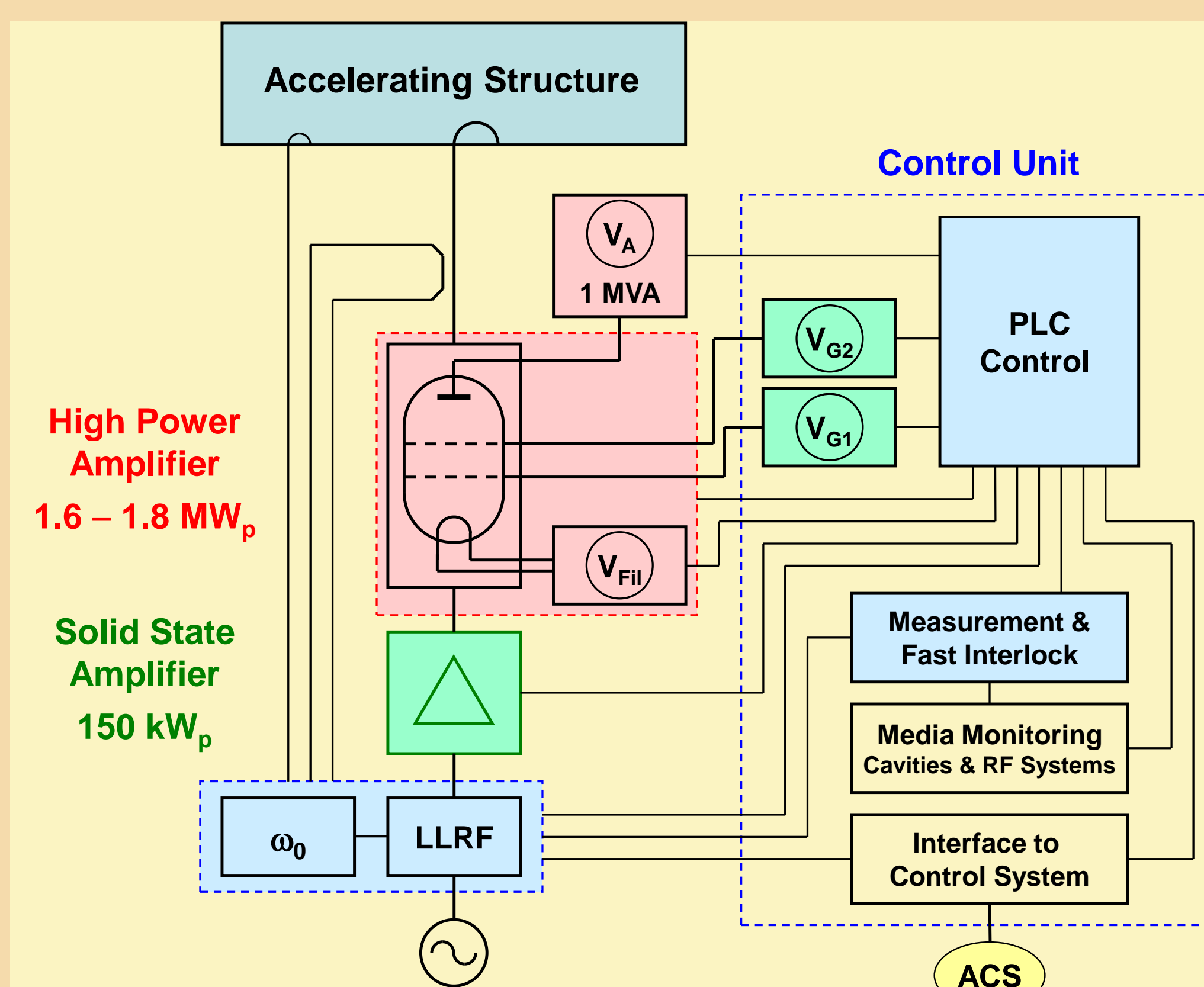


## Abstract

A substantial modernisation of the RF systems at the 108 MHz Alvarez type post-stripper section of the GSI heavy ion linac UNILAC was launched in 2014 to prepare the existing facility for the future FAIR operation. A new 1.8 MW RF cavity amplifier prototype for low duty-cycle operation (2 ms pulse length at 10 Hz repetition rate) based on the widely-used tetrode TH558SC was designed and built by THALES and is under commissioning. A call for tenders was started for a 150 kW solid state driver amplifier. An RF test bench for the amplifier prototypes is in preparation at GSI including new control racks, commercial grid power supplies, and a modern PLC system for amplifier control. The existing powerful 1 MVA anode power supplies will be reused and are also being equipped with new PLC systems. The development of a digital low-level RF system based on the MTCA.4 standard and commercial vector modulator and FPGA boards was started.

