



# LIU BWS

## Electronics status

18.06.2019 J. Emery



# Plan

- Electronics design
- BWSAIF: Latest validated parts
- Electronics production



# New procedure revision for motor cable assembly

- EDMS 1726725 to instruct EN/EL and EN/EA on assembly
- New revision (V3) to simplify assembly (proposed by EN/EA) and for safety reasons (change in tooling)
- New revision will be signed by EN/EL, EN/EA and A-DSO BE (safety)
- Procedure revision 3 by Guillaume.

## STEP 1 HOW TO DO IT CORRECTLY [1/5]



*Make a full 360 turn with the tool n°1 while having carefully adjusted the height of the blade, depending on the thickness of the black jacket.*

**DO NOT CUT TOO DEEP OR YOU WILL DAMAGE THE SHIELDING NEEDED FOR NEXT STEP !!!**





# Electronics design

- Last 2 weeks good progress on BWSAIF HW&FW (see later)
- BWSMIB test procedure completed (Jose Maria)
- BWSMCU  
Cable harness assembled + validated (Guillaume)  
New fans part number (Guillaume)
- Next step:  
Assemble complete crate for complete test of the interaction between boards
- Design office jobs
  - 1) BWSAIF -> V4 to do
  - 2) BWSCPC -> V4 to check almost finished
  - 3) BWSADP -> V1  
Acquisition digitalisers protection  
new board + mechanical assembly design  
into 1U crate.  
  
To protect the input of the acquisition ADC  
against over voltage and maybe some  
signal conditioning.....
  - 4) BWSIDC (intelligent drive crate) V3 tbd
  - 5) BWSMCU (Motion control Unit) V3 tbd



# Detailed electronics design status 18.06.2019

DESIGN							
EDA	Designation	Description	Current rev.	Nbr Part Number	completion	Status	next steps
<a href="#">EDA-03592</a>	BWSCPC	BWS – Capacitor Power Charger	V3->V4	40	70%->80%	V4 done by design office	Finalise validation inside PROTO2
<a href="#">EDA-03519</a>	BWSMIB	BWS – Motor Inverter Board	V2	64	80%	10 boards produced, 1 under tests	integration into PROTO2
<a href="#">EDA-03096</a>	BWSAIF	BWS – Analog Interface FMC	V3->V4	95	60%->80%	2 proto tested	integration into PROTO2 + New PCB revision
<a href="#">EDA-03624</a>	BWSFHE	BWS – FMC Height Extender	V2	1	90%	10 pcs ready for final test	integration into PROTO2
<a href="#">EDA-03698</a>	BWSVPA	BWS – VME Power Adapter	V1	2	100%	12 pcs ready for final test	integration into PROTO2
<a href="#">EDA-03764</a>	BWSPSA	BWS – Particle Shower Acquisition	V1	16	100%	Tested with beam - ready for serie production	order PCB + componants
<a href="#">EDA-03634</a>	BWSIDC	BWS – Intelligent Drive Crate	V2	105	80%	Prototyping on-going	integration into PROTO2
		crate		1	100%	commercial product	integration into PROTO2
		custom mechanics		11		3 sets under construction (BE-BI)	integration into PROTO2
		Cables harness		30	70%	under prototyping with EN/EA	integration into PROTO2
<a href="#">EDA-03697</a>	BWSMCU	BWS – Motion Control Unit	V2	57	80%	Prototyping on-going	
		crate		1	80%	production 25 units (PENTAIR)	integration into PROTO2
		custom mechanics		4		2 systemes under construction	integration into PROTO2
		Cables harness		9	80%->90%	Final validation on-going - New FAN selected	integration into PROTO2
tbd	BWSADP	BWS - Acquisition Digitalisers Protection	>>>> V1				
<b>total</b>				<b>436</b>			



# Electronics tests design for the BWSMIB

- Procedure design completed (13 pages step-by-step)
- Hardware 50% done, all components done
- Software to do

(By Jose Maria)

- LabVIEW will switch ON PSU2 [+HV]. Start monitoring PSU2 voltages and currents.
- Check that the CPLD is not activating any of the transistors. To do this, these DIGITAL INPUTS should be as follows:

DIGITAL IO	CONFIGURATION	STATUS
NI9403_22 to NI9403_27	INPUT	LOW (Transistors OFF)

- The transistors should be OFF. To check this, these ANALOG INPUTS should read these voltages:

ANALOG INPUT	CONFIGURATION	VOLTAGE
NI9221-2_5	INPUT	12.5V ~ 17.5V

▪ ***Transistors (SHORT-CIRCUIT PROTECTION) & SPI INTERFACE***

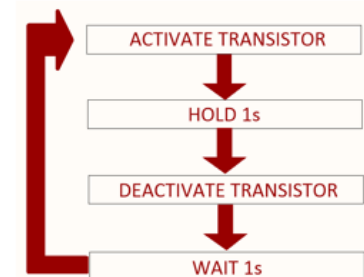
- In order to do this test, we need the SPI INTERFACE. For this interface we need to configure some DIOs as outputs:

DIGITAL IO	CONFIGURATION	STATUS
NI9403_7	OUTPUT	XX [SCLK]
NI9403_8	OUTPUT	XX [MOSI]
NI9403_10	OUTPUT	XX [SS]

- Using the SPI INTERFACE, read the status of the FAULT SIGNALS. The status should be HIGH.
- Connect the phases to PGND using the relays. To do this, these DIGITAL OUTPUTS should be as follows:

DIGITAL IO	CONFIGURATION	STATUS
NI9403_20	OUTPUT	HIGH
NI9403_21	OUTPUT	HIGH (Phases to GND)

- Now, activate the HIGH SIDE TRANSISTORS, one by one. The procedure should be:





# Electronics tests design for the BWSAIF

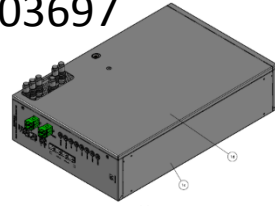
- Procedure design almost completed advancing with the validation of the board.  
(by Jonathan)

