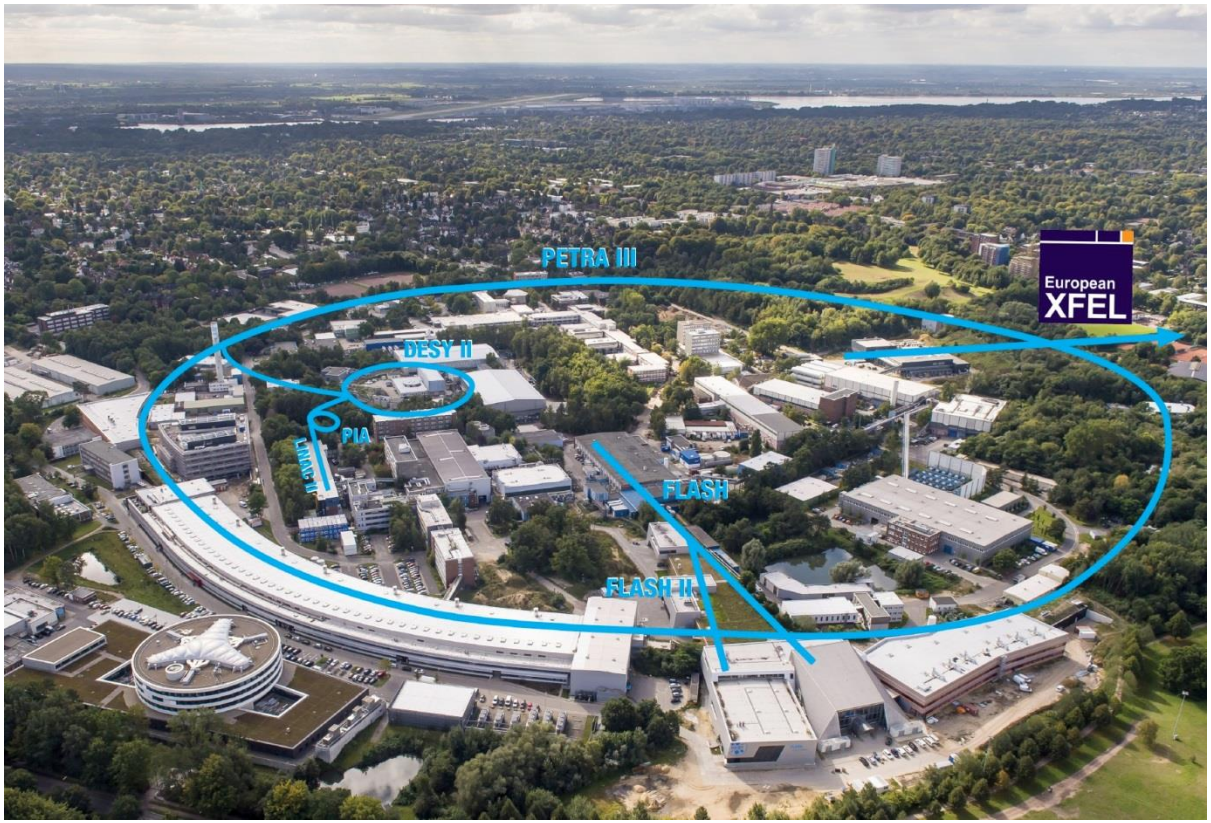
Finger exercises for PETRA IV

PETRA III



Main parameters:

l = 2304 m

beam energy = 6.08 GeV

beam current: 100 mA (4.8 E12 e^-),

Top Up

emittance (hor.) = 1 nmrad

energy loss: ca. 5 MeV per turn
(ca. 65 % from damping wigglers)

20 undulators

fill pattern:

- timing mode :
  - 40 bunches, 192 ns gap
  - 60 bunches, 128 ns gap
- continuous mode:
  - 480 bunches, 16 ns gap
  - 960 bunches, 8 ns gap

