NANOBEAM'08

Project of a new hard X-Ray source for Siberian Synchrotron Radiation Center

E.I. Antokhin, G.N. Kulipanov, N.A.Mezentsev, S.V. Miginsky, A. Netepenko, V.E. Panchenko, A.V. Philipchenko, S.Sinyatkin, N.A. Vinokurov, K.V. Zolotarev

Budker Institute of Nuclear Physics, Novosibirsk

Problems and opportunities

- Siberian Synchrotron Radiation Center (SSRC) unifies many SR users from different scientific organizations. Most popular modern scientific techniques are realized on SSRC beamlines.
- Currently used in the SSRC SR sources (VEPP-3 and VEPP-4) aren't dedicated for SR generation. Absence of specialized SR source in Siberian SR Center (SSRC) suspends a future progress of SR applications.
- BINP stuff has a big experience for creation a modern acceleration facilities (including light sources), so possibility to make such source for own needs is evident.
- Great experience of BINP in developing and fabrication of superconducting insertion devices for SR centers also gives some additional kicks for SR source project.

Superconductive bending dipoles (Superbends) as a SR generators

$\varepsilon_c \sim E^2 \cdot B$ - hard X-ray spectra for low energy

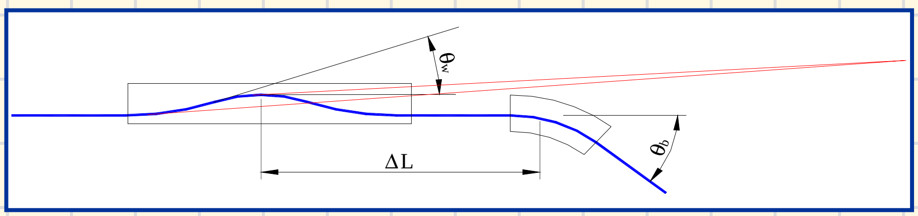
Superbends vs. wavelength shifters

Advantages

- Big bending angle, few SR extraction beamlines are possible
- Absence of second source
- Smaller distance between irradiation point and focal point

Disadvantage

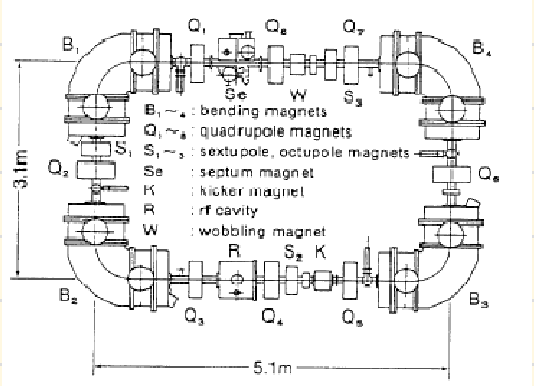
- Reliability requirements similar to requirement for magnetic elements of main ring structure



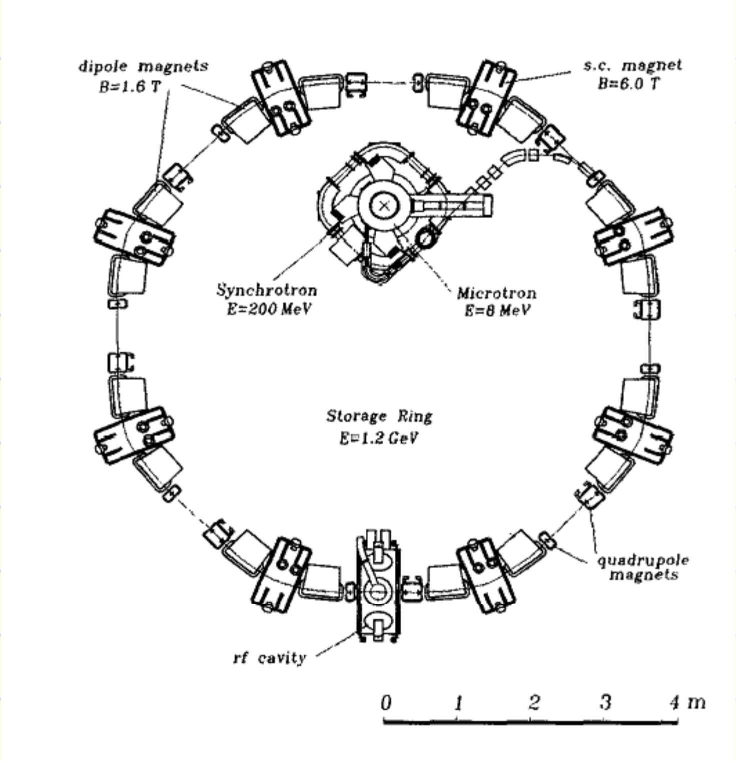
History
Superconducting compact SR sources

- *Compact SR sources for X-ray lithography*
  AURORA (Sumitomo), NIJI-III (ETL), COSY, SXLS, Helios, Super-ALIS (199X).
- *BINP projects (1992)*
  - *6 T superconducting bending magnet prototype*
  - *Siberia-SM*
  - *Siberia-MP*
  - *Siberia-HB*
- *ALS upgrade (5 T SC dipoles, 2002)*
- *9 T superconducting bending magnet for BESSY-II (BINP, 2004)*

NIJI-III (ETL)



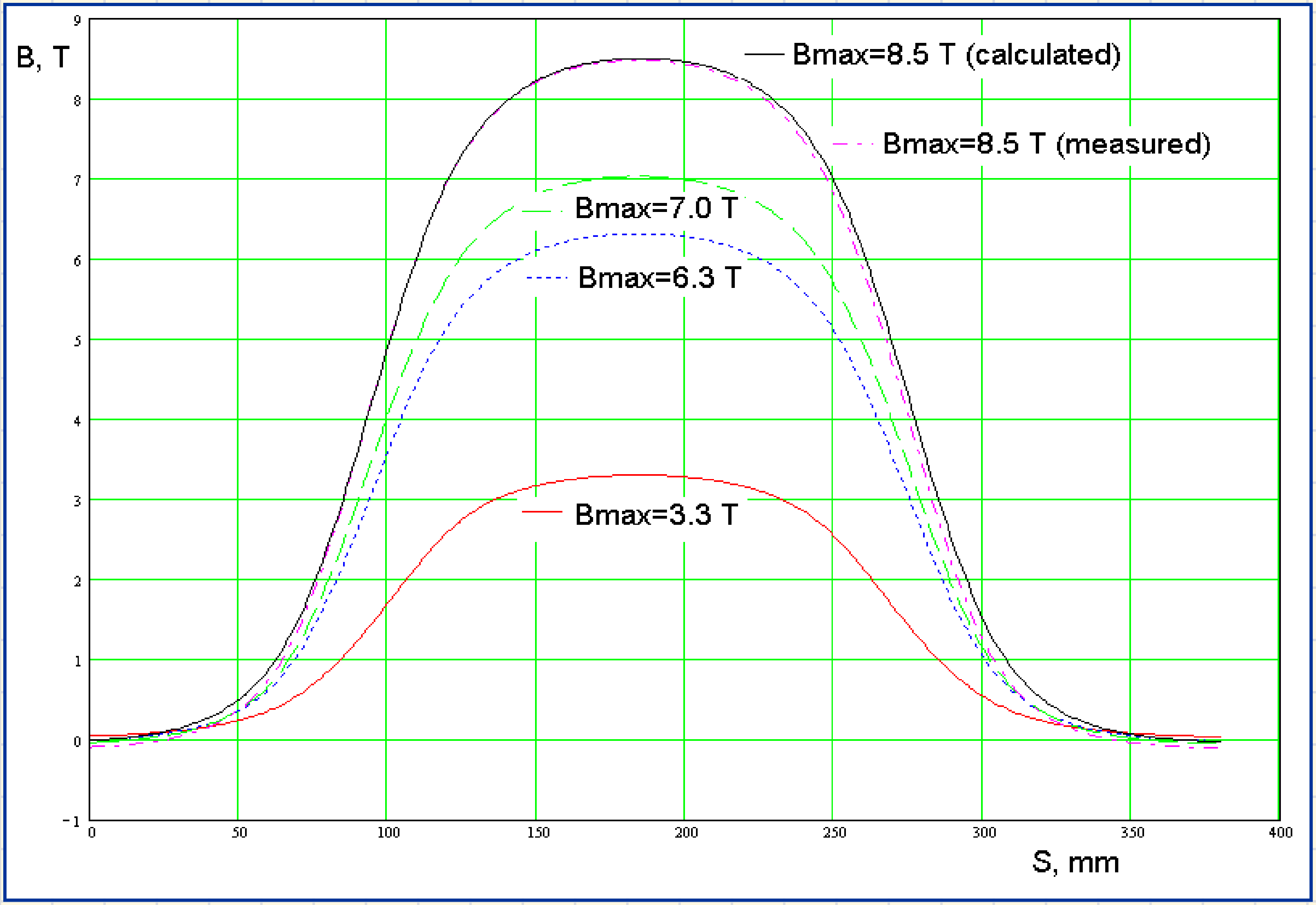
Siberia-MP (BINP,1992)



