



RF Power Linac

M. Omeich, LAL

RF Power for Linac



Modulator / Klystron

TurnKey System

Made by Scandinoa

Modulator type: K2-2

Total cost 1 M€

(Modulator + 3 Klystrons)

Factory Acceptance Test: 14/12/2016

Delivery next month



RF Power for Linac



Parameters:

RF Peak Power max.: 40 MW

Peak Voltage max.: 330 kV

Peak Current max.: 350 A

Electrical Peak Power max.: 92 MW

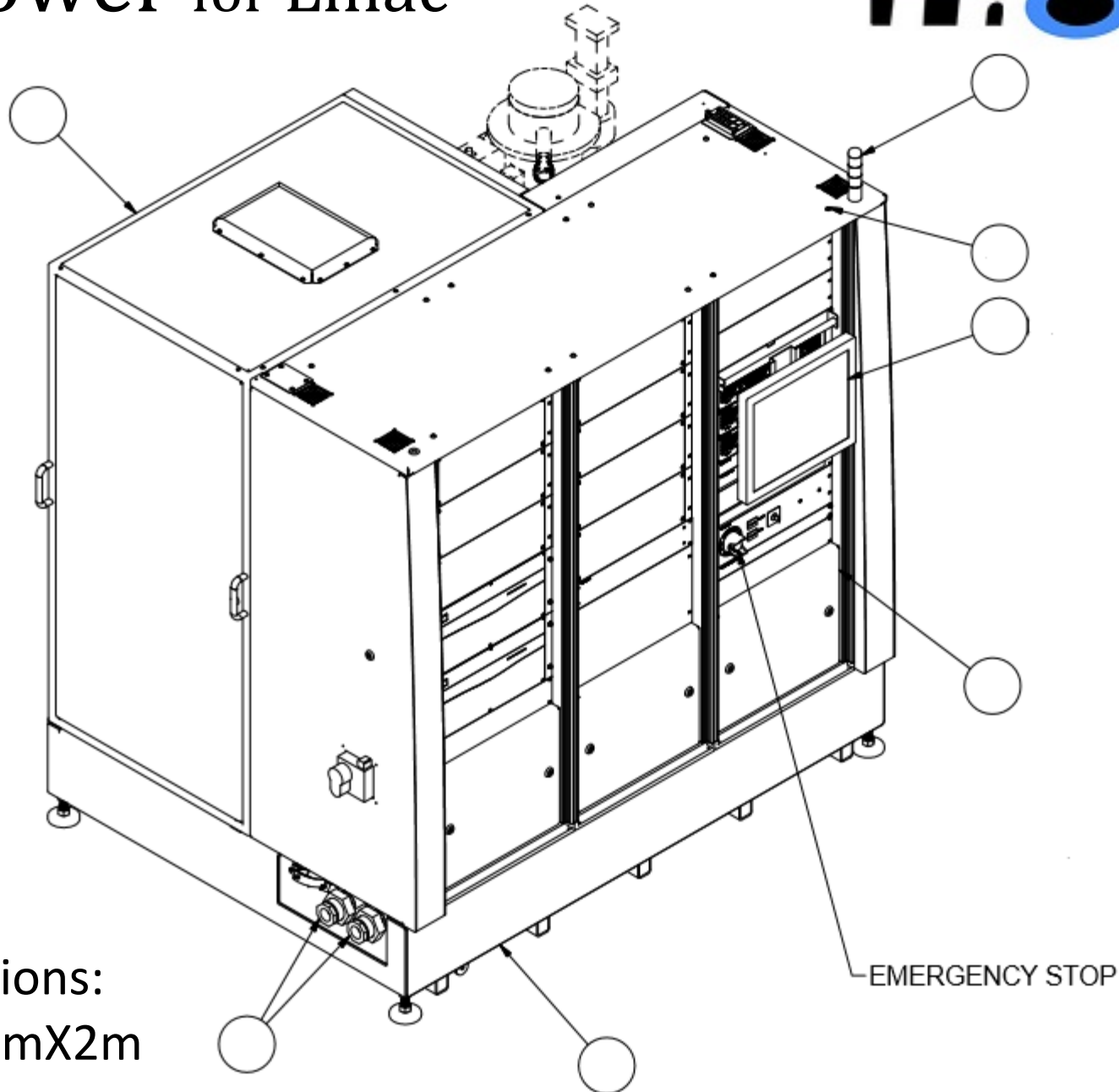
Pulse Width: 6,2 μ S

Rep. Rate: 50 Hz

Jitter: ± 4 nS

Modular System

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Dimensions:
1,5mX2mX2m

EMERGENCY STOP



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Composition

Modulator

- HV Power supplies
- Pulse Forming Units
- Pulse Transformer
- auxiliaires Systems, control & measurement
- Remote Control