Going from PETRA III to PETRA IV

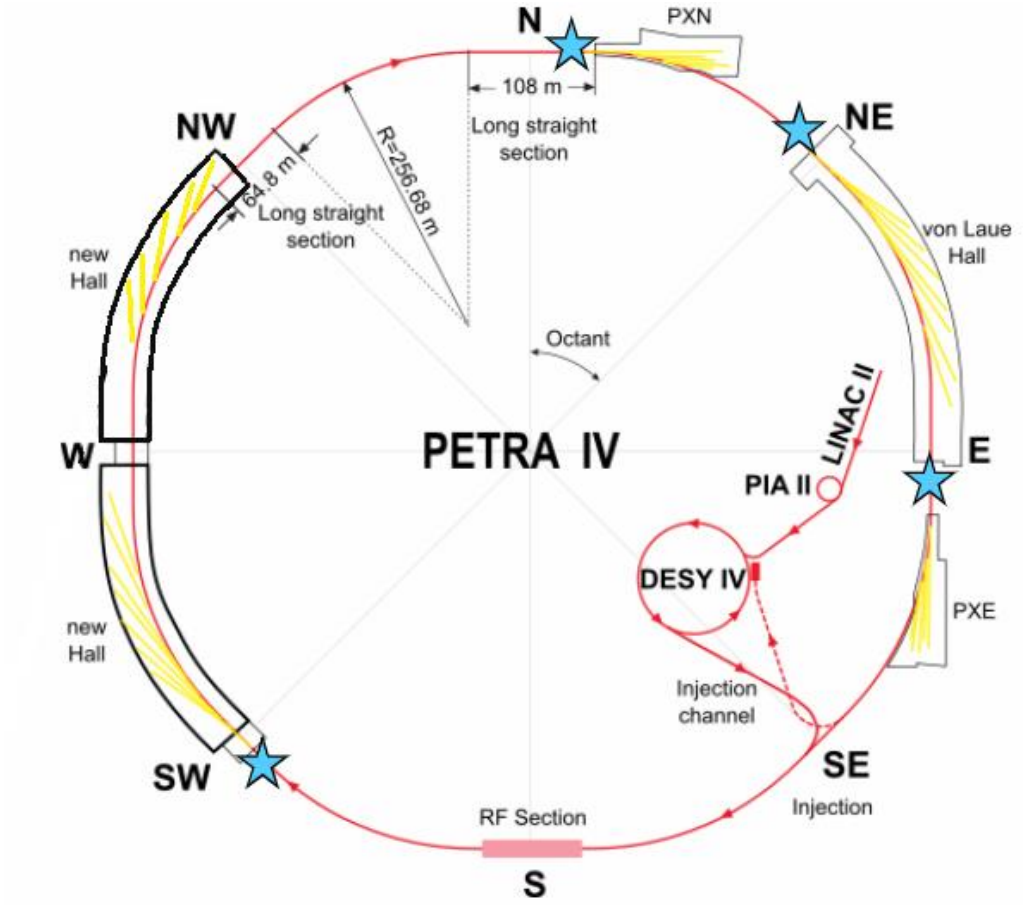
- „H7BA“-Lattice with 26 IDs
- In the same tunnel
- Beamlines stay where they are
- 2 new experimental halls

