JAGIELLONIAN UNIVERSITY
IN KRAKOW

SOLARIS
NATIONAL SYNCHROTRON
RADIATION CENTRE

Status of SOLARIS

Paweł Borowiec
On behalf of Solaris Team

e-mail: pawel.borowiec@uj.edu.pl

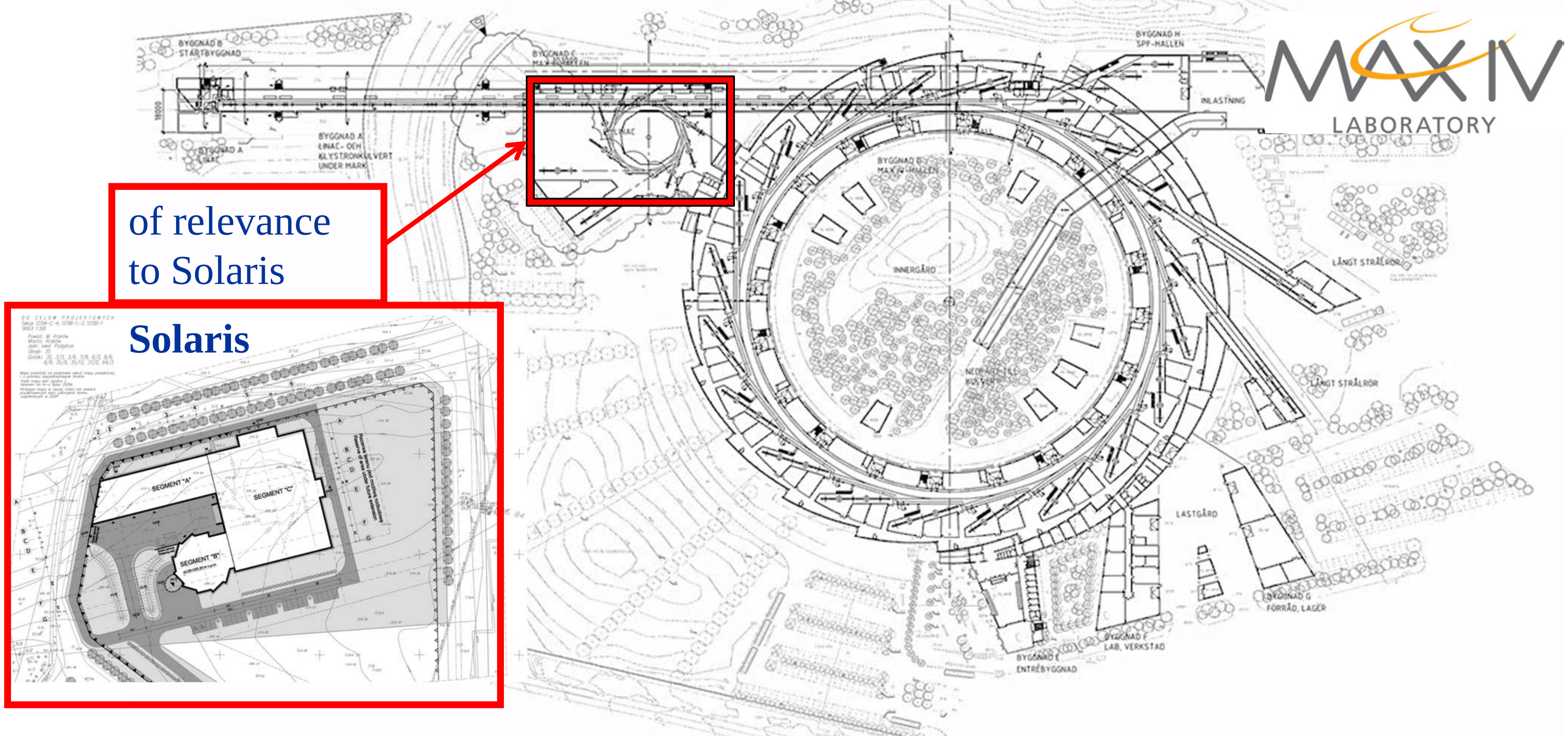
XVII ESLS-RF Meeting, Berlin 19.09.2013

Outline

Overview

Solaris will be the replica of the 1.5 GeV MAX IV Storage Ring and parts of the linac injector.

Solaris will use identical components as far as possible to those of MAX IV.



