

Status Report BESSY + MLS

Bernhard Schriefer

22.10.2025 – 24.10.2025

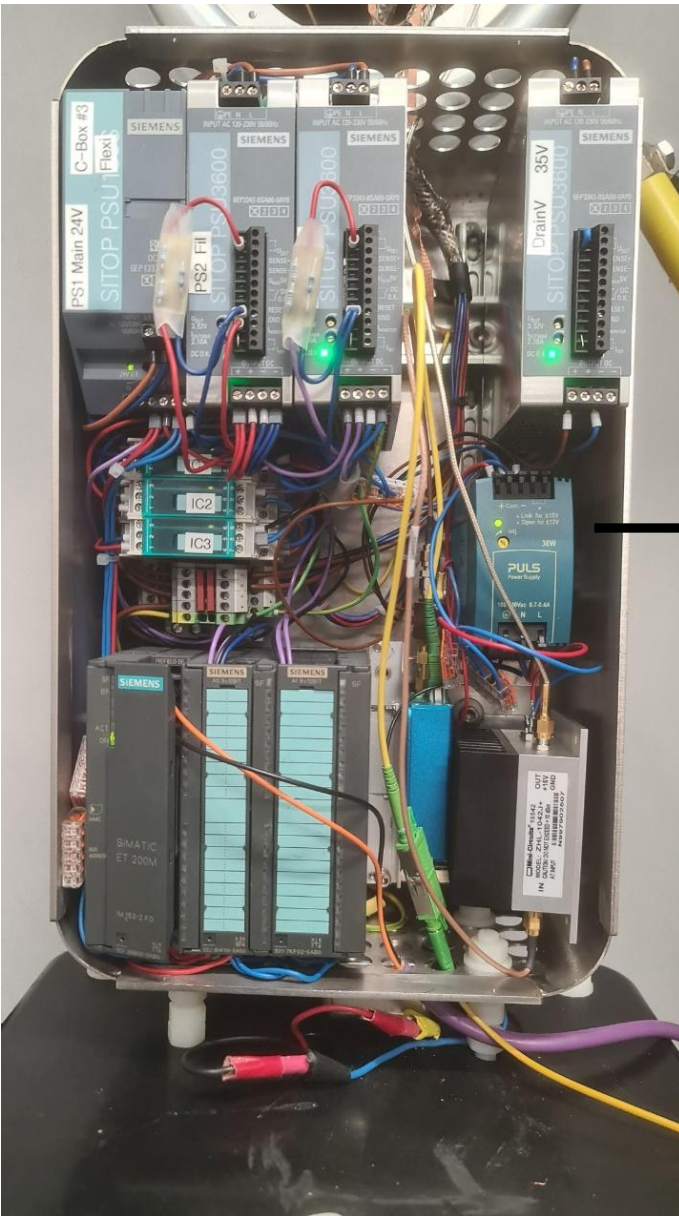
ESLS-RF
Barcelona

- New FlexiGun Board for Linac
- LLRF new parts from Dimtel
- Harmonic Cavities
- New uninterruptible Power Supply
- MLS: New Klystron Modulator commissioned
- BerlinPro/Sealab: Klystron commissioning
- SSA maintenance overview

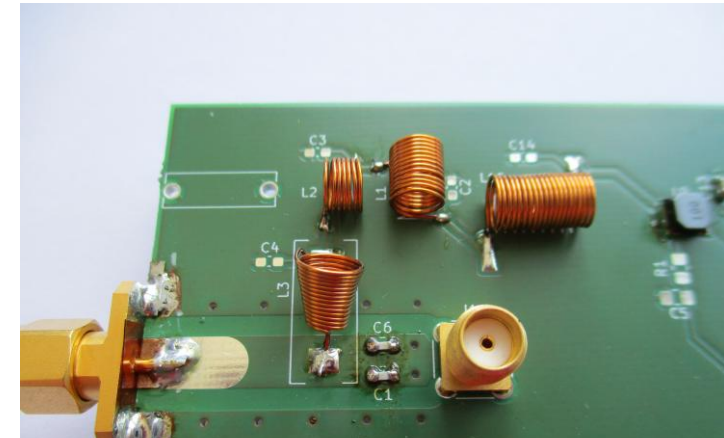
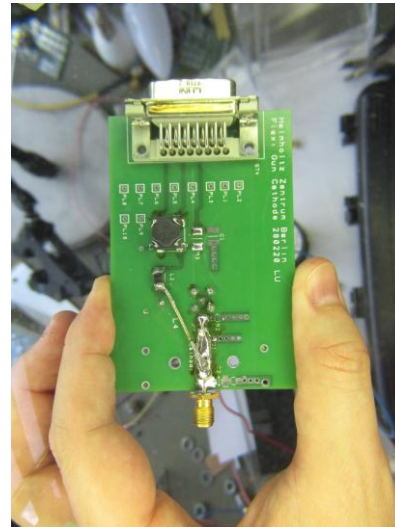
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New FlexiGun Board

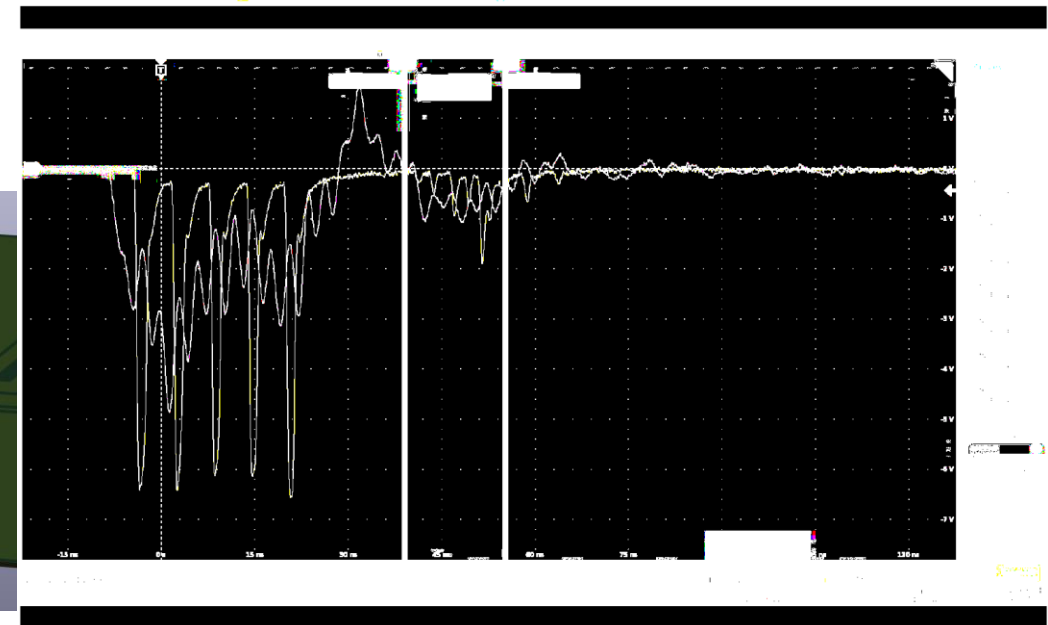
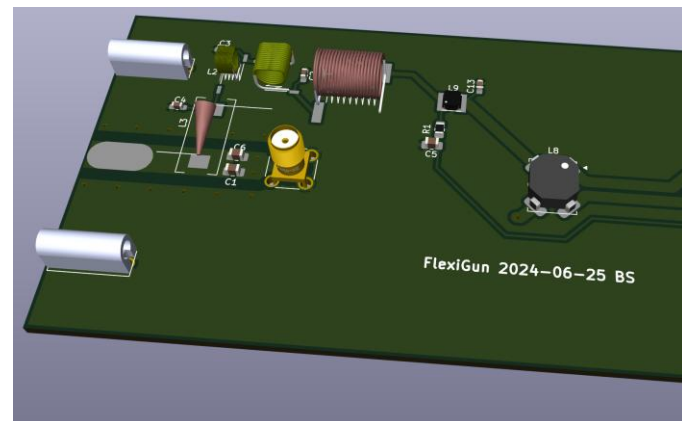
Passive RF Boards connected to Gun