RF-Related PETRA IV Parameters

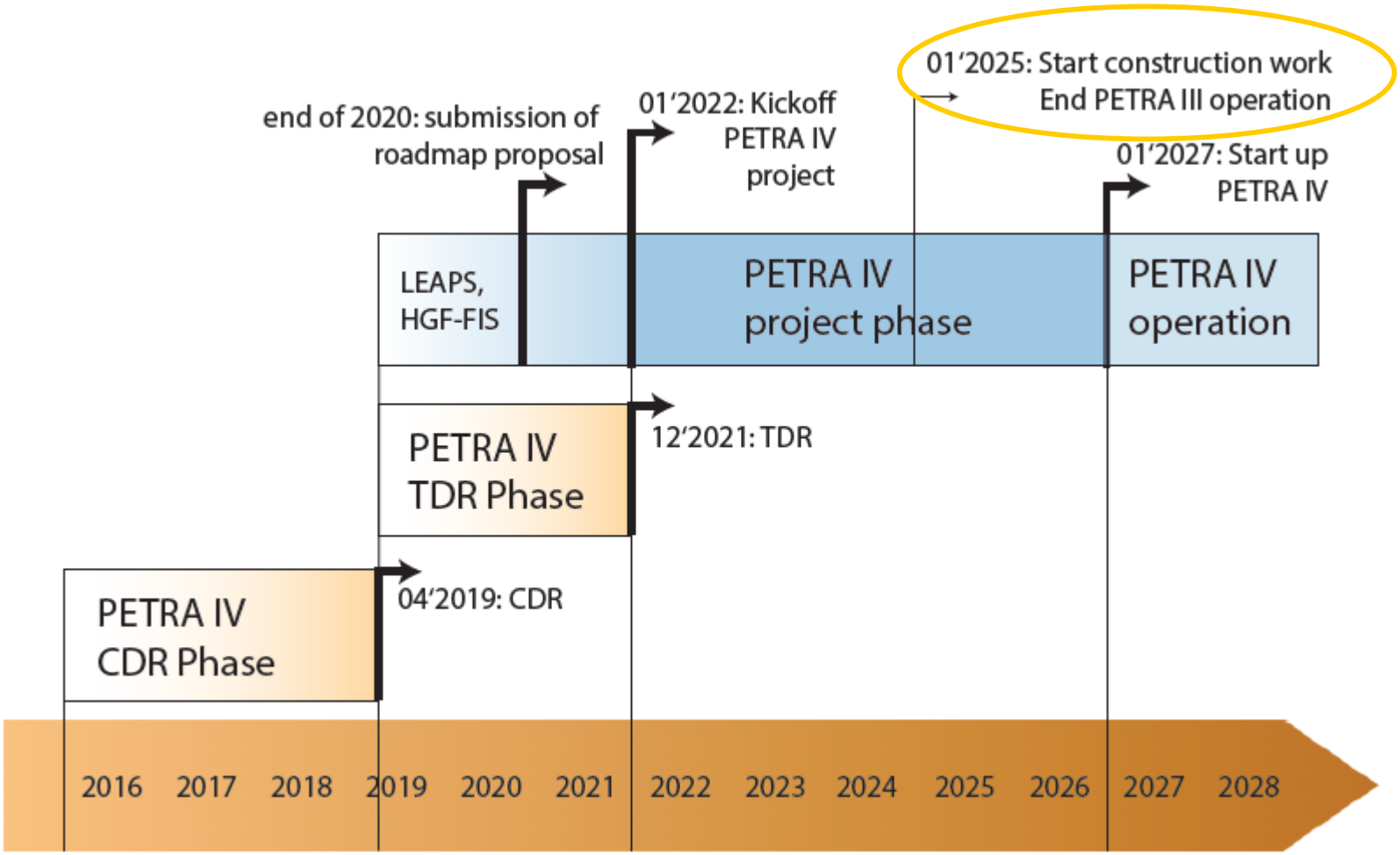
		remarks
Energy	6.0 GeV	
RF frequency	500 MHz	
Circumference voltage	6 MV_{nom} (9 MV_{max})	Optimized for max. Touschek lifetime. Effect of 3. harm. syst. has not yet been considered
Beam current	200 mA / timing mode 80 mA / brightness mode	
Energy loss per turn	3.32 MeV	IDs included
Energy spread	$< 2 \cdot 10^{-3}$	w/o IBS
Momentum compaction factor	$1.43 \cdot 10^{-5}$	About 80 times smaller than PETRA III
Bunch length (1σ)	6.8 ps	
Long. damping time	16.2 ms	

Plans for PETRA IV

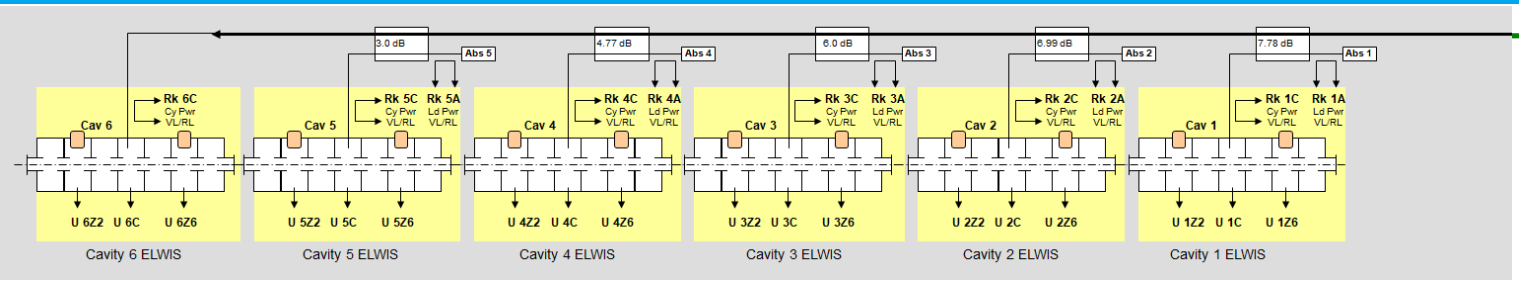
- 2 new experimental halls
- complete new pre-accelerator chain
- New injection scheme
  no topup
  – but swap out part of beam and “on axis injection”

