



# SUMMARY

#### **USER DEMANDS FOR SSRS-4 - R.A.Senin**

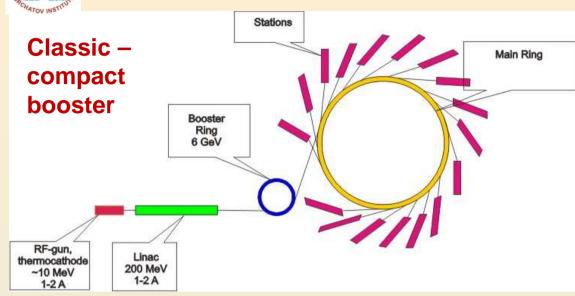
- ➤ Today we are at the stage of pre CDR development, design and preliminary numerical simulations of main components of the SSRS-4: lattice; magnetic systems, beamlines, vacuum, etc.
- We want to take into account the international experience of construction and operation of the new X-ray sources: ESRF, European XFEL, MAX-IV and other projects Russian Federation participates in.
- ➤ The SSRS-4 should be complement to the existing European source and raised interest of the European scientific community. We are not going to be limited only by national scientific projects.
- New machine shouldn't be a replica of any of the existing sources. SSRS-4 must enhance capabilities of new sources and effectively fits into the existing European Mega-science infrastructure.

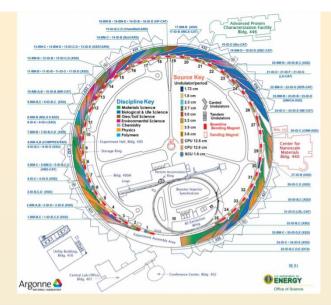


# Storage Ring based 4<sup>th</sup> generation light sources (new projects and upgrades):

Project	Energ y, GeV	Project current, mA	Transverse emittance, pm·rad	Brightnes s, A/(cm²rad ²)	SR length, m	Type of magnetic structure	Status
MAX-IV	3.0	500	200	5.10 <sup>21</sup>	528	7BA	New, commissioned in 2016
Sirius	3.0	350	250	10 <sup>22</sup>	514	2BA	New, commissioned in 2017
HEPS	6.0	300	60	10 <sup>22</sup>	1296	7BA	Under construction
ALS-Upgr.	1.9	500	50	10 <sup>21</sup> - 10 <sup>22</sup>	197	MBA	Upgrade project
APS-Upgr.	7.0	100	67	10 <sup>21</sup> - 10 <sup>22</sup>	1104	MBA	Upgrade project
DIAMOND II	3.0	300	120	10 <sup>21</sup> - 10 <sup>22</sup>	562	MBA	Upgrade project
ELETTRA- Upgr.	2.4	320	280	10 <sup>21</sup>	269	MBA	Upgrade project
ESRF-EBS	6.0	200	130	10 <sup>21</sup> - 10 <sup>22</sup>	844	Hybrid BA	Upgrade starts 2018
PETRA-IV	6.0	100	20 - 100	10 <sup>21</sup> - 10 <sup>22</sup>	2304	MBA	Upgrade project
SLS II	2.4	350	130	10 <sup>21</sup>	288	MBA	Upgrade project
SPring8 Upgr.	8.0	100	140	10 <sup>21</sup> - 10 <sup>22</sup>	1436	5BA	Upgrade project

