RELAZIONE SCIENTIFICA FINALE DEL PROGRAMMA STM 2013

Fruitore

Dalla Palma Mauro

qualifica: Ricercatore III livello

Istituto di afferenza: Istituto Gas Ionizzati (IGI)

Descrizione dell'Istituzione ospitante

ITER Organization

Route de Vinon sur Verdon – 13115 St Paul Lez Durance – France

Dipartimento di afferenza: CODAC, Heating & Diagnostics

Titolo del programma

Sviluppo tecnico e tecnologico per la fornitura dei Componenti della linea d'iniezione dell'esperimento MITICA

Introduzione descrittiva del progetto

Gli obiettivi perseguiti e le attività svolte durante la mobilità rientrano nel progetto e costruzione dei Componenti della linea di iniezione dell'esperimento MITICA che sarà costruito nell'Area del CNR di Padova e costituirà il prototipo degli iniettori per il riscaldamento del plasma del reattore sperimentale ITER.

L'avanzamento del progetto dei Componenti di MITICA ha raggiunto l'importante fase di finalizzazione e revisione sulla base dei requisiti già definiti e delle analisi di verifica svolte. Queste attività di progettazione, verifica e sviluppo sono state gestite dal fruitore della mobilità, nella struttura della

collaborazione internazionale sugli iniettori per ITER, coordinando il gruppo di lavoro composto di Associazioni europee coinvolte nella fornitura dei Componenti per MITICA.

Le attività svolte durante la mobilità hanno richiesto forti interazioni e incontri che hanno rafforzato la cooperazione scientifica dell'IGI con le Associazioni europee.

Obiettivi raggiunti

Gli obiettivi raggiunti durante il programma "Short term mobility" sono elencati di seguito:

1) condividere, con le Associazioni europee coinvolte nella costruzione di MITICA, la revisione del progetto dei Componenti della linea d'iniezione dell'esperimento MITICA;
2) finalizzare i requisiti e valutare le modifiche del progetto dei Componenti per MITICA verificando la compatibilità con i requisiti dei Componenti per ITER;
3) identificare le tecnologie critiche e pianificare attività di ricerca e sviluppo tecnologico propedeutiche ed urgenti per la costruzione dei Componenti per MITICA.

Attività svolte

Le attività svolte durante il programma "Short term mobility" sono elencate nell'allegato I.

Data
28 giugno 2013

Firma

Allegato I

Title	5.3 P3 HNB BLC's & MITICA Vessel
Approver	Bora Dhiraj
Chairman	Falter Hans Dieter
Developer	Graceffa Joseph
Secretary	Schunke Beatrix

Chit No.	IDM Ref.	Cat.	Title	Chit Description	Chit Comments	Classification	Due Date	Action Status	Action Response
1	9AX4QV		**FMECA of RID to include the possible plasma formation & insulators**	The FMECA of the RID should include the possible plasma formation inside the RID. In normal operation it is calculated that this will not occur (with a safety factor about 5). However the RID panel surfaces need "conditioning" - mainly outgassing by beam bombardment. This will occur at low power, low beam energy. During this phase plasma may form and short out the RID voltage so the current in the RID power supply will increase sharply which needs to be detected and the power supply stopped by an interlock. The insulators on the water pipes and supports were also missing from the FMECA. The FMECA for the RID should consider the risk of damages in the ceramic insulators in the water circuit and in the supports.	Chit owner is IO (Joseph and Darshan). *Mauro Dalla Palma*				
2	9B2ZHX	2	**Alignment requirements for BLC's**	The beamline components - in particular the neutraliser and the RID - should be aligned to within plus/minus 10mm in X direction (along the beamline), plus/minus 1mm in Y direction (transverse to the beam) and plus/minus 5mm in Z direction (vertically to the beam). Those alignments are to be under vacuum with the components operational (with water cooling), It is suggested that on MITICA the optical alignment system could be used under vacuum as the MITICA vessel has many windows.	At the FDR we should demonstrate that measuring through the portholes, the maximum error remaining after refraction compensation is compatible with positioning requirements. *Mauro Dalla Palma*	22_Installation	25 Apr 2012	On Going	

Chit No.	IDM Ref.	Cat.	Title	Chit Description	Chit Comments	Classification	Due Date	Action Status	Action Response
3	9AW8F5	2	**Use of Kapton for cables/thermocouples**	Kapton insulated thermocouples and/or Kapton insulated cables should NOT be used on MITICA where they correspond to cables/thermocouples on the HNBs of ITER. MI (mineral insulated) cables/thermocouples should be used so that experience is gained with the installation, routing, performance and connection/de-connection of those cables/thermocouples.	The chit is confirmed. *Mauro Dalla Palma*	17_Material	25 Apr 2012	Waiting Approval	I have contacted the vacuum section (Bastien Boussier) and he gave the following reply: "I would highly recommend MI cable for thermocouples as it is a standard product with well proven vacuum properties and radiation hardness. Kapton cabling is not preferred and should be limited where requirements cannot be met by MI cable (or other metal/mineral cables). For a formal approval regarding material and vacuum behaviour, Liam is the RE. Kapton is currently not yet a formally agreed material and will need formal request and validation before use (see vacuum handbook Appendix 3) To be noted: Kapton isolated cable are used on specific cryogenic sensor wiring were signal sensitivity, wire resistivity and thermal conduction criteria cannot be net by MI cabling (on our TCP). This concerns small bore Kapton wiring (<100micron), which has very low mechanical integrity and should only be used in static, un-exposed area. It is indeed flexible… but insulation may become brittle after high irradiation (so not an argument) Terminations are simpler (weld) and possibly easier to be made compact, but expected reliability is lower. It is not sure that cable cost will be cheaper for Kapton cabling than MI !!!" From the above statement by the vacuum section, it is clear that Kapton insulated cables is not recommended to be used at ITER and should therefore also be avoided at MITICA. Kapton insulated cables at MITICA could only be considered in positions where they are not going to be installed at the ITER HNB. / Lennart

