DIAGNOSTICS FOR SKIF SYNCHROTRON LIGHT SOURCE

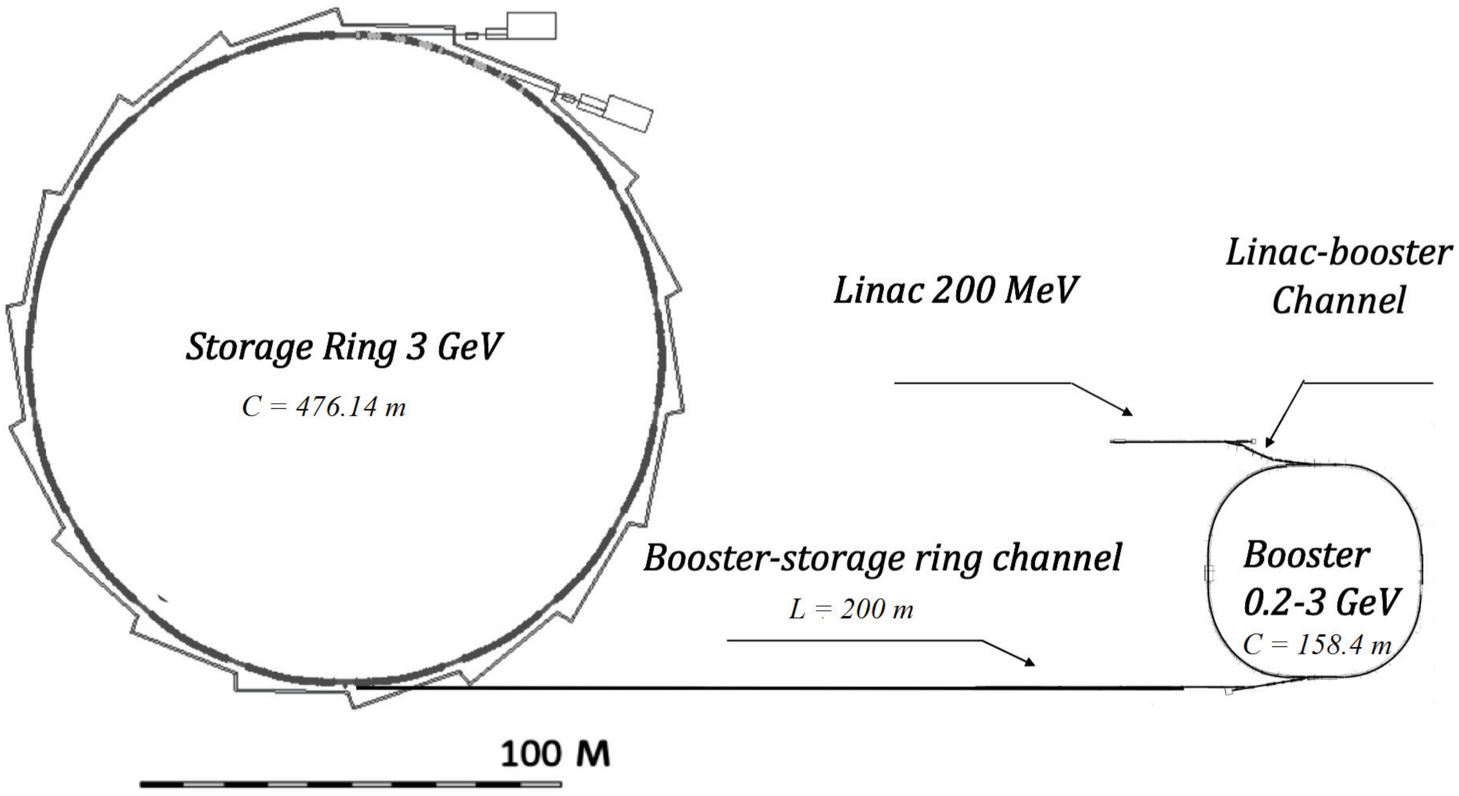
Budker Institute of Nuclear Physics

O. I. Meshkov[1,2], V. G. Cheskidov[1], E. A. Bekhtenev[1], V.L. Dorokhov[1], Yu. I. Maltseva[1,2], S.V. Ivanenko[1], G. V. Karpov[1,2], A.D. Khilchenko[1], Ma Xiao Chao[1], O.A. Pavlov[1], E.A. Puryga[1], V.N.Volkov[1].

[1]Budker Institute of Nuclear Physics SB RAS, Novosibirsk, Russia

[2]Novosibirsk State University, Novosibirsk, Russia

The Siberian ring photon source (SKIF) is a new generation synchrotron light source designed and built by the BINP



СКИФ
СИБИРСКИЙ КОЛЬЦЕВОЙ ИСТОЧНИК ФОТОНОВ

Fig.1. SKIF layout.

Linear accelerator

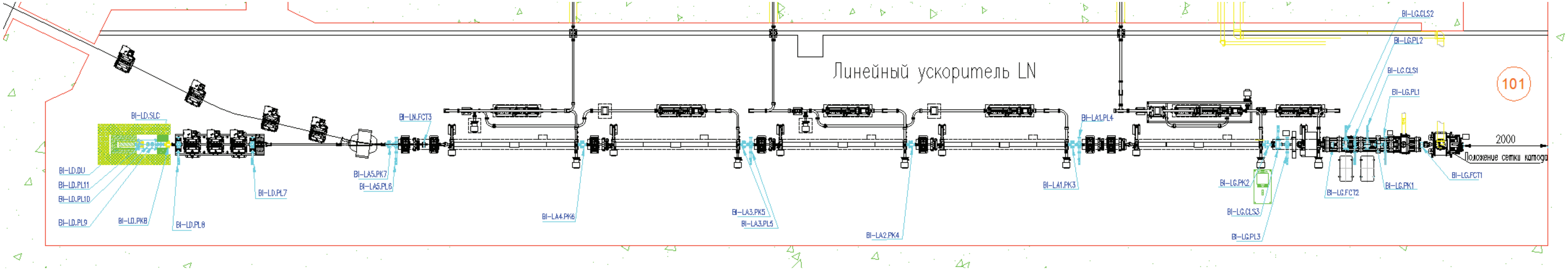
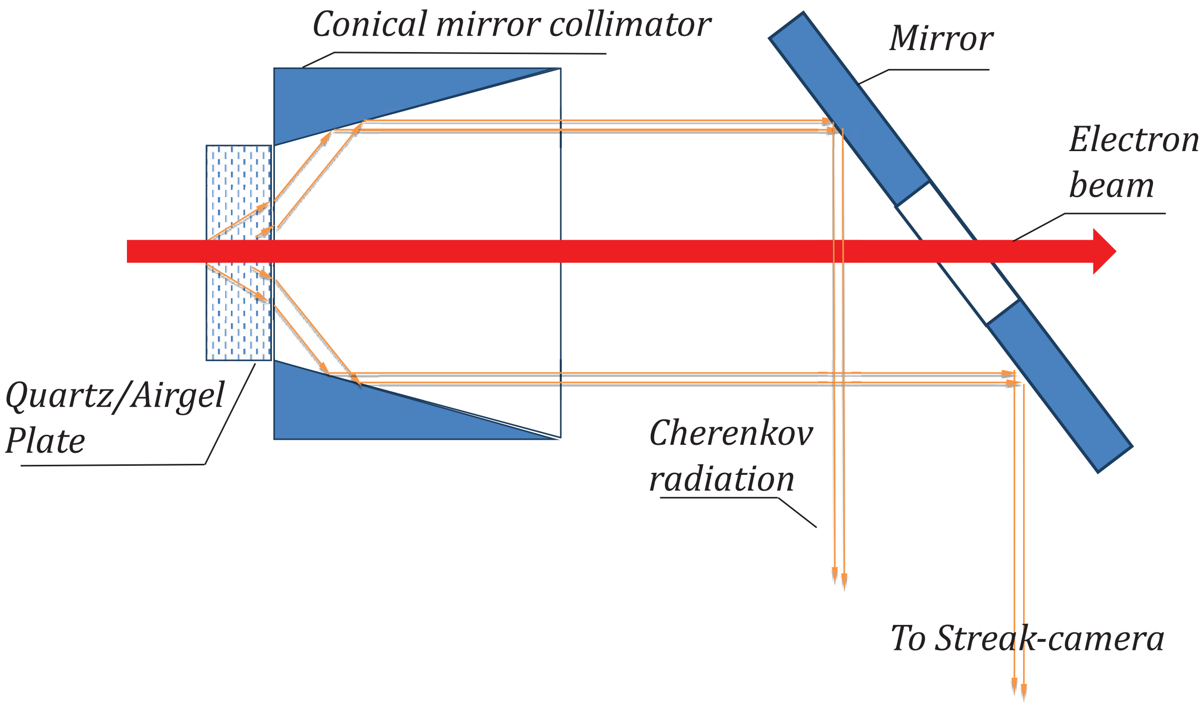


