



Performance of Replica

Hardware review on Replica operation for TRISTAN

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Content

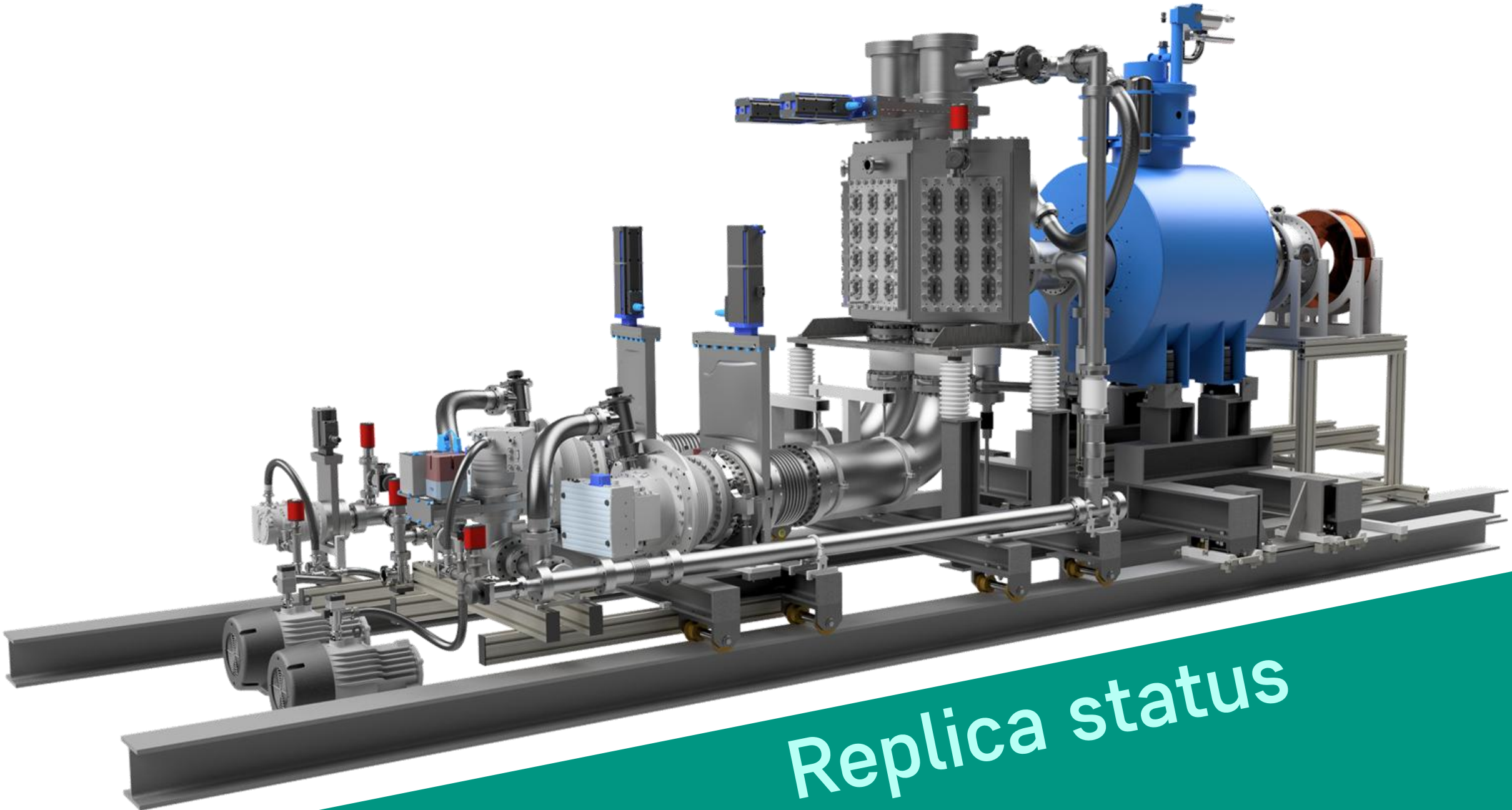
Replica status

- ☐ Vacuum
- ☐ Cooling
- ☐ PAE
- ☐ Slow Control

Way to 460

- ☐ New detector chamber
- ☐ Tower assembly
- ☐ Air Coil upgrade

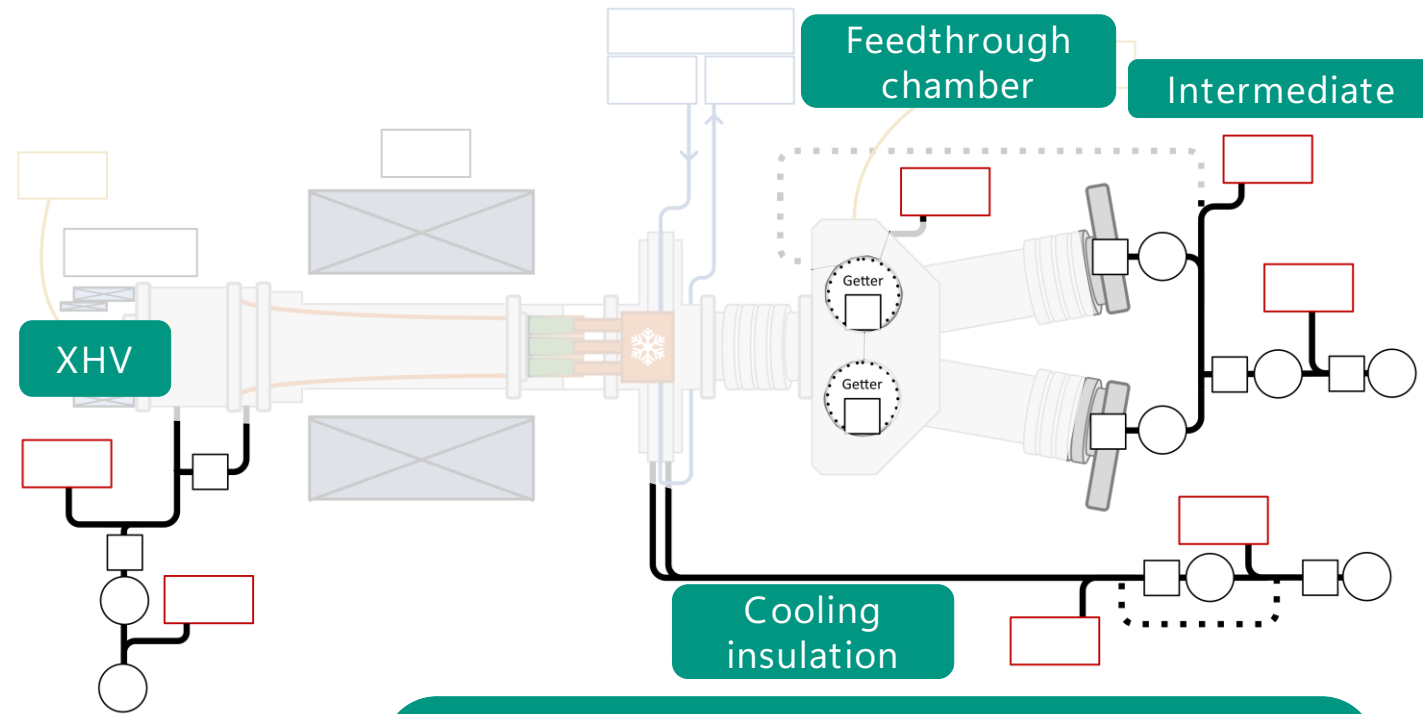
[Replica status display](#)



Replica status

Vacuum setup

- XHV and Cooling insulation
 - HiPace 300 and Scroll pump
- Feedthrough
 - Two MAG W 2200
 - HiPace 300 (intermediate)
 - Scroll pump
 - Two CapaciTorr Z3500 Getter pumps



Nominal operational values

XHV pressure: $7e-8$ mbar

Cooling Insulation pressure: $2e-8$ mbar

Feedthrough chamber pressure: $3e-7$ mbar

Intermediate high vacuum: $4e-6$ mbar

Link to Adei overview

592-RPV-3-1002

582-RPV-4-1720

582-RPV-3-2020

582-RPV-3-1320

Proofed conductance level through detector: ~ 1 l/s within limits

Pressure in Feedthrough chamber in acceptable regime

Additional cleaning before installation at KATRIN for some parts mandatory

Cooling

Group: 590 Tristan Prototype Detector - TRISTAN_Replica - 587Det_IST_CC_MON

ID	Name	Mean	Range
0	ASIC_TEMP_NORTH CC [587-REU-0001-0013]	-16.4	-16.4 to -16.3
1	ASIC_TEMP_SOUTH CC [587-REU-0001-0014]	-16.4	-16.4 to -16.3

