The high power demonstration of the PETS ON/OFF operation with beam.

I. Syratchev for CLIC team

Some history…

International Linear Collider
Technical Review Committee

Second Report
2003

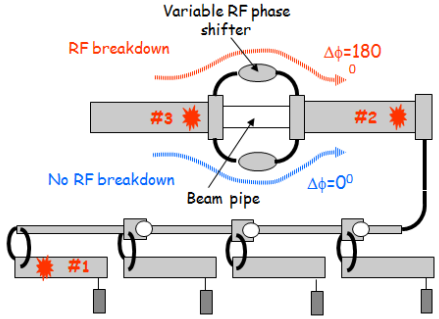
Ranking 1: R&D needed for feasibility demonstration of the machine

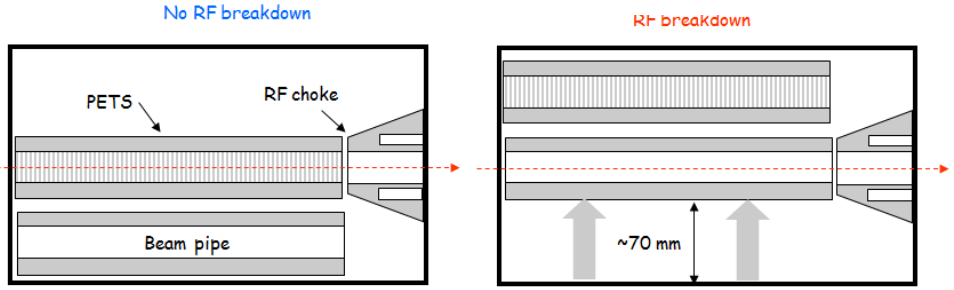
The objective of these R&D items is to show that the key machine parameters are not unrealistic. In particular, a proof of existence of the basic critical constituents of the machines should be available upon completion of the Ranking 1 R&D items.

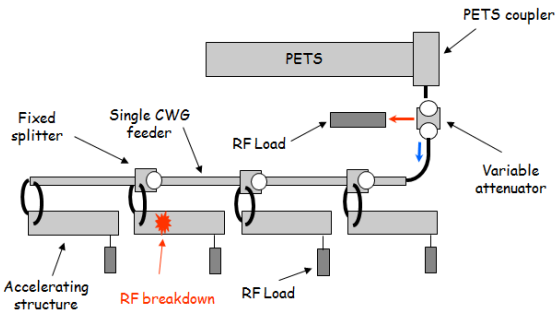
Reliability

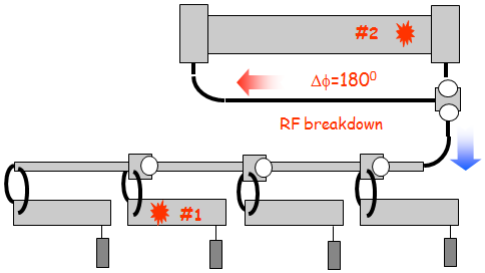
- In the present CLIC design, an entire drive beam section must be turned off on any fault (in particular on any cavity fault). CLIC needs to develop a mechanism to turn off only a few structures in the event of a fault. At the time of writing this report, there is no specific R&D program aimed at that objective but possible schemes are being studied.

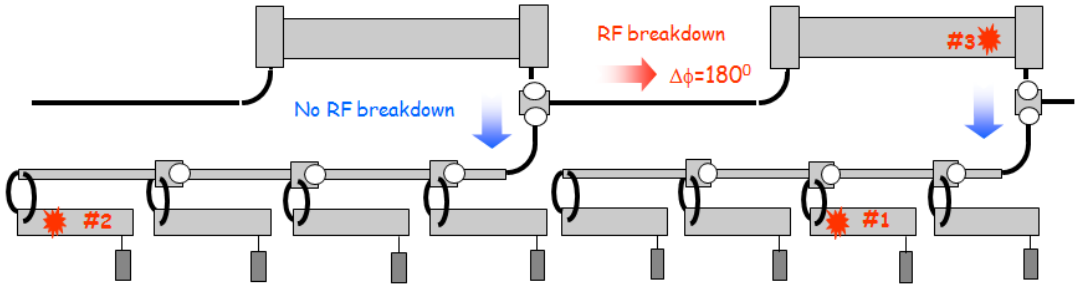
Back in 2003 we have looked into many different scenarios of the local RF power production termination…

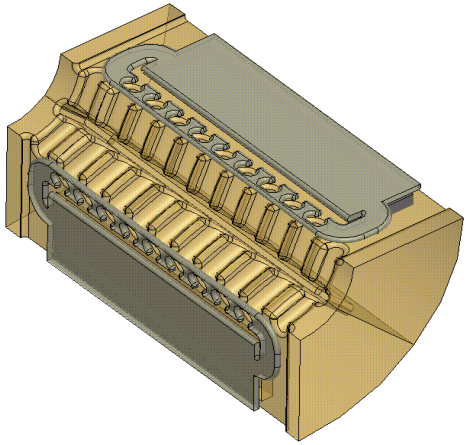


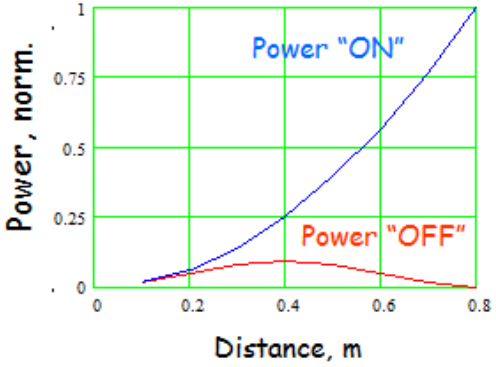








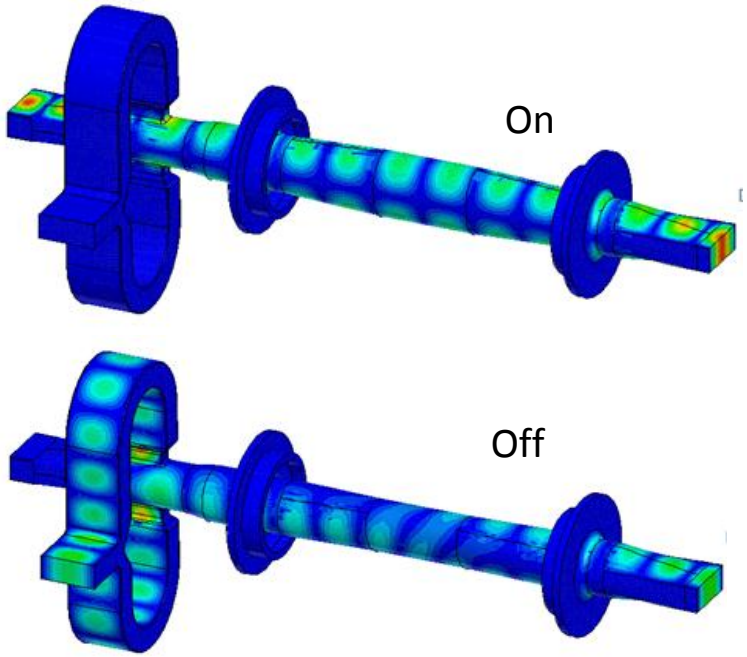




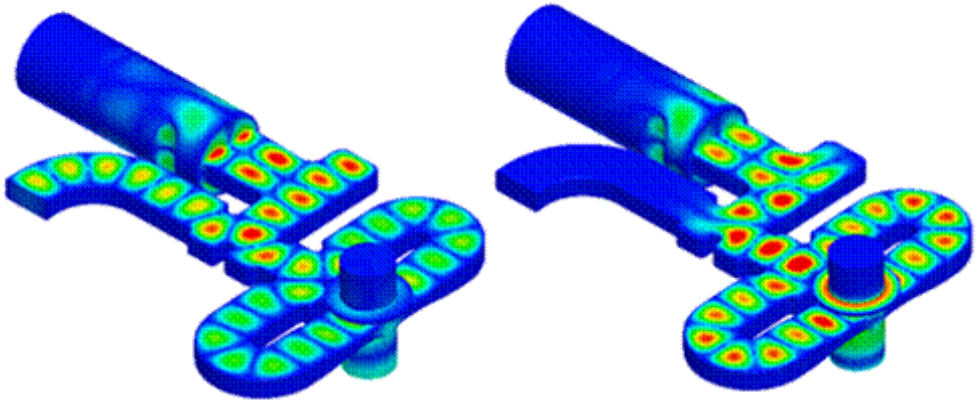
…and developed the very special one with modification of the PETS impedance