	Existing UNILAC Post Stripper	Proposed Substitution
Ion Species	Up to $^{238}\text{U}^{28+}$ ( $A/q = 8.5$ )	
Design Ion Beam Current	Low Current	15 mA
Input Energy	1.4 MeV/u	
Output Energy	$\sim 3 - 13$ MeV/u Cont. Variable	11.4 MeV/u Fixed
Operation Frequency	108.4 MHz	
RF Pulse Length	$\leq 6$ ms	$\leq 2$ ms
RF Pulse Repetition Rate	$\leq 50$ Hz	$\leq 10$ Hz
Max. RF Duty Cycle	$\sim 30$ %	$\sim 2$ %
	5 Alvarez Tanks & 6 Single Gap Resonators	New Alvarez or IH DTL



## RF Systems Modernisation

- Substitution of the old control units of the five existing 1.6 MW high power amplifier (HPA) stages by PLCs
- New fast measurement & interlock systems
- New commercial grid power supplies
- Replacement of old driver amplifiers (50 W & 300 W solid state amplifiers followed by 10 kW & 160 kW tube stages) by new 150 kW solid state amplifiers (call for tenders in progress)
- Substitution of the old relay based control of the 1 MVA anode power supplies by PLCs
- Substitution of old resonance tuning circuits and of the LLRF systems (prototypes in progress)
- Stepwise modernisation in longer shutdown periods during 2015 – 2018 and beyond
- Planned: New HPA stages based on Thales tetrode TH 558SC (prototype delivered)

## Overview of existing RF systems

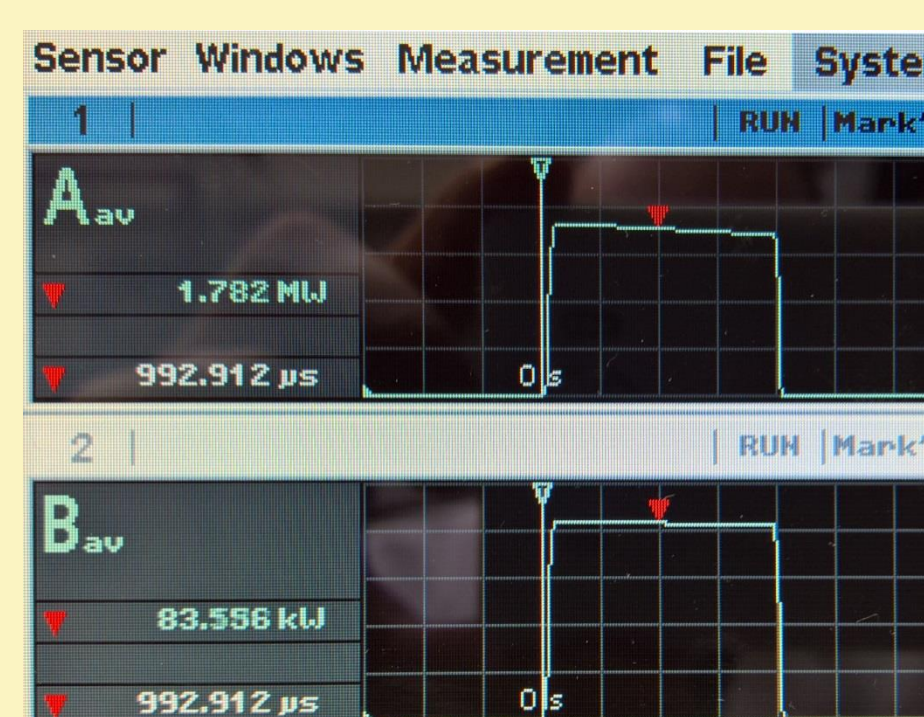


Length of RF System Installation („HF Galerie“)	115 m
Number of Accelerating Structures	28 (each with one dedicated RF system)
RF Amplifiers	7 x ≤ 200 kW, <b>4 x 2 MW</b>
36 MHz	3 x 2 kW SSA, 19 x ≤160 kW, <b>5 x 1,6 MW</b>
108 MHz	
DC Power Supplies	<b>6 x 1 MVA</b> + ca. 28 individual Systems

