Sirius

status on the new Brazilian synchrotron light source

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on behalf of the LNLS Project Team
Presented at IPAC11, San Sebastian, Spain

About Brazil (2011)

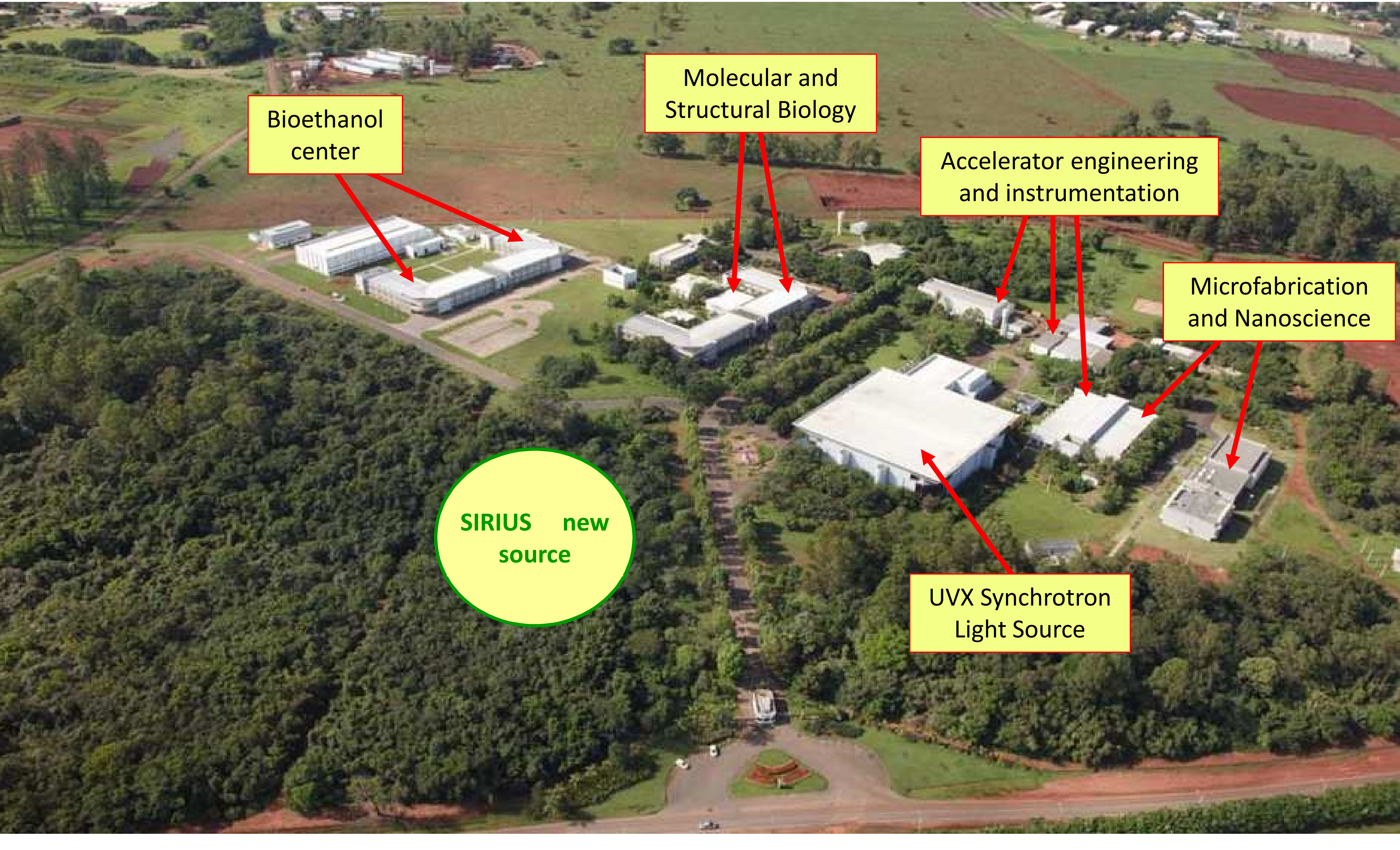
Area	8.5 x 10^6 km^2	World rank 5th
Population	195 million people	World rank 5th
GDP	$1.75 trillion per year	World rank 8th

Source: www.wolphamalpha.com

About Brazil (2011)

2014 – World Cup (football)
2016 – Olympic Games

LNLS campus today



Brief Historical Overview

1987-1997 – Design, construction and commissioning of UVX, a 1.4 GeV Synchroton Light Source, from scratch.

1997 – UVX is opened for users.

2006 – First discussions about a new 3rd generation light source.

Nov/2008 – The Ministry of Science and Technology (MCT) approves R$ 2M (~€ 0.9M) for preliminary studies.

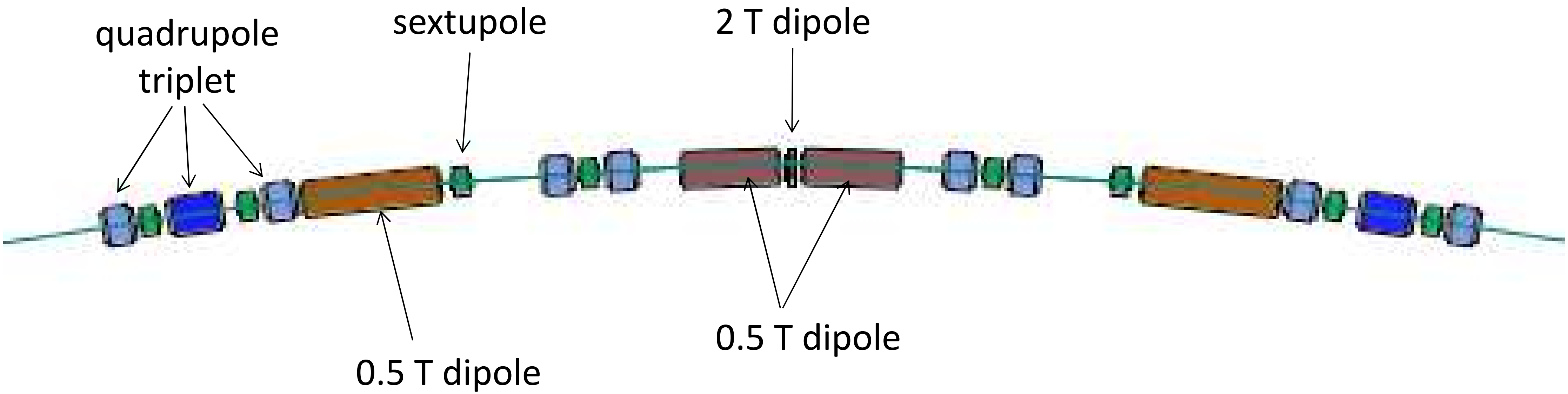
2009 – Two scientific case workshops.
– Design and prototype work starts.

2010 – MCT approves R$ 7M which was mostly used to improve the LNLS engineering infrastructure.
– The new source is named **SIRIUS.**

Aug/2011 – MCT approves R$ 11M (4.9 M€).

The LNLS approach to SIRIUS

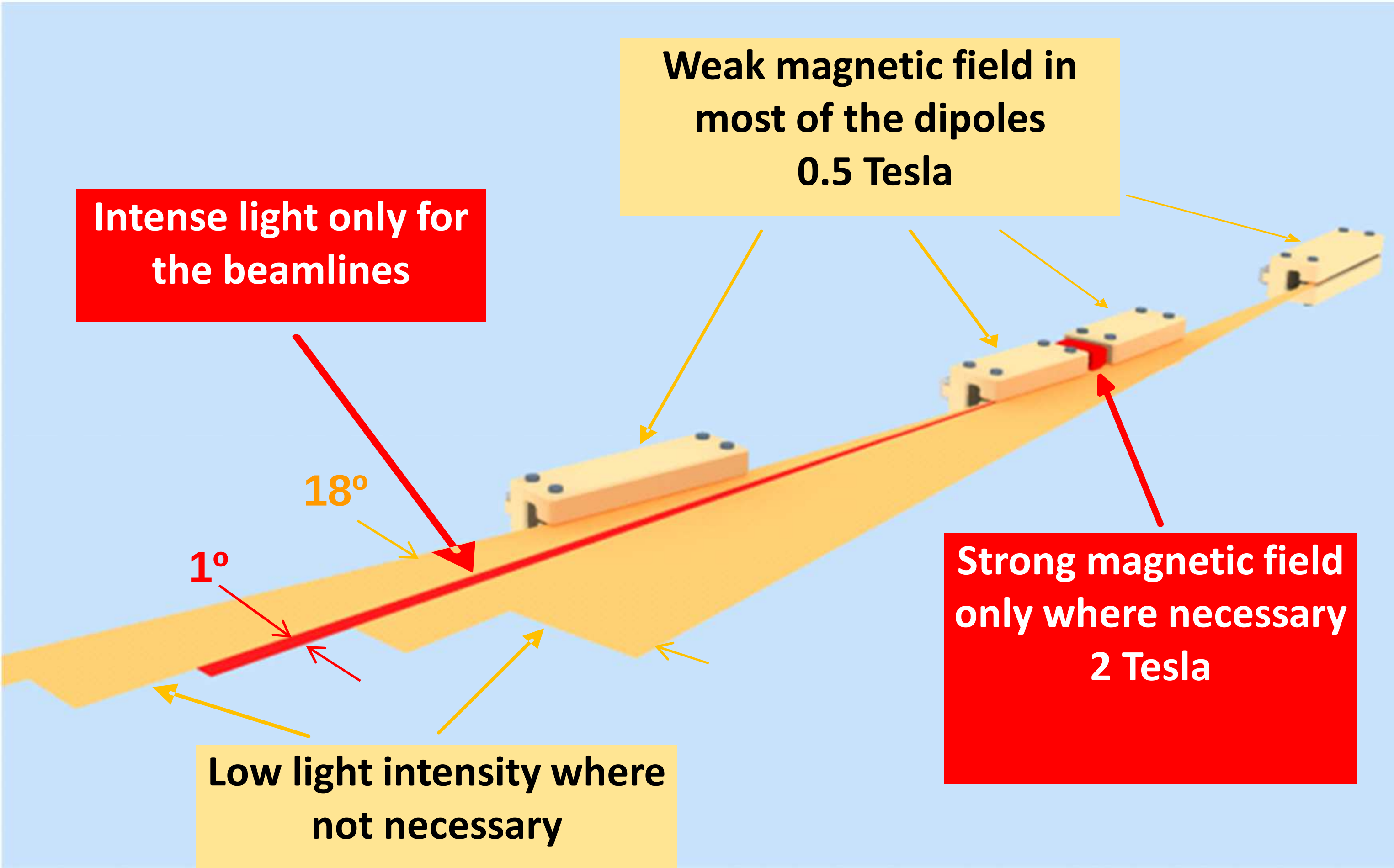
- Energy: 3 GeV
- Use of permanent magnet technology for the dipoles.
- 20 modified TBA cells with low field main dipoles (0.5 T).
- Split central dipole to accommodate a high field (2 T) slice.