Group: 590 Tristan Prototype Detector - TRISTAN_Replica - 587Det_IST_EE_MON

ID	Name	Mean	Range
0	ASIC_TEMP_NORTH EE [587-REU-0004-0013]	-15.4	-15.4 to -15.4
1	ASIC_TEMP_SOUTH EE [587-REU-0004-0014]	-18.4	-18.4 to -18.4

Group: 590 Tristan Prototype Detector - TRISTAN_Replica - 587Det_IST_NN_MON

ID	Name	Mean	Range
0	ASIC_TEMP_NORTH NN [587-REU-0002-0013]	-12.3	-12.3 to -12.2

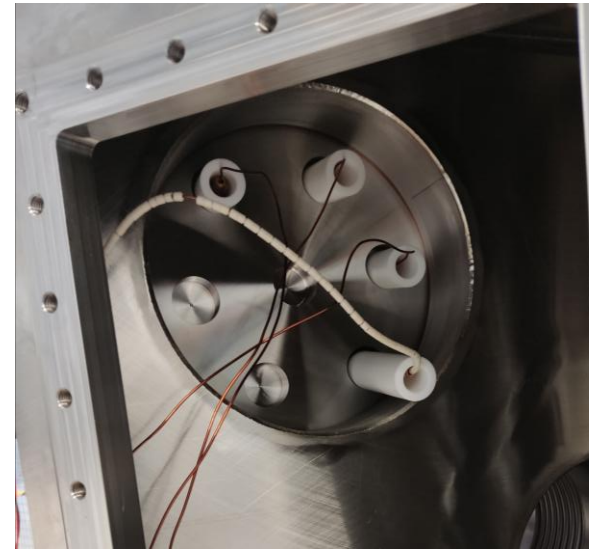
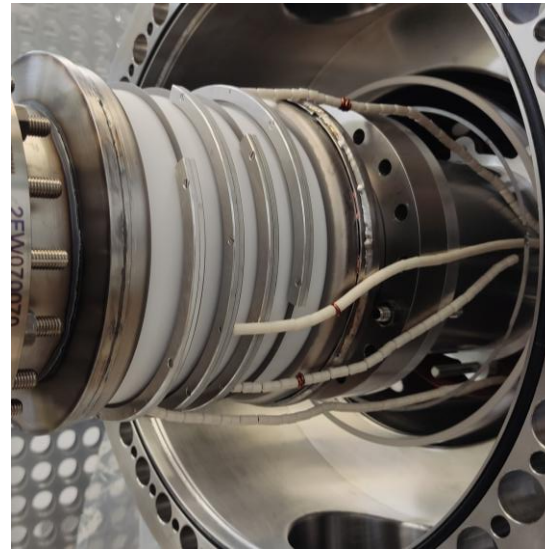
Group: 590 Tristan Prototype Detector - TRISTAN_Replica - 587Det_IST_WW_MON

ID	Name	Mean	Range
0	ASIC_TEMP_NORTH WW [587-REU-0008-0013]	-17.8	-17.8 to -17.8
1	ASIC_TEMP_SOUTH WW [587-REU-0008-0014]	-20.1	-20.1 to -20.1

Works as intended 😊

- Cooling works with expected differences from module
 - ◇ During installation of the final module tower special care needs to be taken for the cooling interface connection
- Insulation vacuum: no issues
- Currently only two of the 4 modules show meaningful data on the SDD temperature diode
- The spare cooling device with less power is used at the replica in the moment
- The larger one came back from manufacture as we observed some malfunction

NEC PAE HV

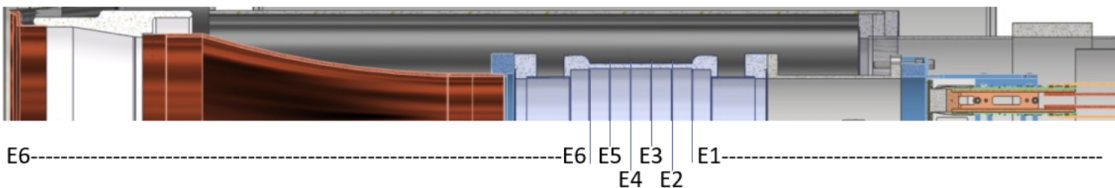


- Recent development:
 - We connect the individual drift stages to wires which are guided to ambient air
 - Flexibility on resistors on air for fine-tuning voltage steps
- Reached pressures for this setup $\sim 5\text{e-}7$ mbar (with 4 detectors installed)
 - Vacuum peaks occur overnight (likely from GlenAir-feedthroughs) – maybe a temperature sensitive leak but no effect on HV performance