Chit No.	IDM Ref.	Cat.	Title	Chit Description	Chit Comments	Classification	Due Date	Action Status	Action Response
4	9AVT8P	2	**Design of ceramic insulators**	The in-line ceramic insulators in the cooling water pipes will be brazed to metallic flanges that are welded to the pipes. The difference thermal expansion will put large forces on the brazed joint. Normally the brazing is done on the outside of the ceramic cylinder and not on the end of it. The design of these insulator sections should be discussed with a ceramic manufacturer since they have the competence.	The activity is already compatible with chit topics. The break failure probability should be fixed considering FMECA, after that the component design should be improved to fulfil this limit. The break life will cover the entire RID life without replacements during operation. Integrated analyses and submodelling are ongoing considering boundary conditions and optimising pipework fastening to the RID structure. *Mauro Dalla Palma*	18_Manufacturing	25 Apr 2012	On Going	
5	9B47NY		**Issue with the manufacture of the high heat flux elements of the RID**	Two of the problems associated with the manufacture of the high heat flux elements of the RID are the 0.5 to 1mm step mid-way along each channel caused by deep drilling from each end and the complication this creates for insertion of the swirl tape in the channel. Using rectangular drawn copper sections with 2 circular channels would avoid those problems (such copper sections have been produced in the past). It is suggested to investigate further using high heat flux elements with only two channels that can be produced using such copper sections. If deep drilling is used from both ends of the BSEs, potentially causing a "step", then the stress concentrations at the internal edges need to be assessed as the wall is thin.	The activity is ongoing as already shared and agreed with the IO on 2nd of May (Deep drilling R&D and thermohydraulic analyses for ERID). *Mauro Dalla Palma*				

Chit No.	IDM Ref.	Cat.	Title	Chit Description	Chit Comments	Classification	Due Date	Action Status	Action Response
6	9B4J3B		**Remove RID cover to allow for better gas flow**	The cover on the top of the RID should be removed and, if necessary, replaced with an open structure. This will increase the pumping of the RID and decrease the re-ionisation loss. The lower part of the RID should be kept as open as possible for gas flow for the same reason. The purpose of the top cover on the ERID model is not clear. Removal of this top cover could aid in a better pumping of the ERID. Is protection from devious particles a consideration? In such a situation, could baffles be considered to trap the same and allow pumping at the same time?	The cover will be removed. Gas pumping takes the priority on deviated particles (see chit No.6). Assessment will be done for deviated particles. *Mauro Dalla Palma*				
7	9AZCP2	1	**Bellows and corrugated hoses on neutraliser and E-Dump - Conformity with Vacuum Handbook**	The bellows used for the water cooling circuit and the gas lines of the neutralizer as well as the corrugated hoses for the e-dump are not conform to the ITER VH. If the bellows cannot be avoided and need to be kept for the final design a request for deviation must be raised for each of the bellows according to the ITER QA program.	Deviation for cooling bellows has been accepted; NED corrugated hoses have been removed. *Mauro Dalla Palma*	14_Design_Definition	25 Apr 2012	Complete	After the PDR a meeting was held with the vacuum group on 04/04/2012 where it was established that requests for acceptance rather than deviation requests are needed, see link Preparatory for the deviation requests covering the use of water bellows in the NBI https://user.iter.org/?uid=9BV67B). The action was on IO NB Section to prepare the necessary documents (one document per component and per type of bellow). For the Neutralizer the following documents have now been approved: Acceptance for HNB Neutralizer Bellows on inlet & outlet water pipes https://user.iter.org/?uid=9YDCC2 Request for the use of bellows in HNB water circuit (9YDCC2) The Chairman has confirmed that this answers adequately the associated e category 1 chit for the bellows. The use of flexible hoses on the E-dump has been rejected, and work has started on alternative design solutions. The Chairman requested that the two issues should be dissociated, closing the category 1 chit and adding a new category 2 chit for finding an alternative to the flexible hoses which is feasible. link: ITER_D_AGQEN9 - Email on the resolution of the category 1 chits of the BLC PDR - Approval of requests for acceptance https://user.iter.org/?uid=AGQEN9

Chit No.	IDM Ref.	Cat.	Title	Chit Description	Chit Comments	Classification	Due Date	Action Status	Action Response
8	8HZT7V	2	**Ceramic insulator maintenance**	The risk of failure of the ceramic insulators is large. The position of the ceramic insulator should be optimised to ease their replacement.	See comment on chit No. 4. IO to provide evidence that replacement of ceramic breaks is challenging considering all boundary conditions. *Mauro Dalla Palma*	24_Maintenance	25 Apr 2012	On Going	
9	9AZH92	2	**Structural integrity of the lifted configuration should be assessed.**	The Beam Line Components are supposed to be lifted by monorail crane. The structural integrity of the component itself and any sub-components in the lifted configuration should be guaranteed. Structural analysis is required for the lifted configuration during SL-1 and SL-2 condition.	Analyses are ongoing as for load combination specification. *Mauro Dalla Palma*	07_Remote_Handling	25 Apr 2012	On Going	
10	9B3NF4	3	**Thermocouples for the measurement of the outlet water temperature on the RID**	Thermocouples for the measurement of the outlet water temperature of the RID elements (grounded panels) do not need to be inserted in the water. Clamping to the outside of the pipe is sufficient. Fast response is not necessary (the water takes seconds to go from one end to the other of an element cooling loop), and the radial temperature gradient is completely negligible in vacuum as the only heat loss is via radiation.	Implementation of off-the-shelf solutions for thermocouple fastening details is ongoing. *Mauro Dalla Palma*	14_Design_Definition	25 Apr 2012	On Going	
11	9B4S7B	2	**IO to give feedback on Out of Plane Deformation of RID HHF Panels**	It is suggested that IO could review the BTR model developed by CCFE used to assess the impact of ERID panel deformations on beam transmission (i.e. in particular cross check if over-conservative).	IO is carrying out BTR analyses to fix the maximum allowable out of plane deformation to be afterwards verified by undertaking thermo-mechanical analyses of panels. *Mauro Dalla Palma*	14_Design_Definition	25 Apr 2012	On Going	
12	9AZTJG	2	**The defined RH features should be implemented in the component design.**	The defined RH interfaces should be implemented in the component design. - Pipes with Removable Bellows Assembly. - RH compatible electrical connectors. - Drain pipes with RH compatible standard pipe interfaces in accessible location of the Beam Line Transporter. - Spaces to access to the tooling location should be checked.	Assembly drawings should be prepared with indication of interfaces and space reservation for accesses considering all boundary conditions. *Mauro Dalla Palma*	07_Remote_Handling	25 Apr 2012	On Going	

