BINP RF group
at a glance

A. Tribendis, BINP
01/02/2017, CERN
1st collaboration meeting on SRF for FCC

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1. CCDTL for Linac4.

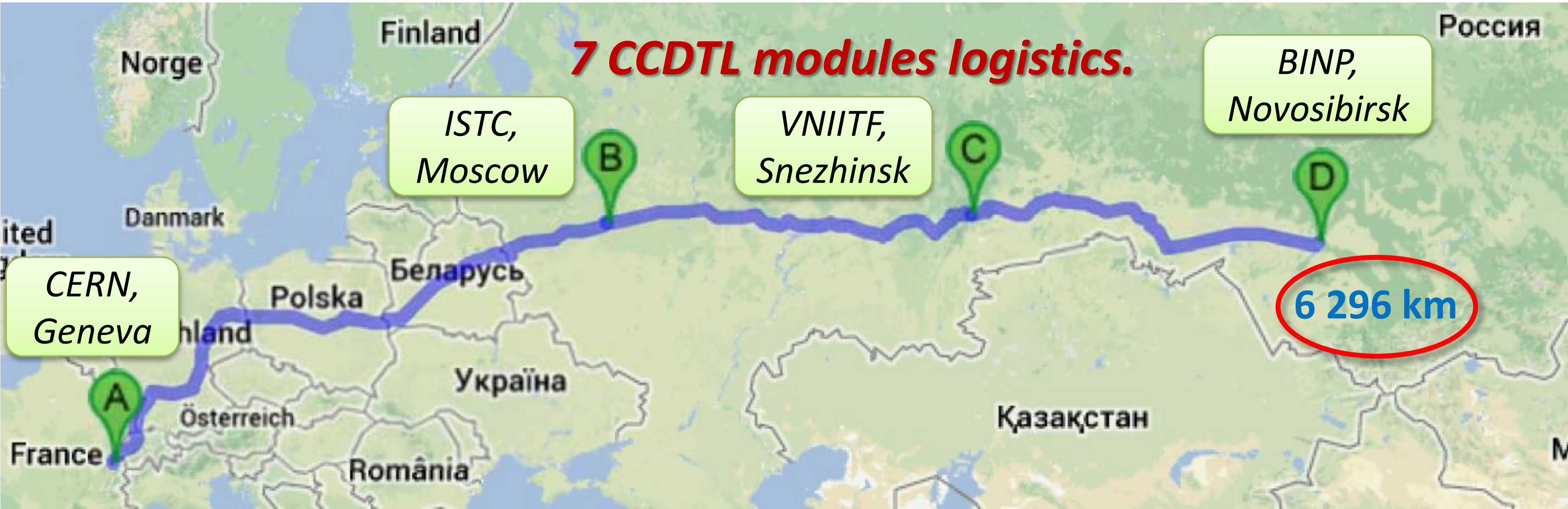
CCDTL for Linac4.

CERN – European Organization for Nuclear Research, Geneva, Switzerland

BINP – Budker Institute of Nuclear Physics of Siberian Branch of Russian Academy of Sciences, Novosibirsk

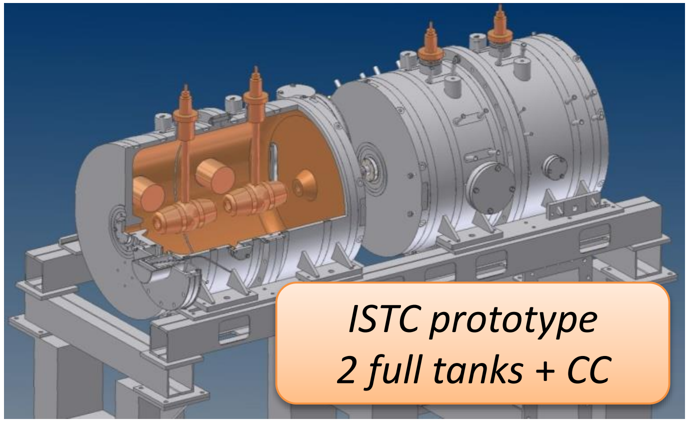
VNIITF – Russian Federal Nuclear Center – Russian Scientific Research Institute of Technical Physics, Snezhinsk

ISTC – International Science and technology Center, Moscow (now moved to Kazakhstan)

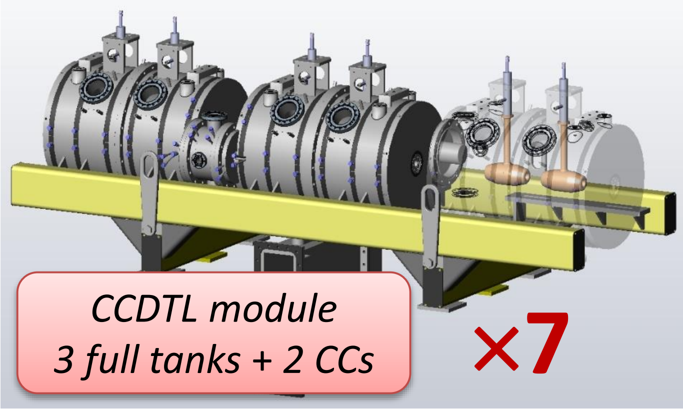


CCDTL for Linac4.

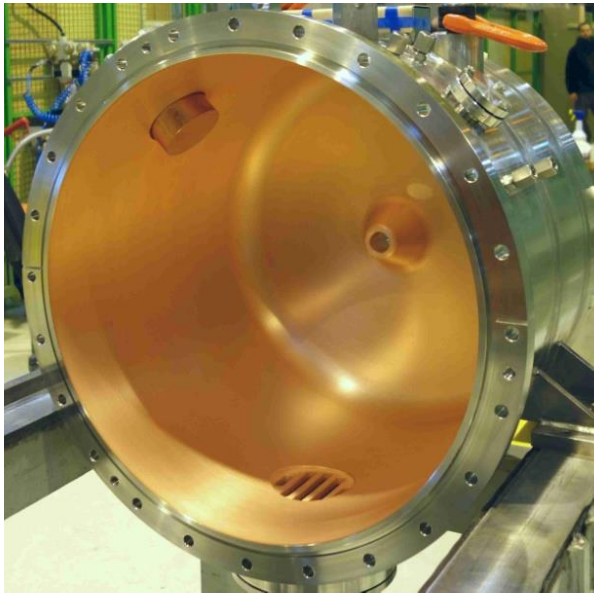
2004	***Start of an ISTC project for the construction of a CCDTL “pre-series” prototype in Russia***
2005 *2006*	*Design and construction of the ISTC prototype* *at BINP / VNIITF*
2007	***Successful high power tests of the ISTC prototype at CERN***



2009	***Start of 2 ISTC project for the construction of the 7 CCDTL modules in Russia***
2010 *2013*	*Design and construction of the 7 CCDTL modules* *at BINP / VNIITF*
2013	***Successful high power tests of the first CCDTL module*** ***at CERN, delivery of the last module to CERN***



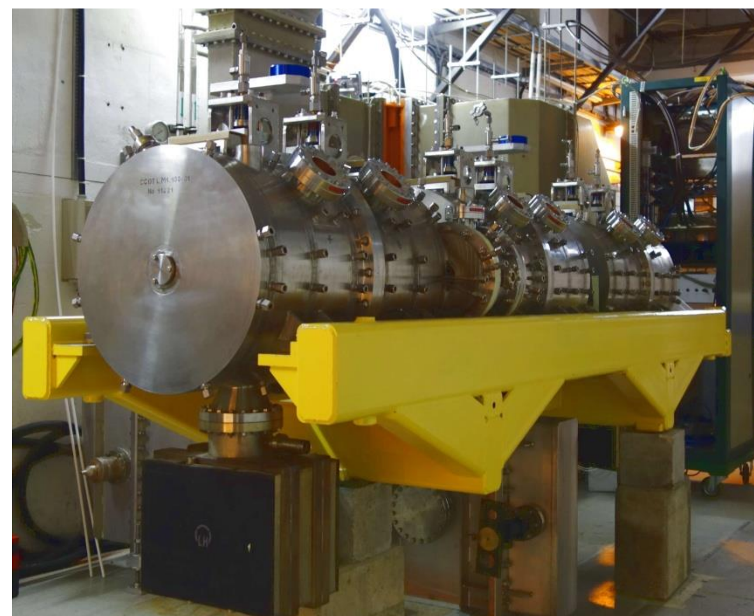
CCDTL for Linac4.



VNIITF

BINP

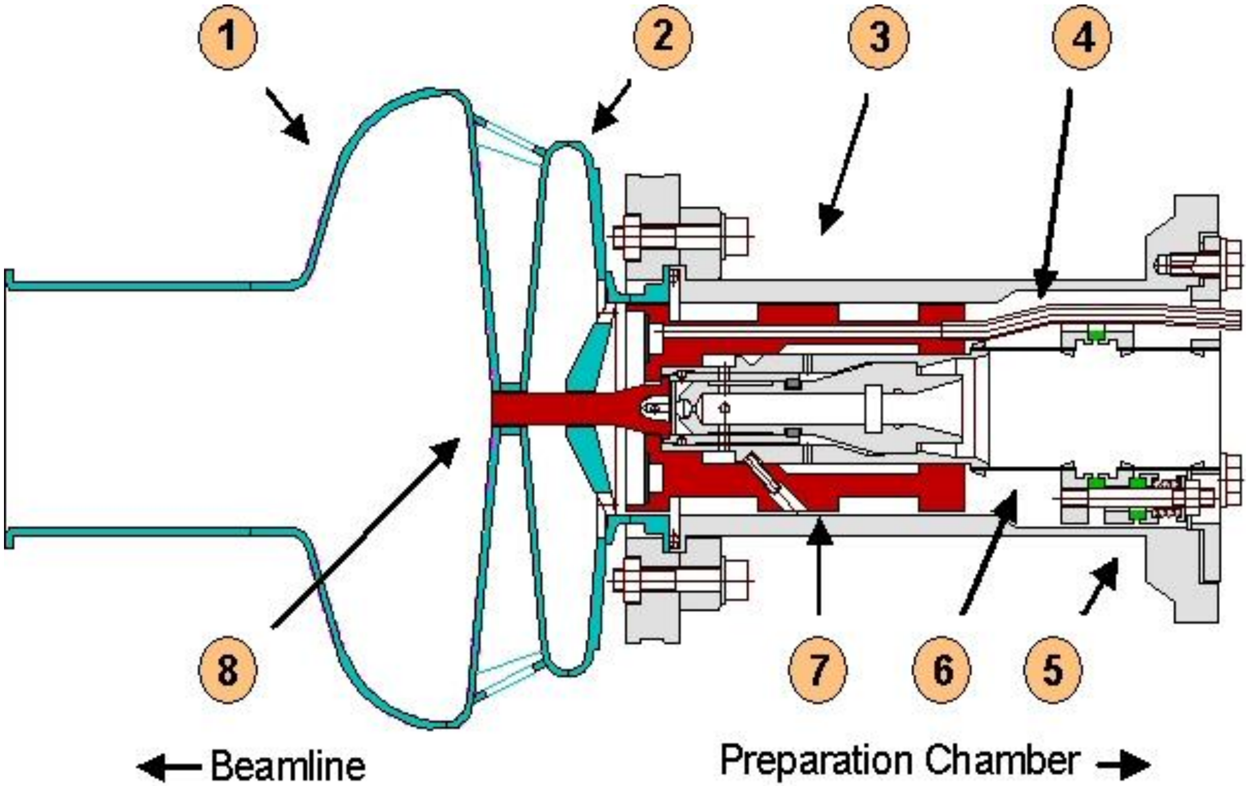
CERN



2. Past SRF activities.

RF superconducting electron photoinjector

A promising option of low emittance, high average current electron source is a CW photo-injector based on a superconducting RF gun. An advanced concept of such injector was worked out in collaboration with Research Center Rossendorf (FZR), Germany. The main feature of the design is an original copper photo-cathode holder inside an SRF Nb cavity. The holder has no thermal contact with the cavity superconducting walls and produces no heat leakage to the LHe bath but is cooled by LN_2. A photolayer of Cs_2Te on a *Mo* substrate is deposited on top of a copper stem in a special preparation chamber and transported to the cathode holder by a manipulator. No vacuum break or cavity warm-up is necessary to change the photo-cathode.



