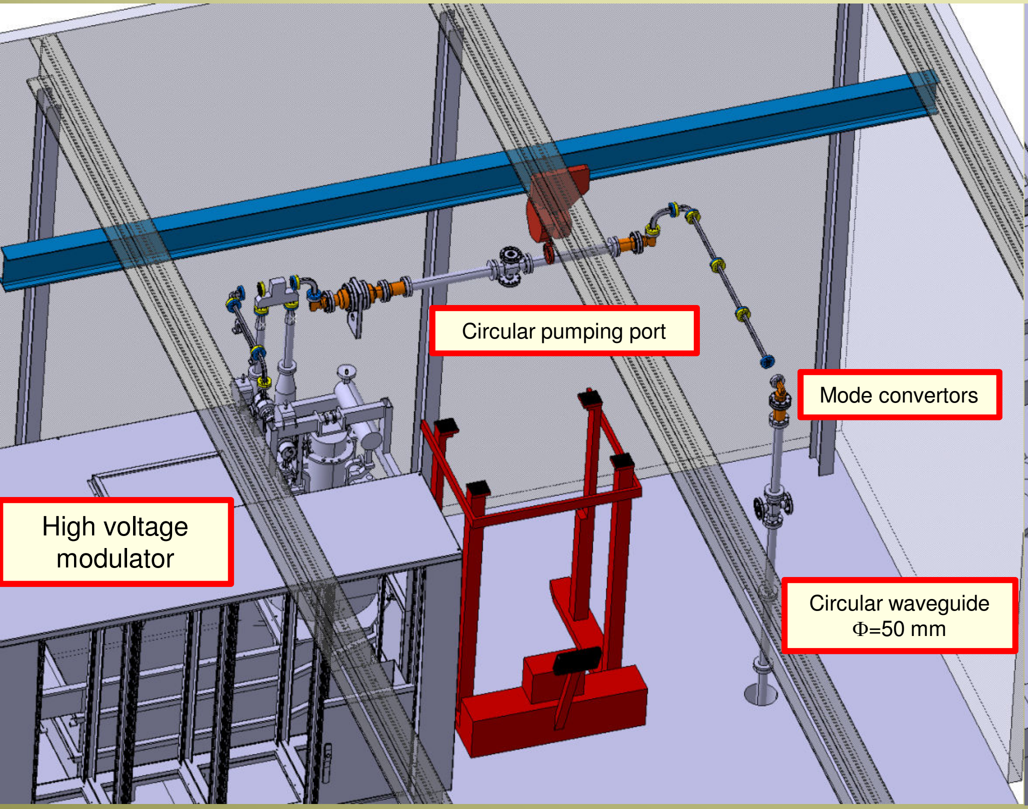
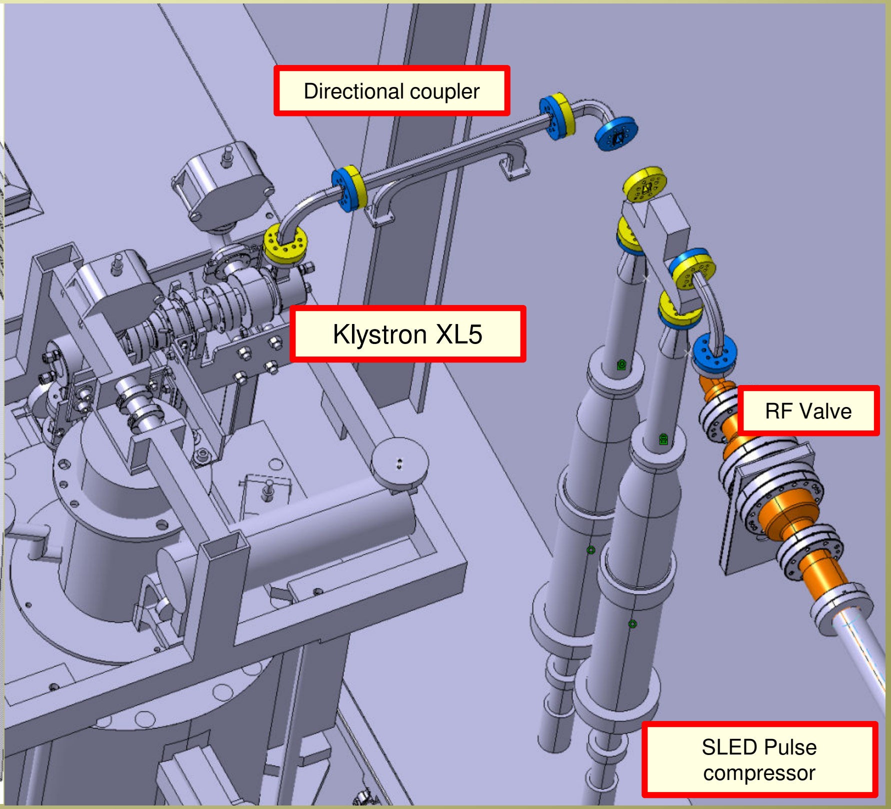
CERN X-band Test-Stand

