Elettra Sincrotrone Trieste

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EUROPEAN SPALLATION SOURCE

- Critical Design Review -

The WS acquisition system project overview

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WS Acquisition System CDR: guidelines to the Committee

Monday, 5 March 2018

09:00 - 09:30	Arrival *30'*	
09:30 - 09:40	Introduction and committee charge *10'* Speaker: Dr. Andreas Jansson (European Spallation Source ERIC)	
09:40 - 10:00	WS acquisition system: Requirements *20'* Speaker: Clement Derrez (European Spallation Source ERIC) Material: Slides	
10:00 - 10:20	The WS Acquisition System project overview *20'* Speaker: Dr. Mario Ferianis (Sincrotrone Trieste) Material: Slides document	**WS _SysDescription_rev1.4_01-03-18.pdf**
10:20 - 10:40	Coffee break	
10:40 - 11:00	Controls infrastructure *20'* Speaker: Joao Paulo Martins (European Spallation Source ERIC)	
11:00 - 11:30	Analog Front End & Back End Design *30'* Speaker: Mr. Raffaele De Monte (Elettra) Material: Slides	
11:30 - 12:00	Optical Front End Design *30'* Speaker: Dr. Sandi Grulja (Elettra) Material: Slides	
12:00 - 13:30	Lunch	
13:30 - 14:00	Tests results at Elettra & LINAC4 *30'* Speaker: Mr. Raffaele De Monte (Elettra) Material: Slides	
14:00 - 14:40	Cabling and Installation *40'* Speaker: Dr. Sandi Grulja (Elettra) Material: Slides document	WS_Interface_rev3.0_23-02-18.pdf
14:40 - 15:10	Software development, EPICS integration *30'* Speaker: Stefano Cleva Material: Slides	
15:10 - 15:30	Coffee break	
15:30 - 16:00	Planning, budget, reliability, response to PDR *30'* Speaker: Dr. Mario Ferianis (Sincrotrone Trieste) Material: Slides document	WS_Quality_rev1.0.pdf WS_Safety_rev2.0_26-02-18.pdf WS_RAMI_rev1.0_19-02-18.pdf WS_Time Schedule_rev1.0_19-02-18.pdf WSACQ 2018_02_26.pdf
16:00 - 16:20	Verification strategy *20'* Speaker: Clement Derrez (European Spallation Source ERIC) Material: Slides document	
16:20 - 17:20	committee discussion *1h0'*	

WS Acquisition
Critical Design Review

Objective

- ✓ Have the design approved by the Committee to start the **Production Phase**

How

- ✓ By reviewing the design of the system
- ✓ By presenting the characteristics of the system
- ✓ By presenting the performances, so far achieved
- ✓ By presenting the cabling system & racks
- ✓ By presenting the production schedule (forecast) & budget
- ✓ By presenting the support documentation (inc. Quality, RAMI, critical paths)
- ✓ By running a real-time DEMO session

WS Acquisition System Design

Our design is based on:

- ✓ Design, development and integration of in-house developed HW modules
- ✓ Integration of COTS HW boards into the ESS ICS
- ✓ Development of a custom control and processing SW, running under EPICS
- ✓ Design of a suitable cabling system

Milestone achieved, so far

✓ PDR-1	2016, June 28th
✓ PDR-2	2016, December 13th
✓ Prototype development (AFE, OFE, BE)	mid 2017
✓ Epics code development	end 2017
✓ Test at Partner Lab (AFE+BE+SW)	2017, Oct,10-13 & Nov 7-10
✓ IKC Tech Annex preparation and signature	2018, Feb/Mar

WS ACQ SYS summary table

item	MEBT	SPOKE	ELLIPTICAL	A2T	Total	notes
AFE	3	3	4	1	11	+ 2 spares = **13** in total
BE	3	3	4	1	11	+ 2 spares = **13** in total
OFE	0	0	4	1	5	+1 spare + 3 FAST WS = **9**
$BE_{modified}$	0	0	4	1	5	+1 spare + 3 FAST WS = **9**
SCINT	0	0	4x4	1x4	20	not part of ST IKC
uTCA CPU	1	1	3	1	6	not part of ST IKC
ADC SIS-8300	2	2	7	2	13	not part of ST IKC
EV_RX	1	1	3	1	6	not part of ST IKC
Motion Controller (3 axis)	1 (3)	1 (6)	2 (6+2)	1 (2)	5	not part of ST IKC