Chit No.	IDM Ref.	Cat.	Title	Chit Description	Chit Comments	Classification	Due Date	Action Status	Action Response
13	9AYC4Z	2	**Alignment of the monorail crane and the beam line components during assembly.**	The issues for the alignment of the monorail to the connecting duct and the beam line components should be resolved. No feasible solution within the limited assembly time schedule has been developed. Possible alternative scenario would be to install the monorail crane aligned to the VV port stub before the connecting duct installation, and to accommodate the remaining misalignment by adjusting the lifting frame of the beam line component.	Requirements shall be provided by the IO. *Mauro Dalla Palma*	07_Remote_Handling	25 Apr 2012	On Going	
14	96J7LF	1	**Bellows for RID - Conformity with Vacuum Handbook**	The bellows used for the water cooling circuit of the RID are not conform to the ITER VH. If the bellows cannot be avoided and need to be kept for the final design a request for deviation must be raised for each of the bellows according to the ITER QA program.	See chit No. 7. *Mauro Dalla Palma*	14_Design_Definition	25 Apr 2012	Complete	After the PDR a meeting was held with the vacuum group on 04/04/2012 where it was established that requests for acceptance rather than deviation requests are needed, see link Preparatory for the deviation requests covering the use of water bellows in the NBI https://user.iter.org/?uid=9BV67B). The action was on IO NB Section to prepare the necessary documents (one document per component and per type of bellow). For the ERID the following documents have now been approved: Acceptance for HNB ERID Bellows on inlet & outlet water pipes https://user.iter.org/?uid=A2SZ4P Request for acceptace - Water bellows in VQC1 (HNB) vacuum (A2SZ4P) The Chairman has confirmed that this answers adequately the associated e category 1 chit. link: ITER_D_AGQEN9 - Email on the resolution of the category 1 chits of the BLC PDR - Approval of requests for acceptance https://user.iter.org/?uid=AGQEN9

Chit No.	IDM Ref.	Cat.	Title	Chit Description	Chit Comments	Classification	Due Date	Action Status	Action Response
15	9AUWYN	2	**Assessment of pressure drop needed to avoid freezing**	The US DA designing the PHTS for NBI proposes a low flow pump (to prevent freezing when the injectors are not working. They propose a maximum pressure drop of 0.4MPa and flow of 85 kg/s. Is this sufficient to ensure flow in all elements of the RID, NED and calorimeter for up to 3 injectors (upgrade scenario)?	IO will provide coolant pressure drop and flow rate partitioning among grounded components considering present piping configuration; this parameters will be used to analyse local conditions for freezing. *Mauro Dalla Palma*	14_Design_Definition	25 Apr 2012	On Going	
16	9B6D8W	2	**Coolant pipe ceramic insulators structural integrity**	Steps should be taken to ensure that the coolant pipe ceramic insulators are placed in compression at all times. Given what seems a lot of space available around the pipes, the addition of electrically insulated metal members in tension, to keep the ceramics in compression, should be relatively straightforward.	See chit No. 4. *Mauro Dalla Palma*	20_Assembly	25 Apr 2012	On Going	
17	9AYP9L		**ERID BSEs stress concentration**	If deep drilling is used from both ends of the BSEs, potentially causing a "step", then the stress concentrations at the internal edges need to be assessed as the wall is thin.	See chit No. 5. *Mauro Dalla Palma*				
18	3397F2		**FMECA for RID**	The FMECA for the RID should consider the risk of damages in the ceramic insulators in the water circuit and in the supports.	Chit owner is IO (Joseph and Darshan). *Mauro Dalla Palma*				
19	33BGTB	2	**Deephole drilling and cleaning operation**	The process of cleaning the deep holes drilled by the deep hole drilling process needs to be established properly to ascertain that no residues are left behind in the channels, as, particulate residues left behind have the potential risk of flowing into the water circuit and thereby pose a risk to the water quality.	See chit No. 5. *Mauro Dalla Palma*	18_Manufacturing	25 Apr 2012	On Going	
20	33WU3Q	3	**Secondary electron emission from RID**	The secondary electron emission in RID is considered as 6 per ion. The feasibility of applying a coating (Ti (?)) on the RID panels to reduce the secondary electron emission may be considered for assessment, for a possible reduction in the ratings for the PS for the ERID.	RID panels are not Ti coated. Current rating shall be verified in PS specification (IO will manage this chit, Joseph and Hans). *Mauro Dalla Palma*	01_Physics	25 Apr 2012	On Going	