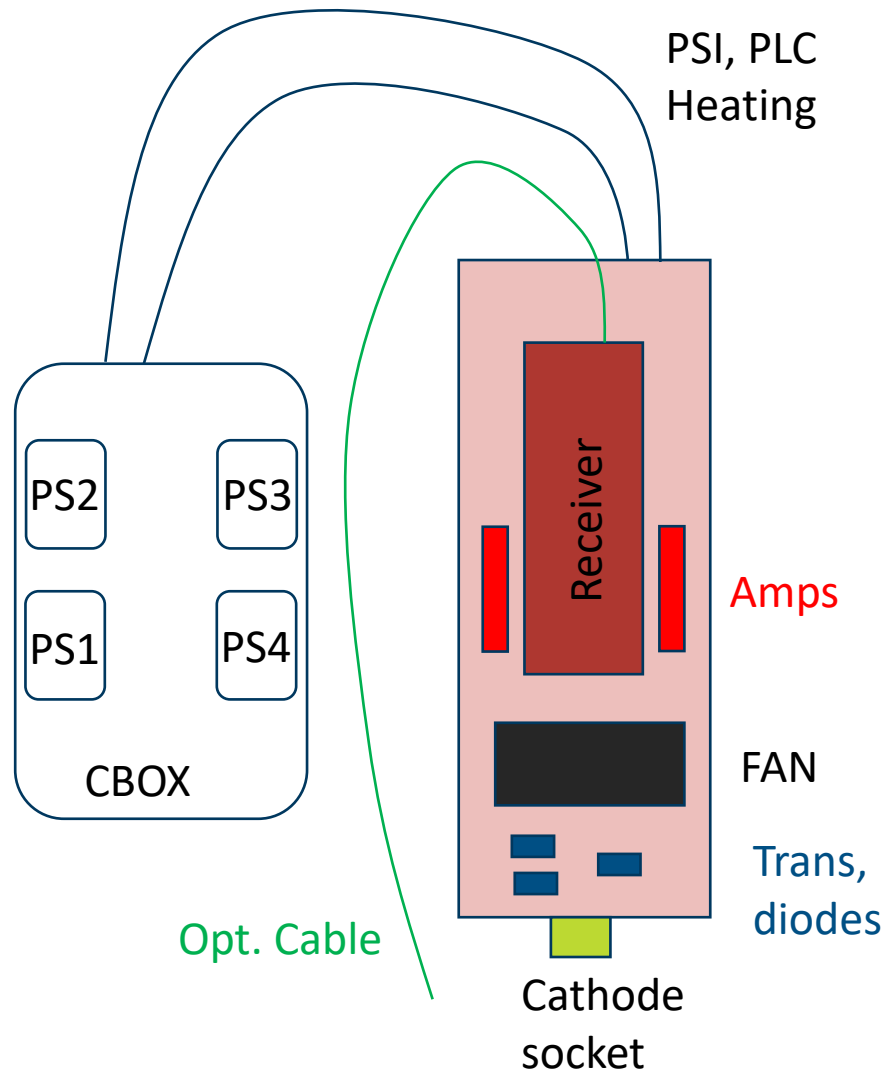
coax →



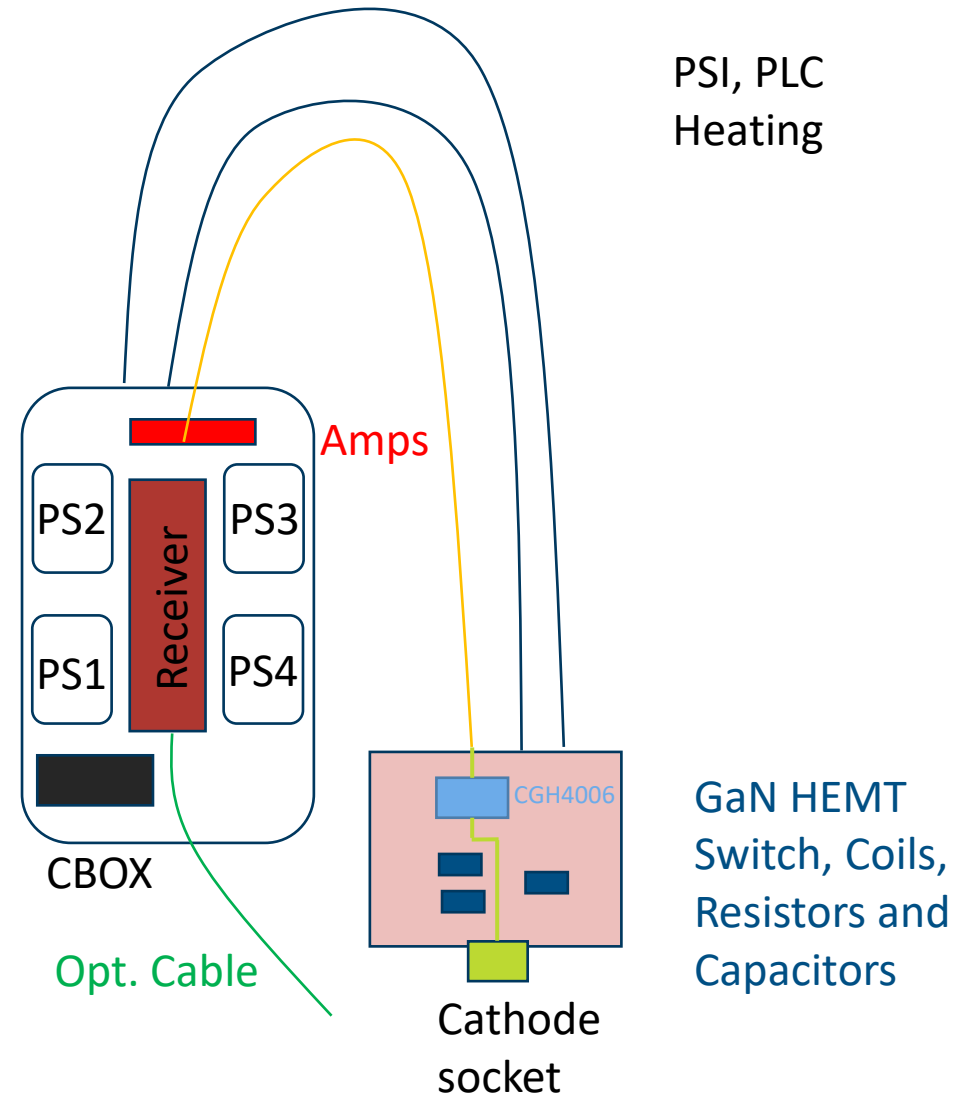
Lots of testing!
Bad results



New FlexiGun Board



Thales setup



new Flexi setup

New FlexiGun Board

CGH40006
GaN HEMT



COAXIAL
Medium High Power Amplifier
500 10 to 4200 MHz

FEATURES

- Wideband, 10 to 4200 MHz
- High IP₃, +35 dBm typ.
- Low noise, 6 dB min.