Main parameters of SC dipole

Vertical aperture, mm Horizontal aperture, mm	30 75
Pole gap, mm	46
Operating magnetic field, Tesla Maximum magnetic field, Tesla	3.3 - 8.5 9.6
Coil material	Nb_3Sn, NbTi
Edge angle, degree	1.3
Current in coil for 8.5 Tesla, A	264
Ramping time 0-7 Tesla, min Ramping time 0-9 Tesla, min	<5 <15
Eff. magnetic length along beam, m	0.1777
Bending angle, degree	11.25
Bending radius, m	0.905
Stored energy for 8.5 Tesla, kJ	180
Cold mass, kg	1300
Liquid He consumption	~0.5 l/h

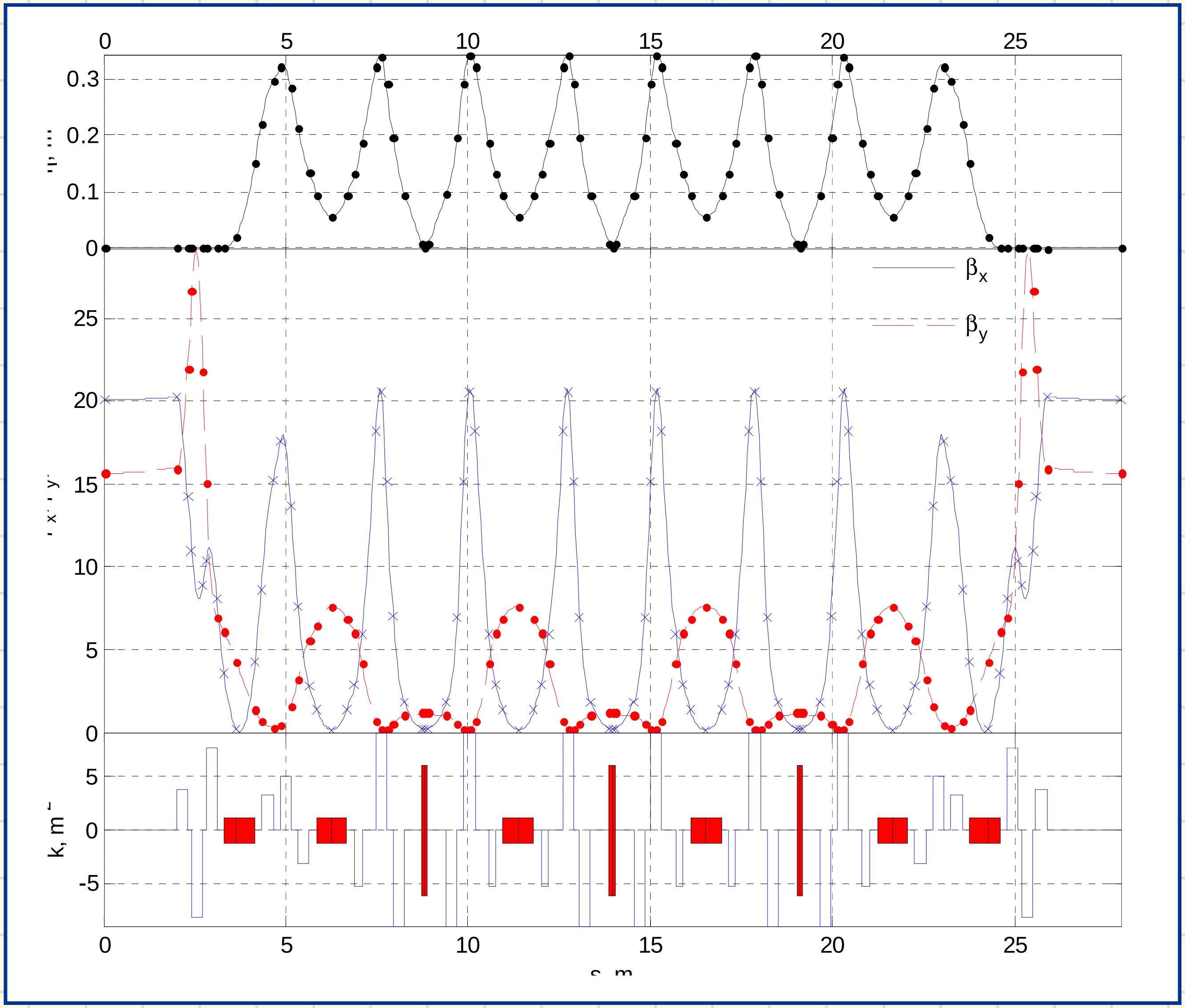
Longitudinal profile of magnetic field in Superbend