Chit No.	IDM Ref.	Cat.	Title	Chit Description	Chit Comments	Classification	Due Date	Action Status	Action Response
21	33YGN3	3	**Electrodeposited stubs - alternatives to EBW**	Electrodeposition of SS stubs for the neutraliser has been proposed as a possible manufacturing alternative (to EBW - the reference process). The consideration is an interesting one as it reduces the demand on the size of EBW facility. To arrive at a good assessment of the feasibility, it is suggested that the tests for leak and pressure tightness be carried out at operational temperatures and possibly under similar loading conditions.	EBW is the reference welding process in technical specifications. *Mauro Dalla Palma*	18_Manufacturing	25 Apr 2012	On Going	
22	343HBG		**E-RID top cover**	The purpose of the top cover on the ERID model is not clear. Removal of this top cover could aid in a better pumping of the ERID. Is protection from devious particles a consideration? In such a situation, could baffles be considered to trap the same and allow pumping at the same time.	See chit No. 6. *Mauro Dalla Palma*				
23	3ZSMTX		**Requirements and standards**	New requirements of the MITICA/HNB BLCs and MITICA Vessel, including all interfaces and RH requirements, shall be updated in the reference documents before continuing with the design. In particular the applicability of standards or laws, such as ESPN (being non SIC-1 components), will have to be clarified in terms of requirements as well as any change in the quality class. The interface requirements of the BLCs should be verified. Up-to-dated interfaces should be recorded in a revised version of the Interface Control Documents (ICDs) and Interface Control Table (ICT). The present status of the ICT is documented in the attached table. Interfaces of BLC with vessel /RH: Reference to Specific Interfaces management in MITICA (MITICA Vessel-BLCs) should be added.	IO will provide new updated documents. *Mauro Dalla Palma*				
24	426BDF	2	**Manufacturability of RID and NED panels**	The fabrication of the panels for both the NED and the RID are quite challenging due to the long channelled structure. A full scale prototype is needed to confirm the design solutions adopted before developing the B-to-P design.	See chit No. 5. *Mauro Dalla Palma*	18_Manufacturing	25 Apr 2012	On Going	

Chit No.	IDM Ref.	Cat.	Title	Chit Description	Chit Comments	Classification	Due Date	Action Status	Action Response
25	7MZ4L6	3	**Panel structure to prevent an uneven deformation of the beam dump surface of the RID**	The beam dump face of the RID needs to keep a smooth surface for avoiding a local overheating. Each panel which consists of the beam dump face must be designed to restrict each other to realize a flat surface without thermal deformation or disorder of each panel.	Panels have been designed with a complementarily shaped groove-and-projection configuration so that one panel is collaborating with the contiguous one with the groove and the projection in an imbricated position in a compact arrangement. Thermo-mechanical verifications will be repeated for the new design. *Mauro Dalla Palma*	14_Design_Definition	25 Apr 2012	On Going	
26	666YW7	3	**Version number of reference documents**	Put version number of reference document in presentation material. All IO reference documents in PA shall be approved before sign-off and put it with version number.	IO will give approved version. *Mauro Dalla Palma*	02_Quality_Management	25 Apr 2012	On Going	
27	66C8XC		**ESPN**	Clarify application of ESPN.	Chit owner is IO that will determine activation level of water waiting final volume. *Mauro Dalla Palma*				
28	9B37GZ	3	**Pipe support on eitherside of the insulating break**	Investigate pipe support on either side of the insulating break to reduce stress exerted onto the insulator from the pipework.	See chit No. 4. *Mauro Dalla Palma*	14_Design_Definition	25 Apr 2012	On Going	
29	9B59BN	2	**Fatigue calculations for the RID**	Fatigue calculations have to be carried out for the RID; considering the beam-on / beam-off operational conditions and sweeping. It should be investigated if beam breakdowns have a non-negligible effect on the total number of cycles.	Analyses and verifications already done since 2010; they will be repeated considering new design. *Mauro Dalla Palma*	14_Design_Definition	25 Apr 2012	On Going	

Chit No.	IDM Ref.	Cat.	Title	Chit Description	Chit Comments	Classification	Due Date	Action Status	Action Response
30	35CS7U	2	**biasing voltage for ERID HV panels**	The requirement to operate the HV panels at mean 25 kV implies that the power deposition is concentrated in a small portion of the panels area. A reduced mean voltage and an increased sweeping could allow to spread the power on a larger area and therefore to reduce the peak temperature and to increase the operating margins of the ERID. Past analyses demonstrated that a lower mean voltage (in the range of 20 kV) is capable to extend the power deposition on a length in the order of 1 m, whereas the overall active length of the ERID is 1.8 m.	The activity is ongoing. *Mauro Dalla Palma*	06_Requirements_PR	25 Apr 2012	On Going	
31	3V9J8F		**BLC interfaces**	The interface requirements of the BLCs should be verified. Up-to-dated interfaces should be recorder in a revised version of the Interface Control Documents (ICDs) and Interface Control Table (ICT). The present status of the ICT is documented in the attached table.	Chit owner is IO; see chit No. 23. *Mauro Dalla Palma*				
32	66CMLJ	1	**Quality Classification**	Re-review Quality Classification based on ITER_D_24VQES v3.0 Quality Classification Determination. Loss of plasma operation more than 3 weeks due to failure is QC1.	**Comment By Falter Hans Dieter:** This chit was withdrawn after the meeting. See ITER_D_9GB7EK	02_Quality_Management	25 Apr 2012		
33	6KMZVD	2	**Cooling of high heat load components**	In case of loss of cooling the high heat flux components (calorimeter, ion-dump, ion-source, neutralizer etc.) will fail in few seconds and cause a coolant spill into the VV or for ex-vessel coolant breaks even a by-pass from the VV to e.g. the NB-cell. To avoid such events, beside normal control and interlocks, also a SIC system has to assure the shutdown of the beam .e.g. detection of loss of flow etc. leads via CSS to beam shut down.	Thermal analysis for simulating dry-up conditions is required as it has been done for the Neutraliser. *Mauro Dalla Palma*	04_Safety	25 Apr 2012	On Going	