Progress and Perspective

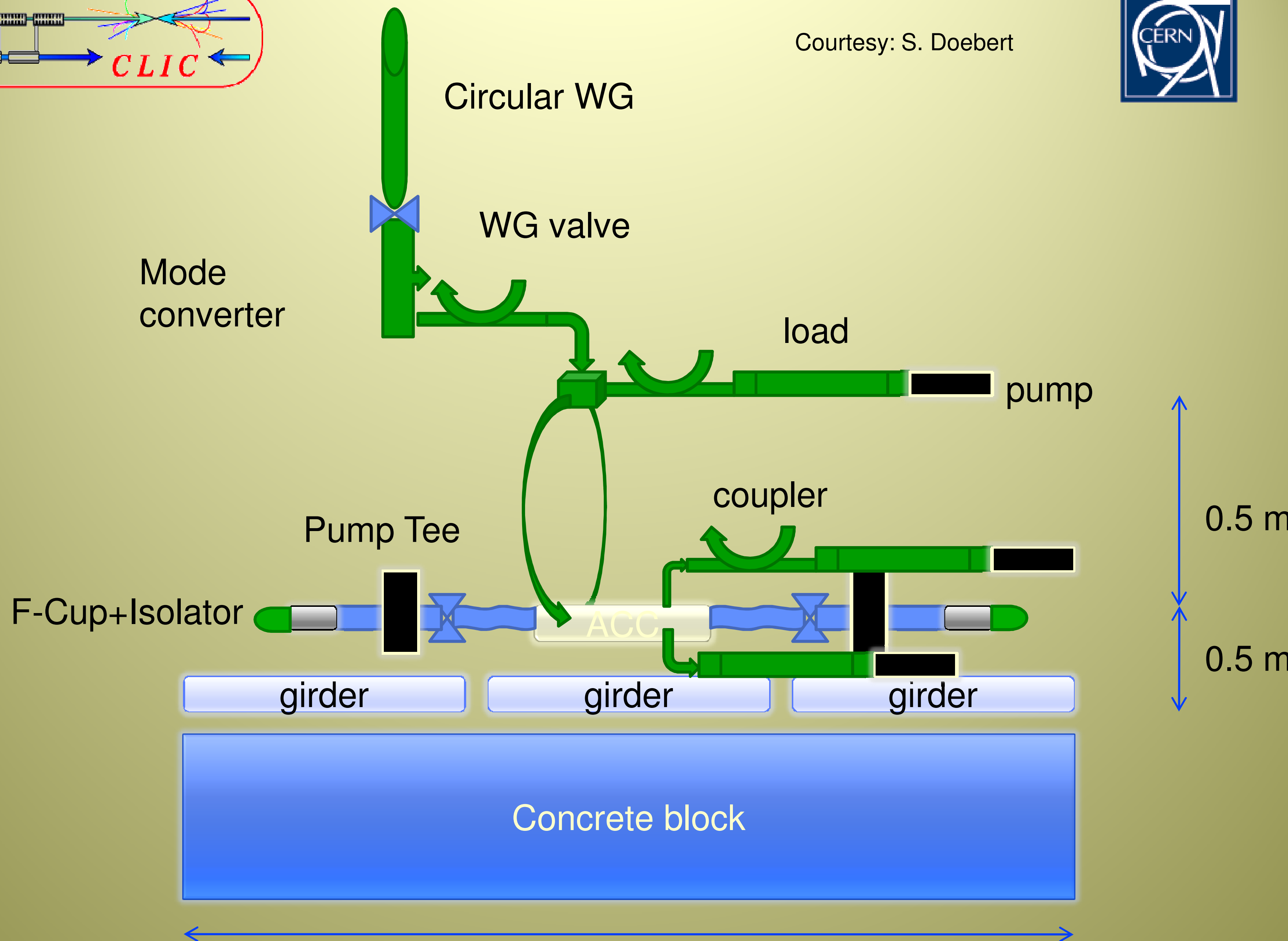




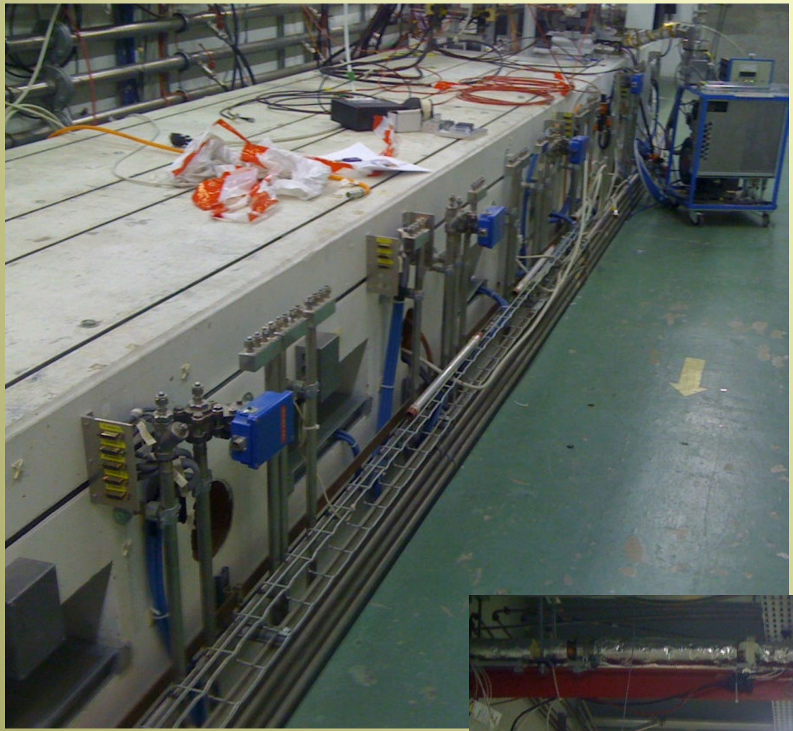
CERN - CEA – PSI – SLAC

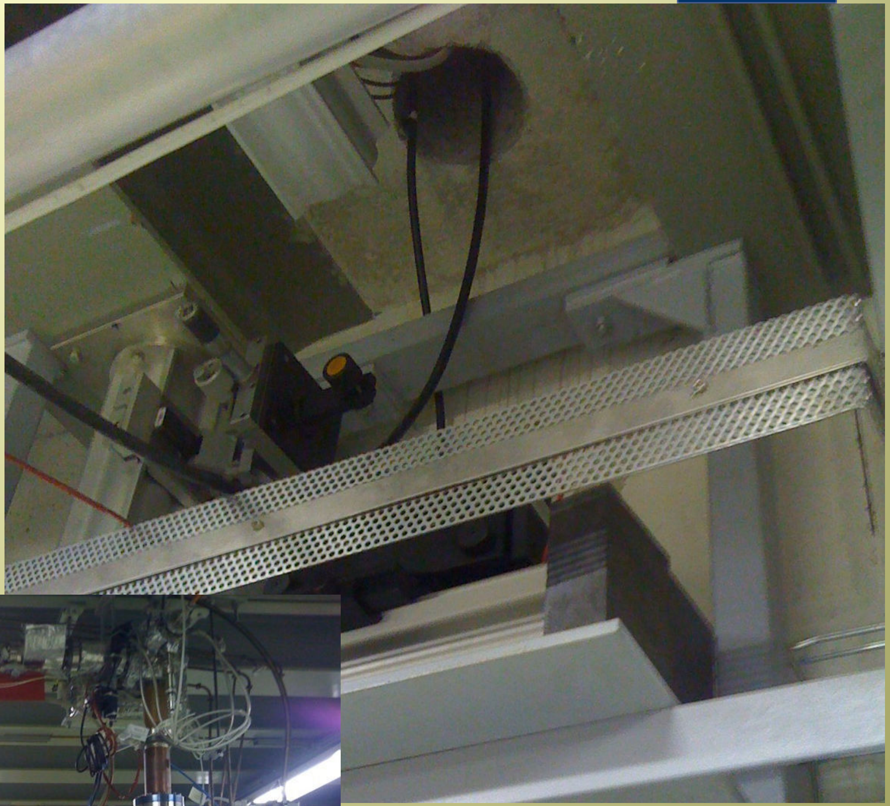
Stand alone Test Stand in CTFII

