Maintenance and Inventory Management of a LLRF System.

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Abstract

The MSK group is responsible for the low level radio frequency (LLRF) systems in several accelerators. This complex subsystem needs a good planning before construction, a reliable organization during the installation and an efficient coordination of the maintenance during the operation and the shutdown times.

The inventory management of the LLRF systems contains several tasks such as the stocking, the documentation handling and the location history during the planning, installation and maintenance of each LLRF system component. Similarly the maintenance requires a set of special procedures and teamwork between experts. They have to share important changes and results of the system, to follow up on failures and improvements, and to support and coordinate across work packages. For each coordination level different tools are used. Downtime periods are minimized via an optimization of spare-part planning, storage and testing, tracking and documentation.

This contribution presents the several tools and procedures used by the MSK

European XFEL

The European XFEL is the world's largest X-ray laser for research. The 3.4 kilometer long facility DESY starts the campus in Hamburg. The LLRF system has several stations along the accelerator, which have to regulate the accelerating field in the cavities.

The stations are located at the gun, the injector and afterwards in the linac. Each stations consist of a master and a slave system, leading to 56 racks in the accelerator of the XFEL which the MSK group has to manage and maintain. Most of the racks are equipped with a variety of different electronic components. That sums up to over 2000 objects in a range of 1.3 km which have to be uniquely treated.

FLASH

FLASH is the world's first free-electron laser (FEL), which produces laser light of short wavelengths from the extreme ultraviolet down to soft X-rays. FLASH was foreseen as a pilot test facility for the XFEL. Of course with its 315 m the facility is not as long as the XFEL, but the MSK group learned and is still learning a lot about handling a LLRF svstem



SINBAD

The Short Innovative Bunches and Accelerators at DESY (SINBAD) belongs to an accelerator and research program from the Helmholtz association. SINBAD is a central and long-term dedicated accelerator research facility for multiple independent experiments with a common infrastructure. The MSK group provide the LLRF system for the ARES (Accelerator Research Experiment at SINBAD) experiment.

This research accelerator is a ever-changing facility, whereby the requirements can change and with it the interfaces from one sub-system to the other. Due to the size and changes of

releases of the the accelerator the same device and documentation the space inside verv limited and and outside of the modifications wil racks which is not be alwavs documented



From incoming inspection to installation of the LLRF system subcomponents and cables

Incoming inspection

The income inspection workflow consists of the following:

- 1. Receiving the components
- 2. Checking the shipping documentation
- Make an entry in the database
- 4. Print and label a sticker to mark the component
- 5. Visually inspection the components
- 6. Checking the company test reports and make a random verification

Important for a big facility like the EuXFEL is that enough storage space is planned for the components (see picture on the right).