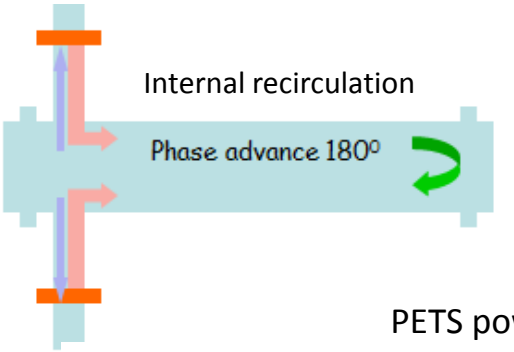
In 2008, with changing the CLIC frequency, the different options with destructive recirculation were reconsidered and special RF components were developed…

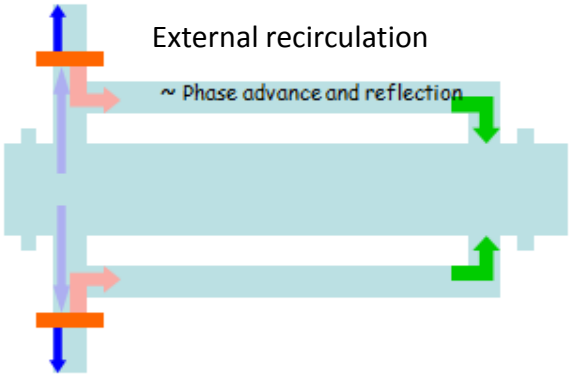
Tuneable splitter with rotating section



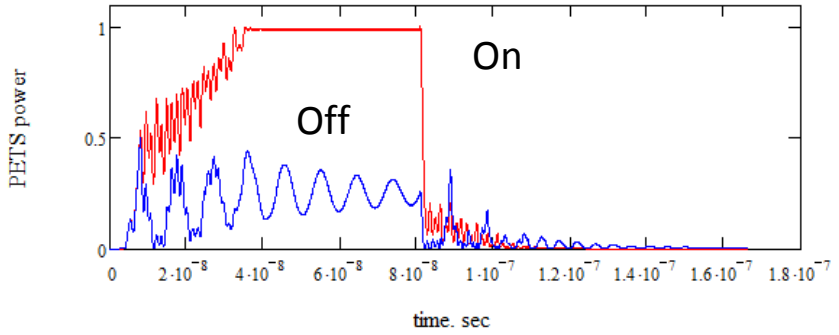
Variable reflector #1



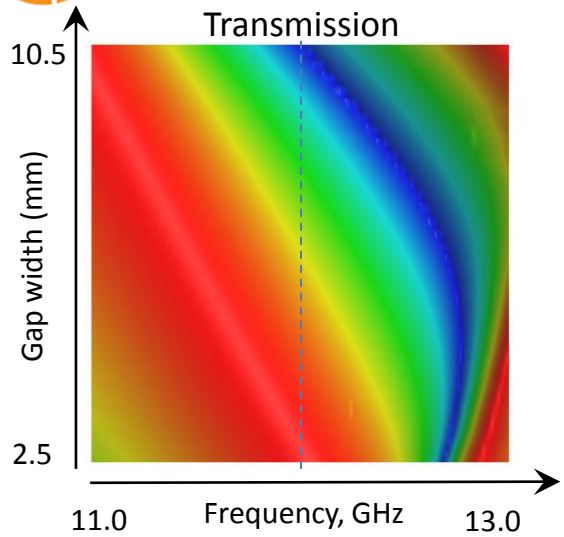


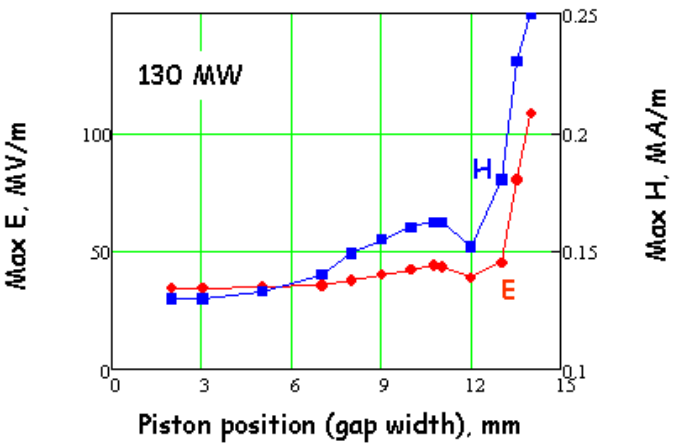


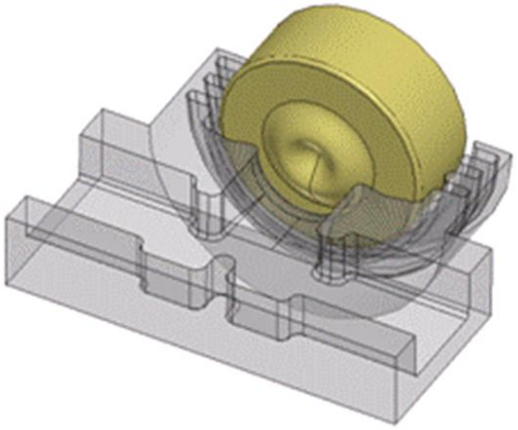
PETS power production

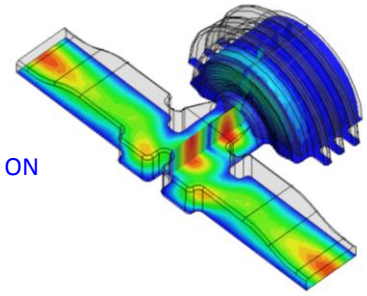


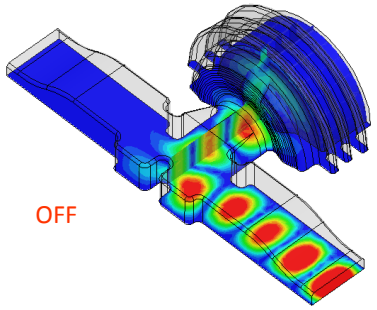
Compact design of the high RF power variable reflector #2 (2010)

