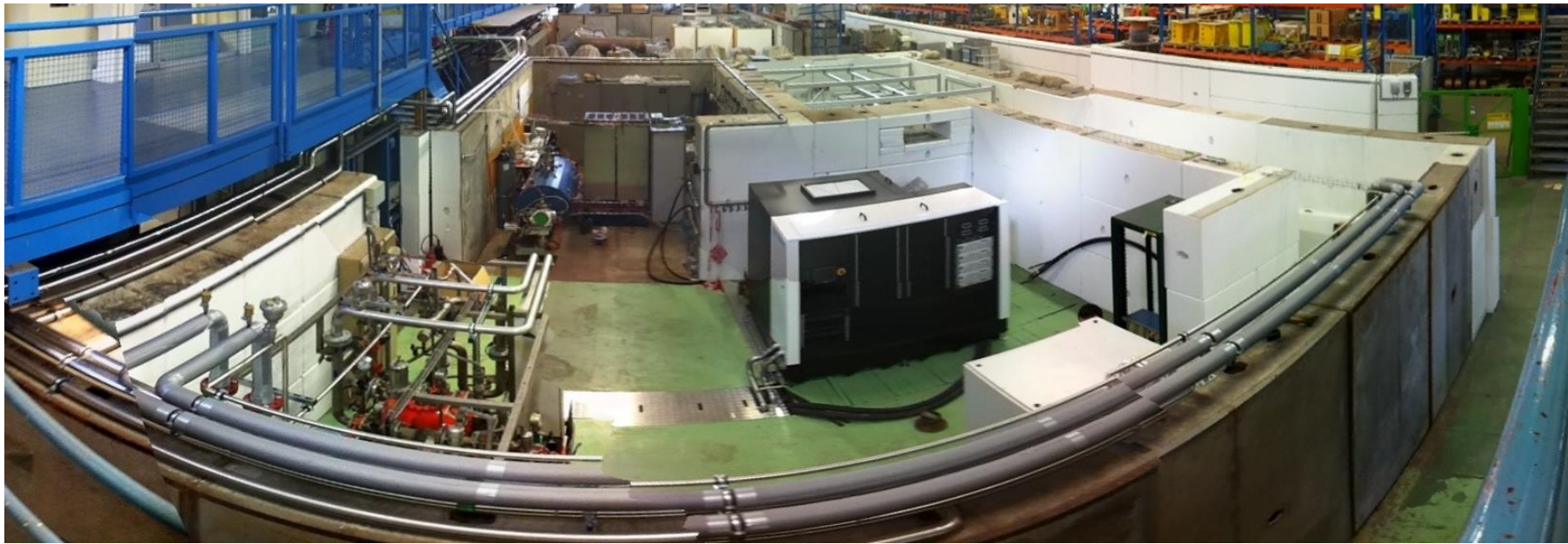


Progress on XBox-2 and 3

N. Catalan Lasheras, G. Mcmonagle, I. Syrathev
04.02.2014





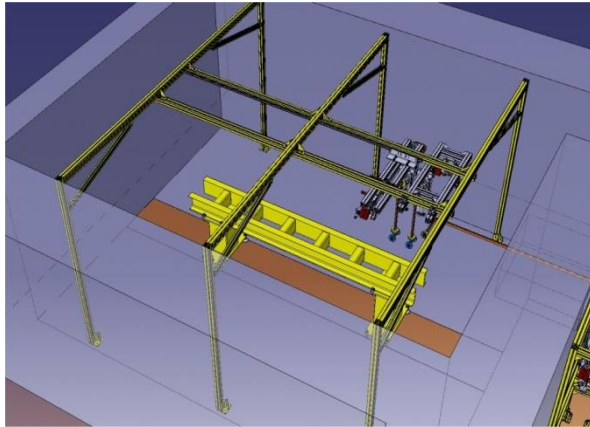
What are Xboxes?

- We need to increase our RF, high power testing facilities in order to validate RF design and manufacturing
- X-band (11.994 GHz) klystron-based test facilities capable of testing the CLIC structures with the same RF power as the one coming from the Two-beam scheme
 - 50MW, 170ns, 50-100Hz
 - Can accommodate also other structures/components with different requirements in peak power or pulse length
- Xbox1: Modulator/klystron/pulse compressor power source. Commissioned in 2012. Up and running into the CTF2 area
- Xbox2: Same principle as Xbox2. Being installed ready to run tests this year
- Xbox3: more sophisticated principle and larger flexibility.
 - Under procurement
 - To be commissioned on 2015