3.0 GeV ring:	20 straights (ε=0.32 nmrad) 528 m circumference
1.5 GeV ring:	12 straights (ε=6.0 nmrad) 96 m circumference
3.0 GeV linac:	Injector + Short Pulse Facility (+ FEL)

Courtesy: A.Wawrzyniak

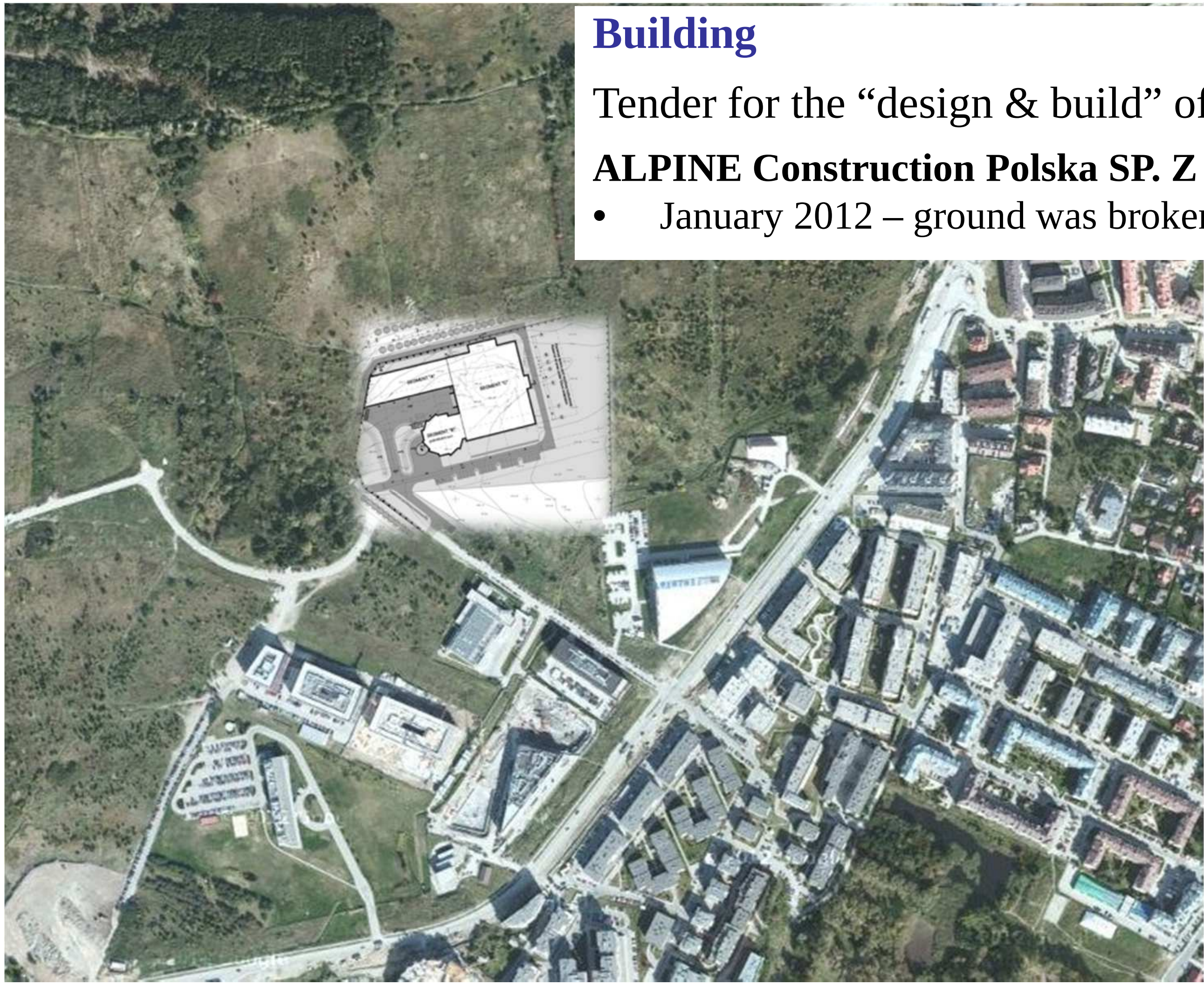
Overview

- **Agreement established between Jagiellonian and Lund Universities for mutual cooperation in the construction of Solaris based on MAX IV.**
- **MAX IV freely giving all know-how, reports, designs, info on tenders, training, ..., to Solaris**
- **Solaris team (technical) is hosted at MAX IV and participate in project activities and training. Sharing of mutual resources and also providing a support to MAX IV.**
- **Procurements for Solaris are as options in MAX IV tenders.**
- **Initial 143 MPLN co-financed by the European Regional development Fund. The money covers:**
  - **People/Services (17%)**
  - **Buildings and laboratories (~29%)**
  - **Accelerators (32% Storage Ring, 18% Linac)**
  - **One bending magnet beamline (4%)**
- **Land donated and administrative support by the Jagiellonian University**
- **Deadline: April 2015**
- **Additional founds: 38 MPLN, including 22 MPLN for 2nd beamline**

Courtesy: A.Wawrzyniak

Location

SOLARIS @ Jagiellonian University new Campus:
ul. Czerwone Maki 98, Kraków 50^{o}01’21” N:19^{o}53’37” E



Building

Tender for the “design & build” of building given to:

ALPINE Construction Polska SP. Z o.o.