EDA-03096-V3-Test protocol table - all - SN.xlsx - Excel

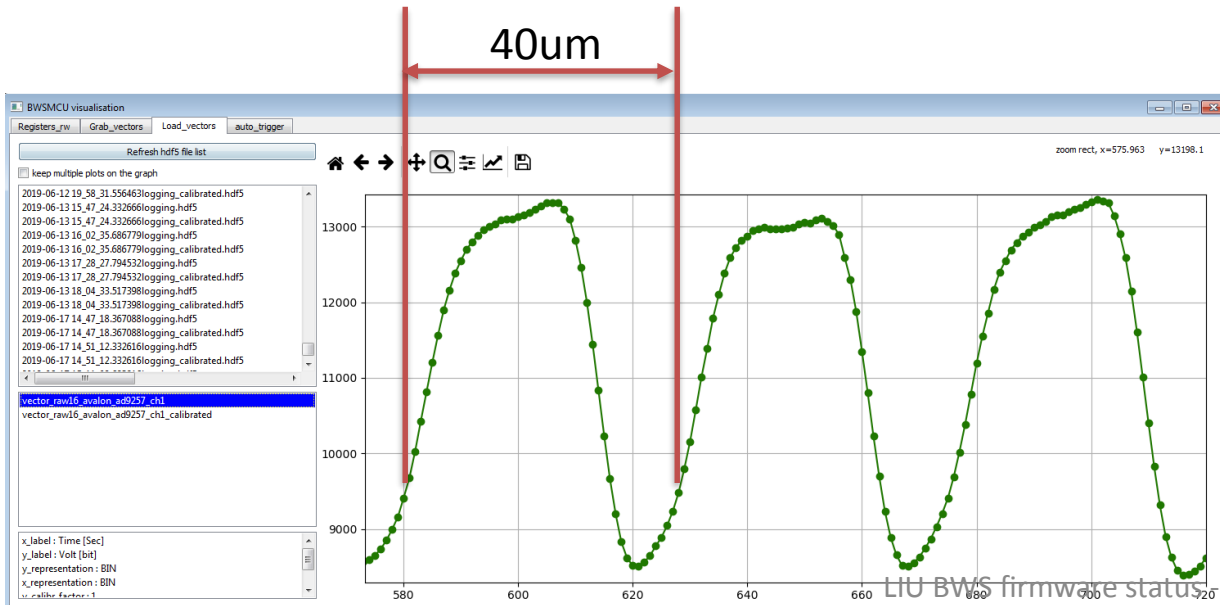
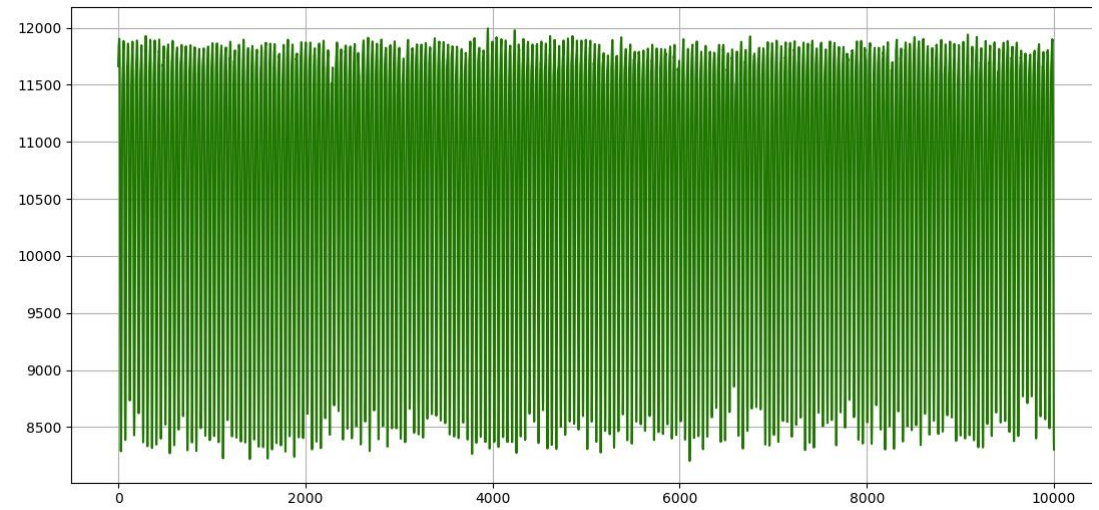
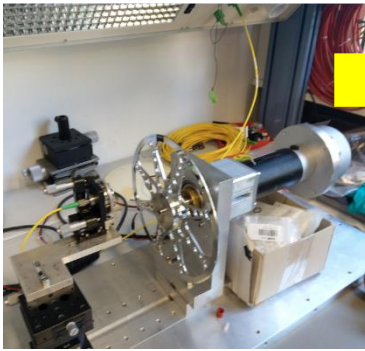
SECURITY WARNING Automatic update of links has been disabled Enable Content

	A	B	C	D	E	F
34	29	PROGRAM THE VFC FPGA				
35	30		3.3 at DC power supply	0.622	0.707	
36			Power estimation [W]	2.0326	2.3331	
37	31		5 at DC power supply	0.538	0.605	
38			Power estimation [W]	2.63	3.025	
39	32		12 at DC power supply	0.755	0.763	
40			Power estimation [W]	3.96	3.156	
41			Total board power estimation [W]	13.8026	14.5141	
42						
43	33	AP15V	TP - AP15V	15.26	15.33	
44		evaluate current 15V	voltage across R361	0.0058	0.0056	
45			Current estimation [mA]	56	56	
46	34	AN15V	TP - AN15V	-15.13	-15.31	
47		evaluate current -15V	across R237	0.0067	0.0066	
48			Current estimation [mA]	67	66	
49	35	AP5V	TP - AP5V	4.36	5.03	
50		evaluate current 5V	across R436	0.0455	0.0462	
51			Current estimation [mA]	455	462	
52	36	AN5V	TP - AN5V	-5	-5.06	
53		evaluate current -5V	across R383	0.0351	0.035	
54			Current estimation [mA]	351	350	
55	37	PWR_CTRL_2	TP8	3.35	3.35	
56	38	3P3VIG - GND	TP10	2.83	2.78	
57	39	P3V3	TP - P3V3	2.815	2.761	
58	40	AP1V8	TP - AP1V8	1.776	1.63	
59		evaluate current 1.8V Analog	voltage across R454	0.004	0.0036	
60			Current estimation [mA]	40	36	
61	41	AP2V5	TP - AP2V5	2.485	2.485	
62		evaluate current 2.5V	voltage across R187	0.0001	0	
63			Current estimation [mA]	1	0	
64	42	P1V8	TP - P1V8	1.773	1.63	
65		evaluate current 1.8V Digital	voltage across R463	0.002	0.004	
66			Current estimation [mA]	20	40	
67	43	REF_2V5_LASER	TP - REF_2V5_LASER	2.438	2.438	
68	44	REF_2V5_AUX	TP - REF_2V5_AUX	2.438	2.438	
69	45	REF_2V5_RESOLVER	TP - REF_2V5_RESOLVER	2.438	2.438	
70	46	REF_2V5_CURRENT	TP - REF_2V5_CURRENT	2.438	2.438	
71	47	REF_2V5_POT	TP - REF_2V5_POT	2.438	2.438	
72	48	REF_2V5_WIRE	TP - REF_2V5_WIRE	2.438	2.438	





# Motion Control Unit (MCU) – IOPS Digitalisation



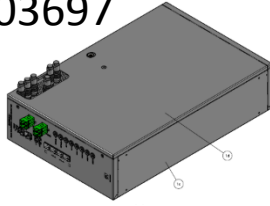
Measures:

48pt/40 um @ 80 rad => 1.2 pt/um

Worst case estimation:

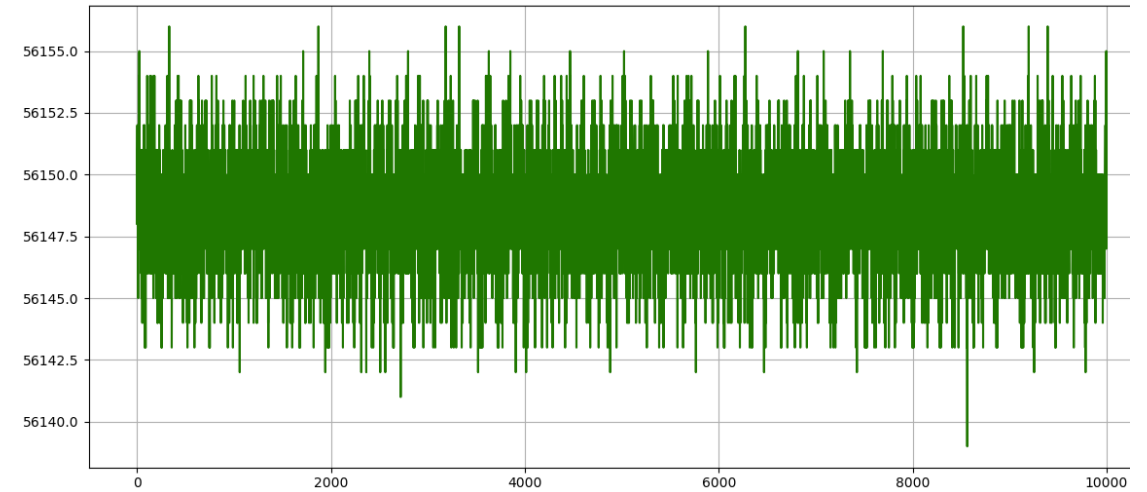
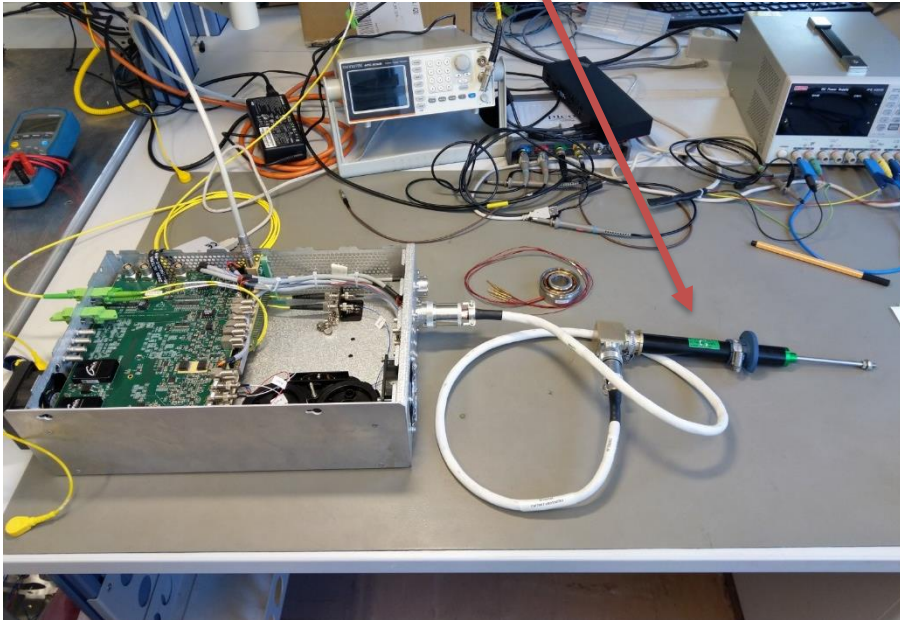
29 pt/40um @ 133 rad/s (PSB) => 0.725 pt/um



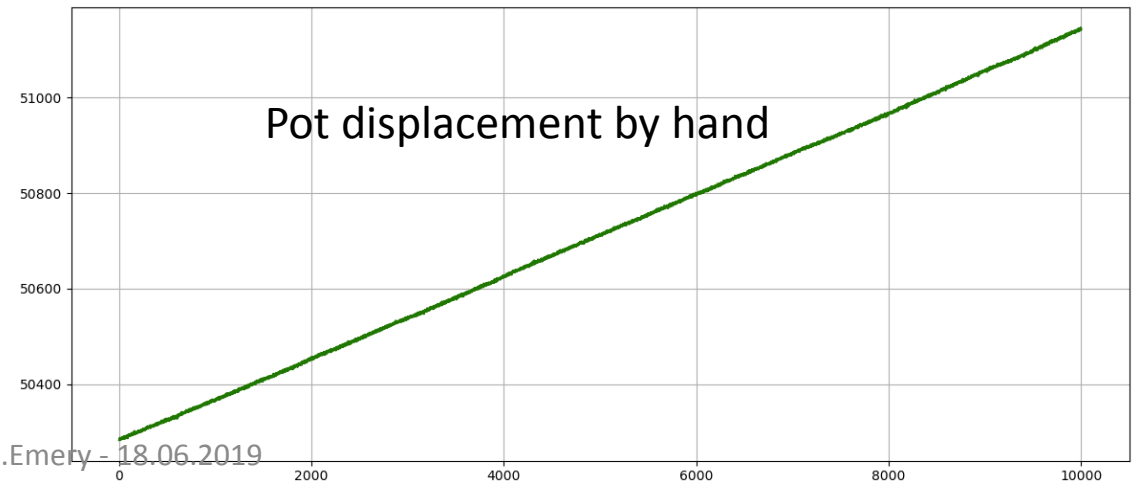


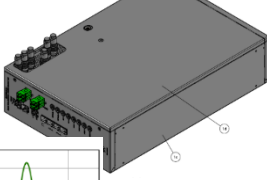
# Motion Control Unit (MCU) – LHC potentiometer