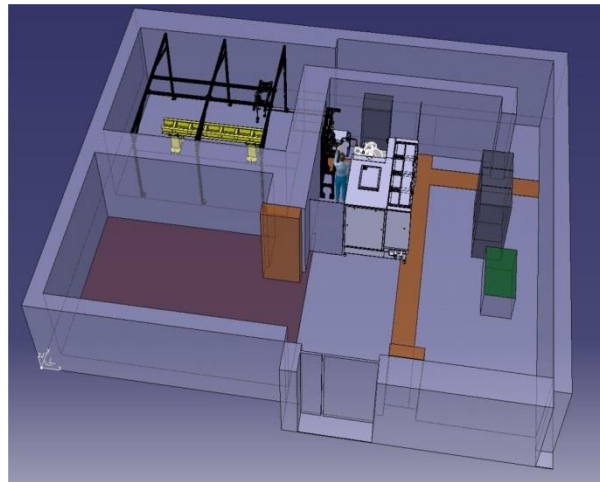




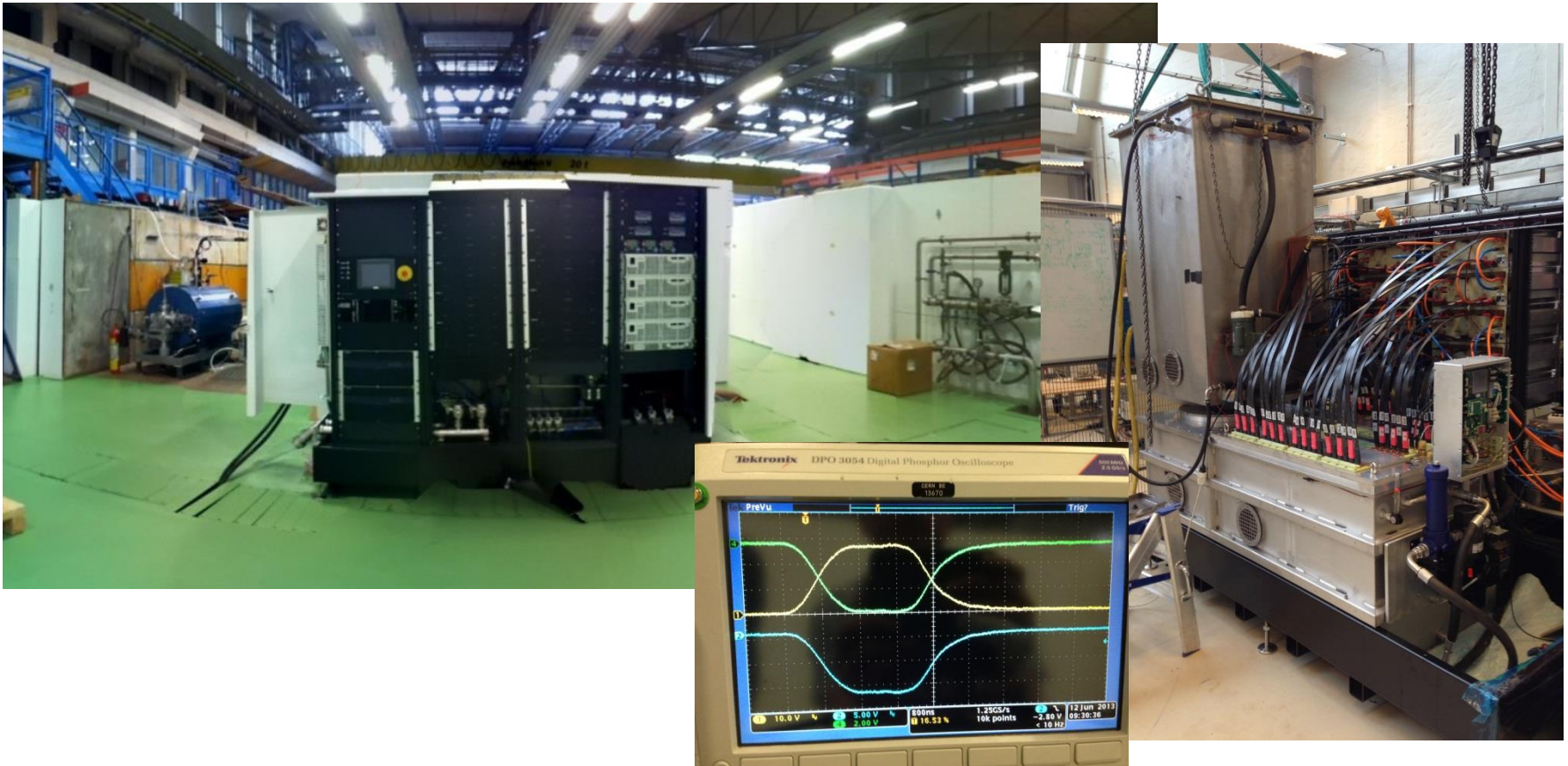
Xbox2. From drawing to reality



XBOX2 area, 03.02.2013

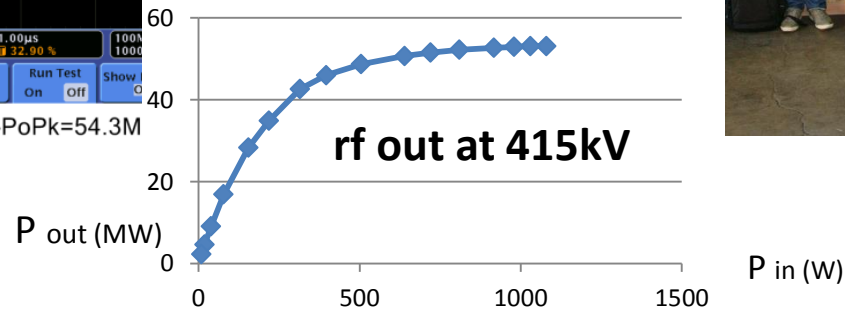
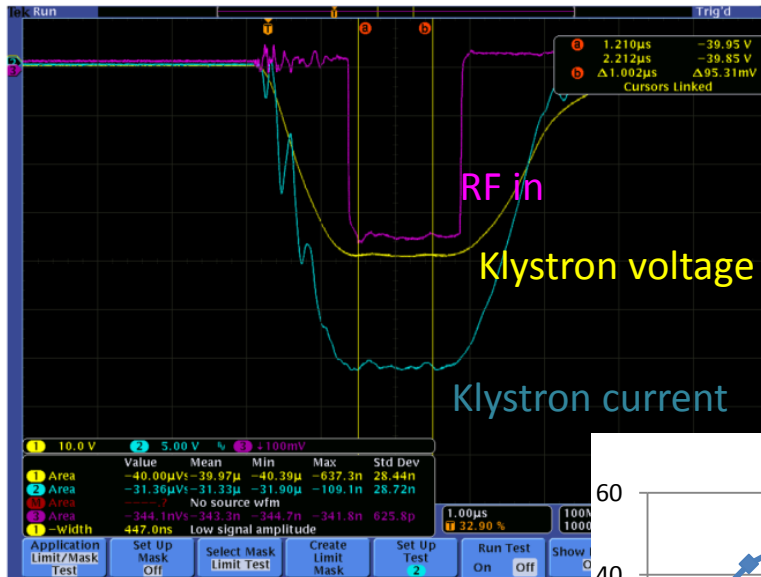


- Modulator arrived, installed and tested in May
 - Second iteration of the K2 modulators by Scandinova
 - first one already used in Xbox1





CPI VKX8311A Klystron



20140111-421kV-1500nS-PoPk=54.3M

- First commercial 50MW, 12GHz build by CPI tested in SLAC
 - Final acceptance tests at the beginning of January for a large audience.
 - Good performance, still conditioning
- Minor mechanical and shielding modifications to be done.
- Should be arriving at CERN in three weeks!

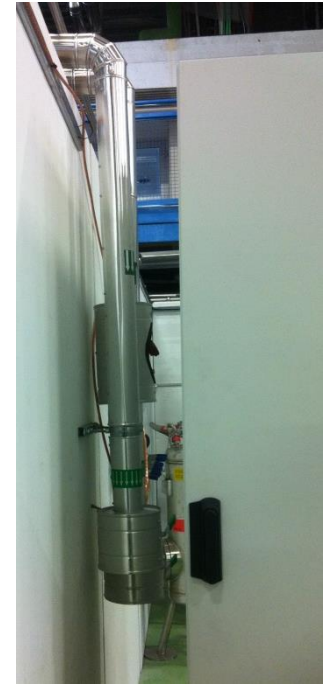
- New demineralised water station
 - Water station final tests today.
 - Enough capacity for cooling Xbox3
 - Fully independent from LEAR station and injectors



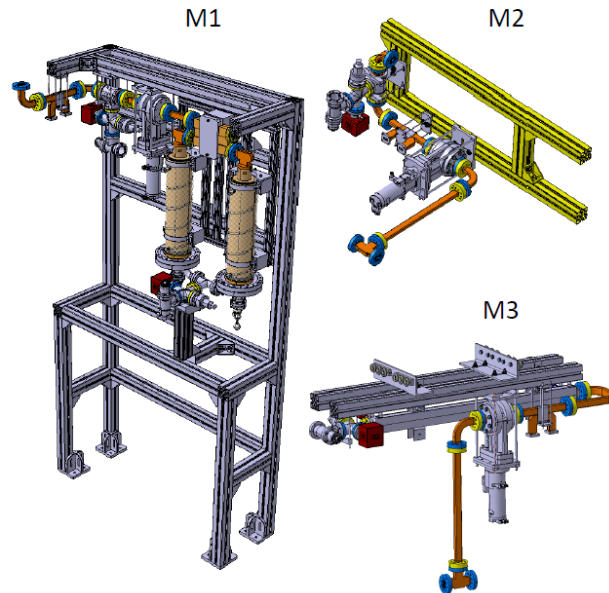
Chilled water for temperature stabilized RF rack.

- shielding,
- electricity,
- cabling,
- ...