APPLICATIONS

- Communication Systems
- Laboratory



Country photo used for illustration purposes only

Model No.	ZHL-1042J+	ZHL-1042JX+
Case Style	NN52	
Connectors	SMA	

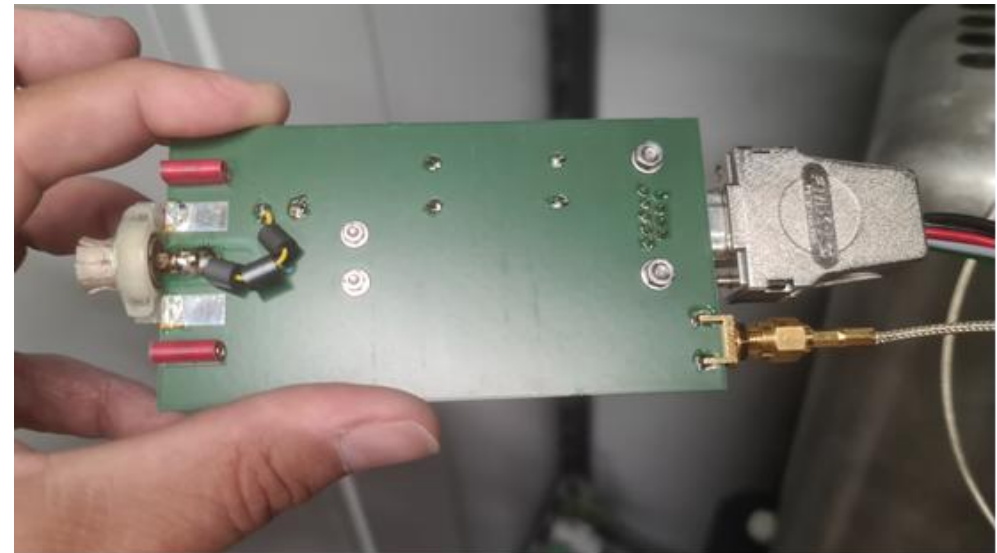
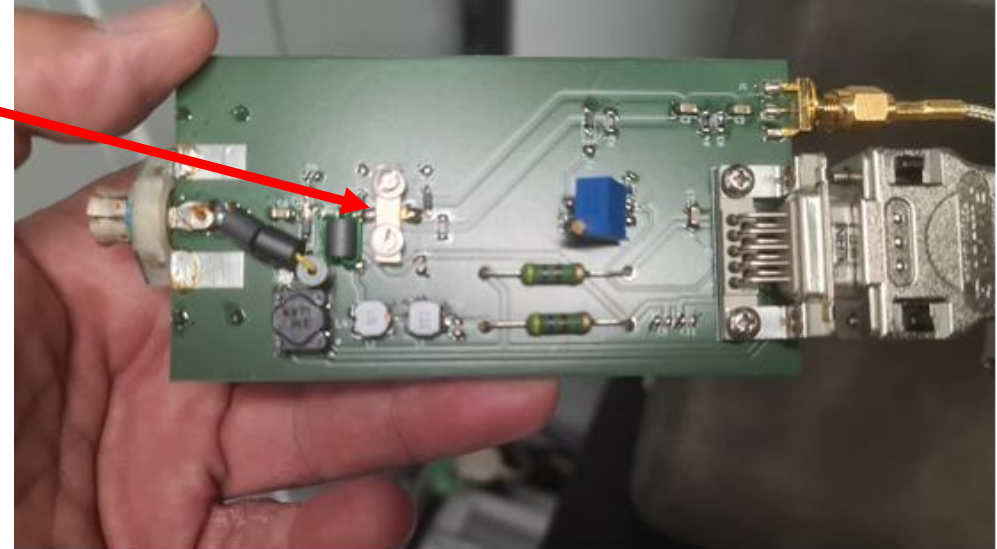
RoHS Compliant
The product is RoHS Compliant. See our website for restrictions and regulations.

ELECTRICAL SPECIFICATIONS AT 25°C

Parameter	Condition (MHz)	ZHL-1042J+ ZHL-1042JX+			Units
		Min.	Typ.	Max.	
Frequency Range	10	—	4200	—	MHz
Gain	10-4200	24	27	32	dB
Gain Flatness	10-4200	—	+1.2	+1.7	dB
Output Power at 1dB compression	10-4200	+20	+22	—	dBm
Output Power at 3dB compression	10-4200	+21	+23	—	dBm
Noise Figure	10-4200	—	6.0	—	dB
Output third order intercept point	10-4200	—	+35	—	dBm
Input VSWR	10-4200	—	—	2.5	:1
Output VSWR	10-4200	—	—	2.5	:1
DC Supply Voltage	—	—	15	—	V
Supply Current	—	—	—	0.330	A

Open load is not recommended, unterminated can cause damage.
With no load device runs. Input power by 10 dB.

*Heat sink not included. Alternative heat sinking and load removal must be provided by the user to limit maximum base plate temperature to 50°C in order to ensure proper performance. For reference, this requires thermal resistance of user's external heat sink to be 2.7°C/W max.



New Pulse Generator

RIDER ➡➡

Time to **Reinvent** advance signal generation



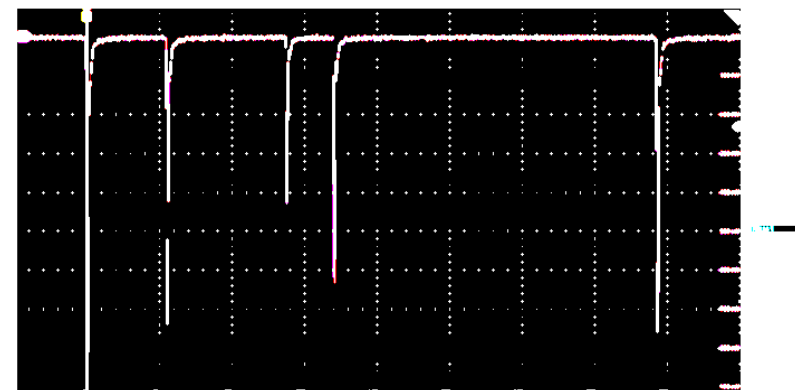
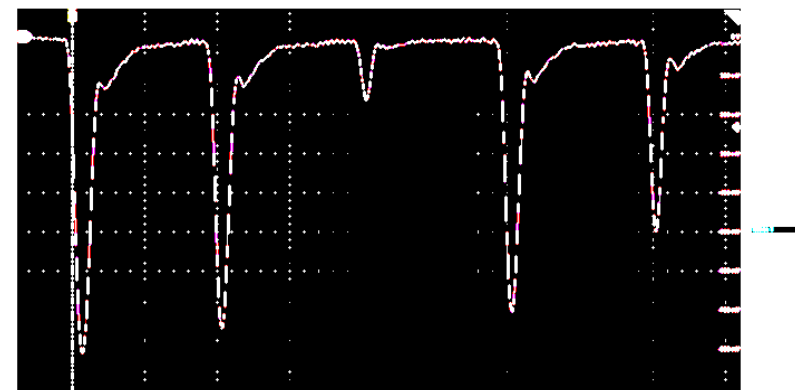
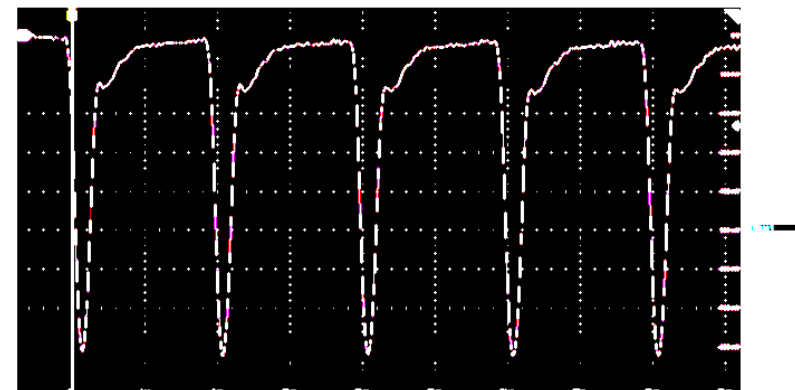
ARB Rider
5062(D)/5064(D)/5068(D)
5032D / 5034D / 5038D

Technical Datasheet

2 / 4 / 8 CHANNELS – ALL IN ONE:
Function Generator, Arb Generator,
Pulse Pattern Generator and Digital
Pattern Generator.