Large
performance
benefit having
the resistors
outside

NEC PAE HV

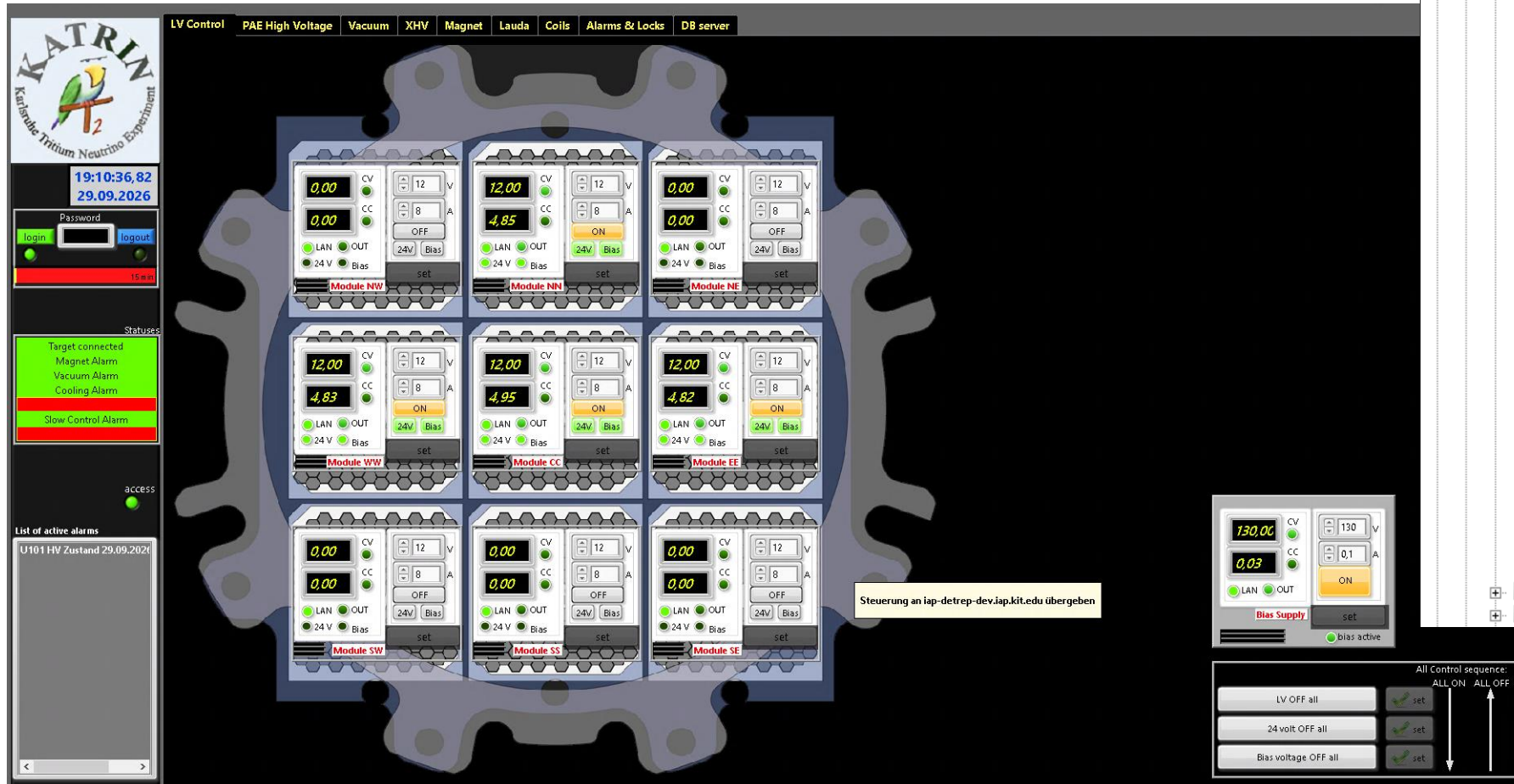
desired max. Voltage U_NEC (kV)	20		Calculations:	
applied Voltage U_HV (kV)	22,353	0,10	Total resistance of chain	170
Voltage U_NEC (kV)		0,089	Total resistance with pre-resistor	190
Pre-resistor (MΩ)	20		Chain current(kV/MΩ = mA)	0,11765
Part	Resistor (MΩ)	Stage		
E1-E2	30	5		
E2-E3	30	4	Max voltage diff. (E1-E5) (kV):	14,12
E3-E4	30	3	Max voltage diff. (E1-E4) (kV):	10,59
E4-E5	30	2	Pre-resistor compensation factor	1,118
E5-E6	50	1		
Electrode	Potential (kV)	HV steps (kV)		
E1 (NEC tube (detector))	20,00	3,53		
E2 (Ring 4)	16,47	3,53		
E3 (Ring 3)	12,94	3,53		
E4 (Ring 2)	9,41	3,53		
E5 (Ring 1)	5,88	5,88		
E6 (Ground)	0,00	0		