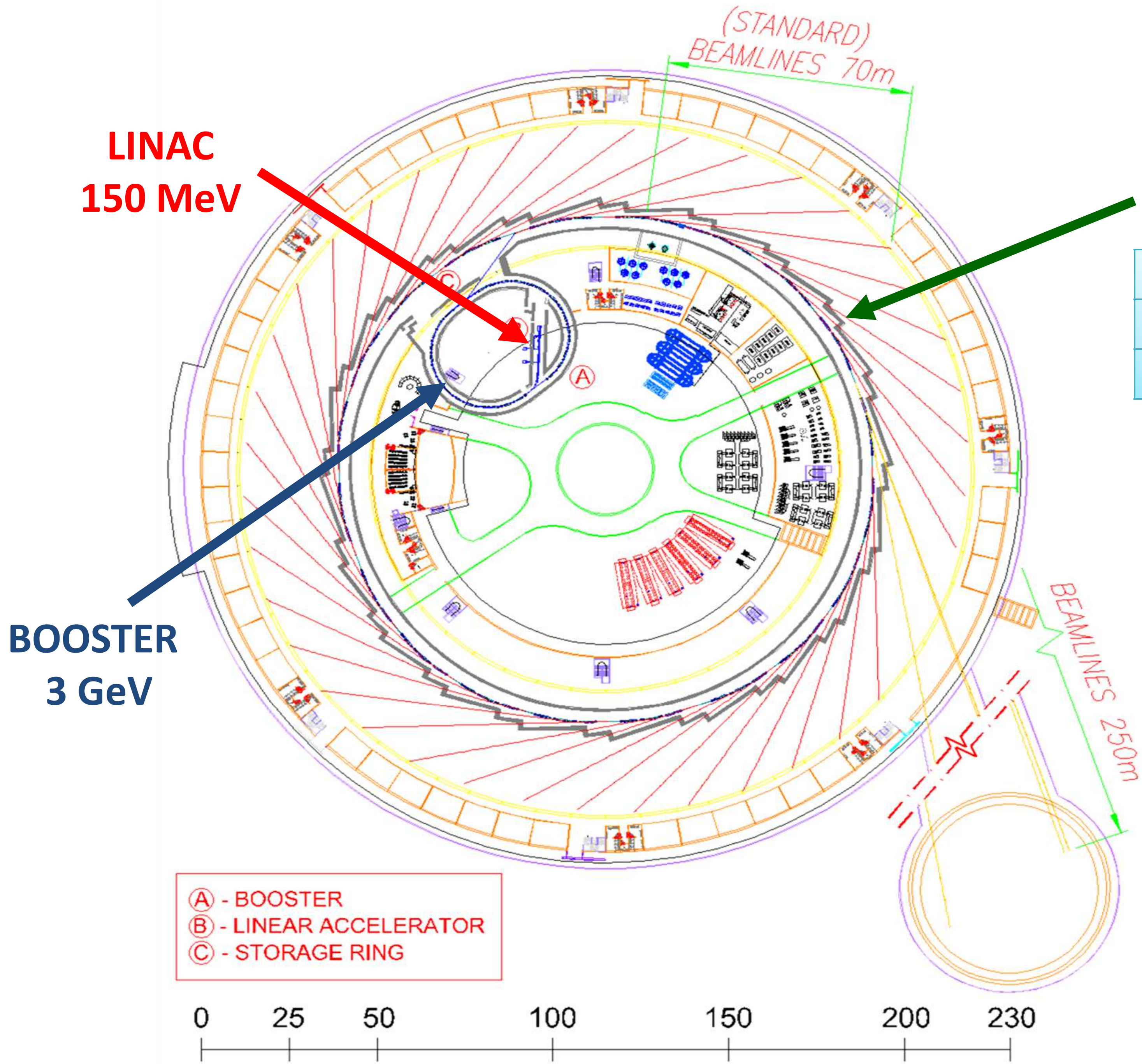
Main particularities

- **Strong magnetic field (hard X-ray) only at beamline exit**
  - Lower radiation power from dipoles → **Lower investments** in high power RF equipment.
    → **Lower investments** in vacuum equipment.
  - **Lower operational costs** (RF power generation and cooling) .

- **Permanent magnet dipoles**
  - **Lower investments** in power supplies and cooling systems.
  - **Lower operational costs.**
  - **Higher reliability.**



