
PS2-8	Using NI-SYNC as GMC synchronized by GPS.	IN-DA	CCS does not support using NI-SYNC board as IEEE1588 GMC synchronized to GPS. Discussions with NI on this are required and ongoing.	BBR
			Using LV RT on ITER standard FC hardware for large palette of available HW. List of issues with our HW catalogue requested.	FDM
PS3-1	Pre-trigger for Laser preparation during the plasma pulse (1min before plasma initiation), necessity of additional PSOS state?	JA-DA	We believe the pre-trigger phase should be mapped to an additional or already existing PSOS state; the difficulty will reside in our baseline design that states that the control is fully handed over to PCS towards the end of the countdown phase. The PSOS transition will therefore have to be mapped to an SDN event and not a COS transition since COS is not involved inside the scope of the pulse (i.e. the whole pulse duration corresponds to a unique COS state). There is no technical issue in delivering a pre-pulse-initiation PSOS trigger 1min ahead of plasma initiation but we need to re-assess the COS-PSOS design which is inappropriate in supporting this context.	BBR
	Alarm to prevent VV window from damage		This interlock function has not been considered yet. We'll work on it together with the IO RO and DA.	AVF

	Electronics in harsh radiation environment		Pragmatic strategy for non-critical electronics at location with harmful radiation in sequence of priority: (1) Move to location with harmless radiation (less than threshold defined in RHA), (2) shielding if radiation level not more than 10 times above threshold (3) find company for radiation hardened/tolerant design and which can qualify electronics according to RHA policy and obtain quotation for providing such electronics.	SSK
	Metadata associated with obtained data and calculated data		In DAN CCS 5.0, one can add metadata at stream and block level. It will be detailed in DAN user's manual.	LAE
	Non-standard HW not in the ITER catalogue		Requests for extension of the list of supported hardware need time to process and resources + time to implement. We also need to federate effort so it would be better to collect all requests for a given yearly deadline for processing those and for implementation of the changes. Could be before end of June (for planning & budget). Anyway, we have concerns for maintenance and will aim at reducing diversity.	FDM
	Level in PDR document		Assuming 1 year preparation (for diagnostics plant I&C) PDR and 1 year for FDR, about 50% of the effort for detailed design should be accomplished for the PDR. Considering that the work for FDR includes iterations on the design and filling in detailed descriptions the suggested level of coverage for PDR is at least 80% percent for procedures, functions, variables, architecture, signals, cubicle configuration and state machine. A more detailed breakdown of expected maturity can be found in IDM: PAED5Z (slide 36 in version 1.2). Maturity assessment metrics is described in IDM: PVM5EL	SSK
PS3-3	With the increase of the sampling rate or the acquisition time, the application generates the error : value too large for defined data type (6368 X-series)	CN-ASIPP	The error that encountered to Shi Li is that the error number 75" which means “Value too large for defined data type” or “buffer overflow”. This kind of problem is frequently happened when • The user configures the buffer size too small • The DAQ process is interrupted by other higher priority process, like 6259 board known issue • DAQ cycle is too slow We’ve talked with Shi Li regarding the board configuration that he made but he couldn’t recall the parameter he configured and he also confirmed that he didn’t put the process with highest priority. In fact, 250K samples/s/ch speed Shi Li configured is not high speed compared with other successful use case (RFX and DAN API test using same X series board driver with 2MS/s/ch). Therefore this problem doesn’t require any kinds of patch 4.3.1 or DMA functions. We just need to change some configuration of the board and DAQ process. Anyhow Shi Li will send their application soon and then I will propose new configuration for them ASAP.	CKM
PS3-5	NFM#07 provides measurements for Plasma Control System, so interface to the PCS is required.	CN-SWIP	Yes	WRA
PS3-6	Simultaneously transit raw data and physics data, by DAN and SDN respectively	CN-SWIP	Demonstration of simultaneous use of SDN and DAN in CCSv4.3 has been done considering 100kHz sampling of I/O and 1kHz physics data reduction and communication on SDN. The use case presented by the user is distinct in real-time rate of 100Hz in lieu of 1kHz and potentially several I/O boards being used in the PCF. IO will provide evidence that DAN/SDN can sustain these rates and throughput reliably. Therefore the existing demonstration will be extended to several data sources from several IO boards to achieve the rates mentioned by the user. A report shall be produced Q1-2014.	BBR
			Besides above reply, it is important to provide guidelines on how to develop programs which inject data to SDN/DAN/PON. There are several possible implementations and knowing pros and cons of the various solutions will help us in guiding people in their design implementation. E.g. NDS integrates everything in one IOC (DAN and SDN), HPN use case has a loose coupling with IOC, here a program manages SDN/DAN and I/O interfaces.	LAE
	Capability of CODAC to stream 280 MB/s of raw data		see above	
PS3-7	High Field Side Reflectometer –need new powerful FPGA module for simultaneous processing at 2GHz internal processing	RF-DA	With the power and cooling capacities of the actual PXIe chassis the performances of the suggested ADQ412 would be difficult to bypass in a manner significant enough as per today. Another form factors with better cooling capacities and larger real-estate area are provided (MTCA.4 and ATCA w/ Extensions for Physics): a COTS product or in-	PMI