Klystron

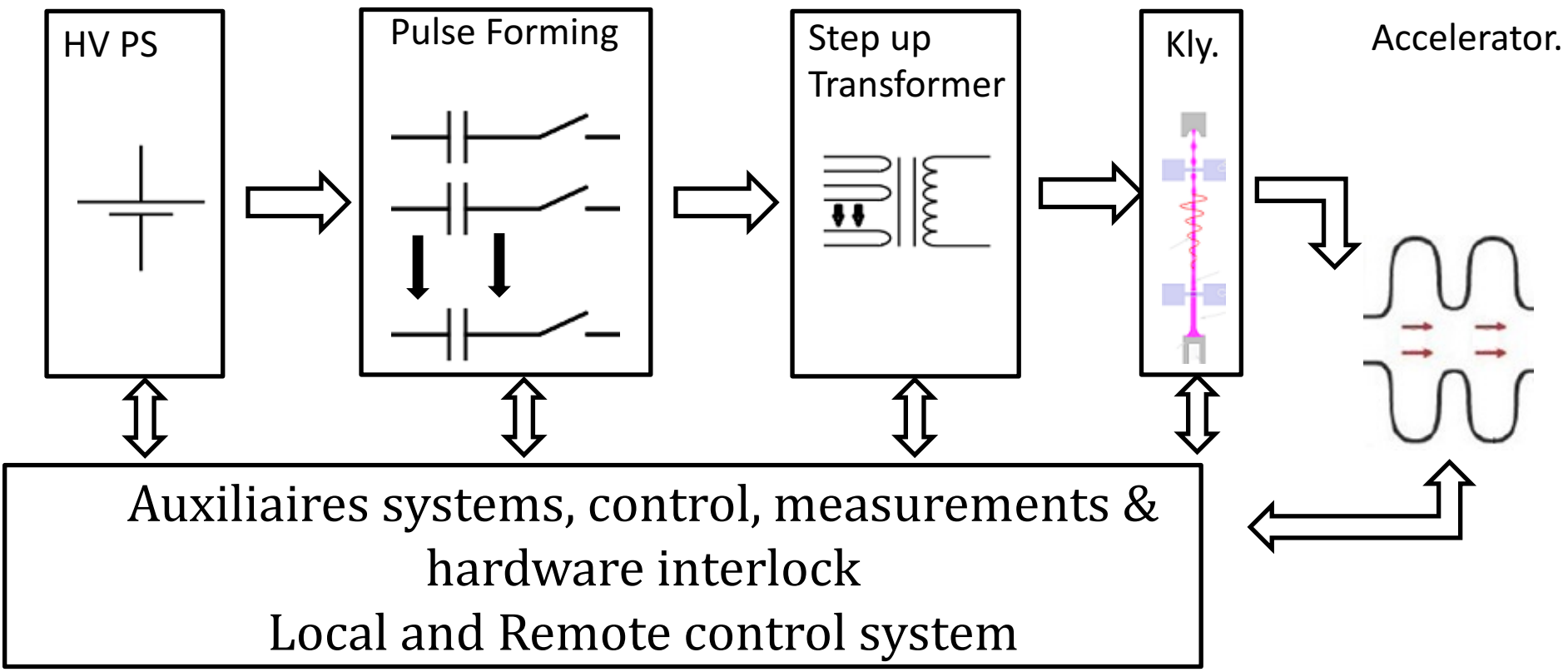
- Thoshiba



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Modulateur



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Modulator Parts

HV Power supply

2 HV capacitor charging power supplies

Pulse width modulation at 25 kHz

Control of PWM by FPGA

Commutation: resonating $\frac{1}{2}$ bridge of 2 IGBT

Power: 25 kW

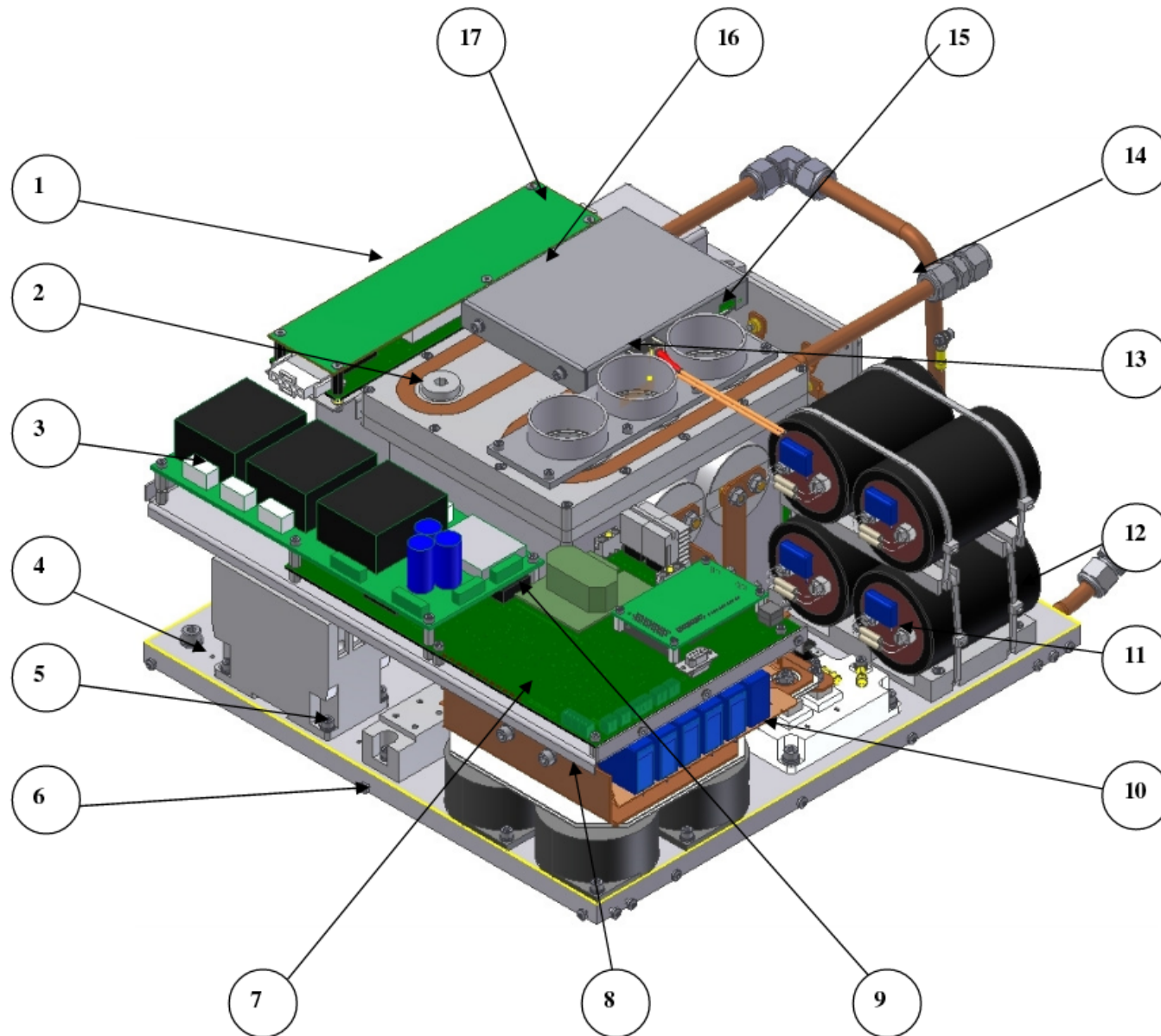
Charging rate: 25kJ/s

Voltage max: 1400 V Current max: 18 A

Optical isolation control to avoid noise

Fine tune to set the capacitor at charge value