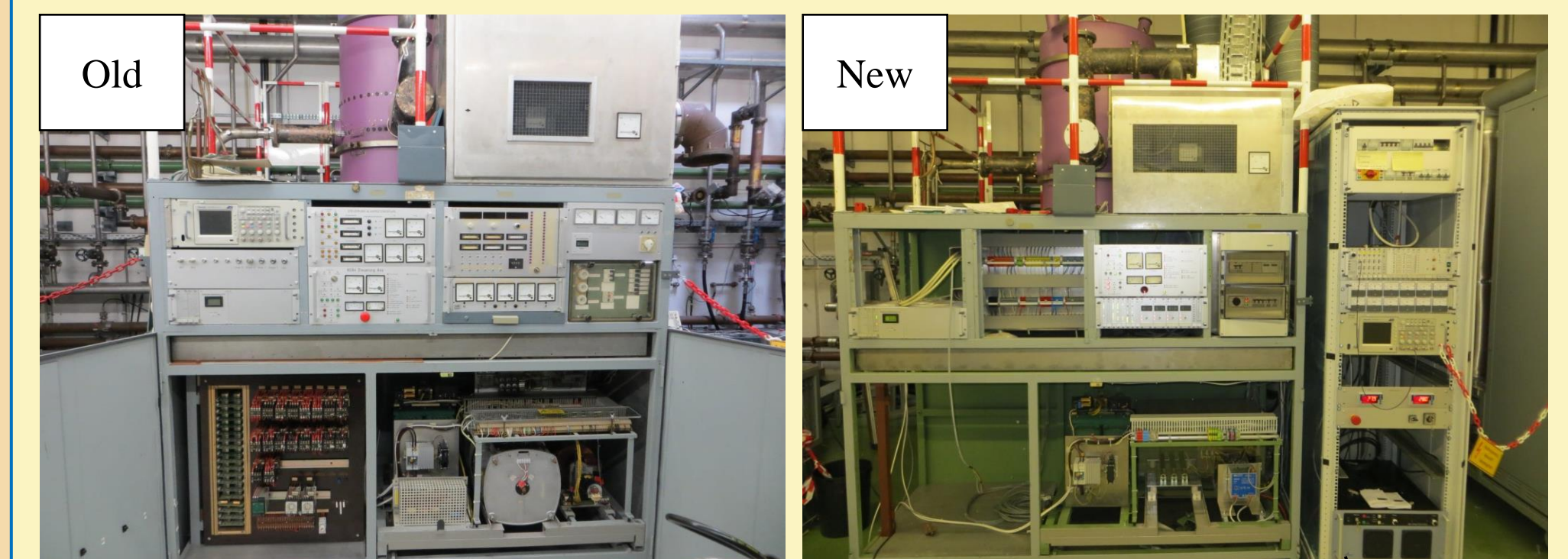
## New Thales 1.8 MW Amplifier Prototype