Chit No.	IDM Ref.	Cat.	Title	Chit Description	Chit Comments	Classification	Due Date	Action Status	Action Response
34	9B5A7B	2	**Optimise the omega shape section of the swirl tubes that make up the calorimeter panels**	The position of the omega shape section of the swirl tubes that make up the calorimeter panels should be optimised. One criterion for that optimisation should be to minimise the fraction of the inner 'column' beams that impact on the upstream section of each swirl tube. If the RHS column beam impinges on the RHS calorimeter panel upstream of the omega section etc., the calorimeter can be used to determine the horizontal distribution of the beam amongst the 4 column beams. The CuCrZr transition depends on the conditioning e.g. annealed condition where the copper needs to be hardened. Hardening might be challenging due to the shape and size of the work piece and could lead to as possible distortion in the size during annealing. The alternative friction welding should be considered.	Current omega position is optimised to minimise portion of each beam column which falls on adjacent panel sections. *Mauro Dalla Palma*	14_Design_Definition	25 Apr 2012	On Going	
35	76ZY27	3	**Reaction forces induces by water bellows under pressure on the pneumatic gate actuator**	It is likely that water bellows under 20 bars pressure will be relatively stiff, therefore inducing significant reaction forces against the rotation of the calorimeter gates. Assessment of these forces is required to dimension the actuator mechanism and also to stress the support structure of the gates against excessive deformation. Ultimately the deflection of the gate support structure could also induce STEs deformations.	Some evaluations are ongoing. *Mauro Dalla Palma*	14_Design_Definition	25 Apr 2012	On Going	
36	96L4VA	3	**Calorimeter actuator double bellows - pressure requirement**	The first bellows connected to the BLV volume will see the high pressures of exceptional load cases. Likely 0.2 MPa-a. This pressure is an internal pressure to the first edge welded bellows and must be taken into account for its design! The bellows cartridge may need to be re-designed that the higher pressure applies to the outside of the first bellows.	Requirement document is going to be improved considering SIC requirements. Verifications will be done to fulfil all requirements. *Mauro Dalla Palma*	14_Design_Definition	25 Apr 2012	On Going	

Chit No.	IDM Ref.	Cat.	Title	Chit Description	Chit Comments	Classification	Due Date	Action Status	Action Response
37	96LURA	1	**Bellows for Calorimeter - Conformity with Vacuum Handbook**	The bellows used for the water cooling circuit of the calorimeter are not compliant to the ITER VH. If the bellows cannot be avoided and need to be kept for the final design a request for deviation must be raised for each of the bellows according to the ITER QA program.	See chit No. 7. *Mauro Dalla Palma*	14_Design_Definition	25 Apr 2012	Complete	After the PDR a meeting was held with the vacuum group on 04/04/2012 where it was established that requests for acceptance rather than deviation requests are needed, see link: Preparatory for the deviation requests covering the use of water bellows in the NBI https://user.iter.org/?uid=9BV67B). The action was on the IO NB Section to prepare the necessary documents (one document per component and per type of bellow). These documents have then been reviewed and approved by Vacuum Group. For the calorimeter the following documents have now been approved: Acceptance for HNB Calorimeter Gate Bellows https://user.iter.org/?uid=A2UKY2 Request for acceptace - Water bellows in VQC1 (HNB) vacuum (A2UKY2) Acceptance for HNB Calorimeter Bellows on inlet & outlet water pipes https://user.iter.org/?uid=A2UEBN Request for acceptace - Water bellows in VQC1 (HNB) vacuum (A2UEBN) The Chairman has confirmed that this answers adequately the associated e category 1 chit. link: ITER_D_AGQEN9 - Email on the resolution of the category 1 chits of the BLC PDR - Approval of requests for acceptance https://user.iter.org/?uid=AGQEN9
38	9AY7A3	2	**Radiation hardness of calorimeter actuator mechanism and magnetic field resilience**	The calorimeter actuator mechanism has to be designed to cope with the estimated radiation dose and the magnetic field. This is especially important for the load cell and the air motor.	Consultations with manufacturers and experts are ongoing to verify the material compatibility with the environment. *Mauro Dalla Palma*	17_Material	25 Apr 2012	On Going	

Chit No.	IDM Ref.	Cat.	Title	Chit Description	Chit Comments	Classification	Due Date	Action Status	Action Response
39	9B2AXB	2	**Calorimeter gate status**	The position of the calorimeter gates must be known. Redundant sensors and preferably using different techniques should be incorporated. These sensors must be compatible with the environment (vacuum, radiation, and magnetic field).	Some investigations about different sensor techniques and possible sensor locations will be done. *Mauro Dalla Palma*	14_Design_Definition	25 Apr 2012	On Going	
40	9AZFFP	2	**Problem with fibre insulated thermocouples**	The fibre insulated thermocouples might be affected by ECRH heating (if the Fast Shutter would be open). This type of thermocouples can therefore not be used at ITER. Kapton insulated cables are not recommended since they will age with high levels of radiation and can become brittle. It is therefore recommended to only use MI-cables for the BLC's.	See chit No. 3. *Mauro Dalla Palma*	17_Material	25 Apr 2012	On Going	
41	44RV87	2	**Integrated mechanical model**	An integrated model of the BLCs should be developed in order to carry out verifications for the agreed load cases: beam-on, draining and drying, seismic, modal analysis, etc. For this an overall FE model of the whole structure is needed in which the stresses for the various load cases can be analysed	Analyses are ongoing. *Mauro Dalla Palma*	14_Design_Definition	25 Apr 2012	On Going	
42	3XP4R9	2	**Electrical insulation of the ERID assembly w.r.t. vacuum vessel**	The ERID assembly could be electrically insulated from the adjustable bed so the ion current will flow to ground only through the cooling headers. This current and the one provided by the power supply for HV panel biasing might be measured and used as an interlock once some experimental results are available in MITICA. The insulation stacks could be placed between the adjustable bed and pads being the bed different from the other.	The activity is ongoing. *Mauro Dalla Palma*	23_Operations	25 Apr 2012	On Going	
43	7A6G59	2	**Approval of RAMI analysis update**	It is good that the RAMI analysis is being updated to reflect the latest design, however before going further, it will be necessary to get the produced documents (Functional Breakdown, Reliability Block Diagrams, Failure Modes Effects & Criticality Analysis and RAMI Summary Report) uploaded in (or at least linked to) the dedicated RAMI Analysis Results Folder 2M588T, reviewed by the HNB TROs and IO RAMI team, and approver by IO Operations Section Leader (D. van Houtte).	The chit owner is IO (Joseph and Darshan). *Mauro Dalla Palma*	11_RAMI	25 Apr 2012	On Going	