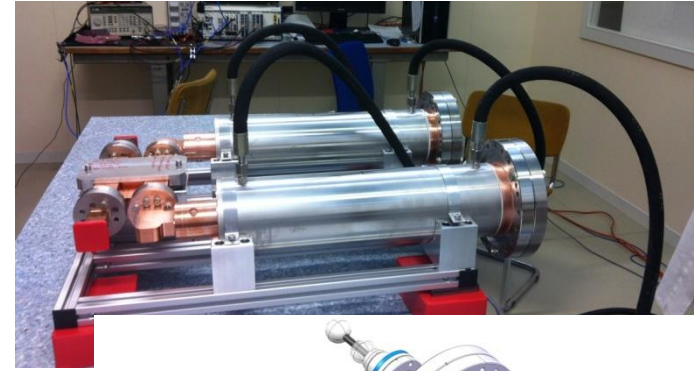
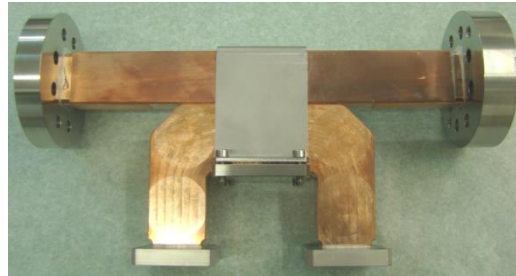
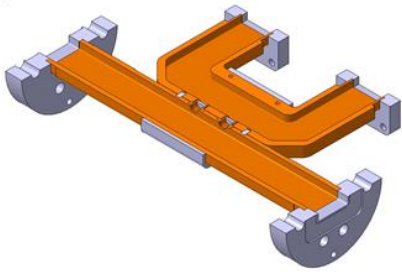
compressed air



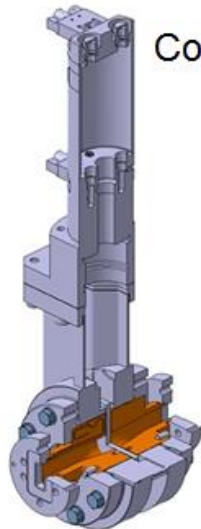
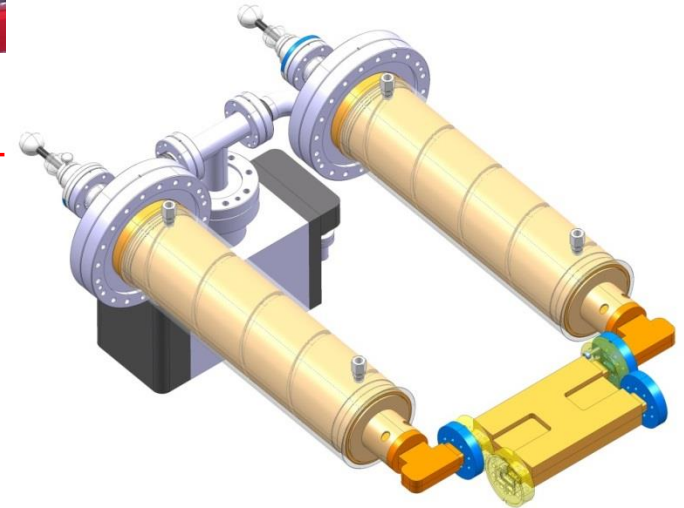
- Mechanical supports under installation
 - Module 1 in the lab waiting for network waveguides
 - Module 3 temporarily reconfigured to be used during commissioning of the CPI klystron



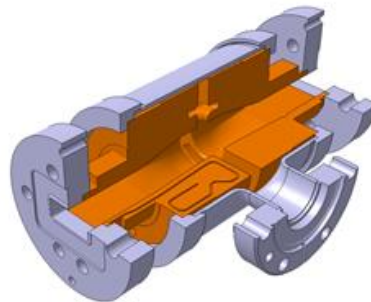
- Network waveguides
 - Machining finished
 - Brazing the first batch this week



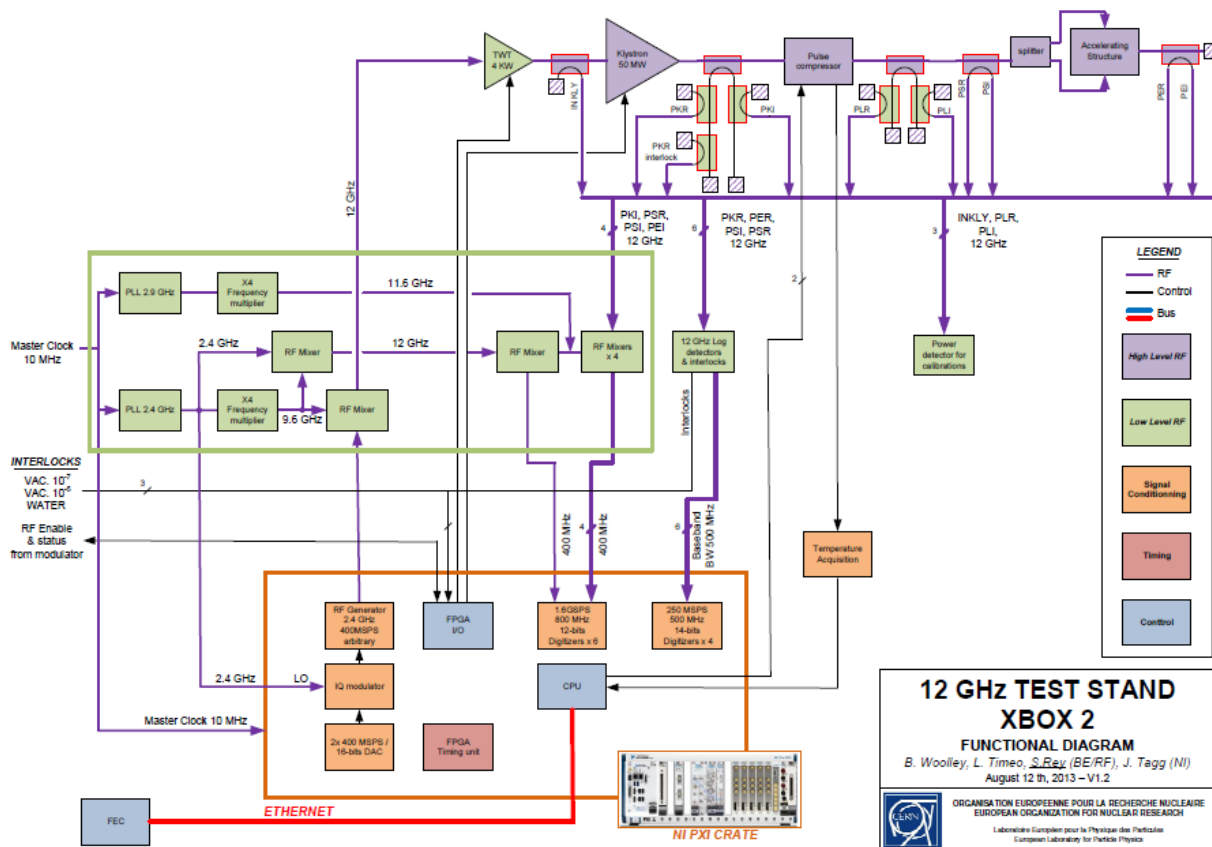
All components for Xbox2 delivered and tested!!

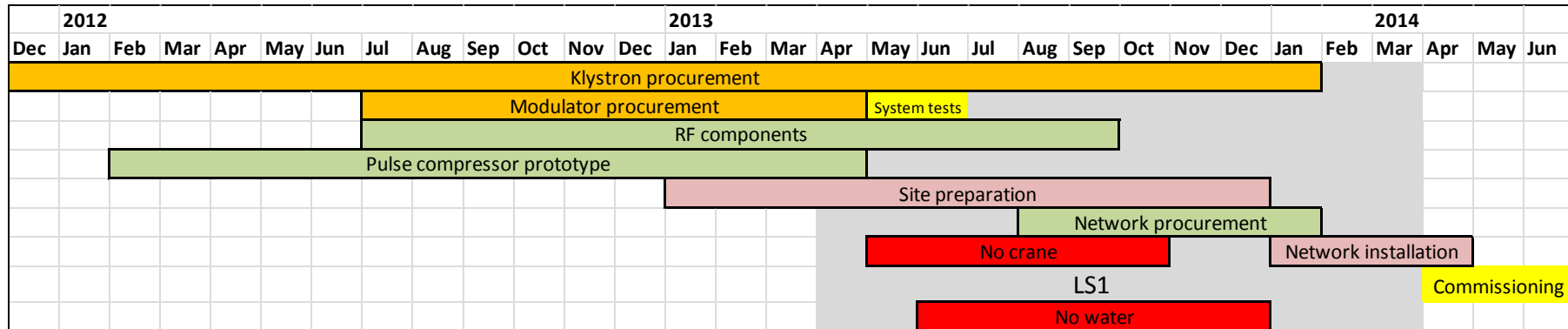


Compact RF/vacuum gate valve and vacuum pumping port.