- 2, 4 or 8 Analog Channels
 - 6.16 GS/s (12.32 GS/s in RF mode)
 - 16 Bit Vertical Resolution
 - Up to 6 GHz output frequency
 - < 110ps Rise/fall time
 - 230ps minimum pulse width
 - Single ended output with up to 5 V_{p-p} into 50 Ω with hardware offset of ±2.5V into 50 Ω. Total Output Voltage Window ±5 V (10 V_{p-p}) into 50 Ohm
 - Differential output with up to 3 V_{p-p} into 100 Ω with common mode voltage of ±2 V into 50 Ω
 - Up to 4 Gpts Waveform Memory per Channel
 - Up to 32 Digital Channels in synchronous with analog Generation
 - Multi-Instrument Synchronization: up to 32 analog and 128 digital channels
- Key performance specifications**
- **True Arb Mode**
 - 16-bit vertical resolution
 - 6.16 GS/s Variable Clock (12.32 GS/s in RF mode)
 - Up to 6 GHz output frequency
 - < 110ps Rise/fall time
 - 8bit, 16bit or 32bit digital channels
 - Up to 4 Gpts Waveform Memory per Channel
 - Single ended amplitude up to 5 V_{p-p} into 50 Ω with hardware offset of ±2.5 V into 50 Ω
 - Differential amplitude up to 3 V_{p-p} into 100 Ω load with common mode voltage of ±2 V into 50 Ω
 - **AFG Mode**
 - 2 GHz Sine Waveforms
 - 6.16 GS/s fixed, 16-bit vertical resolution
 - Single ended amplitude up to 5 V_{p-p} into 50 Ω with hardware offset of ±2.5 V into 50 Ω
 - Differential amplitude up to 3 V_{p-p} into 100 Ω load with common mode voltage of ±2 V into 50 Ω
 - Improved proprietary DDS based technology
 - **Pulse Pattern Generator (PPG) Mode - Optional**
 - Up to 1.5Gbit/s NRZ, RZ and R1 bit stream generation
 - 2,3 or 4 levels pattern
 - 64 point arbitrary shape per transition
 - Programmable duration for any transition
 - Up to 2Mbit (2 levels) or up to 1Msymbols (3 or 4 levels) pattern memory for channel
 - Single ended amplitude up to 5 V_{p-p} into 50 Ω with hardware offset of ±2.5 V into 50 Ω
 - Differential amplitude up to 3V_{p-p} into 100 Ω load with common mode voltage of ±2V into 50 Ω

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Dimtel LLRF



- 17 units ordered in April 2025
- 8 units for 500 MHz
- 5 units for 1.5 GHz
- 4 units for 1.75 GHz

MLS

- 1 x 500 MHz
- 1 x 1.5 GHz

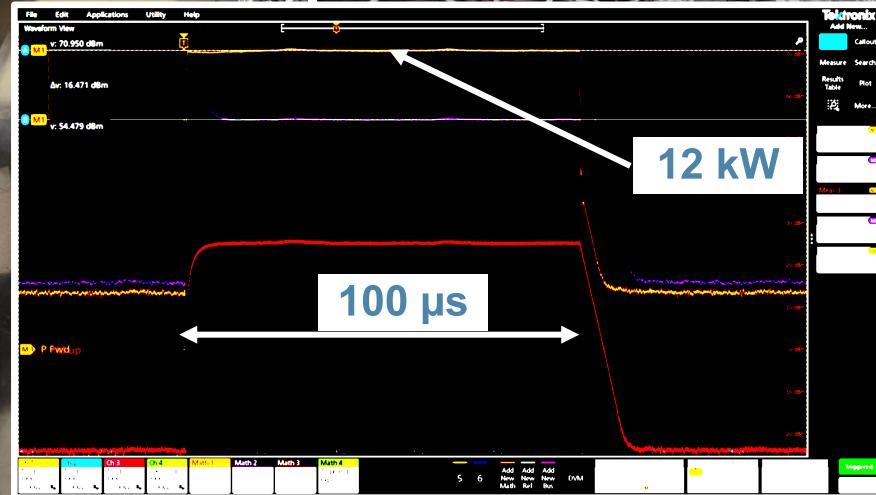
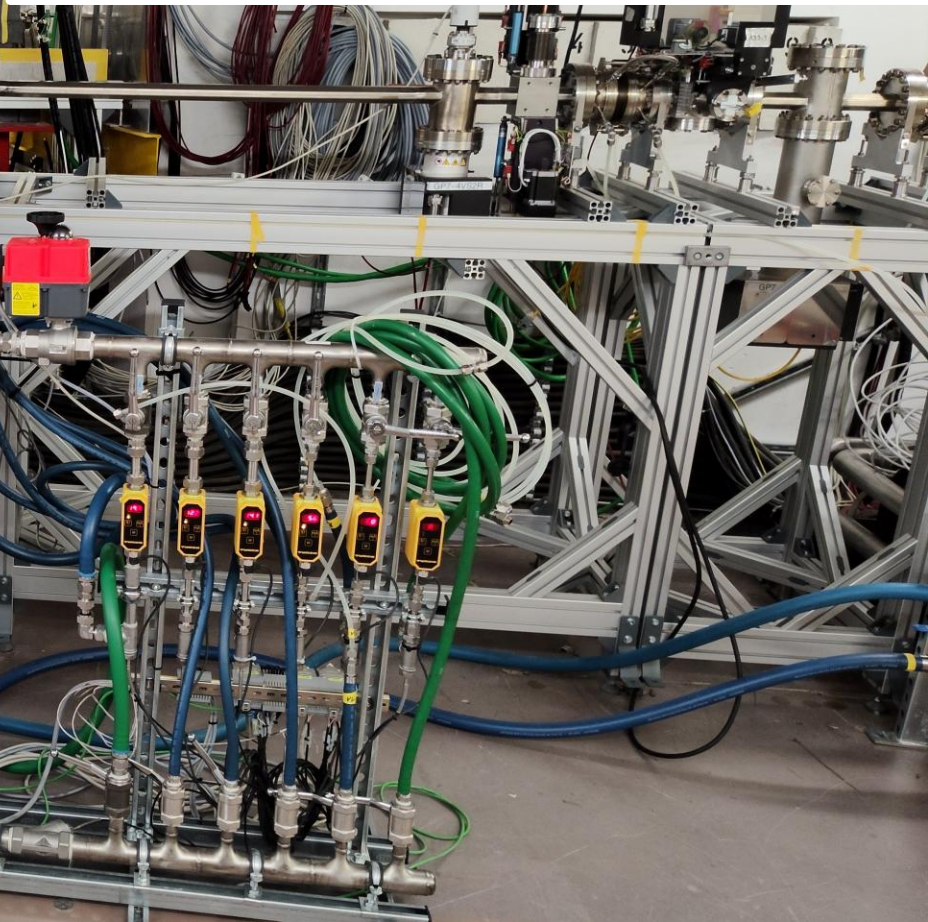
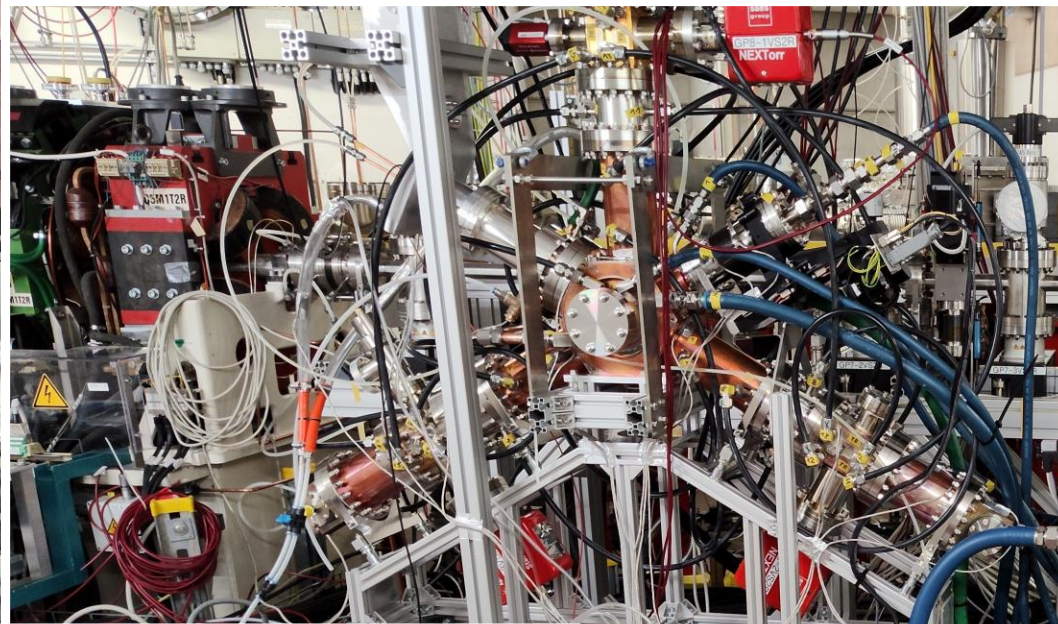
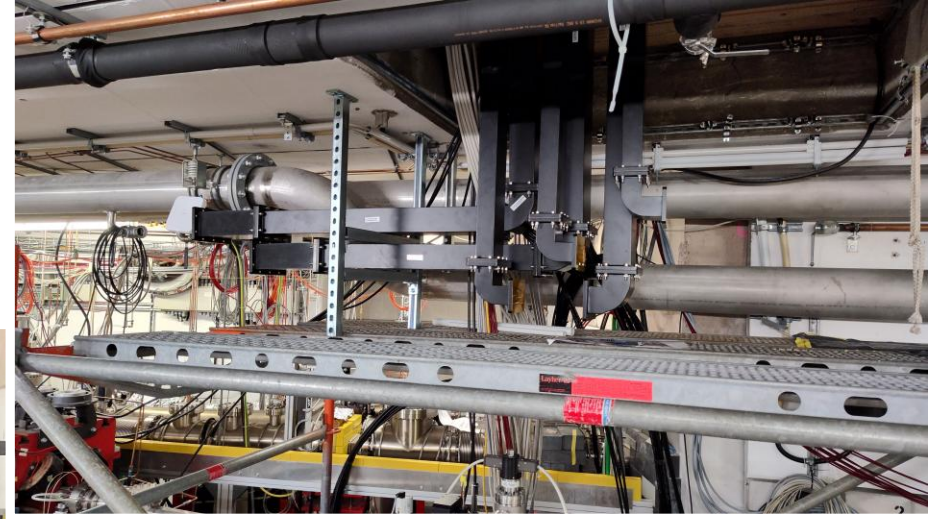
BESSY II