	(ADQ412 in the catalogue is not enough) / Cubicle with extra coiling		house design meeting the requirements of the plant system can be suggested and made compliant with the requirements of PCDH and EDH (see How To QARUAC for guidelines). An air-water exchanger is suggested in PCDH annex document (4H5DW6), section 4.5.4 w/ 7 kW of cooling capacity, attention: requires a chilled water supply. The IO has the unit and will make long term tests in 2015 – 2016 in our diagnostics cubicles.	
	High Field Side Reflectometer - Local archiving		We don't encourage local archive. We will demonstrate that DAN can stream high-throughput data reliably (our current requirements is several GB/sec). Also note that the fast controller can be diskless so no possibility to have local storage.	LAE
PS3-9	Diagnostics SW documents - expensive, rigor requirements	US-DA	Contradicting opinions here. Some people look for more rigors, some complain about it. The main idea is that IO defines process and guidelines, and PS TRO decides how strictly it is applied.	DSV
			For the design description of diagnostics plant I&C two documents containing the deliverables D1-D9 are required: (1) System Requirements Specification (SRS) and (2) System Design Specification (SDS). No additional SW design document is required. Rigor is accomplished by using common methodology, documentation templates supported by examples. It is documented in IDM: JQLRRK. Disagree with cost statement since we have received quotations for system engineering design (SRS + SDS) for estimated 3 person-months.	SSK
	Provision of RHA data		RHA data provided by CODAC (see examples in IDM: HL92GK, HK34LK and E35L2Q) can be used for estimating the impact of gamma and neutron radiation on the operation of the tested I&C equipment. This data can be used to decide on the most appropriate RHA strategy and planning for the qualification and mitigation actions. The radiation tests performed by CODAC are not replacing the radiation qualification required by the RHA policy.	SSK
	Support for SEE Electrical experts		This is a known issue which has to be addressed to the design office.	DSV
PS4-3 & PS4-4	HMI guide, symbols, etc	IO	See IDM documents. (A69URK, 7367JQ)	MPK
	Alarm management and acknowledgement logic		Cs-Studio has its own GUI for the alarm (BEAST GUI) which is intended to be displayed on one of the three VDUs. This remains the main interface to manage the alarms. For 5.1, it is planned to retrieve and send acknowledgement alarm information from BEAST to BOY alarm page.	NJU
	Management and implementation of Interlock, 3IL-1		3IL-1 functions are implemented by the conventional PLC and it is responsibility of the plant system developer to define and design them in the best way. Some of these are used as alarms by the CIS to implement central functions, if such these are used as inputs from Conventional to PIS and treated as 3IL-2 functions.	AVF
PS4-5	Backward compatibility of CCS	EU-GTD	Backward compatibility is a feature that we intend to support. We address it during tests but we may underestimate the impact of some changes (short delays for release verifications). In case we missed some issue resulting in significant migration costs, we should address it, as any other issue. Means if issue with 5.0, we'll aim at resolving in 5.1. Could be with improved migration support or with other corrections (there are examples in previous X.1 releases).	FDM
	Data sharing among suppliers in EU site - PSP, Configuration management??		We have a SDD central, so if it is linked with CCS, please push your project there and everyone can see PVs and its definition. Same remark for code, push it to our central SVN.	LAE
			We have the same recommendation everywhere - use IO tools to share data. • Design drawings - SSD, • Interface data - PSP, • Production implementation - SDD. We can give the necessary access and guidelines.	DSV
PS5-2	Is it necessary to apply redundant configuration (Train A &B) for SIC-2C safety function?	RF-DA	The redundant configuration depends on if the function shall compliant with "Single Failure Criterion" or not. Compliance of SIC-2 Cat C systems with the single failure criterion is required on a case by case basis. The functional specifications of the nuclear I&C safety functions will specify whether compliance with the single failure criterion is required or not.	LIB
IND-1	Did SIEMENS take action against the incident occurred in an 'Iranian Nuclear Plant' relate to a	RF-DA	Introduction to the problem: The most of the investigations done regarding this incident point to a virus developed for professional engineers. The virus was of the type WORM and it was attacking two 'Zero Day' vulnerabilities; one from Windows another from WinCC.	ASO