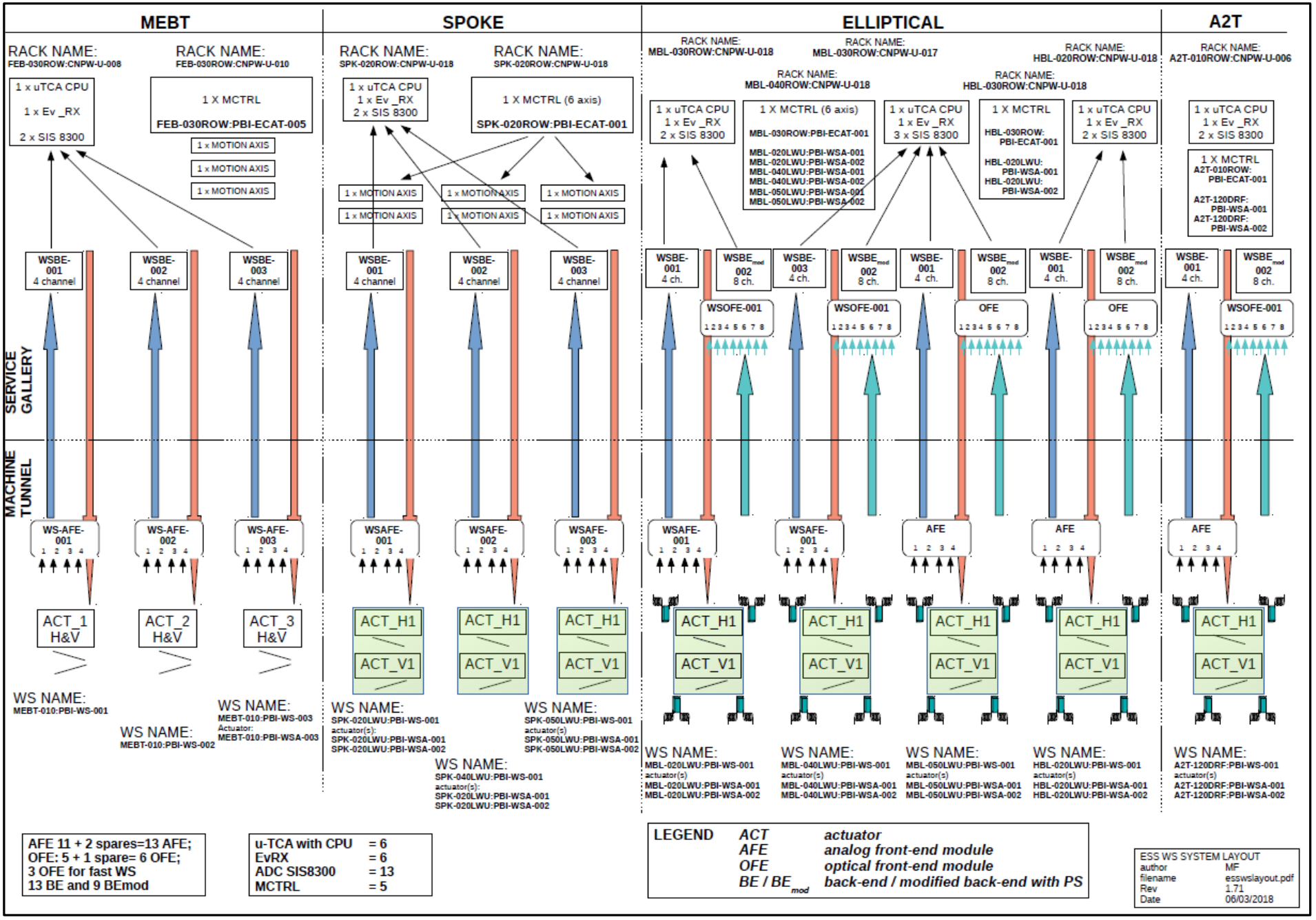
acronyms

- ✓ **AFE** analogue front end
- ✓ **BE** back end (4 ch. Module)

OFE optical front end (8 channel module)

Be_{mod} Modified back end (8 ch. module)