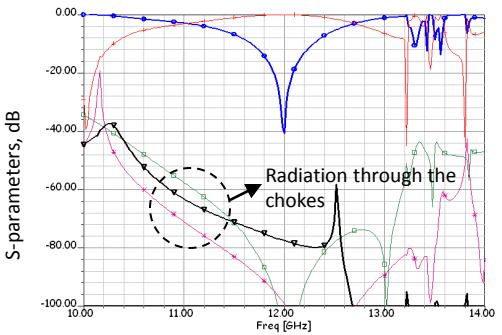


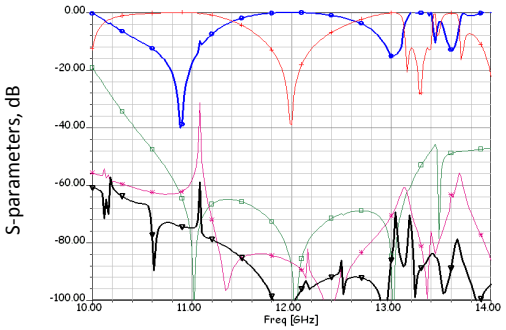




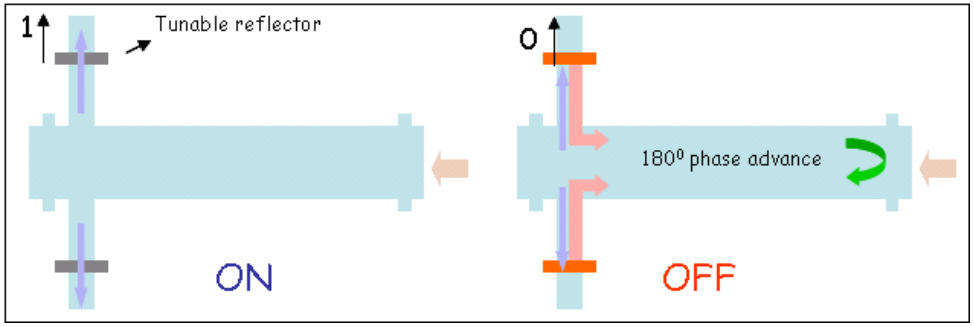






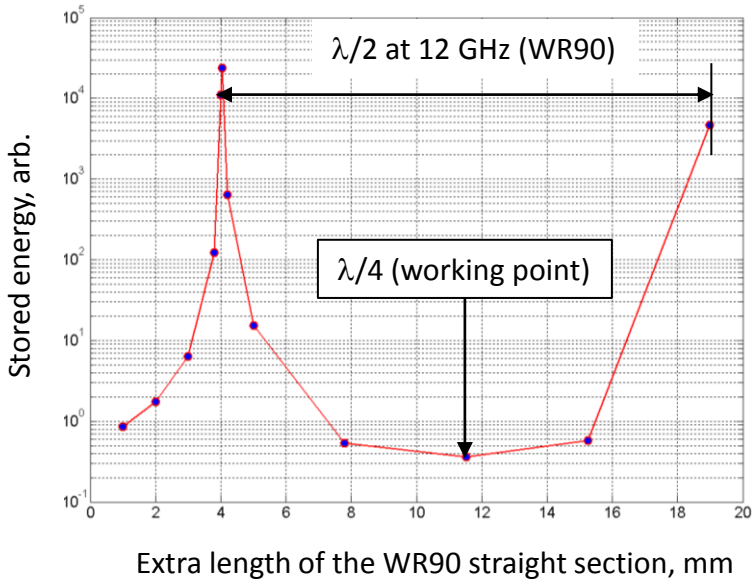


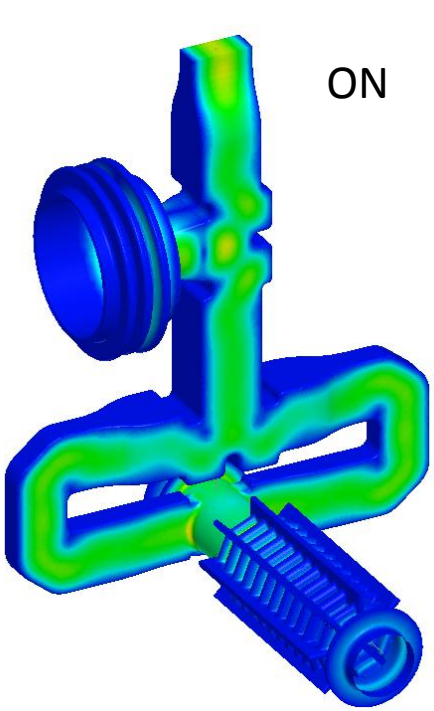
The variable reflector is a core element of the PETS ON/OFF mechanism. It is activated when the local termination of the RF power production in PETS is required.

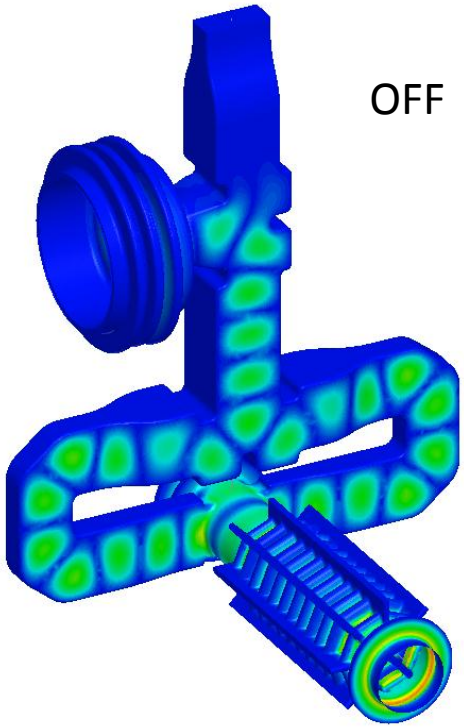


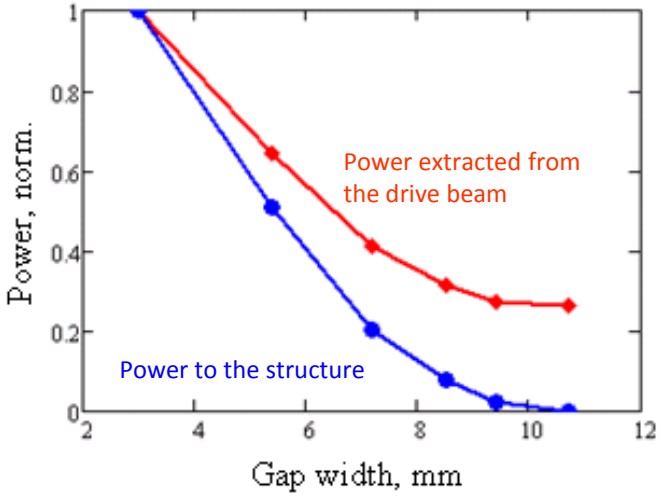
PETS ON/OFF operation (CLIC PETS)

"Closed" circuit RF phase was tuned using HFSS simulations with beam.

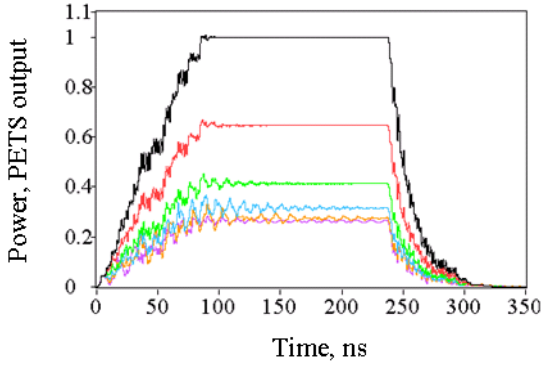


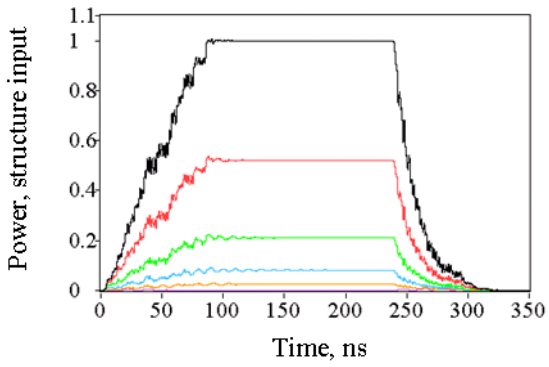






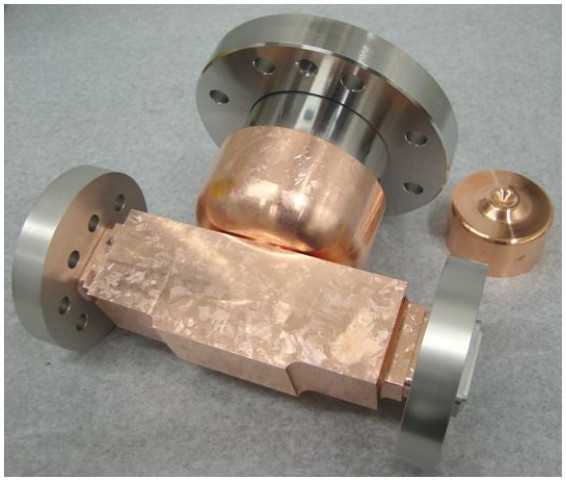
Full model analysis (GDFIDL + HFSS)