ThomX RF Power Linac



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Modulator Parts

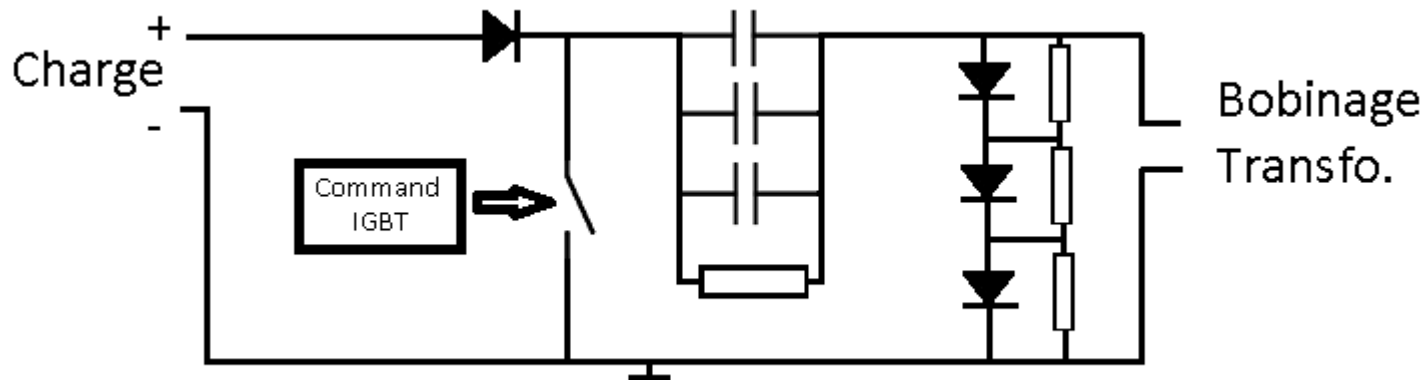
Pulse Forming

7 Units dedicated for the pulse forming

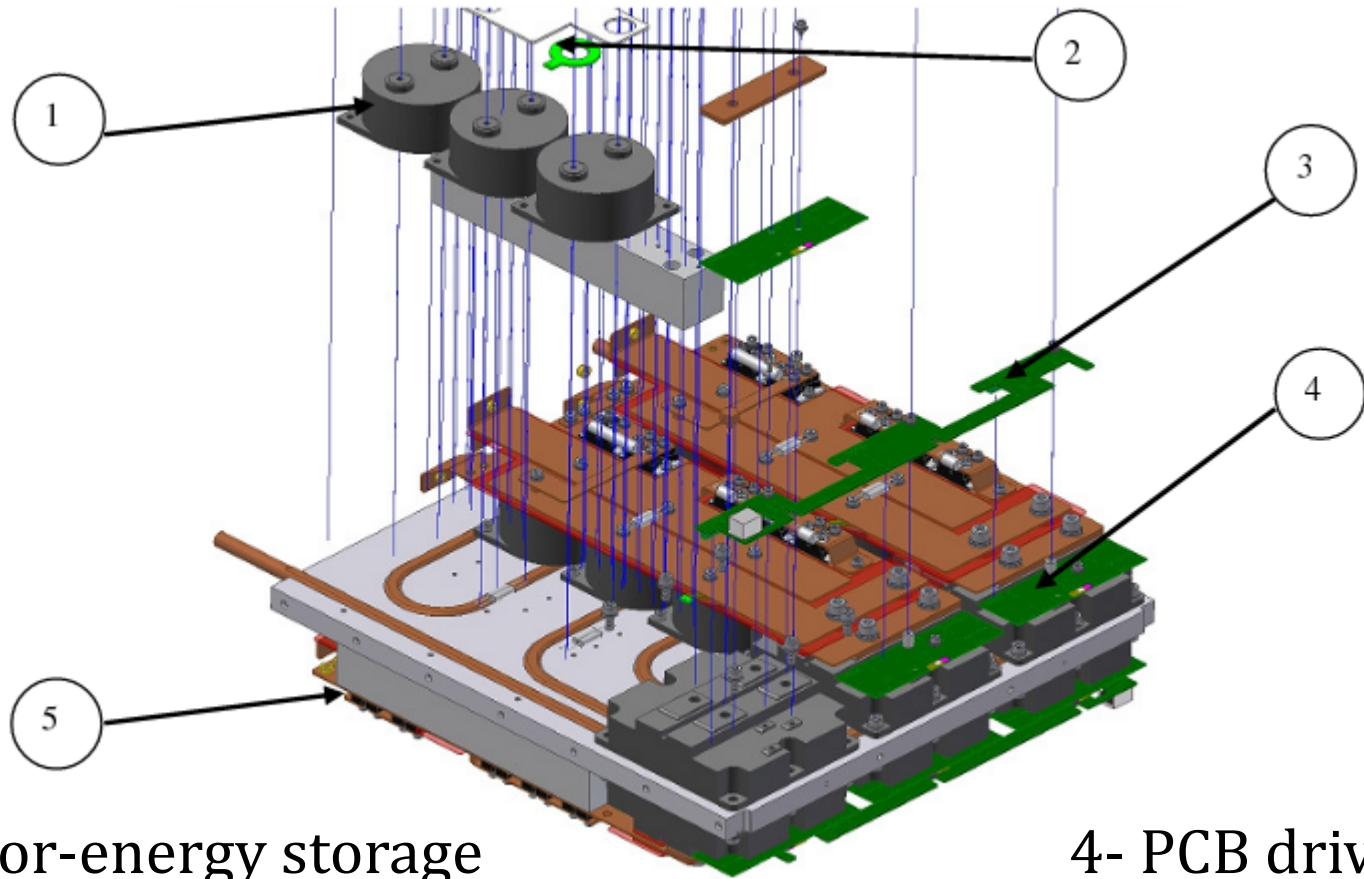
Capacitor-energy storage: $141 \mu\text{F}$

partial discharge of 5 %

Commutation element: IGBT



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- 1- Capacitor-energy storage
- 2- Current measurement
- 3- PCB driver

- 4- PCB driver
- 5- Cooling





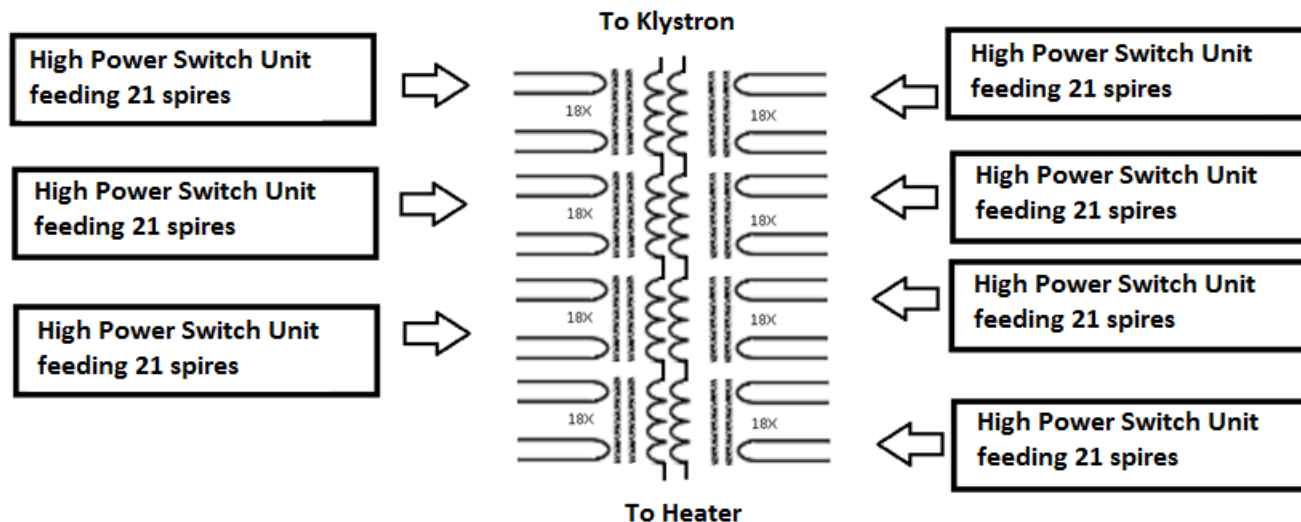
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Modulator Parts