WS ACQ SYS block diagram



WS Acquisition System: status

SEM section: AFE + BE

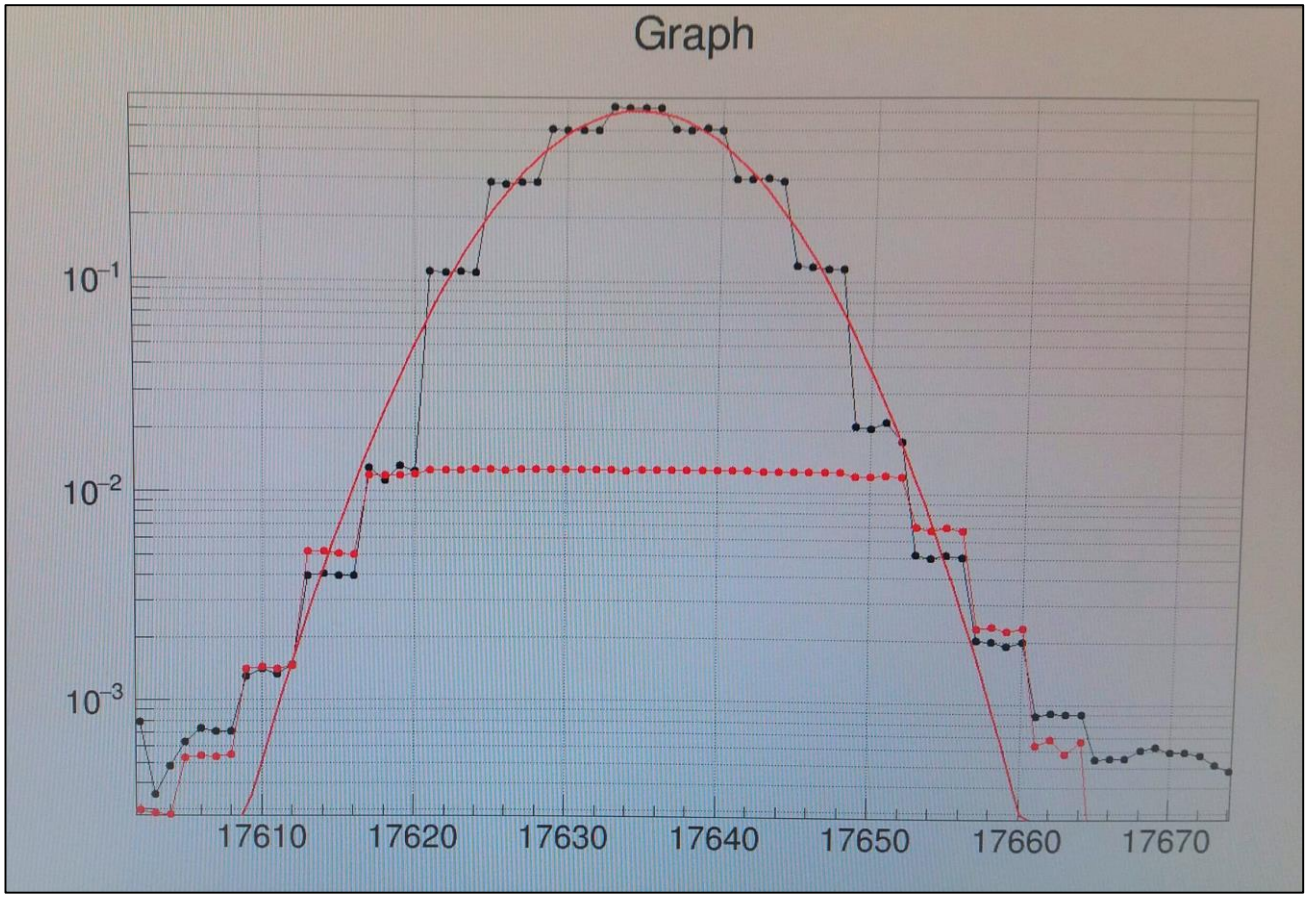
✓ AFE / BE design	completed
✓ Prototype construction	completed
✓ In-house testing	done
✓ Test with beam	done
✓ ICS Integration	running, **done 80%**
✓ Acceptance Test definition	running, **done25%**
✓ Production set-up	running, **done 20%** (PCB, BoM)