Device tests

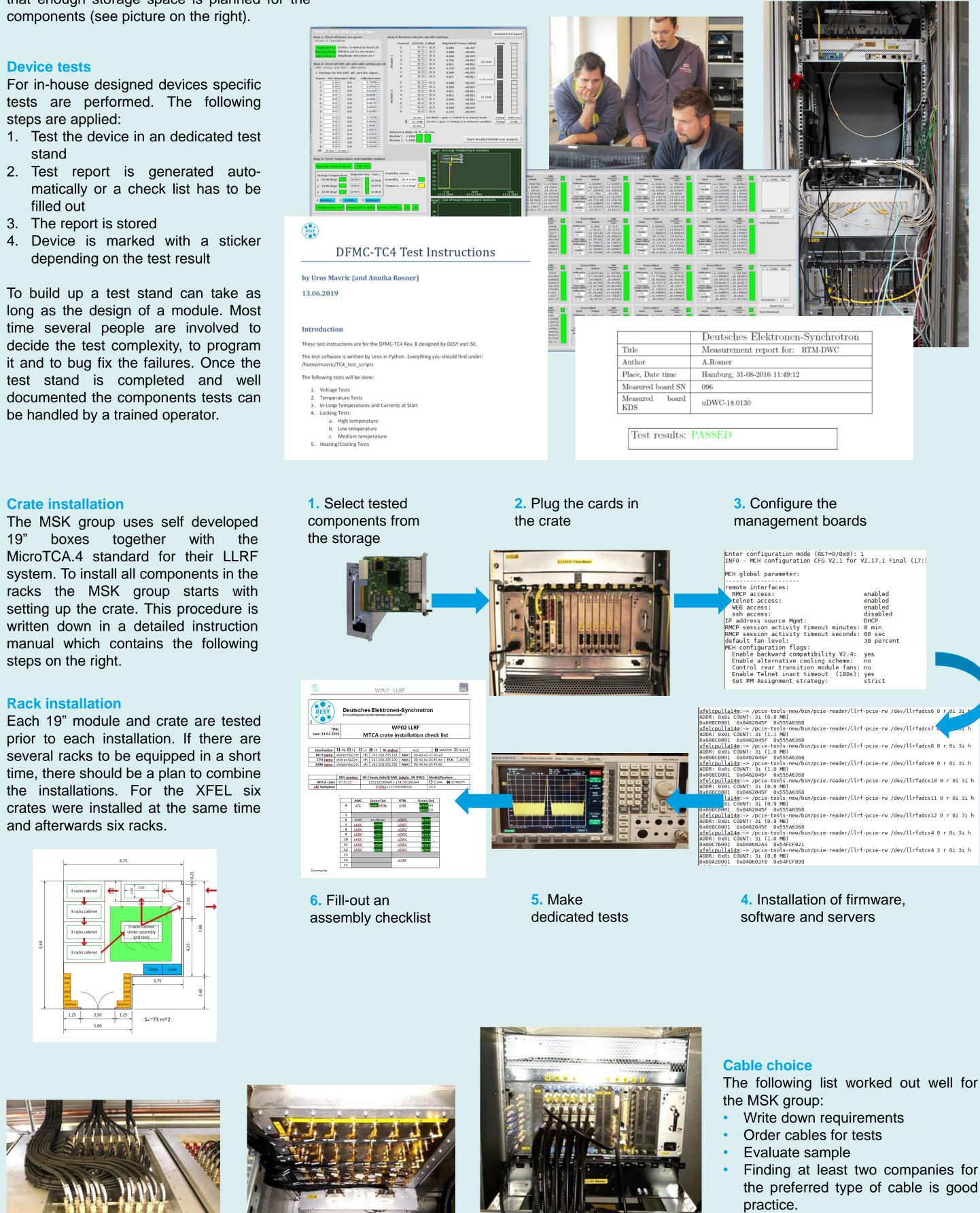
steps are applied:

- stand
- filled out
- 4. Device is marked with a sticker depending on the test result

To build up a test stand can take as long as the design of a module. Most time several people are involved to decide the test complexity, to program it and to bug fix the failures. Once the test stand is completed and well







Maintenance tools

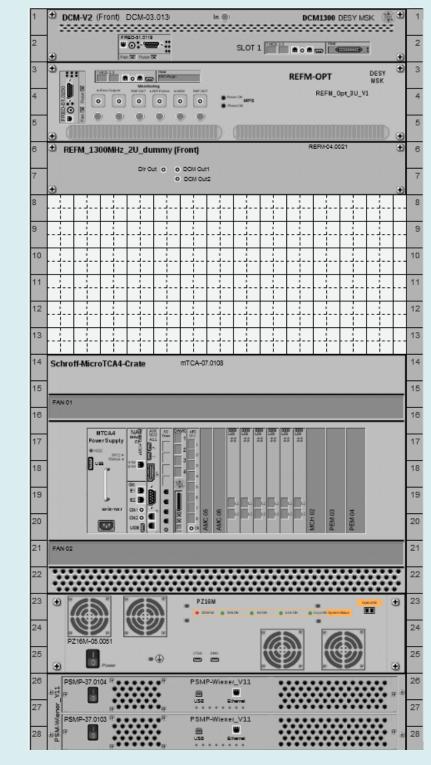
KDS and EDMS

Two tools are used for tracking the devices and save their history. KDS is a cable database system. In KDS the objects and their connected cables can be displayed on the stored graphics. Further more it allows to store and manage of all device information such as the serial number, delivery date, manufacturer, revision etc.