1 – Nb Cavity
2 – Choke Filter
3 – Cooling Insert
4 – LN2 tube
5 – Ceramic Insulation
6 – Thermal Insulation
7 – 3-stage Coax Filter
8 – Cathode Stem

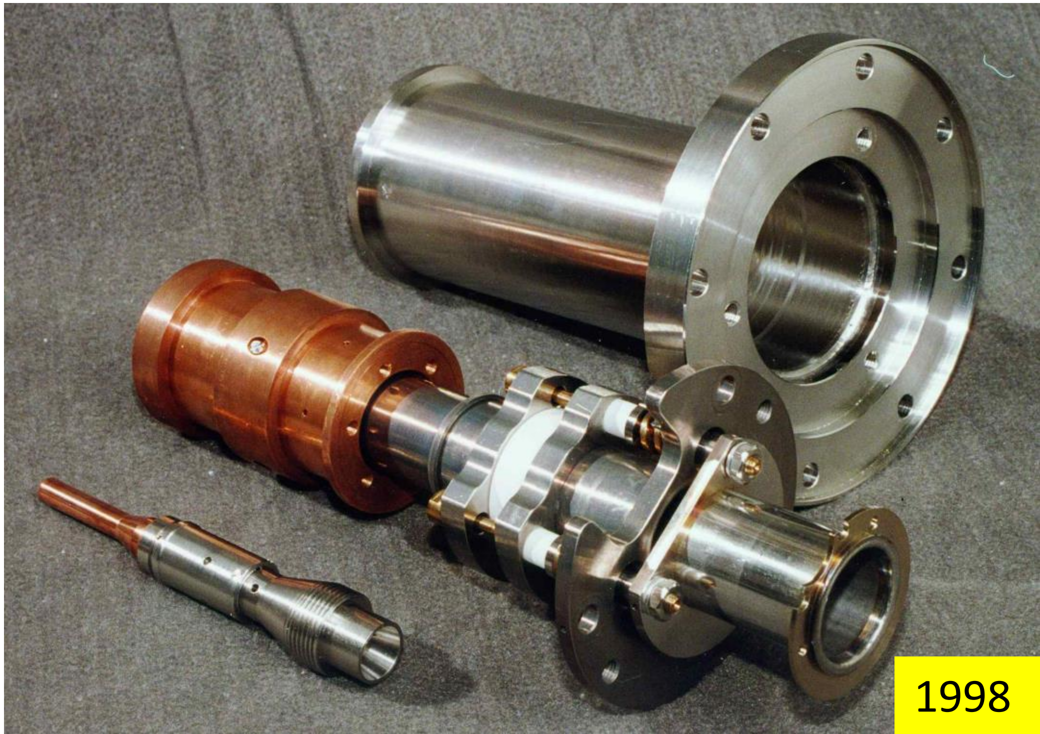
1998

RF superconducting electron photoinjector

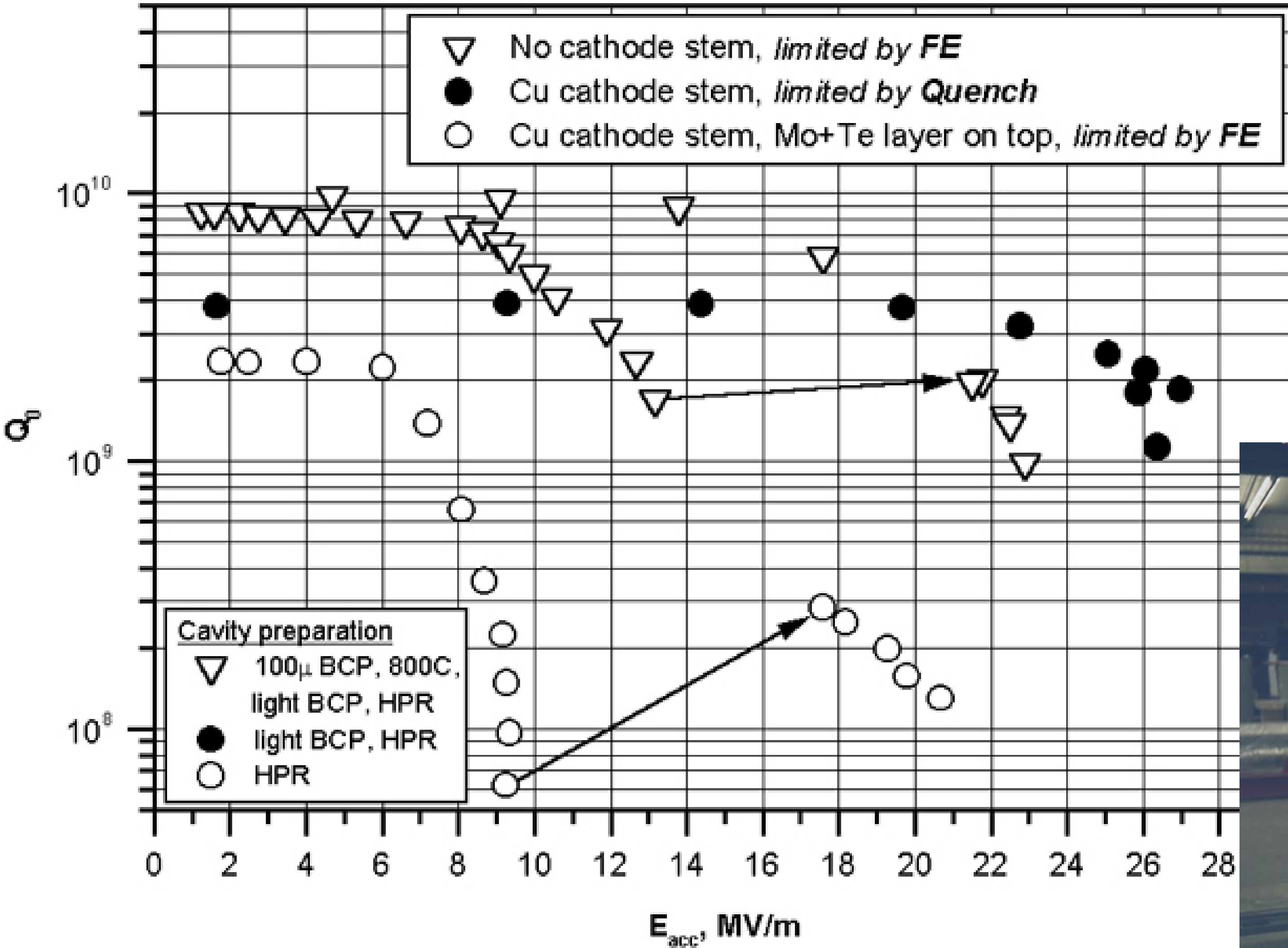
A prototype *1.3 GHz* cavity was developed and produced at Budker Institute and tested at DESY TTF. Maximum achieved E_{acc} is *27 MV/m* at *Q* value of $2 \cdot 10^9$ *at 2K*. A cathode preparation chamber was also produced at BINP.

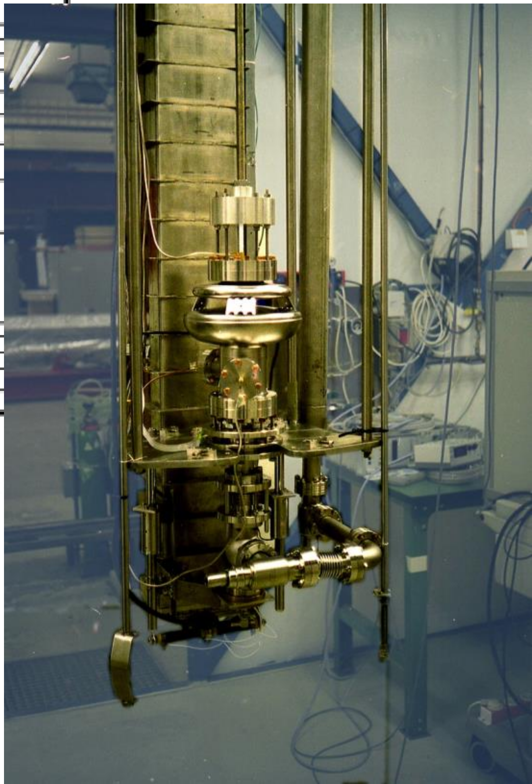
A full scale experiment with *UV* laser driven photo-cathode was performed at FZR and proved the design feasibility.

An optimized injector suitable for FEL and linear collider applications based on a 3.5-cell *TESLA* cavity was developed as well.



Results of the Vertical Cavity Tests at DESY TTF, T_{bath}=2K





1998

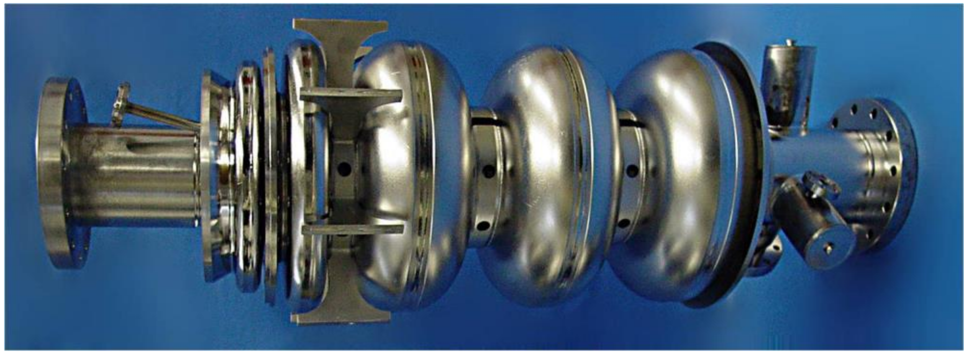
THE ELBE ACCELERATOR FACILITY STARTS OPERATION WITH THE SUPERCONDUCTING RF GUN *

R. Xiang[#], A. Arnold, H. Buettig, D. Janssen, M. Justus, U. Lehnert, P. Michel, P. Murcek, Ch. Schneider, R. Schurig, F. Staufenbiel, J. Teichert, for all ELBE crews. FZD, Dresden, Germany,
T. Kamps, J. Rudolph, M. Schenk, Helmholtz-Zentrum Berlin, Germany,
G. Klemz, I. Will, MBI, Berlin, Germany

Abstract

As the first superconducting rf photo-injector (SRF gun) in practice, the FZD 3+1/2 cell SRF gun is successfully connected to the superconducting linac ELBE. This setting will improve the beam quality for ELBE users. It is the first example for an accelerator facility fully based on superconducting RF technology. For high average power FEL and ERL sources, the combination of SRF linac and SRF gun provides a new chance to produce beams of high average current and low emittance with relative low power consumption.