Fig.2. Linear accelerator layout.

Linear accelerator beam diagnostics:

- **BPM – 7**
- **FCT – 3**
- **Fluorescent screens – 9**
- **Cherenkov sensors – 3**
- **Magnetic spectrometer (E = 0.6 – 200 MeV)**
- **Faraday cup – 2 (E = 0.6 – 3 MeV, E = 50 – 200 MeV)**

Linac: Cherenkov sensors

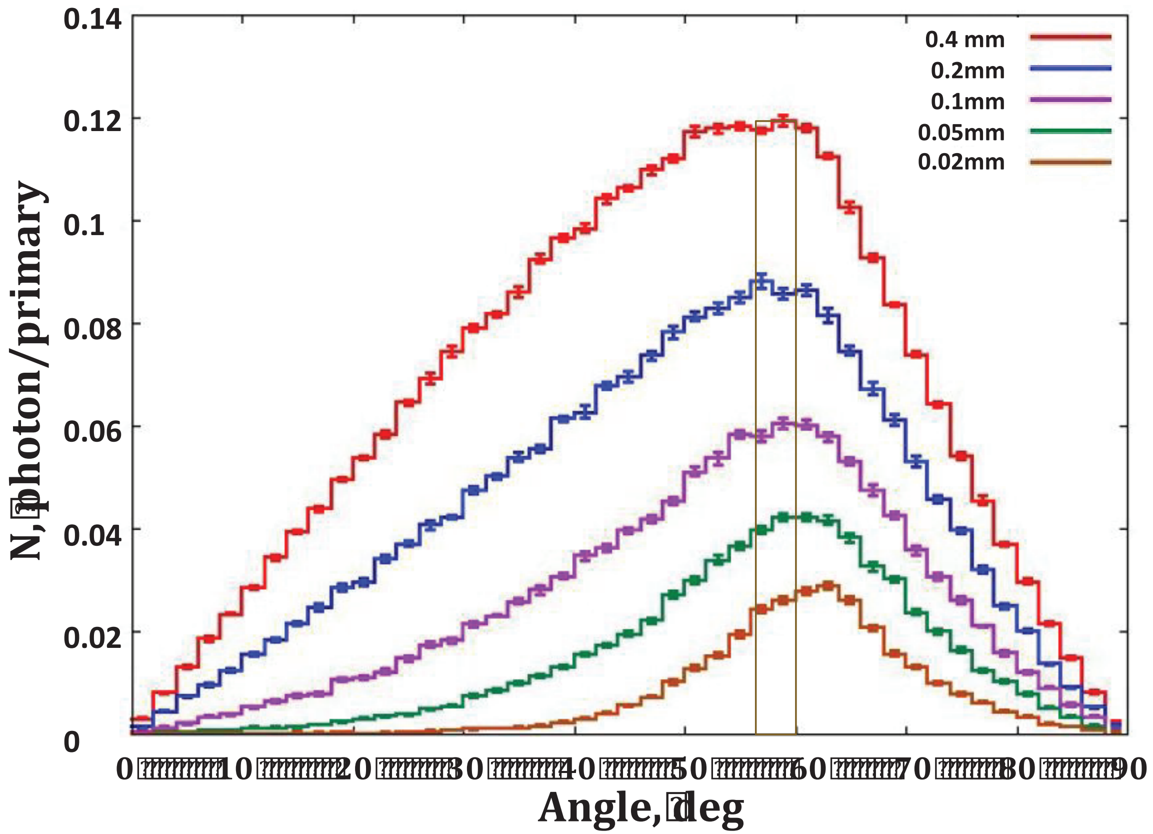


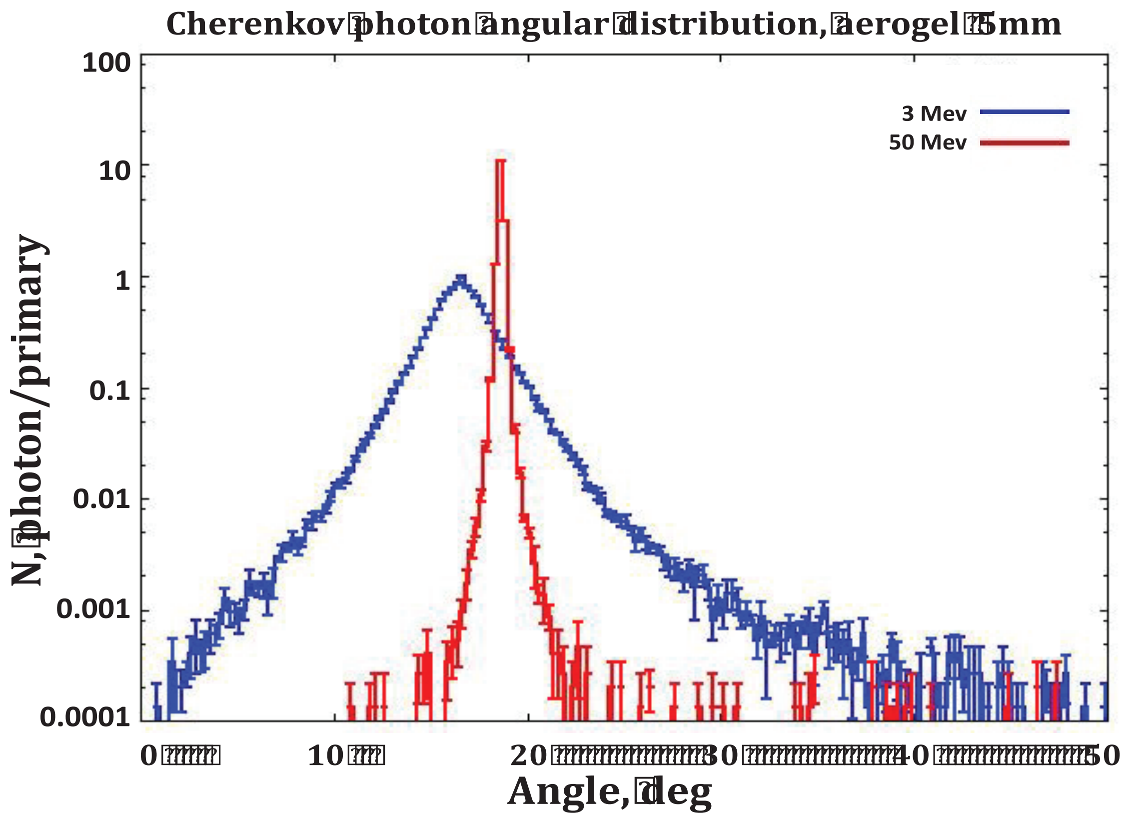
Layout of Cherenkov sensor for measuring longitudinal bunch profile. Cherenkov radiator is manufactured from quartz for beam energy *E* = 0.6 MeV and from quartz aerogel for *E* = 3 MeV and higher.