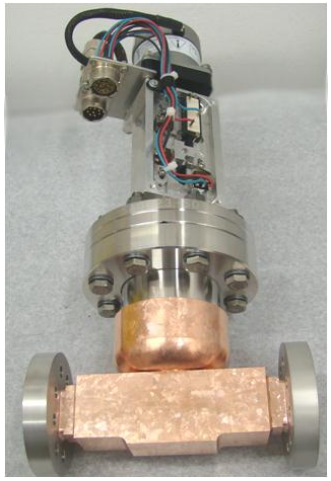




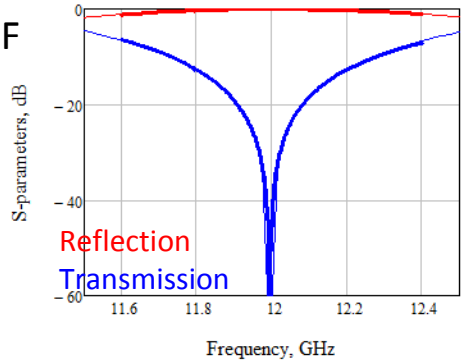
I. Syratchev, HGW 2012, KEK, Japan

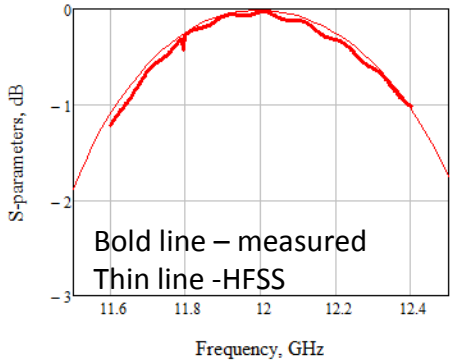
The variable RF reflector.