EDMS is a engineering document management system. EDMS is currently only used for the XFEL and it will organize a larger number of documents over the lifetime of the project. In EDMS are kept all specifications, incoming inspections, test reports and check lists. The Work Status

						La WORK Status	
- 🐼	Physical Part , D00000	Working					
	immary BOM	Properties	Related Items	Next Steps	All Versions	Released	atio
Config	guration: No saved configu	ration.				Outdated	
Expor	tTable As	∕IL ○XML				Obsolete	
E	DM S-ID.	Seri	al Number	Description			
	∃ 🐼 D00000013128979,A,1,	1 L3.A	14.Slave	Equipped LLRF Ra	ck, XTL Master or Slav	/e	
	🐼 D0000013106719,4	A,1,1 PZ16	M-05.0051	PZ16M: 16 Channe	el Piezo Driver Module	(19 inch module)	
	🐼 D0000013112079,A	A,1,1 REFI	1-04.0021	REFM: Generic Re	ference Distribution Mo	odule (19 inch module)	
	🐼 D0000013130219,A	A,1,1 L3.A	14.Slave	Rack 28U			
		A,1,1 Eq-P	SM-23.0058	Eq-PSM: Equipped	Power Supply Module	(19 inch module)	
	🖃 🐼 D0000013143259,/	A,1,1 Eq-m	TCA-07.0108	Equipped LLRF Mi	croTCA.4 9U Crate		
	🐼 D00000130245	59,A,1,1 CLKI	T-65.0028	CLKFT: MicroTCA.	4 Clock Feed-Through	(rear module)	
	🐼 D00000130757	39,A,1,1 uTC/	APS-09.0198	uPM: MicroTCA.4	Power Module		
	🐼 D00000130757	59,A,1,1 uTC/	APS-09.0199	uPM: MicroTCA.4 I	Power Module		
	🐼 D00000130779	59,A,1,1 uMC	H-10.0157	uMCH: MicroTCA.4	4 Management Controll	er Hub	
	🐼 D00000130811	19,A,1,1 uAD	C-15.0284	uADC: MicroTCA.4	4 Digitizer board SIS83	00-L2S (front module)	
	🐼 D00000130811	39,A,1,1 uAD	C-15.0285	uADC: MicroTCA.4	4 Digitizer board SIS83	00-L2S (front module)	

A8M: exchan	ge DWC in slot 11							Redmine		
	a Rosner 6 months ago. Upd	ated 24 days	ago.					Redmine is used by	by the	MSK
Status:	Closed				Start date: Due date:	2019-07-17		group to track n	-	
Priority: Assignee:	Normal Annika Rosner				% Done:	2019-07-17	0%	and issues	for	each
Category:	MTCA				Estimated time:	1.00 h		accelerator ind	epend	ontly
Target version:	XFEL_2019_08				Spent time:	1.00 h			epend	entry.
XFEL LLRF station:	A8M.L3							This open source	e tool	is a
Description								flexible project m	-	
The DWC in slot 11 (KDS	5 nr 71, bp support) is a very	old one, need	ls to be exc	hanged.				web application. T from all entries is u		
	Lipg Q 😧 2.97 MB Julien Bra jpg Q 😨 3.3 MB Julien Bra							working hours s	as pos a dedi count	sible, cated the
Related issues								given task.		
listory										
B Updated by Julien Br	anlard 3 months ago	Tracker	Status	Priority	Subject	Assignee	Updated	Project	Category	Target version
	nged from XFEL_2019_07 to .	Improvement	In Progress	Normal	TCK7,VM and CLKFT in CS9 and INJ A1 for capacito	or	2019-07-02 20:56	XFEL LLRF Installation and Maintenance	MTCA >	XFEL_2019_12
		Improvement	New	Normal	it DCM server with automatic configuration	Martin Killenberg	2019-07-02 09:14	XFEL LLRF Installation and Maintenance	Server >	XFEL_2019_12
Ve need to wait until new		Bug	In Progress	Normal	ation of MCH-RTM-BM in all L3 stations	Uros Mavric	2010-06-26 17:37	XFEL LLRF Installation and Maintenance	MTCA >	XFEL_2019_12