- PXI based LLRF validated and available. Tested in Xbox1 and in the Lab
- Rack for input, frequency multiplication etc. in preparation
- New high stability RF cables ordered



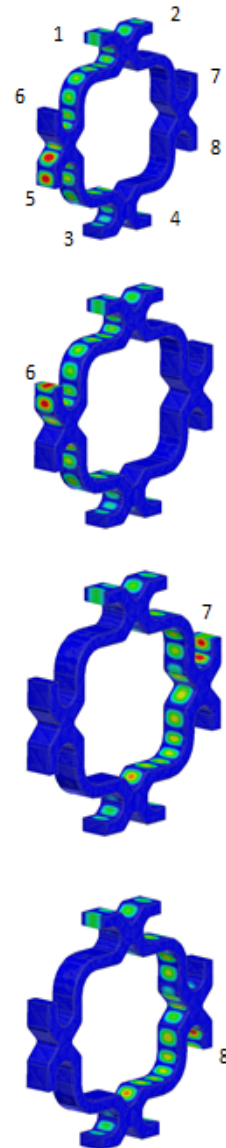
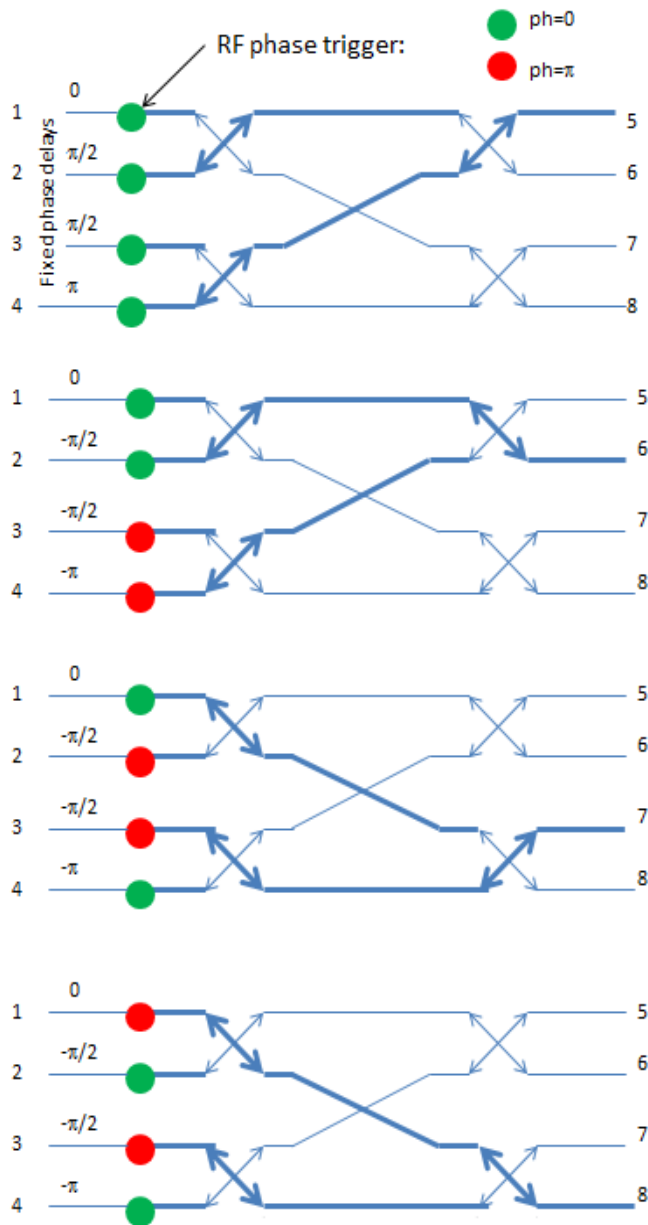


- Large delay on Klystron delivery
 - Contamination problems during manufacturing
 - Long testing at SLAC
- Lots of waiting time due to LS1 works.
 - Water systems works during LS1
 - Chilled and demineralized water installed in parallel.
- Last network components will arrive in February.
- Commissioning on Q2 2014



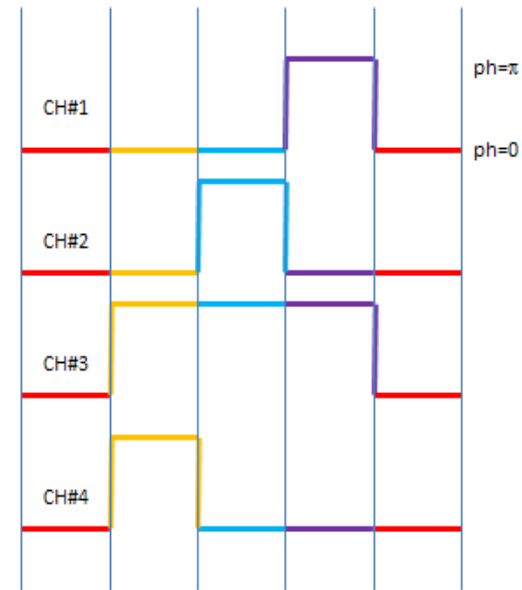


Xbox3 principle



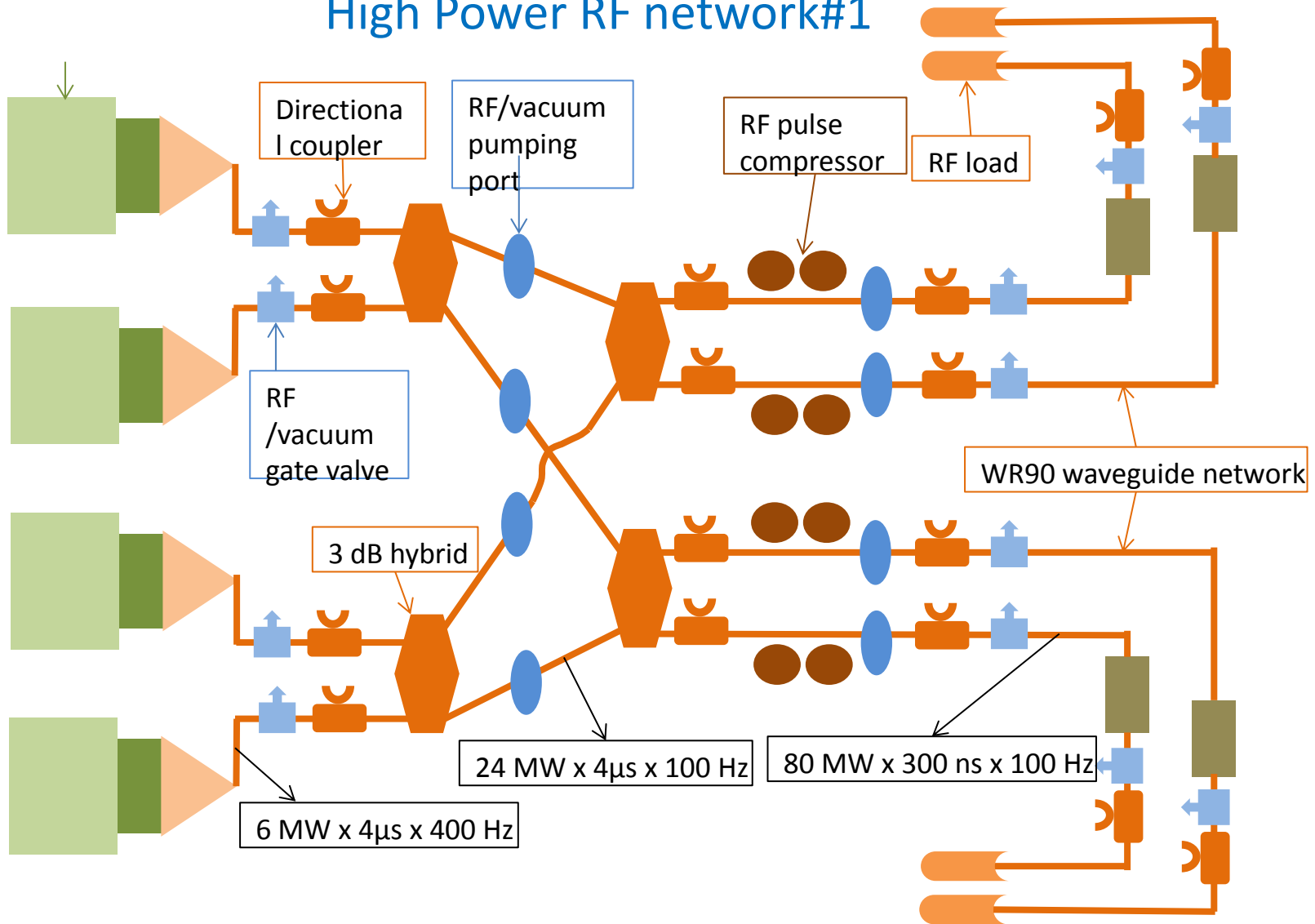
Klystrons commutation using LLRF phase triggers.