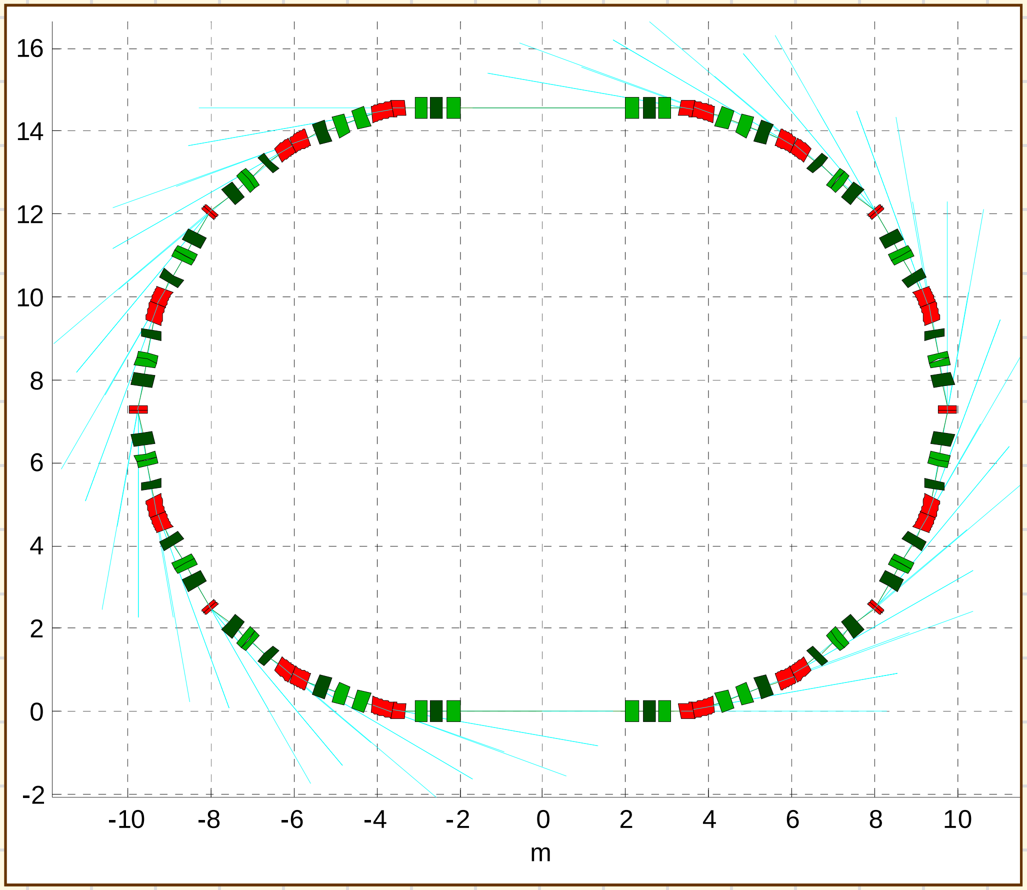
Main parameters of compact SR source

Energy	1.2 GeV
Beam current	700 – 1000 mA
Circumference	~ 56 m
Equilibrium horizontal emittance	~ 10 nm
Number of bending magnets (all magnets have 20° deflecting magnets)	6 superconducting (8.5 T) 12 conventional (1.65 T)
Critical energy of SR photons	7.6 keV for beams from supercoducting magnets 1.4 keV for conventional magnets
Number of beamlines	18 from supercoducting magnets 8 from convetional
Top energy injection	

Optical functions (TME lattice)



Linear optics design layout



Π=55.8 m

Q_x/Q_z = 4.10/3.67

C_x/C_z = -26.78/-9.64

J_x=1.038

α=4.74 10^{-3}

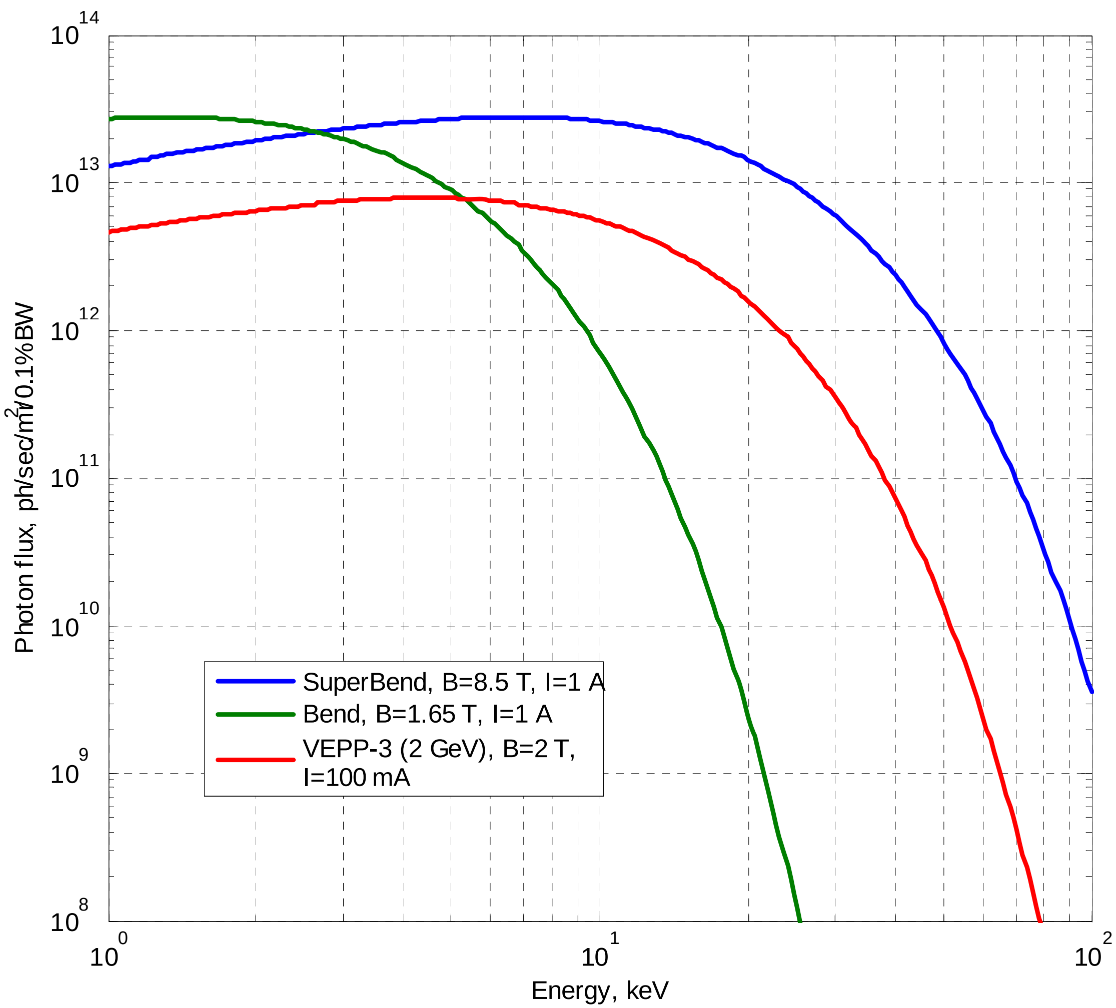
δE/E=1.33 10^{-3}

ε_x = 10.2 nm rad

ΔE = 180.2 keV/turn

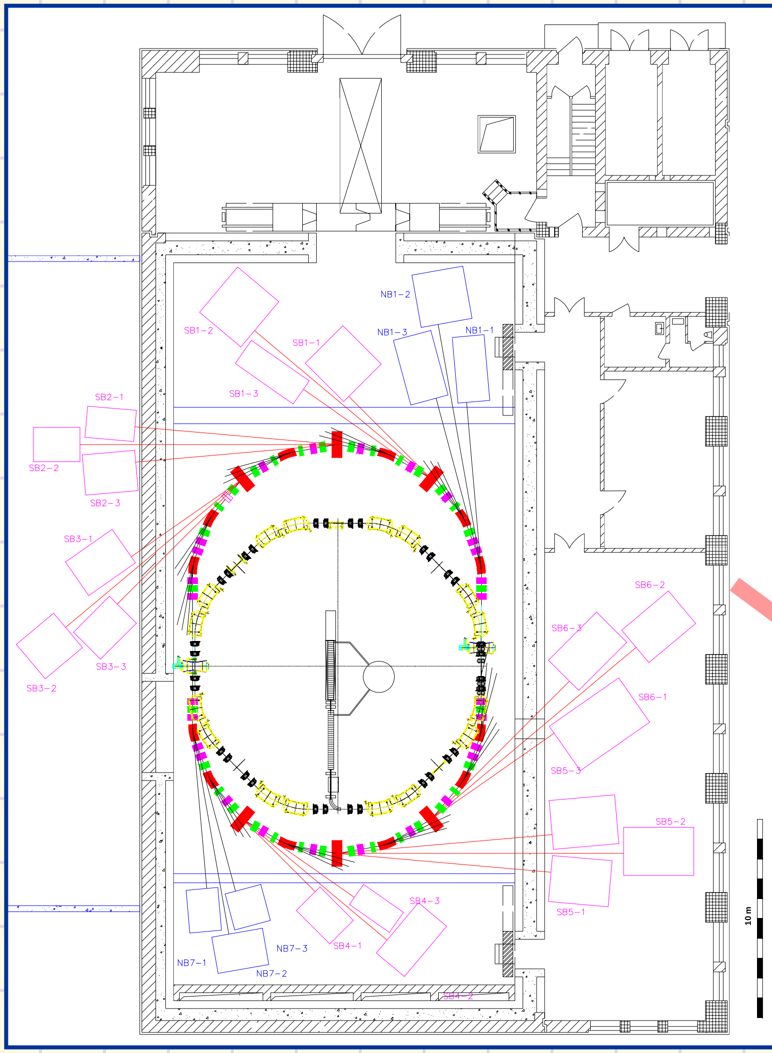
τ = 2.38 ms

Brightness



Photon flux, ph/sec/mm2/0.1%BW
Energy, keV
SuperBend, B=8.5 T, I=1 A
Bend, B=1.65 T, I=1 A
VEPP-3 (2 GeV), B=2 T, I=100 mA