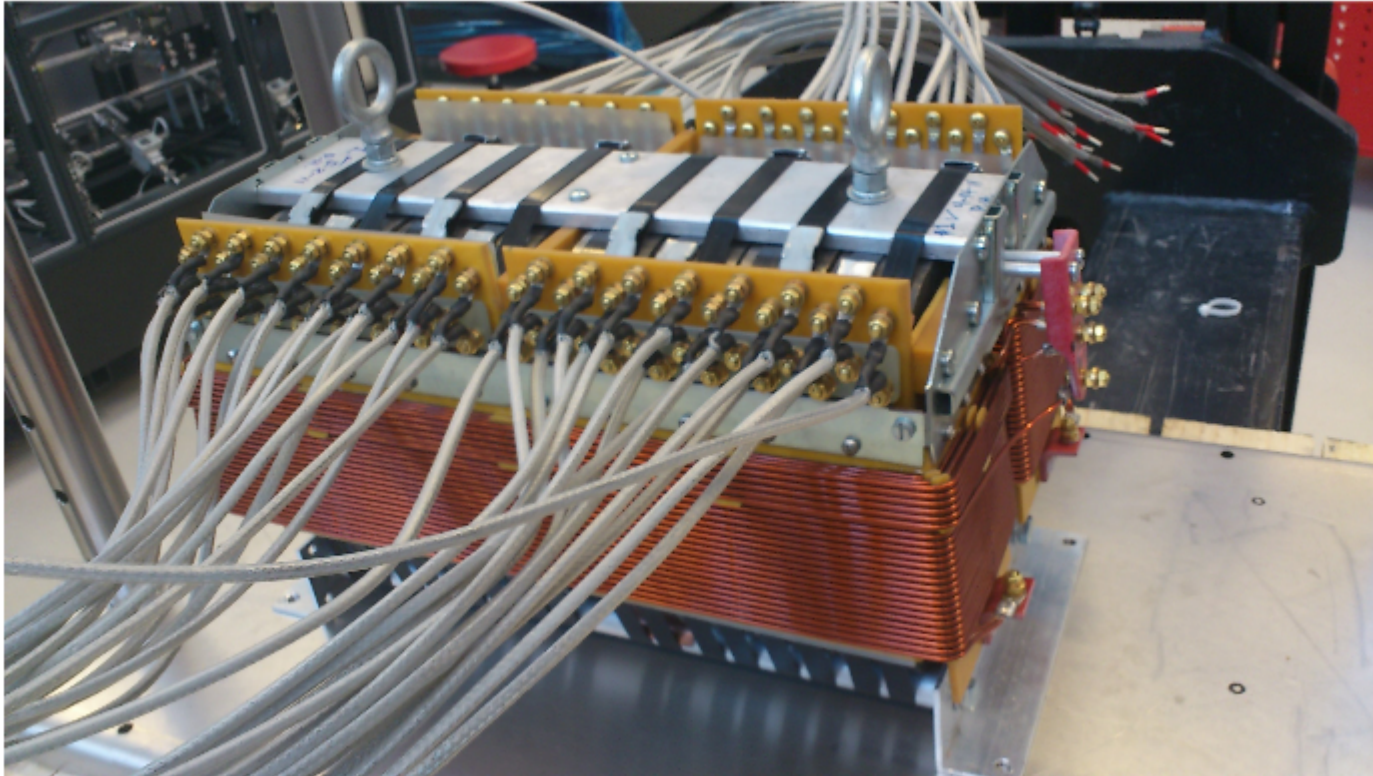
Pulse Transformer

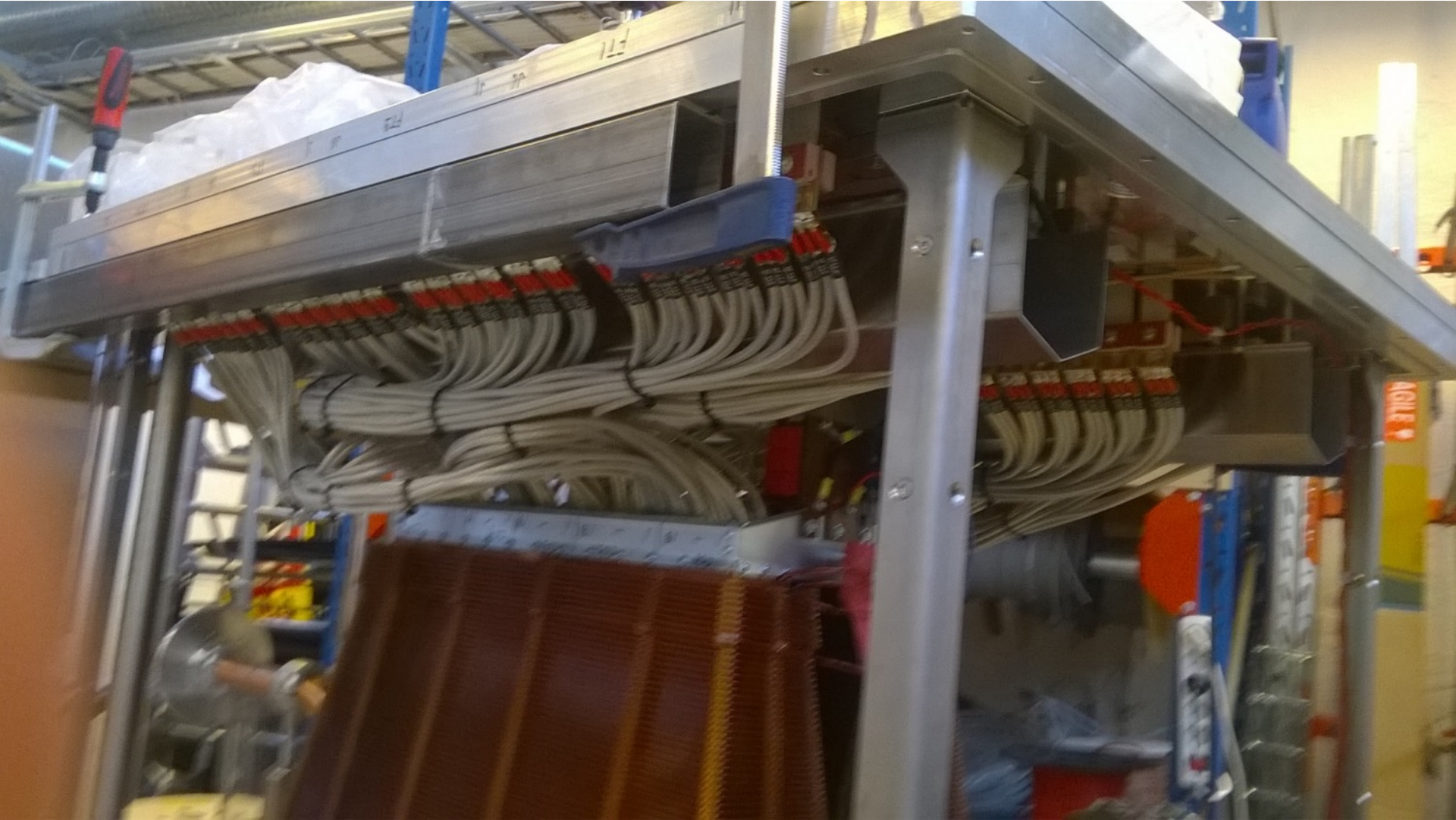
It's the Key component of the modulator

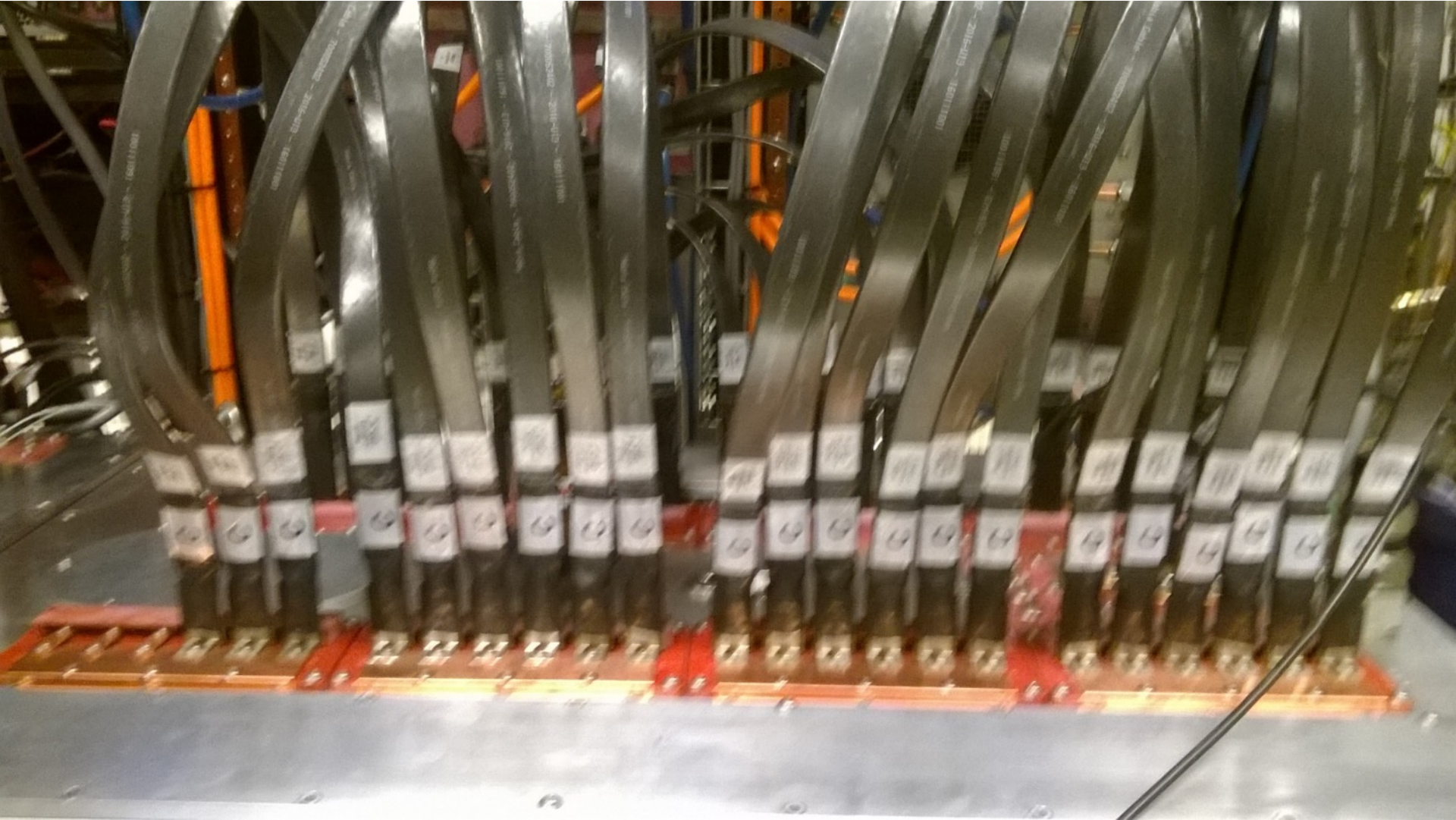
- Several primary windings & split core ⇒
low inductance & low voltage primary

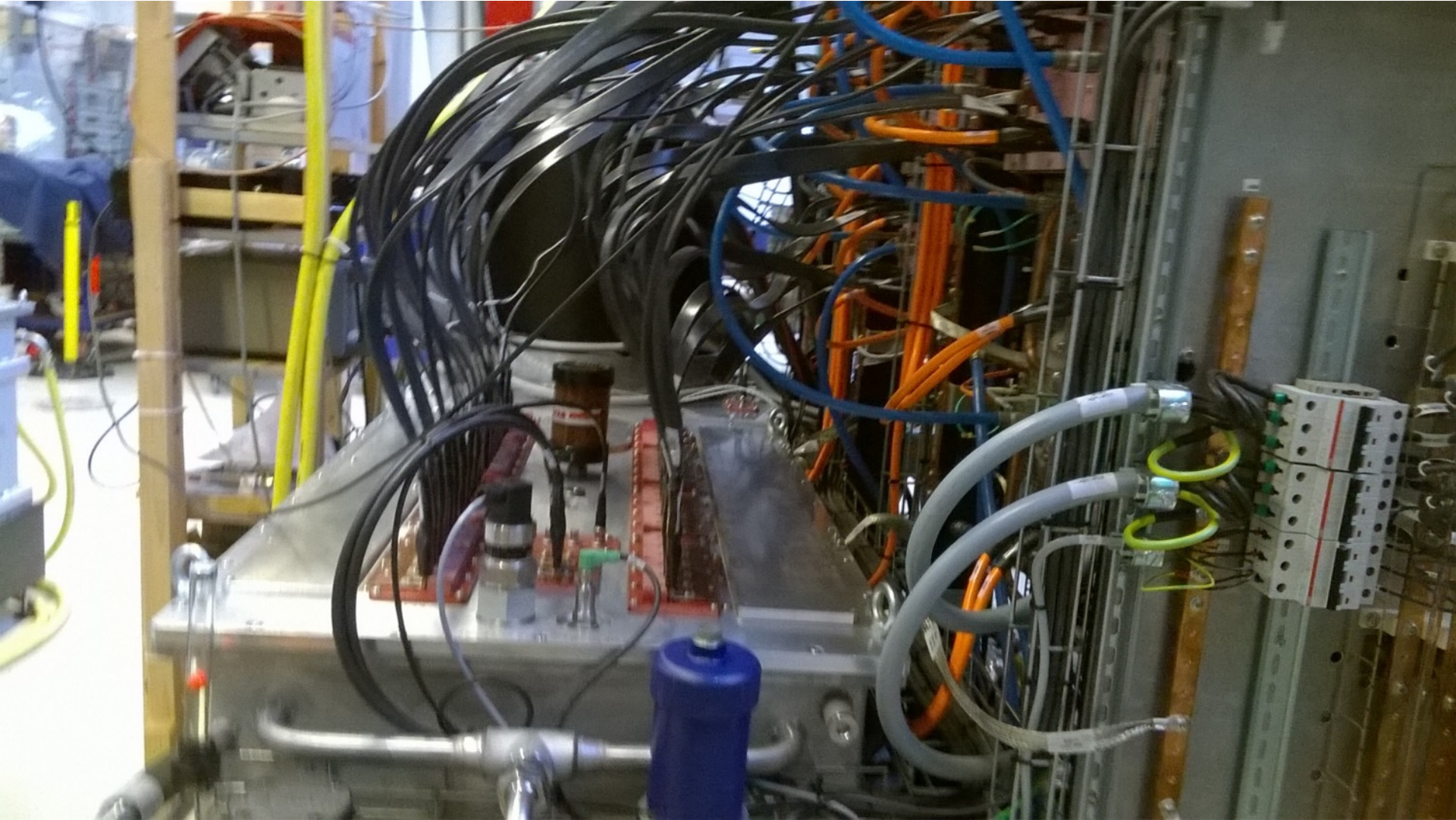


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Modulator Parts

Auxiliaires Systems:

-Timing et Triggering

Timing generation interne/externe

Optical isolation of timing distrib. \Rightarrow Modules

-Hardware interlock & Measurements

Dynamic: Over current; Over voltage; etc...