	PLC SIEMENS infection?		The main suspicion was that the virus was introduced in the computer through the port USB, from the USB attacked WinCC and from WinCC was able to introduce its rootkit onto the PLC and Step7 software, modifying the codes and giving unexpected commands to the PLC while returning a loop of normal operations system values feedback to the users. 1) First Point: • This WORM was called STRUXNET for the engineers that discovered it. • Even if the SIEMENS presenter did not mention this slide in particular during the answer to Mr. Semenov's (RF DA) question, actually, we could see a SLIDE during his presentation directly pointing that problem and the solution that SIEMENS took in account in order to eradicate that problem. • The slide 16 of 'SIEMENS Presentations' stated: 4 weeks after the Struxnet discovery eradication solution released jointly by Microsoft, SIEMENS and other virus releases. 2) Second Point : • STUXNET used a vulnerability of WinCC to attack PLC. • ITER is not using WinCC in the I&C Systems. • ITER is using WinCC OA in the Safety and Interlock systems. But WinCC OA (even if the name is similar) comes from a totally different standard that SIEMENS simply purchased, this standard was called PVSS (for more information, Ignacio Prieto from INTERLOCK team).	
			The requirement of PCDH for SAT is that all source codes (i.e. S7 projects) are actually compiled using ITER computers: To manage this aspect for Siemens PLC the IO has made provisions of multiple. virtualized Windows workstations with the IO's own S7 installation on an isolated cluster environment, where the Windows workstations are controlled regularly against malicious software threats by IO infrastructure services. It is also the requirement of IEC62645 of inspecting the embedded I&C systems of nuclear power plants prior to delivery, notably against malicious software. The responsibility of assuring cybersecurity is not only on Siemens, but on the entire supply chain: 1) Siemens 2) Plant System Manufacturer 3) IO	
Open Discussions				
	Tests for variable magnetic fields? Radiation, magnetic field, qualification in general. Can we comply with some document list of what we have done? Safety has more precise info?	RF-DA	Examples for radiation test reports in IDM: HL92GK, HK34LK and E35L2Q. For EMC tests: We just had a chat with D. Beltran: he confirms that no tests for variable magnetic fields have been performed by IO, because except in the cryostat, it is not expected to have such variable fields on ITER site.. Nevertheless, he has planned to perform such tests using the CEA facility.	SSK/ PPS
	Better supports for NDS (flex RIO, cRIO).	RF-DA	We plan to set-up specific solutions with support for this. The scope is EPICS interface for xRIO platforms compatible with NDS. It may be with CCS 5.1 (to be confirmed).	FDM
	What kind of magnetic field was applied in the Immunity PLC tests?	RF-DA	Magnetic: https://user.iter.org/?uid=C9ZBKB (not variable but progressively increased field until failure) Radiation: https://user.iter.org/?uid=E35L2Q	PMI
			Magnetic Field Immunity of Electronics: PLC Test (9TS58E). Short summary of magnetic test applied on PLC: • Executed in DESY Accelerator Facilities (Hamburg). • Dipole Magnet used to generate the magnetic Field (constant) • The devices where introduced inside the gap of the magnet. Then, the magnetic field was increased making use of simple software that controlled directly the current exciting the magnet. • The size of the gap in horizontal dimension is (W × D) ≈ (1500 × 1500) mm2. The outer dimensions of the magnet are (H × W × D) ≈ (2800 × 3900 × 1500) mm3 and the total weight amounts to ≈ 90tons. • With a current Imax = 1500 A and a vertical gap size of 54cm a magnetic field of Bmax= 0.9 T can be achieved.	ASO
	IDM references to the results of magnetic field test, e.g., for NI hardware	US-DA	https://user.iter.org/?uid=C9ZBKB	PMI

	Mechanism to inform DAs on updates on PCDH and relevant IDM docs in general		We have updates on the public website; people can also subscribe to documents of interest in IDM	DSV
	Policy on providing IO the device support for non-standard hardware?	CN-DA	The policy is set by the requirements in EDH and PCDH baseline documents. We have crafted a How To document (QARUAC) which pinpoints those requirements and provides a practical guideline for the plant system manufacturer and a checklist for the technical responsible officer.	PMI

3. Conclusion

The meeting was a valuable chance to know about progresses of plant system I&Cs and to exchange experiences and difficulties encountered in their developments. In addition to the plenary meeting, small group meetings with DA/organizations on the specific issues turned out practical way to resolve problems and to come to agreement. Moreover, it was requested by participants to assign more time on these meetings instead of progress reporting for next TUM.
While questions and requests came from all areas covering conventional control, interlock and safety, they were mainly about how to apply ITER standards to their designs and to use core CODAC tools for developments. Even considering each plant system is in different phases from conceptual design to production system, it was noticeable that some users had less knowledge of ITER standards and CODAC technologies, and experienced difficulties to access to information. The other things were the requests to extend standard components supported by IO and the increase of adopting non-ITER standards components for their systems, which will cause significant difficulties in maintaining and managing for ITER operation.
As the results, IO-CSD should carefully investigate what we learnt at the meeting and provide clear message to users together with feasible solutions and plans.

- Improvement of user communication and feedback – update of web, contact points, etc
- Enhancement of user supporting structure including training – extension of trainings at DA premises and on-line training materials
- Investigating supportability of additional components
- Establishment of policy to maintain and to manage non-standard components
- Provision of obvious roadmap of CODAC technologies – CCS, OP App, PLC, FAT/SAT supports

Appendix A: Meeting Agenda

Day 1 (Tue, 09 Dec 2014)

N	*From*	*Till*	*Topic*	*Presenter*
I	**Introduction**			Chairman: Izuru YONEKAWA
I-1	09:00	09:05	Welcome	Paul THOMAS (IO-DIP/CHD)
I-2	09:05	09:10	Logistics	Fang GUAN (IO-DIP/CHD/CSD) Catherine MOUTTE (IO-DIP/CHD)
I-3	09:10	09:30	Status of concept of ITER operation	Fabio PICCOLO (IO-DIP/PCA/AOP/OPS)