Layout


NB1-2
SB1-2
SB1-1
NB1-3
NB1-1
SB1-3
SB2-1
SB2-2
SB2-3
SB3-1
SB3-3
SB3-2
SB6-2
SB6-3
SB6-1
SB5-3
SB5-2
SB5-1
SB4-3
SB4-1
NB7-3
NB7-1
NB7-2
10 m

Cost estimation

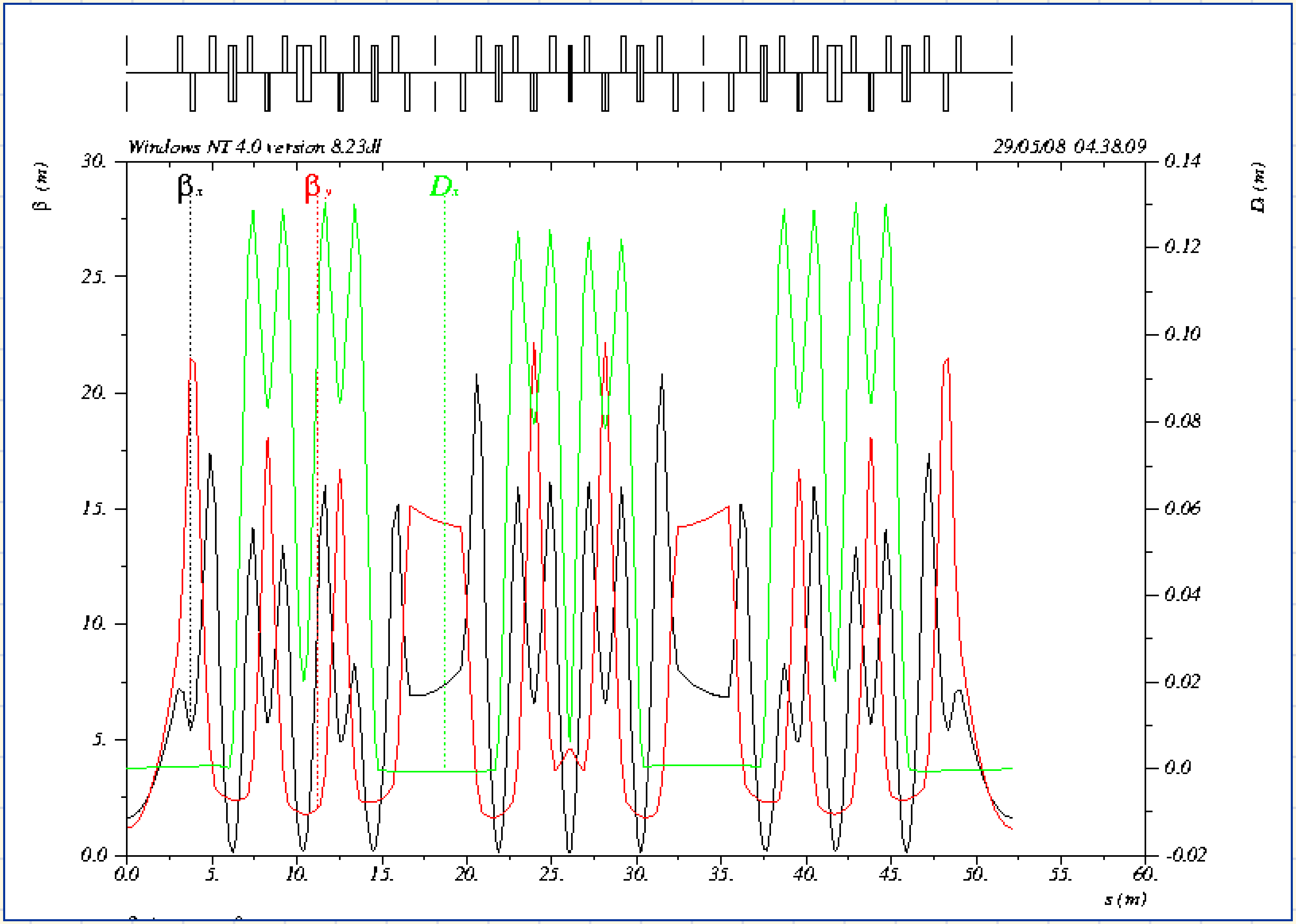
Subsystem	Millions rubles
Superconductive magnets (6 items) with cryogenic system and power suppliers	120
Conventional magnets (12 items)	12
Other elements of magnetic system (quadruple lenses and sextupoles – 60 items)	28
Power supplier for magnetic elements	15
BPMs and correctors	10
RF cavity (180 MHz)	12
RF generator and power supply for RF system	12
Buster synchrotron (1.2 GeV)	150
Linac (100 MeV)	60
Transfer lines	18
Injector system	12
Vacuum chamber	18
Vacuum pumps and power supplier	6
Vacuum valves with RF window	4
Total cost	477

