Status of Kurchatov Synchrotron
Radiation Source

A.Valentinov, A.Belkov, Y.Fomin, E.Kaportsev, V.Korchuganov, Yu.Krylov,
V.Moiseev, K.Moseev, N.Moseiko, D.Odintsov, S. Pesterev, A.Smygacheva, A.
Stirin, V. Ushakov, V.Ushkov, A.Vernov

NRC Kurchatov Institute, pl. Akademika Kurchatova 1, 123182, Moscow, Russia
Content:

1. KSRS operation

2. KSRS development in 2015 -2016

3. KSRS modernization (Federal Program)
KSRS

3 electron accelerators:

- 80 MeV LINAC (1992)
- 450 MeV storage ring SIBERIA-1 (1993)

11 experimental stations (SIBERIA-2)

4 experimental stations (SIBERIA-1)

Experiments in physics, chemistry, biology, medicine, nanotechnologies and many more…
# Accelerators’ parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>SIBERIA-1</th>
<th>SIBERIA-2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy, GeV</td>
<td>0.45</td>
<td>2.5</td>
</tr>
<tr>
<td>Circumference, m</td>
<td>8.68</td>
<td>124.13</td>
</tr>
<tr>
<td>Hor. emittance, nm·rad</td>
<td>860</td>
<td>98</td>
</tr>
<tr>
<td>Energy spread, $\sigma E/E$</td>
<td>$3.8 \cdot 10^{-4}$</td>
<td>$9.54 \cdot 10^{-4}$</td>
</tr>
<tr>
<td>Electron current, mA</td>
<td>up to 300</td>
<td>up to 150</td>
</tr>
<tr>
<td>Lifetime, hours (at 100 mA)</td>
<td>1.5</td>
<td>20 - 25</td>
</tr>
<tr>
<td>SR power, kW (at 100 mA)</td>
<td>0.36</td>
<td>68.5</td>
</tr>
<tr>
<td>Time for users per year, hours</td>
<td>up to 2400</td>
<td>2000 – 2400</td>
</tr>
<tr>
<td>Consumed electric power at working energy, MW</td>
<td>0.4</td>
<td>2.5</td>
</tr>
</tbody>
</table>
KSRS operation in 2012 - 2016
Week of SIBERIA-2 (October 2016)
Main reason:

Machine basis heating by conducting bar of bending magnets power supply. It causes distortions of closed orbit in vertical plane up to 400 microns (after week of operation)

Cure method:

Now: Feedback using luminophor sensor with TV-camera and local orbit bump in order to stabilize photon beam

Future: Improving of conductor cooling by using more powerful water pumps and additional cooling lines
VERTICAL ORBIT DISTORTIONS

Slope of magnet surface vs. time

0                   20                  40             60
hours

0  
0.2  
0.4  
mrad

Photon beam stabilization program using luminophor sensors & TV-cameras

Beam position stability 2 - 4 microns
Station of optical supervision

- Storage ring hall
- Shielding wall
- Ion pump
- Cooled mirrors
- Vacuum shutter
- Beam line

Graphs and diagrams showing intensity and vertical position with different sigma values.
Bunch length in single-bunch mode

![Graph showing bunch length as a function of bunch current for different energies.](image)

- **E=2500 MeV**
- **E=450 MeV**
- **E=1300 MeV**

**σ_s, psec** vs **Bunch current, mA**
Feedbacks for instabilities suppression

**Measured L - kicker parameters:**
- Operation frequency – 954.67 MHz;
- Frequency bandwidth – 104.67 MHz;
Feedbacks for instabilities suppression

The schematic layout of the feedback system

**X- and Z- Kickers:**
The X-kicker is the four electrode stripline structure, turned on 45°;
The Z-kicker is the two electrode stripline structure.

- The Hybrid junctions and Bunch-by-Bunch Front End module is used for an amplitude and phase conversion of broadband pickup signals.
- The Bunch-by-Bunch processor calculates the correction signal for damping coupled bunch instabilities:
  - The 12 bit ADC with the sampling frequency 181 MHz;
  - FPGA device, 4 processing chains with 16 tap FIR filter;
  - The 14 bit 500 MHz DAC.
- The Bunch-by-Bunch Back End module forms the correction signal for the longitudinal kicker.
Control System: CitectSCADA

- Vacuum system
- Temperature measurements and temperature stabilization of linac structure
- Siberia-2 RF generators measurements
- Siberia-2 magnetic system control, including ramping process, cycle of remagnetization, betatron tune correction and so on.
- Control of photon absorbers in SR beamlines
- Control of equipment in superconducting wiggler beamline.

**Plans:** All other system control
**Control System: CitectSCADA**

### Current Mode:
- **Nominal:**
  - Number of modes: 2
- **Status:**
  - Mode setting: 120
- **Control:**
  - Mode setting: 2