I-4	09:30	09:50	ITER control system status report	Anders WALLANDER (IO-DIP/CHD/CSD)
PS1	**Plant Systems 1: Magnets and Power Supplies**			Chairman: William DAVIS
PS1-1	09:50	10:20	The magnet control system - from requirements to manufacture specs	Jean-Yves JOURNEAUX (IO-DIP/TKM/MAG/SSA)
PS1-2	10:20	10:40	Design and test for ITER PF AC/DC converter I&C and its interface	Liansheng HUANG (CN-ASIPP)
PS1-3	10:40	11:00	PBS 41 - MCS (KO)	Daeyeol LEE (KO-Mobiis)
PS1-D1	11:00	11:10	*Discussion*	
	11:10	11:25	*Coffee Break*	
PS1-4	11:25	11:45	AC/DC Converter I&C Status (KO)	Lack-Sang LEE (KO-Dawonsys)
PS1-5	11:45	12:05	Control system for the HTS current lead test bench in ASIPP	Kaizhong DING (CN-ASIPP)
PS1-6	12:05	12:20	Current status of the PFCS plant I&C system design (FDU/SNU/PMS/BusBars)	Anna MAKAROVA (RF-Efremov Institute)
PS1-7	12:20	12:35	PFCS implementation / test plant system configuration (for FAT / SAT tools)	Anna SHALAEVA (RF-Efremov Institute)
PS1-8	12:35	12:50	Overview of LCC design	Anastasia LEONTEVA (RF-Efremov Institute)
PS1-D2	12:50	13:00	*Discussion*	
	13:00	14:00	*Lunch Break*	
PS2	**Plant Systems 2: Heating Systems**			Chairman: Ryan WAGNER
PS2-1	14:00	14:20	EC control system (EU) (by videoconf)	Giuseppe CARANNANTE (EU-DA)
PS2-2	14:20	14:30	RF DA EC gyrotron control unit design	Ekaterina MIRONOVA (RF-DA)
PS2-3	14:30	14:50	EC control system prototype and case study update (JA)	Yasuhisa ODA (JA-DA)
PS2-4	14:50	15:10	Summary of current level of development for ECH and ICH transmission line subsystem controllers, instrumentation and related interfaces	Brian PETERS (US-DA)
PS2-5	15:10	15:30	CODAC Core System usage at NBTF and its integration in existing frameworks	Gabriele MANDUCHI (EU-RFX)
PS2-6	15:30	15:45	Experiences in interfacing EPICS with Labview	Hitesh DHOLA (IN-DA)
PS2-7	15:45	16:00	Experience in slow controller integration with CODAC	Deepak MANDGE (IN-DA)
PS2-D	16:00	16:10	*Discussion*	
	16:10	16:25	*Coffee Break*	
IND	**Industry**			Chairman: Petri MAKIJARVI
IND-1	16:25	16:45	Standard for slow controllers	Frederic BLANC (IO-Siemens)
IND-2	16:45	17:05	ITER - National Instruments Collaboration	Ravi MARAWAR (IO-National Instruments)
IND-3	17:05	17:25	Supplying cubicles and its services for the instrumentation and control Systems (I&C)	Stephane DROXLER (IO-Schneider Electric)
IND-D	17:25	17:40	*Discussion*	

Day 2 (Wed, 10 Dec 2014)

N	*From*	*Till*	*Topic*	*Presenter*
PS3	**Plant Systems 3: Diagnostics**			Chairman: Stefan SIMROCK
PS2-8	09:00	09:20	I&C activity of Indian neutral beam program	Himanshu TYAGI (IN-DA)
PS3-1	09:20	09:40	Status of diagnostic systems development in JA-DA	Tsuyoshi YAMAMOTO (JA-DA)
PS3-2			~~KO diagnostics (by videoconf)~~ - *cancelled*	
PS3-3	09:40	09:55	RXC I&C design progress	Shi LI (CN-ASIPP)
PS3-4	09:55	10:10	~~PI I&C design progress~~ - *cancelled*	
PS3-5	10:10	10:25	Preliminary design for NFM_Eq#07 I&C	Li ZHAO (CN-SWIP)
PS3-6	10:25	10:40	Preliminary analysis of control and data transfer of ITER Langmuir probes	Guangwu ZHONG (CN-SWIP)
PS3-D1	10:40	11:00	*Discussion*	
	11:00	11:15	*Coffee Break*	