- 5 x 500 MHz
- 3 x 1.5 GHz
- 3 x 1.75 GHz (Cavities to be developed)

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Harmonic Cavities



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New Uninterruptible Power Supply for BESSY + MLS



- Start of Operation in November 2024
- 7.5 MW max. Power
- 63 MJ stored Energy
- $63 \text{ MJ} / 2.6 \text{ MW} \approx 24 \text{ Seconds}$
- Gap between old and new: 17 power surges causing 10 interruptions with sometimes hours of work

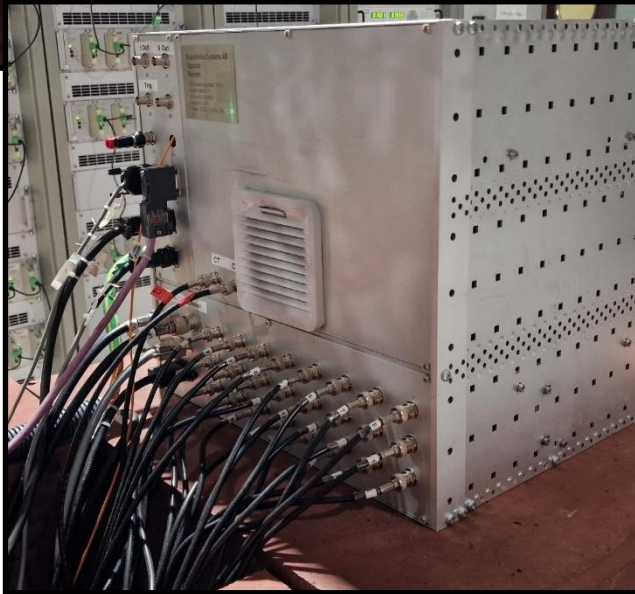
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NEW MODULATORS



