France@FAIR:
Ring RF at FAIR

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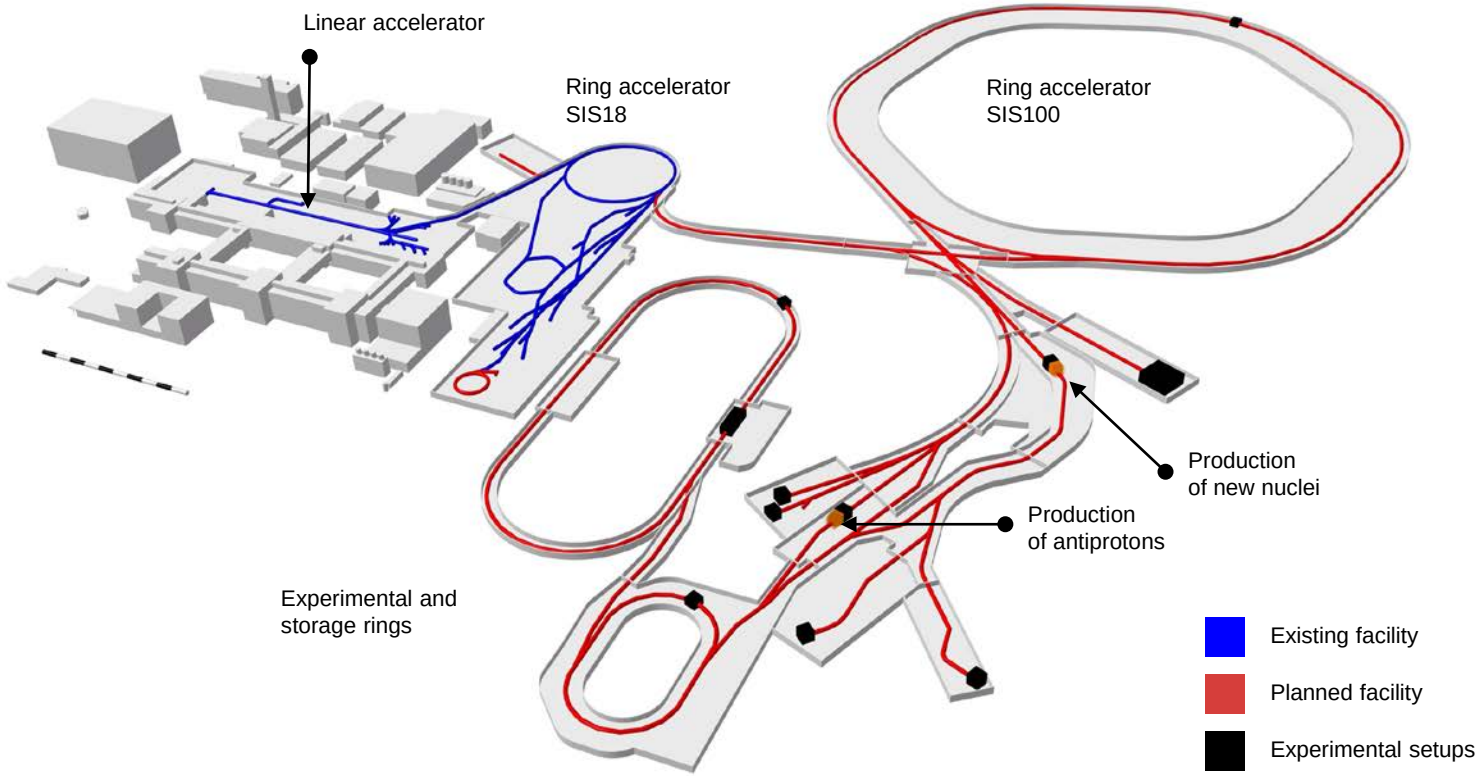
FAIR



Graph: GSI/FAIR

Ring RF Cavities for FAIR
Example: SIS18 h=2 System

SIS18 h=2 cavities
(tetrode power amplifiers on top)

Platform for SIS18 h=2 power supplies (2nd floor),
mains distribution (1st floor),
and oil cooling system (ground floor)