Chit No.	IDM Ref.	Cat.	Title	Chit Description	Chit Comments	Classification	Due Date	Action Status	Action Response
44	7MW2B7		**RH Compatibility Assessment documents created but not reviewed/approved.**	RHCA documents (PDFs and TDFs and RH Compatibility Report) for NED, RID and calorimeter have been created for PDR but have not been reviewed/approved as per the MQP-RH Compatibility Procedure ITER_D_2NRTWR.	The chit owner is IO (Joseph and Darshan). *Mauro Dalla Palma*				
45	7NFE7A	2	**S-ICD and ISs with RH systems not agreed and approved**	New interfaces with PBS 23 (cask transfer system and hot cell facility RH equipment) were identified just before PDR. S-ICD v 1.3 between PBS53-23 has not been reviewed and approved. Interfaces with Cask Transfer System and Hot Cell Facility RH equipment have not been agreed. None of the interface sheets with RH systems are approved. Interface with radwaste, if any, is also not clear.	The chit owner is IO (Joseph and Darshan). *Mauro Dalla Palma*	07_Remote_Handling	25 Apr 2012	On Going	
46	9B3MU2	3	**Gutters in MITICA vessel**	The proposed gutters in the floor of the MITICA vessel are not an ITER requirement. If they are incorporated then they must be designed in such a way that they can be easily cleaned.	Vessel design. *Mauro Dalla Palma*	14_Design_Definition	25 Apr 2012	On Going	
47	9AWWHN	2	**Bursting disk in MITICA Vessel**	It is proposed to install a 1.5 Bar bursting disk on the front flange on the MITICA vessel. No high pressure case has been found during calculations for ITER HNB and the only remaining high pressure case that exist for the MITICA vessel is the spark gap test when the vessel is filled with 1.4 Bar SF6. If the bursting disk would open during this test the SF6 would leak out into the environment. The need to implement the bursting disk must be justified.	Vessel design. *Mauro Dalla Palma*	14_Design_Definition	25 Apr 2012	On Going	
48	66DHGX	2	**Scope of Codes and Standards**	Clarify application of Codes and Standards RCC-MR, Section VIII, B31.3, ... and scope of application. for example: - Pressure Boundary - Bellows - Fabrication - Stress calculation - ...	**Comment By Falter Hans Dieter:** This chit was withdrawn after the meeting, see ITER_D_9GB7EK	10_Codes & Standards	25 Apr 2012		

Chit No.	IDM Ref.	Cat.	Title	Chit Description	Chit Comments	Classification	Due Date	Action Status	Action Response
49	9B44BT		**MITICA vessel should consider the RH tooling interface**	There is a functional requirement on MITICA to enable testing NB RH equipment and tools. Required tooling interface should be implemented. - the removable bellows pipe interfaces - bolting of the top lid and beam source vessel rear flange - etc. Applicable RH tool interfaces: Interface report for generic pipe tools between NB RH and NB system (ITER_D_6ZJUQ6 v1.0) Interface report for lip seal tools between NB RH and NB system (ITER_D_4P5JDN v1.0) Interface report for metallic seal between NB RH and NB system (ITER_D_64ZRC9 v1.0) Interface report for monorail crane twist lock lifting frame between NB RH and NB system (ITER_D_57DCCM v1.0) Interface report for generic bolting tools between NB RH and NB system (ITER_D_7LC58L v1.0) [Draft]Neutral Beam RH System - Design Description Document Appendix D - Generic Tools (ITER_D_7NG2AK v1.0) NB RH CMM model: (2nd March 2012) https://user.iter.org/?uid=7NX32M	Vessel design. *Mauro Dalla Palma*				
50	7L6SKG	3	**CFD calculation for Calorimeter**	CFD analysis should be performed to assess the flow distribution and local heat transfer behaviour.	Analyses completed. *Mauro Dalla Palma*	14_Design_Definition	25 Apr 2012	On Going	
51	9B4VRS	3	**Inaccessible fixing of the cryo-pump**	The fixings of the cryo-pump in the middle of the vessel is not accessible by the beam line transporter. The fixing should be moved up or should have vertical handling such as by using layshaft.	Vessel design and interface. *Mauro Dalla Palma*	07_Remote_Handling	25 Apr 2012	On Going	
52	9B2FGT	3	**Threaded bolt holes placed directly in vacuum vessel wall**	The inclusion of bolts threaded directly into the vessel wall where the two vessels meet will reduce the thickness of the wall considerably. This could lead to leaks due to undetected material defects, and also runs the risk of compromising the vessel during drilling and tapping of the holes, or lead to further complications should a thread be stripped during assembly. In addition, once under vacuum the holes will act as stress concentrations. It is suggested to consider the use of an additional welded piece which is not part of the vacuum boundary, into which bolts could be placed.	Vessel design. *Mauro Dalla Palma*	18_Manufacturing	25 Apr 2012	On Going	