Linear LHC pot

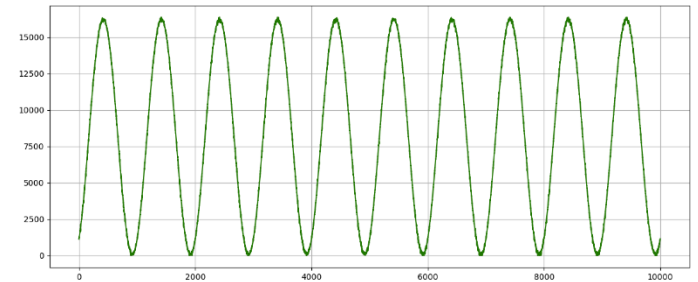
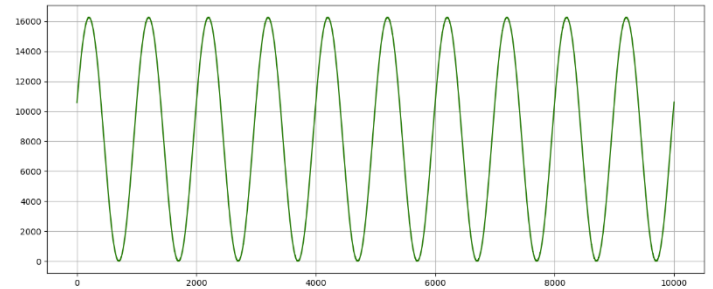
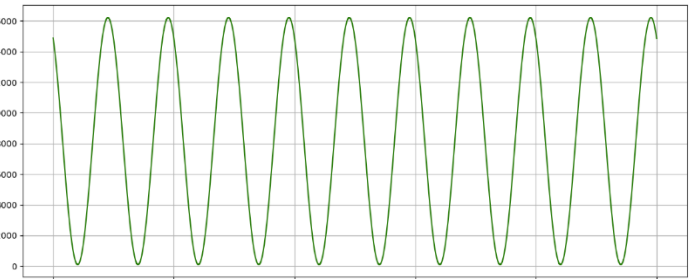
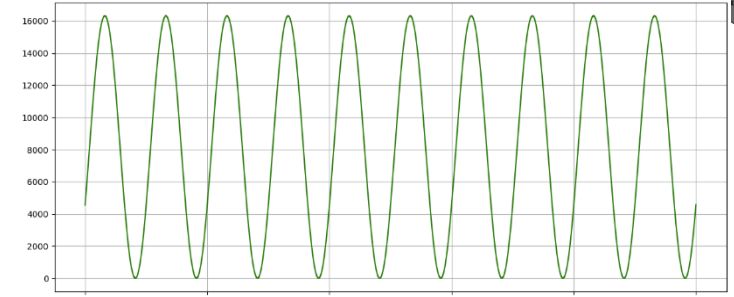
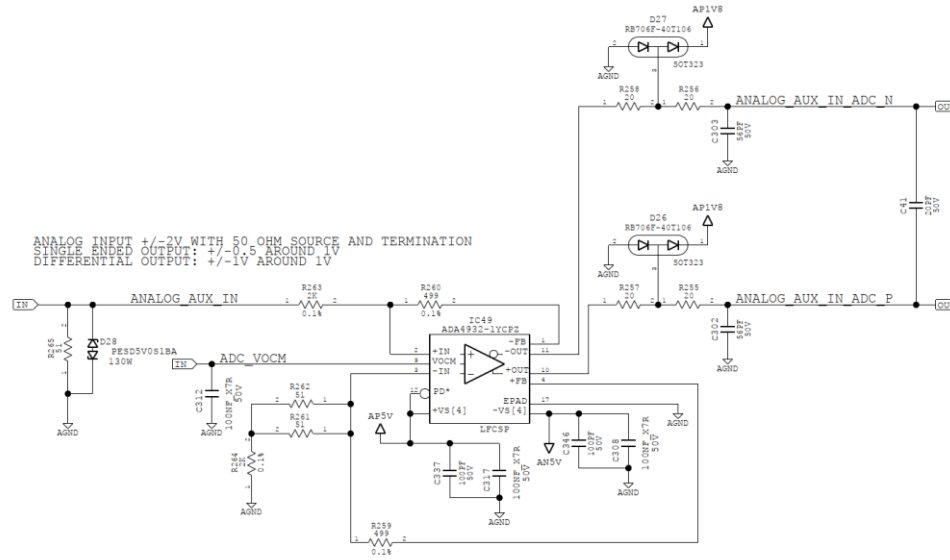


Noise std  $\sim 3$  [bit]  $\Rightarrow$  ENOB 14bits  $\Rightarrow$  133mm stroke  $\Rightarrow$   
8 $\mu$ m resolution before processing





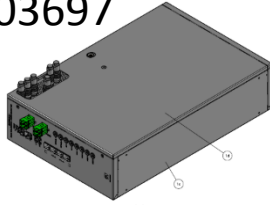
# Motion Control Unit (MCU) – 4x AUX INPUTS



4 auxiliary analog inputs 14 bits @ 10MHz  
 (later upgrade possible at faster speed)  
 +/- 4 Vpp inputs

To think of:  
 Maybe usable temporarily in the PSB if the ADC board are late?