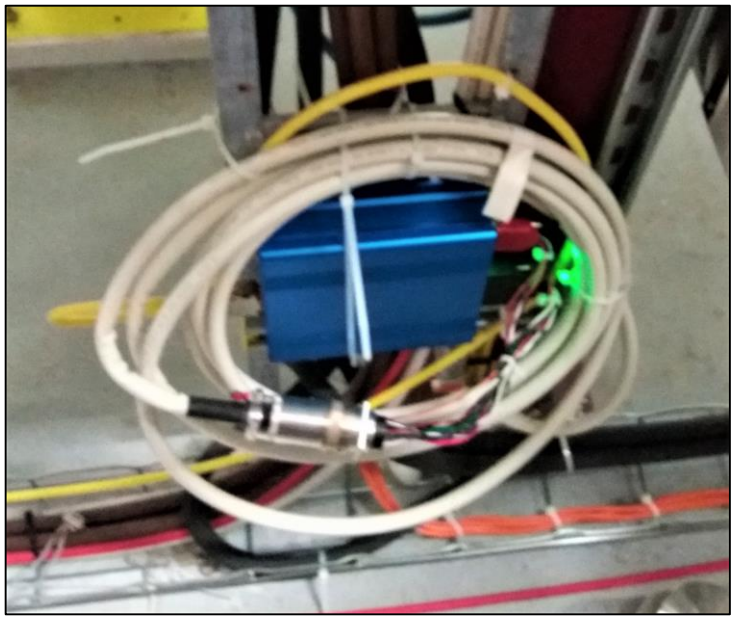
WS Acquisition System: status

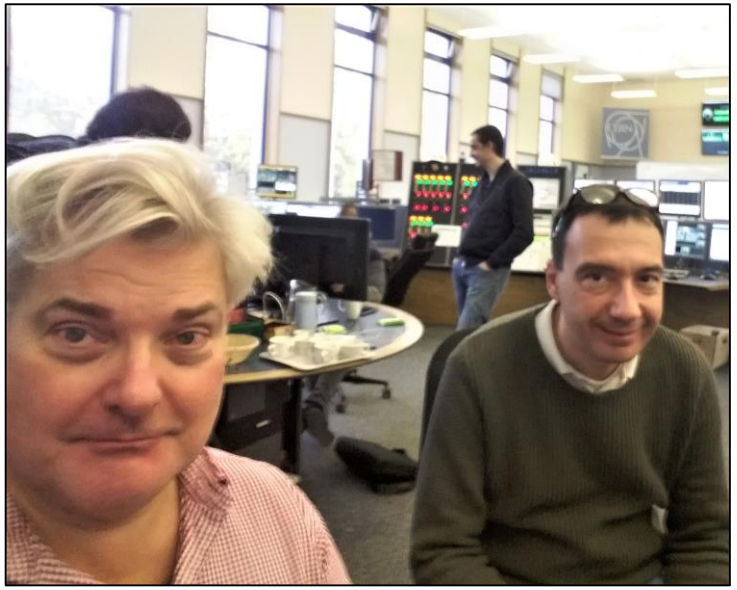
SEM section: AFE + BE

Snapshots from **Test at CERN** on LINAC4

(Oct – Nov / 2017)







WS Acquisition System: status

SCINT section: OFE + BE_{mod}

✓ OFE design	completed
✓ BE_{mod} design	completed
✓ Prototype construction	completed
✓ In-house testing	done
✓ Test with beam	**scheduled** for Spring 2018 at CERN
✓ Scintillator prototype	**running** (external task, Slava G.)
✓ ICS Integration	running, **done 50%**
✓ Acceptance Test definition	running, **done 75%**
✓ Production set-up	running, **done 20%** (PCB, BoM)

WS Acquisition System: status

SCINT section: OFE + BE_{mod}

Optical Front End:

is it really a prototype ??