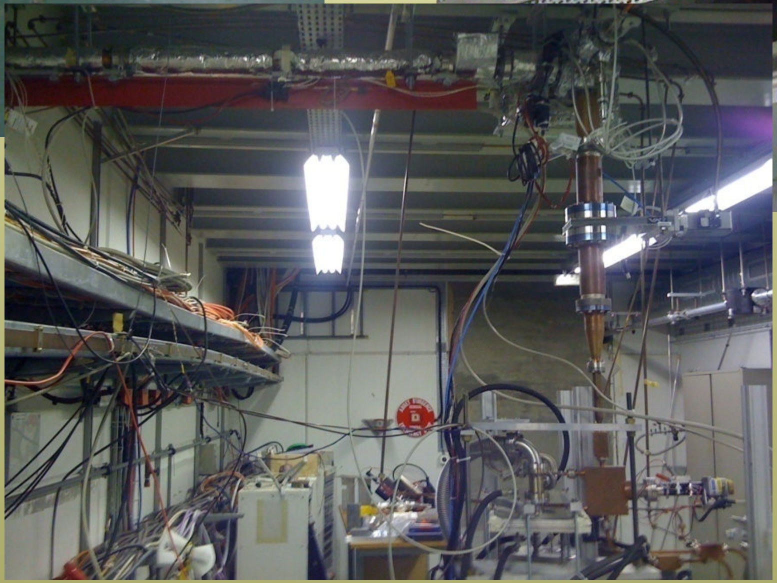
Courtesy: S. Doebert



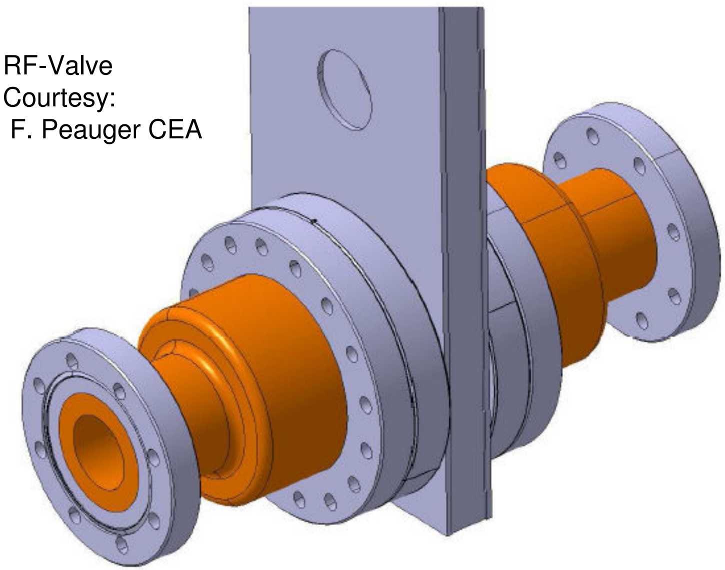
CTF2

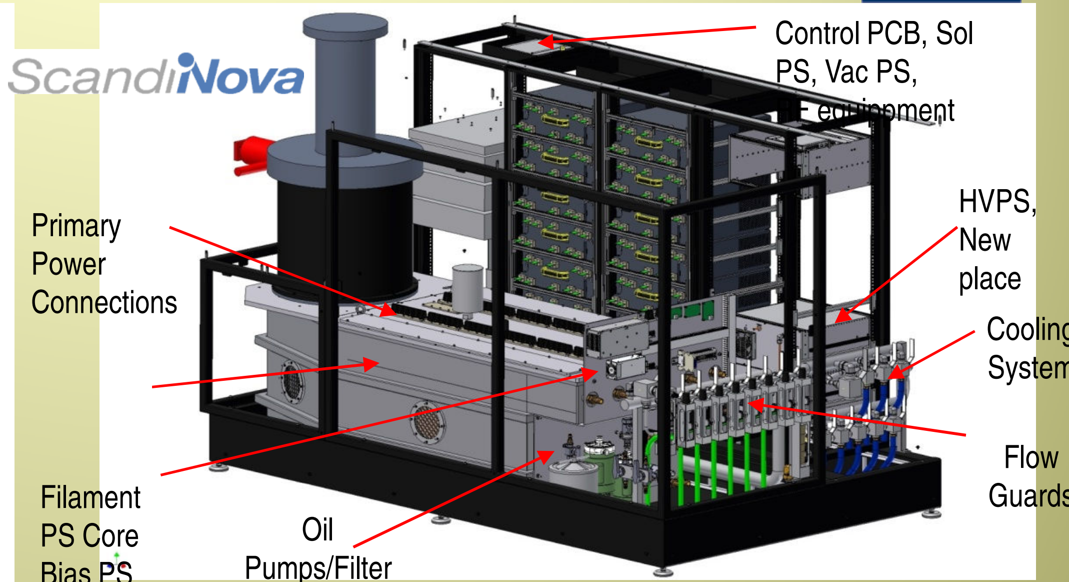




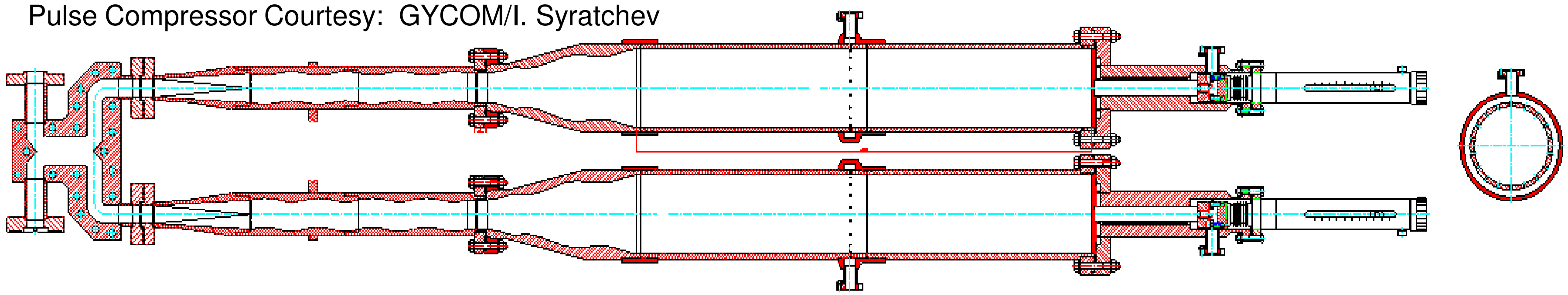