RF phase triggers positions



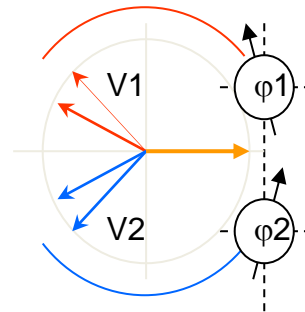
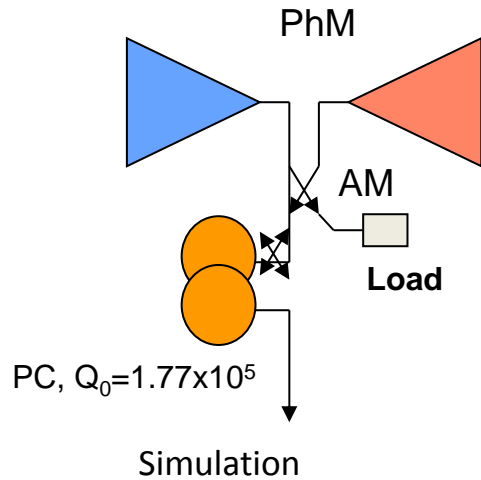
By RF phase manipulation of klystrons (each running at 400 Hz) we can established 4 testing slots running at 100 Hz each.

High Power RF network#1



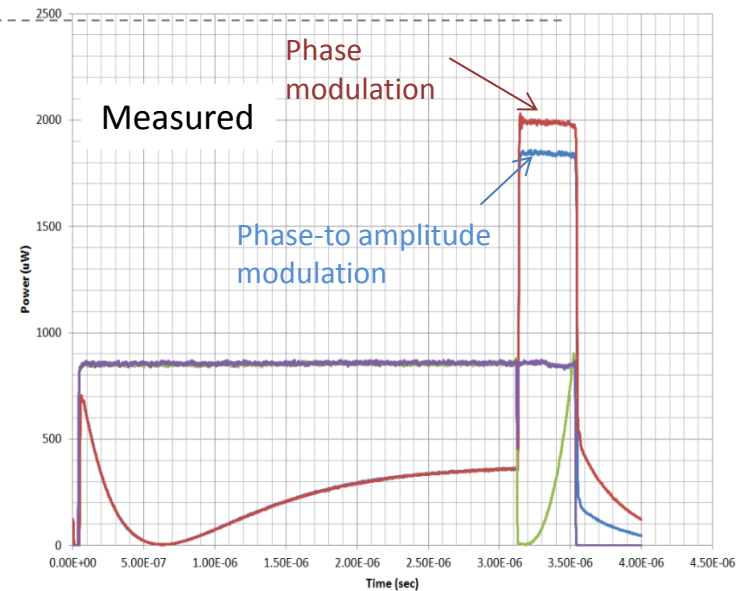
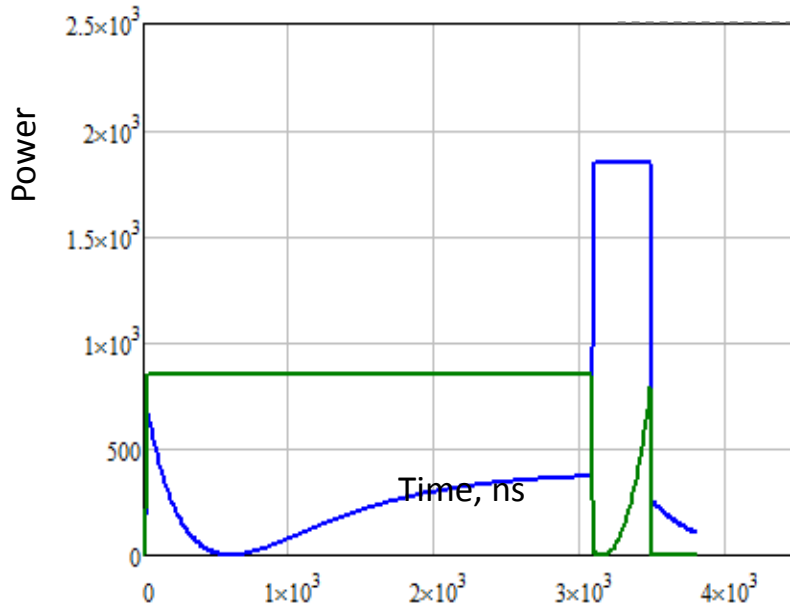
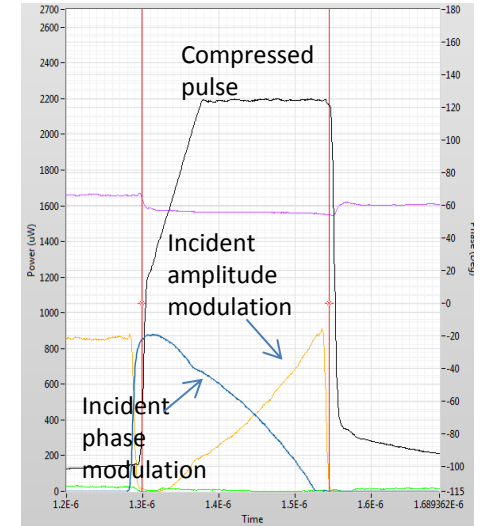


Manipulating the RF pulse using phase modulation of the klystrons pair and Pulse Compression.