		•
Red	h	INP

• Target version changed from XFEL_2019_12 to XFEL_2019_08

SVN, GitHub and Jenkins

To store the hardware designs, software and firmware of the LLRF system SVN and GitHub are used. These tools provide a version and revision control. Jenkins is a continuous integration tool, which allows the developers of software and firmware to reliably build, test and deploy their designs.

All	Chimera	TK Control Applications	Firmware	Libraries Maintenance jobs	SoftwareTools		
S	w	Name ↓		Last Su	Iccess	Last Failure	
	<i>(</i>	FPGA Firmware		N/A		N/A	
	*	Fred_BootLoader		1 yr 10	mo - <u>r4586-b6</u>	N/A	
	*	Fred_Firmware		3 mo 1	7 days - <u>r6049-b127</u>	N/A	
	*	Fred_Firmware_Tags		3 mo 1	7 days - <u>4.0.2_b57</u>	1 yr 5 mo - <u>fred3_beta11_b32</u>	
	*	Idd_firmware		6 mo 1	3 days - <u>head-32a4559</u>	N/A	
	*	Idd_firmware_tags		6 mo 1	3 days - <u>03.00.06-edd1df4</u>	N/A	

D:\02_Projects\DRTM-VM2LF - Update - TortoiseSVN Revision HEAD revision Show log Revision Update Depth Choose items... Working copy Make depth sticky DRTM-CLKFT branches 🔺 📗 tags 🖻 퉲 Rev A OK Cancel D Nev B RevB1 a 📗 trunk Altium Files Documents

Conclusion

- The LLRF system of the EuXFEL was planned in a very efficient way, due to the experience gained at FLASH
- To standardize parts decreases malfunctions, guarantee quality and boost productivity
- Equipping the system similar brings the inventory management and the



and afterwards six racks.

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		Final	Labels	İ.										
	Description				Cable From (Side1 Connector)					To (Side2 Connector)				
Sidel Connector Side2 Connector	Signal Name	Cable Label (Side 1)	Cable Label (Side 2)	Cable Type	Cable Lenght [c	m] Rac	c Crate/Device	Device In short	Connector type	Connecto r	Rack Crate/Device	Device In short	Connector type	Cont
	L1.A2.Sp.M2.PRB.C1			JYB100PUR		R2	DCM Rear Panel	DCMR	FM8W8	Out2.1	R2 MTCA RTM DWC8300 Slot 11		FM8W8	Ch1
	L1.A2.Sp.M2.PRB.C2			JYB100PUR		R2	DCM Rear Panel	DCMR	FM8W8	Out2.2	R2 MTCA RTM DWC8300 Slot 11		FM8W8	Ch2
R2.DCMR.Out2.3 R2.DWC.11.Ch3	L1.A2.Sp.M2.PRB.C3			JYB100PUR		B2	DCM Rear Panel	DCMR	FM8W8	Out2.3	R2 MTCA RTM DWC8300 Slot 11	DWC.11	FM8W8	Ch3

Cab	le installat	tion	
The	followina	list	contair

ns details to make the installation as smooth as possible:

- Cable list
- Cable label on both ends
- Label on the devices
- Custom length
- Cable ducts

maintenance of the system to its minimum of workload Check lists are essential, they save time and brain power Well documented procedures minimizes the potential error during tests Version control is a great way to keep track of which version is currently under development, in the test phase or installed

Outlook:

- Minimize the manual effort to increase the information flow between the two databases and apply missing features
- Get more statistics from redmine for evaluation

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