$$\Delta t = \frac{ndsin\theta}{c} = \frac{d}{c}\sqrt{n^2 - \frac{1}{\beta^2}}$$

The Siberian Ring Photon Source (SKIF) requires very short electron bunches with a charge of 0.3 or 1 nC, having a mean square length of 1 mm or an rms duration of σ= 3 psec. The bunch length will be reduced Such bunches will be obtained from 1 nsec by the velocity bunching method at the 3 meter drift interval, containing a 178 MHz RF gun, 534 MHz third harmonic resonator and 2856 MHz Pre-accelerator, as well as focusing and diagnostic elements. Thus, we must reduce the initial bunch length at 250 times by precisely selecting six parameters – the amplitudes and phases of the RF field in the RF gun and, accordingly, in the third harmonic resonator and in the pre-accelerator section. The appropriate diagnostics of bunch length should be applied for that.

Linac: Cherenkov sensors





Cherenkov radiation angular distribution of **0.6 MeV** electrons beam through different quartz plate thicknesses.

The angular distributions of Cherenkov photons emitted by **3 MeV** and **50 MeV** electron beam passing through 5mm of a quartz aerogel.

FLUKA simulations

Linac: Magnetic spectrometer

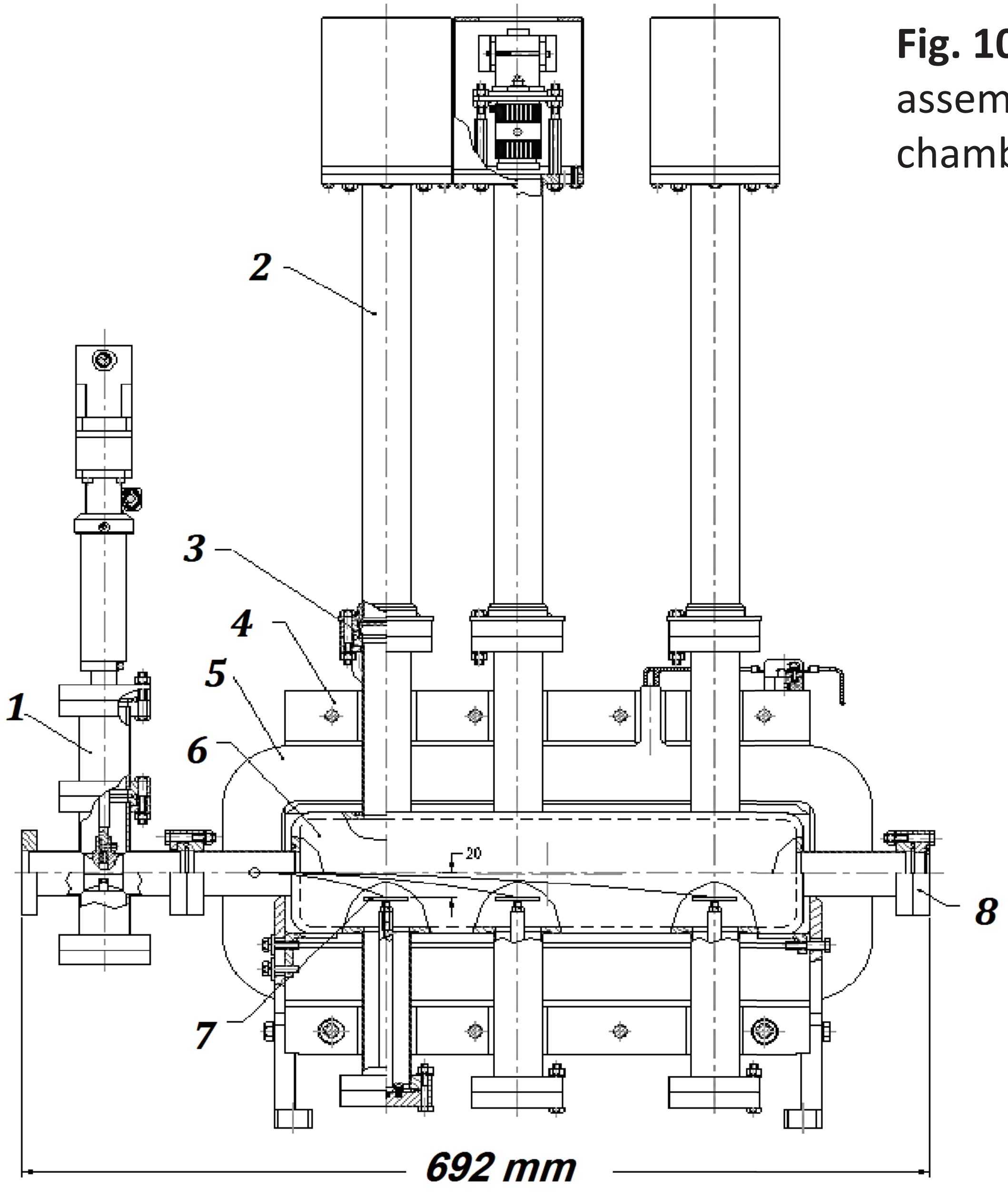
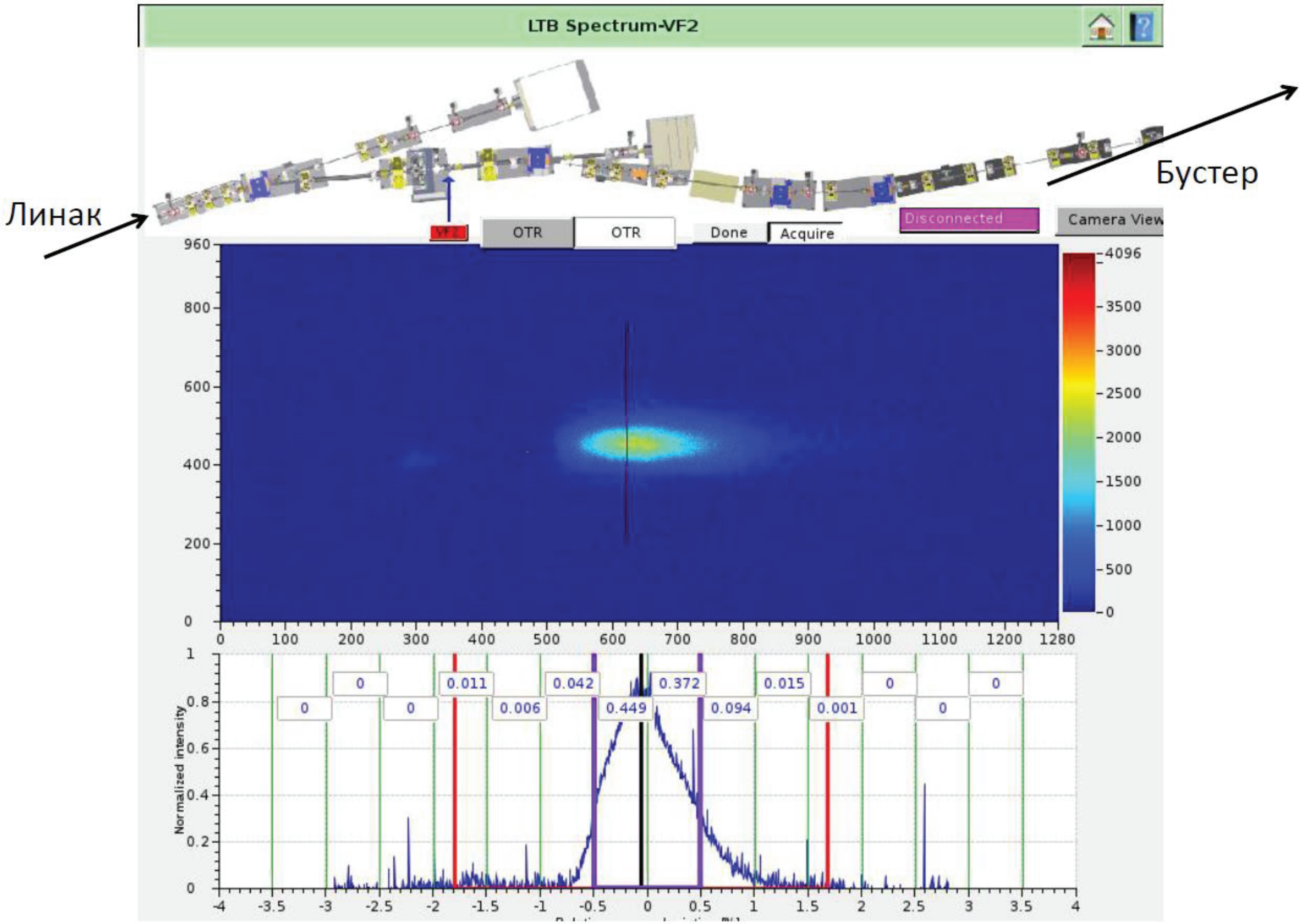