Chit No.	IDM Ref.	Cat.	Title	Chit Description	Chit Comments	Classification	Due Date	Action Status	Action Response
53	7N2LJJ	2	**Prevention of beam shinethrough between swirl tubes in calorimeter design**	When copper tube is fabricated through cold working to a given shape to produce a required dump surface, a residual stress remains in the tube. This stress will be released after repeated thermal cycling. As a result the tube tends to relax back to the original shape. If that happens in the ITER calorimeter, beam shinethrough between tubes could occur. In order to avoid this kind of deformation of the tube, the tube should be constrained to prevent the shape changing, e.g. by fixing each tube mechanically to adjacent tubes. This could be done, for example, by attaching (e.g. by brazing) a feature at the rear side of the tube (the side not facing the beam) that interlocks with a matching feature on the adjacent tubes. This could also be effective in preventing plastic deformation of the tube when it is heated by beam.	IO considers that overlapping of 4 mm is sufficiently large to prevent beam shinethrough. Some tests will be done. *Mauro Dalla Palma*	18_Manufacturing	25 Apr 2012	On Going	

Chit No.	IDM Ref.	Cat.	Title	Chit Description	Chit Comments	Classification	Due Date	Action Status	Action Response
54	7N3LHD	3	**Minimization of the thermal deformation by one sided heating of the copper tube in the calorimeter**	Circular copper tubes used as components of a beam dump or calorimeter are normally heated only from one side, which can cause large thermal deformations because of the temperature gradient across the tubes. Thermal deformation will change the shape of the dump surface and may increase the heat load on the dump surface. Furthermore, if deformation occurs perpendicular to the tube axis, beam shinethrough between tubes can occur. One idea to minimize the thermal deformation on one side is to use a so-called "outer fin tube", which has been used in JT-60 NBI (both positive-ion NB and negative ion systems). The outer fin is connected to the bottom of the tube. Since the fin is irradiated by the beam as well as the top of the tube, power is conducted to the rear of the tube through the fin and the temperature difference is reduced as the result the thermal deformation becomes small. The fin has another role in that it prevents beam shinethrough between tubes by overlapping the fins of adjacent tubes. (JT-60 NBI case; RID for positive-ion NBI: tube inner diameter is 10 mm with straight water flow (without swirl tape) of 6 m/s (beam power density is 5 MW/m2 against the CHF of 10 MW/m2. The CHF was confirmed by ion beam irradiation test.), tube length:~2 m except tube bend section (this bend section is for releasing thermal expansion of the tube). RID for NNBI* tube inner diameter is 20 mm with swirl tape and water velocity is 8 m/s(?), beam power density (design value) is 15 MW/m2 against the CHF of 40 MW/m2, this CHF was also confirmed by the ion beam irradiation test, tube length (swirl tape section): ~2 m except tube bend section.)	See chit No. 53. *Mauro Dalla Palma*	14_Design_Definition	25 Apr 2012	On Going	
55	7N3X86	2	**Sputter shield for calorimeter**	A structure is needed to prevent sputtered particles from the calorimeter reaching the cryopump surface. Sputtered Cu deposition causes the emissivity of the 80 K surface to increase, and hence the heat load to the 6.5 K surface to increase. A shielding plate could be installed at the top and bottom of the "V" shaped calorimeter so as to protect the cryopump from sputtered Cu.	Protection will be provided by installing panels in MITICA; the design is ongoing. *Mauro Dalla Palma*	14_Design_Definition	25 Apr 2012	On Going	

Chit No.	IDM Ref.	Cat.	Title	Chit Description	Chit Comments	Classification	Due Date	Action Status	Action Response
56	7NFCBZ	2	**Prevention of sticking in roller system of Calorimeter**	If a roller mechanism is used in vacuum, the possibility of sticking between rotation shaft and the roller and between the roller and the surface on which it is rolling must be considered. If the mechanical load on the shaft and/or surface is large and present for a long time, the contact surfaces between roller and the shaft or the surface can easily stick to each other, even if the surface is are coated with a lubricant such as MoS2. A way to prevent sticking is the proper selection of the material for the shaft and roller surface, and to select a proper lubricant.	The materials selected for the calorimeter roller (aluminium bronze and steel) were chosen with reference to similar components on JET. This combination is used on the calorimeter hinges of the JET neutral beam system and has proved robust and reliable. *Mauro Dalla Palma*	18_Manufacturing	25 Apr 2012	On Going	
57	34Q9WA	2	**IVH requirement for tests on dissimilar joints**	For dissimilar joints appearing in the BLC's compliance needs to be ensured with IVH requirement: "Acceptance leak tests on VQC 1A or VQC 3A components which include joints of dissimilar materials shall be subject to a minimum of three thermal cycles from ambient to the maximum possible operating temperature prior to leak testing"	The requirement has been integrated in tech spec. *Mauro Dalla Palma*	19_Test & Inspection	25 Apr 2012	On Going	
58	9BS6VC	2	**Vertical stability of calorimeter swirl tubes / shine through**	Horizontal deflection of 8mm of the swirl tubes was shown. The vertical overlap of 4mm within 1.4m clamping length of the tubes seems to be small to certainly avoid shine through. Prove vertical stability of the tubes by adding asymmetric load and/or taking into account pre deformed tubes. Consider feasible tolerances of manufacturing and assembly. Add vertical constraints to the tubes if necessary, e.g. by "fins" at the back of the front tubes (~2 per tube, EB welded, possibly with ceramic surface).	Investigation of asymmetric heating is ongoing by FE analysis. An assembly jig will be used to ensure each tube can be kept at its nominal position with high accuracy during manufacturing. *Mauro Dalla Palma*	14_Design_Definition	25 Apr 2012	On Going	