- [NEC chain calculator](#)
- [Elog-153](#)
- Tests without installed detectors
- No more stability problems due to HV on NEC tube rings
 - ⬡ HV power supply steps out with a falsy state
 - ⬡ Cable rating (12kV) limits performance for some configurations

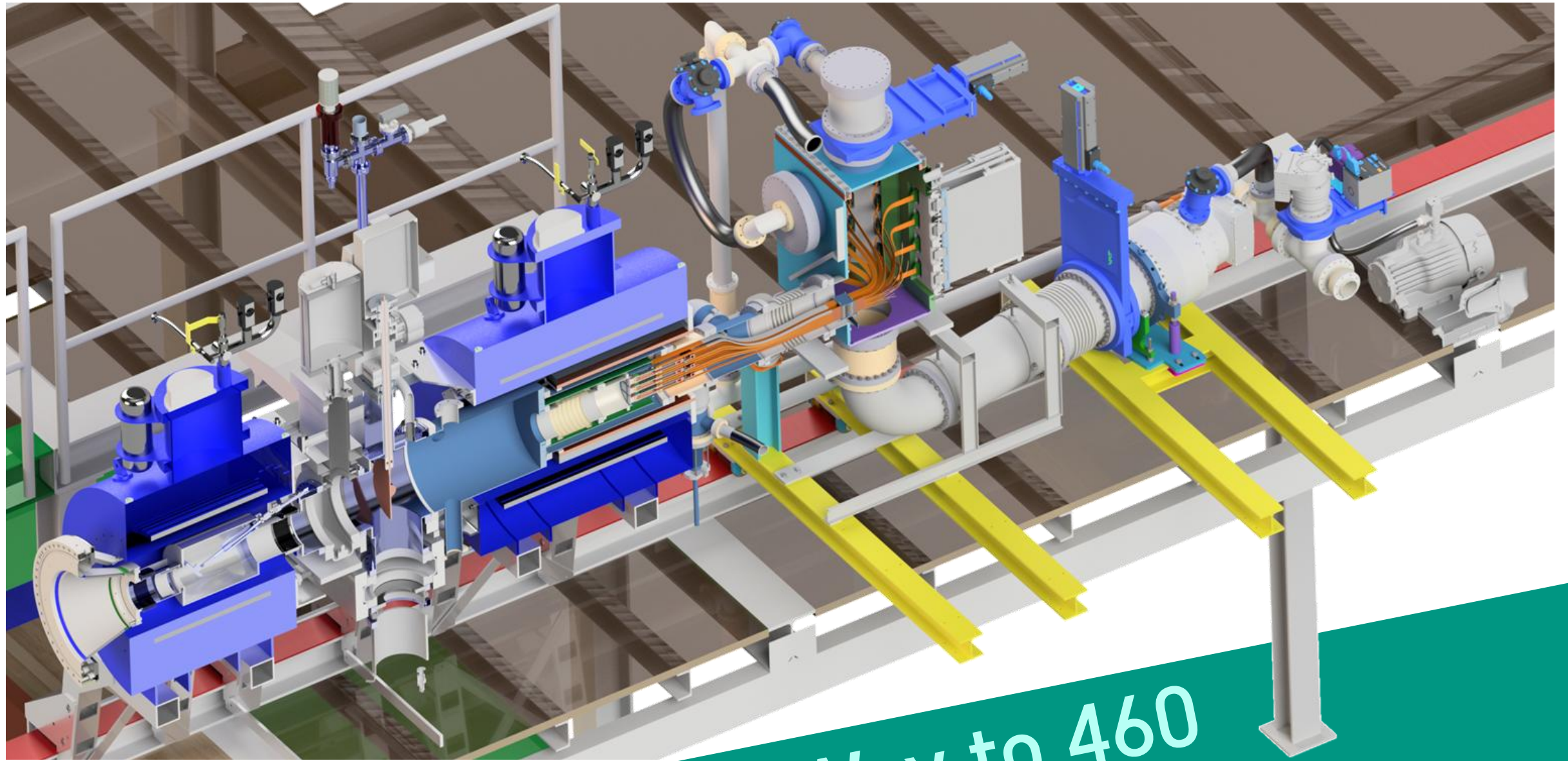
Successful operation of NEC-tube PAE with stable operation (>24h) with ≥ 20 kV post-acceleration in different resistor configurations