Components

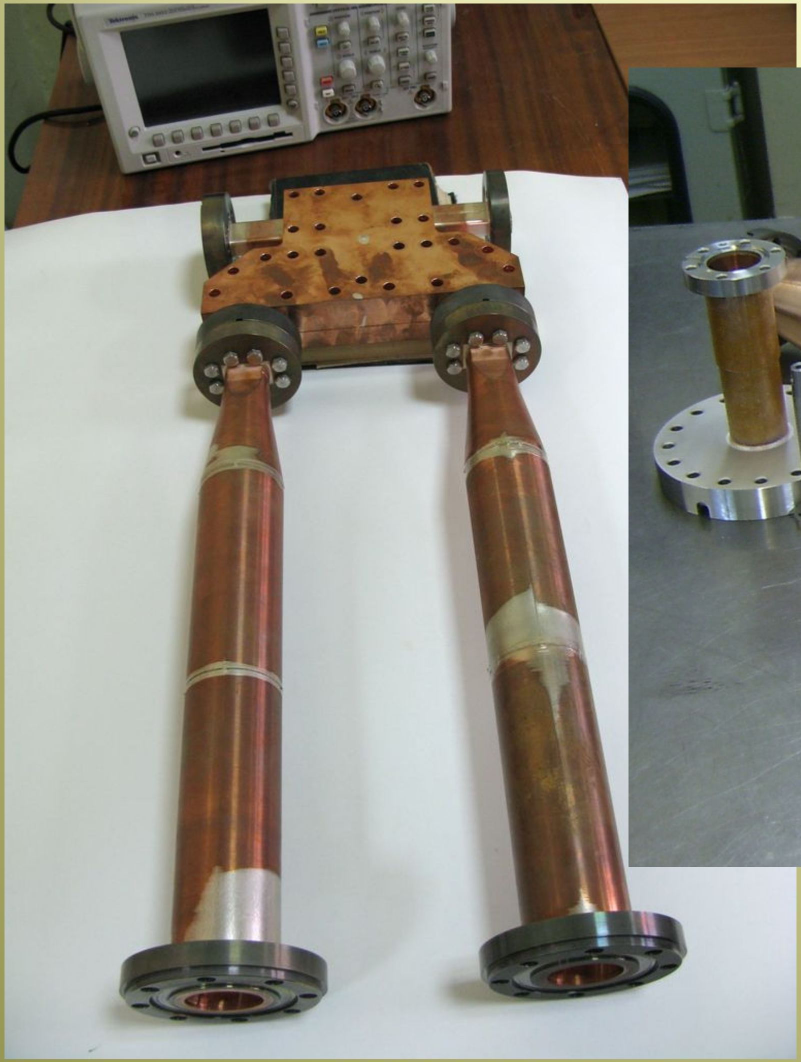

RF-Valve
Courtesy:
F. Peauger CEA



Pulse Compressor Courtesy: GYCOM/I. Syratchev



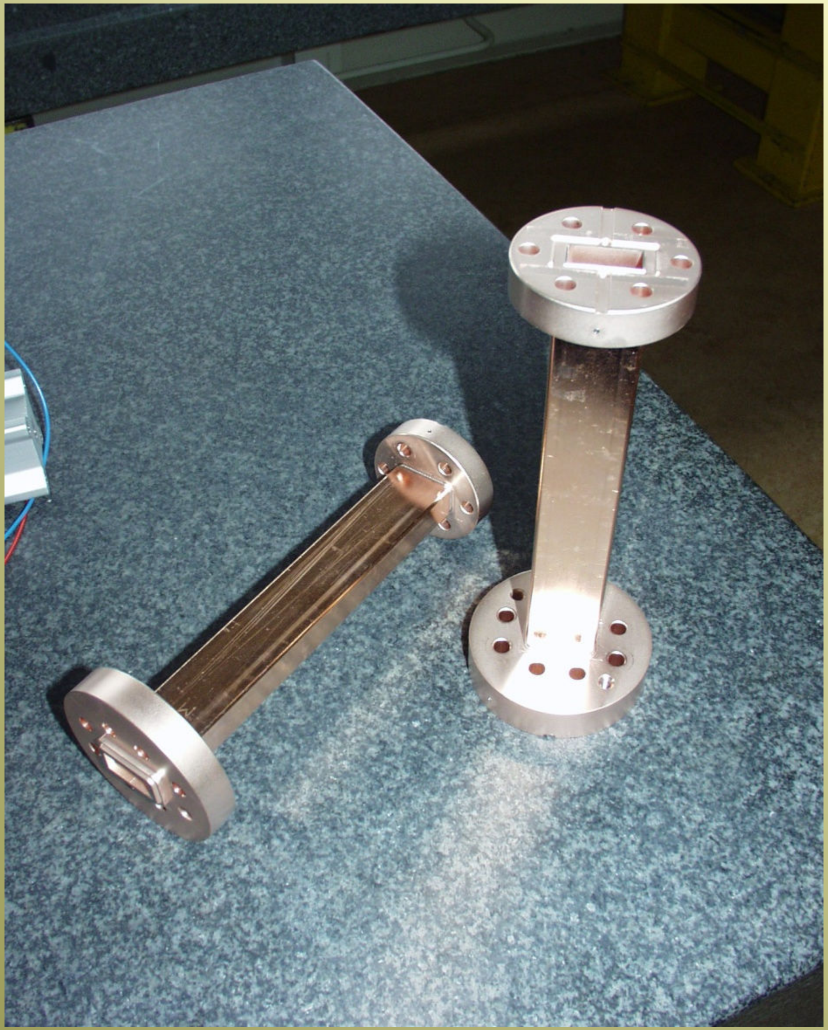
Pulse Compressor (Gycom)