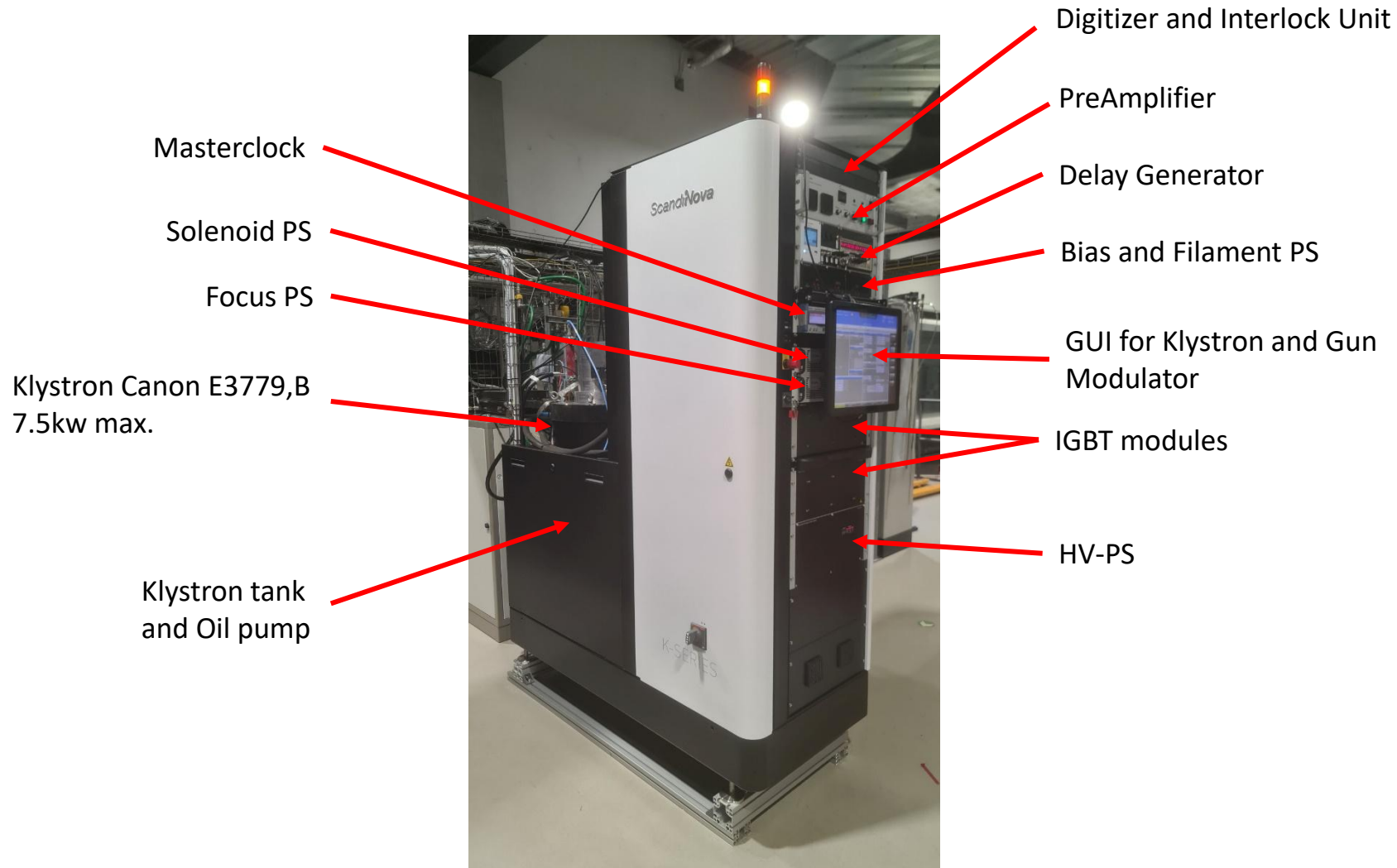
old Gun Modulator



Old Klystron Modulator with Cabinet Gallery

New Modulators for the MLS Microtron in 2024

Klystron Modulator K100



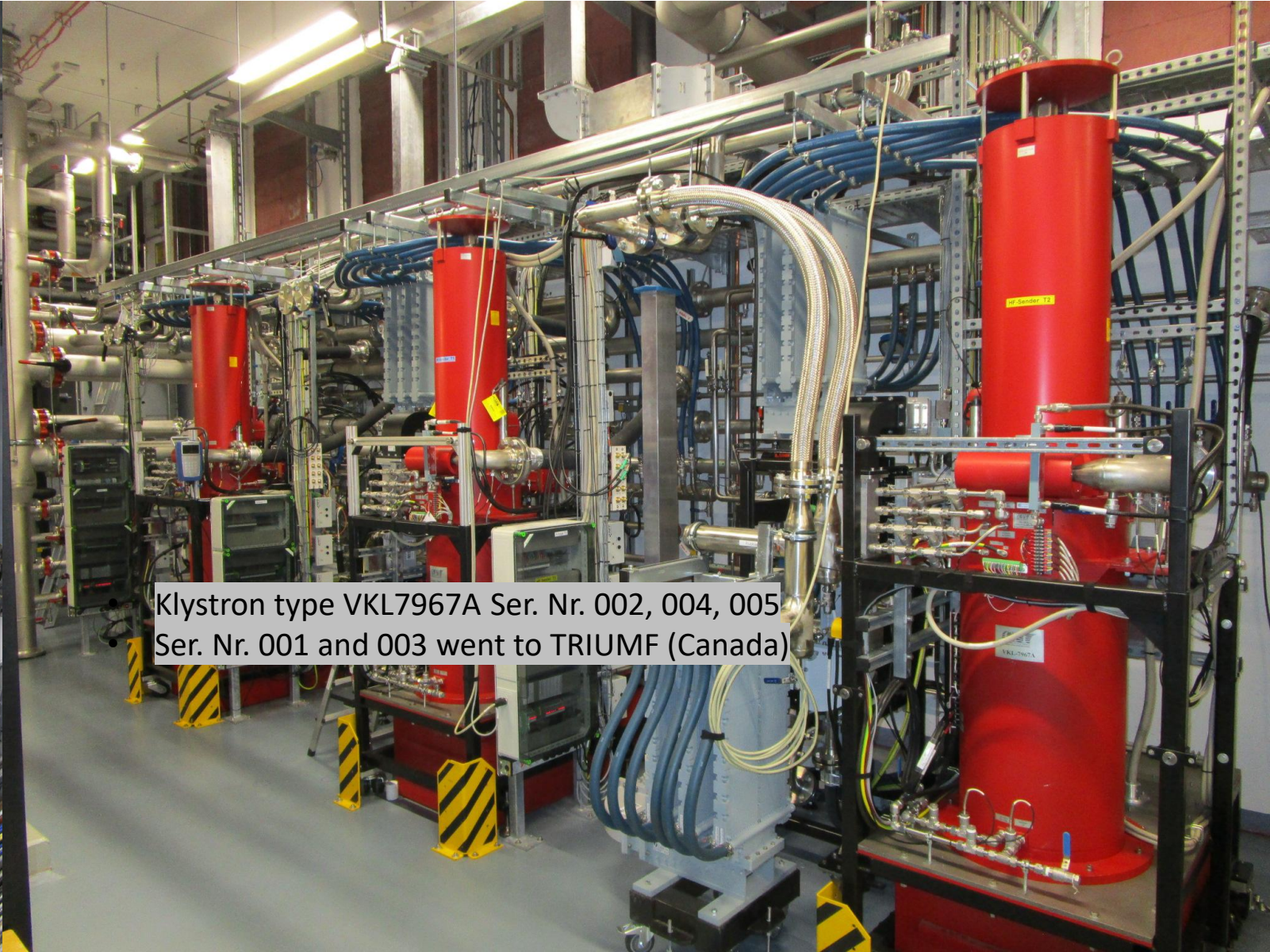
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1.3 GHz 290kW Klystron Transmitters