PS3-7	11:15	11:35	Application of formal modelling methods to the I&C design of the ITER magnetics diagnostic	Andre NETO (EU-DA)
PS3-8	11:35	11:55	RF diagnostics	Ekaterina MIRONOVA (RF-DA)
PS3-9	11:55	12:15	Status of US diagnostics	Bill DEVAN (US-DA)
PS3-D2	12:15	13:00	*Discussion*	
	13:00	14:00	*Lunch Break*	
PS4	**Plant Systems 4: Plant Services**			Chairman: Bruno EVRARD
PS4-1	14:00	14:20	Progress in the design of the tokamak cooling water system (by videoconf)	Kofi KORSAH (US-DA)
PS4-2	14:20	14:40	Status of CGVS pump set and SVS distribution box I&C design	Francis RUPPEL (US-DA)
PS4-3	14:40	15:00	Progress of the cryogenic I&C plant system as per PA current status	Denis HENRY (IO-DIP/PSE/PED/CSE)
PS4-4	15:00	15:20	Progress on the CRYO master controller development regarding HW, SW, interfaces and control logic prototype	Michal KADLEC (IO-DIP/PSE/PED/CSE)
PS4-5	15:20	15:40	Buildings I&C integration	Hector NOVELLA (EU-GTD)
PS4-6	15:40	16:00	The PF coils building experience	Chiara DI CAMILLO (EU-CREATE)
PS4-D	16:00	16:15	*Discussion*	
	16:15	16:30	*Coffee Break*	
PS5	**Plant Systems 5: Tokamak**			Chairman: Bin LI
PS5-1	16:30	16:50	Simulators of tokamak systems	Sergey SADAKOV (IO-DIP/TKM/TIS)
PS5-2	16:50	17:10	PPTF I&C design	Sergey PORTONE (RF-DA)
PS5-D	17:10	17:30	*Discussion*	
	Social Event			
	18:30	22:00	*Dinner (Château de Cadarache)*	

Day 3 (Thu, 11 Dec 2014)

N	*From*	*Till*	*Topic*	*Presenter*
IO	**IO Status and Plans**			Chairman: Anders WALLANDER
IO-1	09:00	09:20	ITER central control system - conventional control	Mikyung PARK (IO-DIP/CHD/CSD/CDC)
IO-2	09:20	09:40	CODAC Core System status and roadmap	Franck DI MAIO (IO-DIP/CHD/CSD/CDC)
IO-3	09:40	10:00	Machine protection and interlocks	Antonio VERGARA FERNANDEZ (IO-DIP/CHD/CSD/PCI)
IO-4	10:00	10:20	Nuclear safety I&C	Pierre PETITPAS (IO-DIP/CHD/CSD/PCI)
IO-5	10:20	10:40	Occupational safety	Pierre PETITPAS (IO-DIP/CHD/CSD/PCI)
IO-D	10:40	11:00	*Discussion*	
	11:00	11:15	*Coffee Break*	
INT	**Integration**			Chairman: Anders WALLANDER
INT-1	11:15	11:35	An IO view on plant system I&C	William DAVIS (IO-DIP/CHD/CSD/PCI)
INT-2	11:35	11:55	FAT / SAT / integration	Izuru YONEKAWA (IO-DIP/CHD/CSD/PCI)
INT-3	11:55	12:15	Status of HMI design guide	Fabio PICCOLO (IO-DIP/PCA/AOP/OPS)
INT-D	12:15	13:00	*Discussion*	
	13:00	14:00	*Lunch Break*	
SITE	**Site Visit**			
SITE-1	14:00	15:30	ITER site visit	Julie MARCILLAT (IO-ODG/COM)
SITE-2	15:30	16:00	CODAC technical room visit	Nicolas PONS (IO-DIP/CHD/CSD/CDC)

				Petri MAKIJARVI (IO-DIP/CHD/CSD/CDC)
	16:00	16:30	*Coffee Break*	
C	**Conclusion**			
C-1	16:30	17:00	Debriefing and closing remarks	Anders WALLANDER (IO-DIP/CHD/CSD) Mikyung PARK (IO-DIP/CHD/CSD/CDC) Izuru YONEKAWA (IO-DIP/CHD/CSD/PCI)
C-2	17:00	17:30	*Discussion*	Anders WALLANDER (IO-DIP/CHD/CSD)