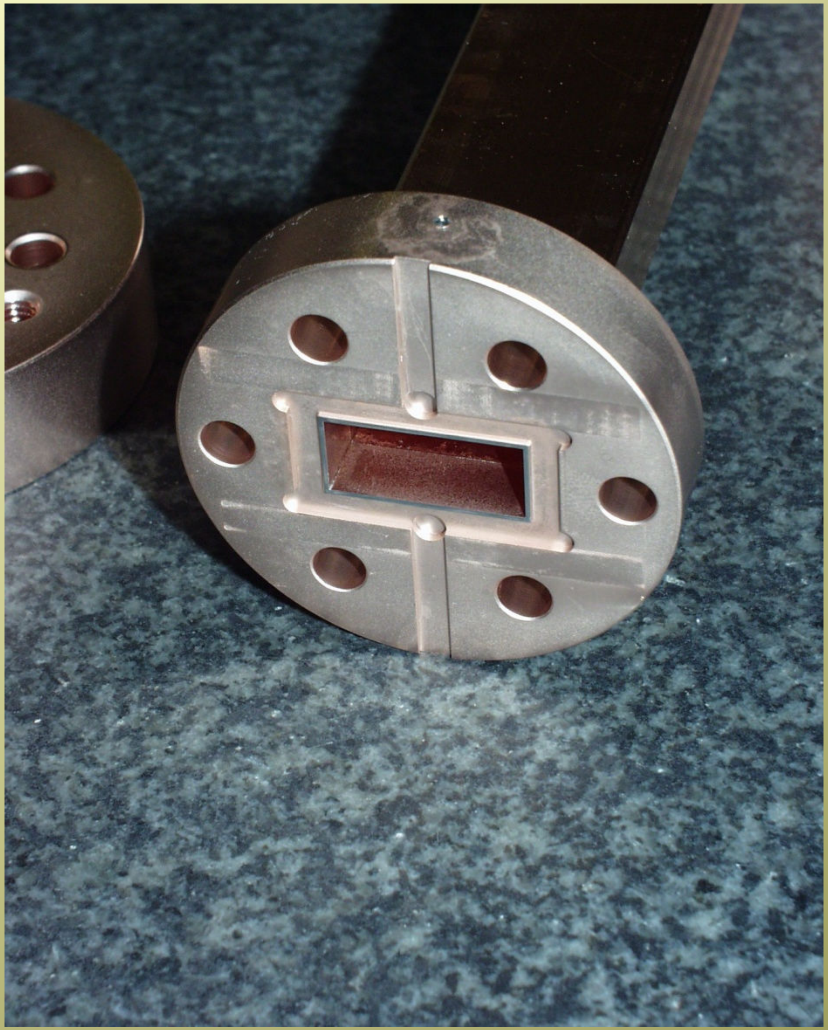


Fabrication Progress Report
Recent Images continued

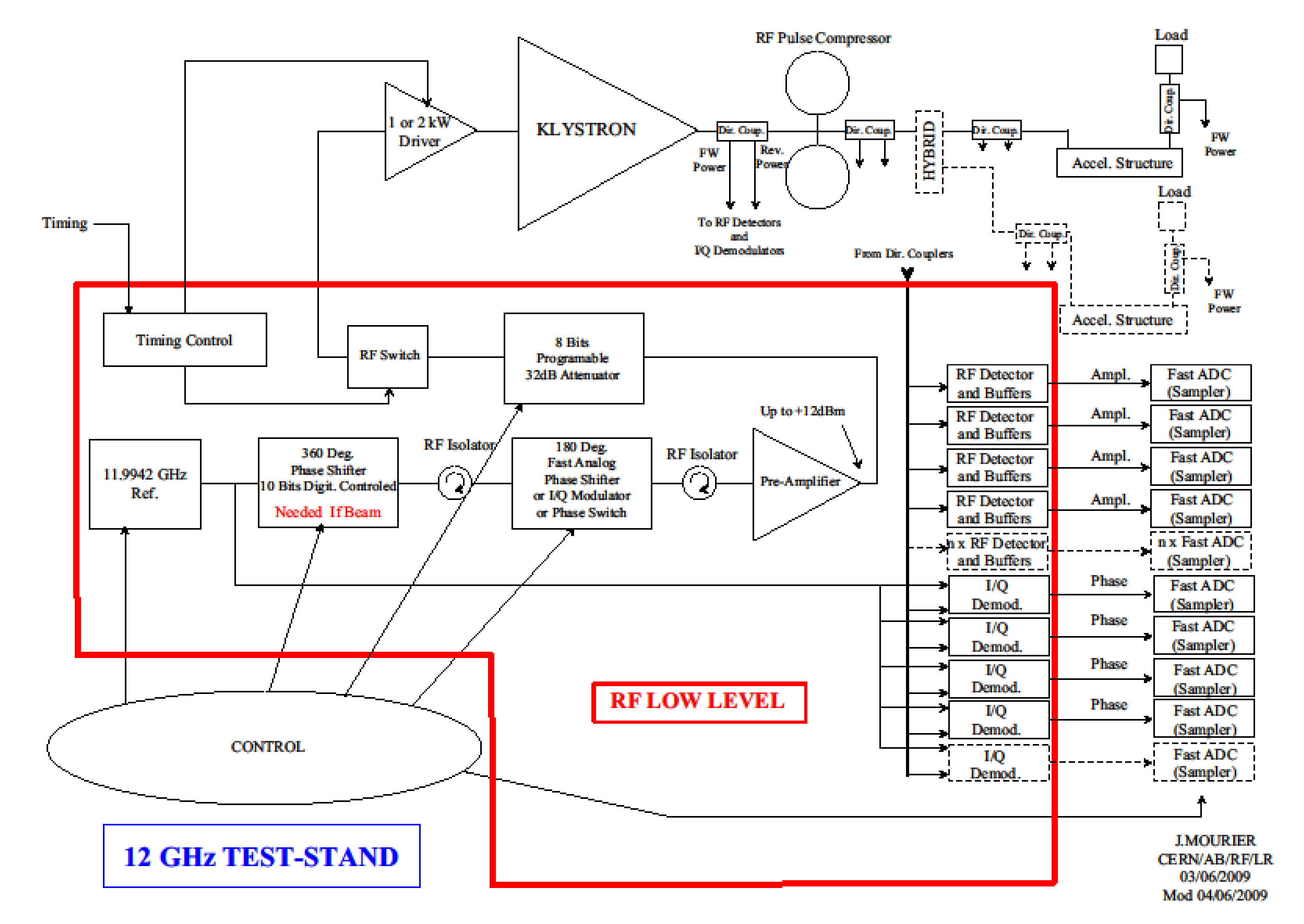
- Miscellaneous images

Flanges



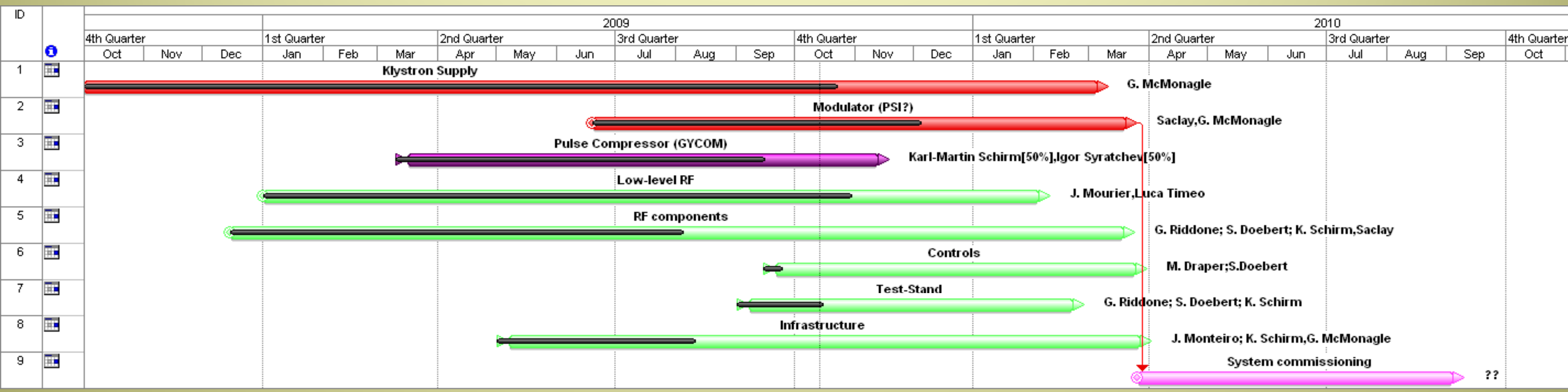


LL-RF



RF Pulse Compressor
Load
1 or 2 kW Driver
KLYSTRON
Dir. Coup.
FW Power
Rev. Power
HYBRID
Accel. Structure
To RF Detectors and I/Q Demodulators
From Dir. Couplers
Timing
Timing Control
RF Switch
8 Bits Programable 32dB Attenuator
Up to +12dBm
11.9942 GHz Ref.
360 Deg. Phase Shifter 10 Bits Digit. Controled
Needed If Beam
RF Isolator
180 Deg. Fast Analog Phase Shifter or I/Q Modulator or Phase Switch
Pre-Amplifier
RF Detector and Buffers
n x RF Detector and Buffers
Ampl.
Phase
Fast ADC (Sampler)
n x Fast ADC (Sampler)
I/Q Demod.
RF LOW LEVEL
CONTROL
12 GHz TEST-STAND
J.MOURIER
CERN/AB/RF/LR
03/06/2009
Mod 04/06/2009

Schedule (10/2009)



! Klystron and Modulator still driving the schedule

! Special RF components require close follow-up

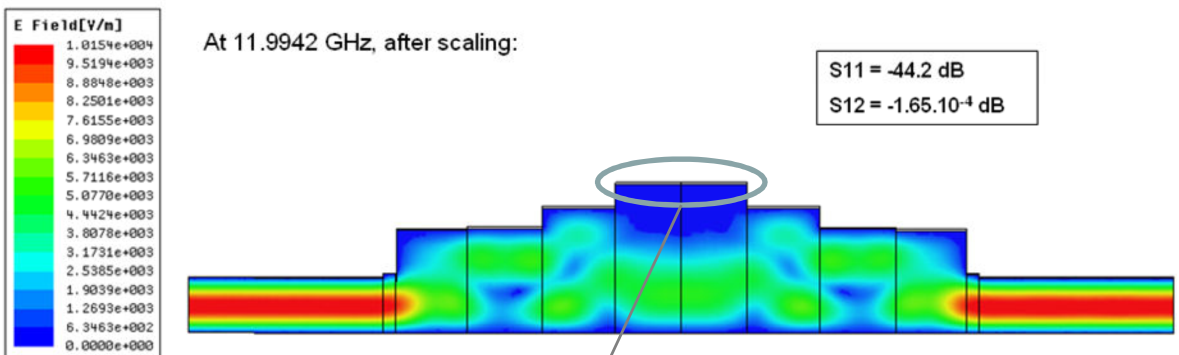
! 12 GHz power (without compression) should be available in CTF2 in May 2010

Conclusion:

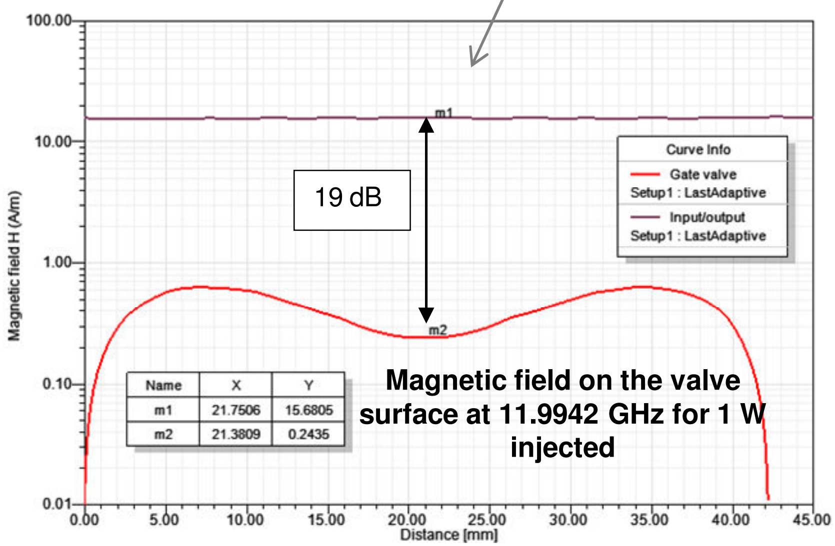
- **Activity running smooth – collaboration is excellent**
- **Program is (still?) on track – planning and budget**
- **Trouble is in the details – real challenges ahead….**
- **Need to follow more closely certain items**
- **Installation and commissioning will be men-power driven……**
- **Involving future users will be required……**
- **Still hoping for an additional klystron……**

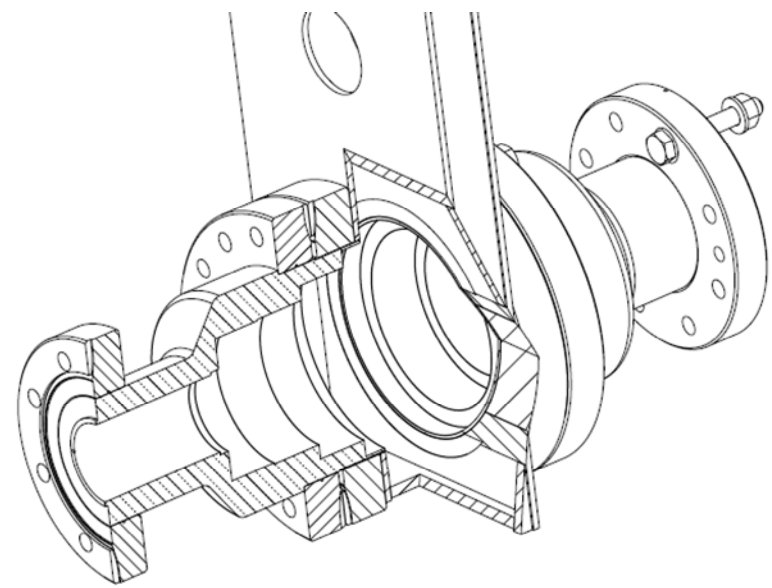
Design and fabrication by CEA/CERN

The RF valve has been introduced by A. Grudiev (CERN) in the CTF3 30 GHz test stand. It works on the circular mode TE_{01}^{o} mainly to avoid surface electric field and have steps in diameter to “focus” the wave in the center of the guide. Based on the same principle, RF valves working at 11.4 GHz have also been developed at SLAC for accelerating structure testing. The 12 GHz RF valve is a scaled version of the SLAC one.



Frequency: 11.994 GHz
Peak power: 120 MW
Pulse length: 300 ns
Repetition rate : 50 Hz

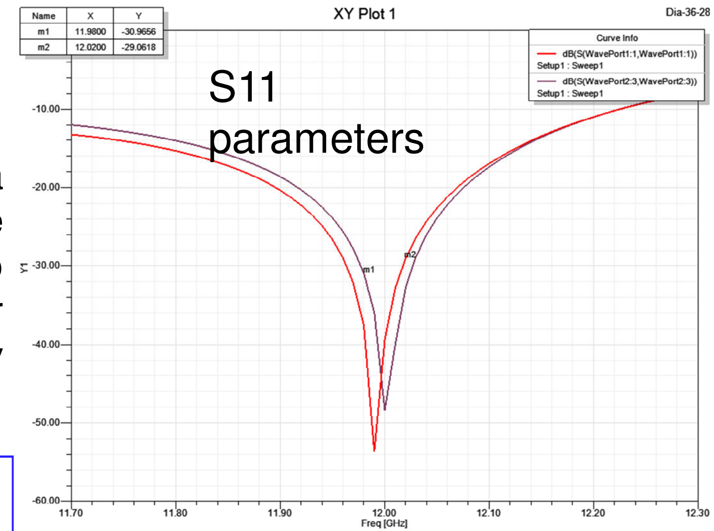




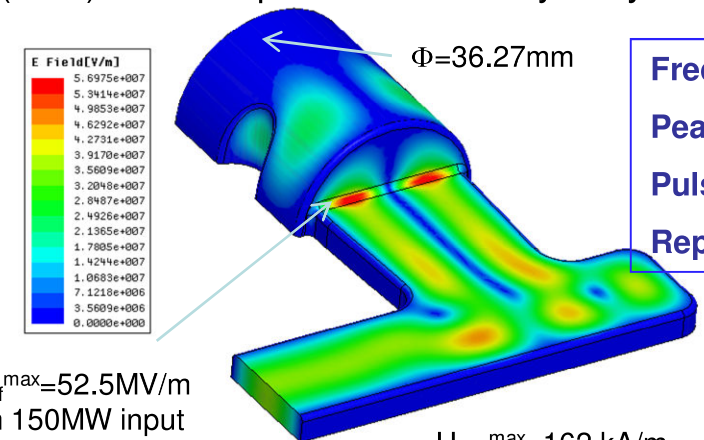
Mode converter

Design and fabrication by CEA/CERN

The mode converter is made in two parts. The first part is a rectangular waveguide bend on H plane. It converts the $TE_{10}^{\square}$ mode into a $TE_{20}^{\square}$ mode. The second part is a circular waveguide with two posts positioned at 180 ° at a certain distance of the rectangular section. This design is based on an original idea of S. Kazakov (KEK). It is compact and relatively easy to fabricate

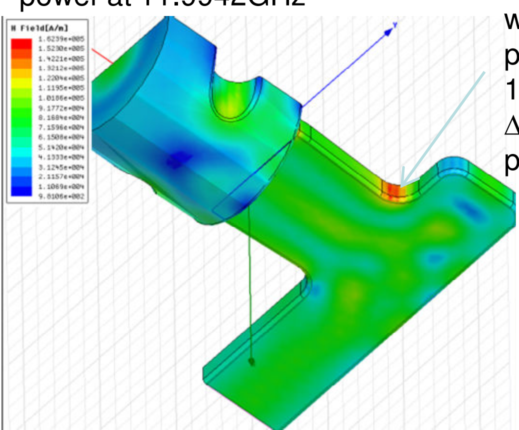


Bandwidth of 150 MHz @ -20dB reflection and -0.0618 dB transmission at 11.994 GHz giving 98.6% conversion efficiency in power

