



research
instruments

Cavity fabrication/testing

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AMICI ETIAM Workshop on Vertical SRF Cavity Testing
DESY, September 14-15, 2022



Facts and figures

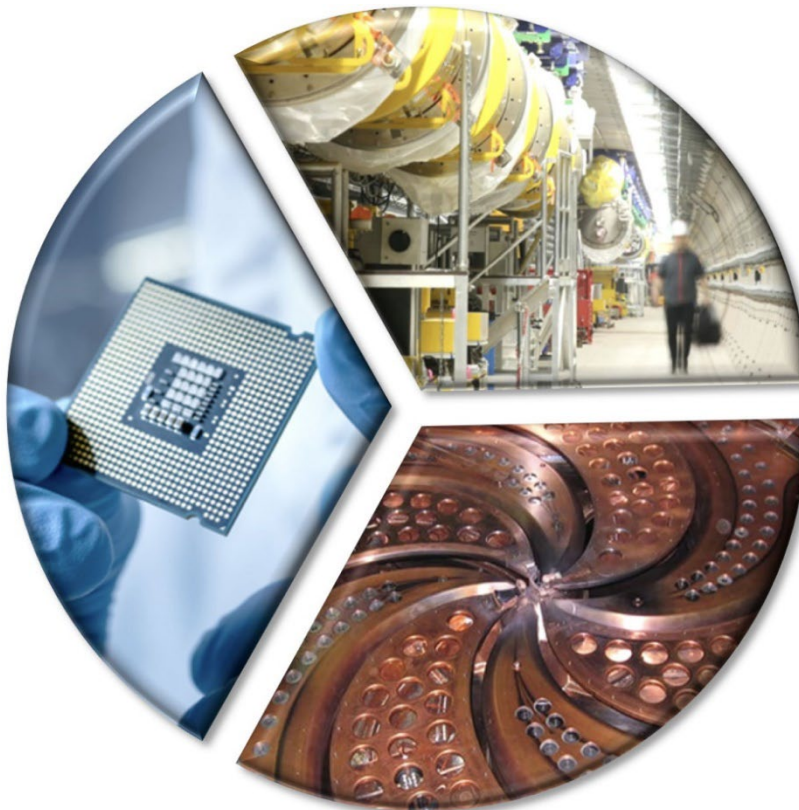
- Founded in 2009
- Employees 320
 - ca. 130 physicists, engineers
 - ca. 150 manufacturing specialists
- Annual revenue: 50-60 million EUR
- Established with the core team of ACCEL Instruments GmbH (1994-2009) and of INTERATOM/Siemens
- Management holds significant equity stake in the company which is majority owned by Bruker EST, Inc.



Our customers

Industry:

- EUV tools
- Components for EUV lithography machines



„Big Science“:

- Superconducting RF cavities and accelerator modules
- Fusion equipment
- Normal conducting RF cavities, RFQ's, linacs
- Photon instrumentation

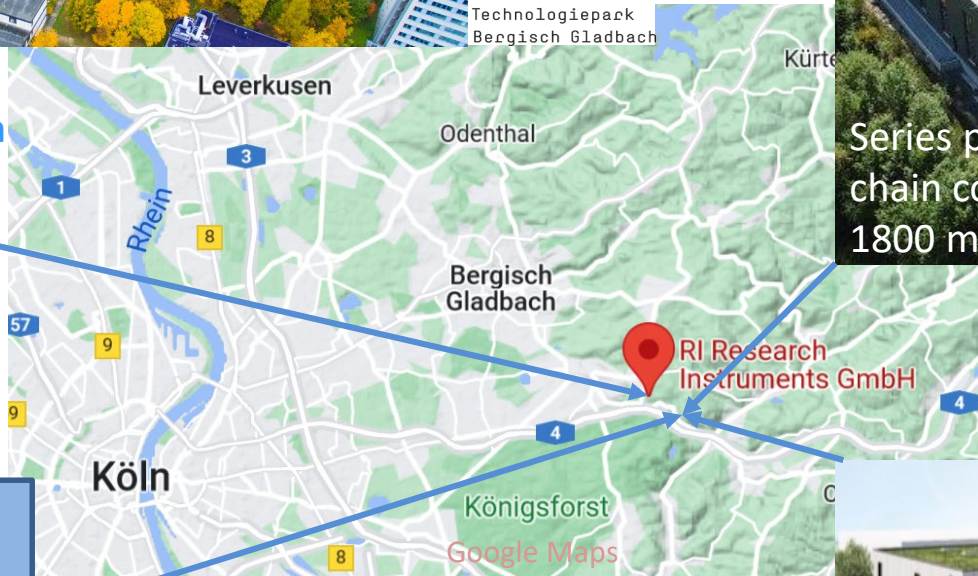
Medical & pharma:

- Components for Varian proton therapy cyclotrons
- Design of SRF accelerator for Mo99 production

Our production sites at Bergisch Gladbach



**RI site at Technology
Park Bergisch Gladbach
(20 km from Cologne)**



Series production for supply
chain components (2022),
1800 m²

**New additional RI site
“Obereschbach”
Bergisch Gladbach**



New „Manufaktur“ (2023),
5000 sqm

TBD:

- extended production facilities (>2023)
- New office building (>2023)

The RI manufactory in Bergisch Gladbach

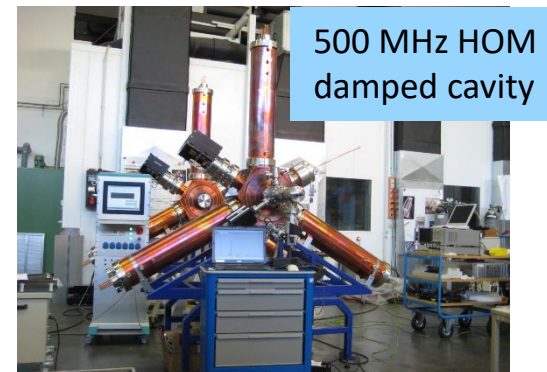
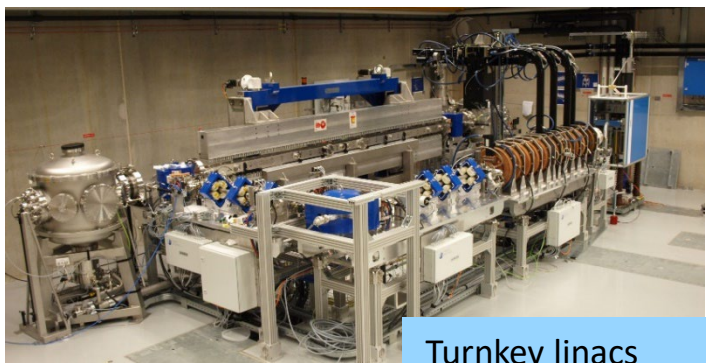
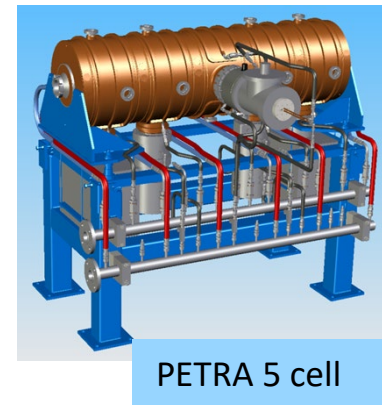
A one-stop-shop on 6000 m²



Milling, turning, metal working, electron-beam welding, TIG welding, vacuum brazing, heat treatment
Leak checking, pressure test, RF testing, dimensional control, vacuum, cryogenics, electropolishing, pickling

Normal conducting cavity production

Examples



1.3 GHz 9-cell SRF cavity production

420 cavities for European XFEL
at DESY from **2010 to 2015**

210 cavities for LCLS-II
at SLAC from **2015 to 2018**

168 (+40) cavities for LCLS-II-HE
at SLAC from **2021 to 2024**

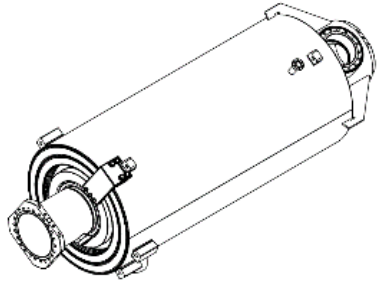
Additional 186 such cavities for various customers since **1995** (DESY, FNAL, Stanford, MESA, PoFEL, STFC, HZDR, SOLEIL, HZB, Ankara University, SINAP, Dalian)