Accelerators layout

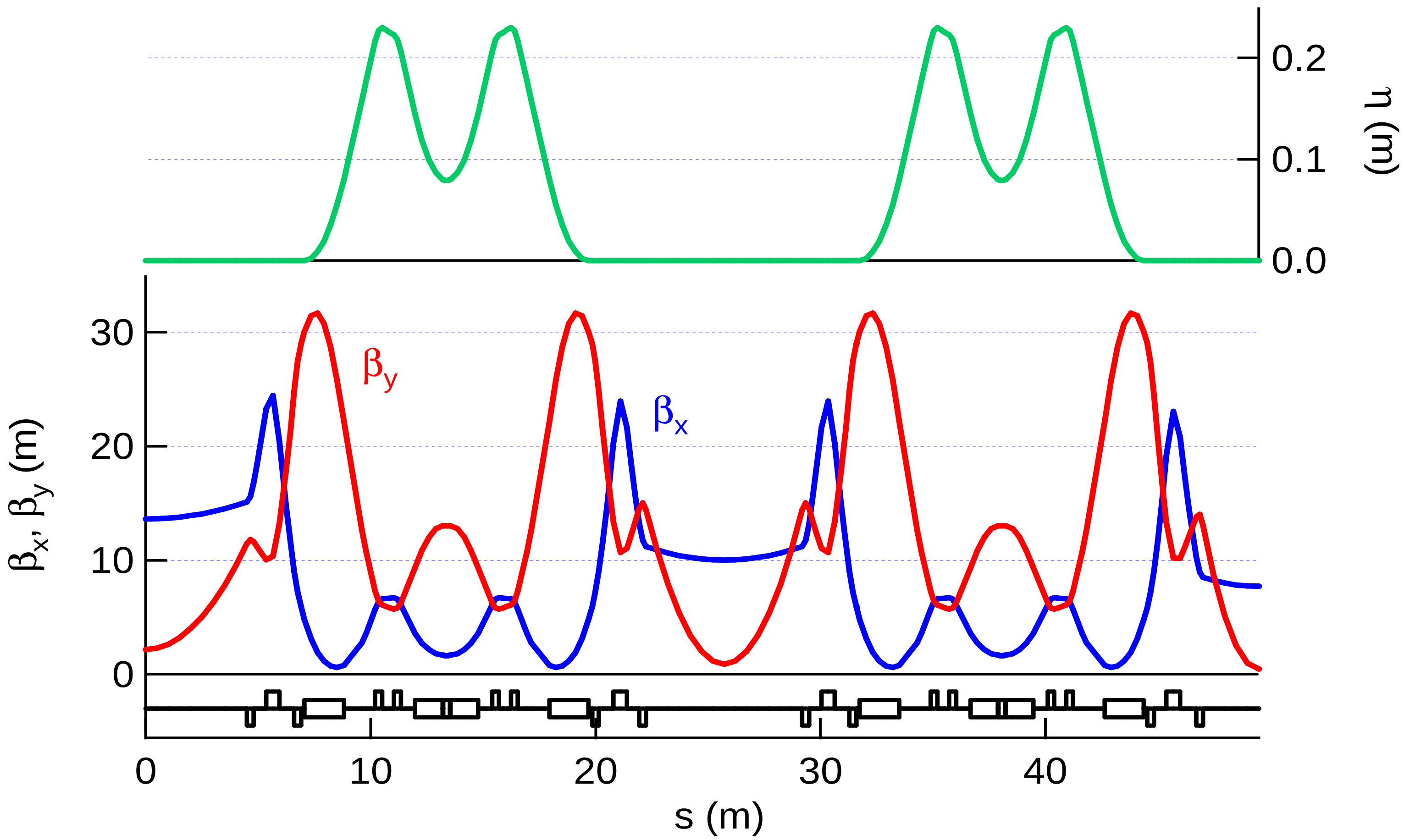


circumference	480 m
dipole BLs	20
critical energy	12 keV

straight sections	
long	4 x 9.0 m
medium	4 x 6.9 m
short	12 x 4.9 m

Storage ring optics

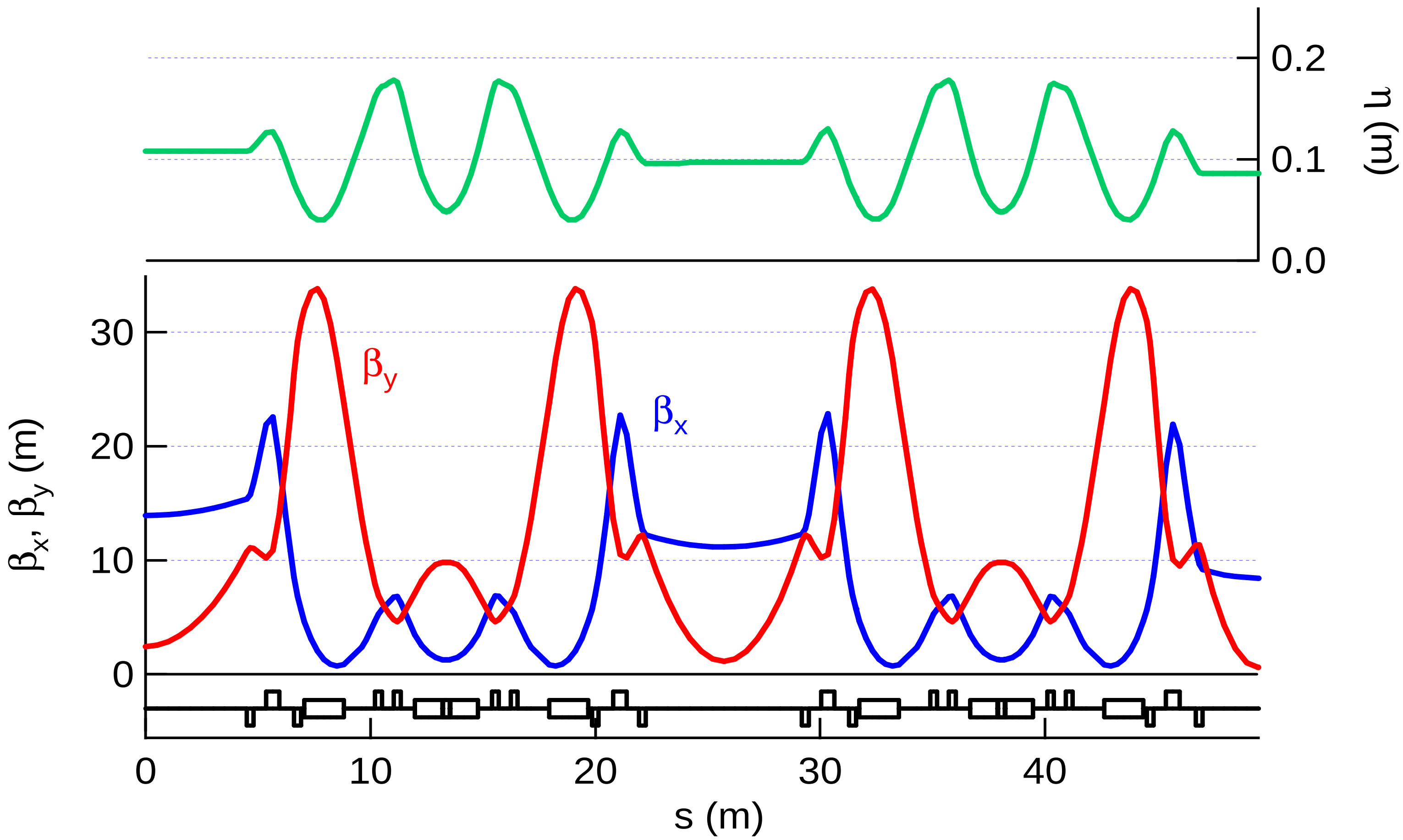
Achromatic mode



Nat.emit. [nm.rad]	**2.8**
Tune X	24.27
Tune Y	13.10
Chrom X	-52.7
Chrom Y	-47.0
Mom.comp.	7.7×10^{-4}

Storage ring optics

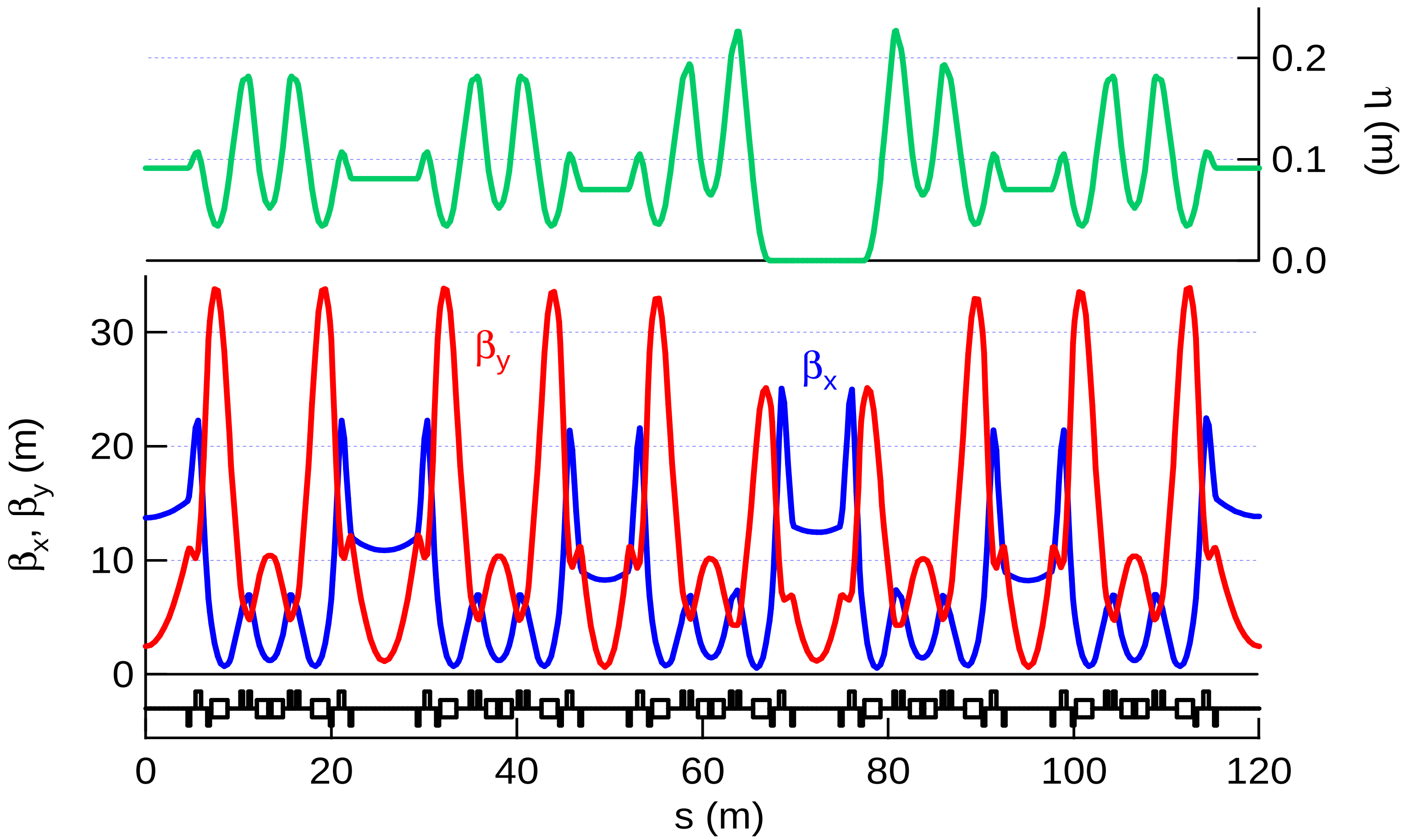
Low emittance mode



Nat.emit. [nm.rad]	**1.7**
Tune X	24.19
Tune Y	13.24
Chrom X	-47.9
Chrom Y	-46.3
Mom.comp.	7.4×10^{-4}