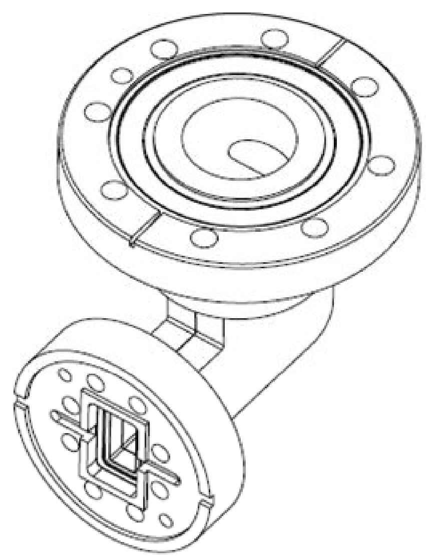


Frequency:	**11.994 GHz**
Peak power:	**120 MW**
Pulse length:	**300 ns**
Repetition rate :	**50 Hz**

E_{surf}^{max}=52.5MV/m with 150MW input power at 11.9942GHz



H_{surf}^{max}=162 kA/m with 150MW input power at 11.9942GHz giving ΔT=5.8° with 250 ns pulse length

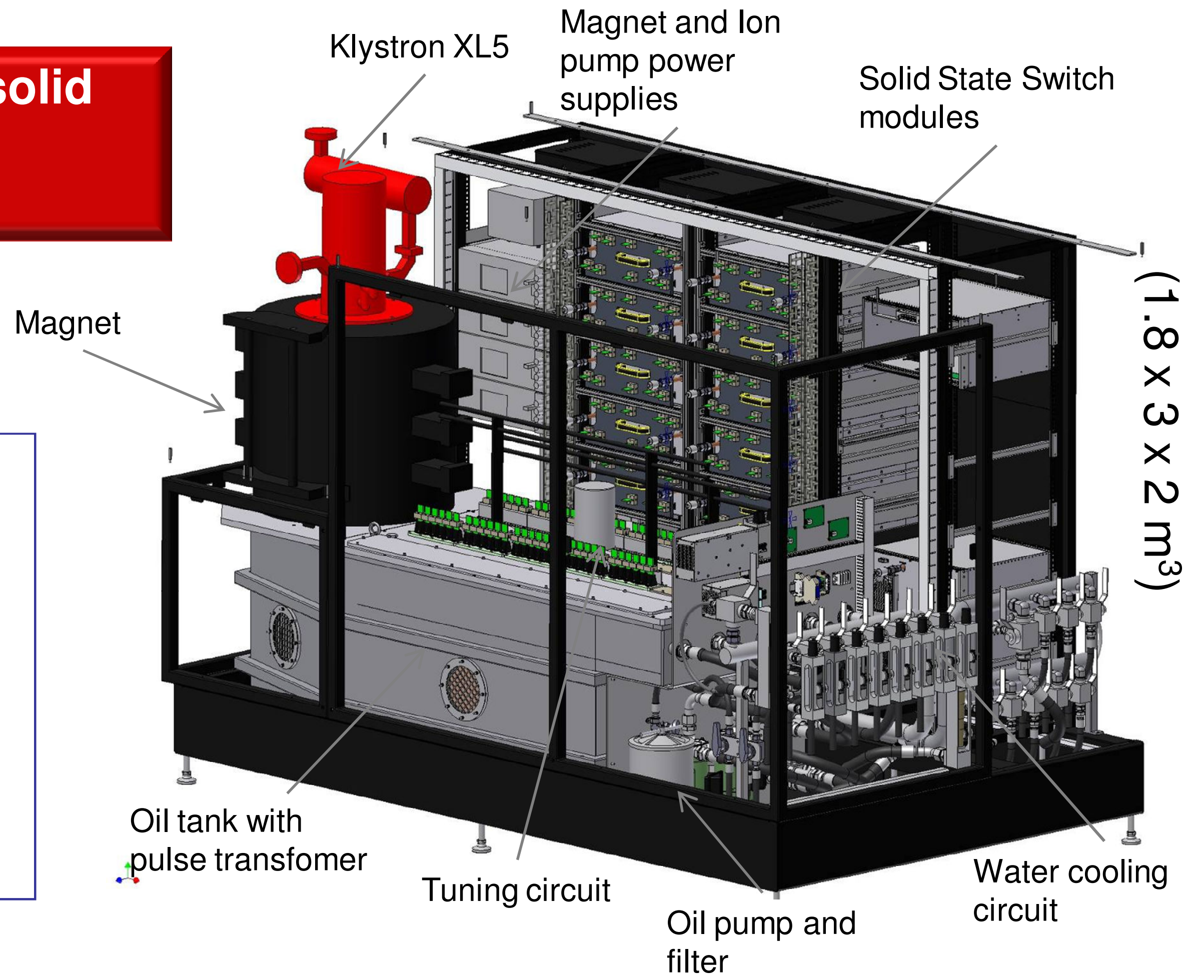


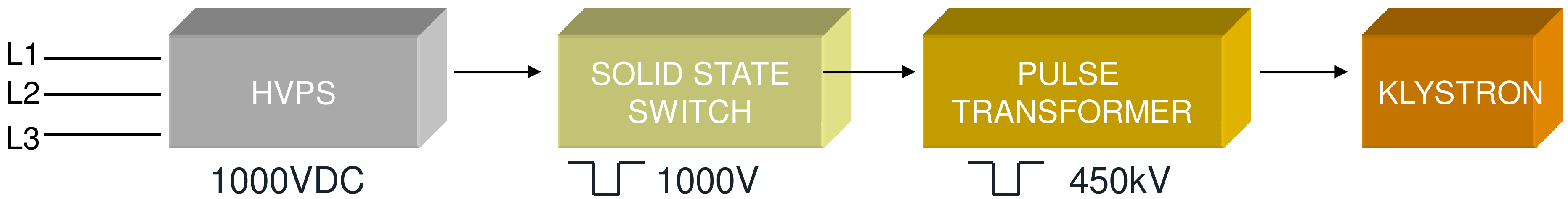
The fabrication technology is based on classical high temperature vacuum brazing of machined CuC2 and 316LN pieces. First the two half parts of the bend and the circ. waveguide with the two posts are brazed separetly. The stainless steel flanges are brased in a second step after re-machining. The third brazing concerns the two sub-assemblies and an intermediate round base used for the transition between the rect. and the circ. Parts.

High Voltage Modulator

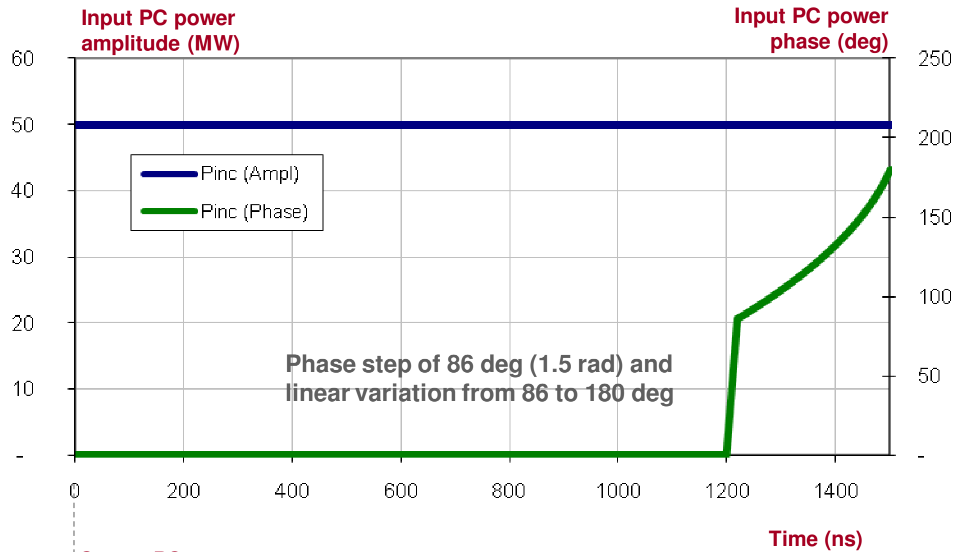
Development of a new solid state modulator by SCANDINOVA