NANOBEAM'08

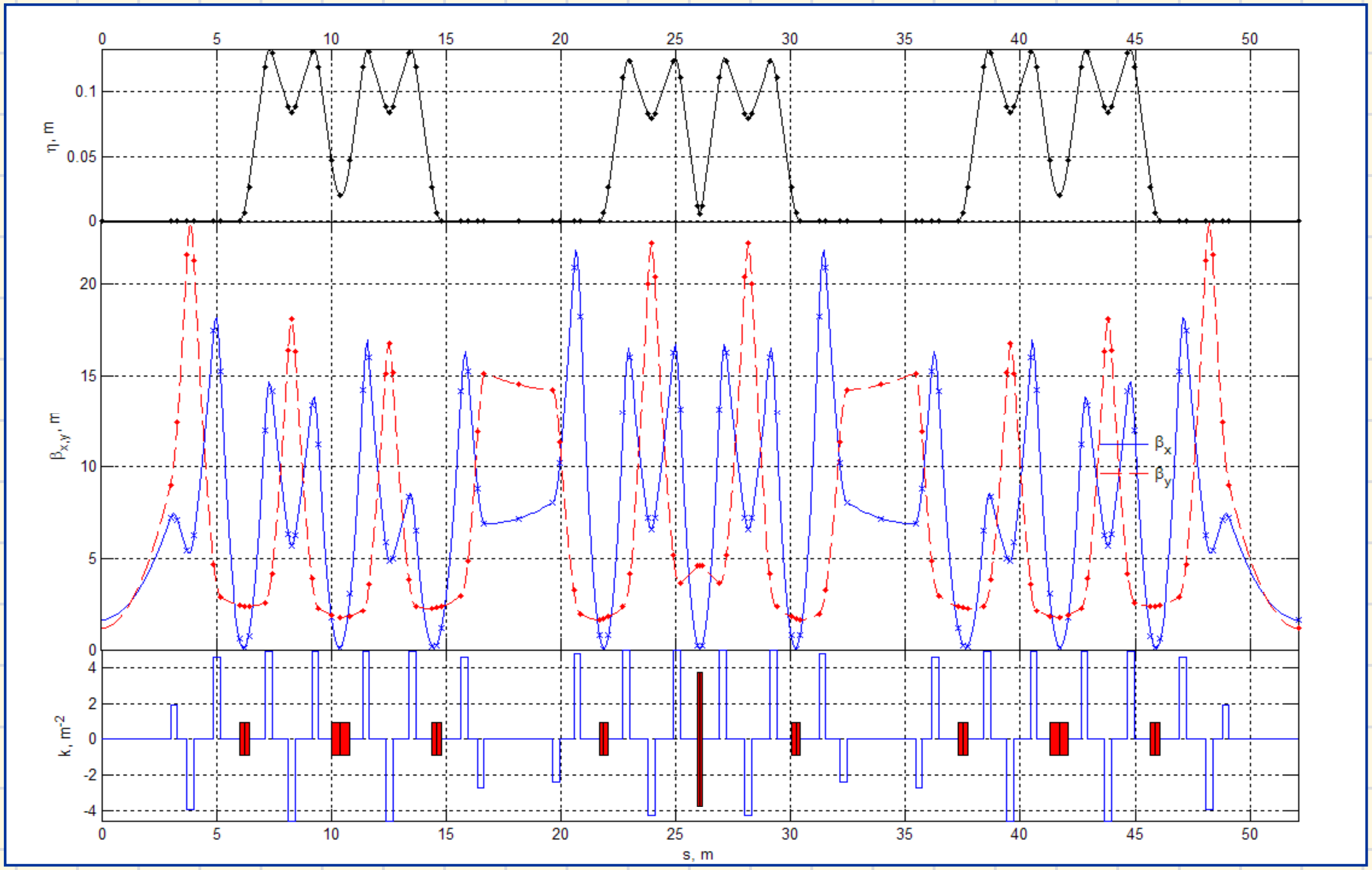
Main parameters of SR source

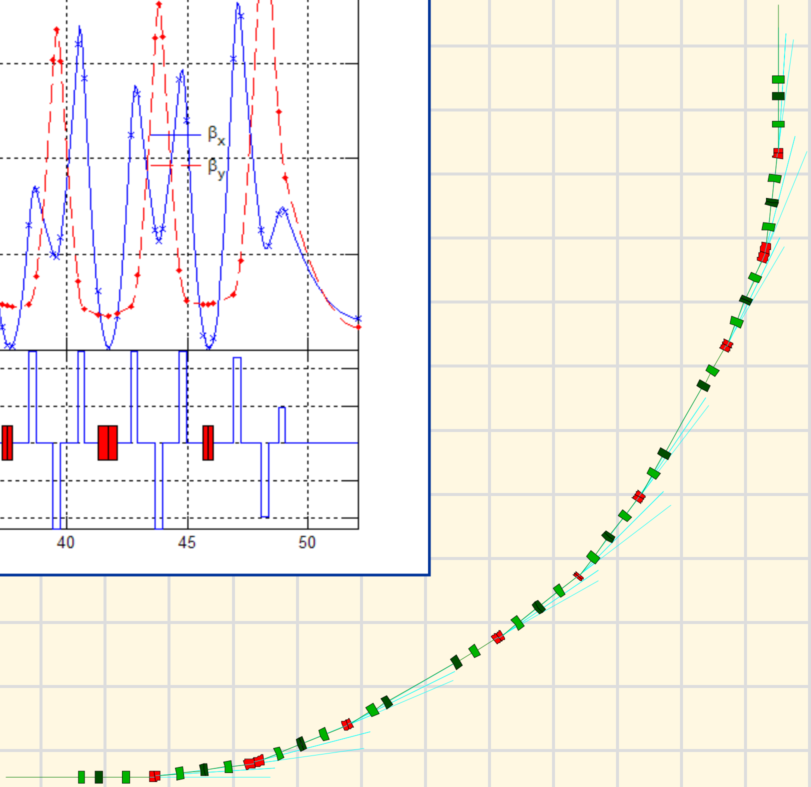
Energy	2.2 GeV
Magnetic field in the bending dipoles	8.5 T in superconductive magnets (Super bends) 1.6 T in normal magnets
SR critical energy	25 keV for beam from Superbends 6 keV for beam from conventional dipols
Bending angle	7.5 and 15 degrees
Number of dipoles	4 Superbends (15°) 8 normal dipoles (15°) 24 normal dipoles (7.5°)
Horizontal emittance	~5 nm rad
RF frequence	180 MHz
Operating current	0.5 – 1 A
Beam lifetime	~ 10 hours
Circumference	~ 210 m