Appendix B: List of Participants

PLANT SYSTEMS							
Nº	**PBS**	**CBS**	**Name**	**DA**	**Affiliation**	**Contribution**	**Registered**
1	**11**	MAG-PFCS	Kaizhong DING	CN	ASIPP	PS1-5	✓
2	**11**	MAG-MATF MAG-MSPC	Jean-Yves JOURNEAUX	IO	IO/DG/DIP/TKM/MAG/SSA	PS1-1	✓
3	**15** **24** **27**	VV-VV1B CRST-CYSI CRST-TSMD	Robin LE BARBIER	IO	IO/DG/DIP/TKM/VV/VVTS		
4	**15** **24** **27**	VV-VV1B CRST-CYSI CRST-TSMD	Sergey SADAKOV	IO	IO/DG/DIP/TKM/TIS	PS5-1	✓
5	**18**	FUEL-FIG FUEL-GDC	Yu YANG	IO	IO/DG/DIP/PSE/FCED/FWC		
6	**23**	RH-RHCS	David HAMILTON	IO	IO/DG/DIP/PSE/PED/RH		
7	**23**	RH-RHCS	Kevin MEYER	IO	Cosylab		✓
8	**24**	CRST-CYSI VV-VPSI	Igor SEKACHEV	IO	IO/DG/DIP/TKM/VV/CRST		
9	**24**	VV CRST	Olivier TAILHARDAT	IO	Arial Industries		remote
10	**26**	CWS-SCSU CWS-TCWS	Fabio SOMBOLI	IO	IO/DG/DIP/PSE/PED/CWS		✓
11	**26**	CWS-TCWS	Kofi KORSAH	US	DA	PS4-1	remote
12	**31**	VAC-GV VAC-SV	Francis RUPPEL	US	DA	PS4-2	✓
13	**34**	CRYO	Denis HENRY	IO	IO/DG/DIP/PSE/PED/CSE	PS4-3	✓
14	**34**	CRYO-MC	Michal KADLEC	IO	IO/DG/DIP/PSE/PED/CSE	PS4-4	✓
15	**41**	MAG-PFCS	Ge GAO	CN	ASIPP		✓
16	**41**	MAG-PFCS	Liansheng HUANG	CN	ASIPP	PS1-2	✓
17	**41**	MAG-PFCS	Jun SHEN	CN	ASIPP		✓
18	**41**	UTIL-RPC	Kai CAO	CN	RXPE		✓
19	**41**	MAG-CCPS MAG-PFCS MAG-TFPS	Inho SONG	IO	IO/DG/DIP/PSE/EED/CPS		remote
20	**41**	MAG-CCPS MAG-PFCS	Hao TAN	IO	IO/DG/DIP/PSE/EED/CPS		remote

		MAG-TFPS					
21	**41**	MAG-CCPS MAG-PFCS MAG-TFPS	Jun TAO	IO	IO/DG/DIP/PSE/EED/CPS		
22	**41** **43**	MAG UTIL	Ivone BENFATTO	IO	IO/DG/DIP/PSE/EED		
23	**41**	MAG-CCPS MAG-PFCS MAG-TFPS	Jaehak SUH	KO	DA		✓
24	**41**	MAG-CCPS MAG-PFCS MAG-TFPS	Hyunkook SHIN	KO	DA		✓
25	**41**	MAG-CCPS MAG-PFCS MAG-TFPS	Lack-Sang LEE	KO	Dawonsys	PS1-4	✓
26	**41**	MAG-CCPS MAG-PFCS MAG-TFPS	Daeyeol LEE	KO	Mobiis	PS1-3	✓
27	**41**	MAG-CCPS MAG-PFCS MAG-TFPS	Yang-hae KWON	KO	Mobiis		remote
28	**41**	MAG-CCPS MAG-PFCS MAG-TFPS	Anna MAKAROVA	RF	Efremov Institute	PS1-6	✓
29	**41**	MAG-CCPS MAG-PFCS MAG-TFPS	Anna SHALAEVA	RF	Efremov Institute	PS1-7	✓
30	**41**	MAG-CCPS MAG-PFCS MAG-TFPS	Anastasia LEONTEVA	RF	Efremov Institute	PS1-8	✓
31	**43**	UTIL	Kyung Woong KANG	IO	IO/DG/DIP/PSE/EED/EPD		
32	**47**	CTRL-PCS	Joseph SNIPES	IO	IO/DG/DIP/POP/SD/STCO		remote
33	**51** **52** **53**	IC-ICH1 IC-ICH2 EC-GN NB-DNBC	Hitesh DHOLA	IN	DA	PS2-6	✓
34	**51** **52**	IC-ICH1 IC-ICH2 EC-TS	Brian PETERS	US	DA	PS2-4	✓
35	**52**	EC-GN EC-TS	Giuseppe CARANNANTE	EU	DA	PS2-1	remote
36	**52**	EC-GN	Deepak MANDGE	IN	DA	PS2-7	✓
37	**52**	EC-MC EC-TS	Franco GANDINI	IO	IO/DG/DIP/CHD/HCD/ECH		
38	**52**	EC-GN EC-TS	Yasuhisa ODA	JA	DA	PS2-3	✓
39	**52** **55**	EC-GN D1 D2	Ekaterina MIRONOVA	RF	DA	PS2-2 PS3-8	✓
40	**53**	NB-NB1C NB-NB2C	Adriano LUCHETTA	EU	RFX		✓
41	**53**	NB-NB1C NB-NB2C	Gabriele MANDUCHI	EU	RFX	PS2-5	✓