Fig. 10. Layout of spectrometer: 1 - collimator, 2 - digital camera assembly, 3 -vacuum window, 4 - magnetic core, 5 - coils, 6 - vacuum chamber, 7 - plate with applied phosphor, 8 –Ti outlet window.

Table 2. Calculated Parameters of the Fluorescent Screens of the Magnetic Spectrometer

L, mm	E, MeV	E_{min}, MeV	E_{max}, MeV	B, Gs	dE/dx, keV/mm
100	0.6	0.40	0.83	77.86	17.3
200	6	5.22	6.83	129.45	64.5
350	50	45.90	53.67	329.7	287.4
350	200	183.5	214.2	1307	1228

Linac: Magnetic spectrometer



Linac: Faraday cup (beam dump)

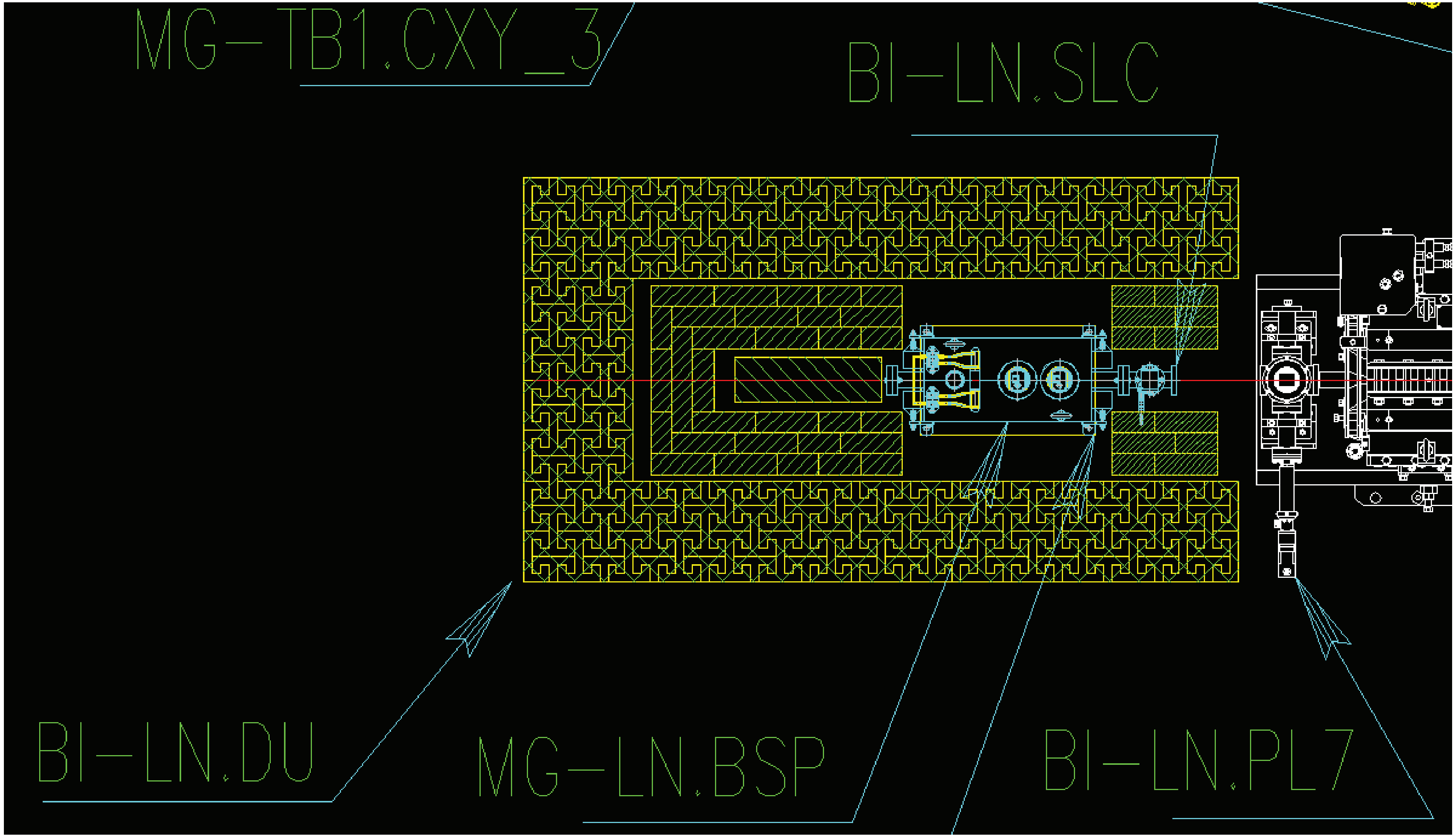
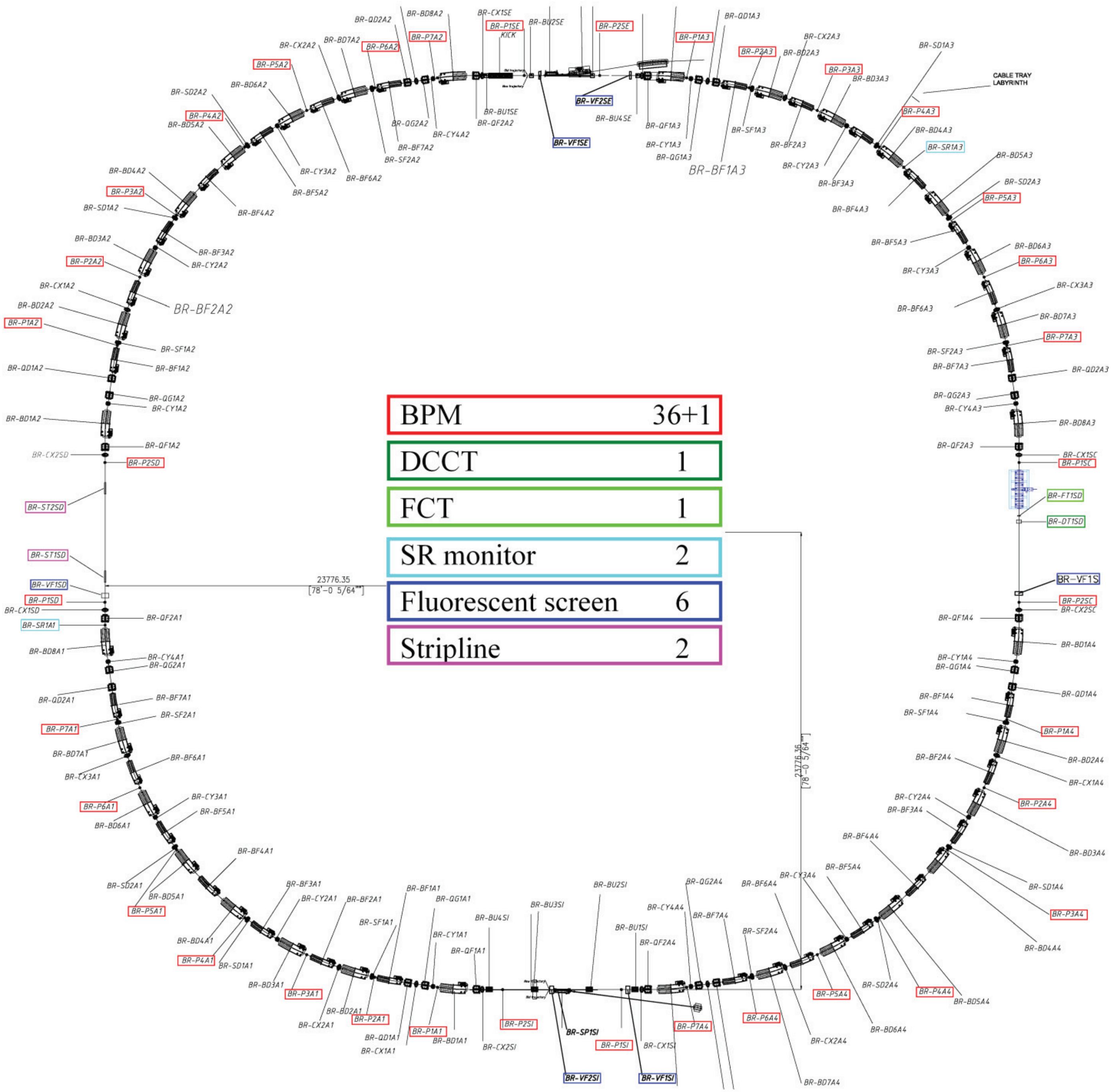