The main parameters achieved from the present SRF gun are the final electron energy of 3 MeV, 16 μA average current, and rms transverse normalized emittances of 3 mm mrad at 77 pC bunch charge. A modified 3+1/2 cell niobium cavity has been fabricated and tested, which will increase the rf gradient in the gun and thus better the beam parameters further. In this paper the status of the integration of the SRF gun with the ELBE linac will be presented, and the latest results of the beam experiments will be discussed.

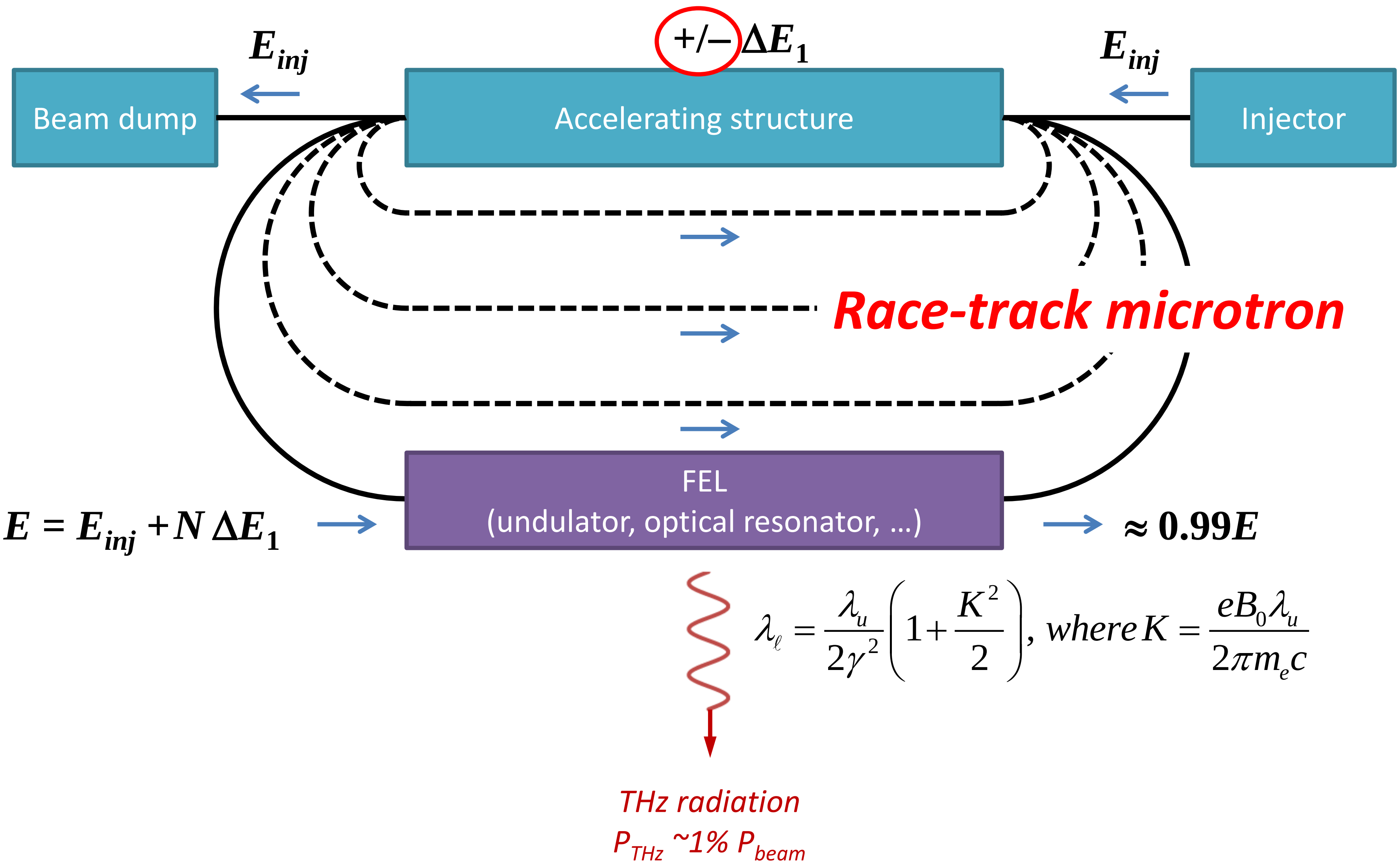


SUMMARY

The Superconducting RF photoinjector within a collaboration of HZB, DESY, FZD, and MBI has been successfully connected to the ELBE SRF linac. The ELBE linac injected with SRF gun can provide high brightness beam for the second-beam users and brighten the application of this radiation source. Before IPAC'10 two shifts were used for the beam optimizing and the beam diagnostics. The mean energy and energy spread have been measured.

3. RF for NovoFEL.

Overview of the NovoFEL facility



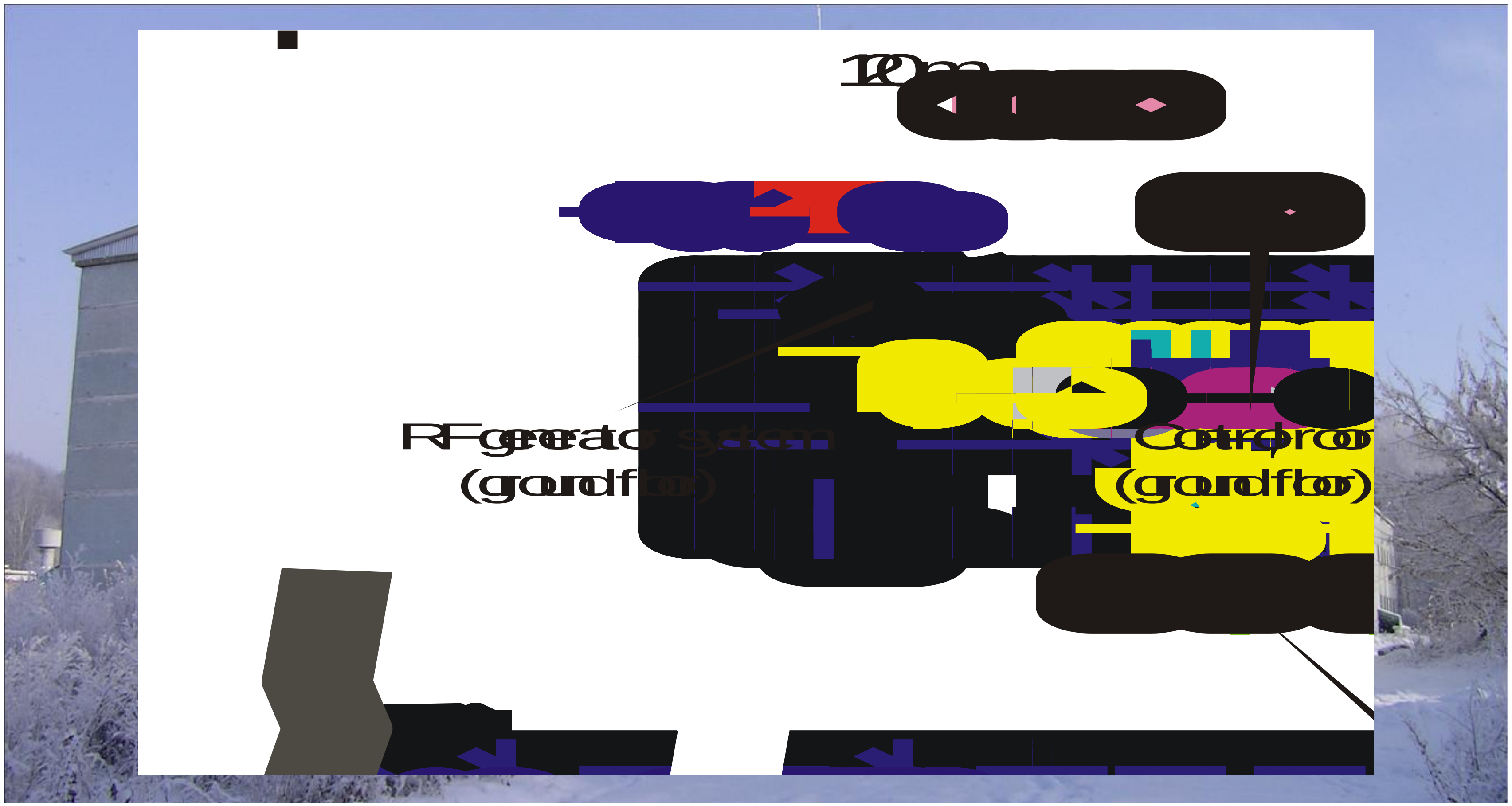
Overview of the NovoFEL facility

- The first stage of Novosibirsk high power free electron laser (NovoFEL) based on one-track energy recovery linac (ERL) working in spectral range (90÷240) μm was commissioned in 2003.

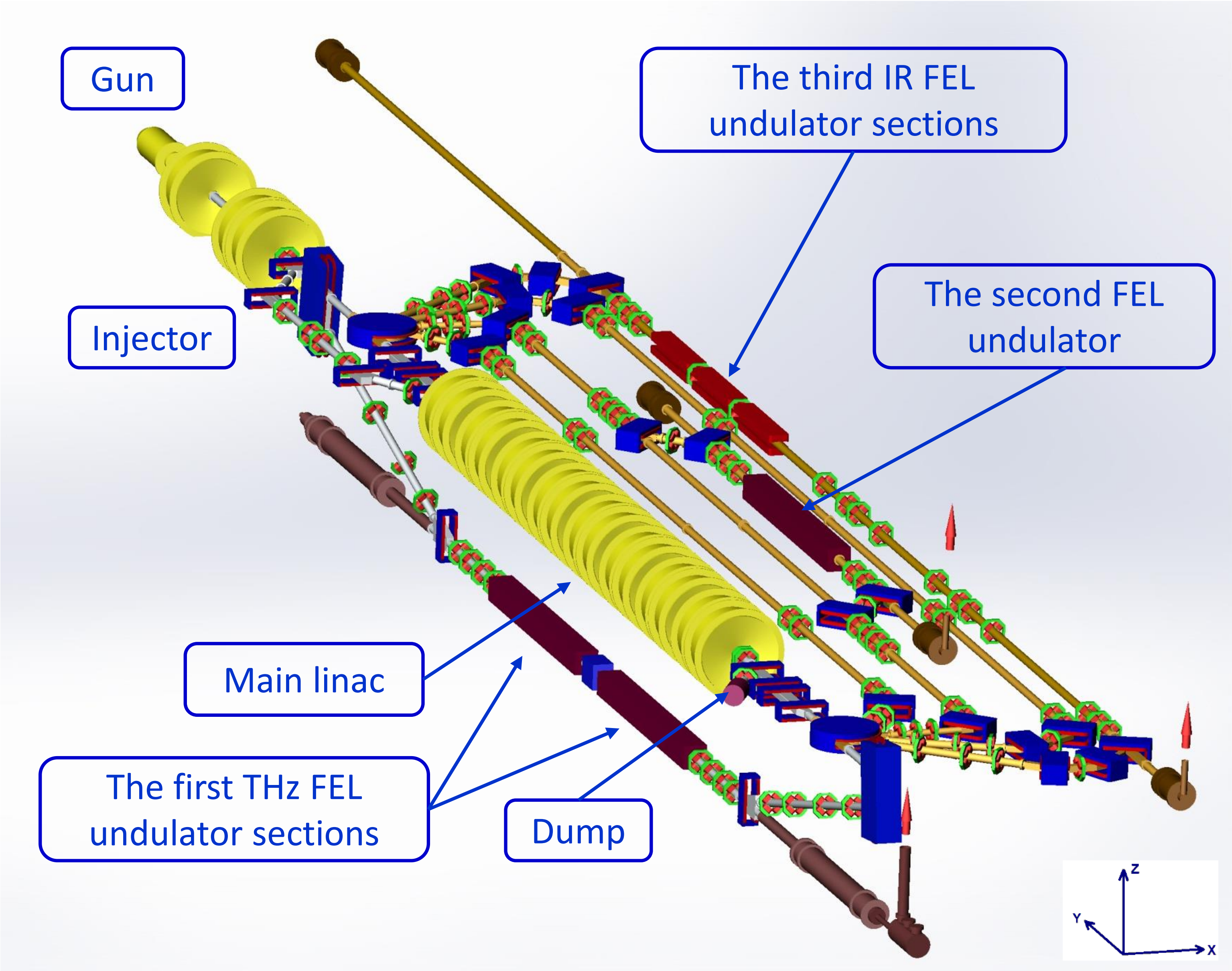
- The second stage of NovoFEL based on two-tracks energy recovery linac, working in spectral range (37÷80) μm, was commissioned in 2009.