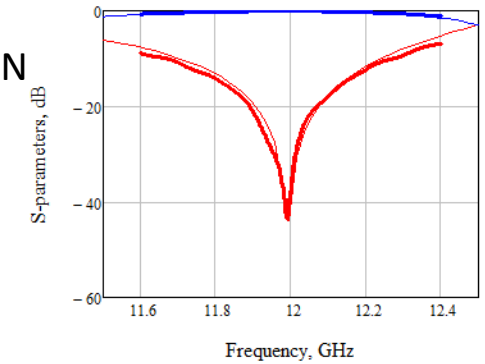


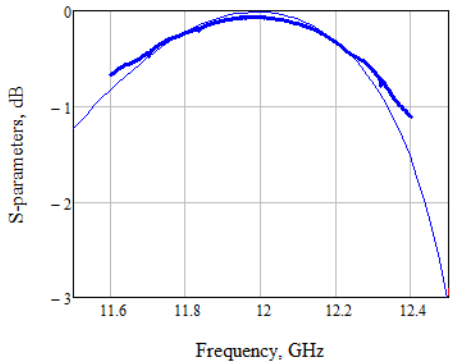
OFF



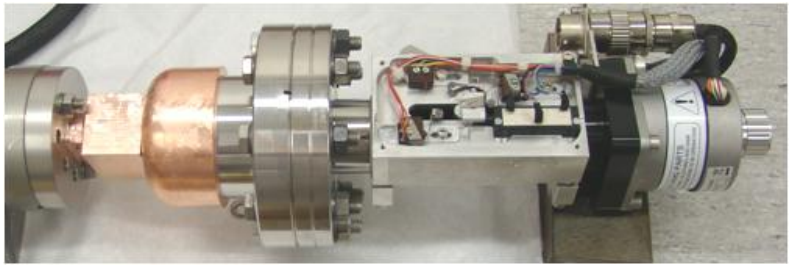


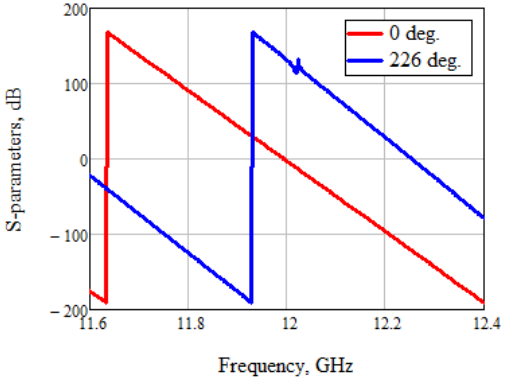
ON





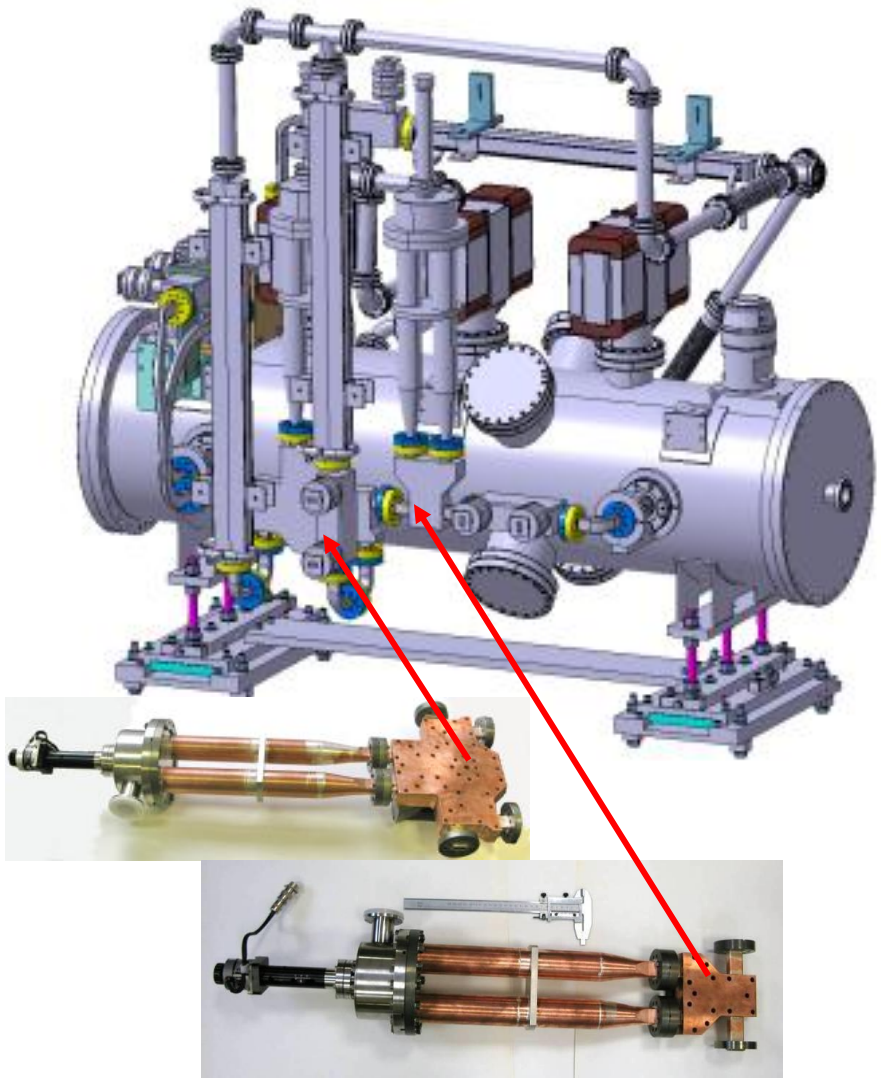
The variable RF short circuit





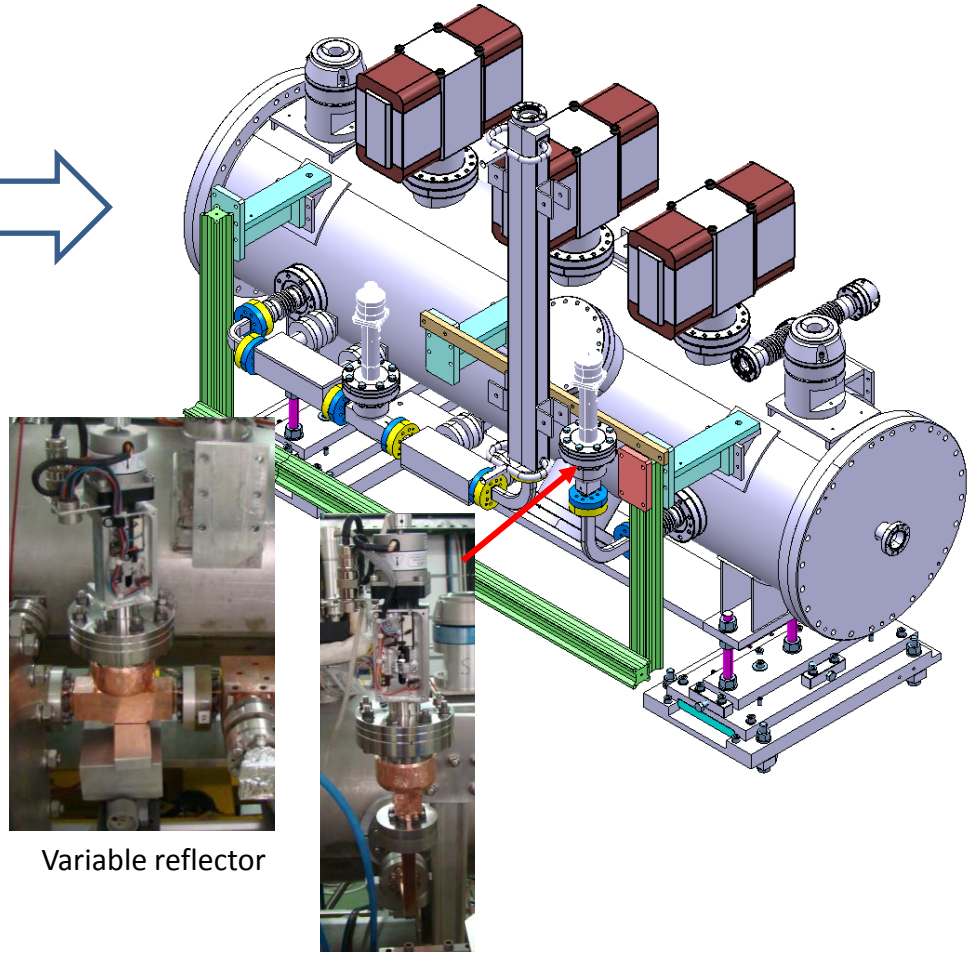
Modification of the TBTS PETS tank layout in 2011.

External recirculation loop



Variable Power splitter and Phase shifter, GYCOM (Russia).

Internal recirculation

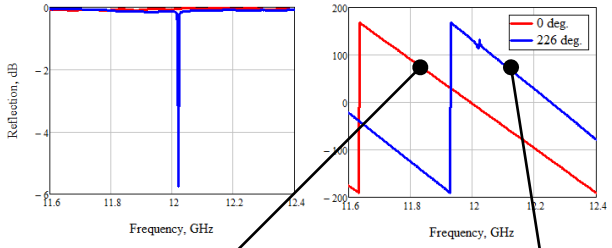


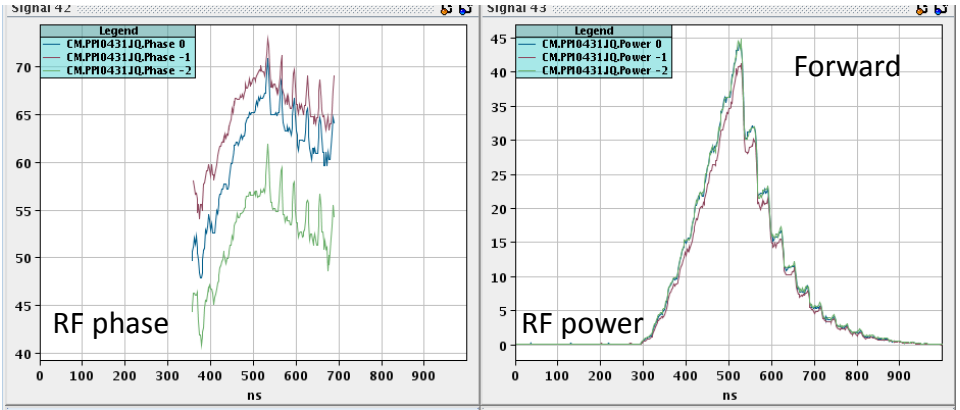
Variable reflector

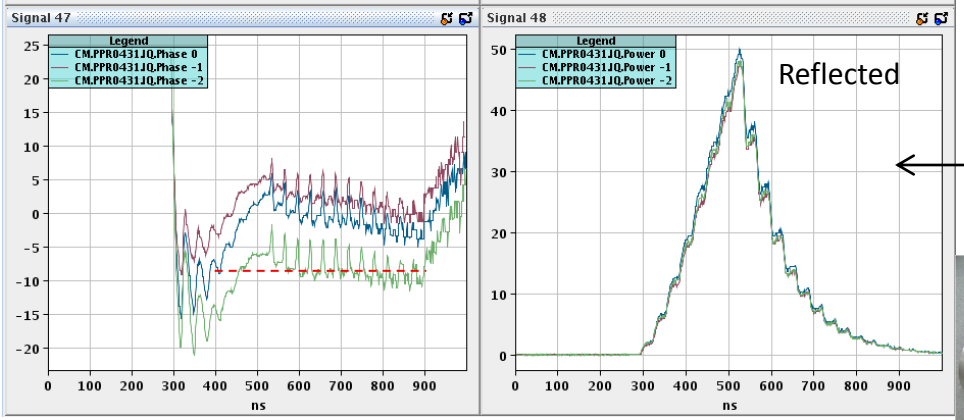
Variable short circuit

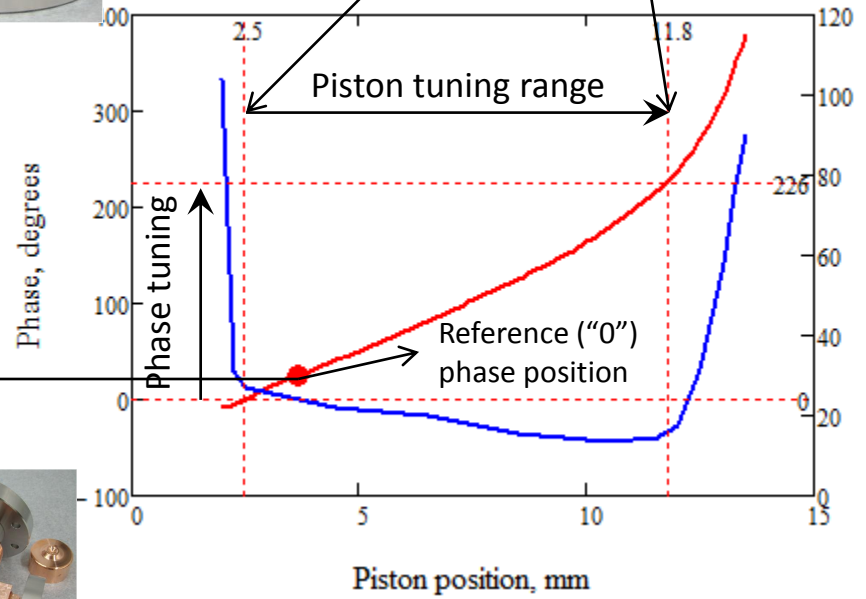
Full recirculation. Reference point.

Short circuit S-parameters measured at two extreme (locked) positions



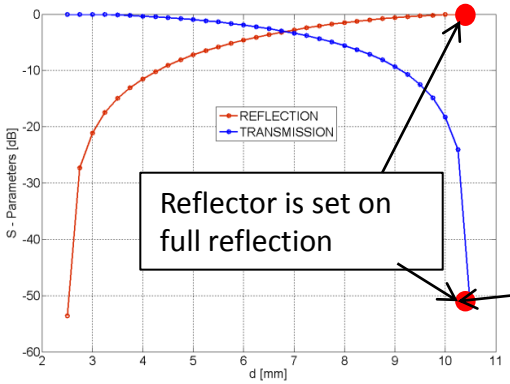


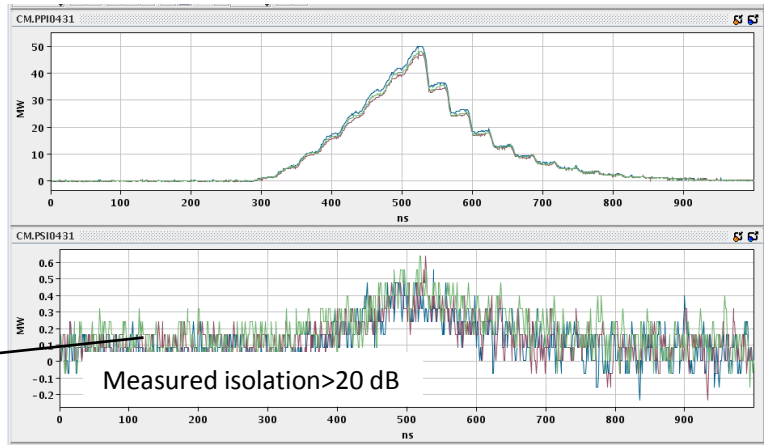




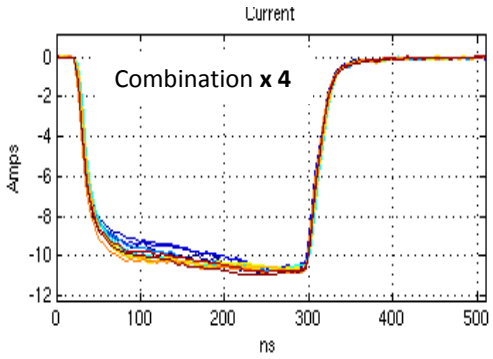
Procedure:

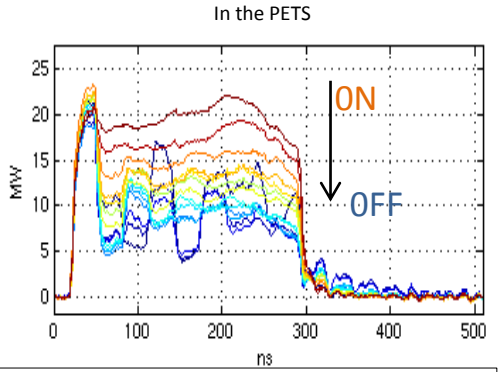
- Low (3A) current, short (200 ns) pulse
- Reflector was set on the full reflection
- The short circuit position was tuned to provide highest peak power and flat RF phase both for the forward and the reflected pulses.

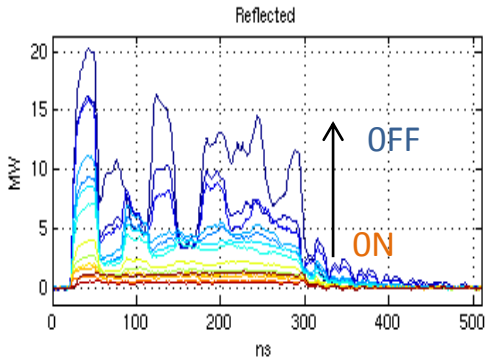


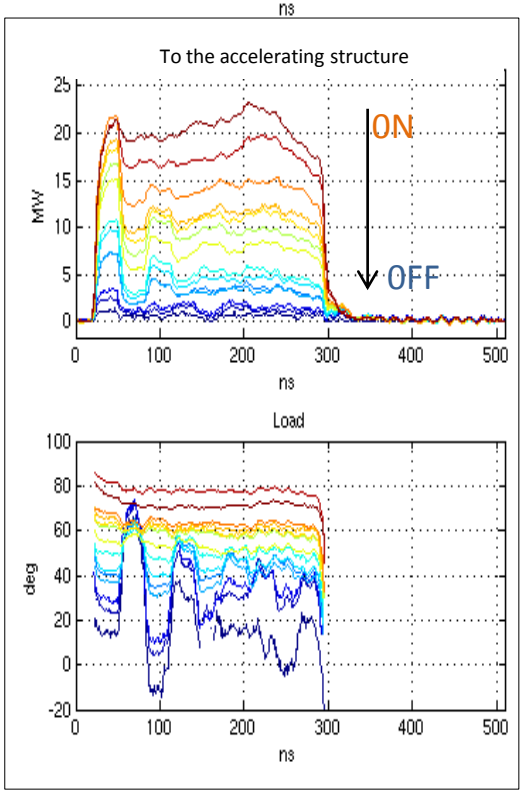


Waveform for the different reflection and fixed (180^0) phase advance

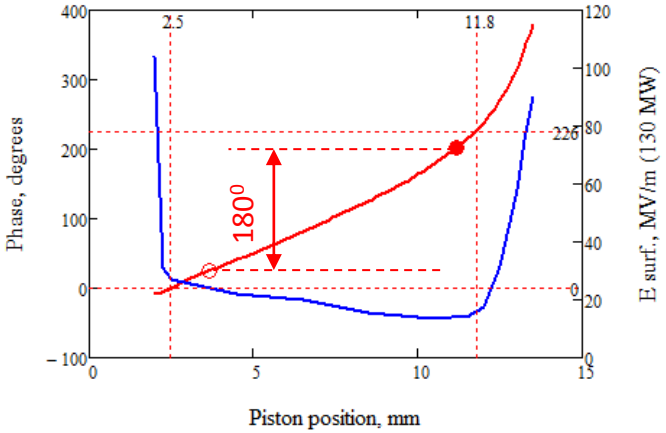


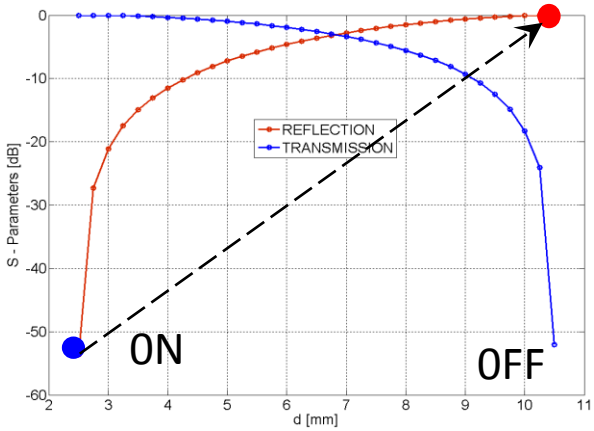






Summarized
by Alexey Dubrovskiy



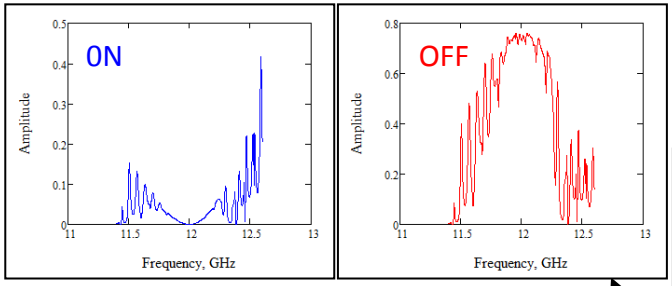


Procedure:

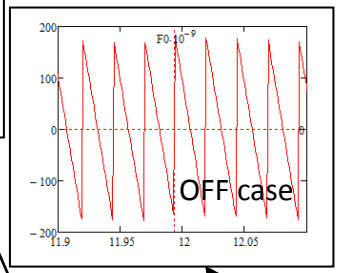
- Medium (10 A) current, long (240 ns) pulse
- The short circuit was set on the expected 180^0 phase advance position.
- The variable reflector position was change from full transmission to the full reflection.

PETS with recirculation modeling and analysis

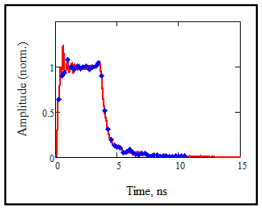
Measured transfer spectra of the recycling loop



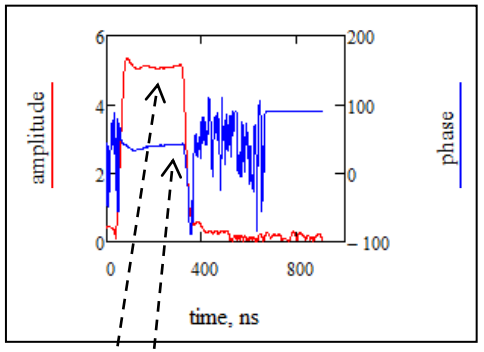
Artificial RF phase delay for tuning



PETS single bunch response (GDFIDL)