Specification :	
High Voltage :	450 kV
Current :	335 A
Flat pulse length:	1.5 µs
Pulse length at 50%:	2.3 µs
Repetition rate:	50 Hz
HV ripple:	0.25 %
Pulse to pulse stability:	0.1 %





Pulse waveform after SLED compression



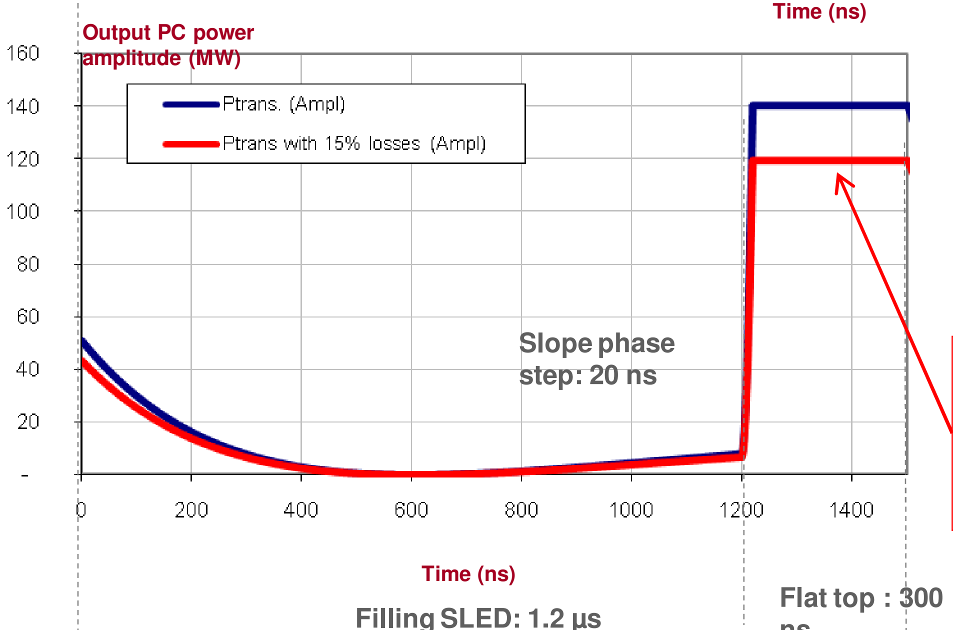
Q0 = 150000

QL = 25000

β=Q0/Qx = 5

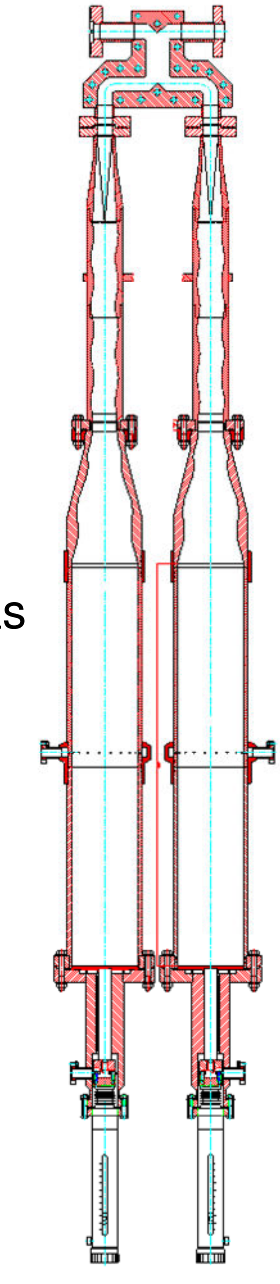
Reflexion coef = 0.67

SLED Filling time = 0.663 µs



Power multiplication factor = 2.75

120 MW, 300 ns assuming 15% of losses in the RF network



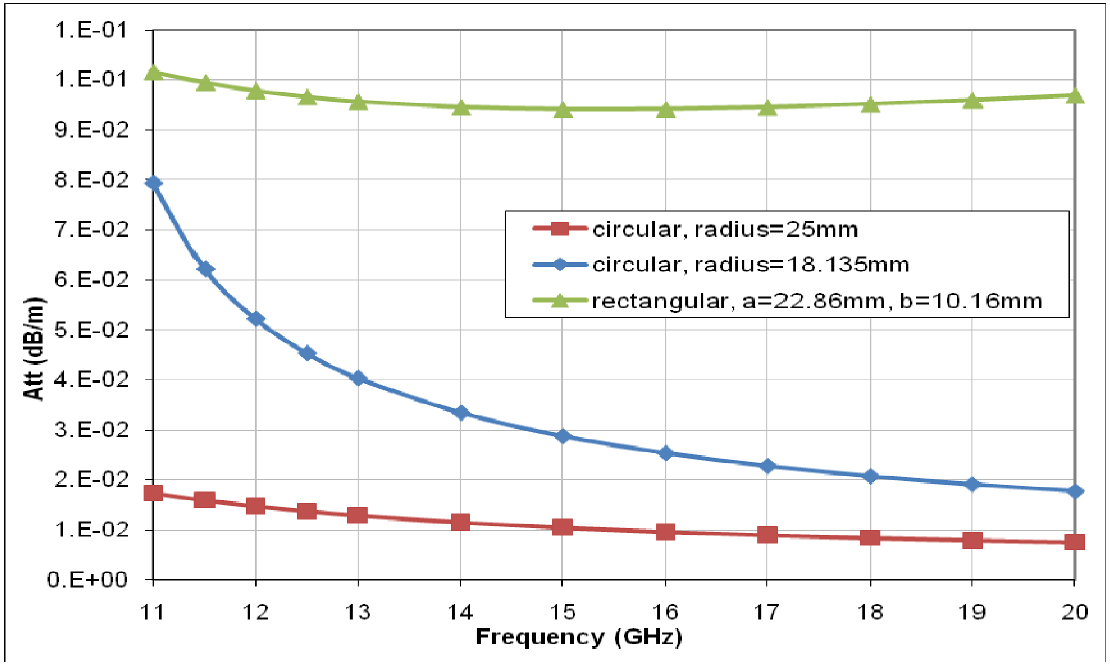
Propagation in the circular higher order mode TE_{01}^{O}

Attenuation:

$$\alpha_c(dB/m) = 8.686\frac{Rs}{a\beta\eta k}\left(k_c^2 + \frac{k^2}{p'^2_{01}-1}\right)$$ for TE_{01}^{o} in circ. waveguide with radius a (m)

$$\alpha_c(dB/m) = 8.686\frac{Rs}{a^3 b\beta\eta k}\left(2b\pi^2 + a^3k^2\right)$$ for $TE_{10}^{\square}$ in rect. waveguides with dimensions a x b (m^2)

With Rs the surface resistance, p'_{01}=3.832 the first root of J'_0 which is the derivative of the Bessel function of first kind J_0, β the propagation constant, k the wavenumber, kc the cut-off wavenumber and η = 376.7 ohm the impedance of free-space.



At 12 GHz, losses are almost ten times lower in 50 mm diameter circular wg than in rectangular wg

("Microwave Engineering", D.M. Pozar, p.125 and 136):