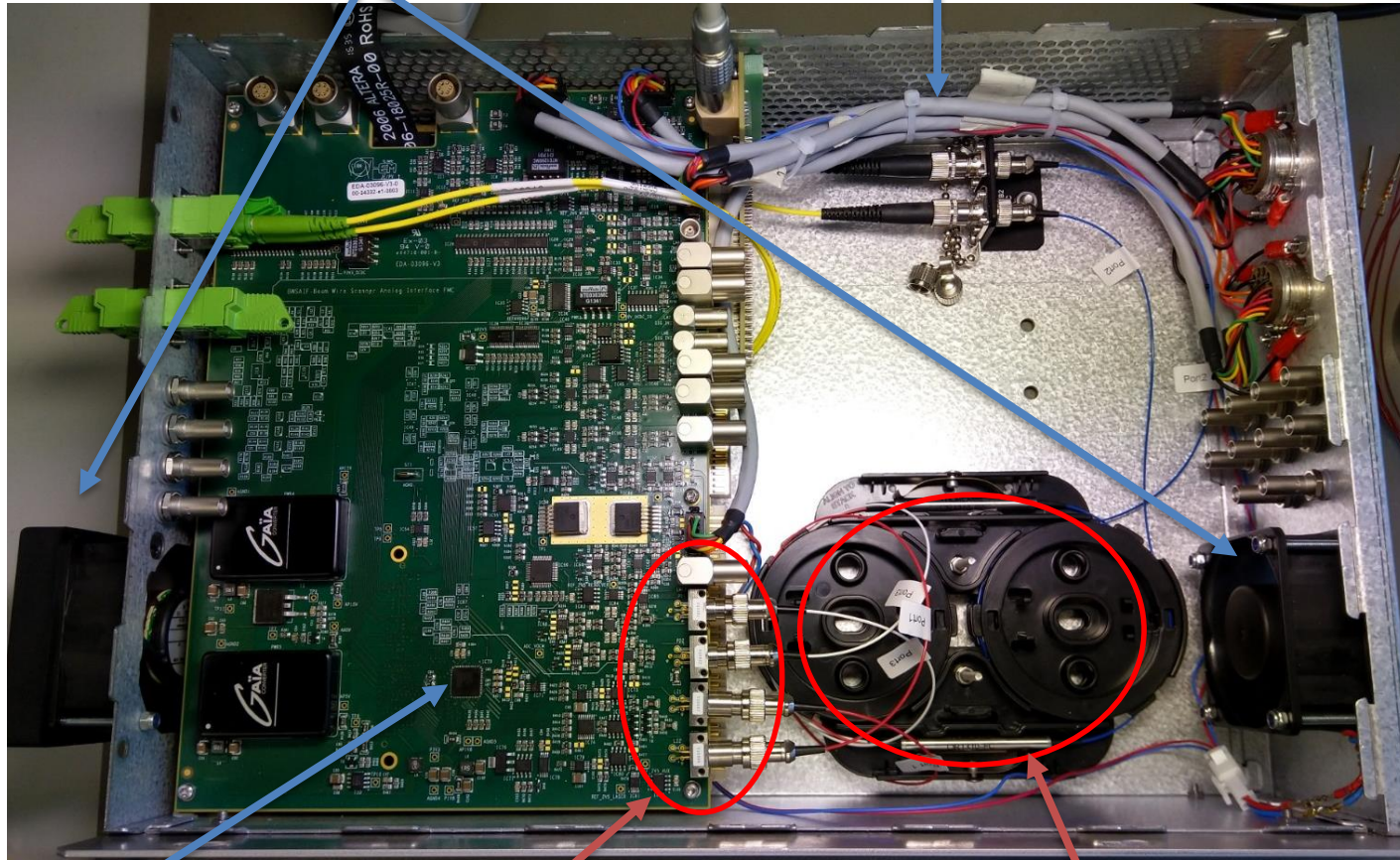




# Motion Control Unit (MCU)

New FANS for cooling  
VFC + MEZZANINE

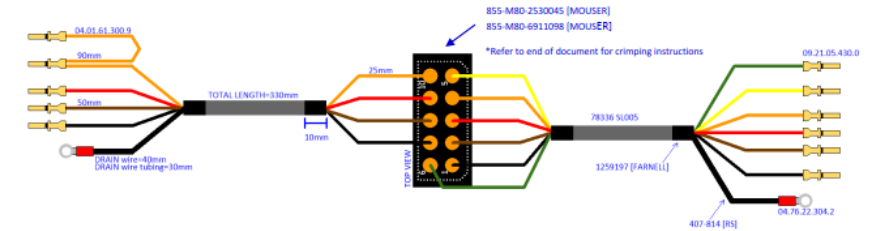
Cable harness



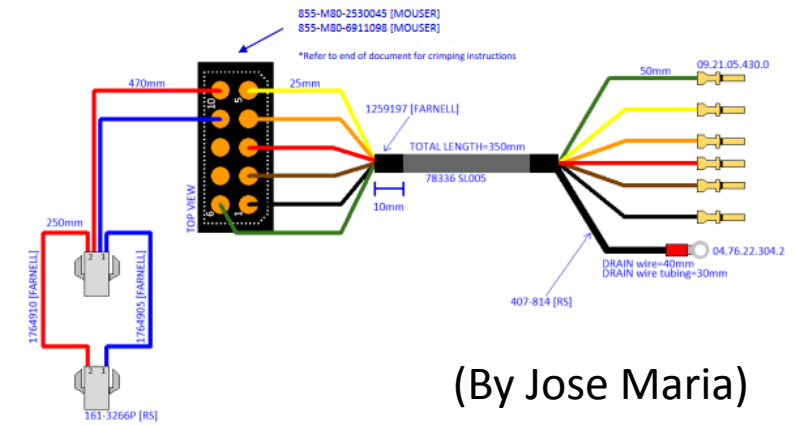
## WIRING EDA-03697 Motor Control Unit

Detailed view of the cables

CABLE CODE	BWS-C-41
DESCRIPTION	J1 to RESOLVER/IDENTIFIER connector



CABLE CODE	BWS-C-42
DESCRIPTION	J2 to FANS & WIRE/TEMP connector



(By Jose Maria)

10MHz ADC

To order for ~27kCHF  
(Laser components)

To order for ~29kCHF  
LIU BWS firmware status - J.Emery - 18.06.2019  
(Thorlabs components)



# Production - Procurement

- Standard components procurement for the PCB on-going (Guillaume)
- PCB production waiting for complete crate test
- Crate assembly starts next week
- 5x BWSPSA assemble by Jose Sirvent

Critical component procurements:

## Above 100k:

- 30x ADC boards cost below 200kCHF
- Price Enquiry on-going
- First company has contacted us for technical questions

## Above 10k limit:

- 62x  
Circulators for the optical encoder 393.31 Euro/pc => 24385.22 Euro => **~29kCHF**
- 50x  
Laserdiode for the optical encoder 118.63 Euro/pc => 11863 Euro => ~14kCHF
- 50x  
Photodiode for the optical encoder 104.85 Euro/pc => 10845 Euro => ~13kCHF

## Above 5k limit:

- 27xSinus Filter: 297.75 CHF/pc => 8039.25 CHF



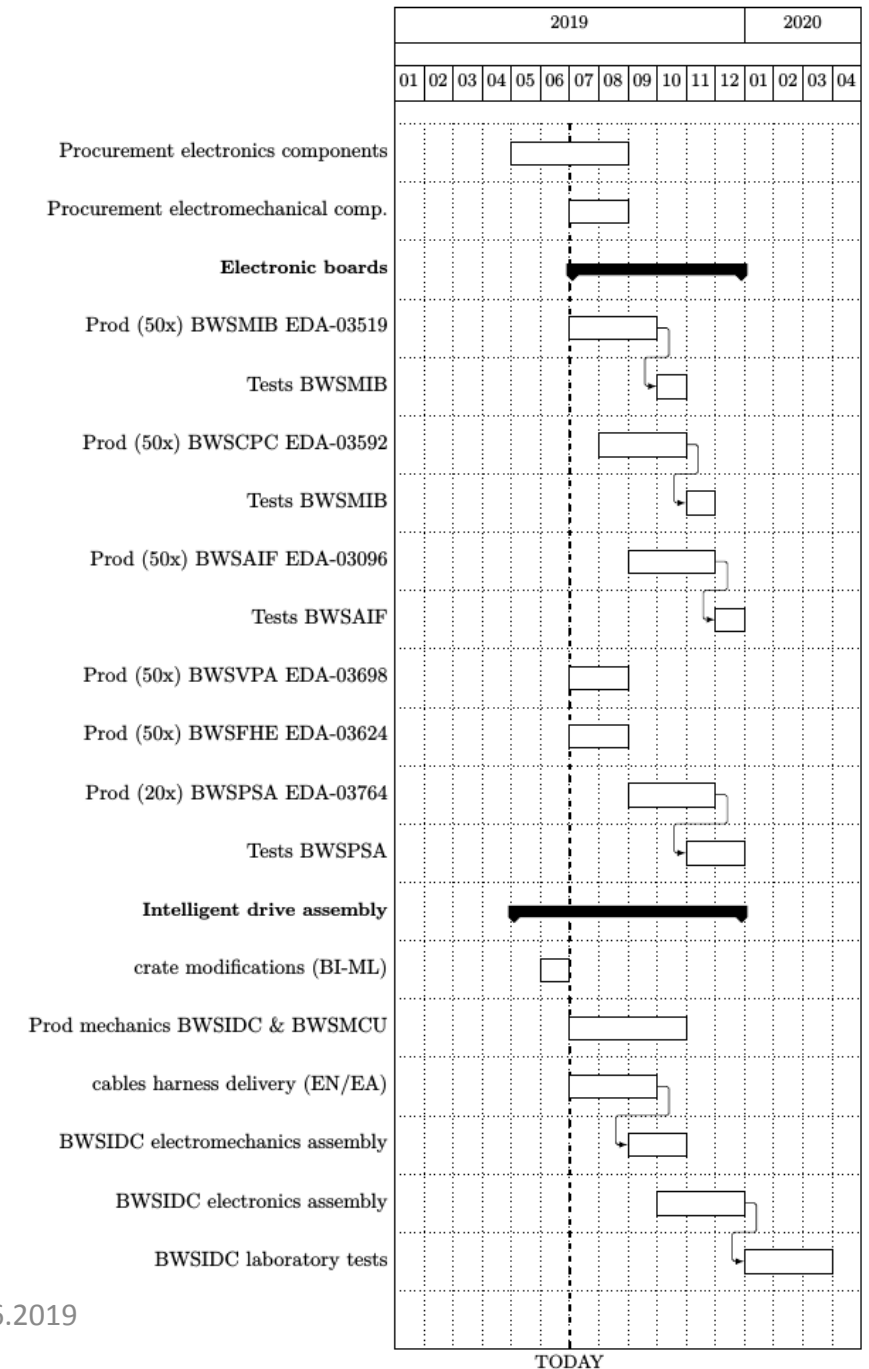
# Detailed electronics production status 18.06.2019