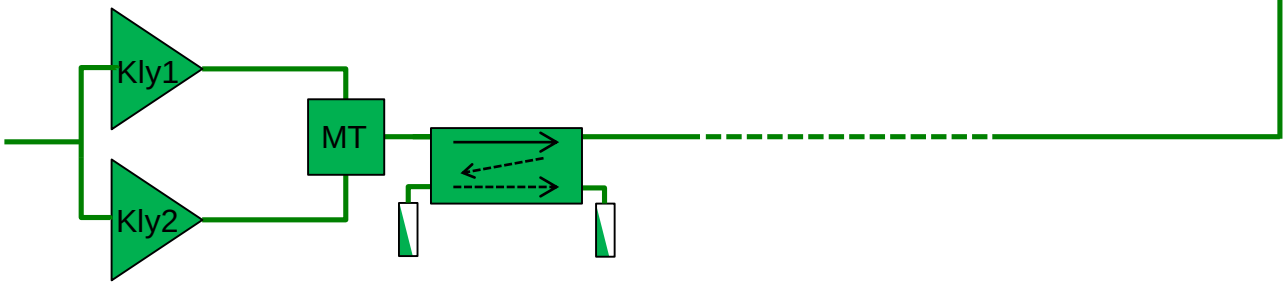


PETRA IV time schedule



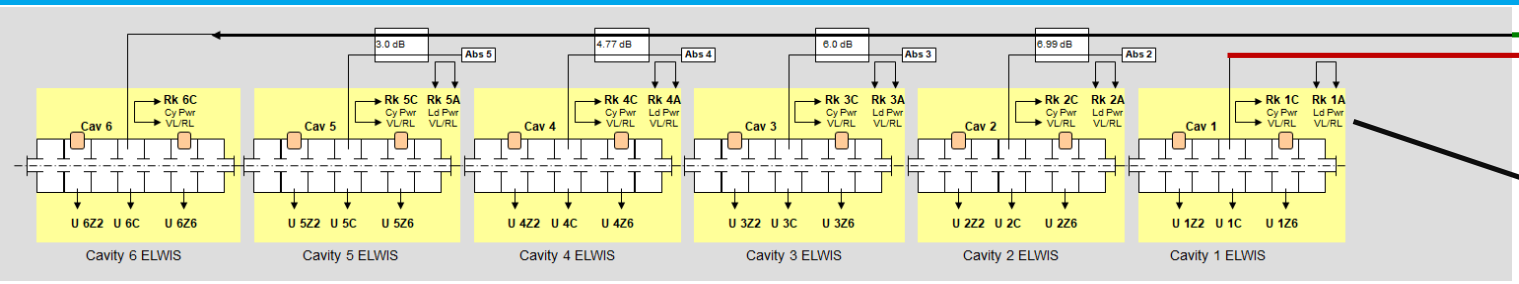
Insert new rf- system

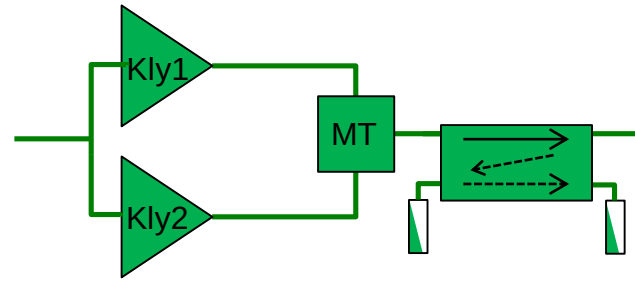




RF System PETRA-SR today

Connecting one of the six cavities to a SSA in 4th quarter 2021



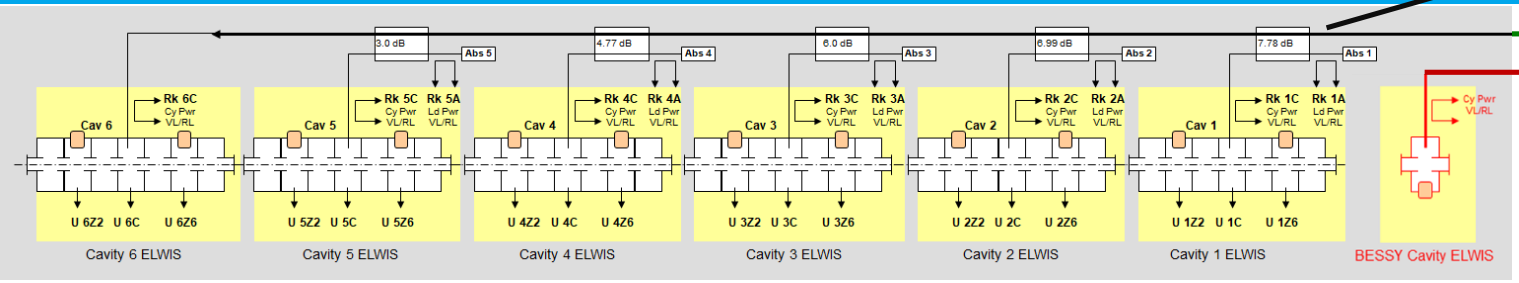


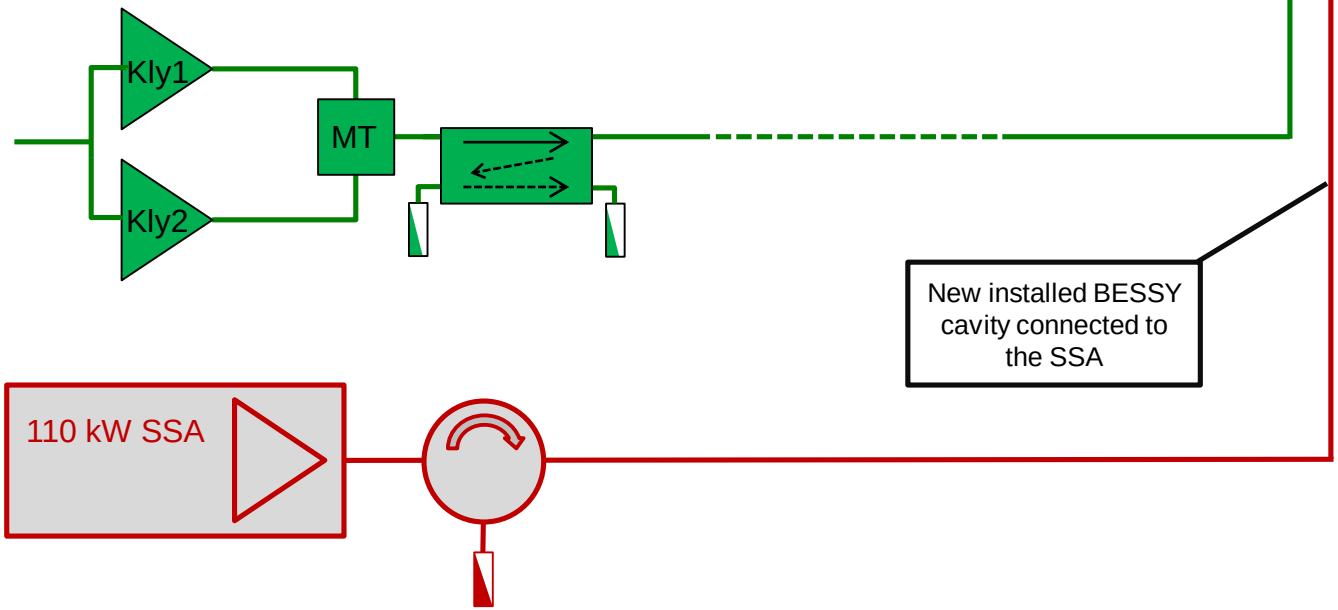
Cavity SR1 disconnected from transmitter SR and connected to the new SSA

New solid state amplifier

Additional waveguide transmission line from hall to tunnel