- **> 1000 pcs 1.3 GHz 9-cell cavities** produced so far in our premises
- Pure niobium, metal working, electron beam welding, electropolishing, ISO 4 clean room

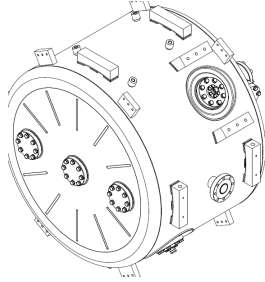


SRF cavities production at RI

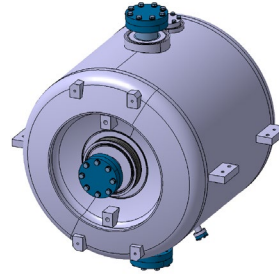
89x HB ESS for STFC
704 MHz



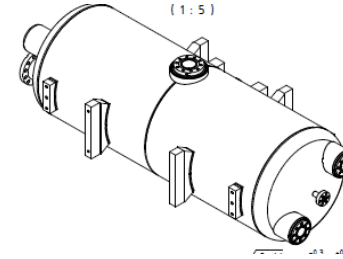
2x Re-buncher GSI/HIM
217 MHz



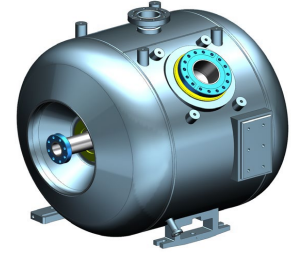
6x+47x MYRRHA
351.75 MHz



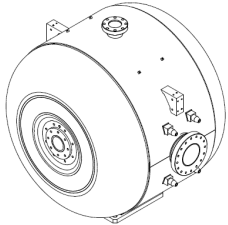
14x LB, 15x HB SARAF
176 MHz



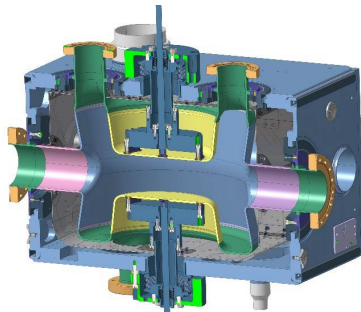
3x SSR2 PIP-II



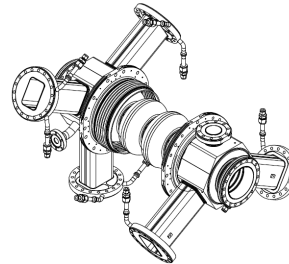
6x SSR2 for VNT/IBS
325 MHz



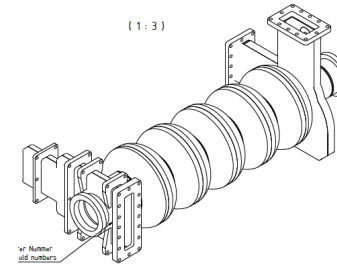
2x+6x DQW CRAB Cavities
400.79 MHz



2x+3x DEMO VSR
1.5 GHz



24x C75 Cavities
1.5 GHz



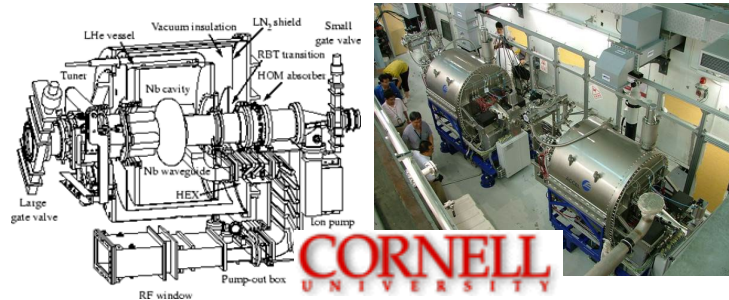
2x SC for Qubits
5 GHz / EP done



Superconducting RF modules

500 MHz (physics design: Cornell University, USA)

2 SRF modules	for NSRRC,	Taiwan
2 SRF modules	for CORNELL,	USA
3 SRF modules	for CLS,	Canada
4 SRF modules	for DLS,	Great Britain
3 SRF modules	for SSRF,	PR China
4 SRF modules	for PAL,	Korea
2 SRF modules	for CNPEM	Brazil