### Current Values:

<table>
<thead>
<tr>
<th>Device</th>
<th>Nominal</th>
<th>Current</th>
<th>Difference</th>
<th>Value</th>
<th>Target</th>
</tr>
</thead>
<tbody>
<tr>
<td>Item 1</td>
<td>7199.933</td>
<td>7199.338</td>
<td>0.595</td>
<td>0.595</td>
<td></td>
</tr>
<tr>
<td>Item 2</td>
<td>499.482</td>
<td>499.538</td>
<td>0.056</td>
<td>0.056</td>
<td></td>
</tr>
<tr>
<td>Item 3</td>
<td>580.999</td>
<td>580.615</td>
<td>0.384</td>
<td>0.384</td>
<td></td>
</tr>
<tr>
<td>Item 4</td>
<td>674.000</td>
<td>673.546</td>
<td>0.454</td>
<td>0.454</td>
<td></td>
</tr>
<tr>
<td>Item 5</td>
<td>795.254</td>
<td>785.852</td>
<td>9.402</td>
<td>9.402</td>
<td></td>
</tr>
<tr>
<td>Item 6</td>
<td>425.645</td>
<td>829.085</td>
<td>403.440</td>
<td>403.440</td>
<td></td>
</tr>
<tr>
<td>Item 7</td>
<td>3.461</td>
<td>3.461</td>
<td>0.000</td>
<td>0.000</td>
<td></td>
</tr>
<tr>
<td>Item 8</td>
<td>3.450</td>
<td>3.451</td>
<td>0.001</td>
<td>0.001</td>
<td></td>
</tr>
</tbody>
</table>

### Controls:
- **Controlled Variables:**
  - K312, K313, K314, K315
  - K322, K323, K324, K325
  - K332, K333, K334, K335

### Graphs:
- Various data trends and charts are displayed, showing real-time data and historical trends.

---

Перенасыщено и непонятно...
RUPAC 2016 REPORTS

THPSC063
SYSTEM OF THERMOMONITORING AND THERMOSTABILIZING FOR KSRS

THPSC026
THE AUTOMATION OF ENERGY RAMPING FOR THE MAIN STORAGE RING OF KSRS

THPSC084
THE NEW CONTROL FOR MAGNET SYSTEM OF KSRS

THPSC054
MODERNIZATION OF THE ELECTRON BEAM STABILIZATION SYSTEM IN THE KSRS

WEPSB016
COUPLED BUNCH INSTABILITIES IN THE STORAGE RINGS

WEPSB010
THE USE OF MULTI-OBJECTIVE GENETIC ALGORITHMS FOR ACCELERATOR AND LIGHT SOURCE OPTIMIZATION

TUPSA055
COMPUTER CODE FOR SIMULATION OF WIGGLER RADIATION POWER DISTRIBUTION
KSRS modernization in 2018 - 2020

Problems:

• Non-adequate condition of technical systems: water and air cooling, electric circuits, air conditioning

• Old accelerators’ equipment: high-current power supply systems, pulse generators, control system hardware

• Number of vacuum equipment must be changed: inoperative valves, ion pumps, titanium evaporation units

• Not-optimal RF system scheme of SIBERIA-2 (2 generators + 3 cavities) limits electron current, doesn’t allow operation with all planned wigglers

• Complicated structure of control system
Goals:

• Maintenance of reliable and effective operation of all KSRS systems

• Improvement of KSRS essential parameters: electron current, beam lifetime, operation time

• New experimental possibilities for users: beamlines, experimental stations, new superconducting wigglers
RF system after modernization

- New RF generator №3
- New waveguides
- Cavities
- 2 existing RF generators
- New power supply racks
- New control racks
Magnet system modernization

- New transformers
- Power supply room
- New high-current power supplies
Vacuum system modernization

- New wiggler
- New valves
- New ion pumps, ion pumps, BPMs
- Heating by SR
- Existing wiggler
- New ion pumps, valves, titanium evaporating units, additional BPMs
## Superconducting wigglers

<table>
<thead>
<tr>
<th>Parameter</th>
<th>SCW-1</th>
<th>SCW-2,3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max. field</td>
<td>7.5 (4) T</td>
<td>3 T</td>
</tr>
<tr>
<td>Field period</td>
<td>164 mm</td>
<td>46 mm</td>
</tr>
<tr>
<td>Number of poles</td>
<td>19+2</td>
<td>50+4</td>
</tr>
<tr>
<td>Undulator factor, K</td>
<td>115 (61)</td>
<td>12.9</td>
</tr>
<tr>
<td>SR power at 2.5 GeV, 100 mA</td>
<td>35 (10) kW</td>
<td>4.1 kW</td>
</tr>
<tr>
<td>Max. angle, K/\gamma</td>
<td>23 (12.2) mrad</td>
<td>2.6 mrad</td>
</tr>
</tbody>
</table>
MODERNIZATION of TECHNICAL SYSTEMS

- New water pumps and distillers
- New electricity transformers and high-voltage circuits for RF generator #3
- Equipment for trouble-proof power supplies
- New air-cooling equipment for RF generators and waveguides
- Modernization of ground circuits
- New pneumatic lines for vacuum valves
- Air conditioning (equipment rooms and experimental halls, main storage ring tunnel)
- New admission and safety systems
### RESULTS of MODERNIZATION

<table>
<thead>
<tr>
<th>SIBERIA-2 parameters</th>
<th>before 2016</th>
<th>2020</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time for users per year, hours</td>
<td>2000 - 2400</td>
<td>3000</td>
</tr>
<tr>
<td></td>
<td>(in 24/5 mode)</td>
<td>4200</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(in 24/7 mode)</td>
</tr>
<tr>
<td>Maximal current, mA</td>
<td>200</td>
<td>300</td>
</tr>
<tr>
<td>Maximal total RF voltage, MV</td>
<td>2.0</td>
<td>2.7</td>
</tr>
<tr>
<td>Lifetime, hours (at 100 mA)</td>
<td>20 - 25</td>
<td>35 - 40</td>
</tr>
<tr>
<td>Lifetime restoring after vacuum chamber repair</td>
<td>2 weeks</td>
<td>3 - 4 days</td>
</tr>
<tr>
<td>Number of wigglers</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Number of experimental stations</td>
<td>11</td>
<td>21</td>
</tr>
</tbody>
</table>
Thank you for your attention!