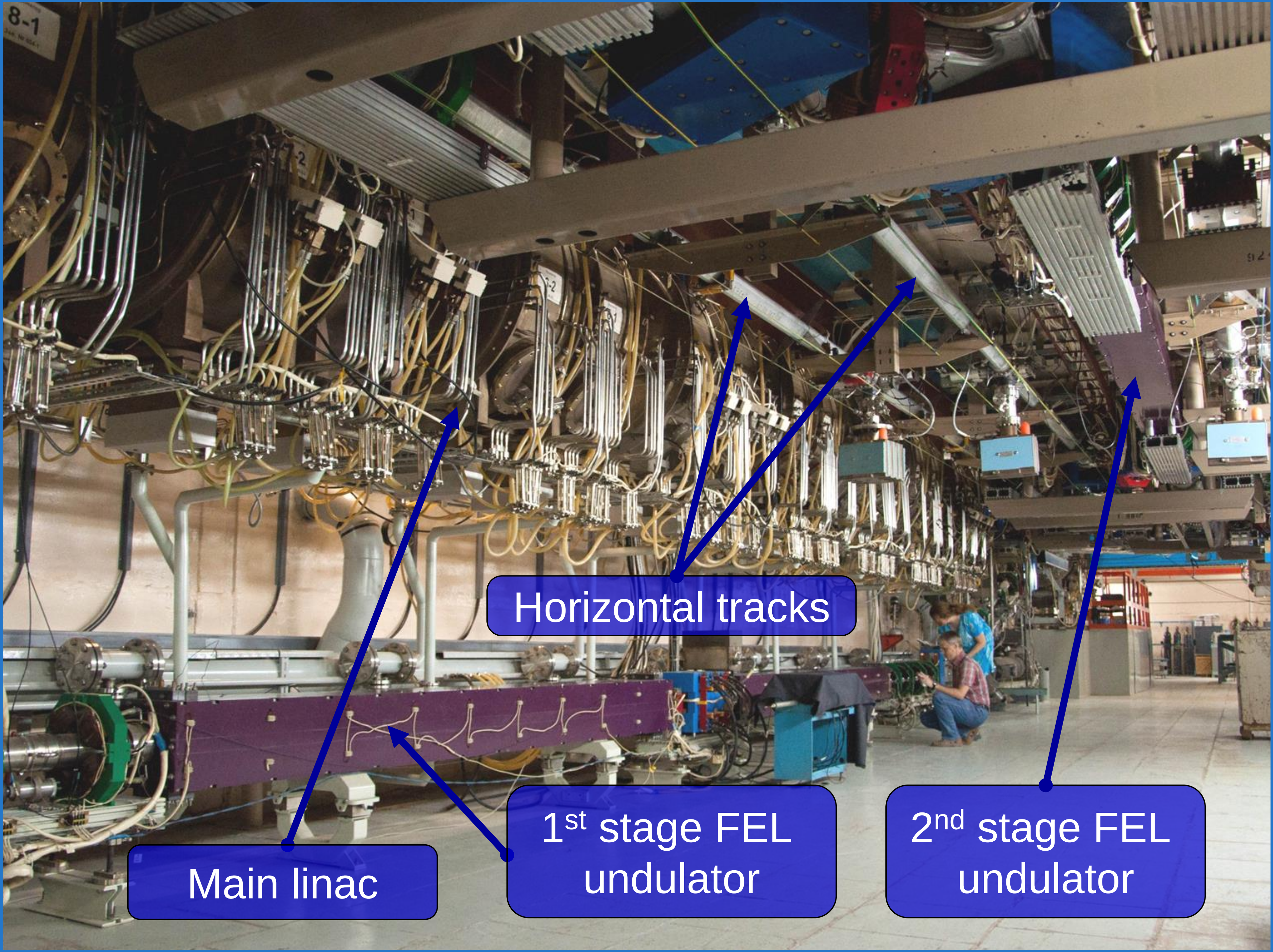
- The third stage of NovoFEL based on four-tracks ERL was commissioned in July of 2015. Spectral range now is (8÷11) μm. First operation for users was done in 2016.