1.3 GHz (Rossendorf / XFEL)

2 SRF modules	for Daresbury,	Great Britain
2 SRF modules	for Ankara,	Turkey
2 SRF modules	for Mainz,	Germany
4 SRF modules	for Polfel,	Poland

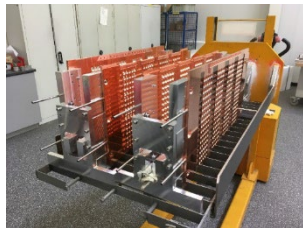
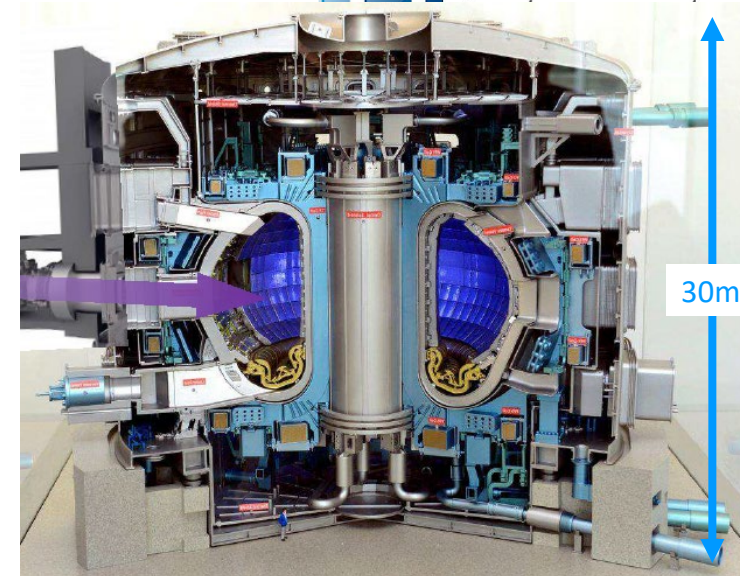


Includes cryogenic distribution system and control electronics, installation and site acceptance testing,
Turn-key superconducting RF modules, ready for beam acceleration

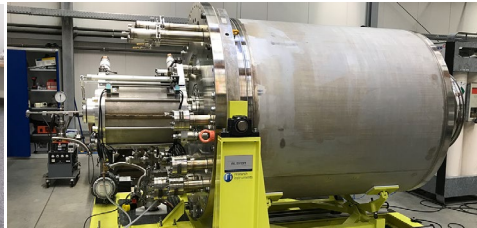
RI components for ITER/fusion

RI produces components for fusion since 2012

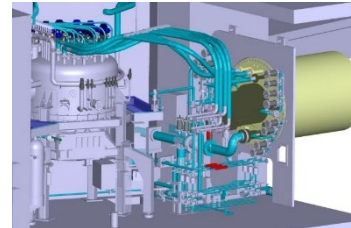
- Grids for neutral beam sources (heating sources and diagnostic beam sources)
- Cryopumps
- Valve boxes and warm regeneration box (WRB) to supply cryopumps with liquid helium and to heat up cryopump up to 500 K for regeneration of cryopumps
- Inner vertical target of divertor (IVT)



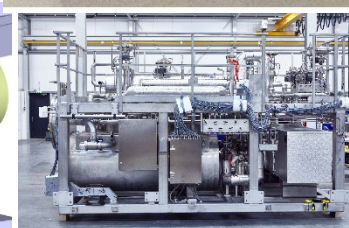
Grids
Beam source:
50 A, 1 MV, 50 MW



Cryopump
3 m length, Ø1,5 m, large all metal
valve for 30 000 open/close cycles



Valve box
23 cryo valves,
oper. 4 K and 500 K



WRB
500 K He gas for
VB/cryopumps



IVT 20 MW/m² @2000C
W monoblocks brazed
to CuCrZr-pipe

Superconducting e- Accelerator

- Solid-state RF-amplifiers (GaN transistors, η ca. 65%)
- 360d/y, 23h/d production
- Goal: Beam on target Q3/2027