Measured current pulse

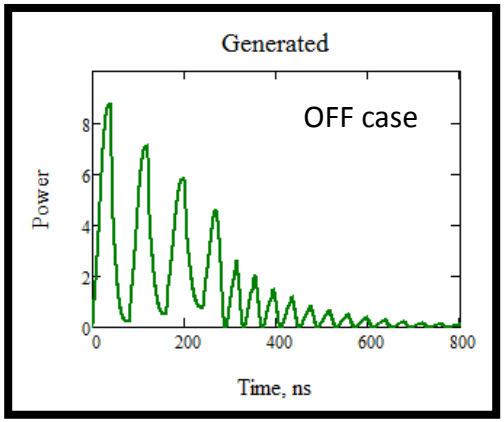


Number of round trips

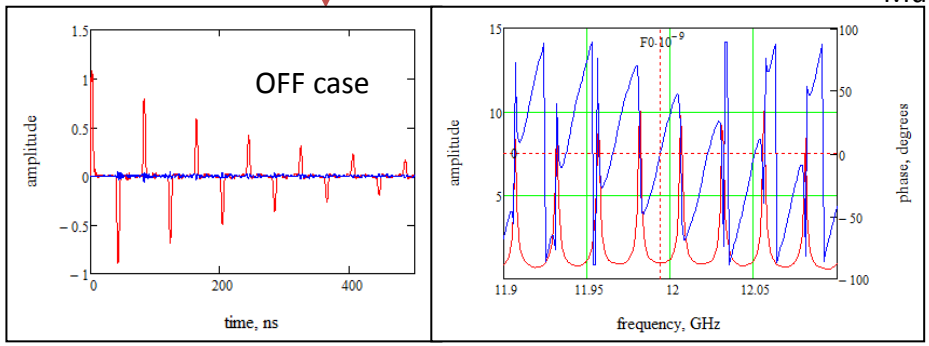
Number of bunches

$$U(t) = FFt\left(FFw\left\{ \sum_{k=0}^{N_{rc}} FFt\left[S_{12}(\omega)^k \times e^{j\Delta\varphi} FFw\left(A_b(t)\right) \right] \right\} \times \sum_{n=0}^{N_b} a_n e^{jn\omega\times\Delta t_n} \right)$$

Multi-bunch part



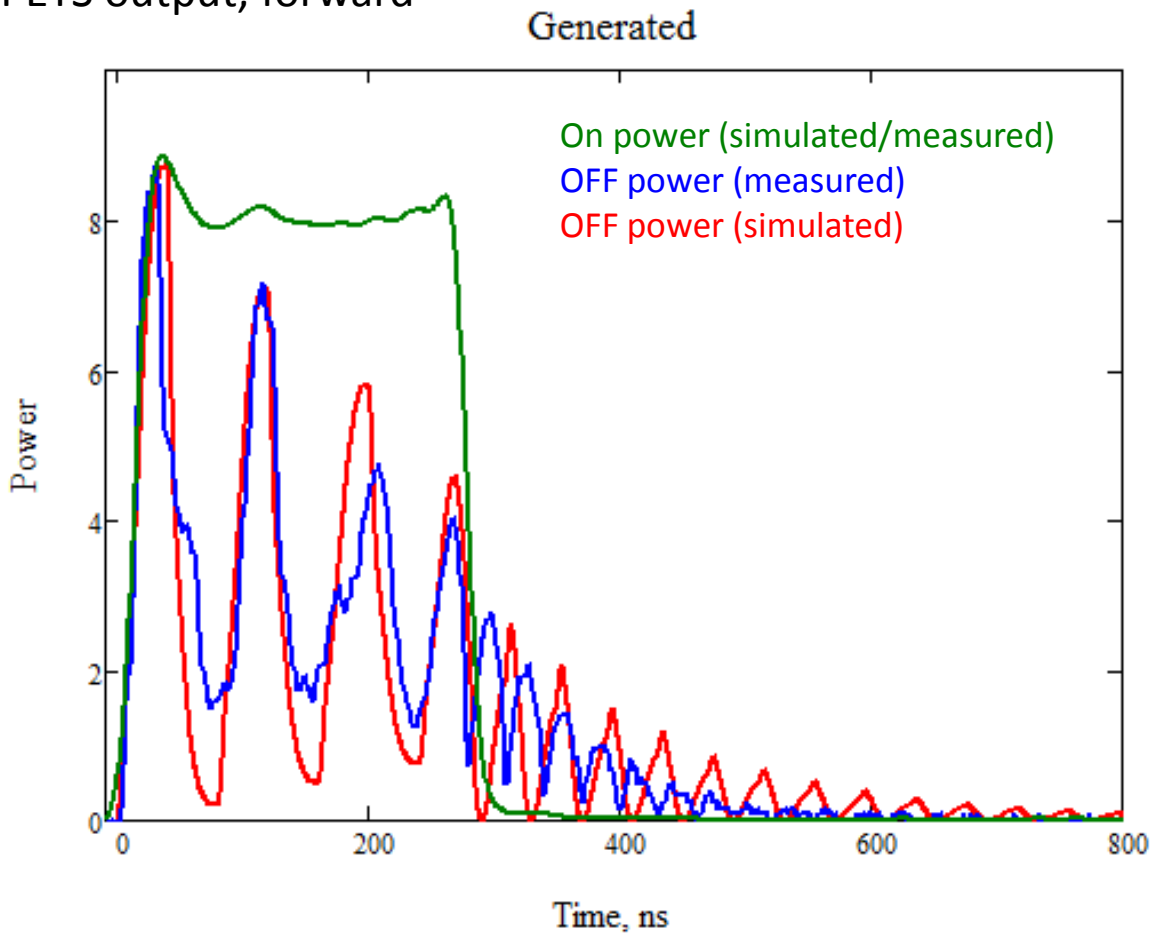
RESULT



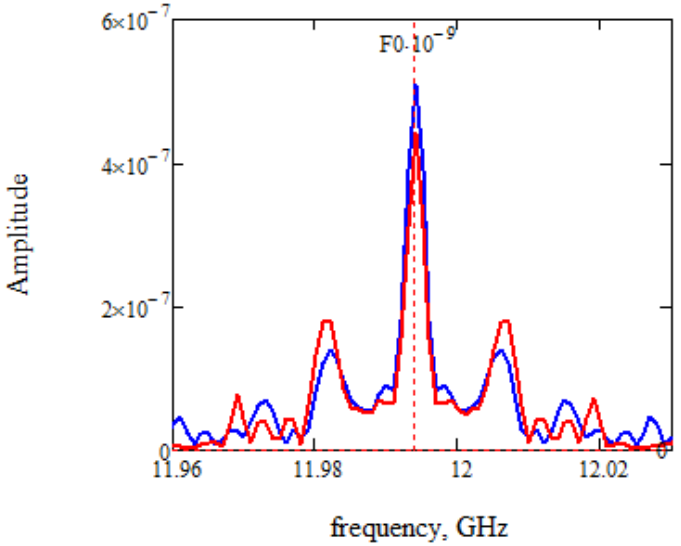
The complete system single bunch response and spectrum