Siberian Center of Photochemical Research



NovoFEL Accelerator Design



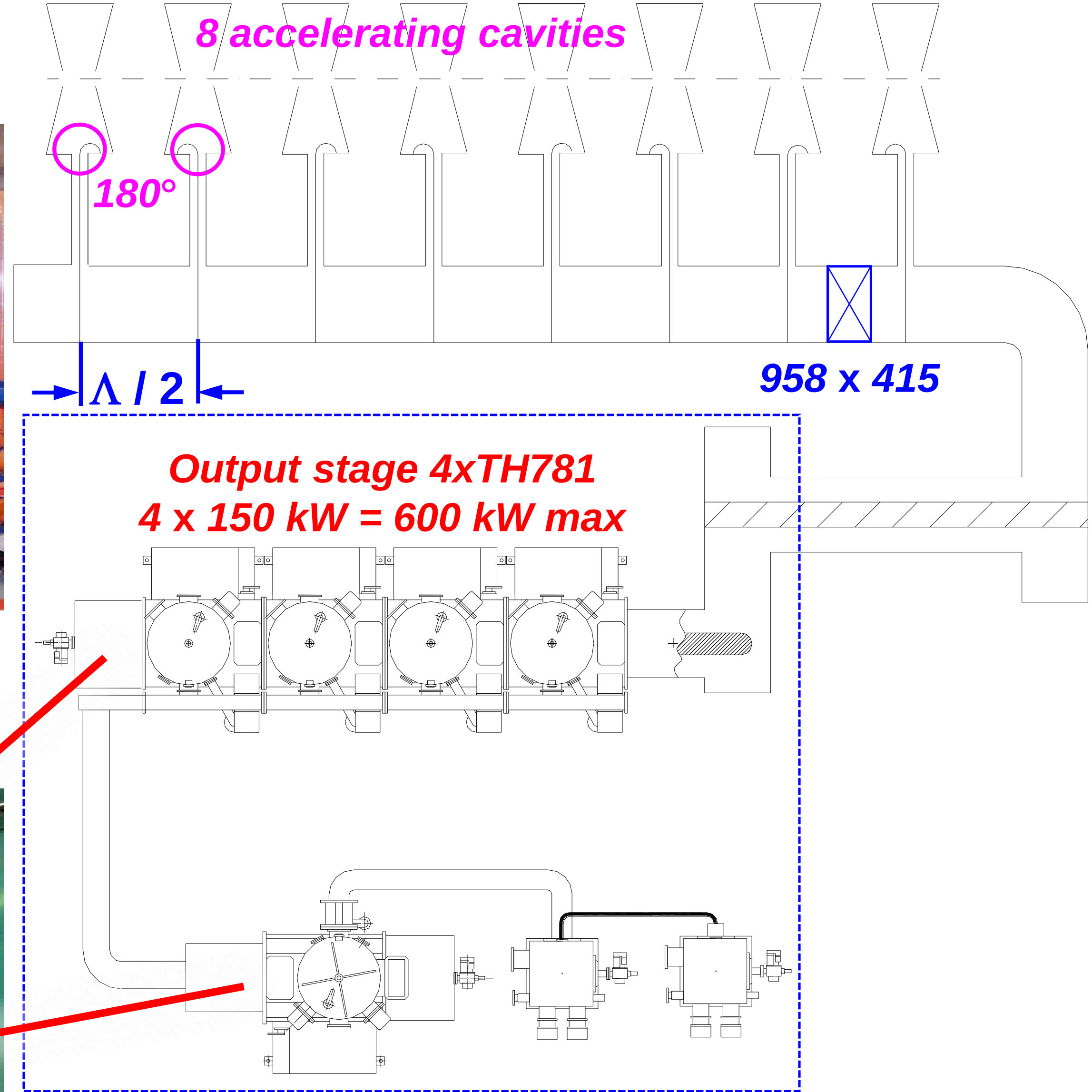

Horizontal tracks
Main linac
1st stage FEL undulator
2nd stage FEL undulator


3rd stage FEL
undulator

1/2 of the Microtron RF system

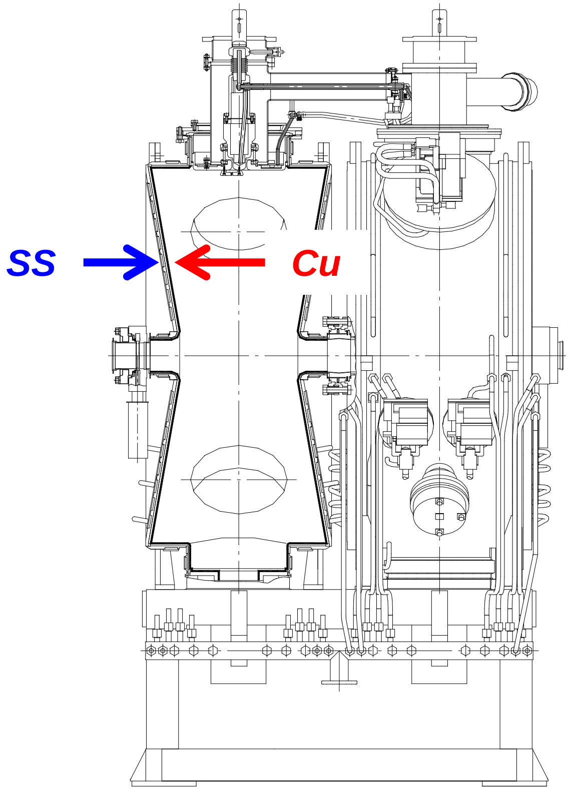
WG/coax power distribution system

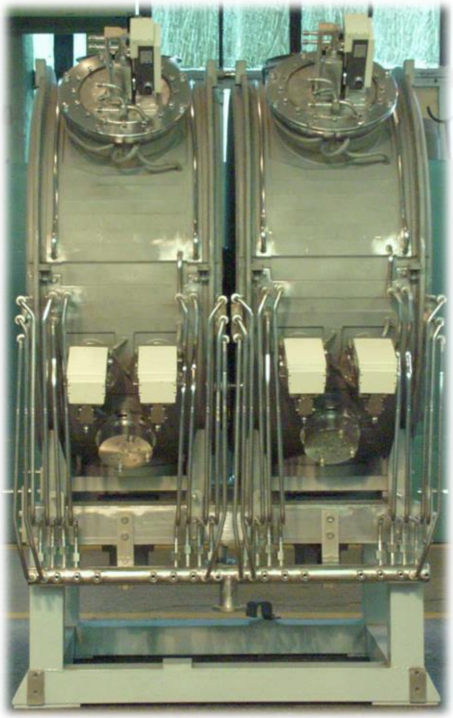
Coax lines to the cavities



RF amplifier

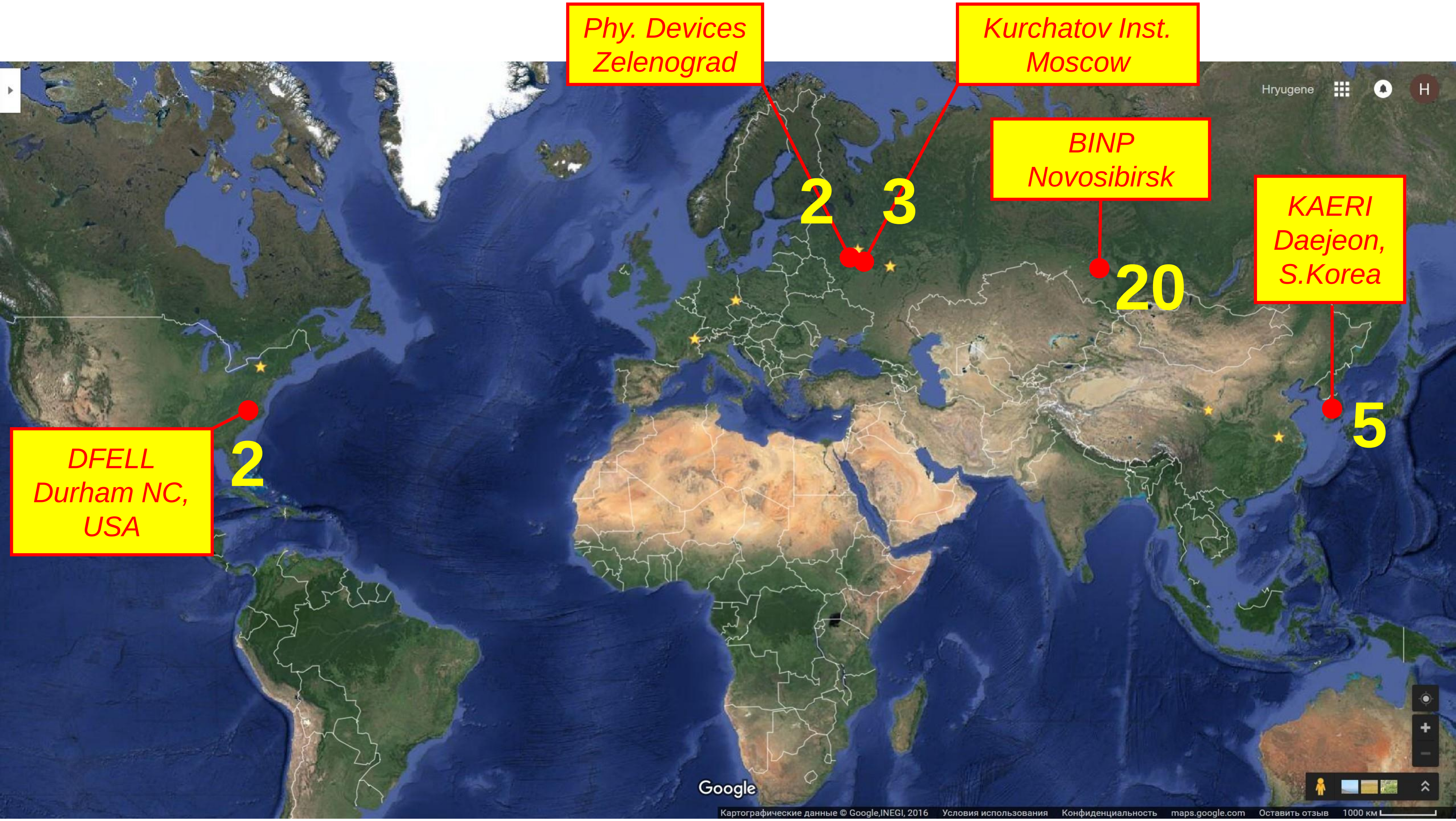
Bi-metal cavities of NovoFEL



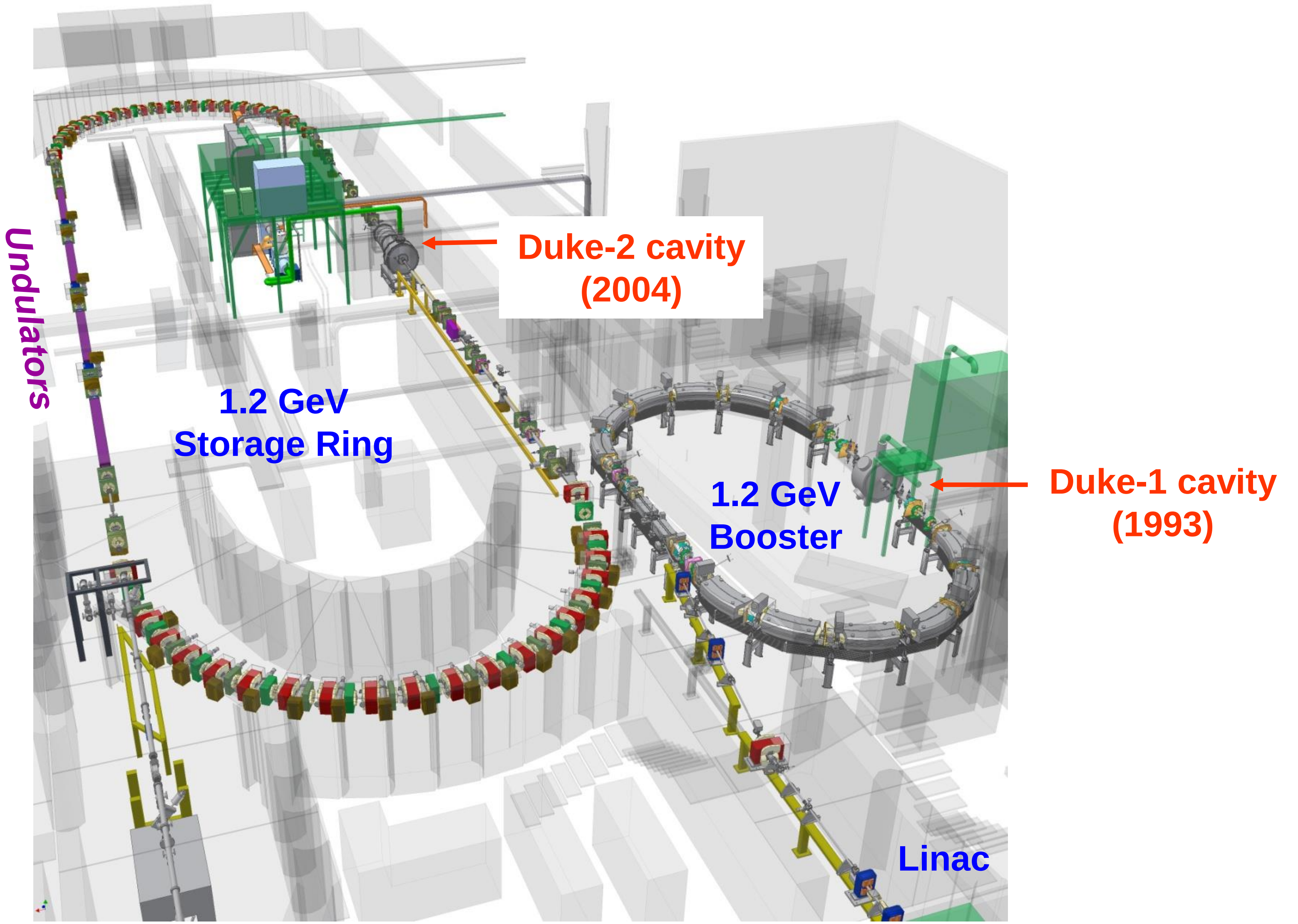


Operating frequency, MHz	180.4
Tuning range, kHz	320
Characteristic impedance, Ohm	133.5
Quality factor	$40 \cdot 10^3$
Shunt impedance, MOhm	5.3
Operating gap voltage, kV	$\leq$ 950
Power dissipation, kW	85
Transit time factor	0.9

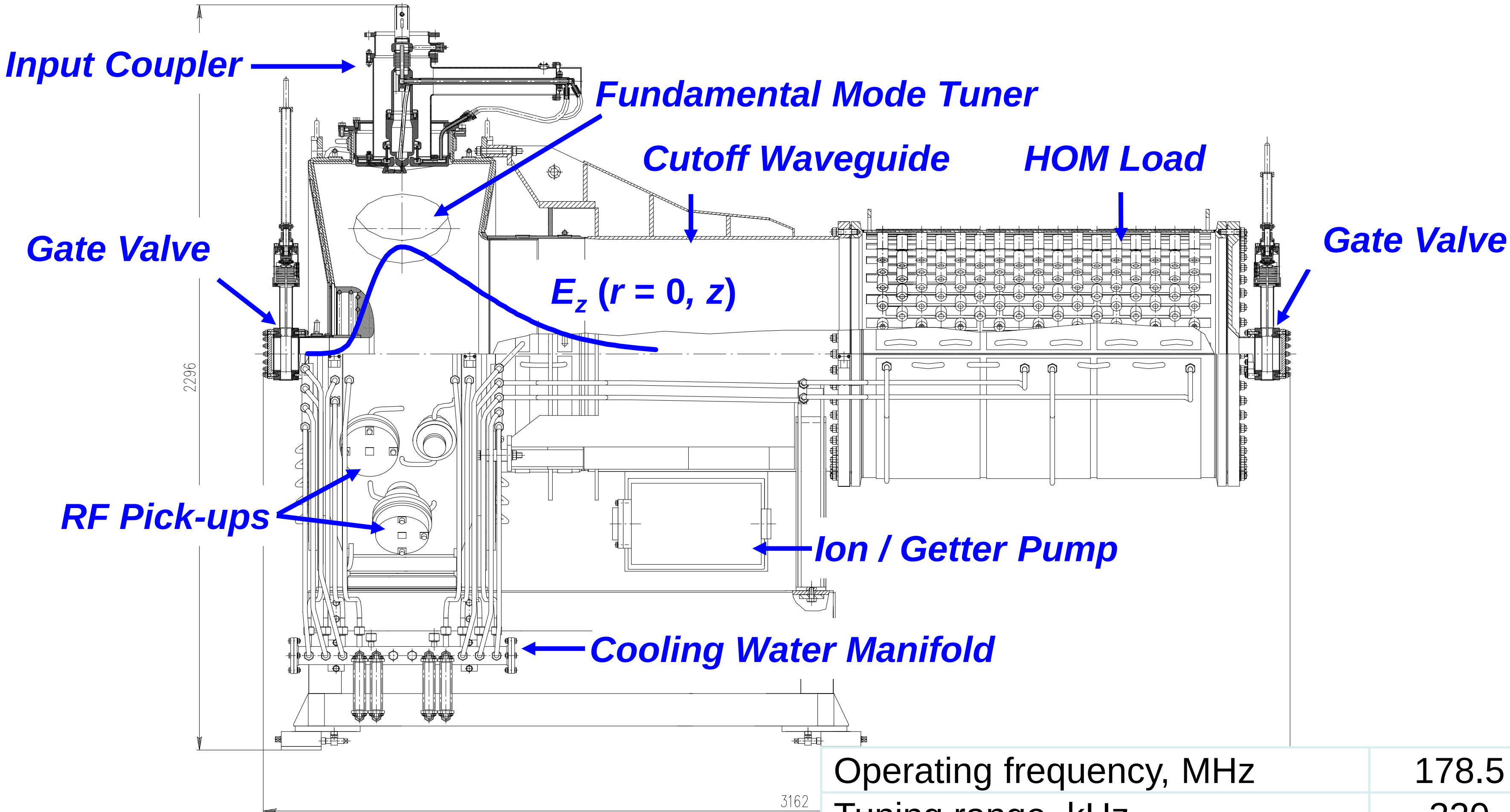
BINP NovoFEL-like cavities over the World