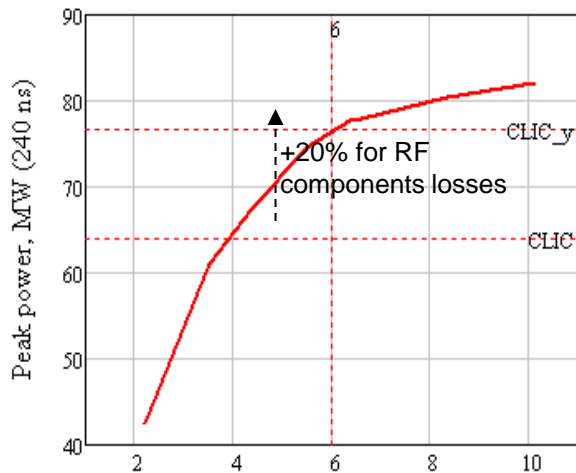
3.5 μ s \rightarrow 400 ns

Making CLIC pulse shape with two klystrons



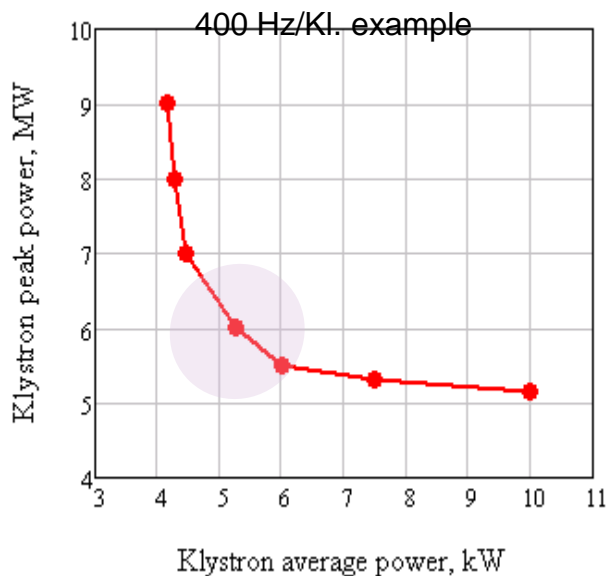


Single klystron peak power issues

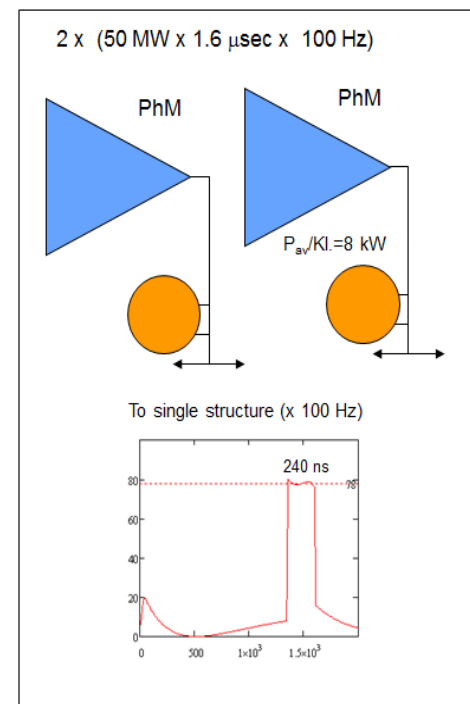
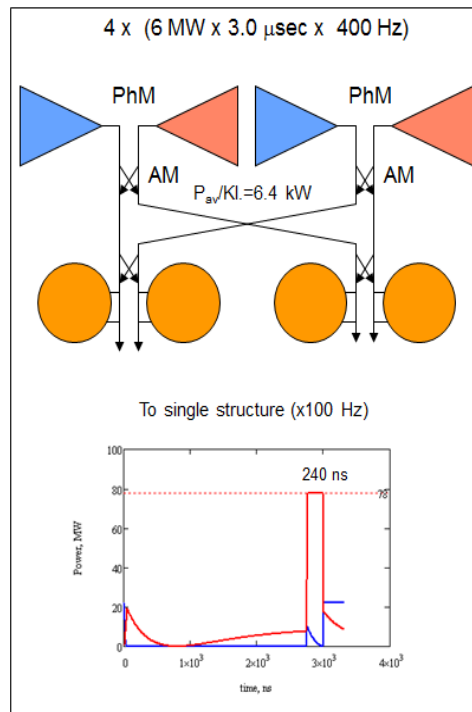
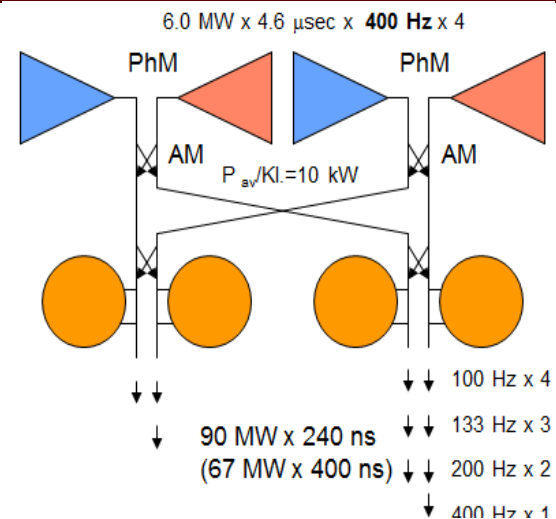


Average power, kW (5.5 MW peak, 400 Hz)

Single klystron parameters (for 78 MW x 240ns compressed pulse)



6.0 MW peak power klystron looks like an optimal choice to provide efficient generation of the pulses for CLIC accelerating structures testing.





Xbox3. Toshiba Klystrons

Simulation results of the main parameters

TOSHIBA

E37113

SERIAL No.

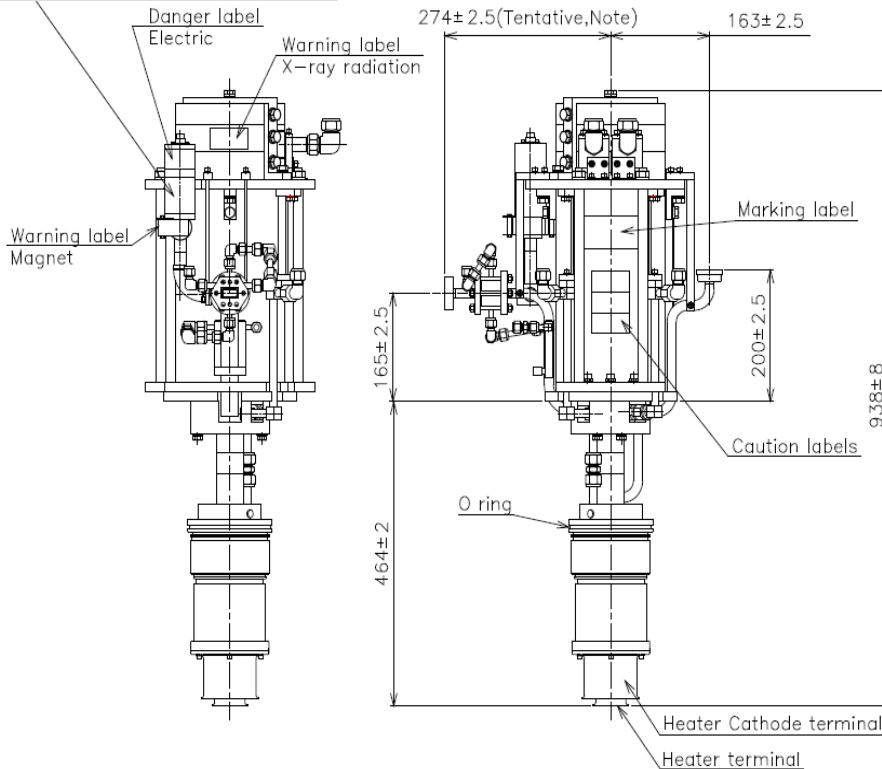
TOSHIBA ELECTRON TUBES & DEVICES CO.,
MADE IN JAPAN

Parameter	Design		Specification		Unit
	Target	Simulation result	Min.	Max.	
Operation frequency	11.9942	11.9942	11.9932	11.9952	GHz
Peak output power	≥ 6	6.4	-	6.2	MW
Beam voltage	~ 160	150	-	175	kV
Beam current	~ 100	90	-	115	A
RF pulse width	5		-	5	μ s
Beam pulse width	~ 7		-	7.5	μ s
Repetition rate	400		-	400	pps
Efficiency	≥ 40	47.5	36	--	%
Gain	~ 43	47.6	40.8	41.8	dB
Drive power	≤ 300	110	-	500	W
Average power	12		-	12.4	kW
Max. Electrical field					
Electron gun	≤ 250	184 at 175kV of beam voltage			kV/cm
Output section	≤ 500	490 at 6.3 MW of output power			kV/cm
On ceramic window	≤ 60	43 at 6 MW of output power			kV/cm