Test of a HOM-damped BESSY cavity in 2nd half 2023





Cavity SR1 reconnected to transmitter SR

New installed BESSY cavity connected to the SSA

Harmonic RF System

Development of a 1.5 GHz downscaled BESSY cavity

- ALBA offered DESY to participate (Jan. 2019)
- Cooperation agreement contract set up and sent to ALBA for review (Aug. 2019)

Courtesy of Beatriz Bravo, ALBA

Harmonic RF System

Learning to “play harmonics”

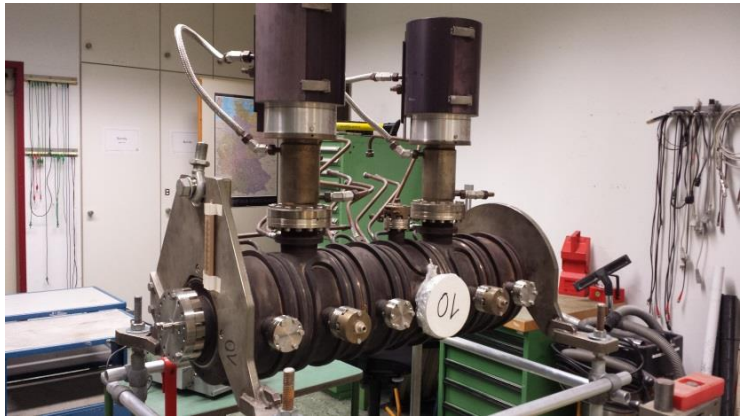
Installation of 2nd harmonic rf system for PETRA III and operating it in a “3 GeV- Testrun”