Duke Free Electron Laser Laboratory, Durham NC, USA

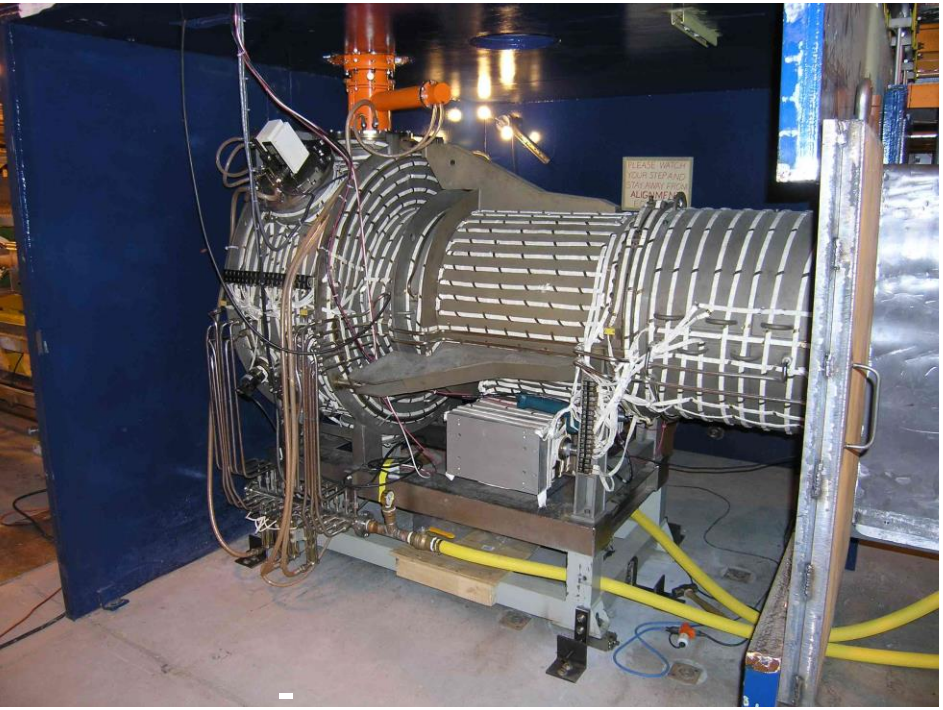


Single mode cavity for the DFELL

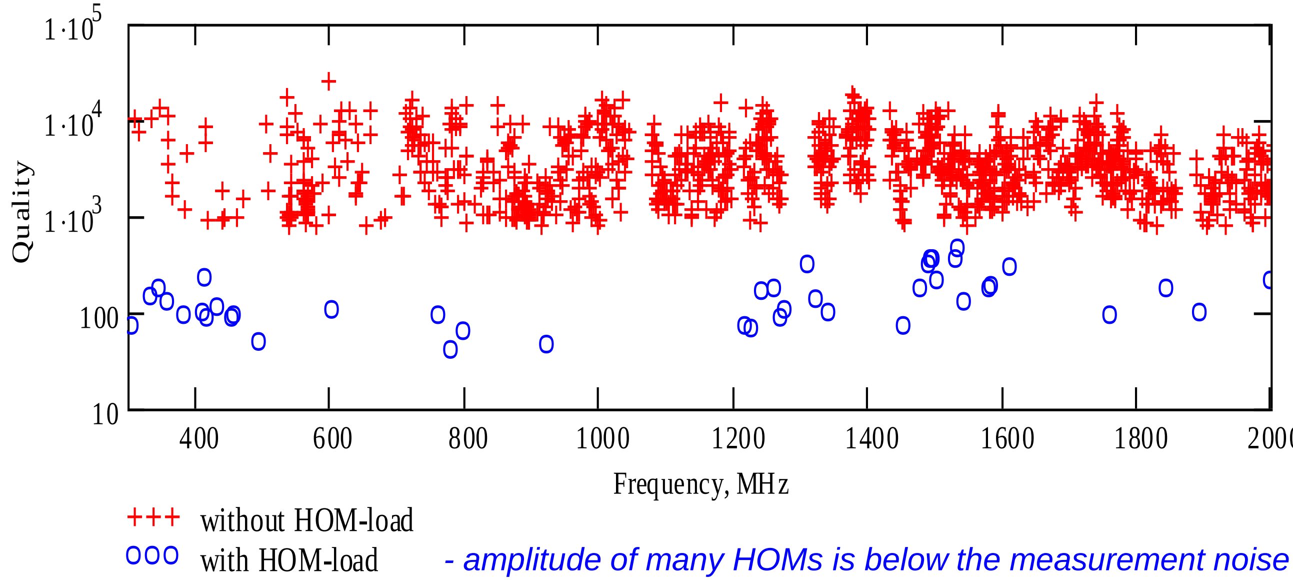


Operating frequency, MHz	178.5
Tuning range, kHz	320
Characteristic impedance, Ohm	150
Quality factor	$40 \cdot 10^3$
Shunt impedance, MOhm	6
Operating gap voltage, kV	≤ 950
Power dissipation, kW	85
Transit time factor	0.77

Single mode cavity for the DFELL



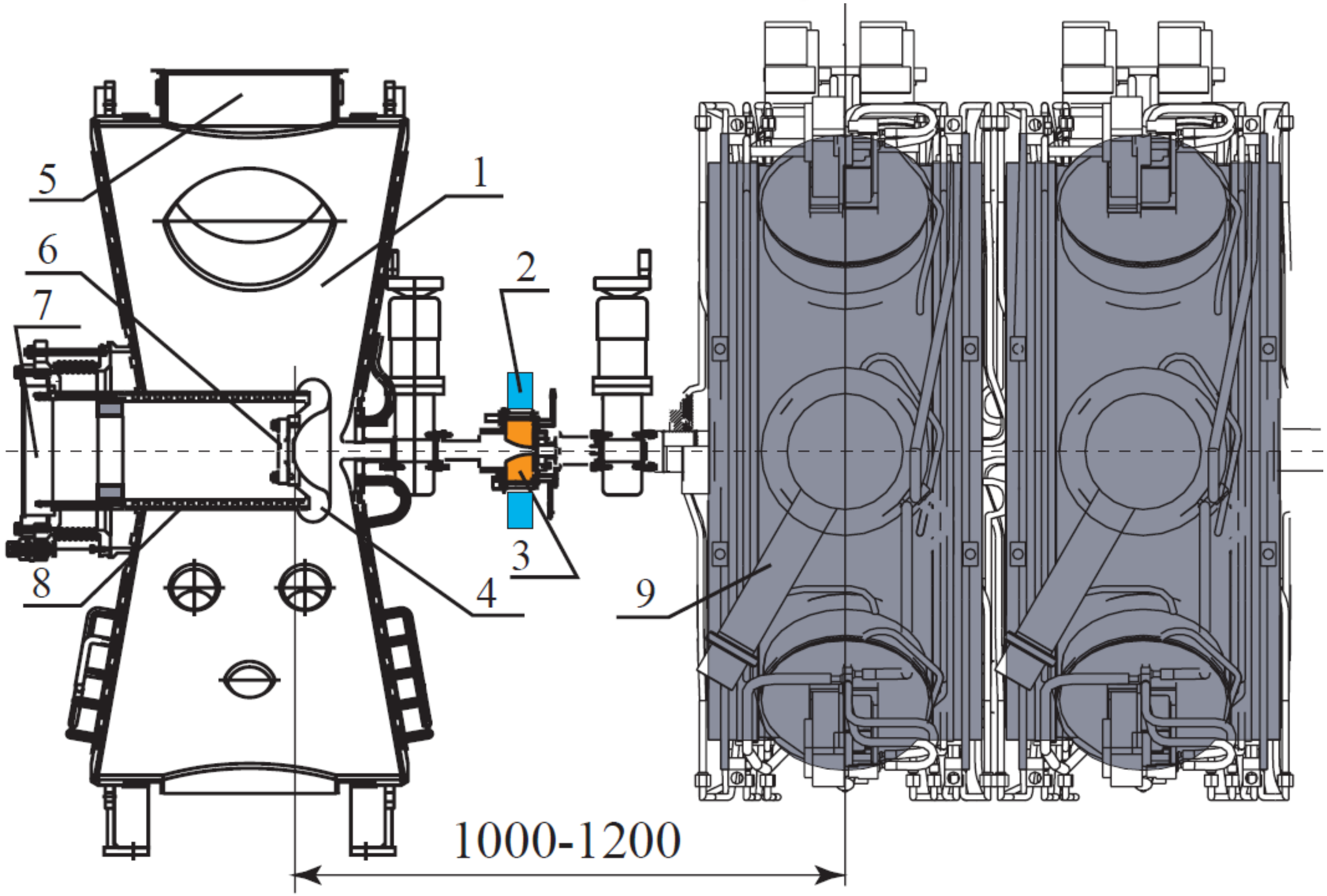
HOM damping measurement data:



- amplitude of many HOMs is below the measurement noise level

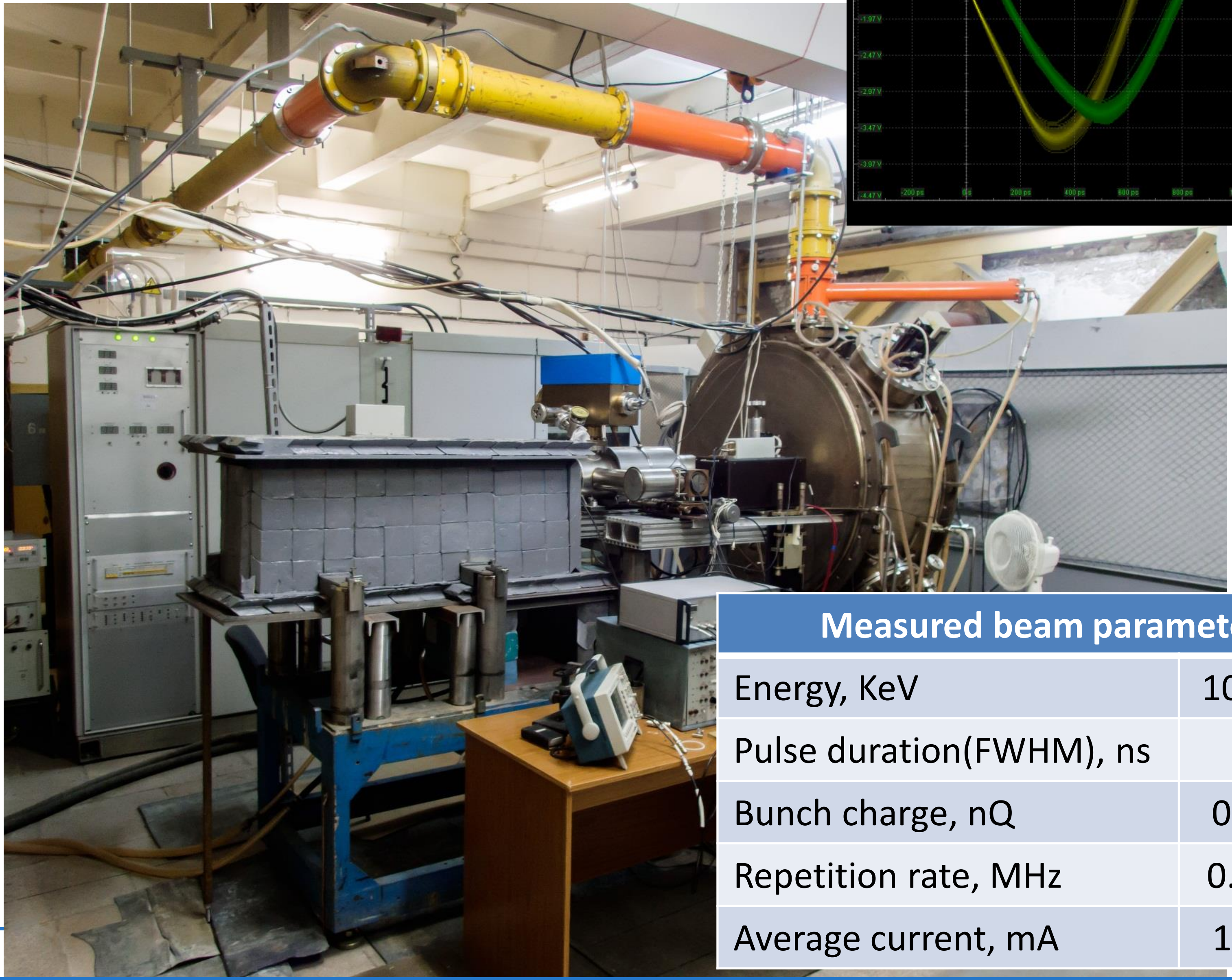
4. RF electron sources.

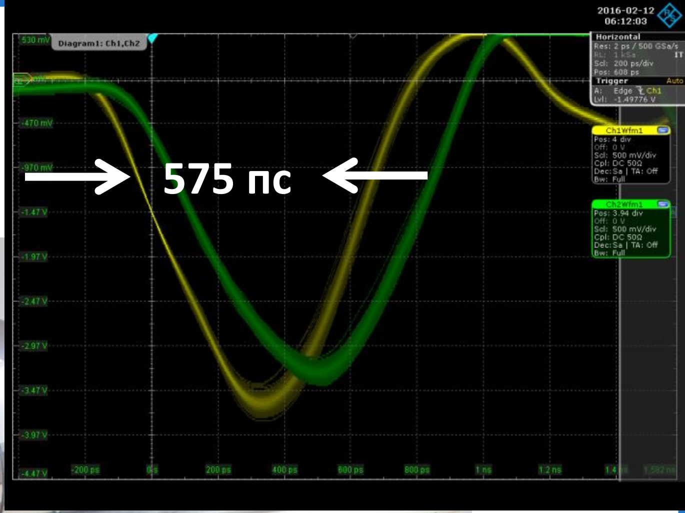
New RF electron source for NovoFEL.



1 – RF gun 90 MHz cavity
5 – input coupler port
6 – cathode-grid unit
9 – accelerating 180 MHz cavity

RF Gun Test Setup

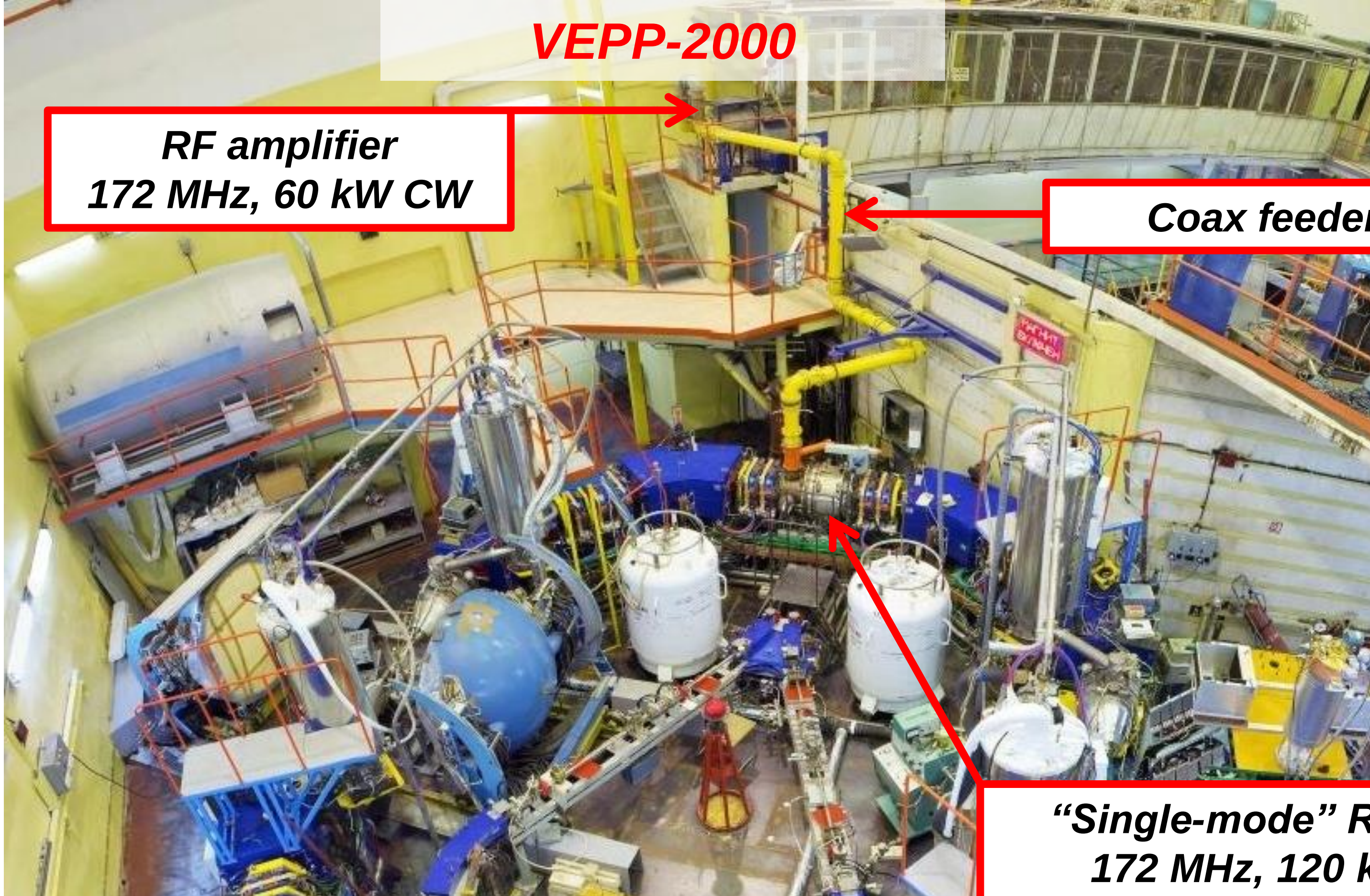




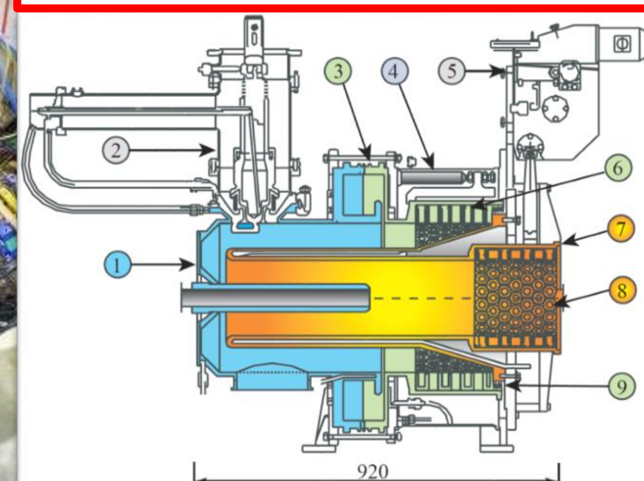
Measured beam parameters	
Energy, KeV	100 ÷ 320
Pulse duration(FWHM), ns	≤ 0.6
Bunch charge, nQ	0.3 ÷ 1.5
Repetition rate, MHz	0.01 ÷ 90
Average current, mA	102 max