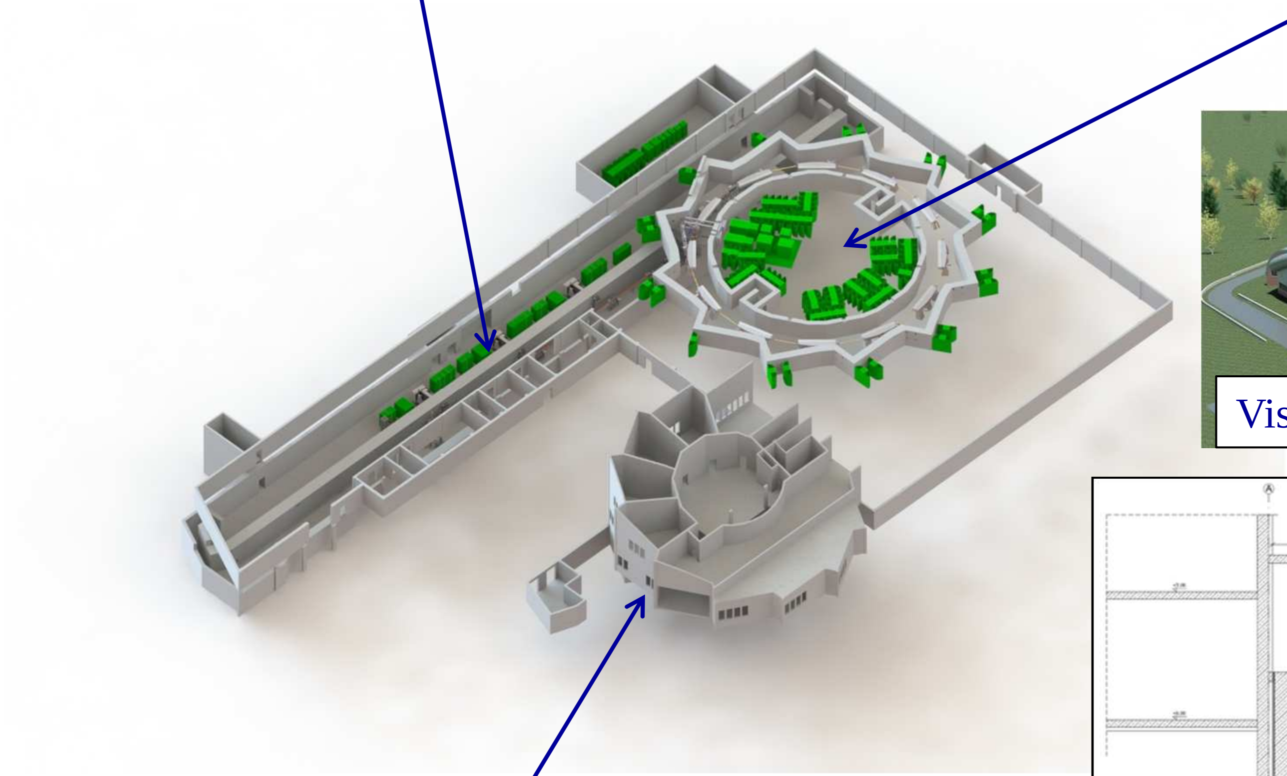
- January 2012 – ground was broken

Courtesy: A.Wawrzyniak

Facility

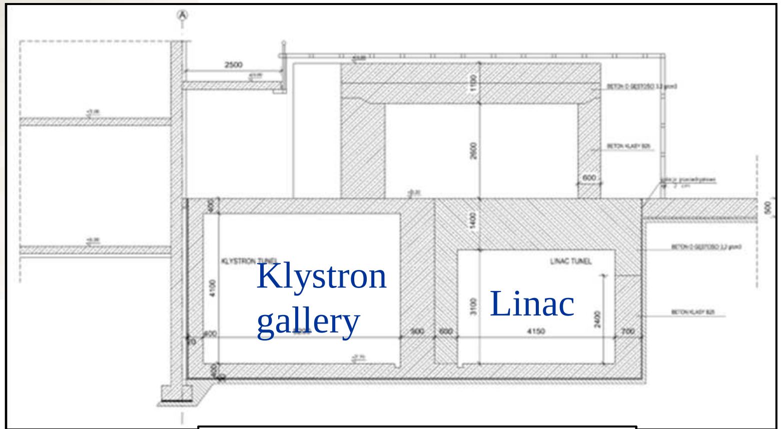
Linac Floor at -7.7 m from surface

Storage ring floor -3.2 m from surface



Administration building at ground level

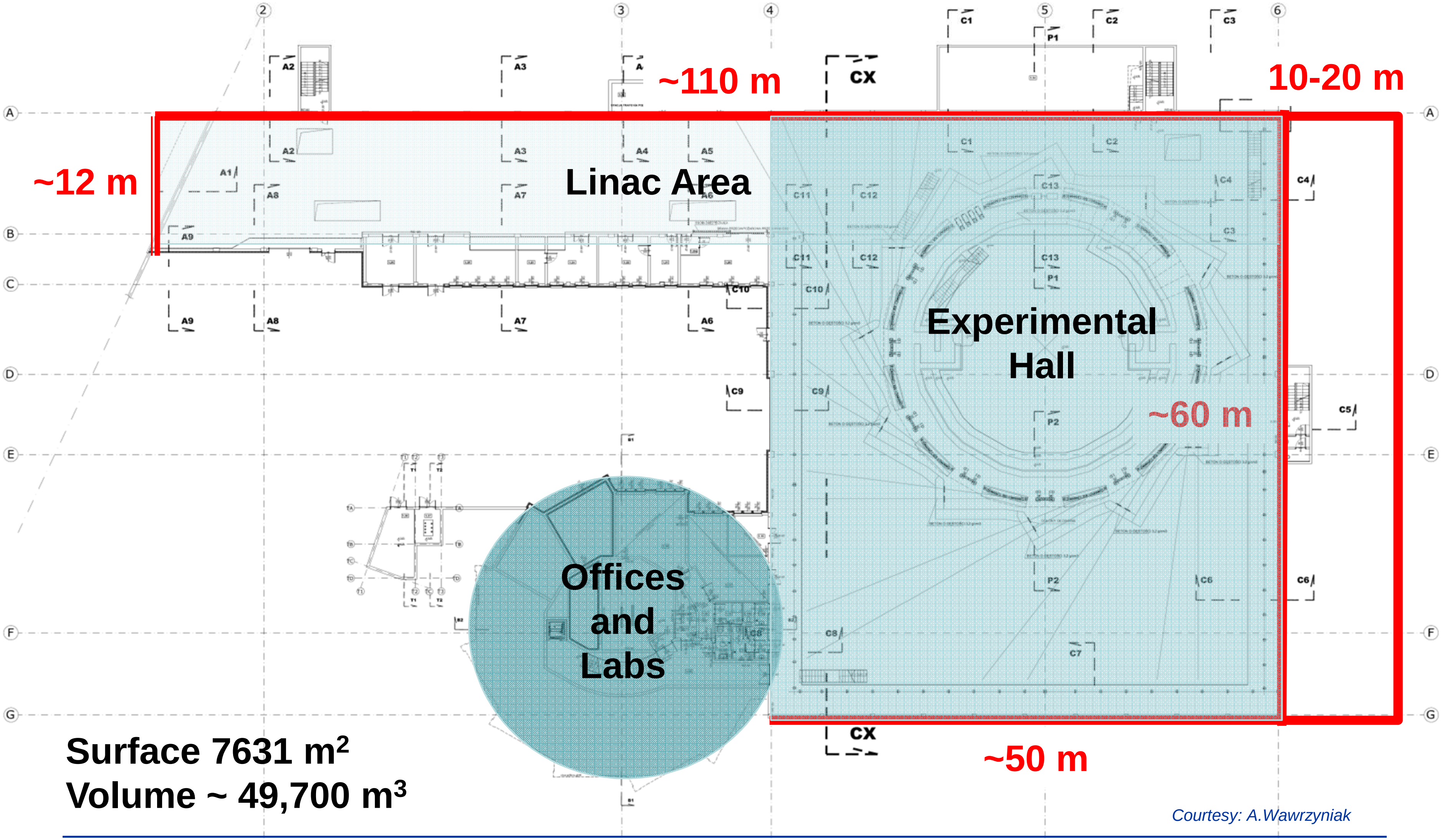
Visualization of Solaris facility



Tunnels cross-section

Facility