Fig. 11. Layout of Faraday cup and magnetic spectrometer inside the radiation protection.

Booster diagnostics



The SKIF booster is almost copy of the NSLS-II booster and has the same set of diagnostics.

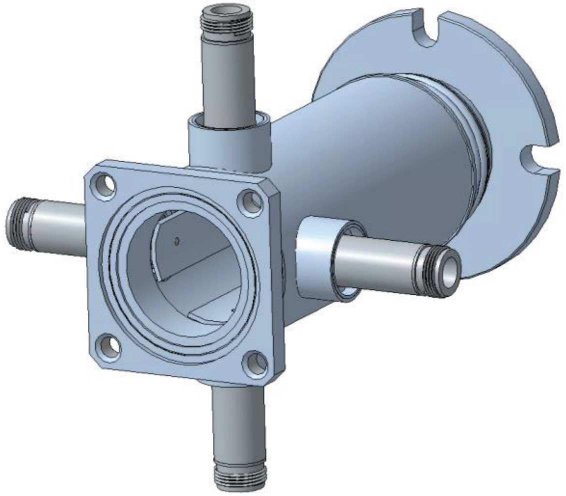
Beam position monitors (G. V. Karpov, E. A. Bekhtenev -)

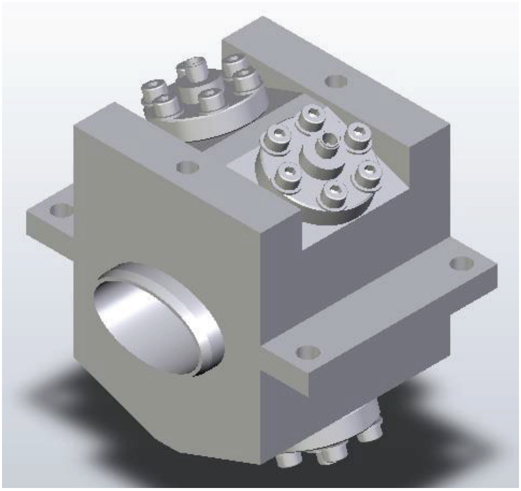
3 types of beam position monitors will be used in the SKIF light source.

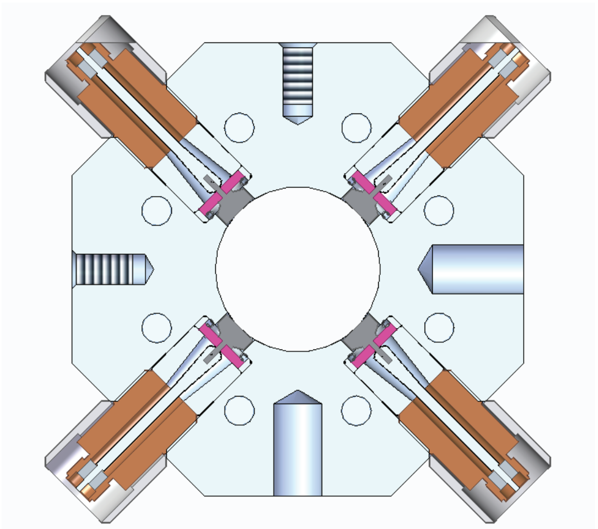
1. Stripline type BPMs (Linac)

2. Button type BPMs with button diameter of 15 mm (Booster)

3. Button type BPMs with button diameter of 6 mm (Storage ring)







SKIF part	Number of BPMs
Linear accelerator	7
channel Linear accelerator – Booster	6
Booster	36
channel Booster – Storage ring	9
Storage ring	224

VEPP-4: 54 BPM

Table. 1. Amount of BPMs in the SKIF.

Beam position monitors (G. V. Karpov, E. A. Bekhtenev)

BINP-made electronics will be used in the linac, booster, channel linac-booster and channel booster-storage ring.

Parameter	Value
Resolution of the turn-by-turn measurements*: - For beam charge 15 nC - For beam charge 1 nC	 ~2 µm ~20 µm
Resolution of 10kHz data for beam charge 15 nC	~0.5 µm
Beam-charge dependence for the range 1-15 nC	~10 µm
Dependence of the measurement result on the temperature without using of local temperature stabilization	~2 µm/ºC

Table. 2. Main accuracy parameters of the BPM electronics.