Simulation vs. experiment

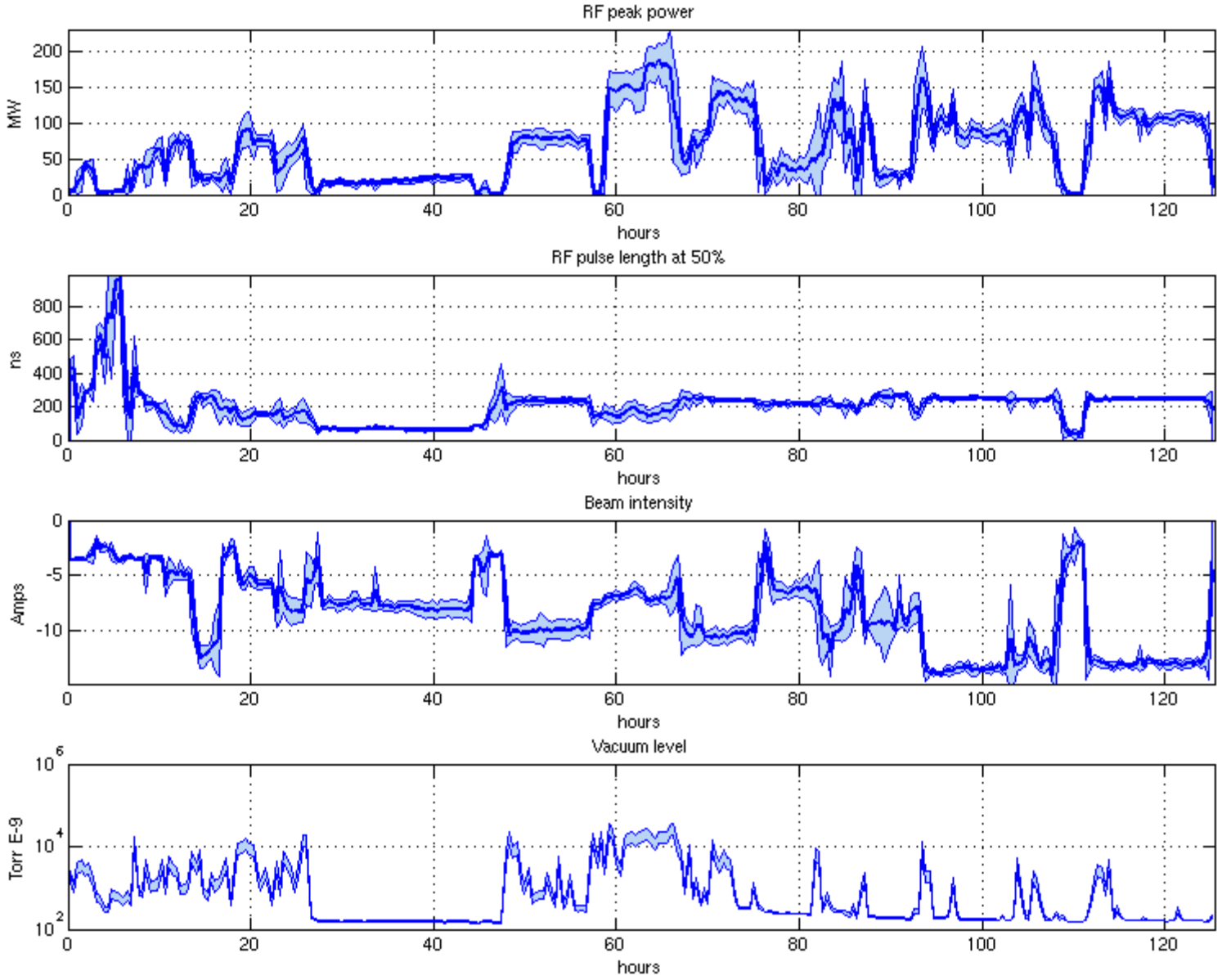
PETS output, forward



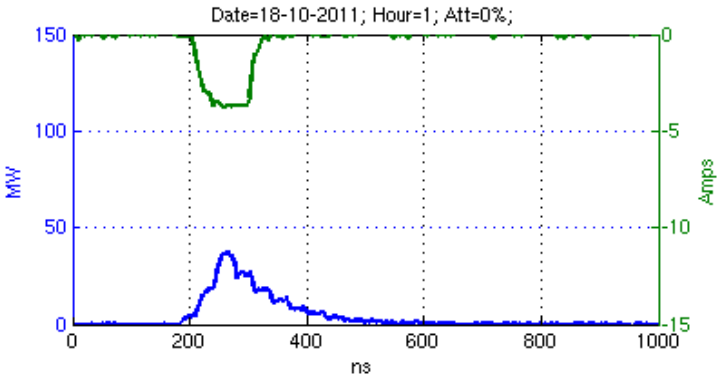
Spectra comparison

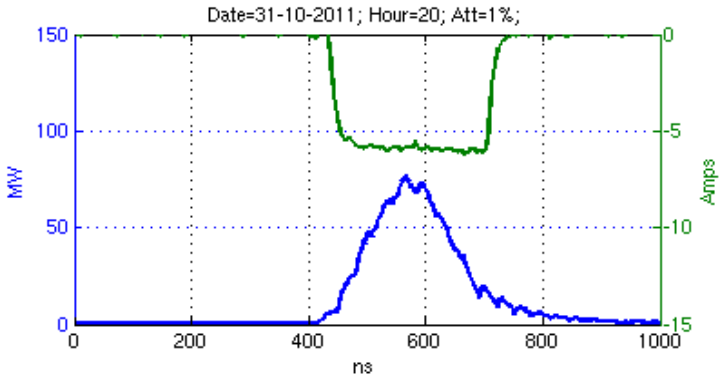


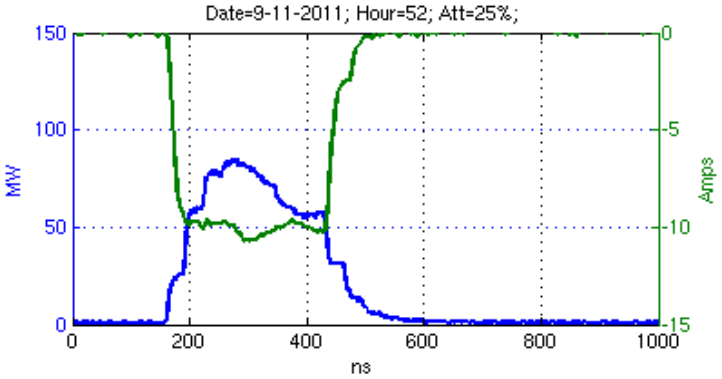
TBTS PETS processing history in 2011. Amplification regime.

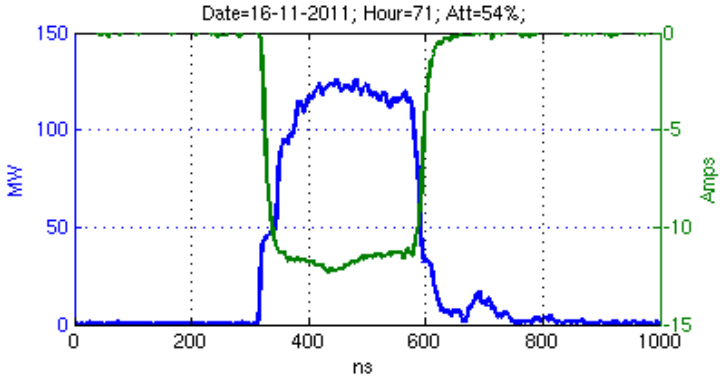


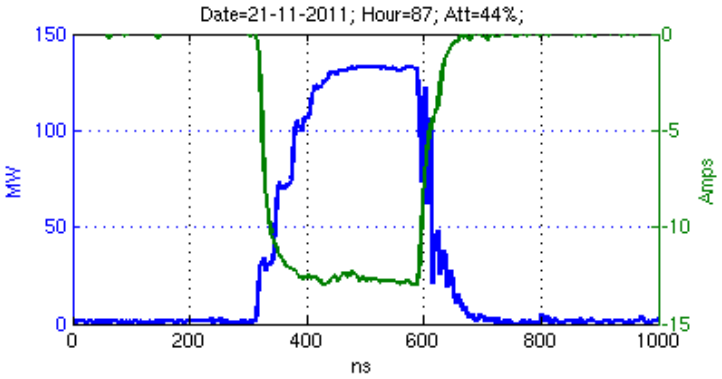
TBTS PETS processing results. Generated pulse shapes

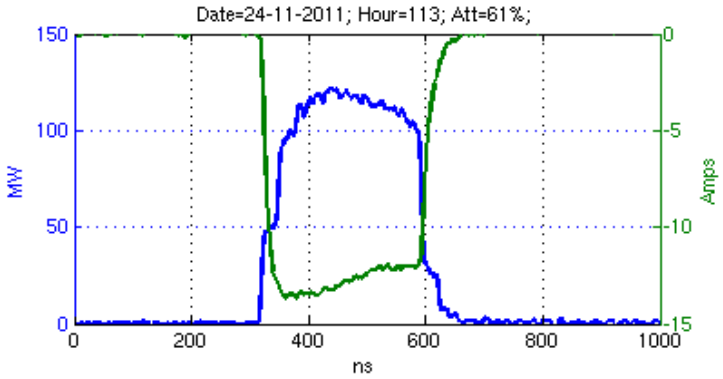












The PETS ON/OFF capability was successfully demonstrated in experiments with drive beam in CTF3. Currently it is used to provide RF power for the two-beam experiments in TBTS