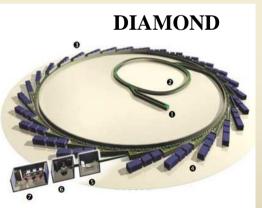
# **Injection: three possible ways**





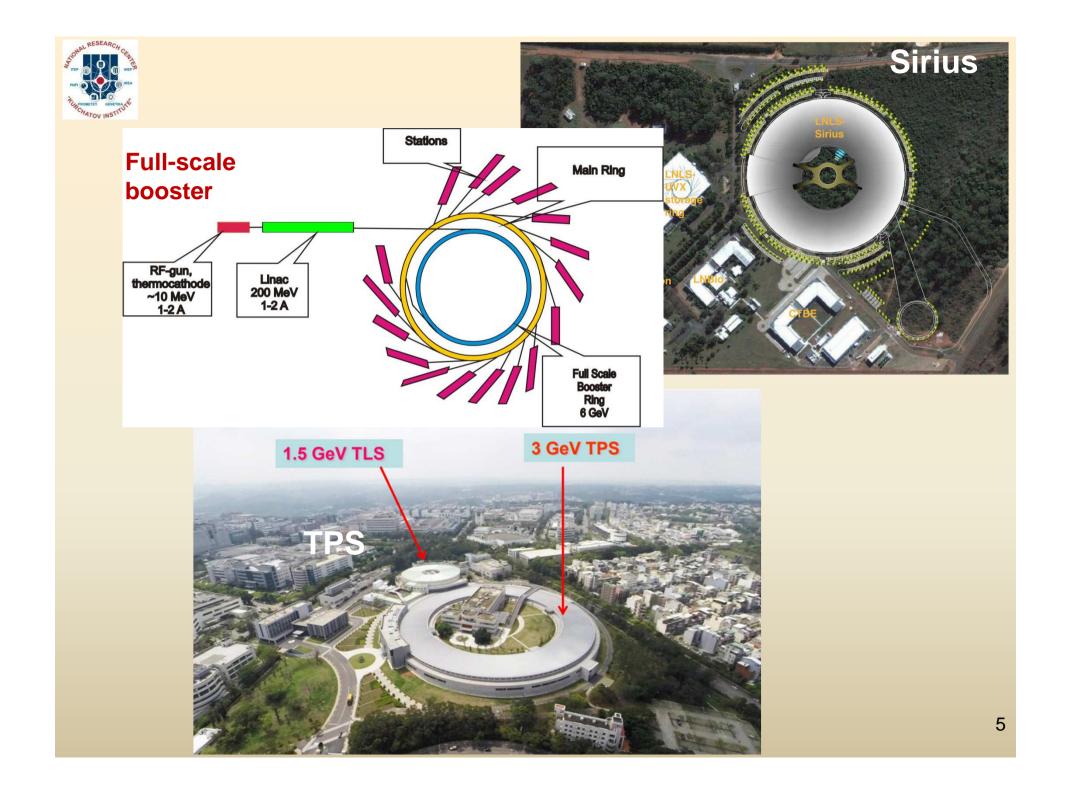
APS







**NSLS-II** booster was developed by Budker Institute of Nuclear Physics (BINP)







MAX-IV: first source with top-up linac injection (also used for SPF)



planned to be used instead of booster

PLS: current linac is planned to be replaced by the operating driver linac of PAL-FEL after upgrade 6



#### SSRS4 current discussed configuration:

- Beam energy in syncrotron 6 GeV;
- Beam current up to 300 mA;
- > Transverse emittance <100 pm·rad (two schemes are under simulation today: "user machine" with emittance of 70-100 pm·rad and "record machine" with 20-50 pm·rad);
- > Top-up injection from linac or booster;
- MBA magnet structure with SR length ~1300 m and 40 superperiods;
- ➤ Low energy (~1.5 2.0 GeV SR for UV stations) as an option;
- Injection linac based FEL(s) as the second option (in the case of top-up linac);
- Four groups of RF cavities (3 or 4 cavities/group) in fully symmetries periods, solid state RF power sources, operation frequency 500 or 700 MHz;
- Not less than 40 stations for THz, soft, medium and hard photon energies and strongly-hard FEL on linac (as option);



# **Organization**

#### **General layout and beam dynamics**

BD WG1: SR with 70-100 pm·rad

+ full-scale booster

Injection linac

BD WG2:

SR with 20-50 pm·rad + compact booster

Injection schemes

**RF** 

Control system

Insertion devices and FEL's

Diagnostics

Vacuum system

Engineering systems

#### Research programme

Research programme

Stations and channels

Beam requirements

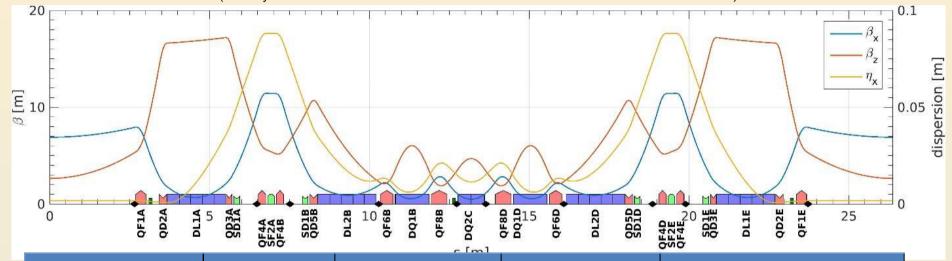


### **SSRS4** magnet structure:

Start configuration is based on MBA;

first structure is kindly prepared by our ESRF partners and based on scaled ESRF-ESB design