42	**53**	NB-NB1C NB-NB2C	Rigato WLADI	EU	RFX		remote
43	**53**	NB-DNBC	Sandip GAJJAR	IN	DA		
44	**53**	NB-DNBC	Himanshu TYAGI	IN	DA	PS2-8	✓
45	**53**	NB	Beatrix SCHUNKE	IO	IO/DG/DIP/CHD/HCD/NB		remote
46	**53**	NB	Mahesh KUSHWAH	IO	IO/DG/DIP/CHD/HCD/NB		remote
47	**55**	D1-I4	Qingwei YANG	CN	DA		✓
48	**55**	D1-I4	Li ZHAO	CN	SWIP	PS3-5	✓
49	**55**	D1-L8	Shi LI	CN	ASIPP	PS3-3	✓
50	**55**	D1-L8	Kaiyun CHEN	CN	ASIPP		✓
51	**55**	D1-N6	Guangwu ZHONG	CN	SWIP	PS3-6	✓
52	**55**	D1-H1 D1-H2 D1-H3 D1-H4 D1-H5	Andre NETO	EU	DA	PS3-7	✓
53	**55**	D1	Tsuyoshi YAMAMOTO	JA	DA	PS3-1	✓
54	**55**	D1 D2	Paul SICHTA	US	PPPL		remote
55	**55**	D1 D2	Bill DEVAN	US	DA	PS3-9	✓
56	**56**	PFCS-TBCN	Fen WANG	CN	SWIP		✓
57	**58**	RH-PPT1 RH-PPT2 RH-PPTS	Thierry CERISIER	IO	IO/DG/DIP/PSE/PEI/DIN		✓
58	**58**	RH-PPT1 RH-PPT2 RH-PPTS	Sergey PORTONE	RF	DA	PS5-2	✓
59	**61** **62** **63** **65**	BUIL UTIL	Renan MACIOSZCZYK	EU	OMEGA Consortium		✓
60	**61** **62** **63** **65**	BUIL UTIL	Christophe SONTAG	EU	OMEGA Consortium		✓
61	**61** **62** **63**	BUIL	Isidro BAS	EU	GTD		✓
62	**61** **62** **63**	BUIL	Hector NOVELLA	EU	GTD	PS4-5	✓
63	**61** **62** **63**	BUIL	Gema DONOSO ROSA	EU	ENGAGE		remote
64	**61** **62** **63**	BUIL	Ana GONZALEZ	EU	ENERGHIA		remote
65	**61** **62** **63**	BUIL	Roberto LANZA	IO	IO/DG/DIP/BSI/BSS		remote
66	**62**	BUIL	Cyril LESCURE	EU	DA		remote

	63 **65**	UTIL					
67	**63**	BUIL-B55	Chiara DI CAMILLO	EU	CREATE	PS4-6	✓
68	**66**	RAD-RWTX	David TORCY	IO	IO/DG/DIP/PSE/PED/RME		✓
69	**66**	RAD-RWTX	Oliviero BARANA	IO	Assystem		✓
70	**66**	RAD-RWTX	Je Keun CHON	IO	IO/DG/DIP/PSE/PED/RME		remote
CROSS-PLANT / COORDINATORS / OBSERVERS							
Nº			**Name**	**DA**	**Affiliation**	**Contribution**	**Registered**
71			Shuqin WU	CN	DA		✓
72			Pan LI	CN	SWIP		remote
73			Andrew HYNES	EU	CCFE		✓
74			Martin TOWNSEND	EU	CCFE		✓
75			Adam STEPHEN	EU	CCFE		✓
76			John WATERHOUSE	EU	CCFE		✓
77			Ana Belen DEL CELLO GORDO	EU	CDTI		✓
78			Maurizio PANELLA	EU	CREATE		✓
79			Cristina CENTIOLI	EU	ENEA		✓
80			Marco VELLUCCI	EU	ENEA		✓
81			Luca BONCAGNI	EU	ENEA		✓
82			Juan Carlos LLORENTE GOMEZ	EU	GMV		✓
83			Jose Carlos GONZALEZ	EU	GMV		✓
84			Nuria PEREZ	EU	GMV		✓
85			Roberto CAPOBIANCO	EU	RFX		✓
86			Mauro BREDA	EU	RFX		✓
87			Modesto MORESSA	EU	RFX		✓
88			Rajnish KUMAR	IN	DA		remote
89			Rasesh DAVE	IN	DA		remote
90			Shivakant JHA	IN	DA		remote
91			Vipal RATHOD	IN	DA		remote
92			Anuj GARG	IN	DA		remote
93			Ratnakar Kumar YADAV	IN	DA		remote
94			Hannah TREVET	IO	ARCADIS		
95			Rodrigo CASTRO	IO	CIEMAT		✓
96			Jesus VEGA	IO	CIEMAT		✓
97			Rok SABJAN	IO	Cosylab		✓
98			Mikel ROJO	IO	Cosylab		✓
99			Paul THOMAS	IO	IO/DG/DIP/CHD	I-1	
100			Fabio PICCOLO	IO	IO/DG/DIP/PCA/AOP/OPS	I-3 INT-3	✓
101			Catherine MOUTTE	IO	IO/DG/DIP/CHD	I-2	✓
102			Emilio DE LAS HERAS MECO	IO	Indra		✓
103			Fernando SASTRE BECEIRO	IO	Indra		✓
104			Murali RAVINDRAN	IO	National Instruments		✓