LLRF racks for one unit of the
SIS18 h=2 system

Ring RF Cavities for FAIR

Ring	RF System	Frequency Range [MHz]	Voltage per Cavity [kV]	Duty Cycle	Length	Qty
SIS18 Upgrade	Ferrite cavities, h=4 Accel. h=2 Bunch Compression	0.85 ... 5.5 0.43 ... 2.8 0.8 ... 1.2	16 13.3 40	100% 100% 0.05%	3 m 1.2 m ≈1 m	2 3 1
SIS100 **2.8.4**	Accel. h=10 (Ferrite) Bunch Compression Barrier Bucket Long. Feedback	1.1 ... 3.2 0.310 ... 0.560 broadband broadband	20 40 2 x 15 12...15	100% 0.05% 20% 100%	3.0 m 1.2 m 1.3 m 1.3 m	14 9 2 2
CR **2.5.4**	Debuncher (RIB, anti-protons, incl. Bucket Generation)	1.10...1.25 (1.50) (pbar)	Pulsed: 40 (21) CW: 2 (1.35) (pbar)	0.06%	1.125 m	5
CRYRING	Existing Swedish system	0.135...2.4	0.15...0.35	100%	≈3 m	1
ESR	Ferrite cavity, h=2 Barrier bucket cavity	0.85 ... 5.5 broadband	5 0.6 (2 pulses)	100% 50%	1.68 1.13	1 2 in 1

Ring RF Cavities for FAIR

SIS100 Acceleration
(RI Research Instruments GmbH)

SIS100 Bunch Compression
(Aurion Anlagentechnik GmbH)

CR Debuncher
(RI Research Instruments GmbH)

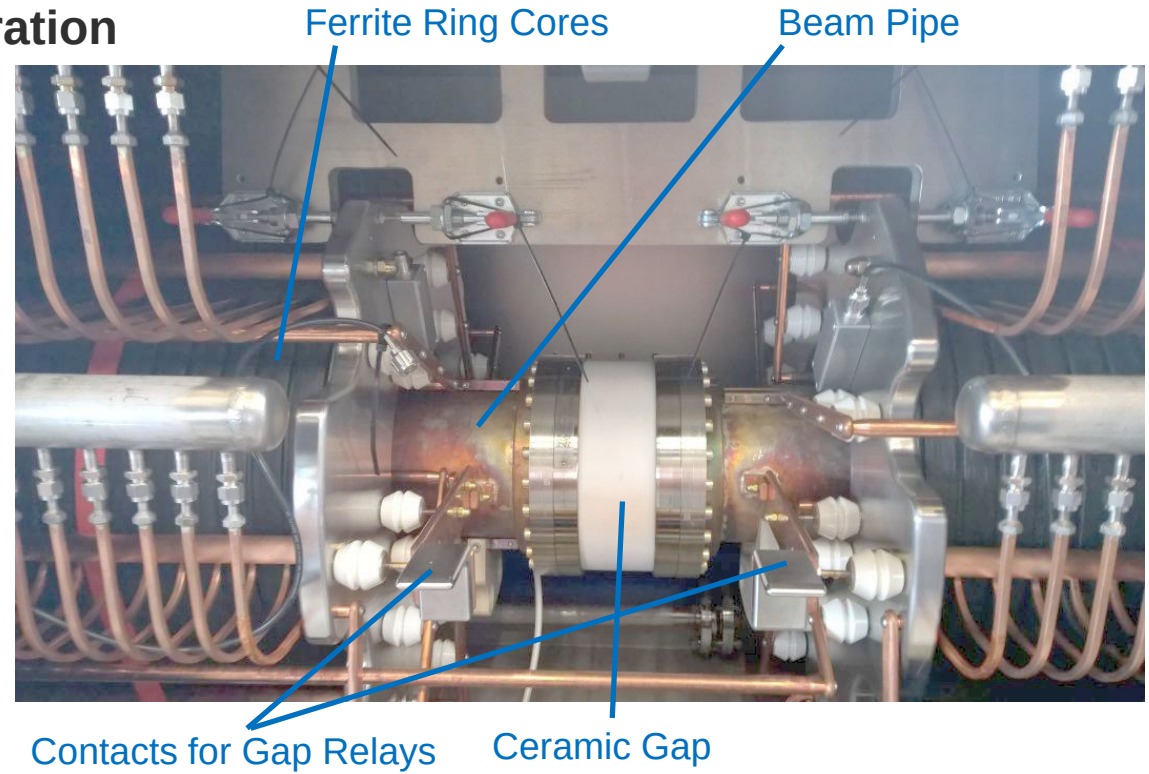
Properties of Ring RF Systems for FAIR

- Ramped frequency, ramped amplitude, ramped phase
- Fast frequency sweep, large frequency range
- Power amplifier as part of the cavity, no 50 Ω impedance matching between power amplifier and cavity (only from driver amplifier to power amplifier)
- Cavities loaded with ferrite or magnetic alloy (MA) ring cores
- Typically, tetrode power amplifiers are used due to power and frequency range (and radiation hardness for Ring RF cavities)
- Driver amplifier stages (solid state) needed to feed power amplifiers