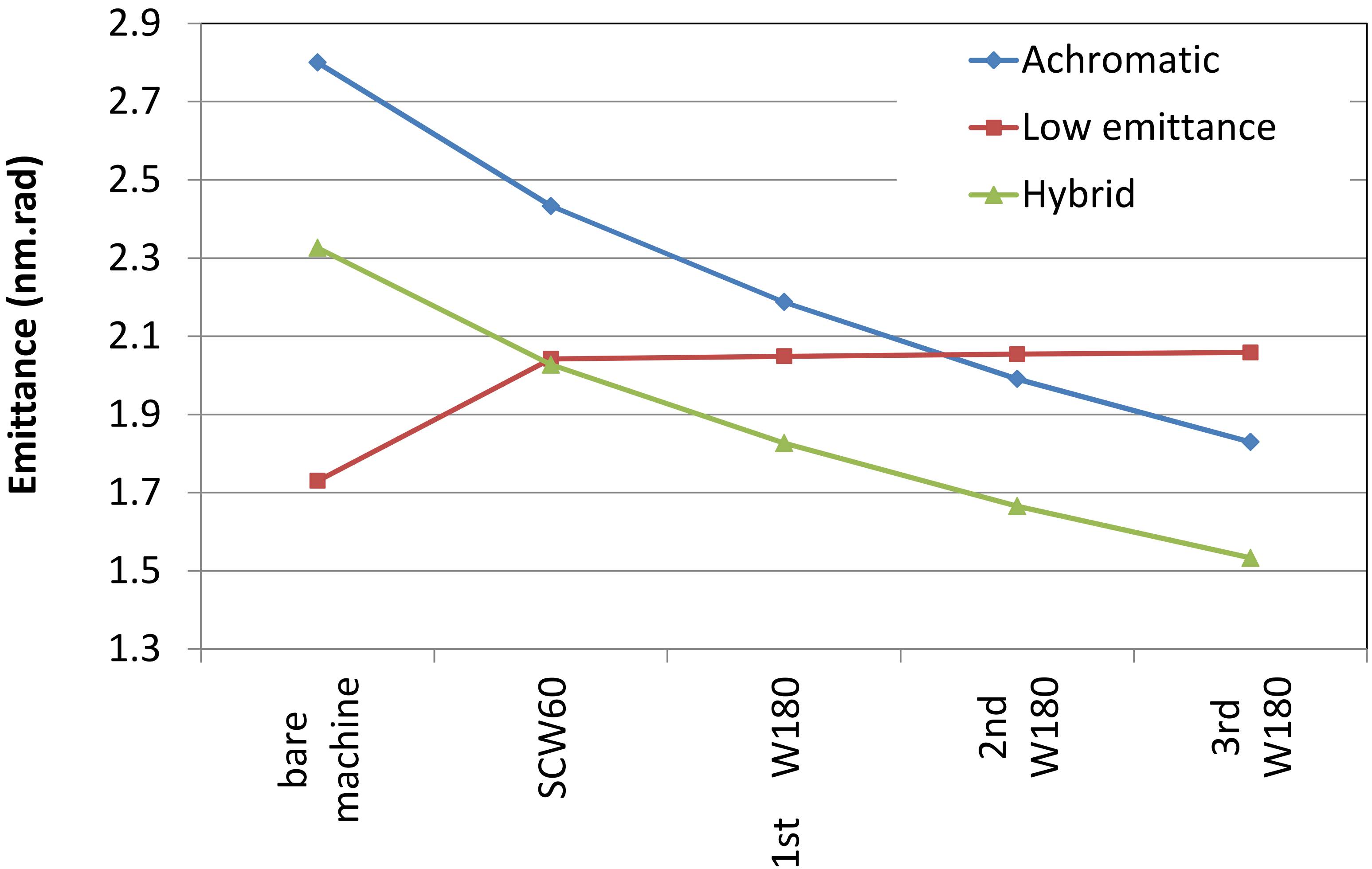
Storage ring optics

Hybrid mode



Nat.emit. [nm.rad]	**2.1**
Tune X	24.26
Tune Y	13.13
Chrom X	-48.9
Chrom Y	-44.0
Mom.comp.	7.4×10^{-4}

Effect of wigglers on emittance



Insertion Devices already existing at LNLS (presently installed in UVX)

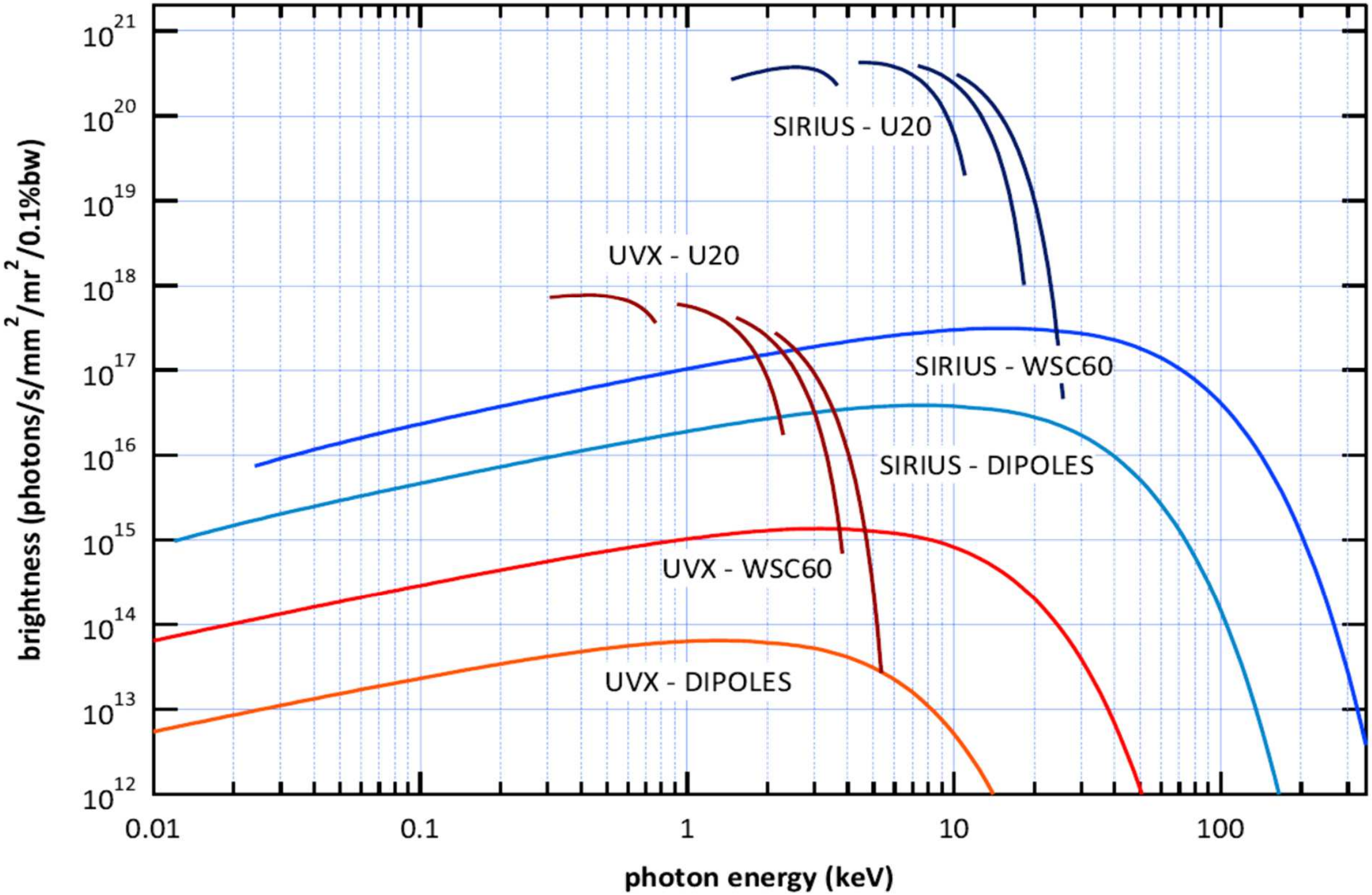
WSC60 = 4 T superconducting wiggler, period=60 mm, N=17

W180 = 2 T hybrid wiggler, period=180 mm, N=15

Sirius general parameters

Parameter	Value	unit
Operation energy	**3.0**	**GeV**
Injection energy	**3.0**	**GeV**
Maximum beam current	500	mA
Ring circumference	**479.7**	**m**
Revolution period	1.600	μs
Beam emittance without IDs, horizontal	**1.7 – 2.8**	**nm.rad**
vertical (@ 0.5% coupling)	**8.5 – 14**	**pm.rad**
Main bending field	0.5	T
Slice (1.24°) bending field (NdFeB)	1.95	T
Number of achromats	20	
Main bending radius	20.0	m
Slice bending radius	5.1	m
Critical energy from dipoles (2 T slice)	**11.7**	**keV**
Critical wavelength from dipoles (2 T slice)	**1.1**	**Å**
Energy loss per turn from dipoles	430	keV
Synchrotron radiation power from dipoles (500 mA)	215	kW