WS Acquisition System: status

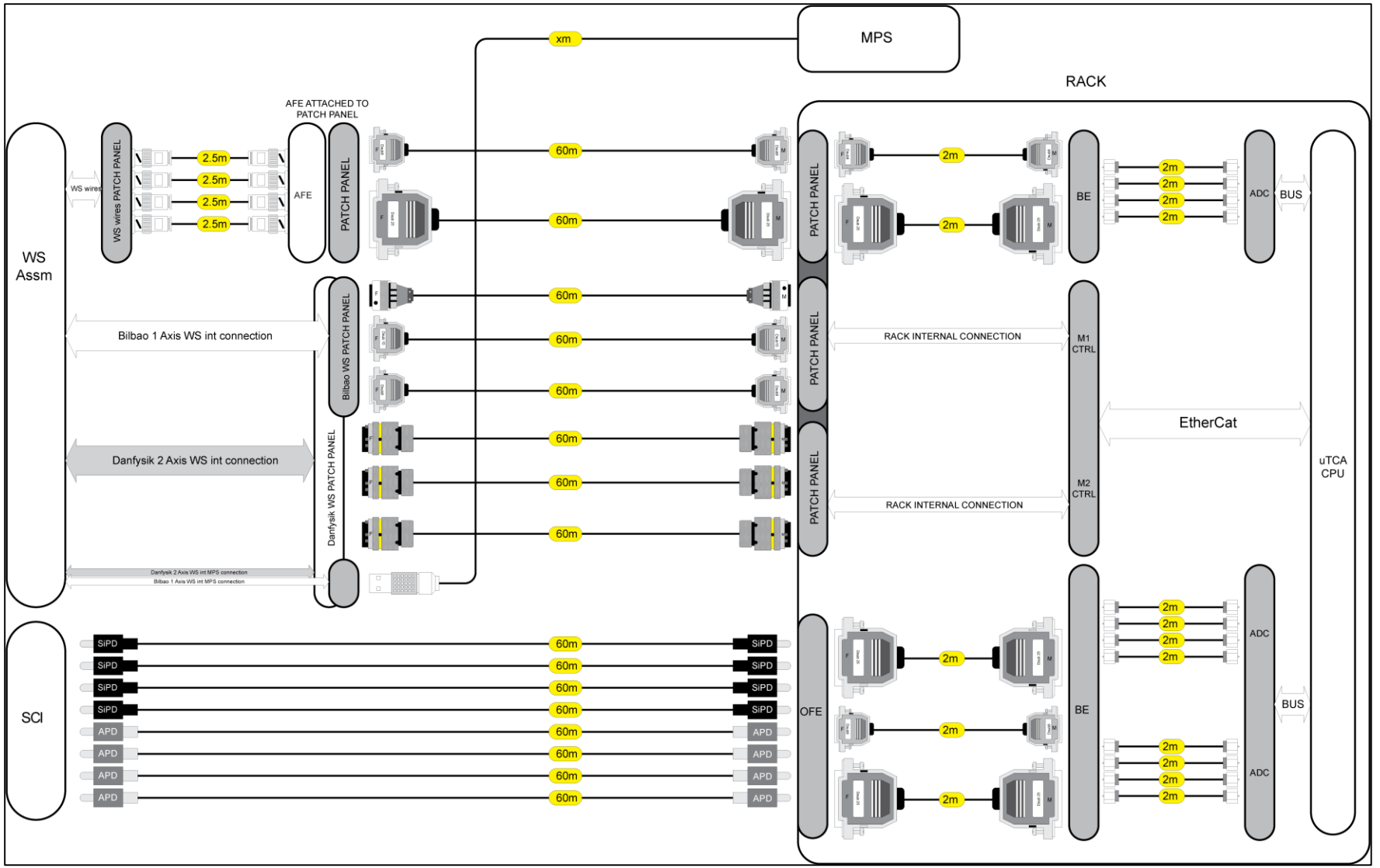
Racks & cabling

✓ Cabling specifications	completed
✓ Cabling documentation	completed
✓ WS on-board cabling	completed (with ESS Bilbao)
✓ Long run cable list	completed
✓ Rack identification	completed
✓ Rack layout	completed
✓ In-rack cabling	running, **done 50%**
✓ AFE to BE communication	tested with beam
✓ OFE to BE_{mod} via Fiber Optics	completed
✓ Final cabling and signal double check	running, **done 50%**