PRODUCTION							
EDA	Designation	Description	Current rev.	Nbr Part Number	Components ordering status	Status	next steps
<a href="#">EDA-03592</a>	BWSCPC	BWS – Capacitor Power Charger	V3->V4	40	50%	ordering components	launch PCB
<a href="#">EDA-03519</a>	BWSMIB	BWS – Motor Inverter Board	V2	64	90%	ordering components	launch PCB
<a href="#">EDA-03096</a>	BWSAIF	BWS – Analog Interface FMC	V3->V4	95	0%	ordering components	launch PCB
<a href="#">EDA-03624</a>	BWSFHE	BWS – FMC Height Extender	V2	1	100%	ordering components	launch PCB
<a href="#">EDA-03698</a>	BWSVPA	BWS – VME Power Adapter	V1	2	100%	ordering components	launch PCB
<a href="#">EDA-03764</a>	BWSPSA	BWS – Particle Shower Acquisition	V1	16		5 PCB ready for tests - 4 prototypes	launch PCB
<a href="#">EDA-03634</a>	BWSIDC	BWS – Intelligent Drive Crate	V2	105		Preparing orders above 5k	order components
		crate		1	88%	29 pcs ready	order missing pcs
		custom mechanics		11	0%	Prototyping	
		Cables harness		30	0%	Prototyping	launch production by EN/EA
<a href="#">EDA-03697</a>	BWSMCU	BWS – Motion Control Unit	V2	57	0%	Preparing orders above 10k	order components
		crate		1	50%	waiting for tests results	order missing pcs
		custom mechanics		4		Prototyping	
		Cables harness		9	0%	Changing FAN part number	launch production by EN/EA
<b>total</b>				<b>436</b>			



# Production Schedule

- PCB Production waiting for final tests of the boards.
- Optimistic validation during July
- If we still want to finalize production by end of the year, we need to
  - Launch PCB production by the end of the month (before final validation!)
  - The risk is to have to reproduce some board (loss of money)
  - Assembly should start by August.
- If we accept a delay in the production for other machines than PSB, we could delay the production by 1 month?





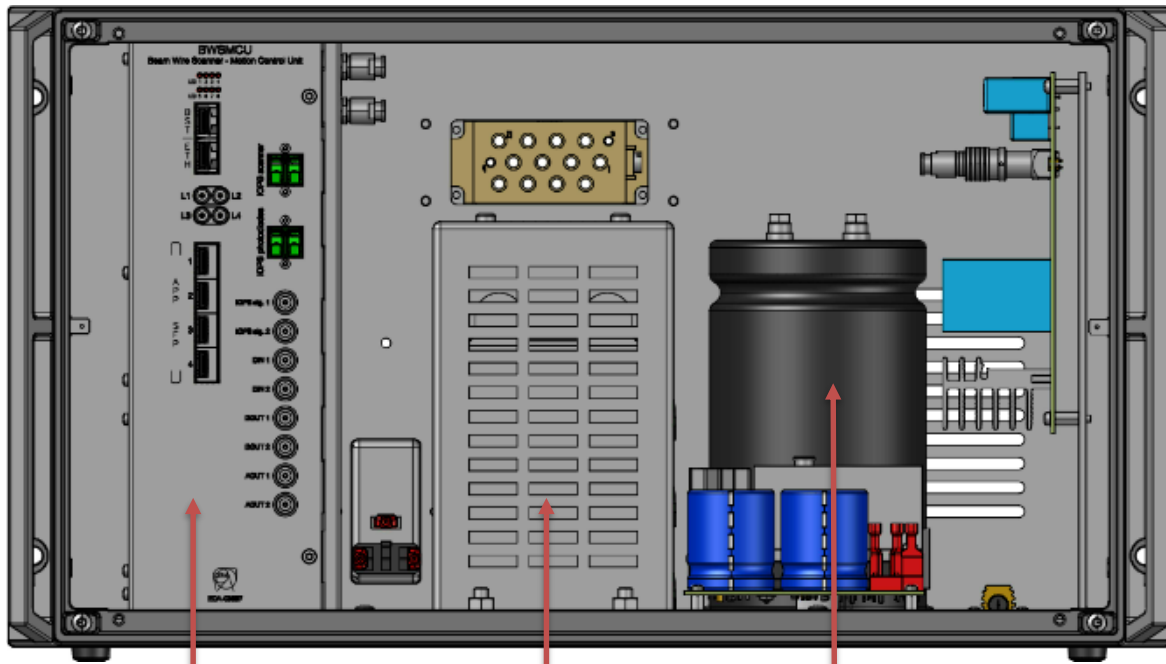
# **ADDITIONAL SLIDES**





# Intelligent Drive Crate (IDC)

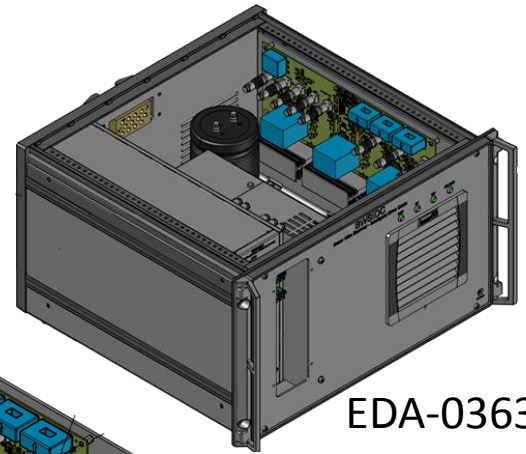
6U, ≈ 22Kg



BWSMCU  
Motion Control Unit  
EDA-03697

Output filter "sinus"