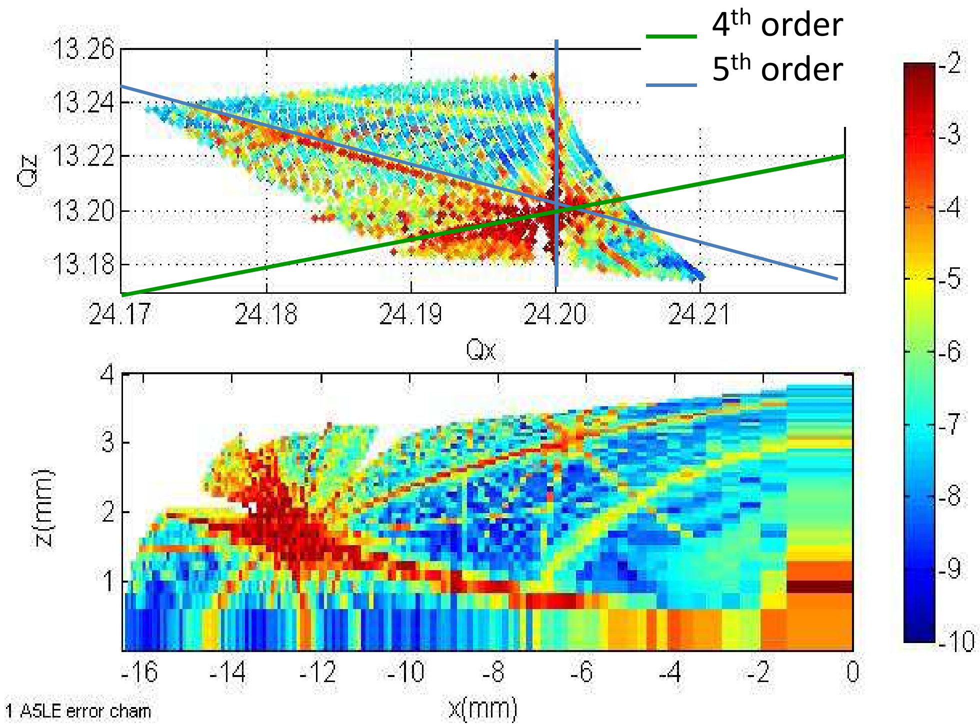
Improvements in brightness



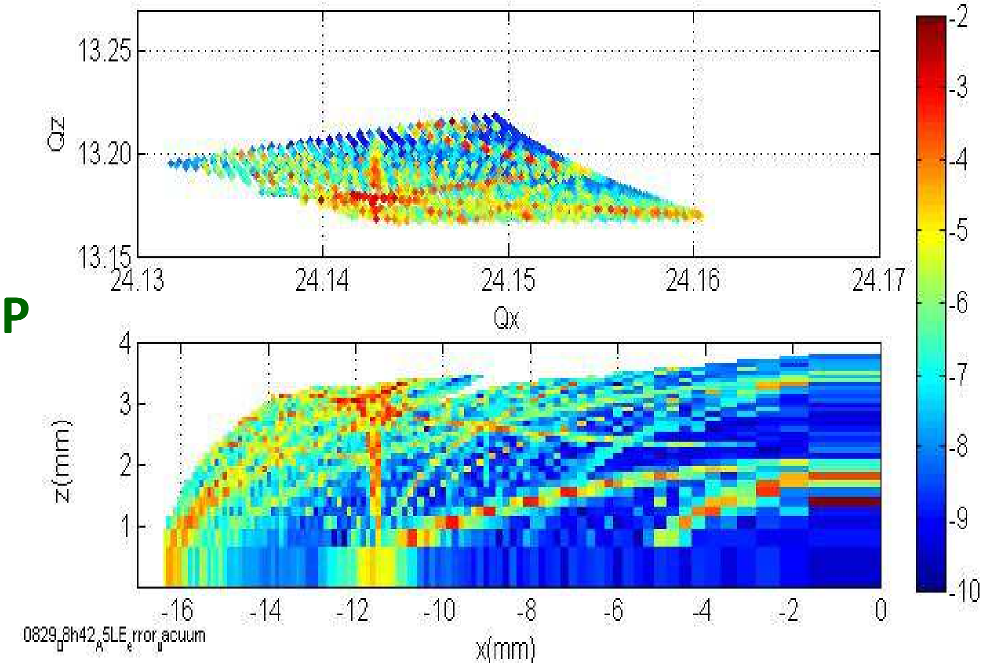
UVX = existing synchrotron light source (1.37 GeV/250 mA)
SIRIUS = new source in design (3 GeV/500 mA)
U20 = 20 mm period in-vacuum undulator
WSC60 = 4 T superconducting wiggler

Non-linear optimization

Optimization of WP and sextupole configuration using MAD (CERN), OPA (SLS) and Tracy3 (Soleil)



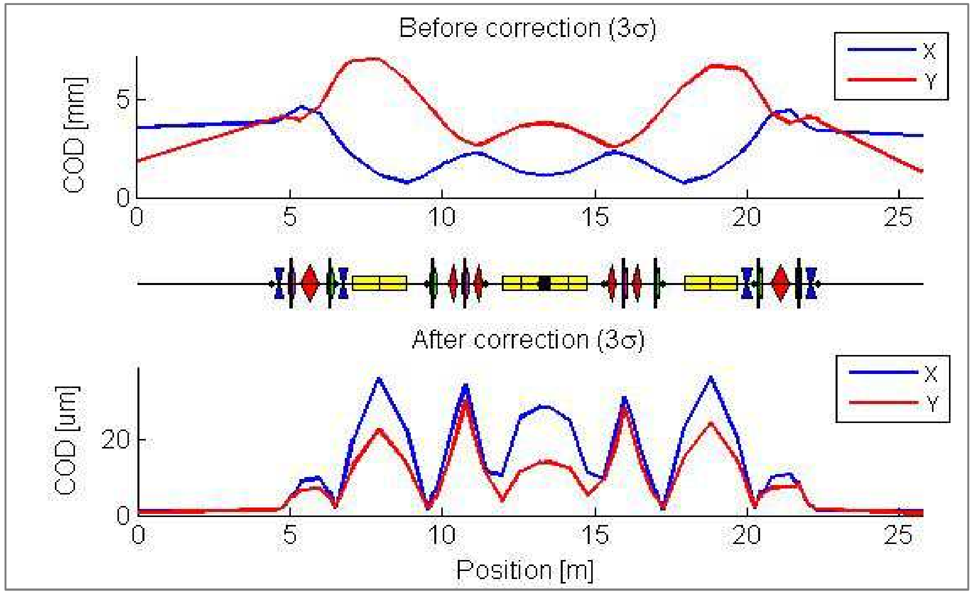
new WP



Low emittance mode, lattice with multipole errors in all magnets

Orbit correction

Closed orbit, statistics over 100 random machines



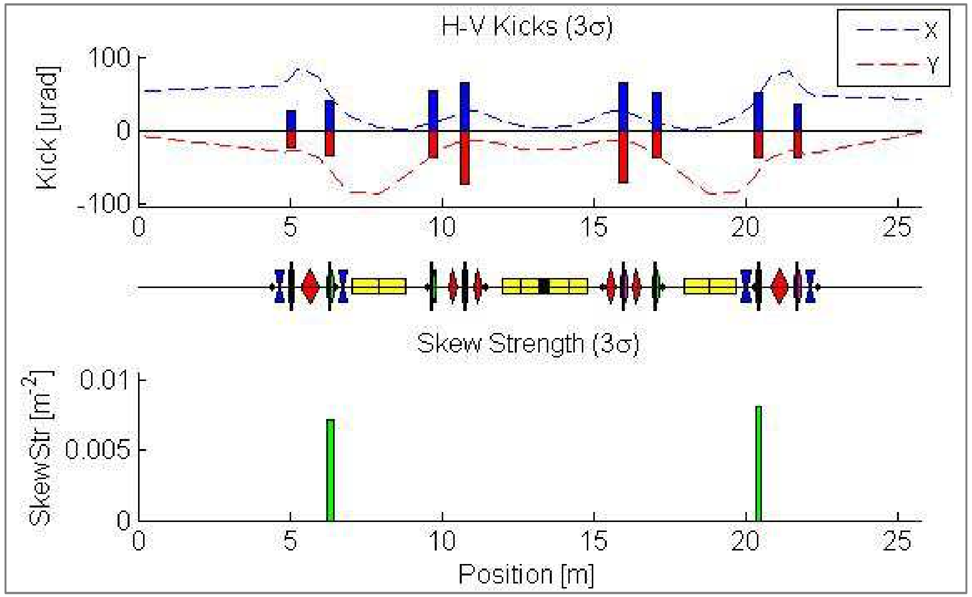
Alignment and excitation errors, uniform random distribution

X, Y [μm]	30
Roll [mrad]	0.2
Excitation [%]	0.05

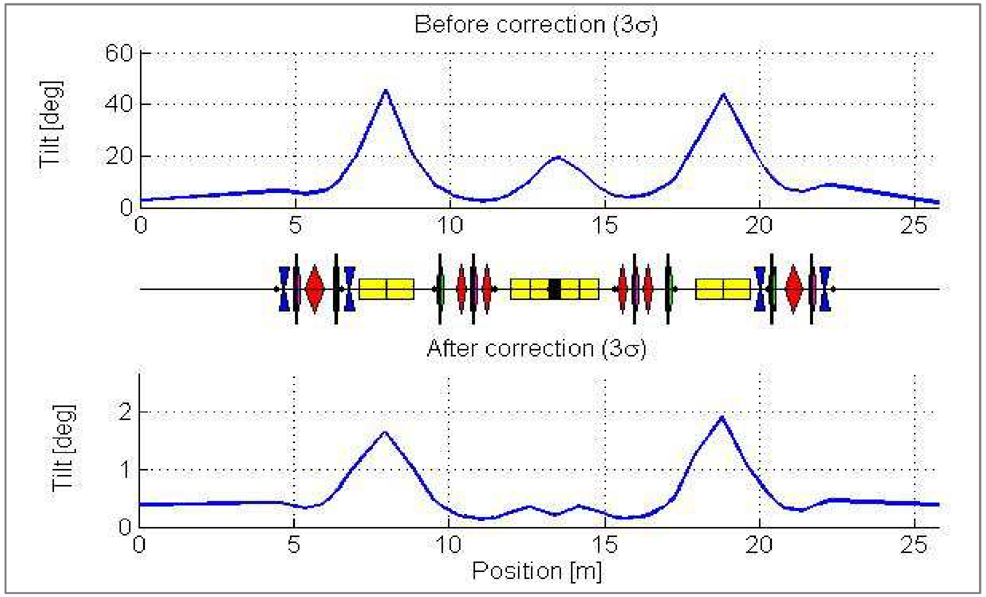
Simulated configuration

BPMs	180
Hor. Correctors	160
Ver. Correctors	160
Skew Correctors	40

Corrector values



Coupling



Investments in LNLS infra-structure

Machine shop

Laser cutting machine

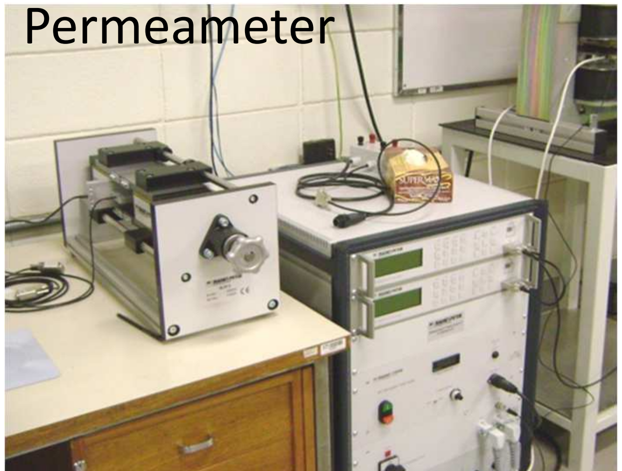
5 axis machining center
Precision: 0.003 mm