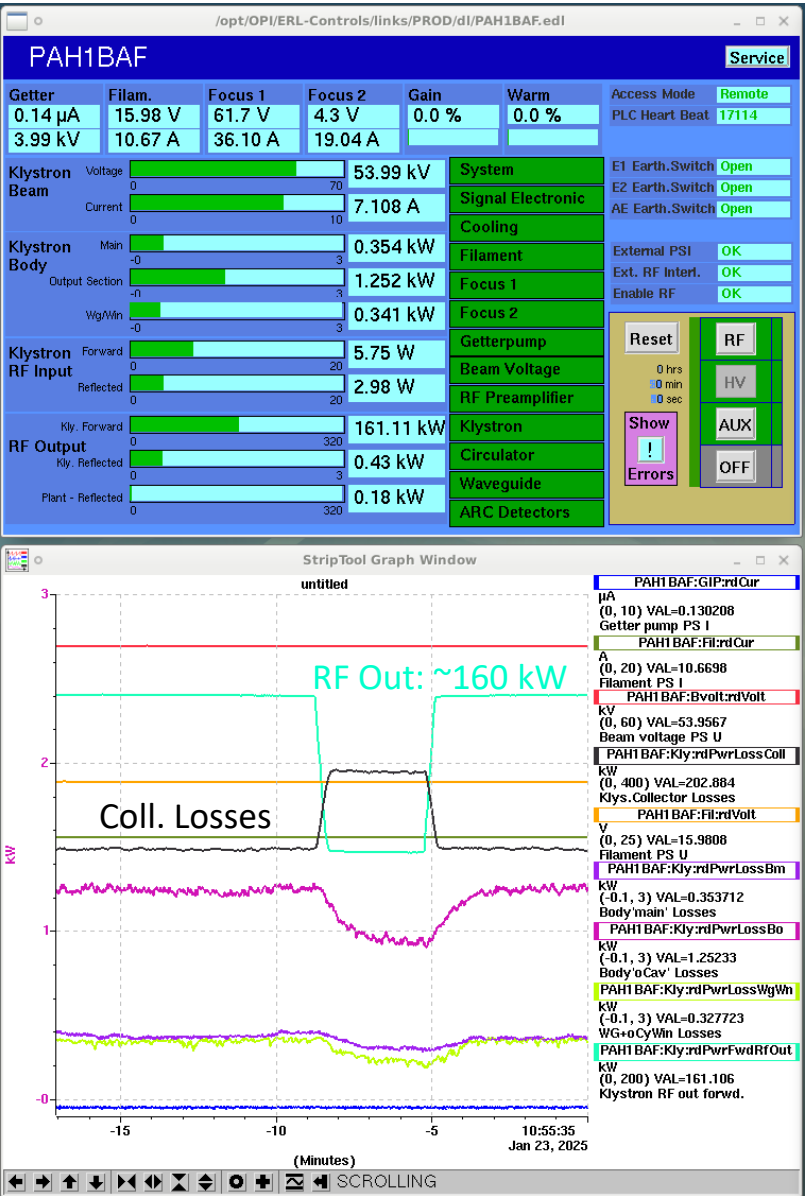


Power Supplies from FuG Elektronik



Klystron type VKL7967A Ser. Nr. 002, 004, 005
Ser. Nr. 001 and 003 went to TRIUMF (Canada)

1.3 GHz 300kW Klystron Transmitters



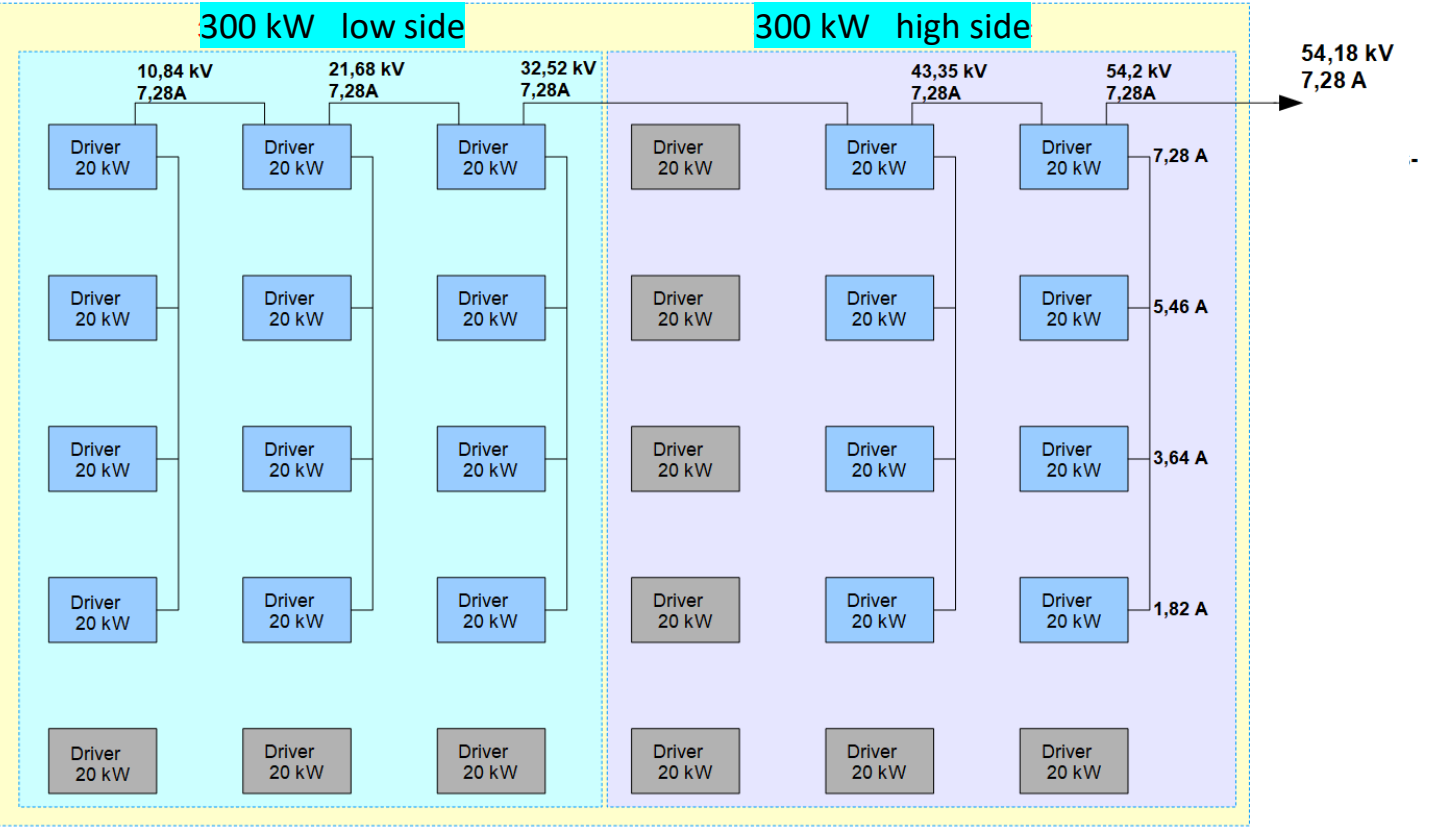
400kW Drivers power (20 Driver a 20kW)

CPI-Klystron Spec:

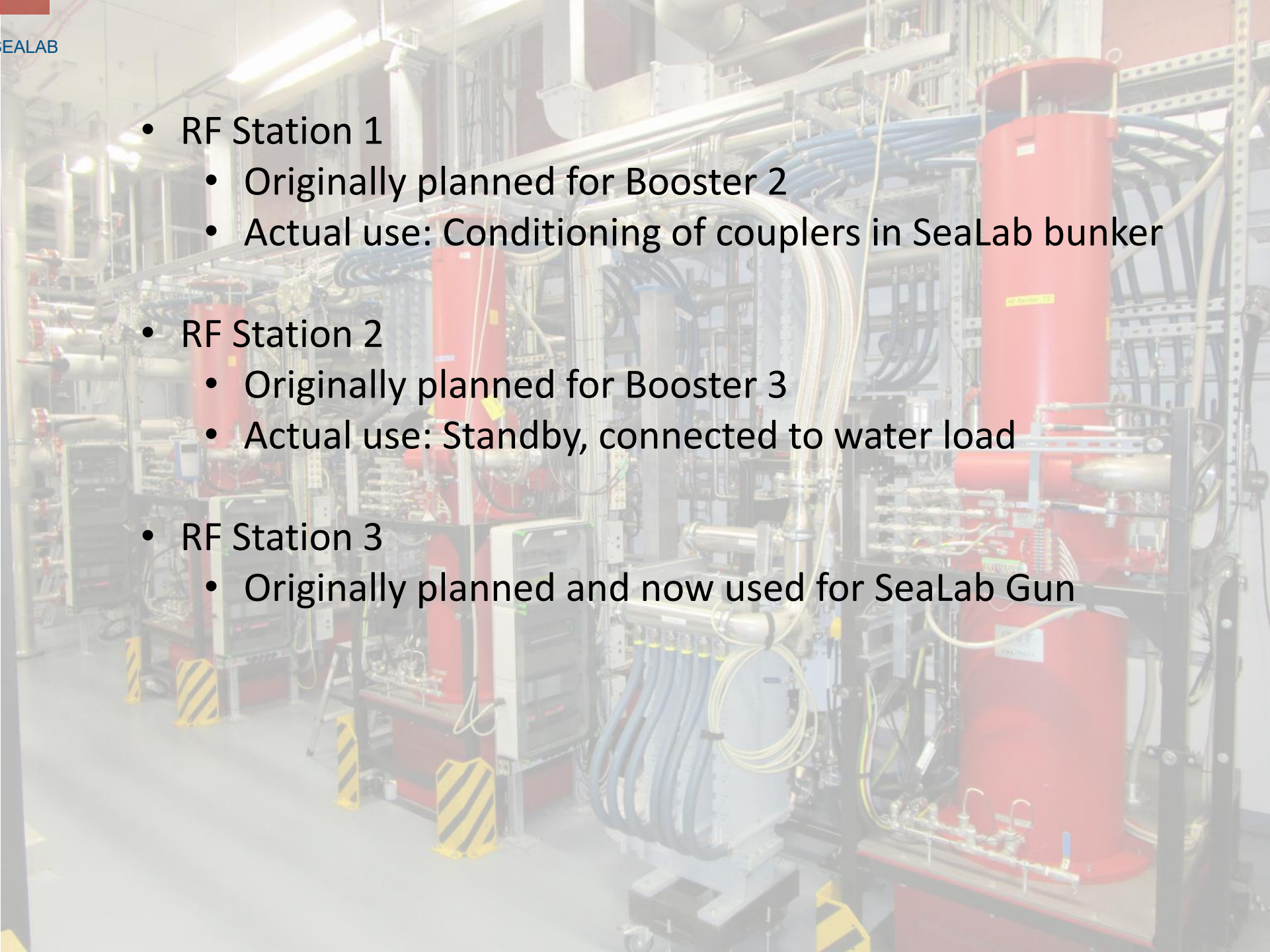
120 kW: 50kV / 6A
200 kW: 56kV / 7.7A
280 kW: 62.5kV / 8.96A