Why:

- We got all that stuff - klystron, cavities, waveguides and space in the machine
- Learning to operate and active harmonic system

First mode measurements of the PETRA six-cell cavity carried out (May 2019)

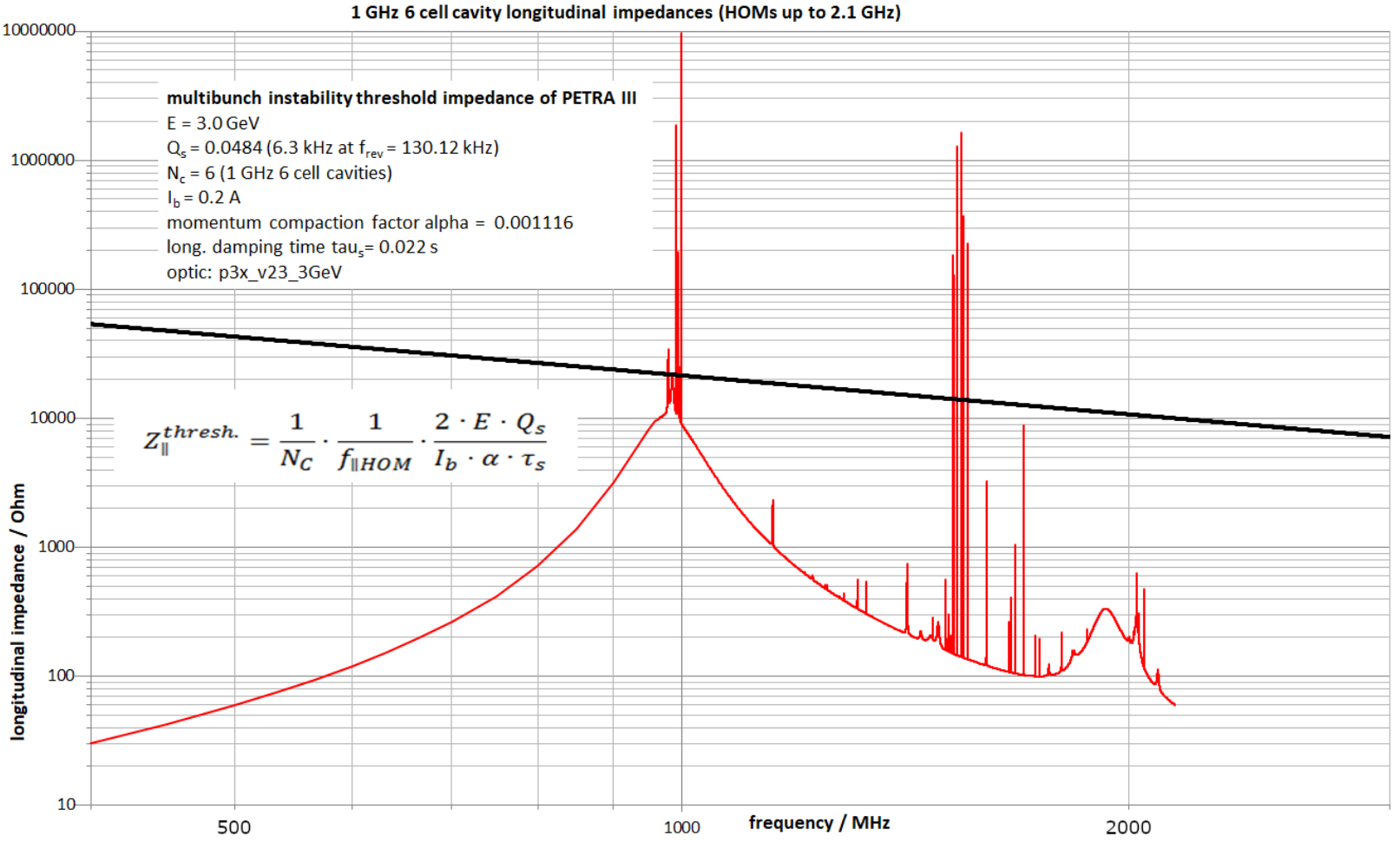
PETRA six-cell cavity modelized in CST-MWS (May 2019)



Harmonic RF System

Learning to “play harmonics”