Chit No.	IDM Ref.	Cat.	Title	Chit Description	Chit Comments	Classification	Due Date	Action Status	Action Response
59	9CB297	2	**ERID, HHF panel design**	Difficulties in calculating material junctions do not seem to be a strong argument for the design of the HHF panels of the RID. Allowing brazing, welding, electro deposition (or the pultrusion of CuCrZr panels) would not only solve the problems arising with the deep drilling and the insertion of the twisted tape but also allow a more efficient design. Dispensing the swirl tubes for example and considering brazed half shells and the manufacturing of the cooling channels by milling offer a wide range of design options and therefore the possibility to match the requirements perfectly. The panels could be much smaller and bowing could be reduced as well. This seems to be an easy way to enhance the efficiency of the whole beam line.	See chit No. 5. *Mauro Dalla Palma*	14_Design_Definition	25 Apr 2012	On Going	
60	9B737V	3	**Avoid the use of flexible hoses in the neutralizer**	Study if the need of having flexible hoses can be avoided in the neutraliser by first locating the electron dump after installation of the neutraliser and then connecting the supplies to the electron dump when the plates are already in the final position - or better.	See chit No. 7. *Mauro Dalla Palma*	14_Design_Definition	25 Apr 2012	On Going	
61	9PMRZ2	2	**Copy of Issue with the manufacture of the high heat flux elements of the RID - ERID BSEs stress concentration**	Two of the problems associated with the manufacture of the high heat flux elements of the RID are the 0.5 to 1mm step mid-way along each channel caused by deep drilling from each end and the complication this creates for insertion of the swirl tape in the channel. Using rectangular drawn copper sections with 2 circular channels would avoid those problems (such copper sections have been produced in the past). It is suggested to investigate further using high heat flux elements with only two channels that can be produced using such copper sections. If deep drilling is used from both ends of the BSEs, potentially causing a "step", then the stress concentrations at the internal edges need to be assessed as the wall is thin.	See chit No. 5. *Mauro Dalla Palma*	18_Manufacturing	25 Apr 2012		

Chit No.	IDM Ref.	Cat.	Title	Chit Description	Chit Comments	Classification	Due Date	Action Status	Action Response
62	9PTZVB	2	**Copy of FMECA of RID to include the possible plasma formation & insulators - FMECA for RID**	The FMECA of the RID should include the possible plasma formation inside the RID. In normal operation it is calculated that this will not occur (with a safety factor about 5). However the RID panel surfaces need "conditioning" - mainly outgassing by beam bombardment. This will occur at low power, low beam energy. During this phase plasma may form and short out the RID voltage so the current in the RID power supply will increase sharply which needs to be detected and the power supply stopped by an interlock. The insulators on the water pipes and supports were also missing from the FMECA. The FMECA for the RID should consider the risk of damages in the ceramic insulators in the water circuit and in the supports.	See chit No. 1. *Mauro Dalla Palma*	11_RAMI	25 Apr 2012		
63	9PK6W7	2	**Copy of Remove RID cover to allow for better gas flow - E-RID top cover**	The cover on the top of the RID should be removed and, if necessary, replaced with an open structure. This will increase the pumping of the RID and decrease the re-ionisation loss. The lower part of the RID should be kept as open as possible for gas flow for the same reason. The purpose of the top cover on the ERID model is not clear. Removal of this top cover could aid in a better pumping of the ERID. Is protection from devious particles a consideration? In such a situation, could baffles be considered to trap the same and allow pumping at the same time?	See chit No. 6. *Mauro Dalla Palma*	14_Design_Definition	25 Apr 2012		
64	9PWXH9	2	**Copy of Requirements and standards - ESPN - BLC interfaces**	New requirements of the MITICA/HNB BLCs and MITICA Vessel, including all interfaces and RH requirements, shall be updated in the reference documents before continuing with the design. In particular the applicability of standards or laws, such as ESPN (being non SIC-1 components), will have to be clarified in terms of requirements as well as any change in the quality class. The interface requirements of the BLCs should be verified. Up-to-dated interfaces should be recorded in a revised version of the Interface Control Documents (ICDs) and Interface Control Table (ICT). The present status of the ICT is documented in the attached table. Interfaces of BLC with vessel /RH: Reference to Specific Interfaces management in MITICA(MITICA Vessel-BLCs) should be added.	See chits No. 12, 23, 27, 31. *Mauro Dalla Palma*	10_Codes & Standards	25 Apr 2012		

Chit No.	IDM Ref.	Cat.	Title	Chit Description	Chit Comments	Classification	Due Date	Action Status	Action Response
65	9QD8AL	2	**Copy of RH Compatibility Assessment documents created but not reviewed/approved. - MITICA vessel should consider the RH tooling interface**	RHCA documents (PDFs and TDFs and RH Compatibility Report) for NED, RID and calorimeter have been created for PDR but have not been reviewed/approved as per the MQP-RH Compatibility Procedure ITER_D_2NRTWR. There is a functional requirement on MITICA to enable testing NB RH equipment and tools. Required tooling interface should be implemented. - the removable bellows pipe interfaces - bolting of the top lid and beam source vessel rear flange - etc. Applicable RH tool interfaces: Interface report for generic pipe tools between NB RH and NB system (ITER_D_6ZJUQ6 v1.0) Interface report for lip seal tools between NB RH and NB system (ITER_D_4P5JDN v1.0) Interface report for metallic seal between NB RH and NB system (ITER_D_64ZRC9 v1.0) Interface report for monorail crane twist lock lifting frame between NB RH and NB system (ITER_D_57DCCM v1.0) Interface report for generic bolting tools between NB RH and NB system (ITER_D_7LC58L v1.0) [Draft]Neutral Beam RH System - Design Description Document Appendix D - Generic Tools (ITER_D_7NG2AK v1.0). NB RH CMM model: (2nd March 2012) https://user.iter.org/?uid=7NX32M	See chits No. 44, 49. *Mauro Dalla Palma*	07_Remote_Handling	25 Apr 2012		
66	AH5UW4	2	**Use of corrugated hoses on E-Dump - Conformity with Vacuum Handbook**	The design of the electron dump has to be modified in such a way that no flexible hoses are required for the functioning of the component.	See chit No. 7. *Mauro Dalla Palma*	14_Design_Definition	25 Apr 2012		