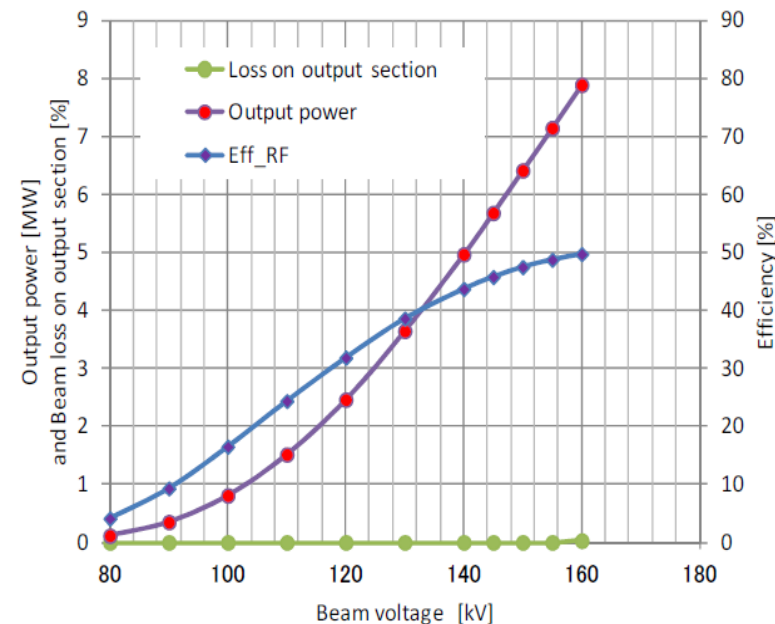
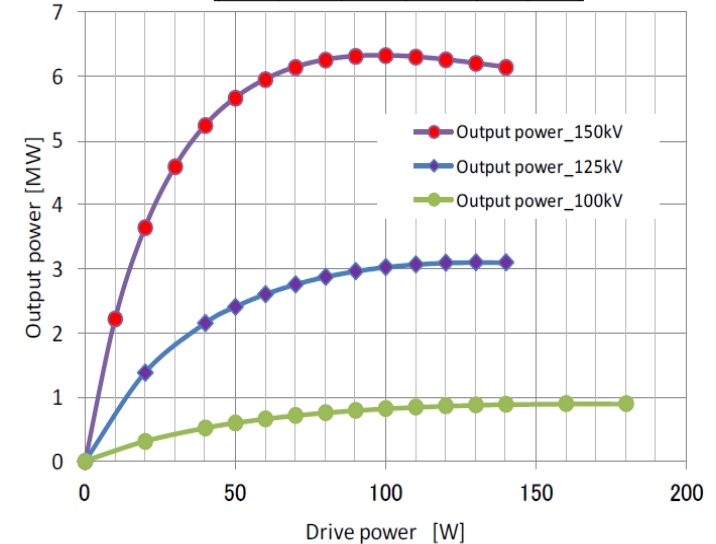


Xbox3. Toshiba Klystron (II)

Peak power: 6 MW
Beam Voltage: 150 kV
Beam current: 90 A
Average power: 12.4 kW
Efficiency: 47.5%



X-band Klystron E37113 Transfer characteristics
(150kV/125kV/100kV/BF1.02/damp0.00)



- 4 turn-key 6 MW, 11.9942 GHz power stations (klystron/modulator) have been ordered from industry.
- The first unit is scheduled to arrive at CERN in October 2014. The full delivery will be completed before July 2015.



Xbox3. Scandinova modulator



ScandiNova

Modified K1 ScandiNova modulator

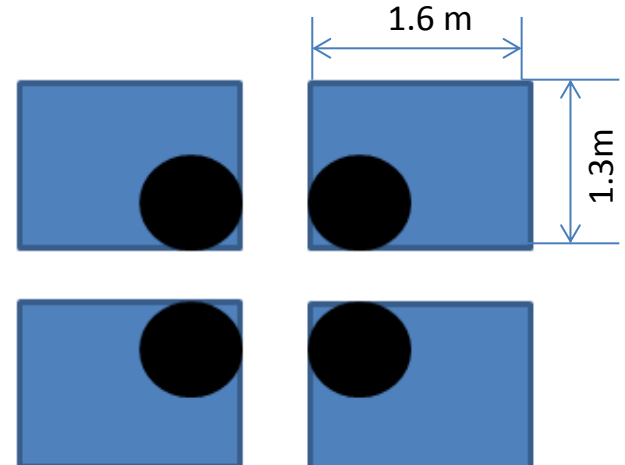
The illustration of new 2 cabinet concept that will be adopted for 6 MW Toshiba klystrons.

Doubled width oil tank. To facilitate installation of the Toshiba klystron which has rather wide ($\varnothing 0.7$ m) solenoid.

- Additional cabinet (comes for free). It can be used for Klystron RF driver amplifier, Solenoid PS, Ion Pump PS etc.
- New Control System that will simplify integration of external parts and offer a lot of new features.
- Flexible design (klystrons positioning) to minimize the length of RF waveguide circuit:

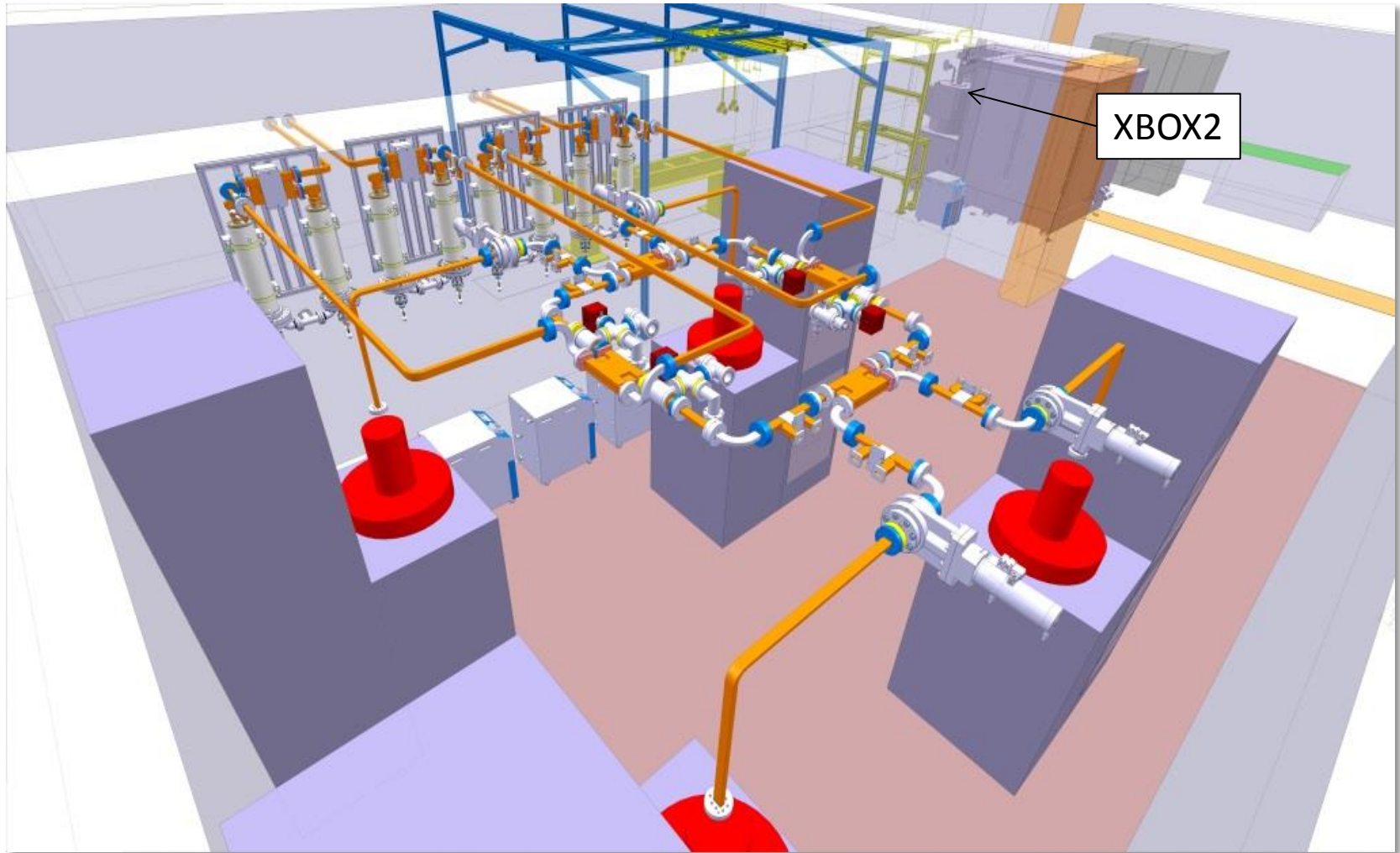
Modulator parameters (max.)
for 6 MW Toshiba klystron

