



Current status of VEPP-5 Injection Complex

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RuPAC-2021, Sept. 26 - Oct. 2, 2021, Alushta



- VEPP-5 Injection Complex:
 - main goal, parameters, operation modes
- Performance in 2020/2021:
 - achievements and challenges
- Performance improvements:
 - beam diagnostics, control system etc.
- Summary



BINP Colliders Layout



2016 – main injector for VEPP-4M, and routine operation for both colliders simultaneously 3



VEPP-5 Injection Complex





Two Collider Operation

- 4 modes of K-500- 12 transitions between user/particle type







- Operation over 7000 hours, (50/50% VEPP-4 / VEPP-2000)
- Maintenance work 10 % of the operation time,
- System failures mostly are due to outdated electronics of klystron modulators,
- Less failures due to magnetic system power supplies, since: 9 of 500 A and 8 of 1000 A power supplies have been replaced in 2019/2020,
- Energy increase to 430 MeV due to more accurate linac tuning,
- Decrease of e+ storage rate due to positron solenoid malfunction, by the factor of 2.

| Parameter | Value |
|------------------------------|---|
| Energy, MeV | 430 (previous 390) |
| Extraction freq, Hz | ≤ 2 |
| Injection frequency, Hz | Up to 12.5 |
| Max. e+ storage rate, e+/sec | 0.9·10 ¹⁰ (previous 1.7·10 ¹⁰) |
| Max. e- storage rate, e-/sec | 1.4·10 ¹¹ |
| Single injection, e+ | 0.7·10 ⁹ |
| Single injection, e- | 1.3·10 ¹⁰ |



New electron gun cathode assembly of up to 10 A, 8 ns.





12.10.2019 - positron solenoid accidental damage.

New positron solenoid

- Damage to positron solenoid resulted in significant reduction of e+ production rate: from $1.7 \cdot 10^{10}$ to $0.9 \cdot 10^{10}$ e+/sec,
- It only can be replaced as a whole unit including conversion system and 1st positron accelerating structure.
- Estimated replacement period 2021/2022.



Project of a new solenoid







Performance Improvement



Beam Loss Monitors

Fiber-based beam loss monitors were installed at the extraction channels in both collider directions. They allow on-line monitoring of beam loss distributions along the transfer lines.

Currently devices are integrated in the Complex control system and used in routine operation.





Linac RF System Monitoring

Sub-harmonic

buncher

Electron gun

Linac RF measurement points

Conversion system

- BINP developed VME ADC250x4 are deployed in order to measure all signals simultaneously.
- Common ADC clock connected to injection complex master generator allows to measure time between any signals.
- Integrated into injection complex software, automatic detection of usual signal changes under development.





Electron linac, 300 MeV



Control Software

Injection complex software based on CXv4 framework. We are constantly improving our software set. There are our latest steps in this direction:

- Many base framework improvements
- Server-side bridging, used to easily interface beam user control systems.
- EPICS and TANGO client modules for CX
- Improved python bindings for CX client libraries
- Improved CX-connected Qt widgets set
- Improved Database tools for machine configuration, configuration files generation and operation data archieving.
- Improved automatic and data preprocessing software
- Developed a software set for damping ring optic measurement and studies
- Developed few new operator's screens



Frontend clients for damping ring optic studies



Injection Efficiency

Amount of captured positrons in the damping ring vs. tunes



V. Balakin, WEPSC56, Poster session C

Beam Diagnostics for Injection Channels

Layout of proposed BPMs for injection channels



New set of BPMs should prevent additional losses related to trajectory or optics inaccuracies.

And as a result, better productivity and operation stability of the Injection Complex.



- Since 2016 VEPP-5 IC routinely supplies both BINP colliders with high energy electron and positron beams.
- Sufficient charge production rates and minimal switching times between the operating modes for colliders to achieve their desired luminosity, are obtained.
- 10 A electron gun for better production rate is installed.
- Fiber-based beam loss monitor system for reliable operation is installed.
- Software improvements were performed.
- Measurements for injection efficiency are performed.
- Further IC performance and operation stability improvements are still required and under consideration.

Thank you for your attention

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