Static: Cooling; Acces; Radioprotection

External interrupt requird; etc...

-Control System

Local and Remote

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Modulator Parts

Auxiliaires Systems for Klystron:

-Heater power supply

Voltage: 20 V Current: 20 A

-Focus Magnet (Solenoid)

2 PS for 6 windings

-RF Power supply

Ampli 400 W 3 Ghz

-Vaccum (Ion pump) Power supply

Voltage: 3,5 kV Current: 1 mA

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Klystron

Klystron: Toshiba E37310

RF power(output): 37,5 MW

RF power(input): 325 W

Cathode Voltage: 285 kV

Cathode Current: 308 A

Cathode Heater Current: 17 A

RF Pulse Width: 4,5 μ S

Rep. Rate: 50 Hz

Efficiency: 42,9 %

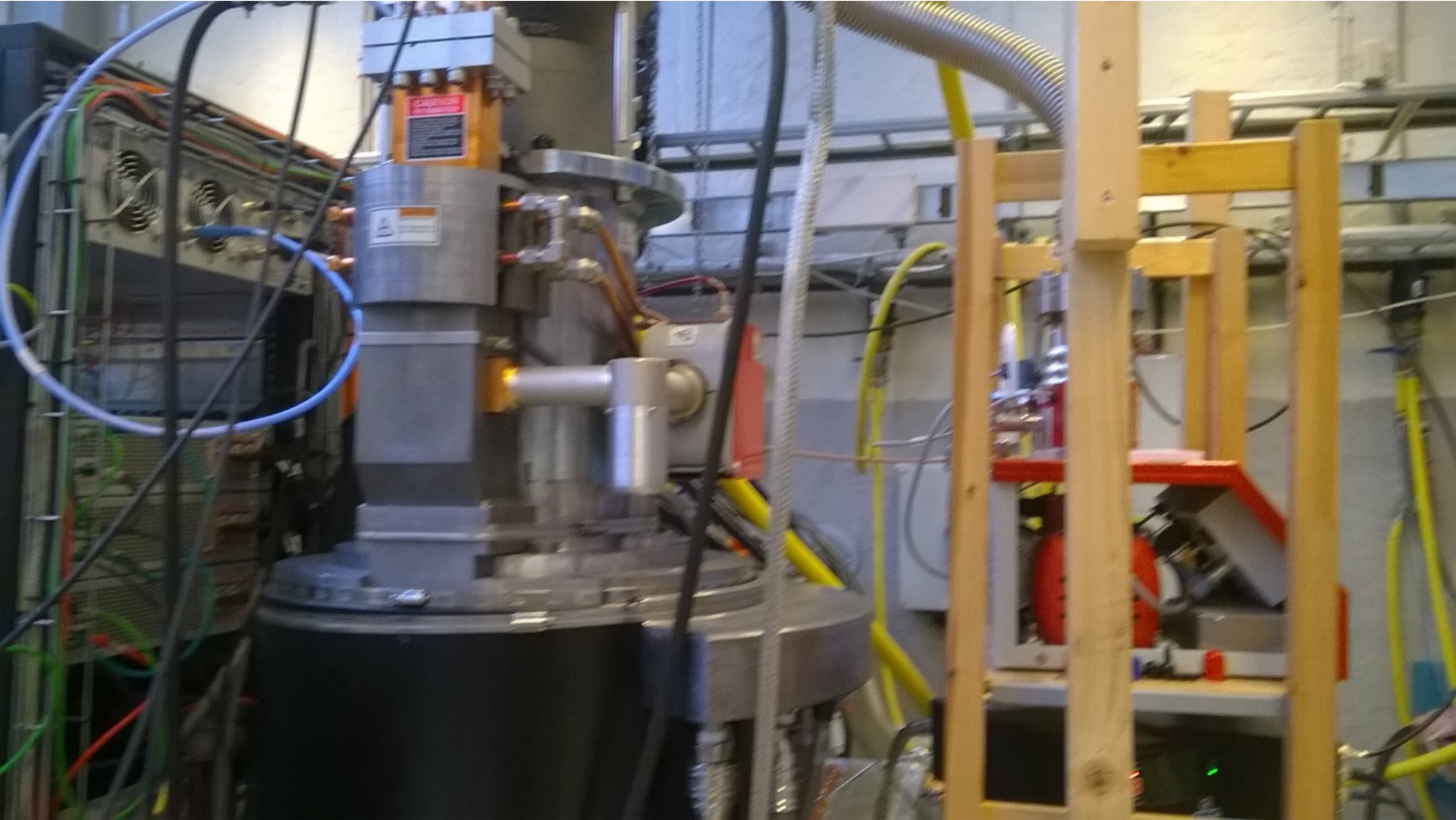
Gain: 50,6 dB

Perveance: 2,02 [μ a/v^{3/2}]



TOSHIBA

Leading Innovation >>>



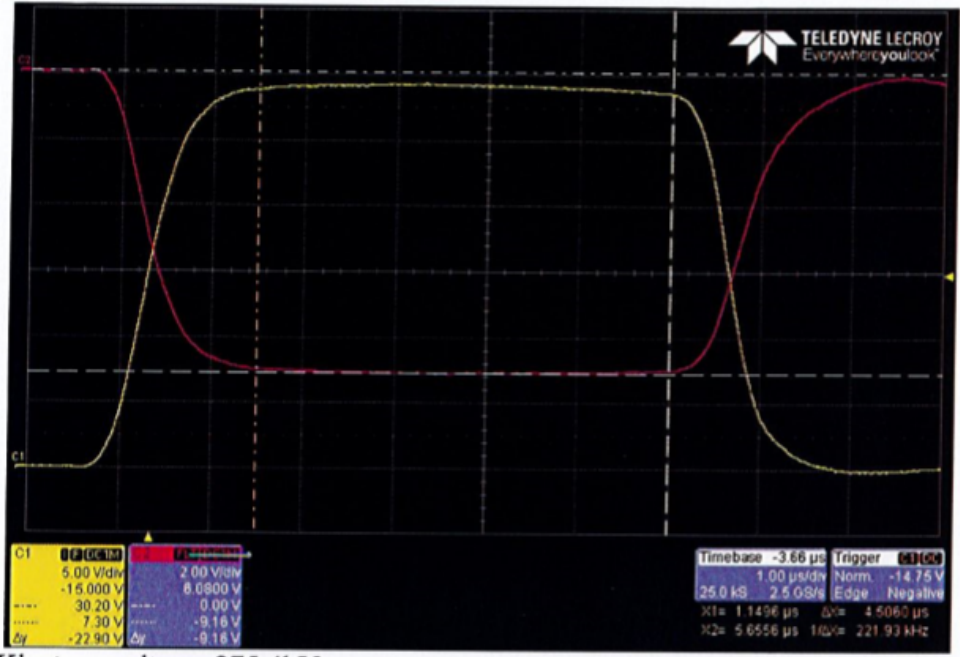
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Modulator Factory Test