105			Ravi MARAWAR	IO	National Instruments	IND-2	✓
106			Benjamin MAVEL	IO	National Instruments		✓
107			Stephane DROXLER	IO	Schneider Electric	IND-3	✓
108			Dominique BOUILLIEZ	IO	Schneider Electric		✓
109			Jean-Paul VION	IO	Siemens		remote
110			Frederic BLANC	IO	Siemens		✓
111			Mariano RUIZ	IO	UPM		✓
112			Diego SANZ	IO	UPM		✓
113			Daan PURBRICK	IO	Vectra Group		remote
114			Kwangcheol HWANG	KO	Dawonsys		✓
115			In-Seung CHUNG	KO	Dawonsys		✓
116			Igor SEMENOV	RF	DA		✓
117			Nikolay MARUSOV	RF	DA		✓
118			Bobby WHITUS	US	DA		remote
119			Eva FREER	US	DA		remote
120			Vicki WHEELER	US	DA		remote
121			Gheni ABLA	US	General Atomics		✓
PARTICIPANTS FROM THE ITER CONTROL SYSTEM TEAM							
Nº	**PBS**	**CBS**	**Name**	**DA**	**Affiliation**	**Contribution**	**Registered**
122	**45** **46** **48**	CTRL SAFE	Fang GUAN	IO	IO/DG/DIP/CHD/CSD	I-2	✓
123	**45** **46** **48**	CTRL SAFE	Anders WALLANDER	IO	IO/DG/DIP/CHD/CSD	I-4 C-1	✓
124	**45**	CTRL	Franck DI MAIO	IO	IO/DG/DIP/CHD/CSD/CDC	IO-2	✓
125	**45**	CTRL	Mikyung PARK	IO	IO/DG/DIP/CHD/CSD/CDC	IO-1 C-1	✓
126	**45**	CTRL	William DAVIS	IO	IO/DG/DIP/CHD/CSD/PCI	INT-1	✓
127	**45** **46** **48**	CTRL SAFE	Izuru YONEKAWA	IO	IO/DG/DIP/CHD/CSD/PCI	INT-2 C-1	✓
128	**45**	CTRL	Nicolas PONS	IO	IO/DG/DIP/CHD/CSD/CDC	SITE-2	✓
129	**45**	CTRL	Denis STEPANOV	IO	IO/DG/DIP/CHD/CSD/CDC		✓
130	**45**	CTRL	Sangwon YUN	IO	IO/DG/DIP/CHD/CSD/CDC		✓
131	**45**	CTRL	Vishnukumar PATEL	IO	IO/DG/DIP/CHD/CSD/CDC		✓
132	**45**	CTRL	Jignesh PATEL	IO	IO/DG/DIP/CHD/CSD/CDC		✓
133	**45**	CTRL	Petri MAKIJARVI	IO	IO/DG/DIP/CHD/CSD/CDC	SITE-2	✓
134	**45**	CTRL	Nadine UTZEL	IO	IO/DG/DIP/CHD/CSD/CDC		✓
135	**45**	CTRL	Antoni SIMELIO	IO	IO/DG/DIP/CHD/CSD/PCI		✓
136	**45**	CTRL	Martynas PROKOPAS	IO	IST University		✓
137	**45**	CTRL	Ralph LANGE	IO	IO/DG/DIP/CHD/CSD/CDC		✓
138	**45**	CTRL	Ryan WAGNER	IO	IO/DG/DIP/CHD/CSD/PCI		✓
139	**45**	CTRL	Stefan SIMROCK	IO	IO/DG/DIP/CHD/CSD/CDC		✓
140	**45**	CTRL	Bruno EVRARD	IO	IO/DG/DIP/CHD/CSD/PCI		✓
141	**45**	CTRL	Bin LI	IO	IO/DG/DIP/CHD/CSD/PCI		✓

142	**45** **46** **48**	CTRL SAFE	Guoming LIU	IO	IO/DG/DIP/CHD/CSD/CDC		✓
143	**45** **47**	CTRL	Axel WINTER	IO	IO/DG/DIP/CHD/CSD/CDC		✓
144	**45**	CTRL	Lana ABADIE	IO	IO/DG/DIP/CHD/CSD/CDC		
145	**45**	CTRL	Changseung KIM	IO	IO/DG/DIP/CHD/CSD/CDC		
146	**45**	CTRL	Olivier LIOTARD	IO	TCS		
147	**45**	CTRL	Ranjan SHARMA	IO	TCS		
148	**45** **46** **48**	CTRL SAFE	Geug-sin BANG	IO	KEPCO		
149	**45**	CTRL	Sawantdesai PRASAD	IO	TCS		
150	**45**	CTRL	Ronak PATEL	IO	TCS		remote
151	**46**	CTRL-CIS	Antonio VERGARA FERNANDEZ	IO	IO/DG/DIP/CHD/CSD/PCI	IO-3	✓
152	**46**	CTRL-CIS	Yuhua LIU	IO	IO/DG/DIP/CHD/CSD/PCI		✓
153	**46**	CTRL-CIS	Marion SAVOUILLAN	IO	Assystem		✓
154	**46**	CTRL-CIS	Ignacio PRIETO DIAZ	IO	Iberdrola		✓
155	**48**	SAFE	Pierre PETITPAS	IO	IO/DG/DIP/CHD/CSD/PCI	IO-4 IO-5	✓
156	**48**	SAFE	Jean-Marc FOURNERON	IO	IO/DG/DIP/CHD/CSD/PCI		✓
157	**48**	SAFE	Jean-Marc PERNIN	IO	Assystem		✓
158	**48**	SAFE	Rossen BADIN	IO	Assystem		✓