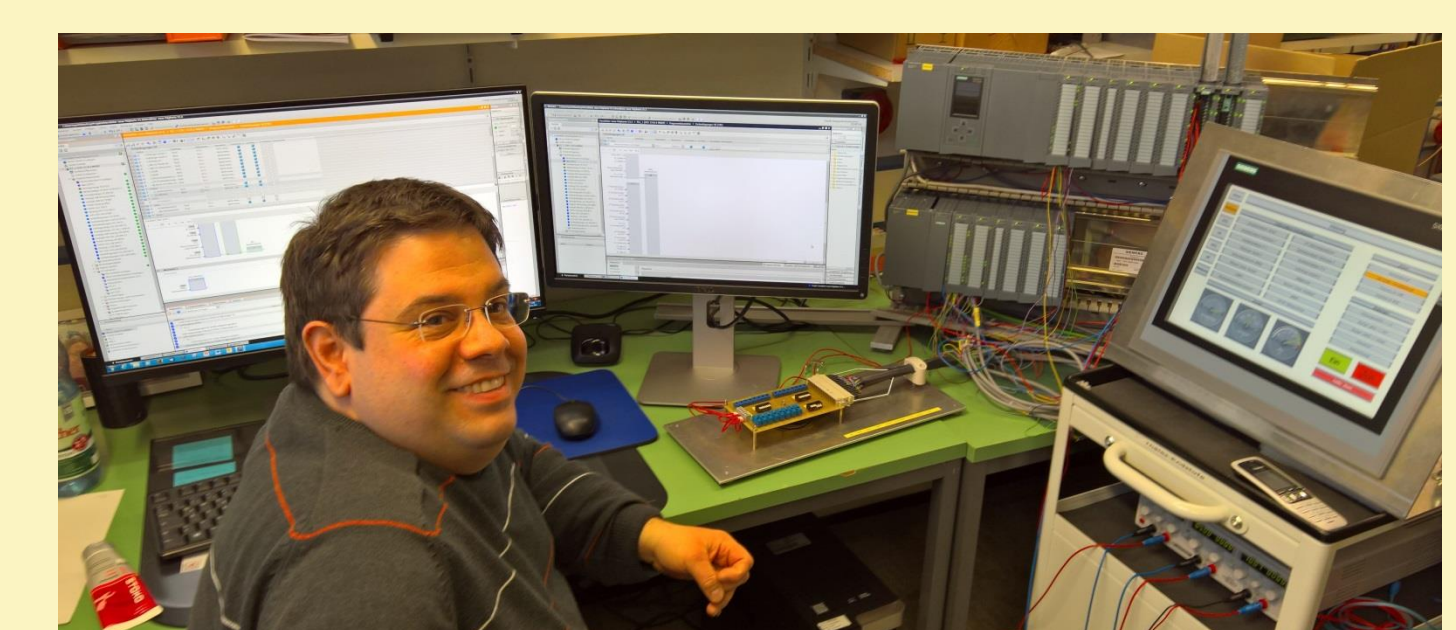
- 1.8 MW pulse at 10 Hz repetition rate, 2 ms
- FAT in May – July 2016, delivered recently
- Testbench at GSI in preparation
- Operation on Alvarez A4 tank for test & beamtimes