Electronics

Circuit board prototyping machine

4 axis machining center
Precision: 0.01 mm
table: 2.9 m X 0.7 m

Magnetic measurement



Permeameter

Mechanical design

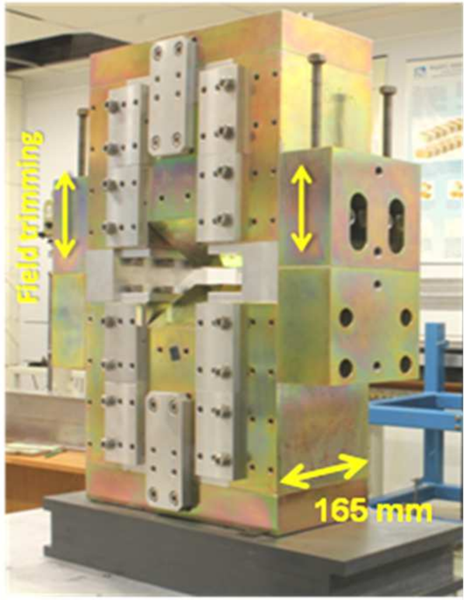
Laser Tracker

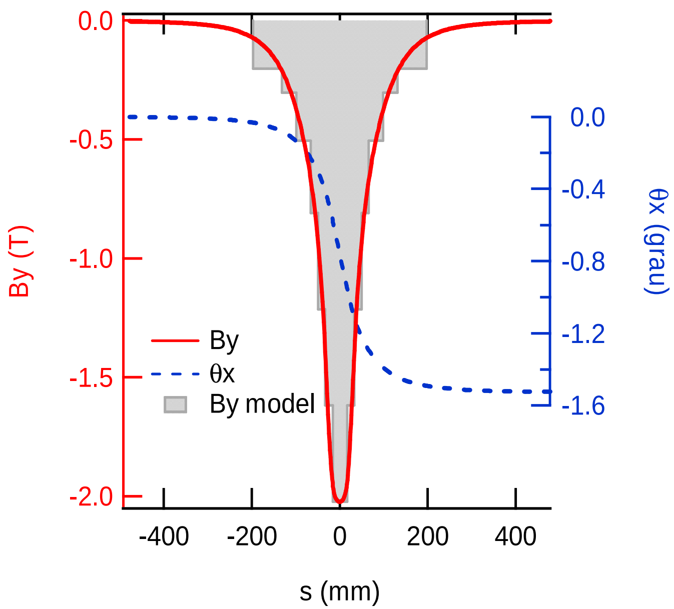
Fast mechanical prototyping machine

First permanent magnet dipole prototypes

2 T slice dipole

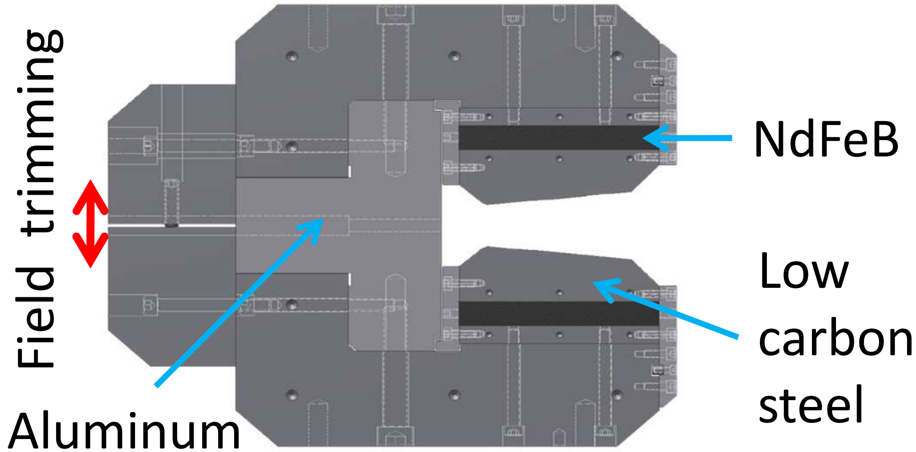
Model using segmented dipoles
Sextupole component incorporated into non-linear optimization

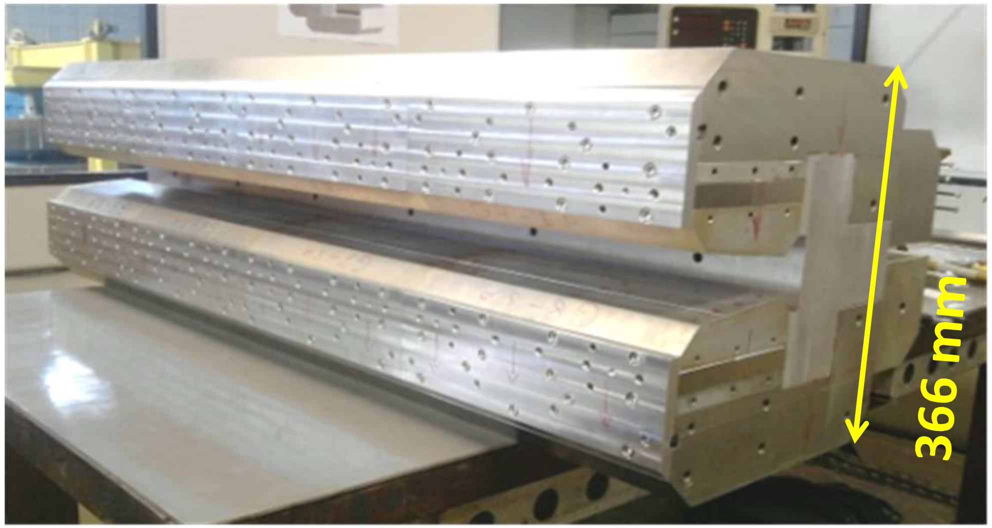




For the next prototype:
Bmax = 1.95 T
$\theta = 1.24°$

0.5 T main deflection dipole

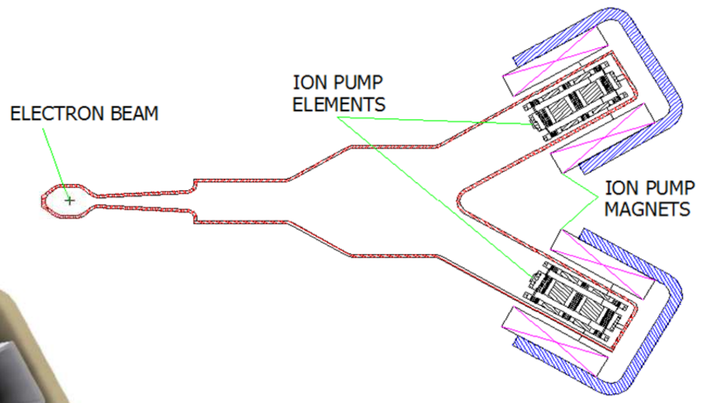


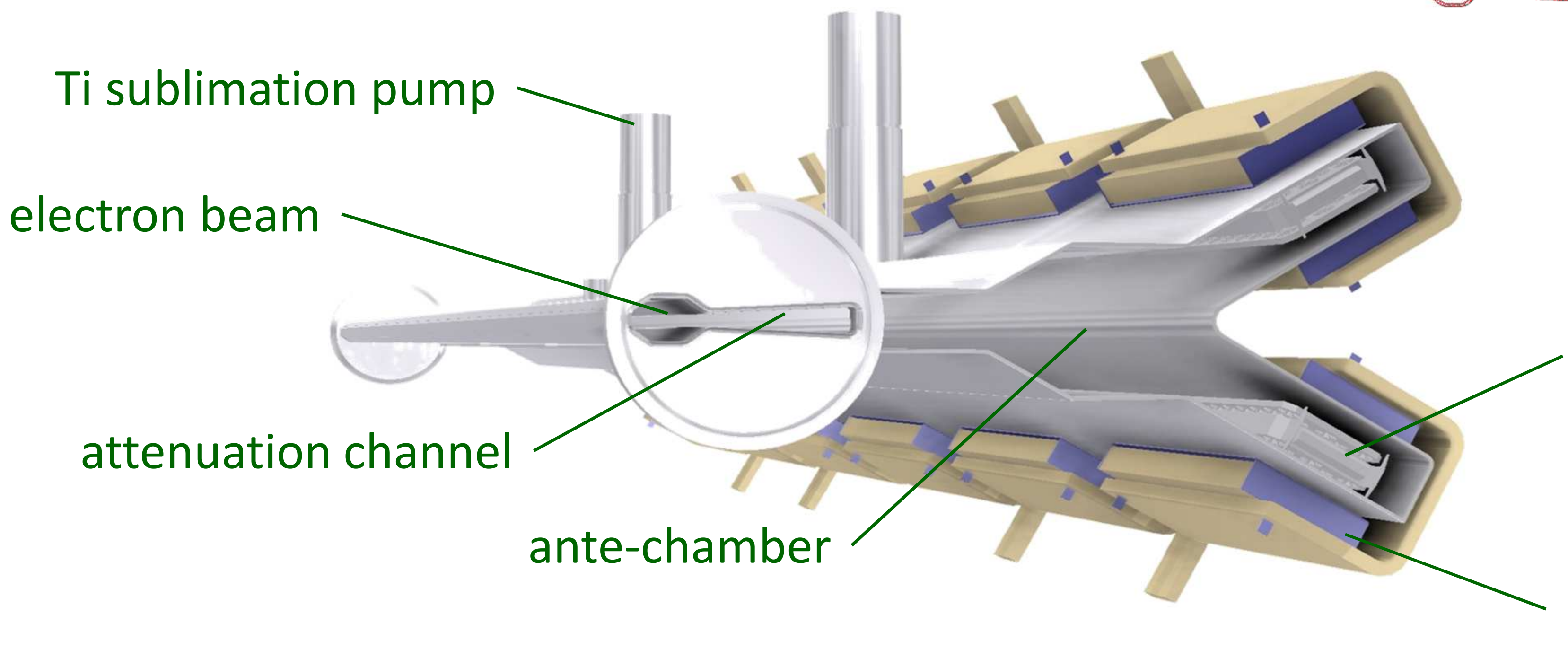


We need to improve the stability of the hall probe measurement bench

Proposed vacuum system concept

- NEG pumps cannot be employed because the use of permanent magnets prevents in-situ activation.
- Use of 'distributed' ion pumps, with pumping cells installed inside the ante-chamber.
- Ion pump magnets are mechanically decoupled from chamber to facilitate alignment.