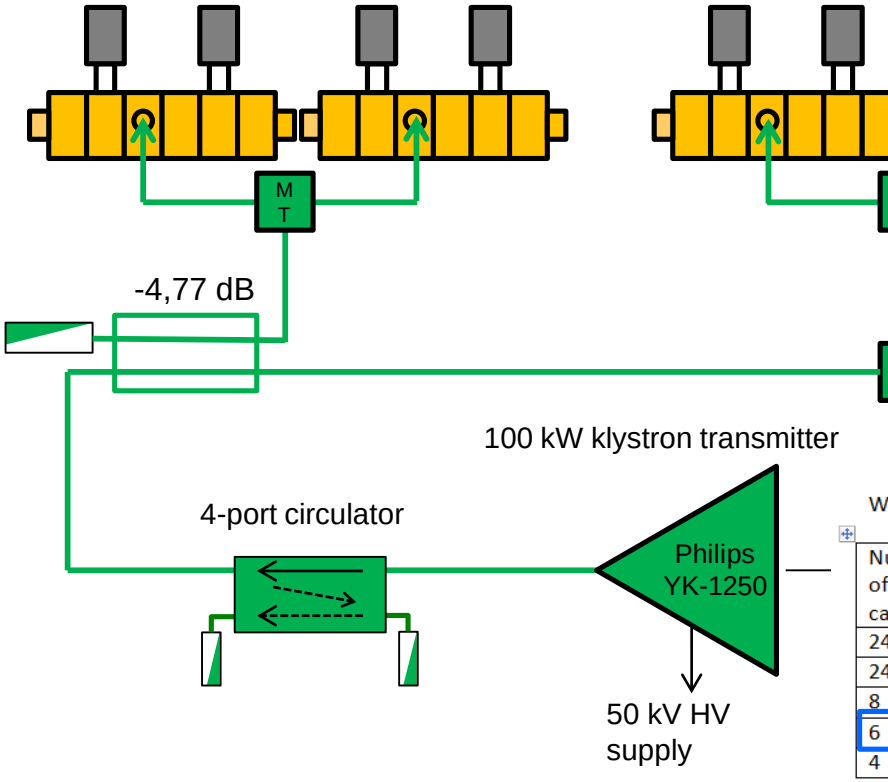
Some modes need to be damped => we research the solution



Harmonic RF System

Learning to “play harmonics”

2nd Harmonic RF System for PETRA III could be installed in PETRA hall



Data of a 1 GHz 6-cell cavity

Fundamental mode frequency	f_{res}	999.38 MHz
Characteristic impedance per cell	R/Q	57 Ω
Unloaded quality factor	Q_0	27.700
Shunt impedance	R_S	9.5 MΩ
rf voltage	V_c	600 kV
Dissipated power	P_{cav}	19 kW
Tuning range	Δf	tbm

W_0 = 1.2 MeV; V_{cf} = 6 MV; V_{HHC} = 2.92 MV; I_B = 100 mA; n = 2

Number of 6-cell cavities	Shunt impedance R_S	Generator power P_{HHG}	Dissipated power per cavity	Coupling factor β	Cavity detuning angle	Cavity detuning frequency
24	227 MΩ	0 (passive)	0.78 kW	0	86.3 °	282 kHz
24	227 MΩ	19 kW	0.78 kW	1	82.7 °	282 kHz
8	76 MΩ	56 kW	7.02 kW	1	69.0 °	94 kHz
6	57 MΩ	75 kW	12.5 kW	1	62.9 °	70 kHz
4	38 MΩ	112 kW	28.0 kW	1	52.5 °	47 kHz

Tentative schedule:

Until 2nt quarter 2020: continue CST-MWS simulations, HOM damping measurements

3rd quarter 2020: Conditioning and power test of cavities

2021: Installation of klystron transmitter in hall PETRA NW

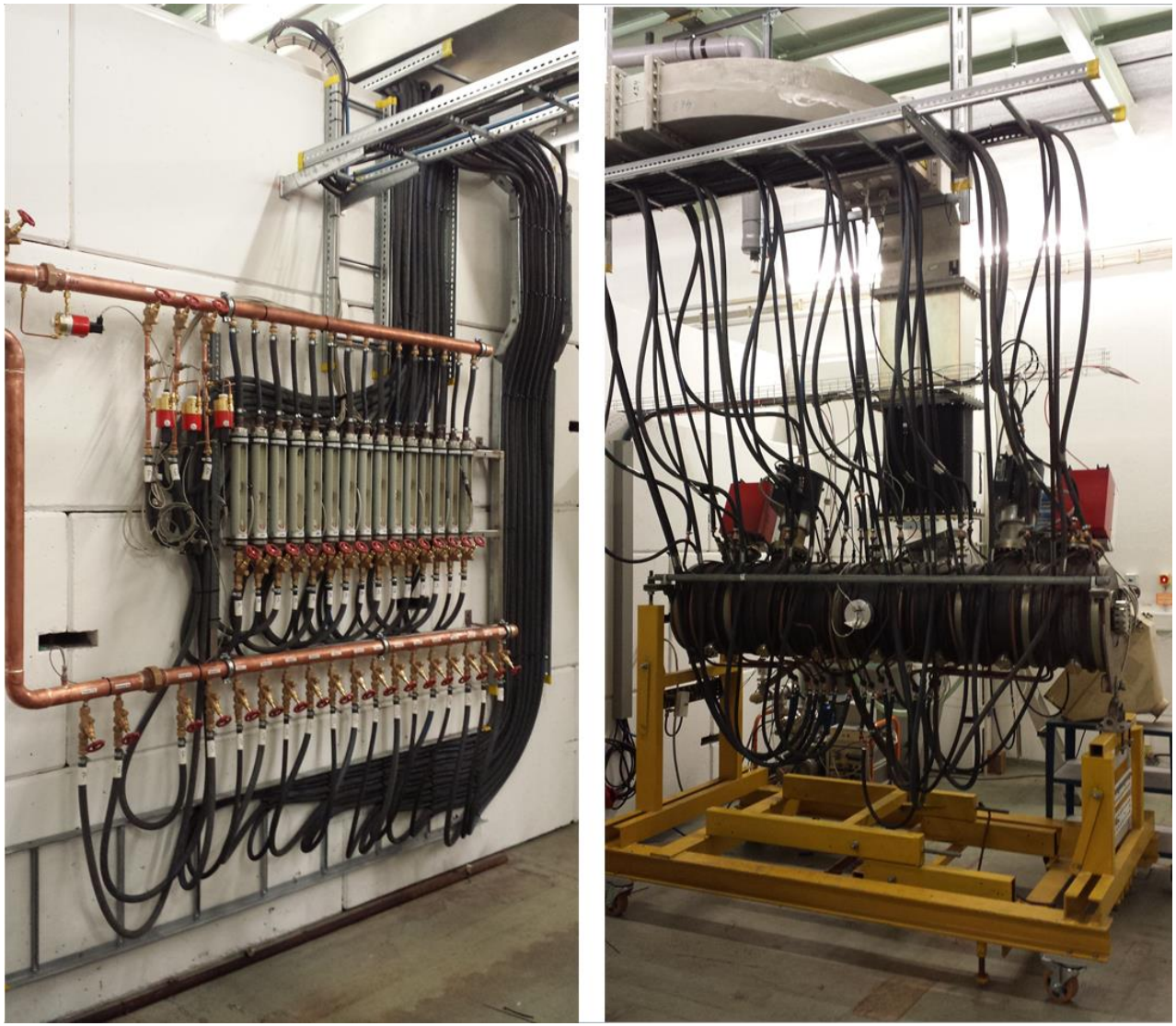
2022: Installation of cavities in tunnel PETRA NW

2023 - shut down: Harmonic system studies in PETRA III

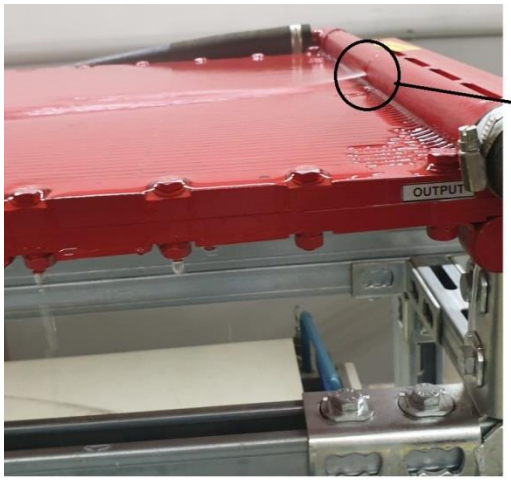
Test transmitter

- Testing cavities, loads, waveguide- components, klystrons

Cavity test bunker



Water leakage at Ferrite-absorbers



Lupe

- We have 60 pcs total, 30 pcs in use. Some build in the late 1990s
- The design of the water flow has been changed several times.
- The separation between flow and return squeezed. Water can flow by.
- Or the separation is done by a disc soldered in.

➢ Leakage sensor and water level monitoring to obtain an estimate of whether access is required.