Slow Control



Info	Search	{Source Tree}
Export	Aggregator	Plot
TRISTAN_Replica		
587_IST		
587_SOLL		
587Det_IST_CC_MON		
DET_TEMP CC [587-REU-0001-0012]		
ASIC_TEMP_NORTH CC [587-REU-0001-0013]		
ASIC_TEMP_SOUTH CC [587-REU-0001-0014]		
V_D CC [587-REU-0001-0015]		
V_R1 CC [587-REU-0001-0016]		
V_IGR CC [587-REU-0001-0017]		
V_RX CC [587-REU-0001-0018]		
V_BF CC [587-REU-0001-0019]		
V_SSS CC [587-REU-0001-0020]		
V_BC CC [587-REU-0001-0021]		
Vref_TEMP_ADC CC [587-REU-0001-0022]		
I_IO CC [587-REI-0001-0001]		
I_D CC [587-REI-0001-0002]		
I_SSS CC [587-REI-0001-0003]		
I_IGR CC [587-REI-0001-0004]		
I_R1 CC [587-REI-0001-0005]		
I_RX CC [587-REI-0001-0006]		
I_BC CC [587-REI-0001-0007]		
I_BF CC [587-REI-0001-0008]		
TEMP CC [587-RTP-0001-0001]		
IOUT CC [587-REI-0001-0009]		
VOUT CC [587-REU-0001-0001]		
I IN CC [587-REI-0001-0010]		
V IN CC [587-REU-0001-0002]		
Status Word CC [587-CHN-0001-0006]		
Status Byte CC [587-CHN-0001-0007]		
587Det_IST_CC_SET		
587Det_IST_EE_MON		

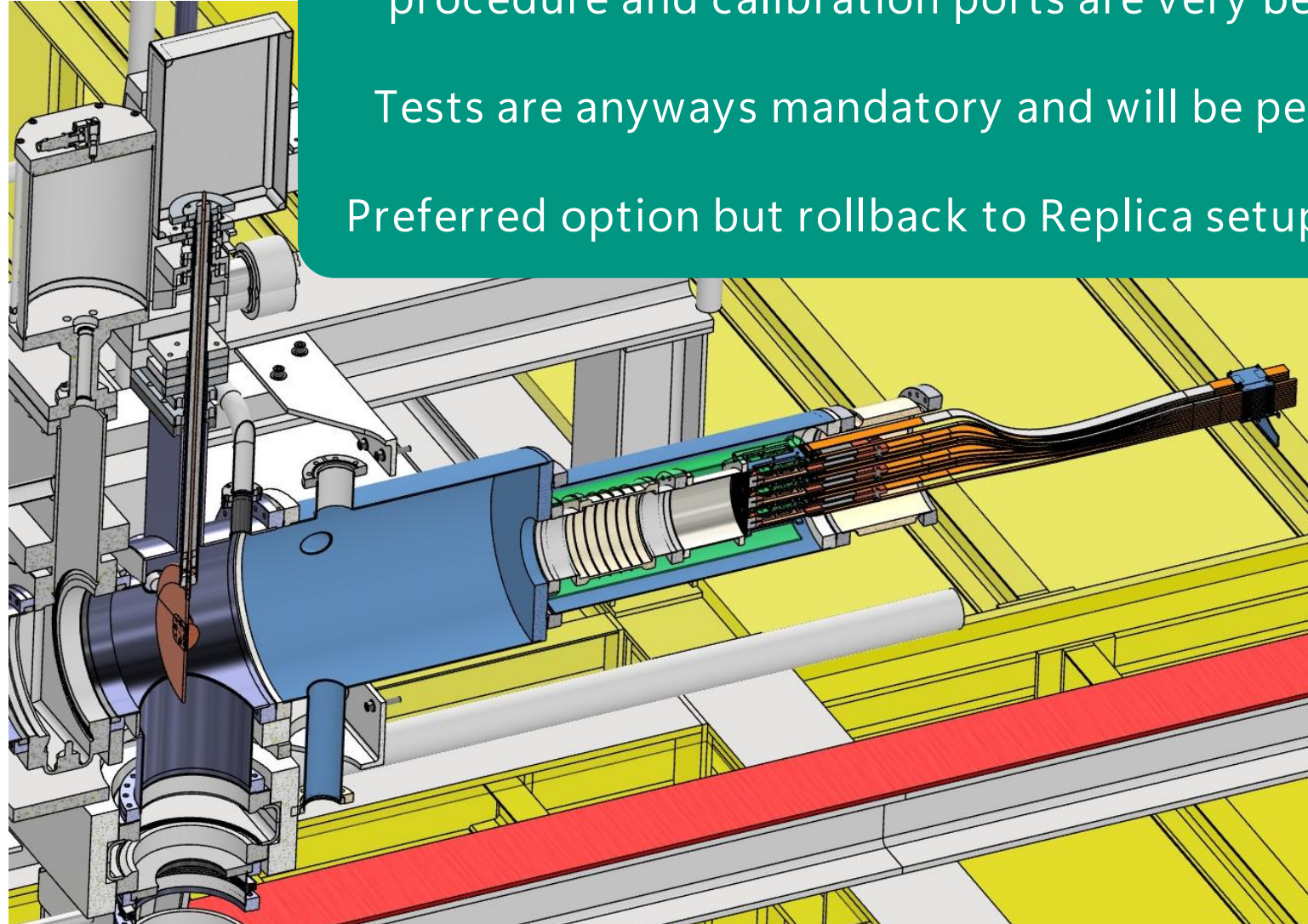
- Slow Control and data storage to ADEI works as intended
- Bias parameters (VR1, VRX, VBC, VBF, VIGR, ...) are set via script individually for each detector