Beam position monitors (G. V. Karpov, E. A. Bekhtenev)

Fig. 5. BPM Processor module from the BINP

Libera Brilliance + will be used as BPM electronics at Storage ring.

Parameter	Value
Resolution of the turn-by-turn measurements	<0.5 μm
Resolution of 10kHz data	<70 nm
Beam-current dependence	<1 μm
Dependence of the measurement result on the temperature	<0.2 μm/ºC

Table 3. Main accuracy parameters of the Libera Brilliance +.

FCT and DCCT (G. V. Karpov, E. A. Bekhtenev)

Fig. 6. FCT from Bergoz

Table 4. Main parameters of FCT.

Parameter	Value
Bandwidth	1.2 GHz
Transformation coefficient	1:10
Sensitivity	2.5 B/A

Table 5. Number of FCTs in the SKIF.

Linear accelerator	3
channel Linear accelerator – Booster	2
Booster	1
channel Booster – Storage ring	2
Storage ring	2

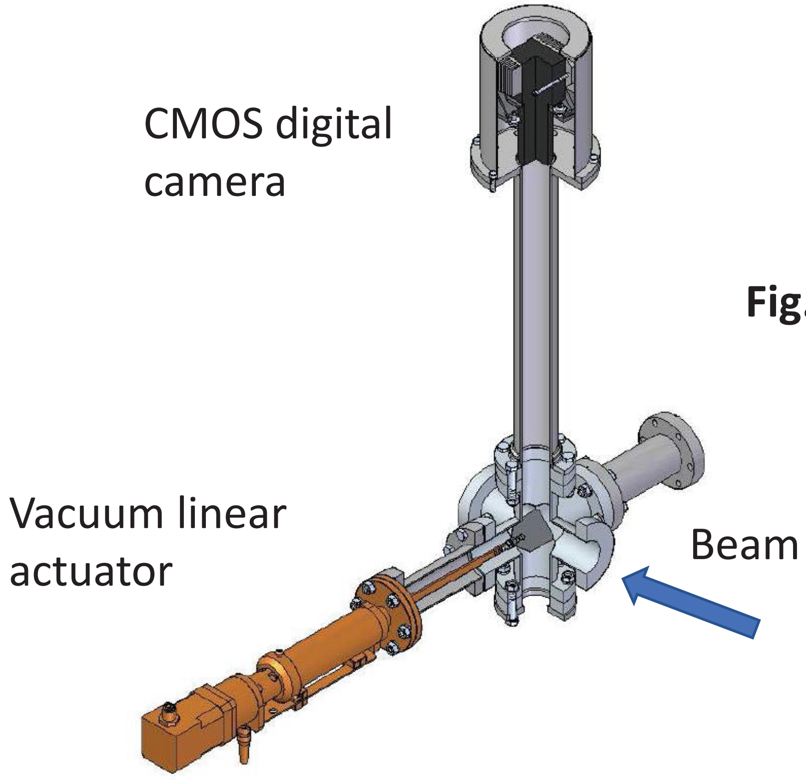
Fig.7. DCCTs from Bergoz with analog electronics.

Table 6. Main parameters of DCCT.

Parameter	Value
Bandwidth	10 kHz
Nonlinearity	< 0.1%
Resolution	< 1 μA/Гц$^{1/2}$
Temperature instability	< 0.5 μA/°C

Fluorescent screens

Type 1: Linac and channels



Type 2: Booster

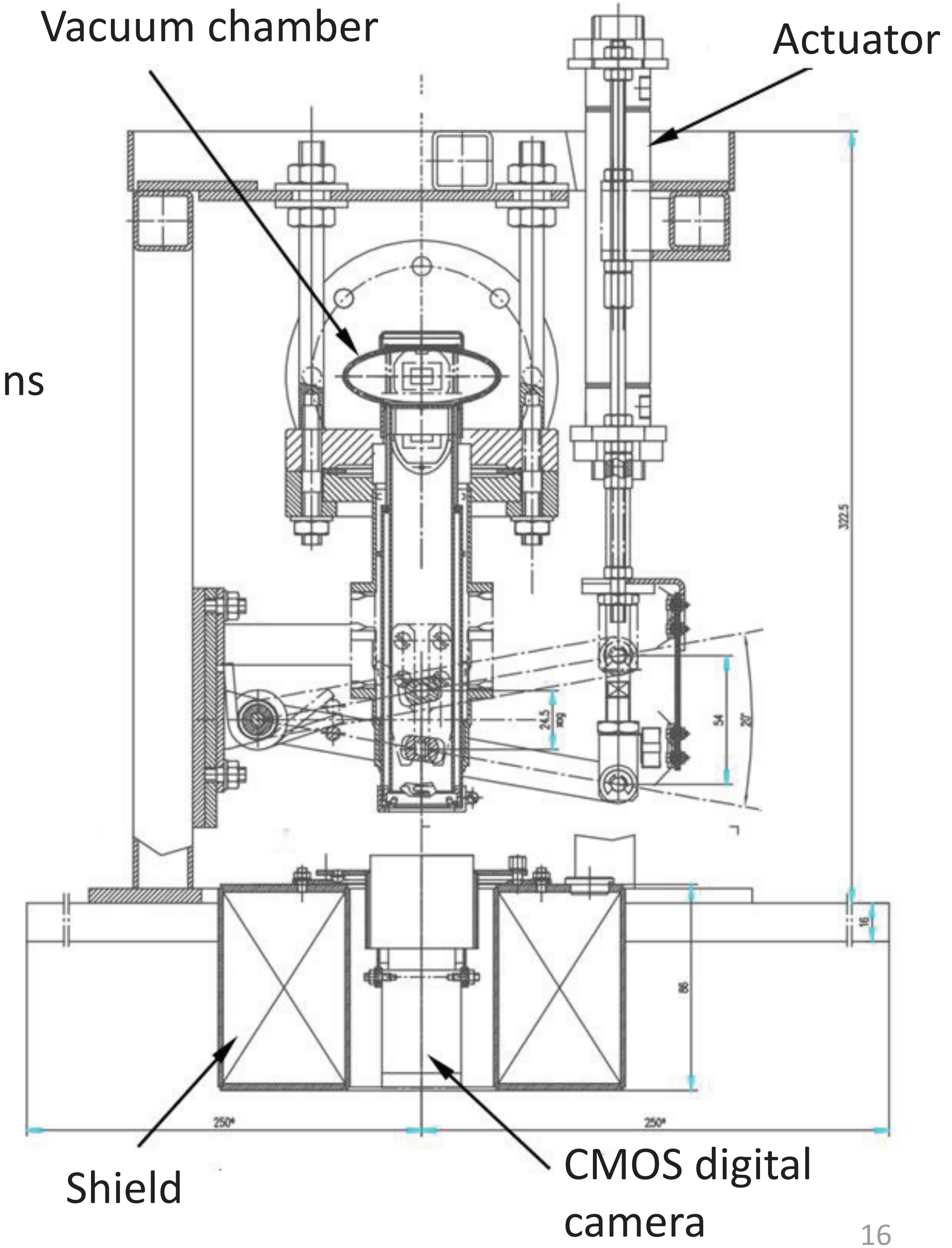


Fig.8. Layout of scintillating screens

Table 7. Number of Fluor. Screens at different parts of the SKIF

Linear accelerator	9
channel Linear accelerator – Booster	5
Booster (Type 2)	6
channel Booster – Storage ring	9
Storage ring	1 (?)