## Modernisation of existing HPA & PS



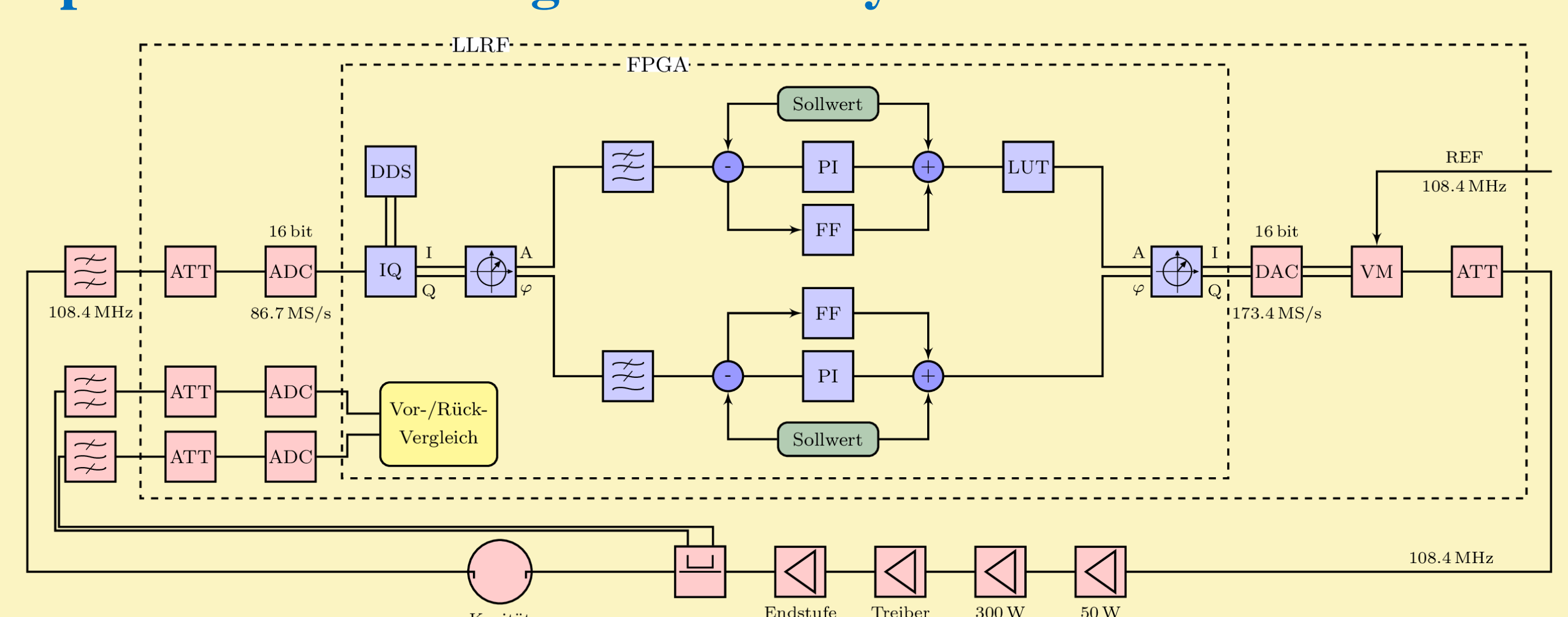
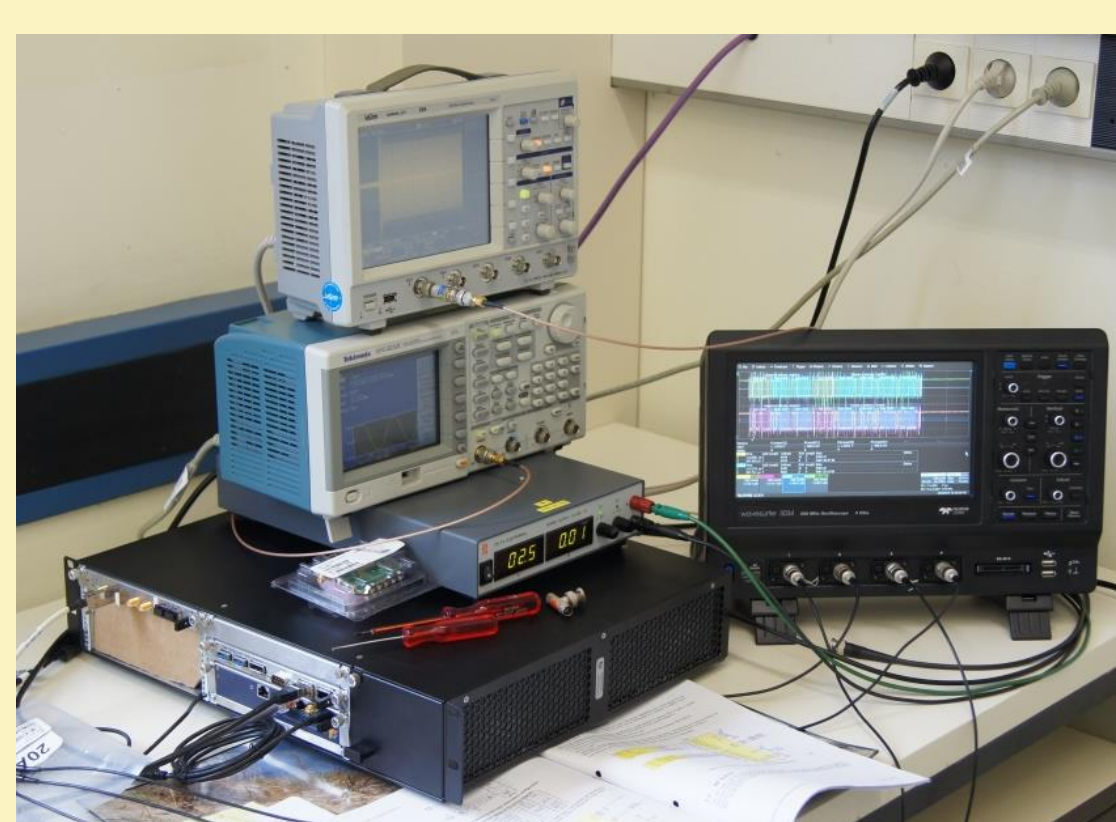
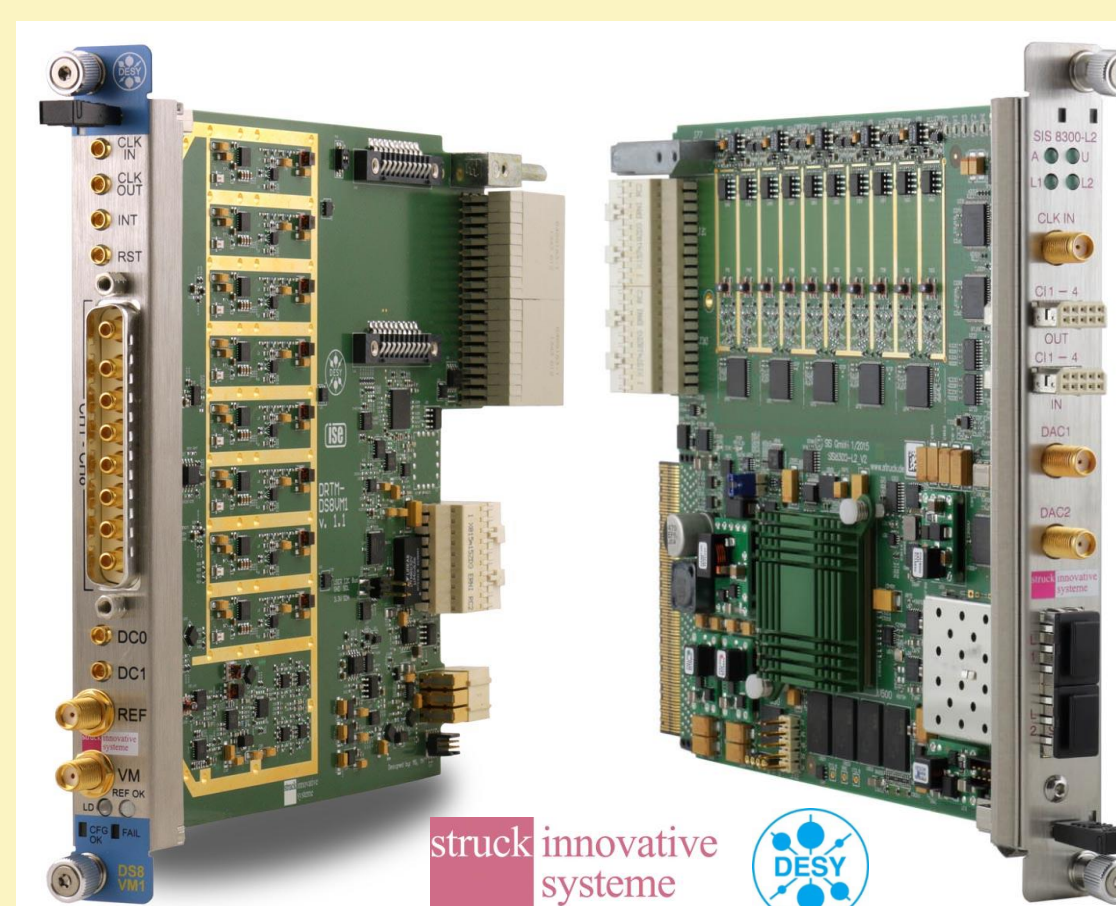
- New separate control racks comprising:
  - New UG1 power supplies
  - New measurement & fast interlock units
  - New PLC for amplifier control

Control  
Rack

- 1 MVA anode power supply with new PLC



## Development of a new digital LLRF System



- MTCA.4 based prototype system consisting of SIS8300-L2 and DS8VM1
- Combination of digital down conversion and analog vector modulator
- PI feedback control and adaptive feed forward for beam loading compensation
- Targeting for delay  $\leq 1 \mu s$  and precision in amplitude and phase  $\leq 0.1 \%$  and  $0.1^\circ$  respectively