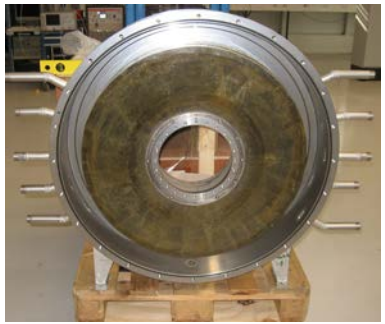
Components: Cavity

Example: SIS100 Acceleration

- 1.1 to 3.2 MHz
- 20 kV gap voltage

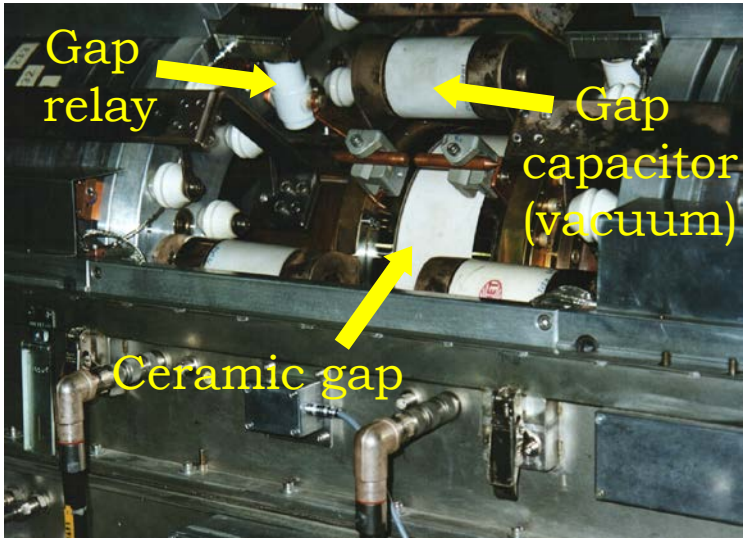


Example: MA Ring Core for SIS18 h=2 Cavity

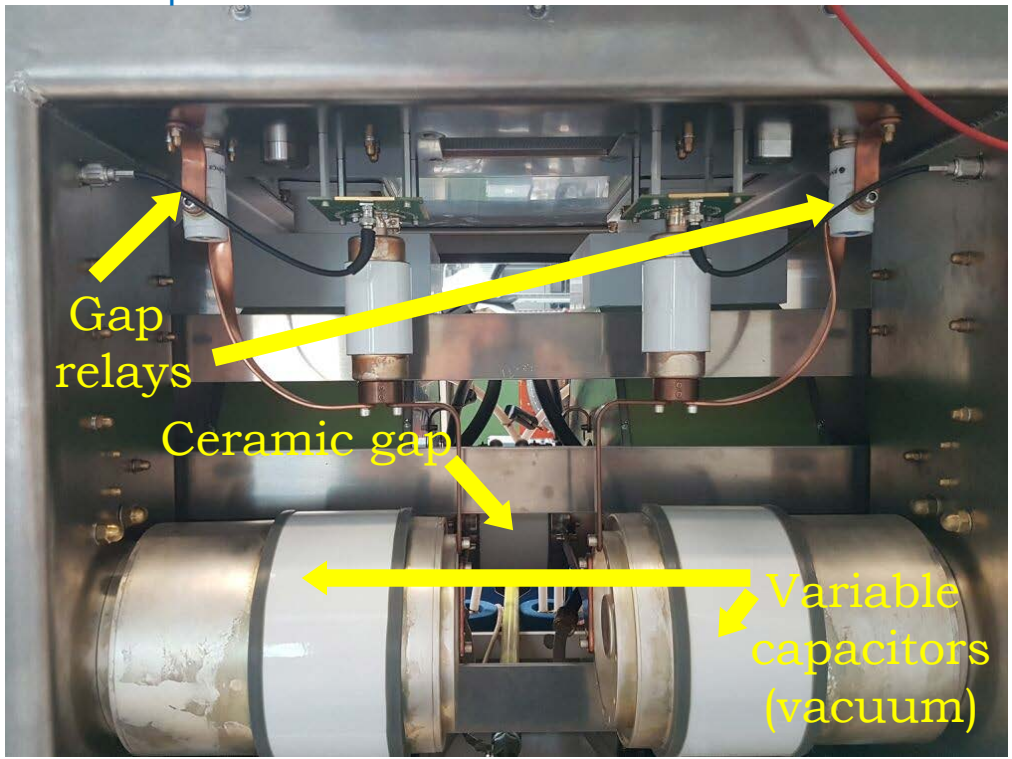


Components: Cavity

Example: SIS18 Ferrite Cavity



Example: CR Debuncher



Components: Tetrode Amplifiers

Type	Anode Dissipation (std. spec.)	Used in
TH 555 ASC	250 kW	SIS100 BC, CR DB
RS 2054 SKSC	120 kW	SIS18 ferrite cav., SIS18 BC, SIS100 Accel
TH 537 SC	300 kW	SIS18 MA cavity (h=2)