Low emittance
DC photoinjector
(30pC, 20ps, 1.3GHz)

5 SRF Modules (Cornell – CBETA)



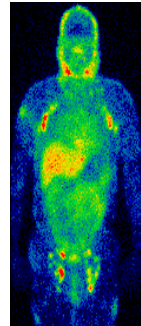
75MeV,
40mA
3MW CW
on target

Mo-100
target

SPECT scan

High levels of
^{99m}Tc in pelvis and
axilla (red)
showing areas of
cutaneous T-cell
lymphoma.

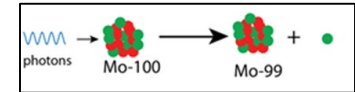
~ 60 million
procedures world
wide p.a.



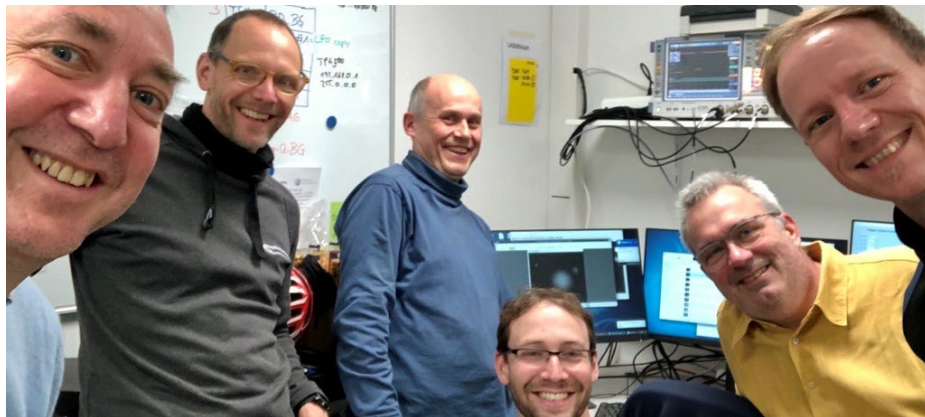
^{99m}Tc
→ 141 keV
(6 hrs)



⁹⁹Mo → ^{99m}Tc
(66 hrs)



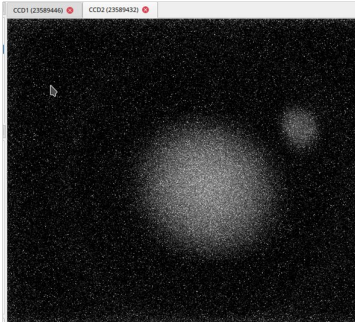
1st Electron beam @ RI beam test facility



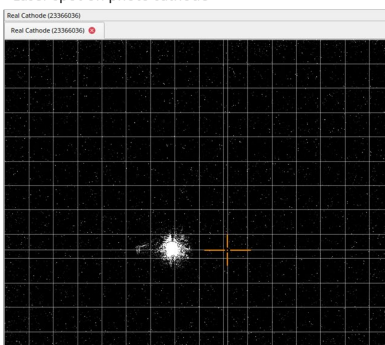
RI has installed a DC photoinjector of the Cornell ERL type at RI

Single bunch charge equivalent to 100mA beam
Duty cycle: 10^{-4}
quantum efficiency of photocathode: 5%

CCD#2
Electron beam on 2nd view screen



Laser spot on photo cathode



Cavity vertical testing requirements

RI Research Instruments GmbH

Pending Projects

Project name (not obligatory)	Frequency	Amount of cavities	Operating temperature	Comment
POLFEL	1.3GHz	2	2K	with tank
DALIAN	1.3GHz	2	2K	naked

Foreseen Projects

Project name (not obligatory)	Frequency	Amount of cavities	Operating temperature	Comment
LHI	1.3GHz	30	2K	naked qualif. and with tank, >2024
other	1.3GHz	1-2 /year	2K	with tank