(Ministry of Education and Science of Russian Federation-ESRF collaboration contracts)



L Cell [m]0	N cells	Circ. [m]	Emit. [pm]	Max. Sext. [T/m2]
26	40	1040	69	2316
30	40	1200	70	1220
30	50	1500	36	1534

**Especial thanks to:** 

Pantaleo Raimondi, Simone Liuzzo, Laurent Farvacque

and Simon White

# Bird's eye view at SSRS4 control and diagnostics (D.Liakin)

MRF signal

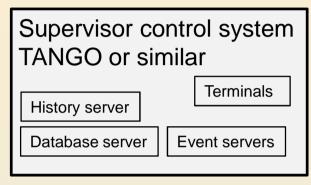
BPM module

ps timing option

synchronization with 50

- Classical SCADA architecture
- Uses mainly Ethernet network
- Dedicated network for BPMs
- Open source middleware solutions and

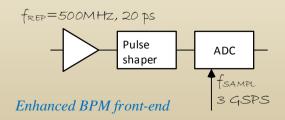
so on

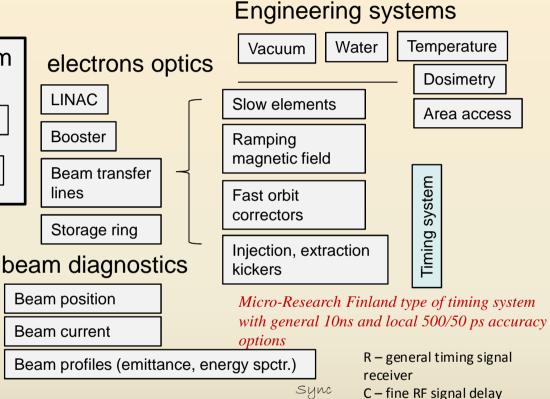


Fully digital lowlevel RF



High performance BPM front-end with most up-to-date components





adjustment

S – sync. generator pick-up signal

PLL – phase locked loop with



# **Preliminary diagnostics scheme**

Injectors

Linac

Ring

moderately relativistic e-beams

elativistic e-beams

key role of the bunches length

importance of longitudinal diagnostics

straight trajectory - no deflecting magnets problems with noninvasive emittance diagnostics

special solutions are needed

collaboration with DESY is welcomed

ultrarelativistic beams

highest requirements to transverse beam size and emittance diagnostics

longitudinal diagnostics is not so important

high background radiation

vital role of synchrotron and betatron oscillations at high currents (>200-300 µA)

the noninvasiveness of the emittance diagnostics is provided by using of pinholes after deflecting magnets (collaboration with ESRF-EBS team)



# **SSRS-4** Linac general concept

Injection scheme choice affects on linac layout and parameters

	Facility with booster ring	Facility with top-up injection	
Energy	~200 MeV	6 GeV	
RF gun (s)	Thermionic+ RF SW buncher 10 MeV	Photo and Thermionic+RF SW buncher 10 MeV	
Linac operation mode	injector in booster ring	injector in booster ring provide beam for X-FEL	
	Compact, cheaper and more safe in construction	Promising but challenging	

Comprehensive DESY expertise in e-linac development and operation could be EXTREMELY helpful for this project

More details in report by Mikhail Lalayan



### Plans for 2018:

- General complex scheme should be fixed;
- Beam dynamics for both schemes ("user machine" with emittance of 70-100 pm·rad and "record machine" with 20-50 pm·rad);
- Magnetic structure preliminary design;
- Linac and booster preliminary design;
- Injection scheme should be chosen;
- RF system and Insertion devices preliminary design;
- Diagnostic system preliminary design;
- Control system preliminary design;
- Vacuum system preliminary design.

#### And foundation:

- ✓ International Collaboration
- ✓ Scientific Advisory Committee
- ✓ Machine Advisory Committee







NRNU MEPhi





Inst. of Crystallography