Jeder Driver 10,8 kV / 1,82 A

20 Driver : 54,18 kV / 7,28 A
Klystron - RF - power : ~ 160 kW



- RF Station 1
 - Originally planned for Booster 2
 - Actual use: Conditioning of couplers in SeaLab bunker
- RF Station 2
 - Originally planned for Booster 3
 - Actual use: Standby, connected to water load
- RF Station 3
 - Originally planned and now used for SeaLab Gun



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SSA Maintenance Overview

MLS

Transmitter	331E-001	331D-001	331D-002	331D-003	331D-004	331D-005	331D-006	331D-007	Sum/Year
	PAHB (Booster)	PAH4R	PAH3R	PAH2R	PAH1R	PAH3B	PAH2B	PAHRP (MLS)	
2014	4	0	0	0	0				4
2015	4	8	18	3	0				33
2016	0	0	2	7	3				12
2017	1	3	5	6	5				20
2018	1	3	3	1	4				12
2019	0	4	5	5	6				20
2020	1	3	2	5	1				12
2021	0	1	3	2	2	0	0		8
2022	0	2	3	5	4	0	0		14
2023	0	6	8	6	7	0	0	0	27
2024	0	4	6	7	1	0	0	1	19
Till 10/2025	0	4	5	5	4	0	0	0	18
Sum per Transmitter	11	38	60	52	37	0	0	1	199

SSA Maintenance Overview

Modules

1

2

3

4

5

6

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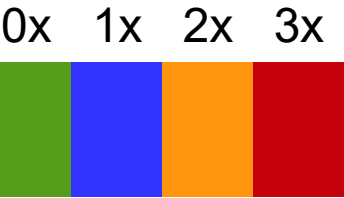
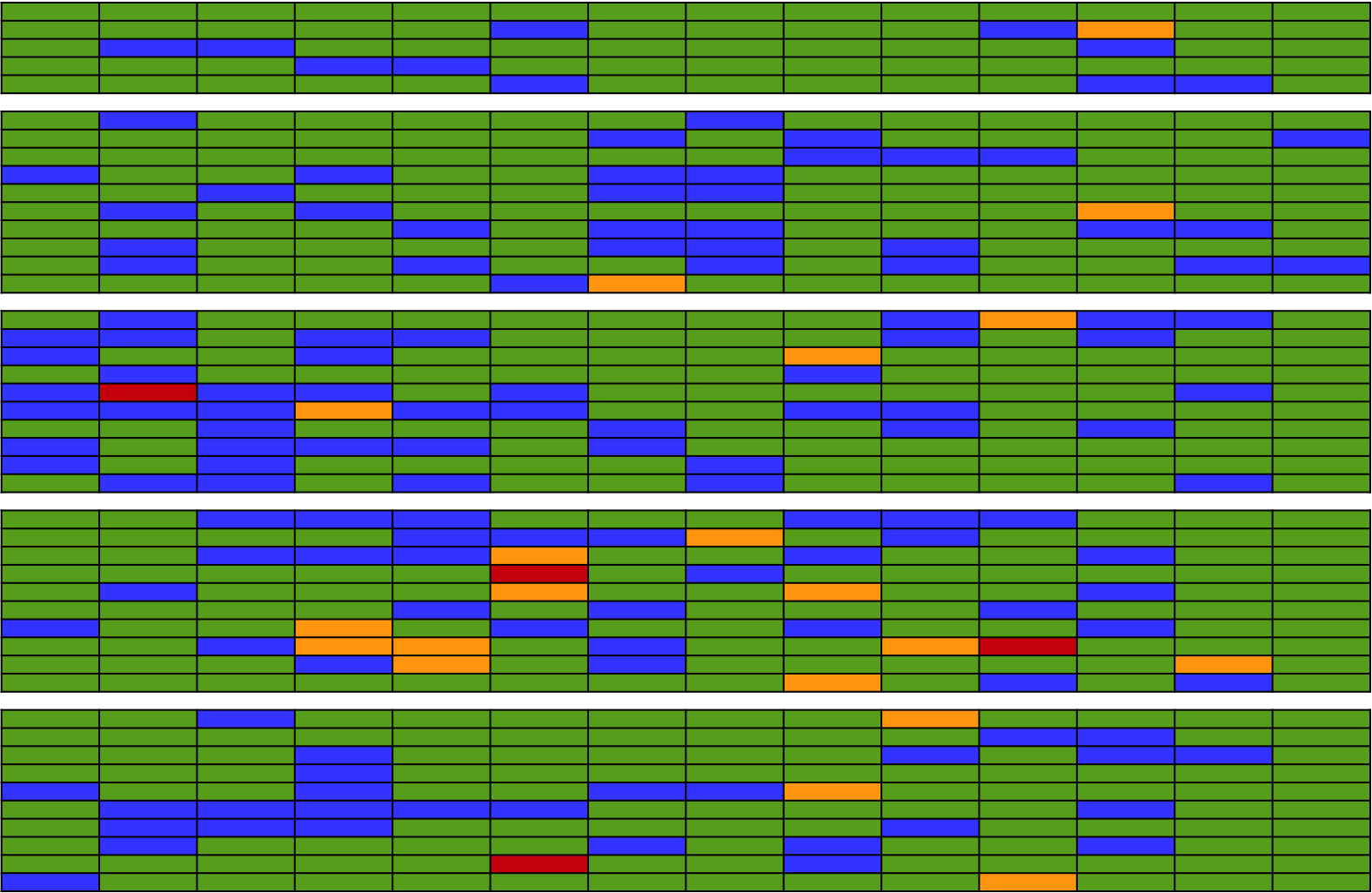
11

12

13

14 (Driver)

Sections 1-10
↓





HZB Helmholtz
Zentrum Berlin

**Thank you for your attention.
Questions?**