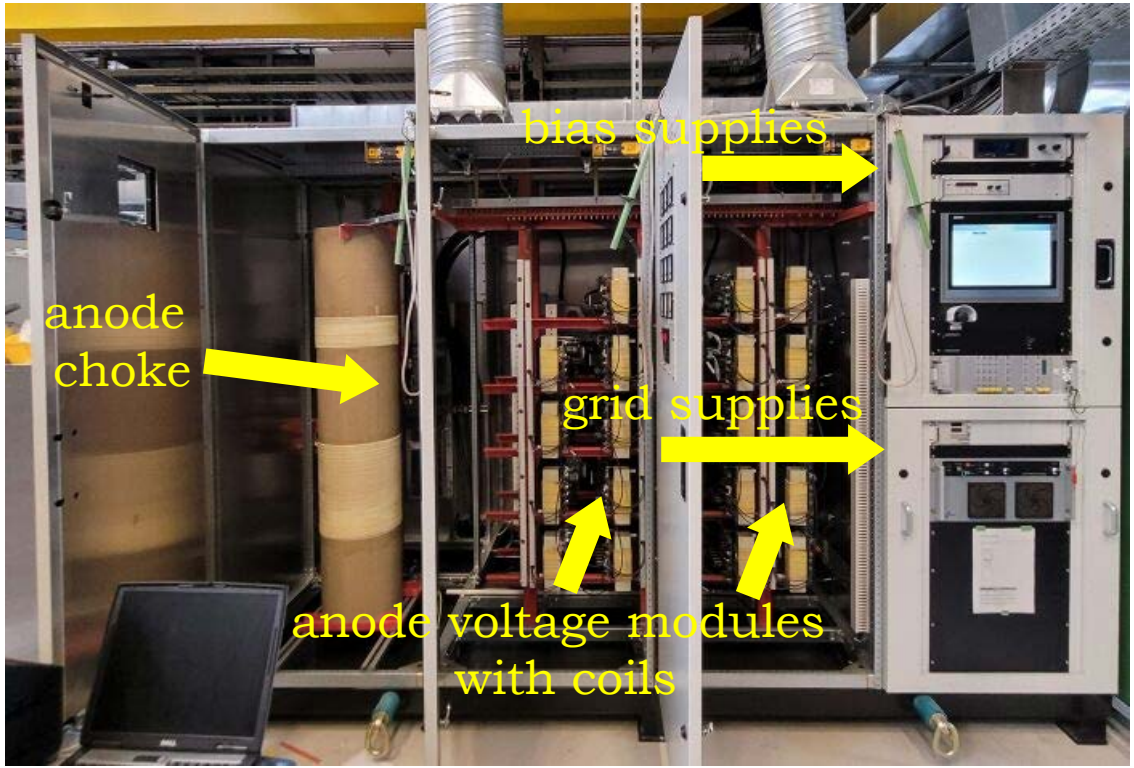
SIS100 Bunch Compressor Tetrode Amplifier (anode)

CR Debuncher Tetrode Amplifier (anode)

Components: Power Supply Units

Example for Ring RF: PSU for SIS100 Acceleration System

- 400 V mains, 220 kW
- transformer + SMPS principle
- up to 15 kV DC anode voltage
- up to 200 A bias current



Components: Solid-State Power Amplifiers (Driver Stage)

Example for Ring RF: Modular Power Amplifier

- 500 W per module
- 300 kHz … 6 MHz
- CW
- RF combiner allows combination of 2 or 4 modules

Storage Depot: Cavities

Storage Depot: PSUs

Power Supply Units for SIS100 Accelerating Systems

- Power supplies
- PLC

Storage Depot: PSUs

Power Supply Units for SIS100 Bunch Compressor Systems

- Power supplies
- PLC

Storage Depot: LLRF Racks

Outlook to Future Needs

- **Technology will be similar**
- **Commercial off-the-shelf components *and* industrial partners for joint developments**
- **Next systems to be realized**
  - SIS100 Barrier Bucket system, SIS100 Longitudinal Feedback system (4 identical cavities)
- **Challenges**
  - Reliability (6000 operating hours per year, 24/7)
  - Maintenance (must be simple in order to reduce presence in radiation-controlled area and to reduce repair time, must be possible by GSI/FAIR staff)
  - In most cases customer-specific development required
  - Long-term availability of spare parts (at least 8 years, 30 years of operation not unusual)
    – commercial product life cycles are often too short for us.
  - EMC
  - Radiation hardness
  - More automation (measurement technology, data acquisition – also post-mortem, calibration, etc.)
  - Control system integration (FESA, PLC, etc.)

Thank you for your attention!

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Graph: ion42/FAIR