Peak RF power: 8.0 MW
Pulsed voltage: 175 kV
Pulse current: 115 A
Average power: 50 kW
Pulse length (flat): 5 μ sec
Rep. rate: 400 HZ



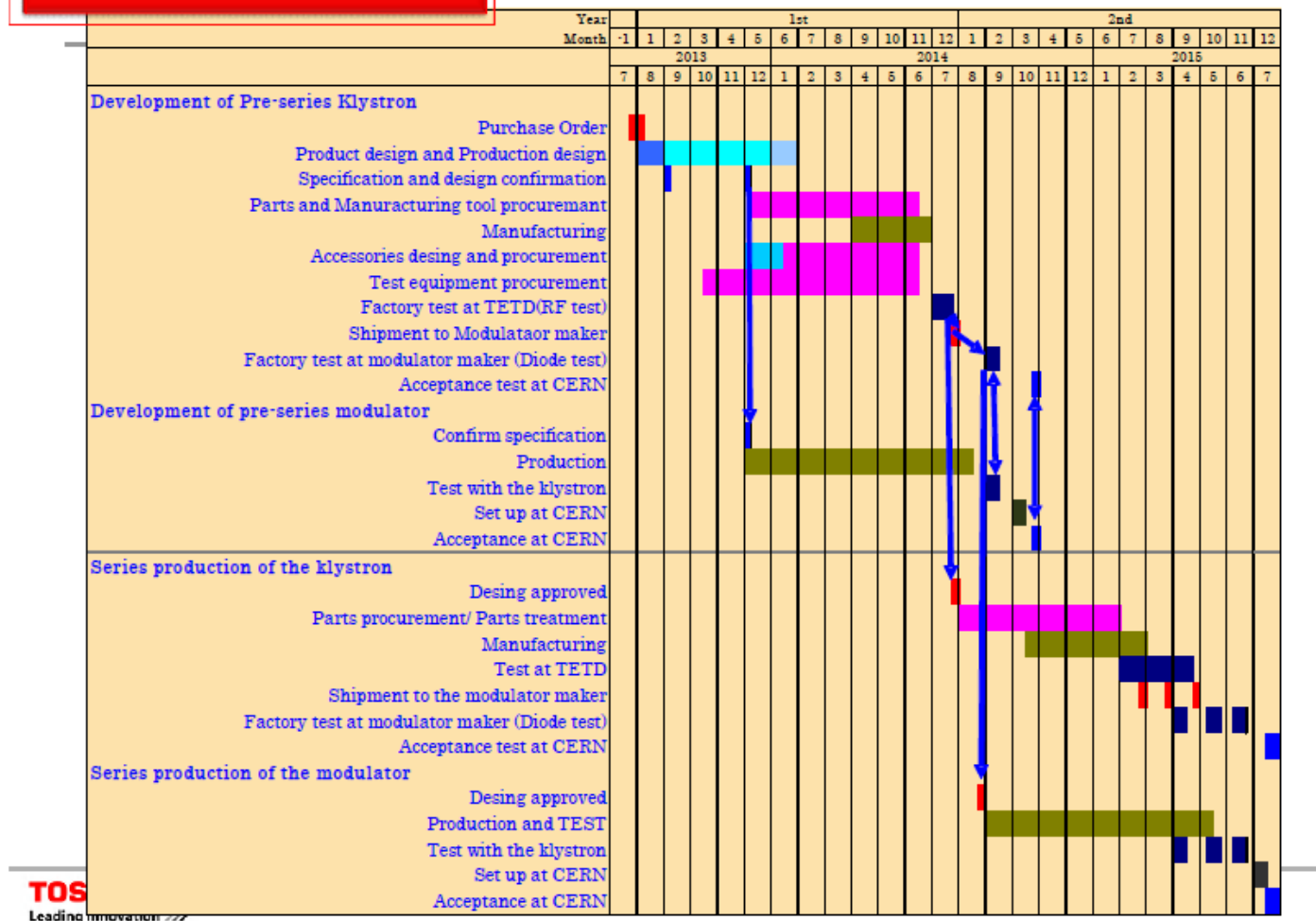


Xbox3. 3D layout/integration

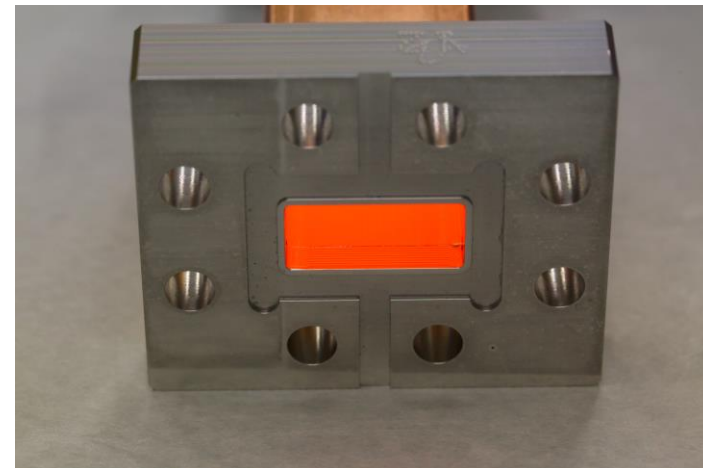
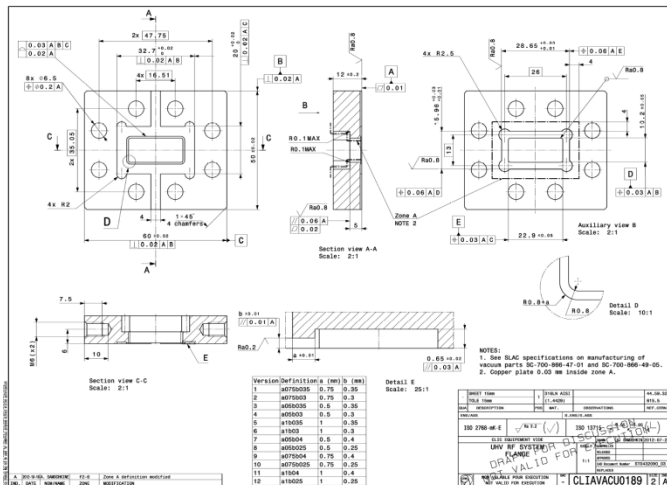


- Klystron/modulator units contract signed with TOSHIBA last summer
- First unit expected on October 2014!

5. Development schedule



- New unisex Xband flanges
 - International committee with representatives of KEK, SLAC and CERN
 - Tested in SLAC up to 40 MW, 1us and 10MW, 200 ns
 - Vacuum gasket optimized
 - Becomes the new Xband flanges after this workshop
 - Next: manufacturing for the last Xbox3 components





Thanks for your attention!!!