Booster SR optical diagnostics

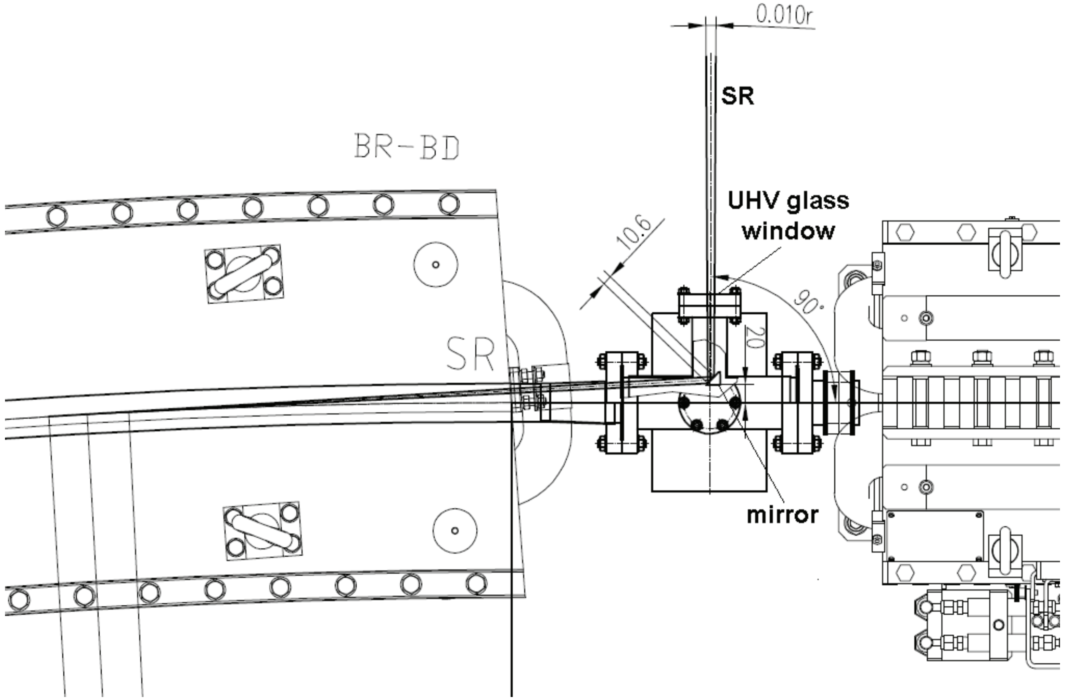


Fig. 12. Layout of one of the SR outlet.

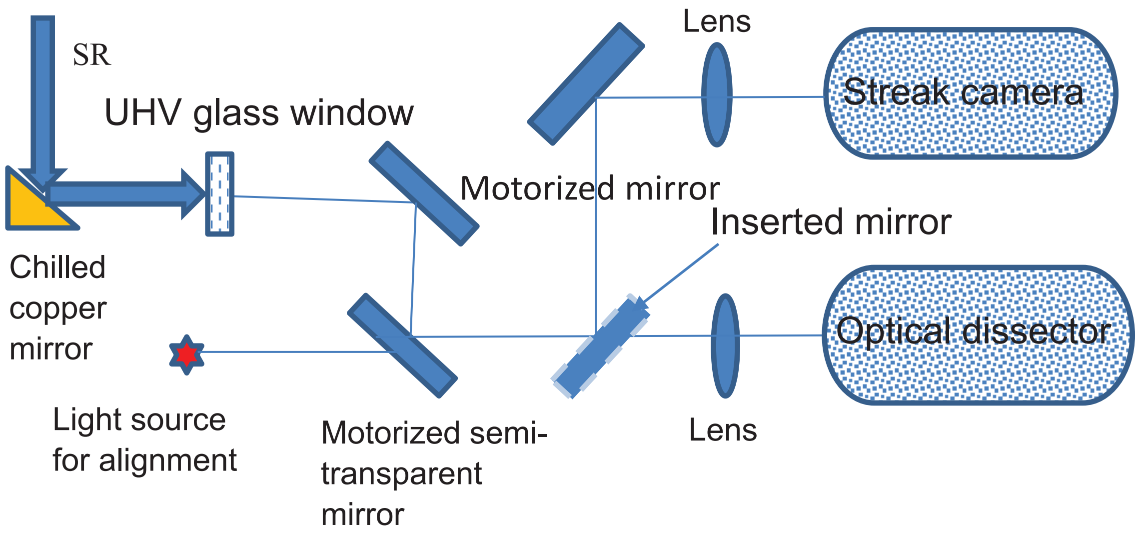


Fig. 13. Optical scheme of beam length measurements.

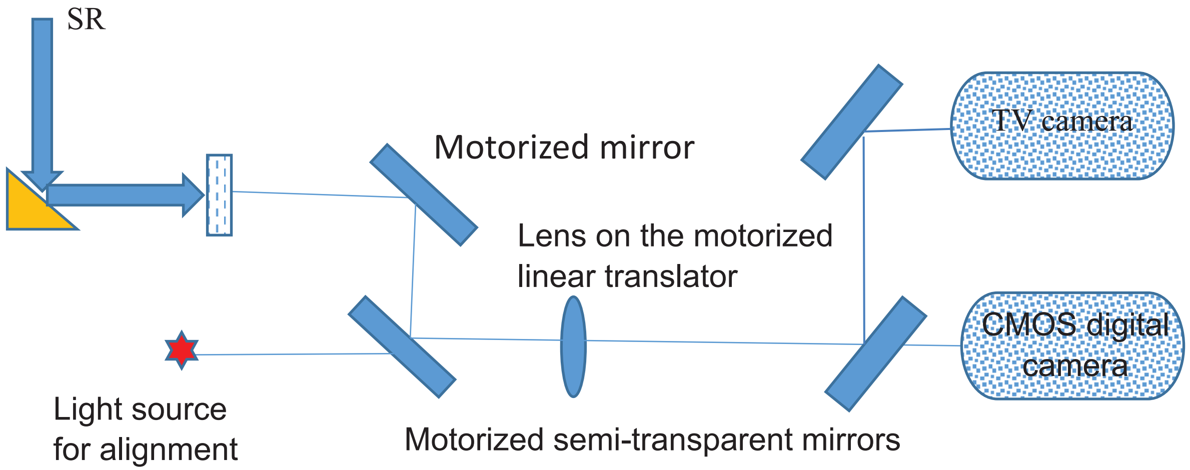
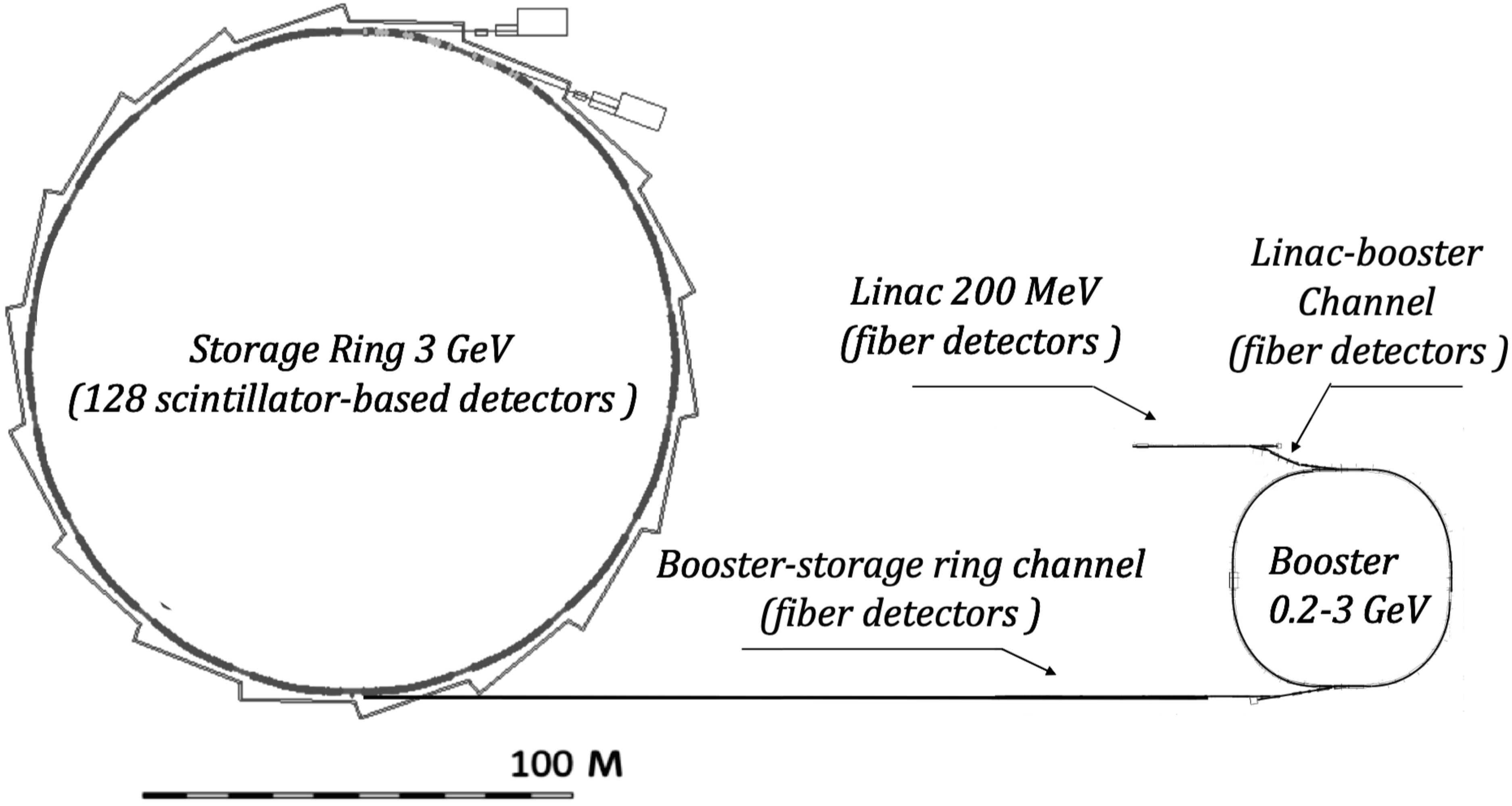