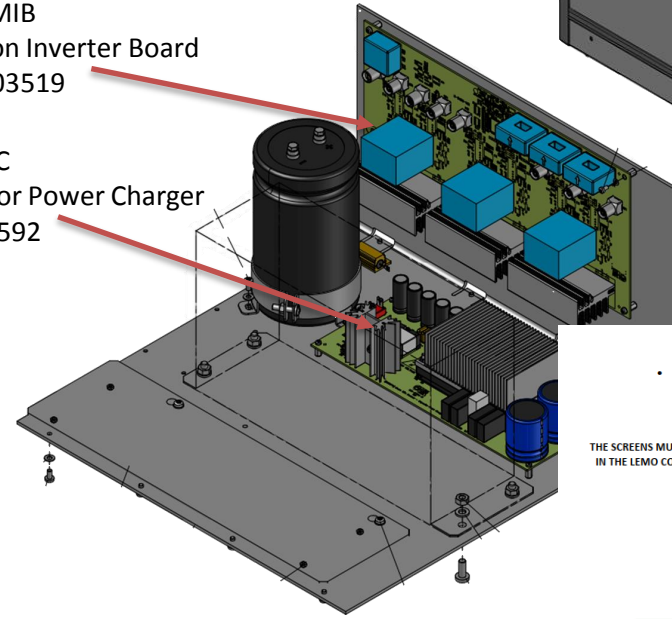
DC-BUS Capacitor



EDA-03634

BWSMIB  
Motion Inverter Board  
EDA-03519

BWSCPC  
Capacitor Power Charger  
EDA-03592

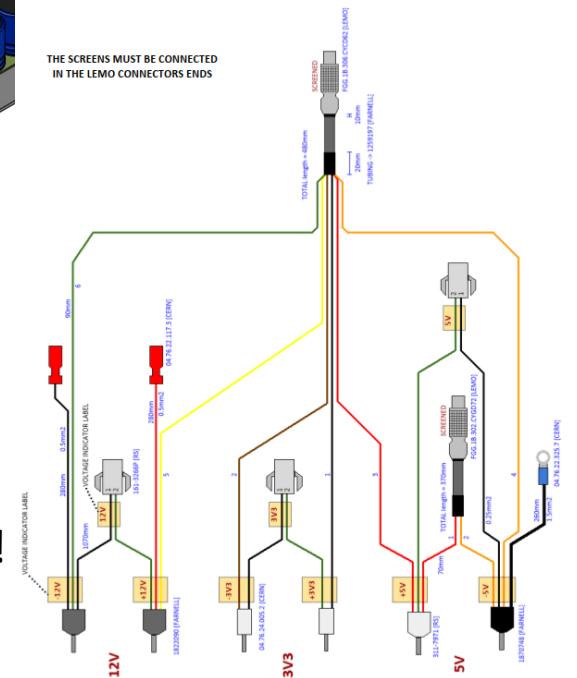


• Detailed view of the cable

CABLE CODE BWS-C-20

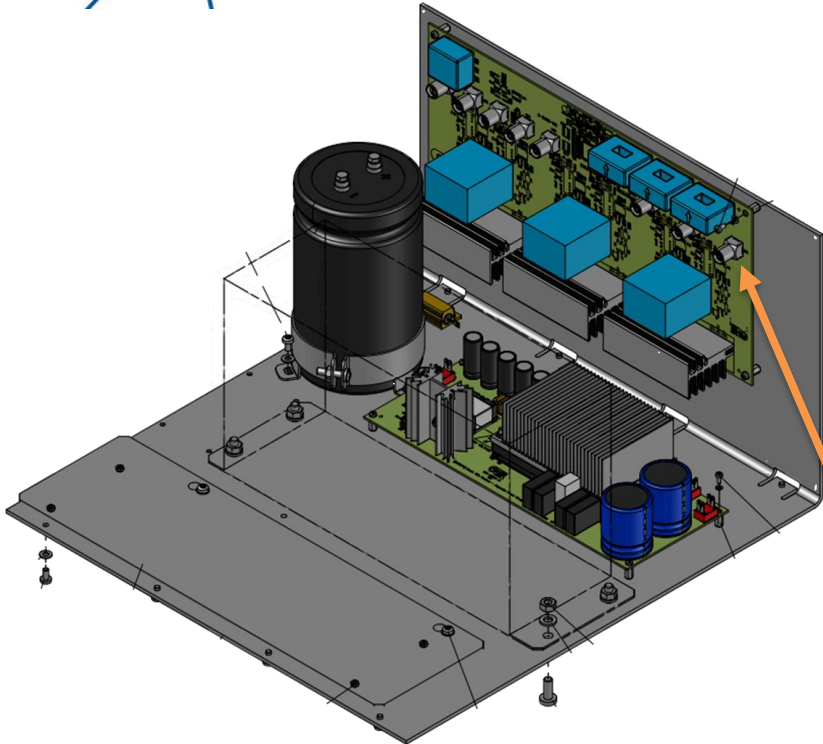
THE SCREENS MUST BE CONNECTED IN THE LEMO CONNECTORS ENDS

Cable harness  
(30 references)!