Lattice

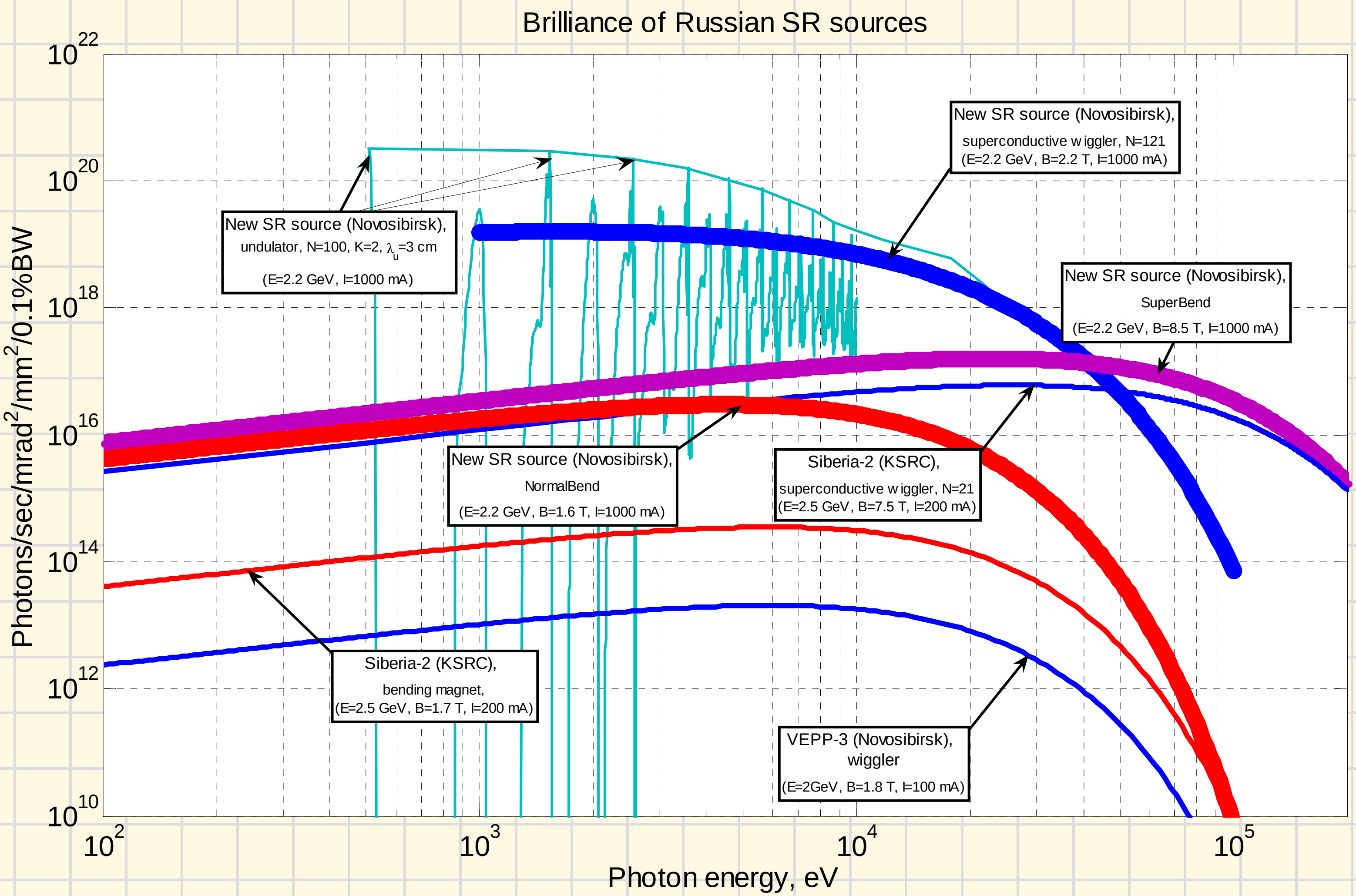

Windows NT 4.0 version 8.23dl
29/05/08 04.38.09
β (m)
D (m)
βx
βy
Dx
30.
25.
20.
15.
10.
5.
0.0
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.0
-0.02
0.0
5.
10.
15.
20.
25.
30.
35.
40.
45.
50.
55.
60.
s (m)