WS Acquisition System: status

Racks & cabling

MEBT WS cabling diagram



WS Acquisition System: status

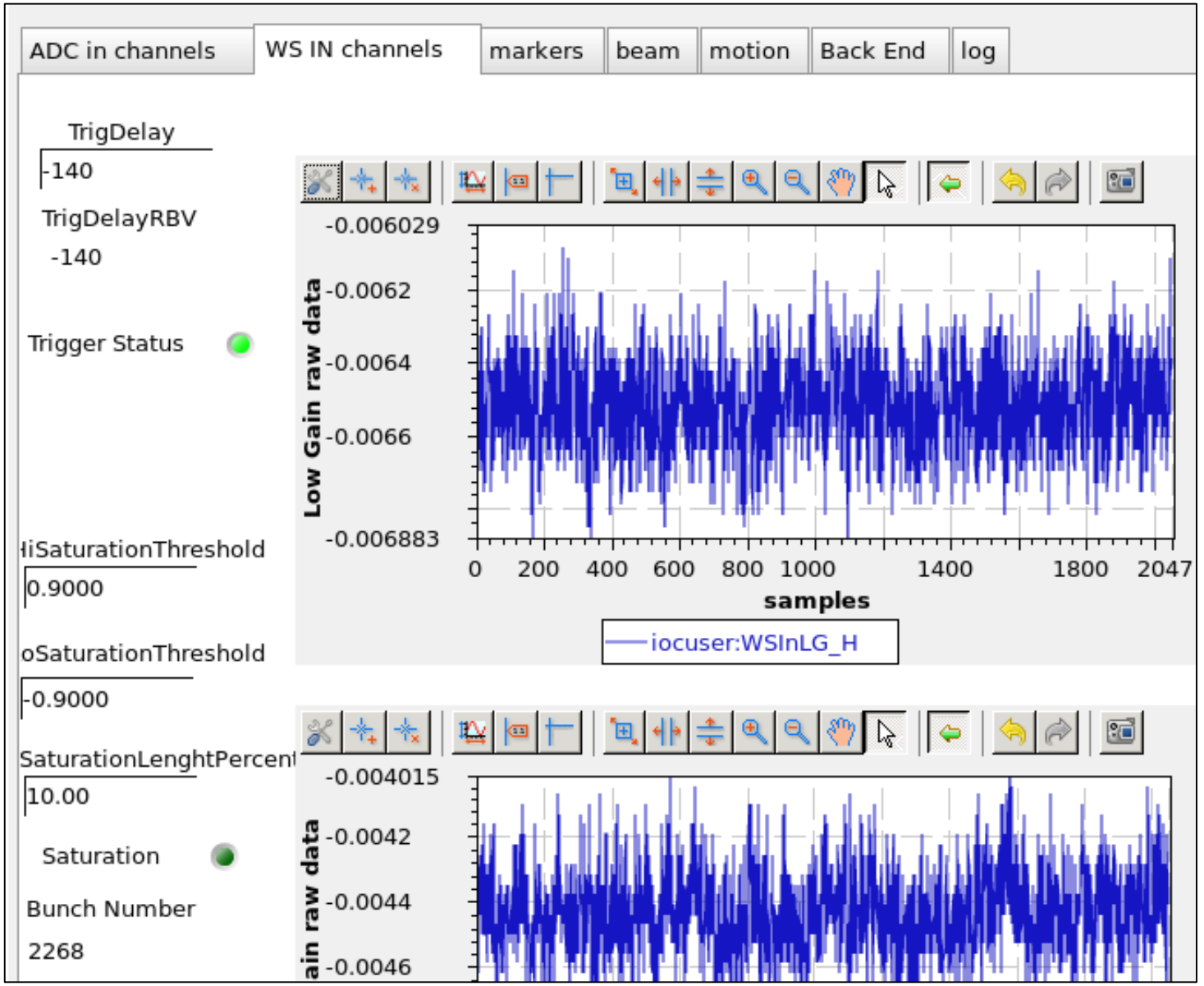
WS software

✓ Control software specifications	completed
✓ μ-TCA / EPICS dev. system set up	done
✓ Low level integration /link to ICS IOC	done
✓ Motion controller integration	done
✓ Event / timing system integration	done
✓ Control panel	running, **done 75%**
✓ Engineering panel	running, **done 75%**
✓ Data post processing	running, **done 75%**