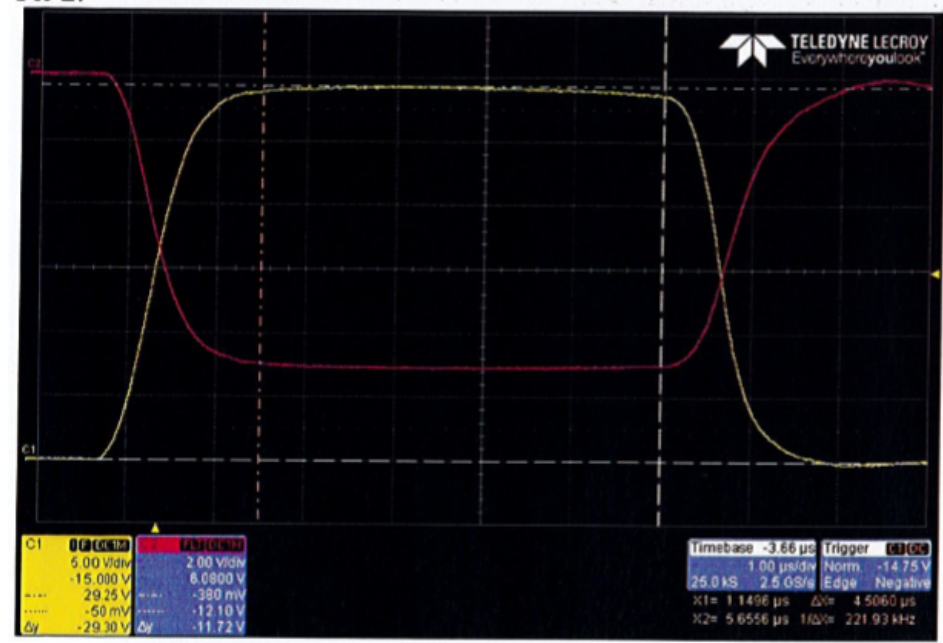
The FAT was done from 14/12/16 to 16/12/16
Modulator/Klystron running in HV mode (no RF)
All ccs where cheked out, long time test (8 hours)

Pic 1:



Klystron voltage 275.4kV

Pic 2:



Klystron current 292A

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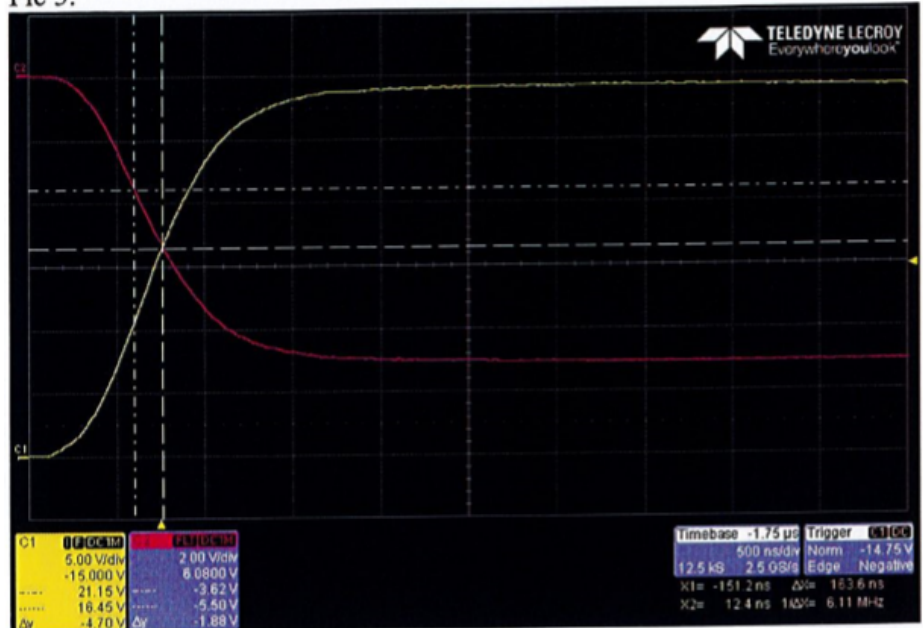


Modulator Factory Test

Rise Rate: 346 kV/ μ S

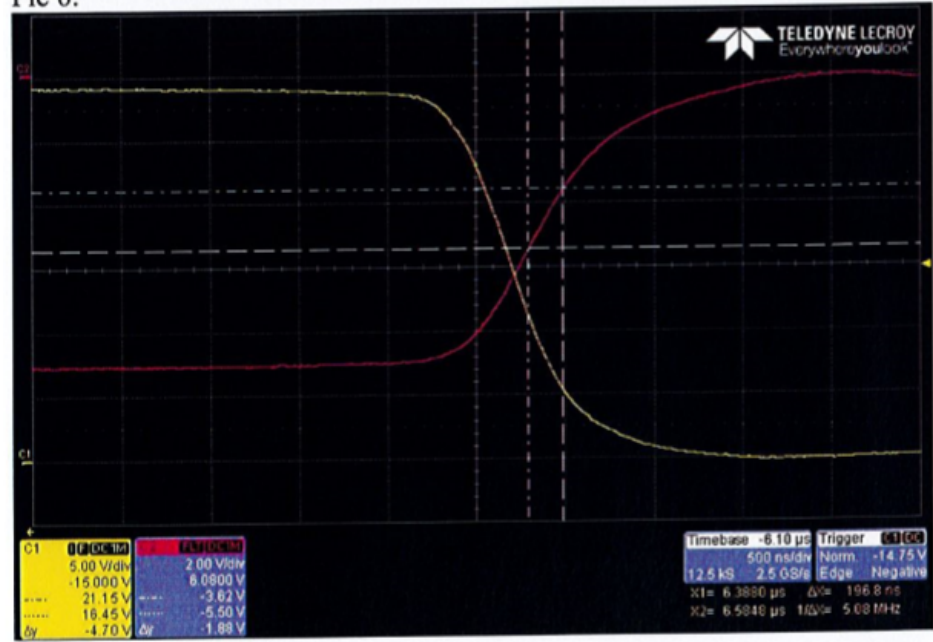
Fall Rate: 278 kV/ μ S

Pic 5:



Rate of rise 346kV/ μ s

Pic 6:



Rate of fall 287kV/ μ s



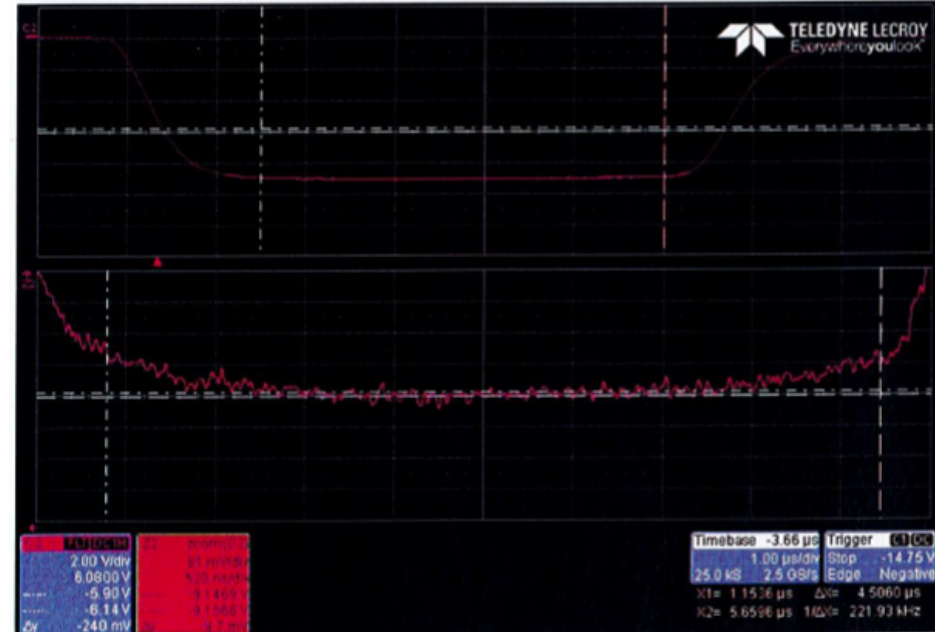
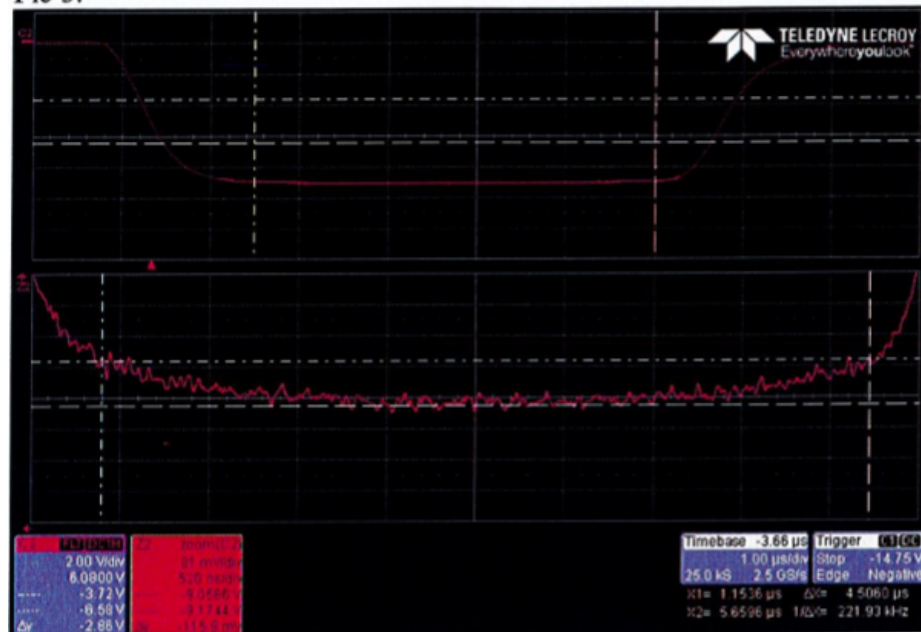
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Modulator Factory Test

Flat top during pulse: 1.2 %

Flat top during 1 μ S: 0.2 %

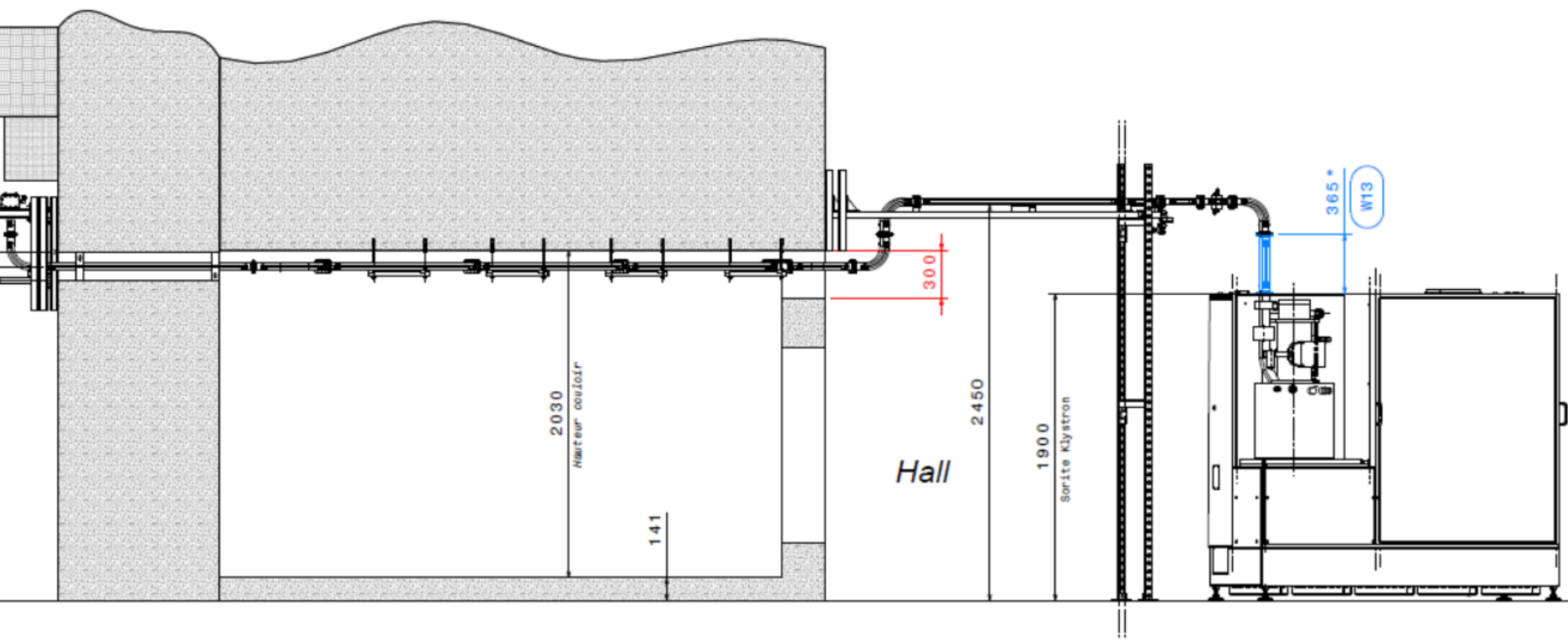
Pic 3:



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RF Network



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RF Network