Superperiod structure

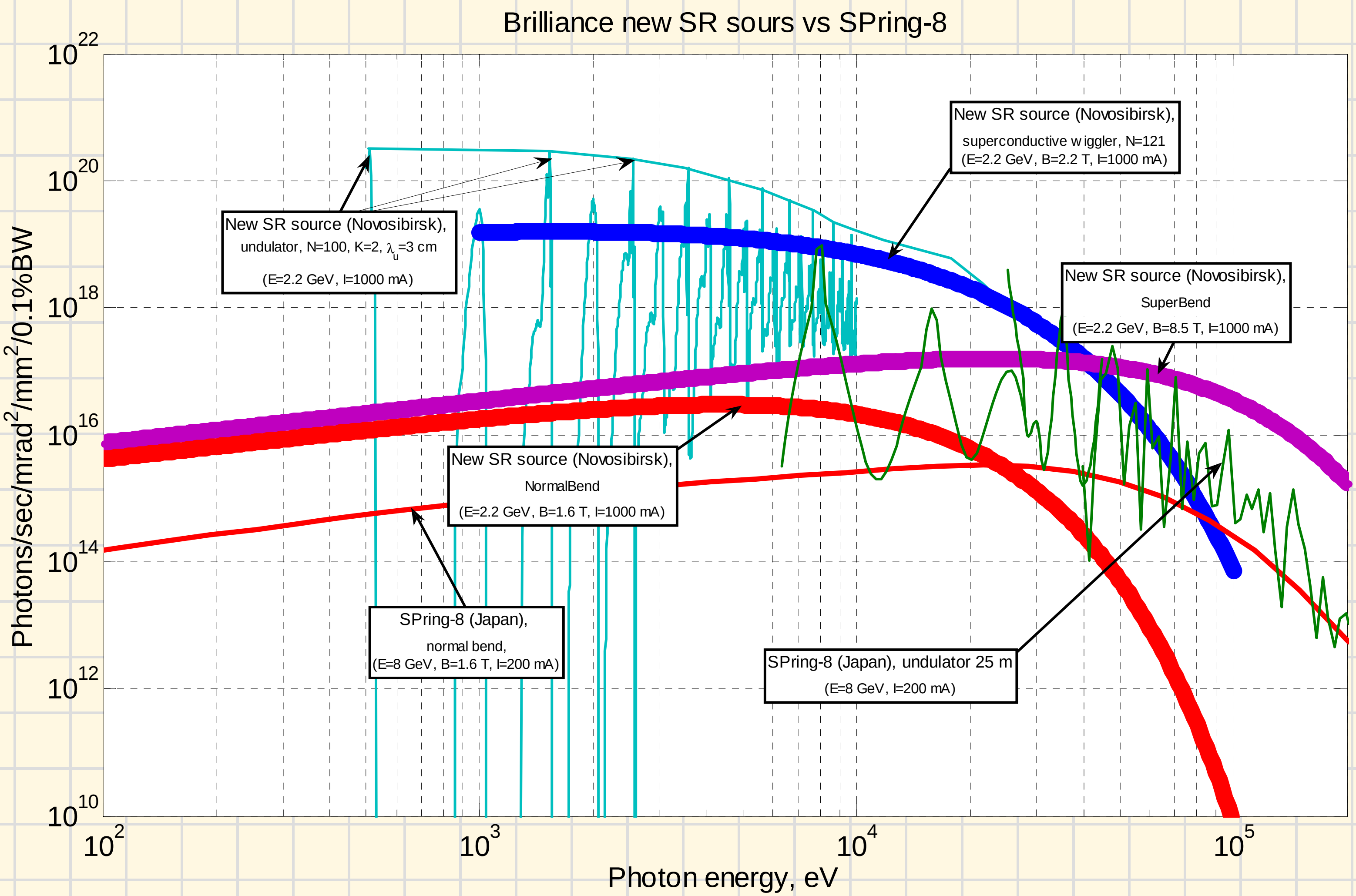




Source brilliance

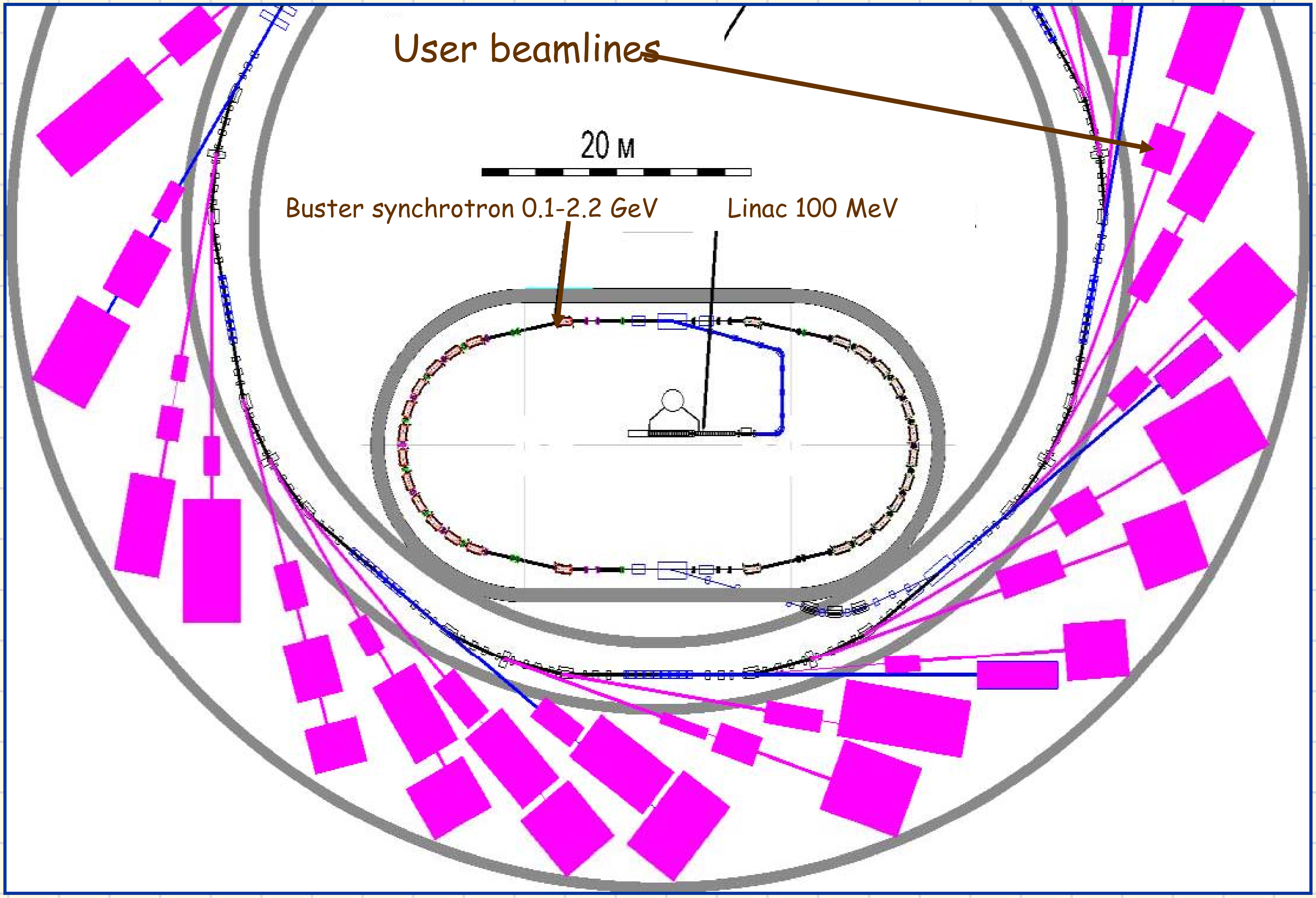


Source brilliance



NANOBEAM'08

Facility layout



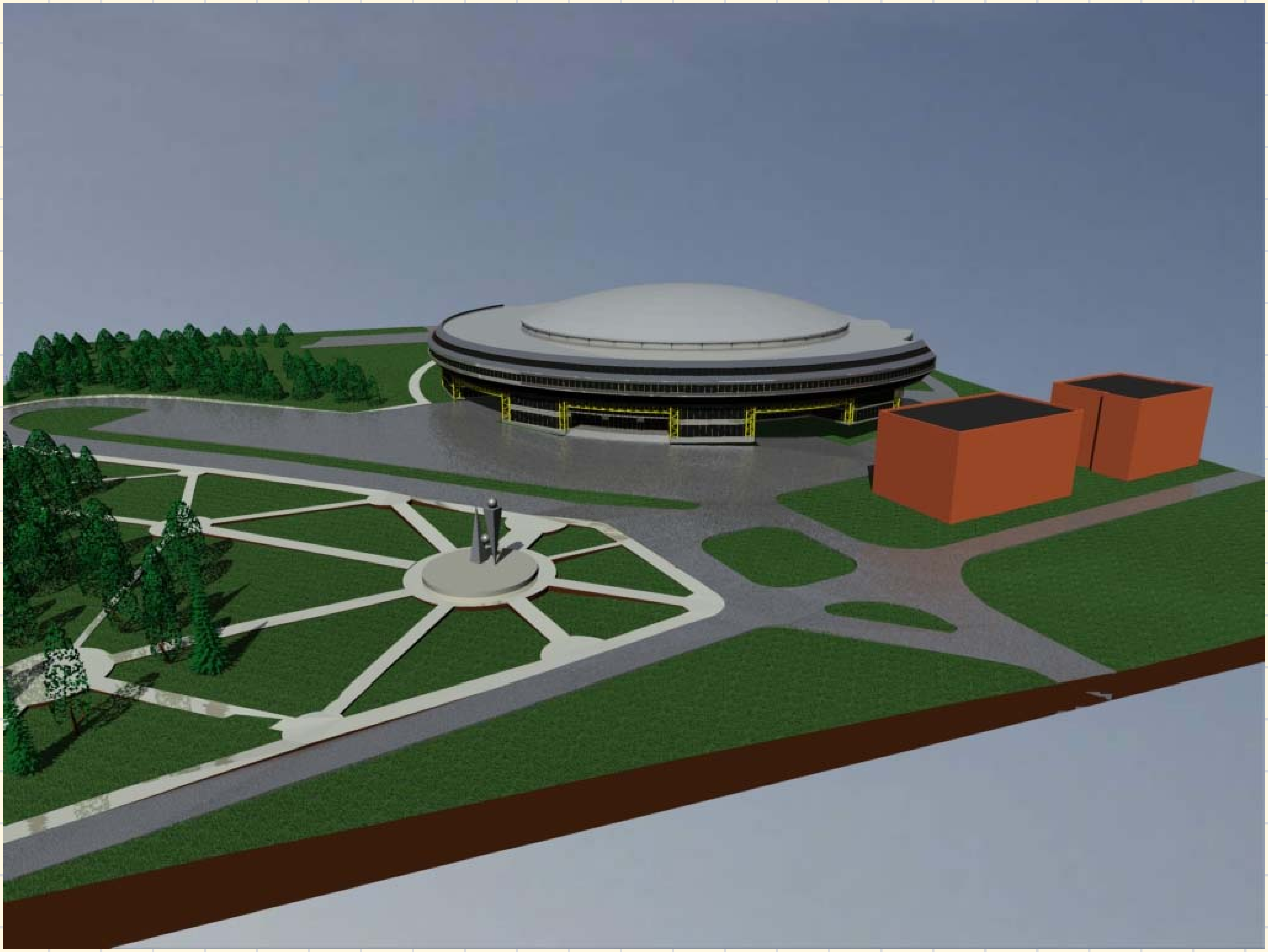
NANOBEAM'08

Location

NANOBEAM'08

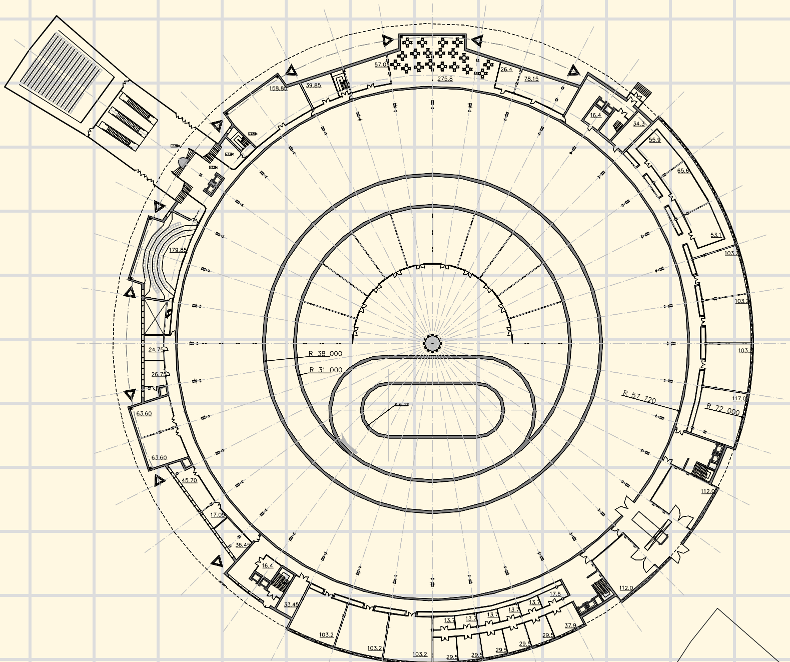
Location

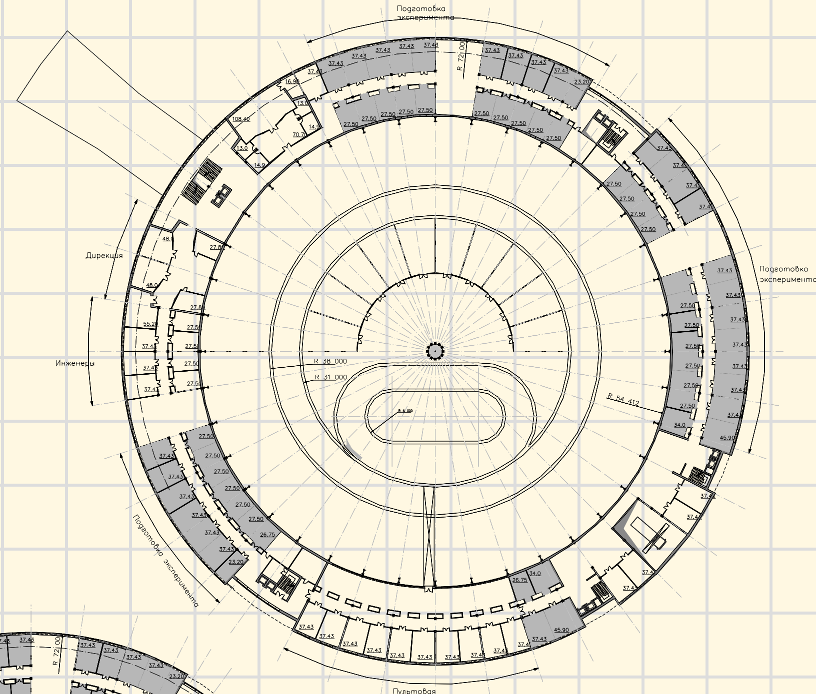
Building general view

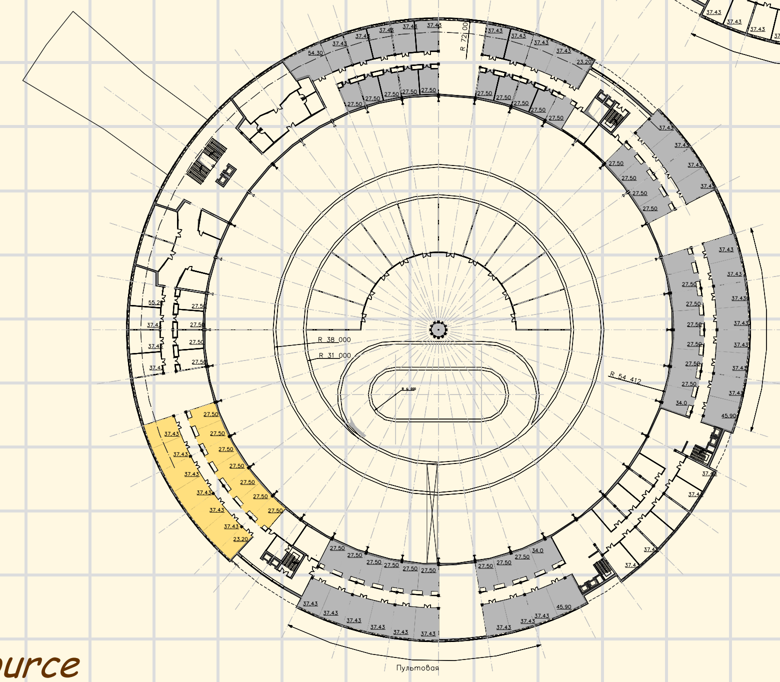