WS Acquisition System: status

WS software

Control Panel



WS Acquisition System: schedule

Task #	Description	notes
1	System design	SEM section and SCINT section
2	PDR-1	SEM section
3	PDR-2	SCINT section
4	Prototype construction	SEM and SCINT
5	Prototype in-house test	SEM and SCINT
6	Prototype test at Partner lab	SEM
7	CDR	jointly, SEM and SCINT
8	Prototype test at Partner lab	SCINT
9	WS Vertical test (mech+ACQ SYS)	at ESS
10	Series construction	SEM
11	SEM Series in-house acceptance	at Elettra
12	SEM series delivery to ESS	
13	SAR-1	Acceptance test at ESS / SEM
14	Series construction	SCINT
15	SCINT series in-house acceptance	at Elettra
16	SCINT series delivery to ESS	
17	SAR-2	Acceptance test at ESS / SCINT

WS Acquisition System: schedule

ID	Milestone	Task Name	Duration	Start	Finish	Prede
1		**WSACQ**	**859 days**	**01/10/15**	**11/01/19**	
2	1	Kick-off meeting	0 days	01/10/15	01/10/15	
3	2	ESS final specification for the scintillator	0 days	01/04/16	01/04/16	
4		WS ACQ SYS layout definition	198 days	01/10/15	30/06/16	
5		Design of SEM prototype	198 days	01/10/15	30/06/16	
6		SEM ICS integration preliminary design	132 days	01/01/16	30/06/16	
7	4	PDR-1 Full system SEM (ICS+AD)	0 days	28/06/16	28/06/16	
8		Shipment of 1st ICS development station to Elettra	0 days	15/02/17	15/02/17	
9		SEM ACQ SYS design	88 days	01/06/16	30/09/16	
10		SEM board&module; prototype & characterization	195 days	01/09/16	31/05/17	
11		Controls Detailed Design Document	0 days	16/12/16	16/12/16	
12		Control Acceptance Test Plan	0 days	30/06/17	30/06/17	
13		SEM prototype integration in ICS	97 days	01/12/16	14/04/17	
14		SEM ICS engineering and interface panels	108 days	15/02/17	14/07/17	8
15		SEM ICS computation SW	108 days	15/02/17	14/07/17	8
16		SCINT detection protoype design	87 days	01/09/16	31/12/16	
17		SCINT ICS integration design	195 days	01/11/16	31/07/17	
18	6	PDR- 2 - Full system SCINT	0 days	13/12/16	13/12/16	
19		Shipment of 2nd ICS development station to Elettra	0 days	31/10/17	31/10/17	
20		Delivery of final uTCA boards to Elettra	0 days	31/10/17	31/10/17	
21		SCINT ACQ SYS prototype	65 days	02/01/17	31/03/17	
22		SCINT ACQ SYS CDR Data package	109 days	01/03/17	31/07/17	
23		SCINT PROTOTYPE characterization	129 days	01/02/17	31/07/17	
24		SCINT prototype integration in ICS	44 days	31/10/17	29/12/17	19
25		Delivery of one Danphysique mechanical WS assembly to ESS	0 days	15/06/17	15/06/17	
26		SCINT ICS engineering and interface panels	44 days	31/10/17	29/12/17	19
27		SCINT computation SW	44 days	31/10/17	29/12/17	19
28	9	CDR- 1 - Full system design SEM (ICS+AD)	2 days	05/03/18	06/03/18	
29	11	CDR- 2 - Full system design (SCINT)	2 days	05/03/18	06/03/18	

WS Acquisition System: schedule

Differently from what originally planned, also due to the overall ESS project delays, the developments of the two sub-systems of the WS ACQ SYS, the SEM section and the SCINT section, ended almost at the same time resulting in a single CDR.

There are also some other minor changes from what originally foreseen, like:

- line 19 *shipment of the 2nd dev. station to Elettra* …. never accomplished
- line 20 *delivery of final μ-TCA acq. board* ….. never accomplished
- line 25 *delivery of WS mech. assembly* …… never accomplished