5. RF for e+e- BINP colliders.

VEPP-2000

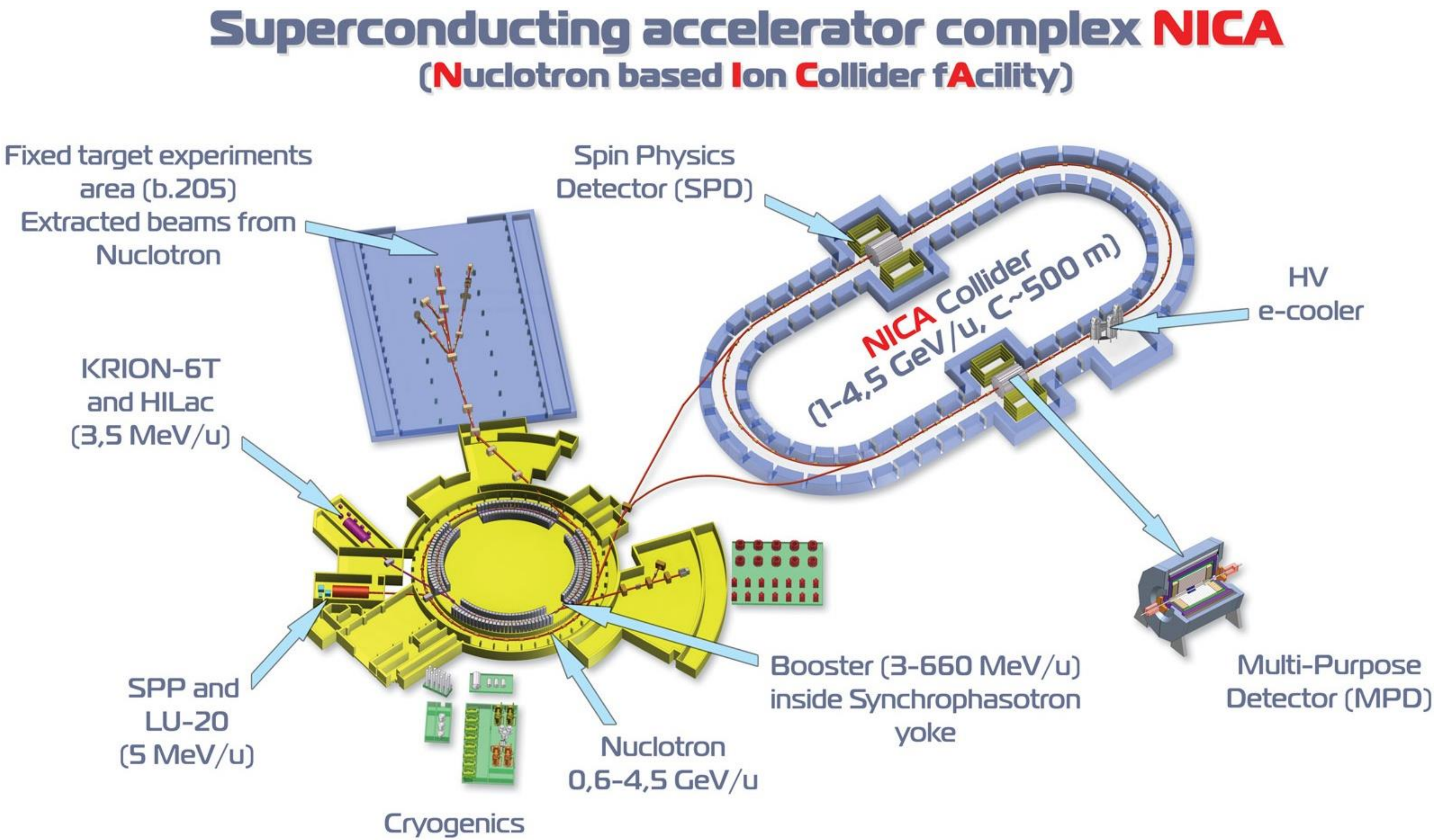


Operating frequency, MHz	172.09
Quality factor	8 200
Transit time factor	0.99
Characteristic impedance, Ohm	28
Shunt impedance, kOhm	230
HOM shunt impedances, Ohm	≤ 300
Operating gap voltage, kV	120
Cavity power losses, kW	30
RF power transmitted to beam, kW	24



6. RF for NICA at JINR, Dubna.

Joint Institute for Nuclear research, Dubna

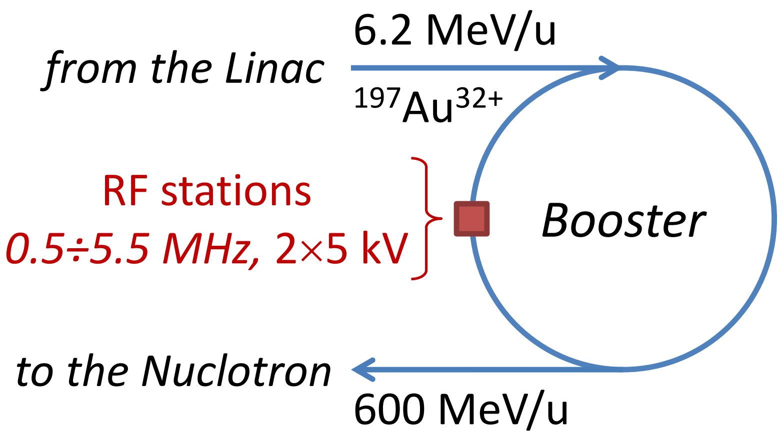


BINP contribution to the RF:

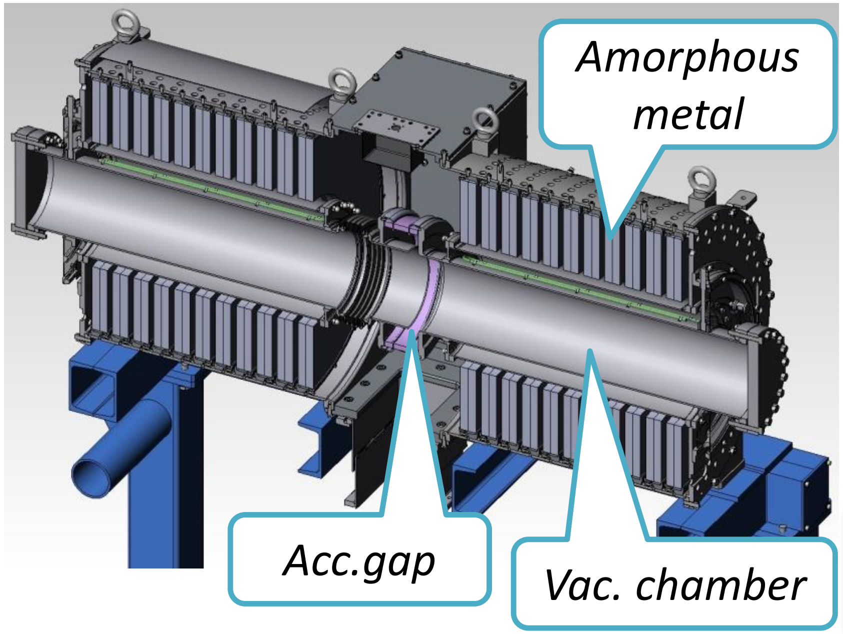
1. 2 RF stations for the Booster
2. 2 + 8 + 16 RF stations for the Collider

…2023

RF stations for the Booster.



Caxial RF cavity



ДУБНА НАУКА СОДРУЖЕСТВО ПРОГРЕСС

ЕЖЕНЕДЕЛЬНИК ОБЪЕДИНЕННОГО ИНСТИТУТА ЯДЕРНЫХ ИССЛЕДОВАНИЙ

Газета выходит с ноября 1957 года № 49 (4239) Пятница, 19 декабря 2014 года

Проекты XXI века

NICA: на основе передовых разработок

В соответствии с планами создания ускорительного комплекса NICA в ЛФВЭ поступает оборудование, изготовленное в ведущих ускорительных центрах мира.

С середины ноября по 3 декабря группа специалистов из Института ядерной физики имени Будкера осуществляла сборку, настройку и тестирование на стенде в ЛФВЭ ускоряющих станций бустера, изготовленных в Новосибирске. 25–26 ноября было проведено рабочее совещание по проекту создания барьерных высокочастотных станций коллайдера NICA, за изготовление которых также готов взяться ИЯФ. В начале декабря в ЛФВЭ прибыла первая секция нового ускорителя тяжелых ионов, изготовленная в Германии, а двумя неделями ранее получен из Австралии высокочастотный усилитель, предназначенный для ее питания.

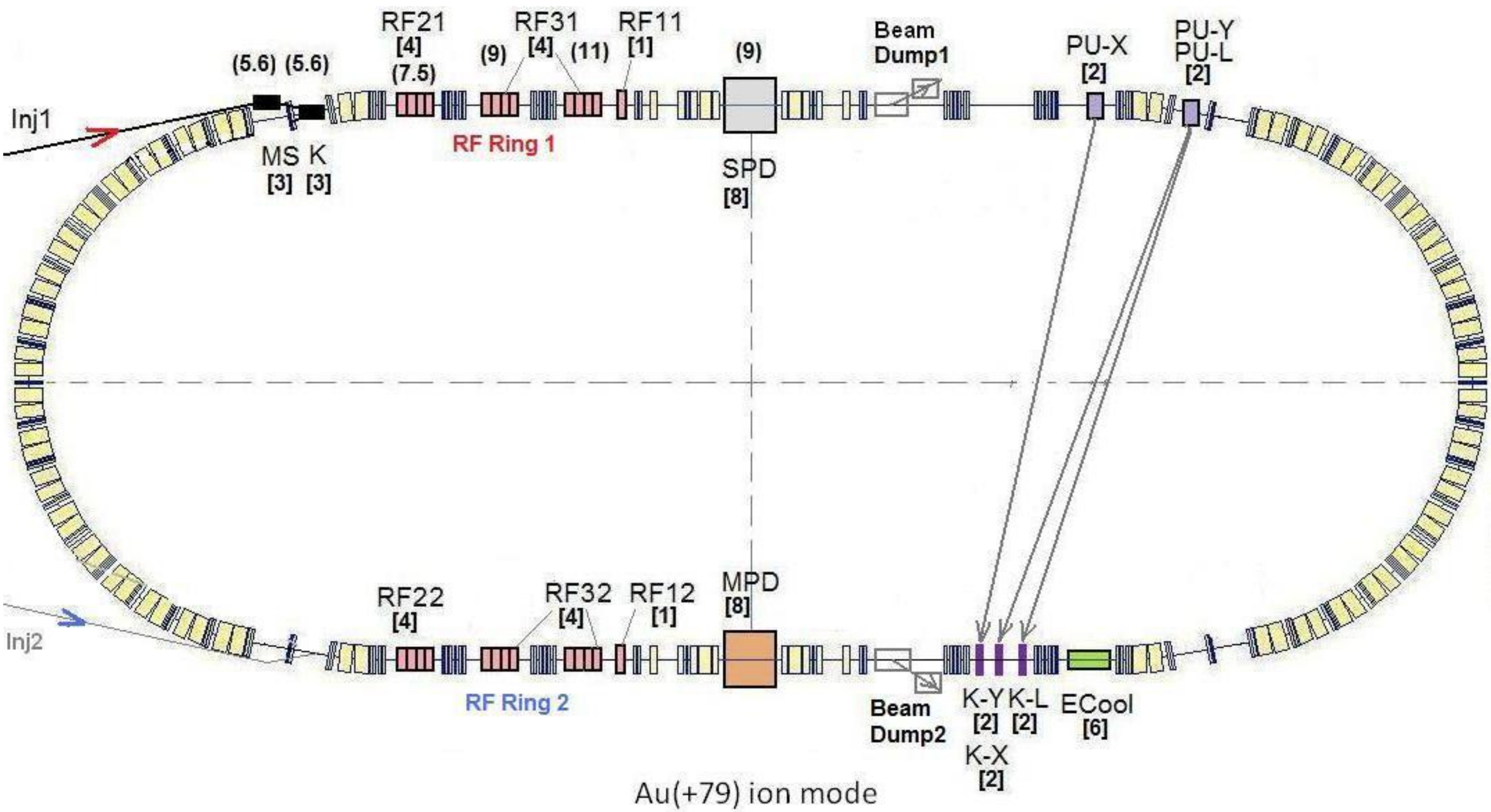
(Окончание на 4–5-й стр.)

Испытание ускоряющей станции бустера на стенде в ЛФВЭ. На снимке слева направо: А. М. Пилан, А. М. Батраков, Г. А. Фатькин, О. И. Бровко, И. В. Ильин, Г. Я. Куркин.

2 RF stations shipped to Dubna in 2014 and successfully tested at a test stand.

RF stations for the Collider.

RF1 – barrier bucket RF system (±5 kV 20÷80 ns pulses), 1/ring
RF2 – 22nd harmonic RF station (coaxial cavity 11÷13 MHz,   25 kV), 4/ring
RF3 – 66nd harmonic RF station (coaxial cavity 34÷39 MHz, 125 kV), 8/ring



Thank you for your attention and welcome to BINP!