Fig. 14. Optical scheme of beam transverse profile measurements.

The SKIF storage ring has the same set of the diagnostics as the booster has, but the differences are:

1. Fluorescent screens are absent because vacuum chamber cross-section is too small
2. The beam loss monitors system is planned.
3. The optical diagnostics of transverse beam dimensions is more sophisticated.

Beam Loss Monitors (Yu. Maltseva)



More detailed: Yu. Maltseva, Beam Loss Diagnostics System for SKIF Synchrotron Light Source. Poster session C, WEPSC44.

Storage ring SR optical diagnostics (V. Dorokhov)

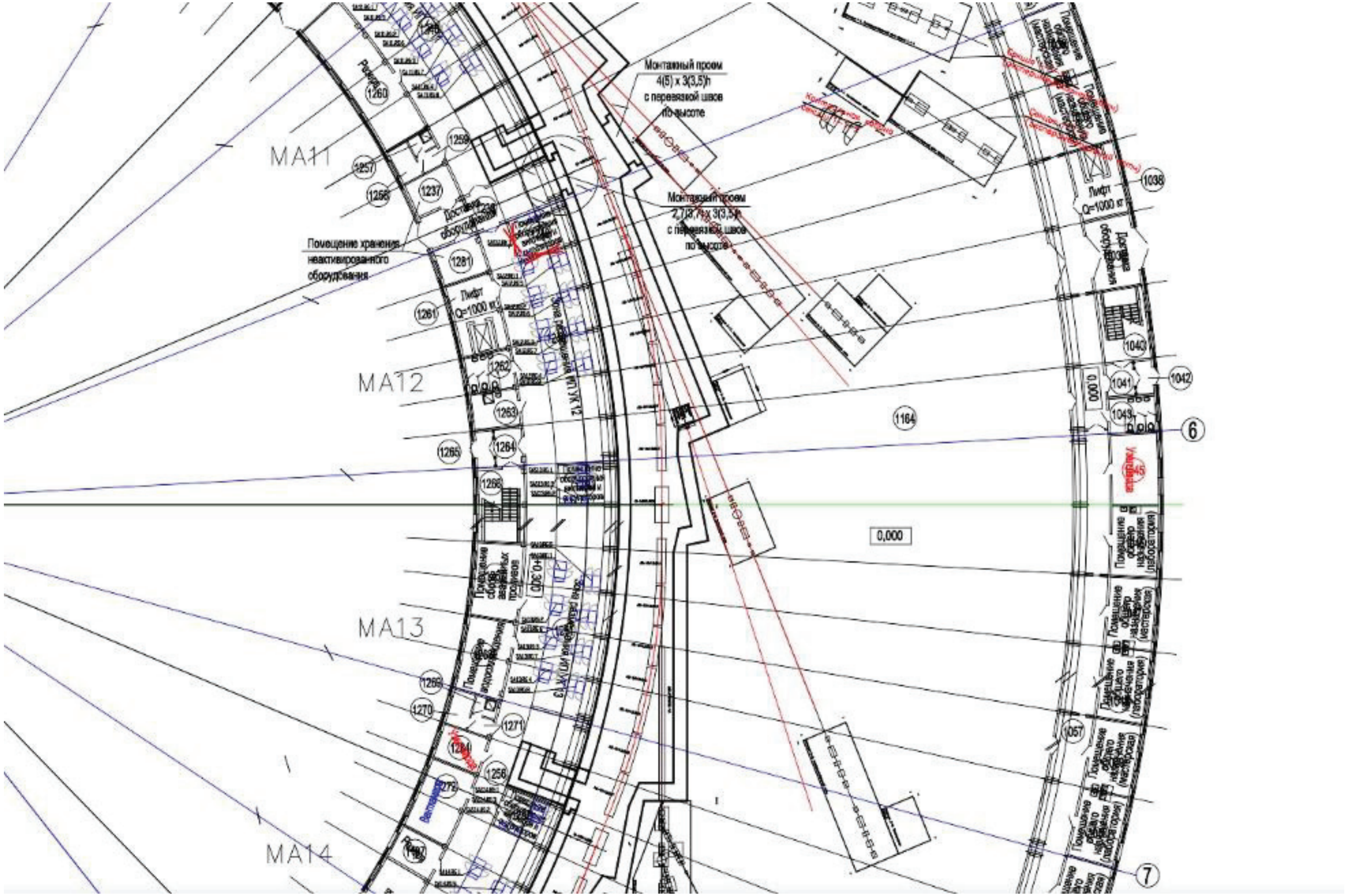
Two SR outlets :

1.) For longitudinal beam profile measurements:

Dissector and streak camera

2.) For transverse beam dimension measurements:

TV camera + 2 double-slit interferometers



Budker Institute of Nuclear Physics

СИБИРСКИЙ КОЛЬЦЕВОЙ ИСТОЧНИК ФОТОНОВ

Thank you for your attention!