Vacuum system

Measurement of effective ion pump pumping speed

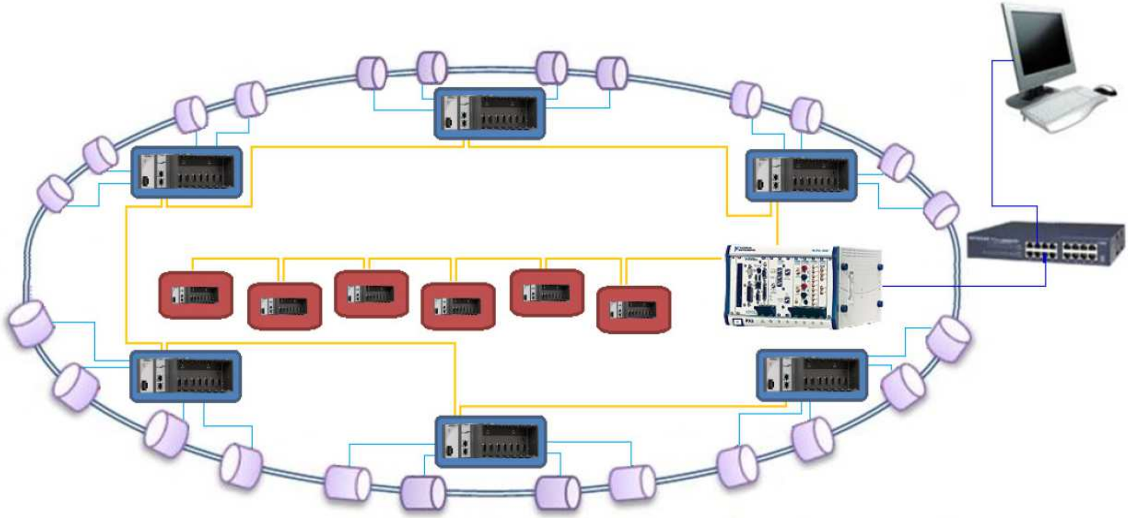
Ion pump in conventional set-up

Proposed setup for Sirius

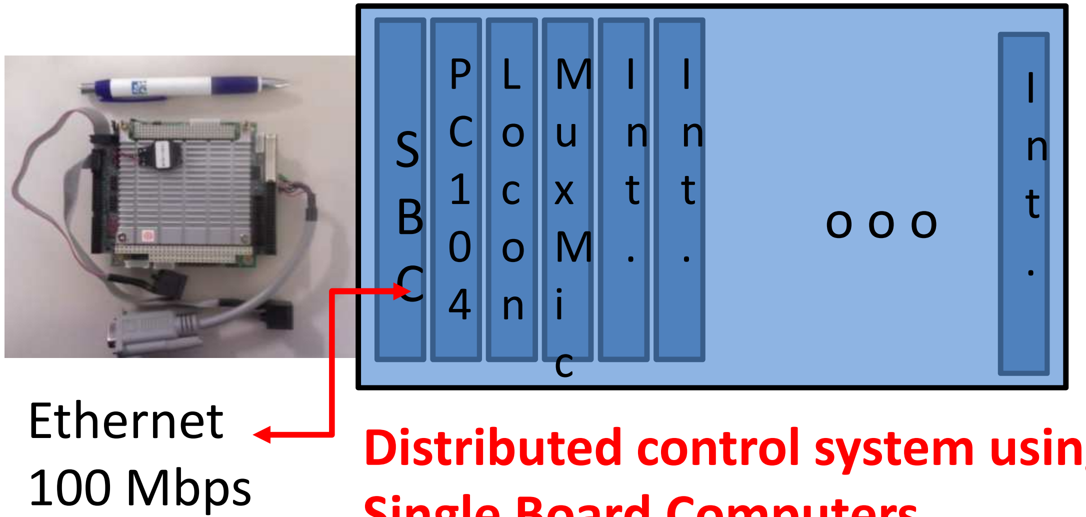
Effective pumping speed of ion pumps increases by 70%

UVX as a test bench for Sirius

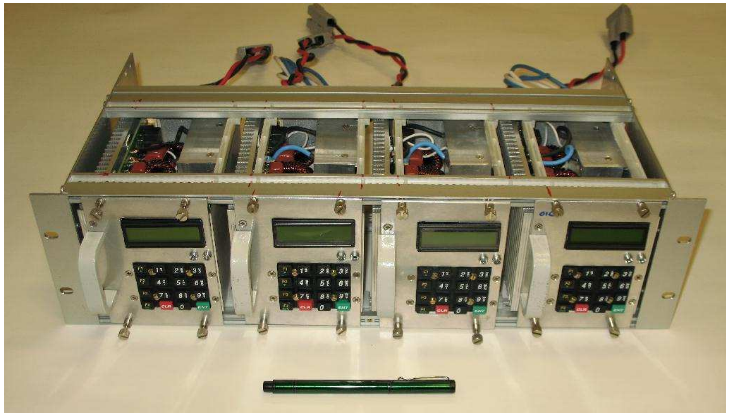
RF system using solid state amplifiers at 476 MHz developed in collaboration with Soleil.



Fast orbit and bunch-by-bunch feedback loops.



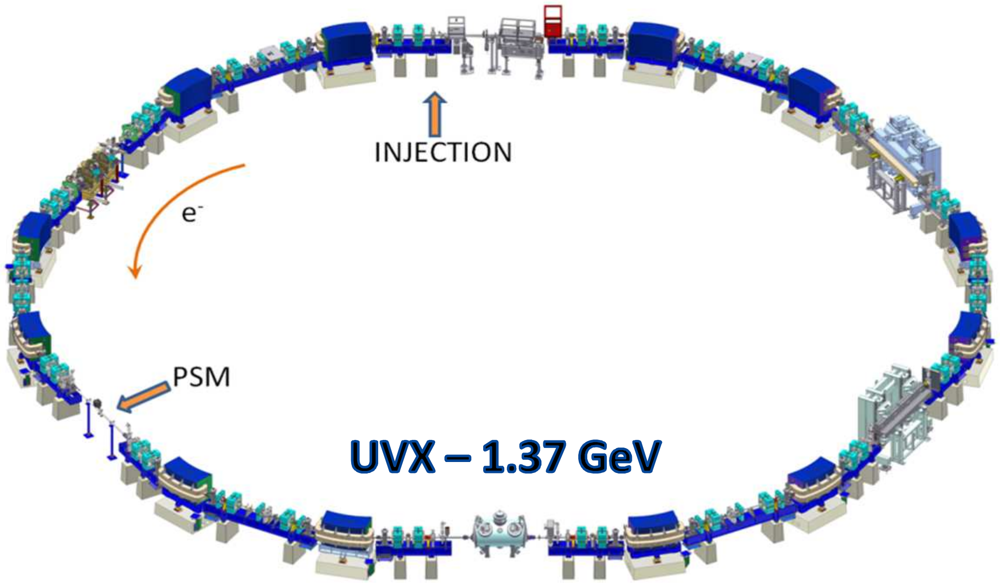
Distributed control system using Single Board Computers.



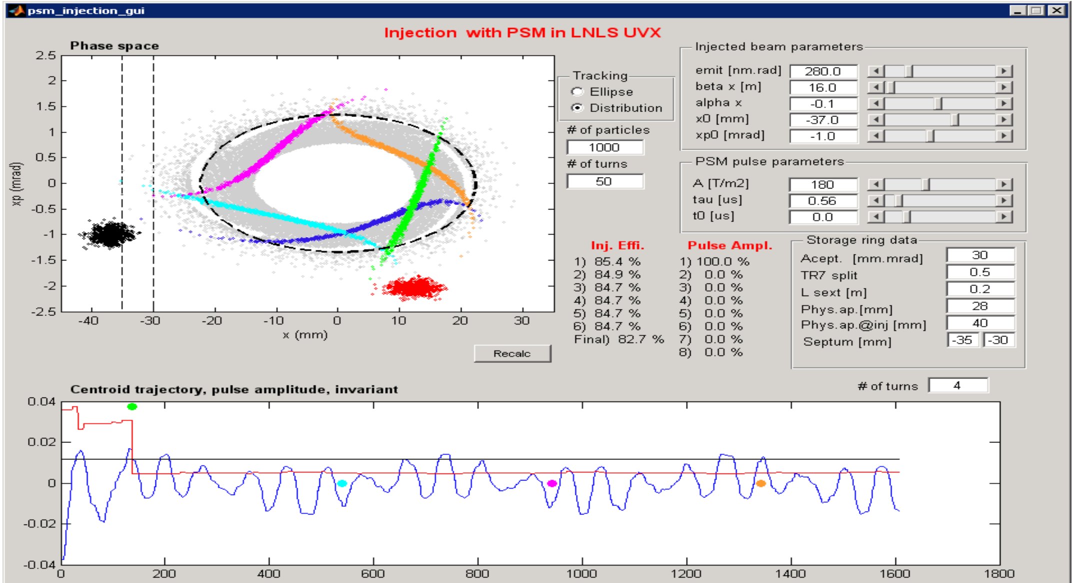
Modular power supplies. The units can operate independently or combined for higher current.

Injection using pulsed sextupole in UVX

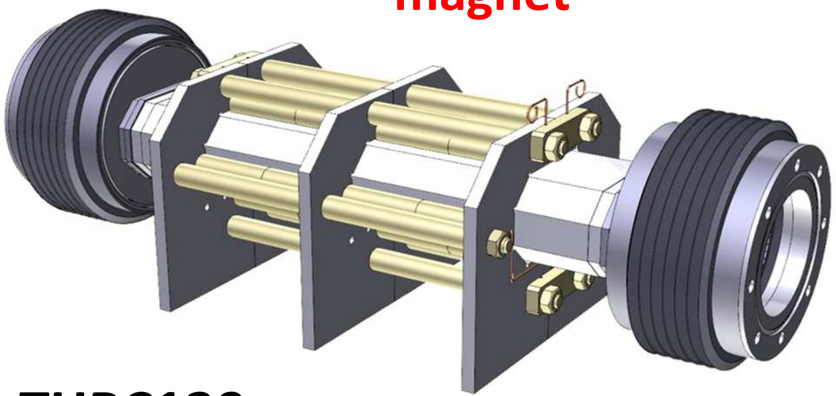
Preparation for tests at next shutdown in December.