Way to 460

New detector chamber

- ◆ Initial problems on inner surface conditions – likely problems with water content on surface and HV issues
- ◆ Two times surface treatment within the last weeks to reduce surface roughness
- ◆ Currently freshly cleaned and vacuum tests about to start
- ◆ After measurements with the 4d Tower: HV tests with NEC and new chamber planned (no detector)

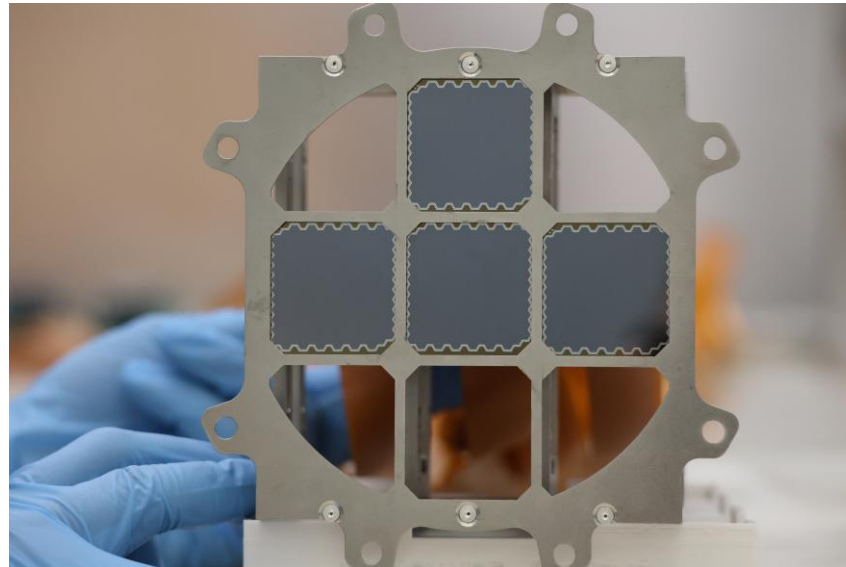
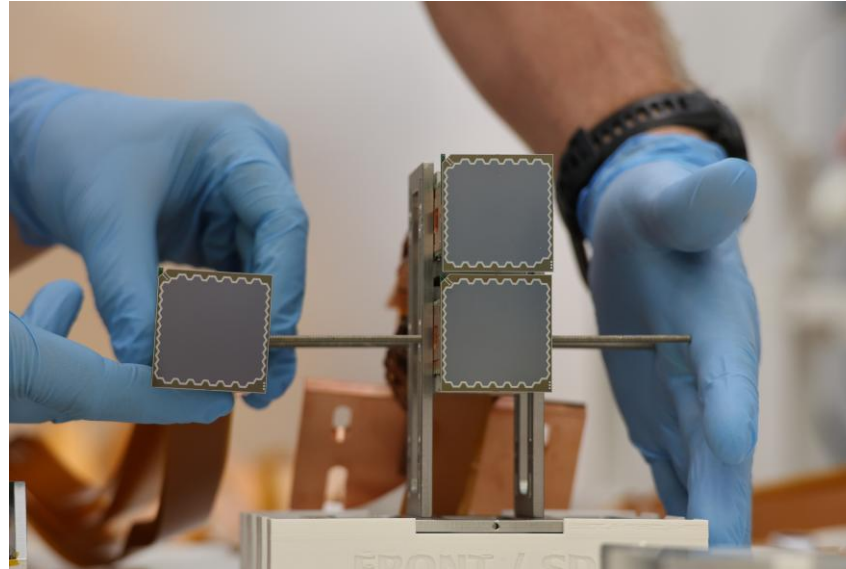
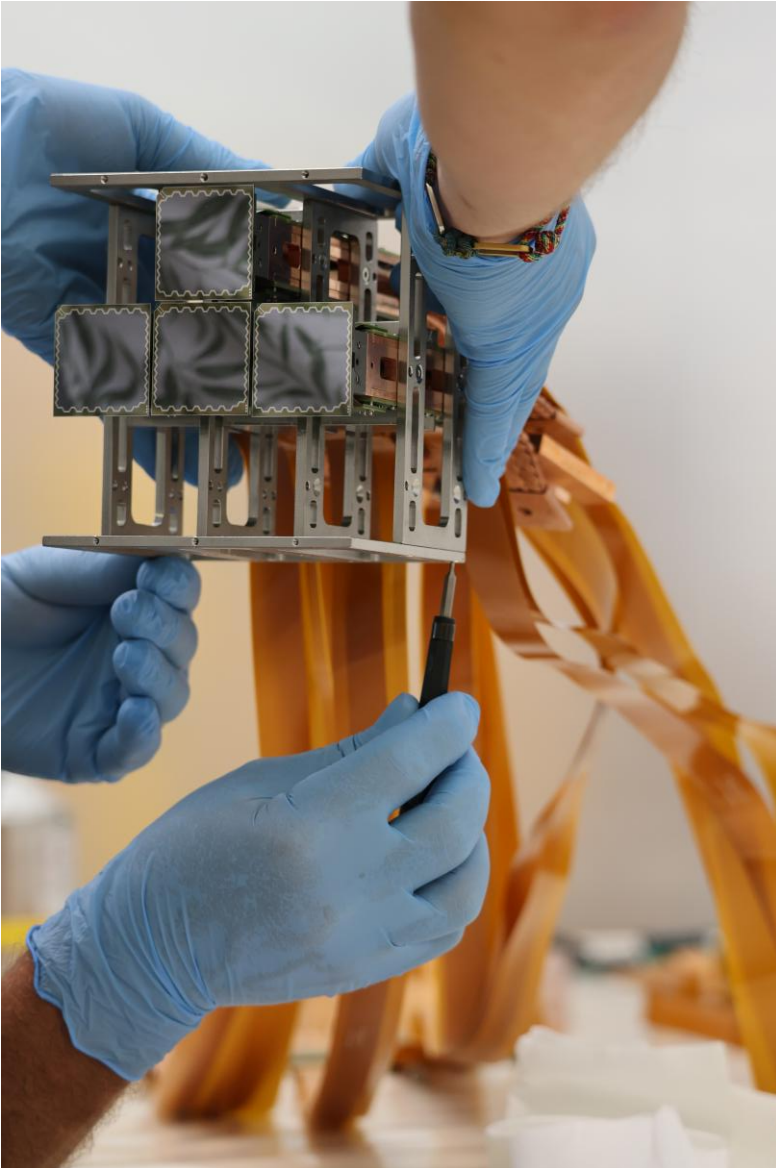


Not yet ready but improvements regarding installation procedure and calibration ports are very beneficial

Tests are anyways mandatory and will be performed

Preferred option but rollback to Replica setup possible

Tower assembly



- Cleanroom tent at 602 is set up
- Was used for 4d-Tower mounting
- Final cleaning once parts are deinstalled from Replica
- New screws already cleaned in stock
- Guiding questions:
 - ◊ When should arrive the final modules at KIT?
 - ◊ Store them fully assembled as tower?

The Replica team supports the timely retrofitting of the KATRIN detector system to integrate the TRISTAN modules

Thanks to all involved:

Luisa, Steffen, Alex J., Markus, Monika, Jörg and Team, Thomas Th., Roman, Fiona, Norwin, Woosik, Hendrik, Michael, Jürgen, Christian, Thomas H. and everyone I might forgot 😊