WS Acquisition System: schedule

28		9	CDR- 1 - Full system design SEM (ICS+AD)	2 days	05/03/18	06/03/18	
29		11	CDR- 2 - Full system design (SCINT)	2 days	05/03/18	06/03/18	
30			setup TRR data package	216 days	06/11/17	03/09/18	
31		15	TRR -Test readiness for SEM prototype	0 days	14/09/18	14/09/18	
32			In-house test of SEM boards (AFE+BE)	86 days	01/02/17	31/05/17	
33		12	Vertical test in lab: test of WSAS on WS MECH at ESS	22 days	19/04/18	18/05/18	25
34			SEM Prototype TESTED (no beam)	0 days	30/06/17	30/06/17	
35			arrange AFE module test at partner lab; including ICS part	119 days	04/04/17	15/09/17	
36		7	(AFE+BE+ADC) module test at partner lab	29 days	10/10/17	17/11/17	
37			AFE Prototype TESTED (with beam, @PARTNER LAB)	0 days	17/11/17	17/11/17	36
38			Construction budget release after Signature	0 days	23/02/18	23/02/18	
39			SEM PO for: Components; PCB; Assembly	24 days	23/02/18	28/03/18	38
40		14	Delivery of first series to ESS (SEM)	60 days	29/03/18	20/06/18	39
41			Manufacturing of SEM module series	56 days	21/06/18	06/09/18	40
42			In-house acceptance test of SEM module series	19 days	07/09/18	03/10/18	41
43			Shipment to ESS – SEM modules	5 days	04/10/18	10/10/18	42
44			Delivery of SCINT prototype by ESS	0 days	27/04/18	27/04/18	
45		13	SCINT detector prototype test at Partner facility (SCINT)	25 days	27/04/18	31/05/18	44
46			SCINT mode TESTED	0 days	31/05/18	31/05/18	45
47			SCINT PO for: Components; PCB; Assembly	50 days	01/06/18	09/08/18	46
48			Manufacturing of SCINT Module series	80 days	10/08/18	29/11/18	47
49			In-house acceptance test of SCINT module series	20 days	30/11/18	27/12/18	48
50		17	SAR-1 SEM only	0 days	12/10/18	12/10/18	43
51			Shipment to ESS – OFE modules	11 days	28/12/18	11/01/19	49
52			COTS hardware available & tested at ESS site	0 days	01/06/18	01/06/18	
53		21	SAR-2 Full system SCINT	0 days	11/01/19	11/01/19	51

WS Acquisition System: schedule

- line 32 *in-house test of SEM boards* …. completed
- line 34 *SEM prototype tested* …. completed
- line 35 *arrange AFE module test at Partner Lab* …. completed
- line 36 *(AFE+BE+ADC) module test at P. Lab.* …. completed
- line 37 *AFE prototype tested (with beam at P. Lab.)* completed

• SCINT test at Partner lab	line 45
• Vertical integration with one mechanical set-up	line 33
• Production of the two series: SEM and SCINT	lines 39 to 41 lines 47 to 48
• Acceptance test, in-house at Elettra	lines 42 & 49
• Shipment to ESS	lines 43 & 51
• SAR, 1 and 2	lines 50 & 53

Next steps …

Vertical Integration Test (VIT)

- ✓ Multi partner effort (Elettra, ESS diag & ICS, ESS bilbao…)
- ✓ At ESS, in a suitable laboratory: faster debugging and fixing
- ✓ The final output of the VIT is the synchronous acquisition of both the AFE and OFE outputs while the WS is moving, either in "**fly mode**" or "**step by step mode**", while both electrical pulse generator and diode laser are generating pulses of programmable and variable amplitude (*to mimic the signals generated during a WS scan*). Once the scan is over, the FW processes the acquired data and plots the calculated profile
- ✓ Test the WS ACQ SYS integration & portability into ESS / ICS
- ✓ Test the interfacing to the WS mechanics

Install a full prototype system in LEBT

- ✓ Test the cabling system in-situ

Finalize the acceptance tests @ ESS

- ✓ Key task for successful SAR completion

Start and complete the series production (SEM & SCINT)

- ✓ Agree on delivery / shipment schedule

Vertical Integration Test (VIT)

- WS ACQ SYS with:
  - AFE prototype
  - BE prototype
  - μ-TCA crate with boards (CPU, ADC, EV_Rx)
  - Motion controller
  - OFE prototype
  - BE_{mod} prototype
  - Short WS ACQ SYS cables
  - Control panel
  - Engineering panel
  - Acquired data processing

- Long Run cables (short stub)
- Local Ev_gen with FO output

- Local control PC / WS
- Local PLC to mimic machine safety I/Os

- Pulse generator to mimic beam current
- Diode laser to mimic scintillator light signal

- anything else I may have forgotten

Next talk …

- **Production schedule and budget**
- **Quality**
- **Safety**
- **RAMI**
- **Risk Assessment**

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