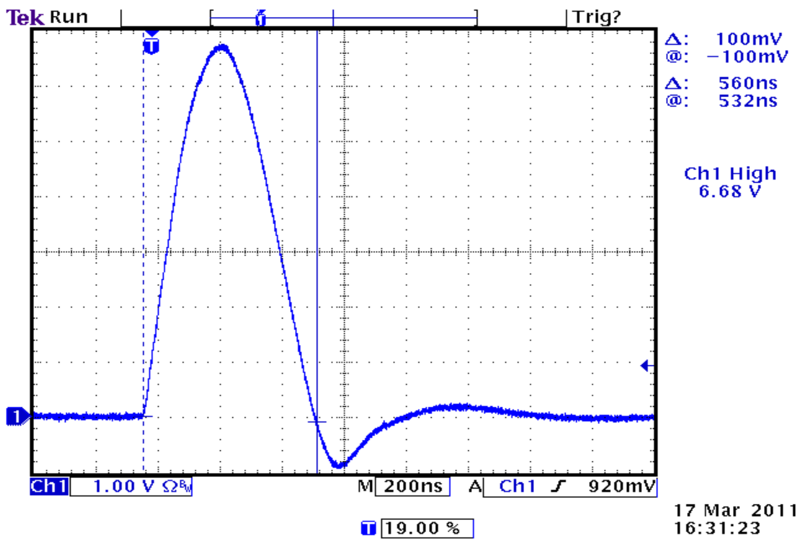
simulation



magnet

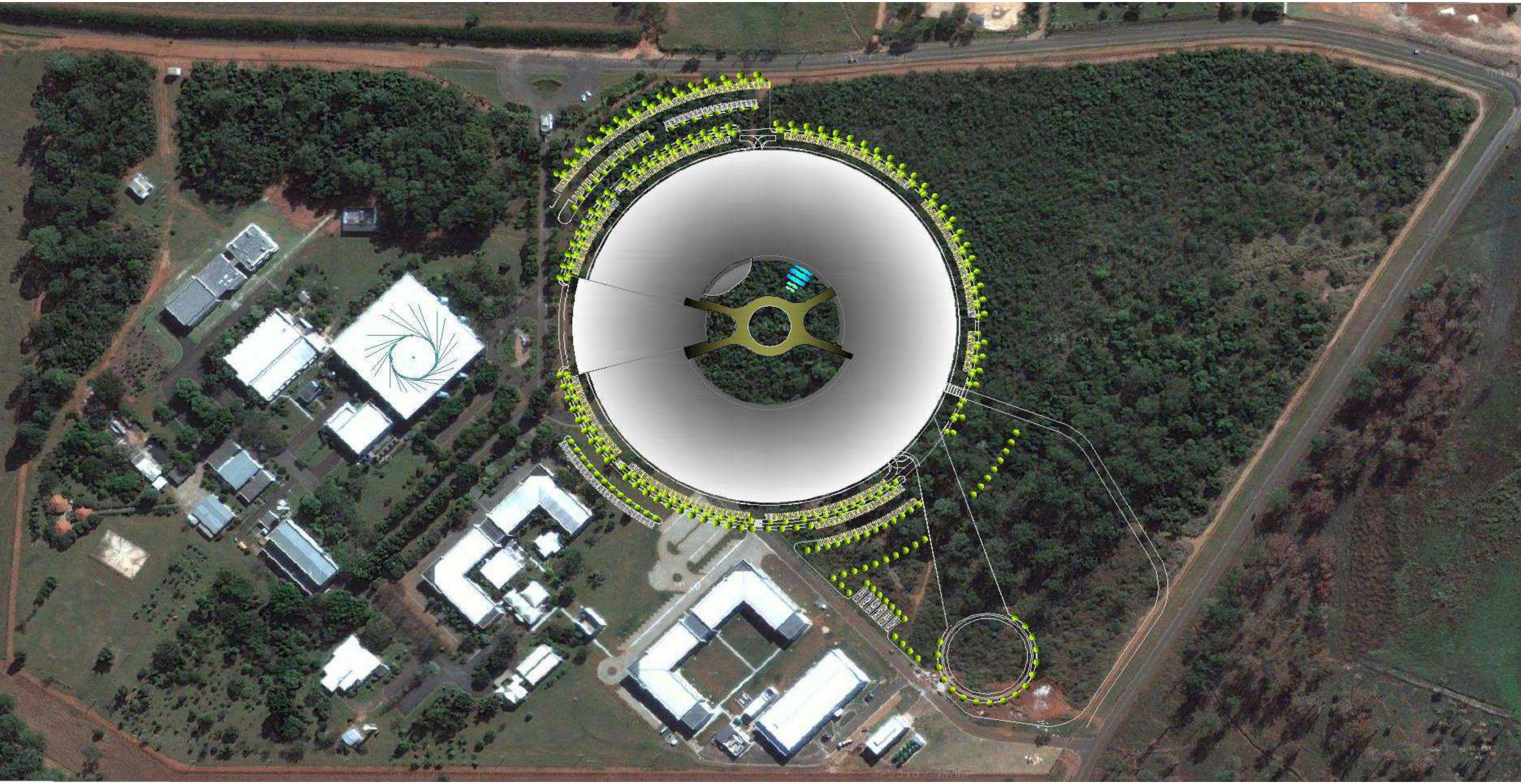


Power supply pulse

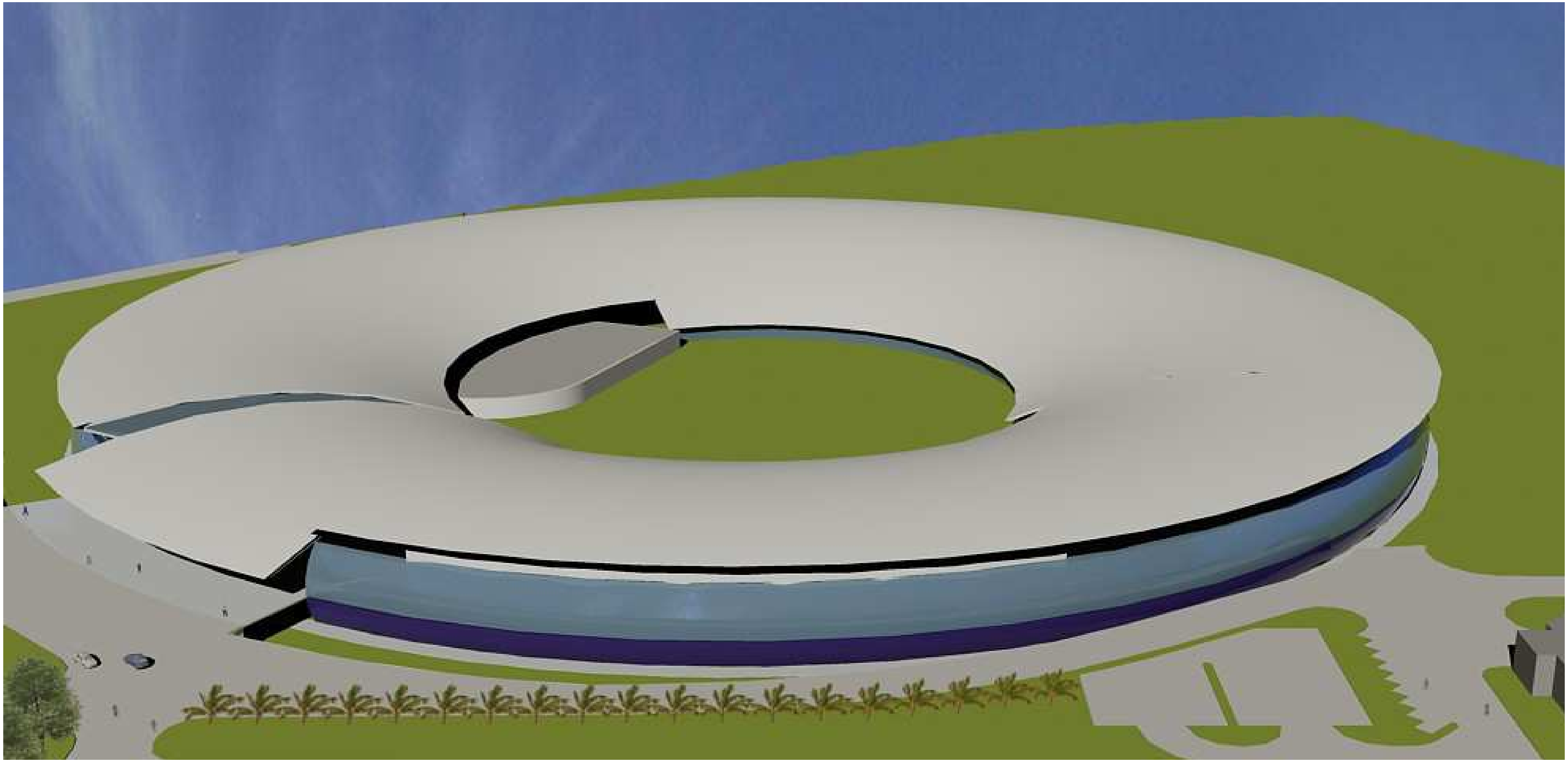


Poster THPC139

Sirius location on LNLS campus



Building



Thank you

for your attention!