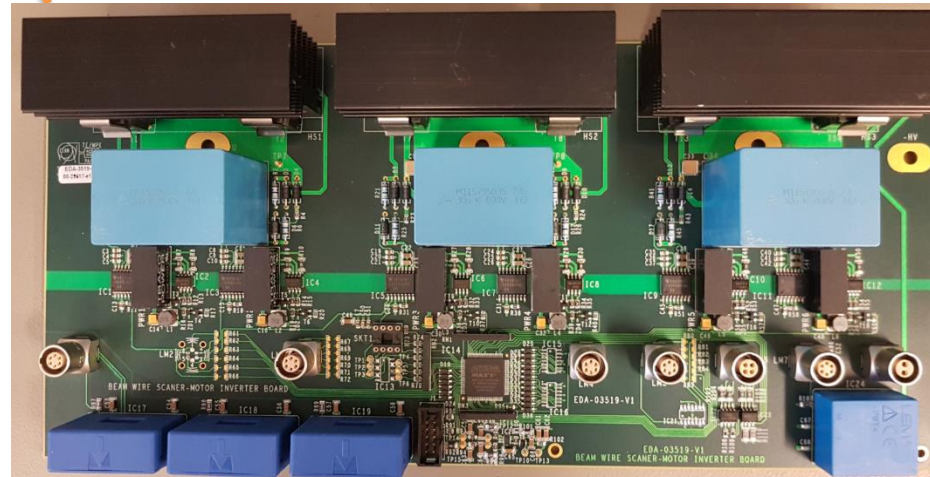


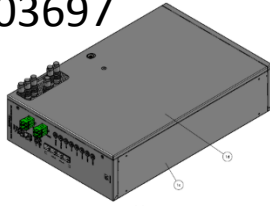


# BWSMIB - Motion Inverter Board - EDA-03519

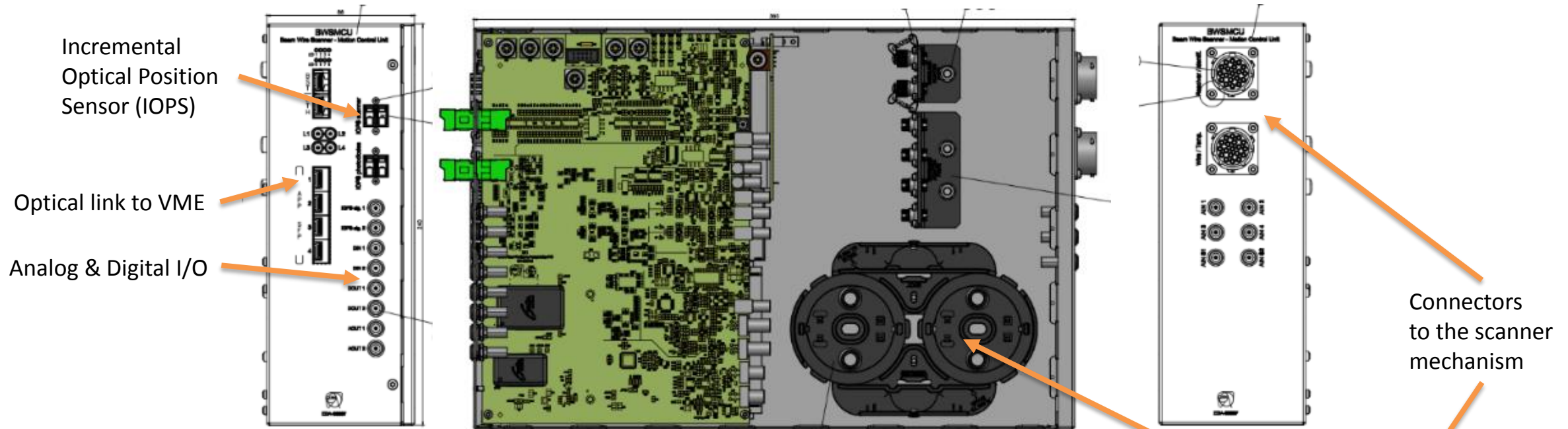


- Motor phases powering by chopping the DC-BUS (**PWM control**)
- Design for the wire-scanner repetition rate (~every few sec.)  
To reduce size by 3 compared to off the shelf inverter
- **CPLD** based digital interface and controls
- Also replace DC-BUS control and measure card
- SPI based interface, IGBT protection, faults signalisation, PWM generation (tbc)
- Version 2 to the design office mid-February 2018





# Motion Control Unit (MCU)



VFC-HD - EDA-03133

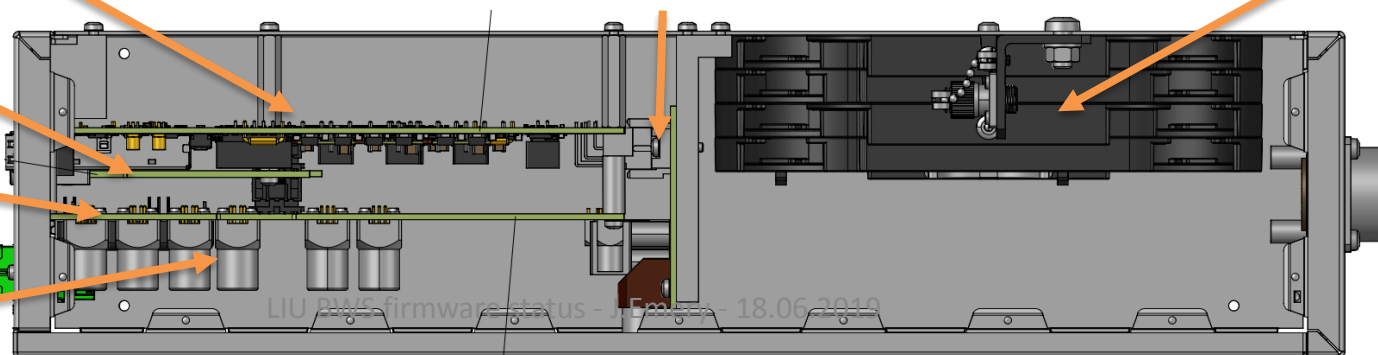
BWSVPA - VME Power Adapter  
EDA-03698

Optical fibre components

BWSFHE - FMC-height-extender  
EDA-03624

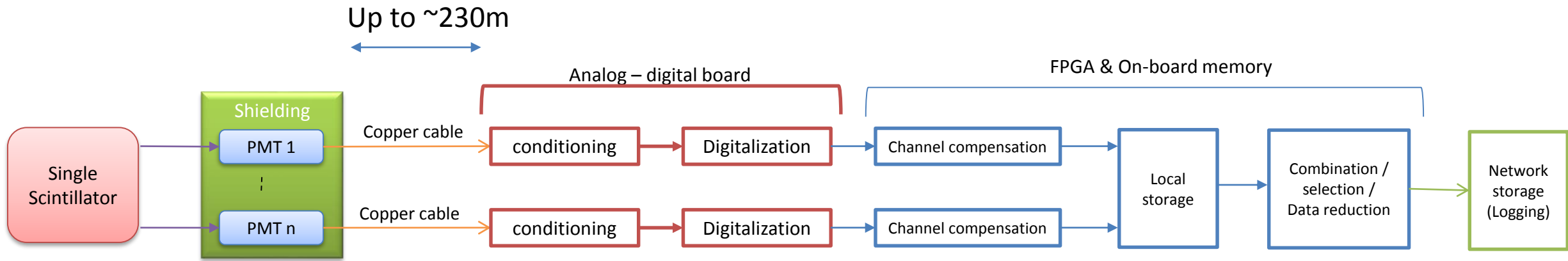
BWSAIF - Analog Interfaces FMC  
EDA-03096

Connection to the power stage





# BWS Secondary shower sensing acquisition chain using fast digitalizers



- Similar sensor as today: Scintillator + PMT
- Moving filters replaced by fixed filter and 4 PMTs
- Signal digitalization at the surface using direct digitalization on VFC
- Channel compensation, sensors combination and data reduction to be developed this year using field measurement (starting with scopes)
- Take advantage of the FBCT experience with similar architecture