NANOBEAM'08

Floors plans of SSRC building





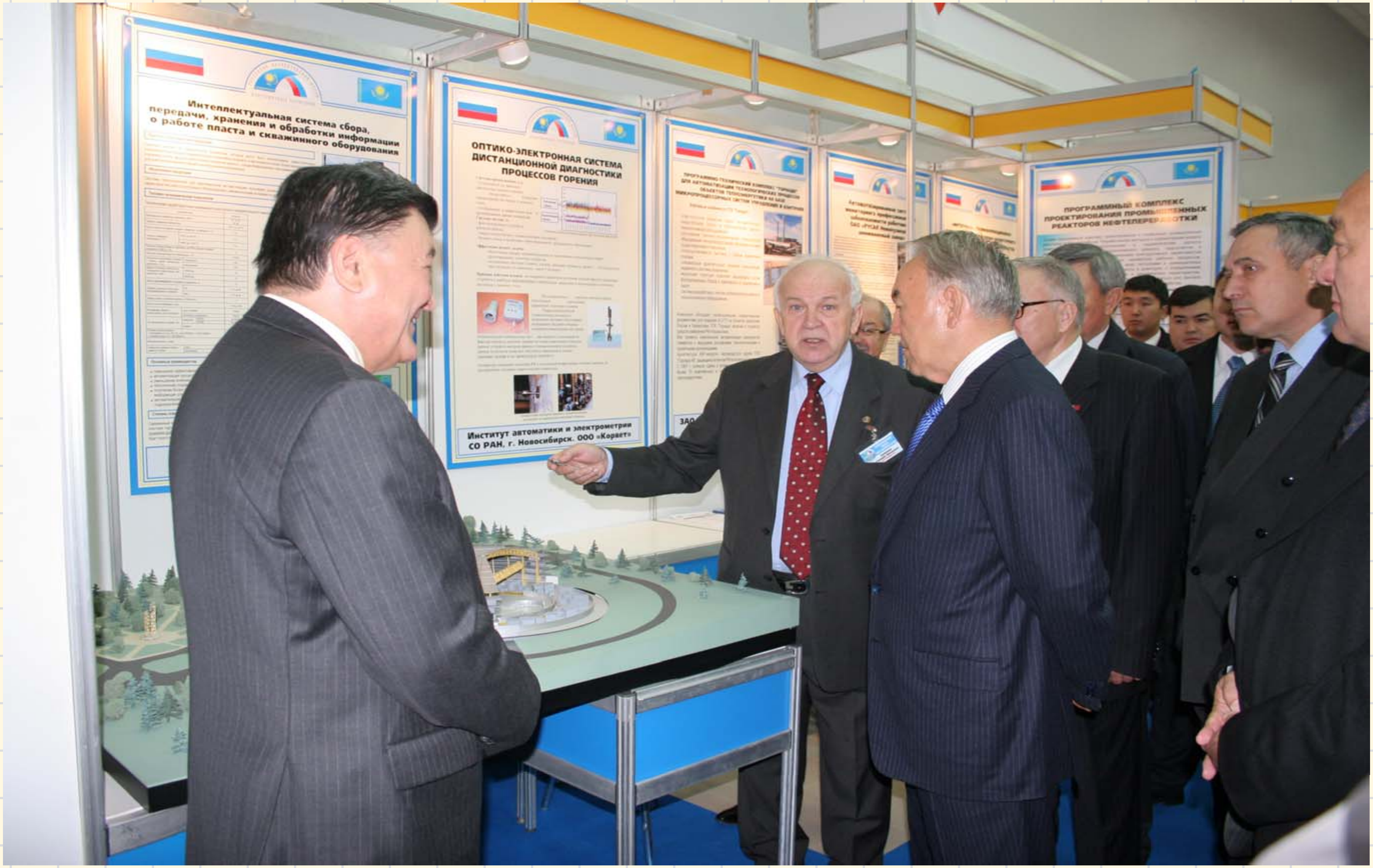


Conclusions

- BINP has a real opportunity to create modern SR source with using superconductive bending magnets
- Project cost should be about 100 M€ (50 M€ for facility and 50 M€ for building)
- Construction duration about 5 years

NANOBEAM'08

NOMAD light source for Kazakhstan



Thank you for attention