Solaris Building Overview



Surface 7631 m^2
Volume ~ 49,700 m^3

Courtesy: A.Wawrzyniak

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Building

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Summer 2012

October 2012

November 2012

April 2013

September 2013

September 2013

Building

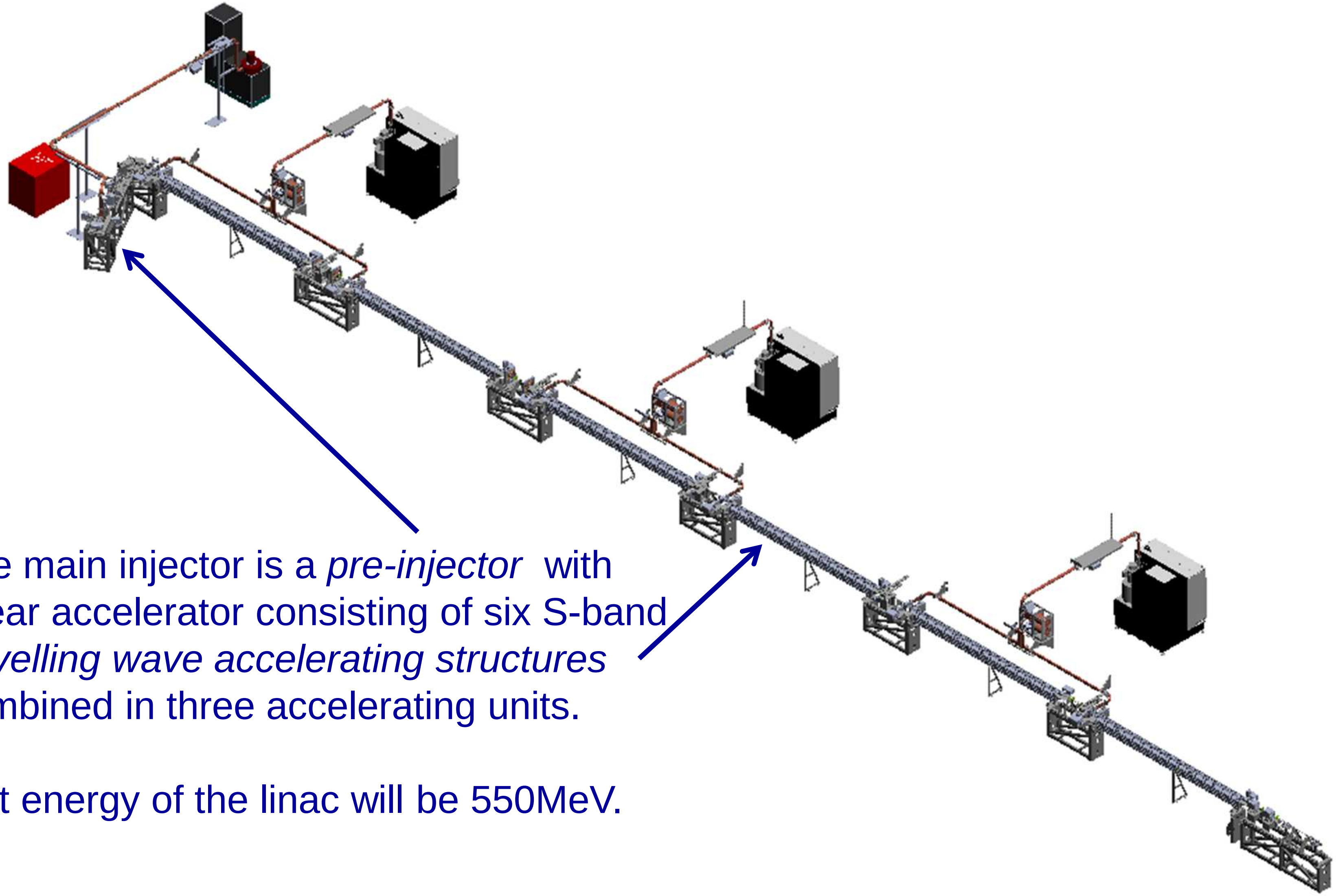

Klystron Gallery

Linac


Storage Ring and Experimental hall


Control Room

Linac



The main injector is a *pre-injector* with linear accelerator consisting of six S-band *travelling wave accelerating structures* combined in three accelerating units.

Exit energy of the linac will be 550MeV.

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Pre-injector

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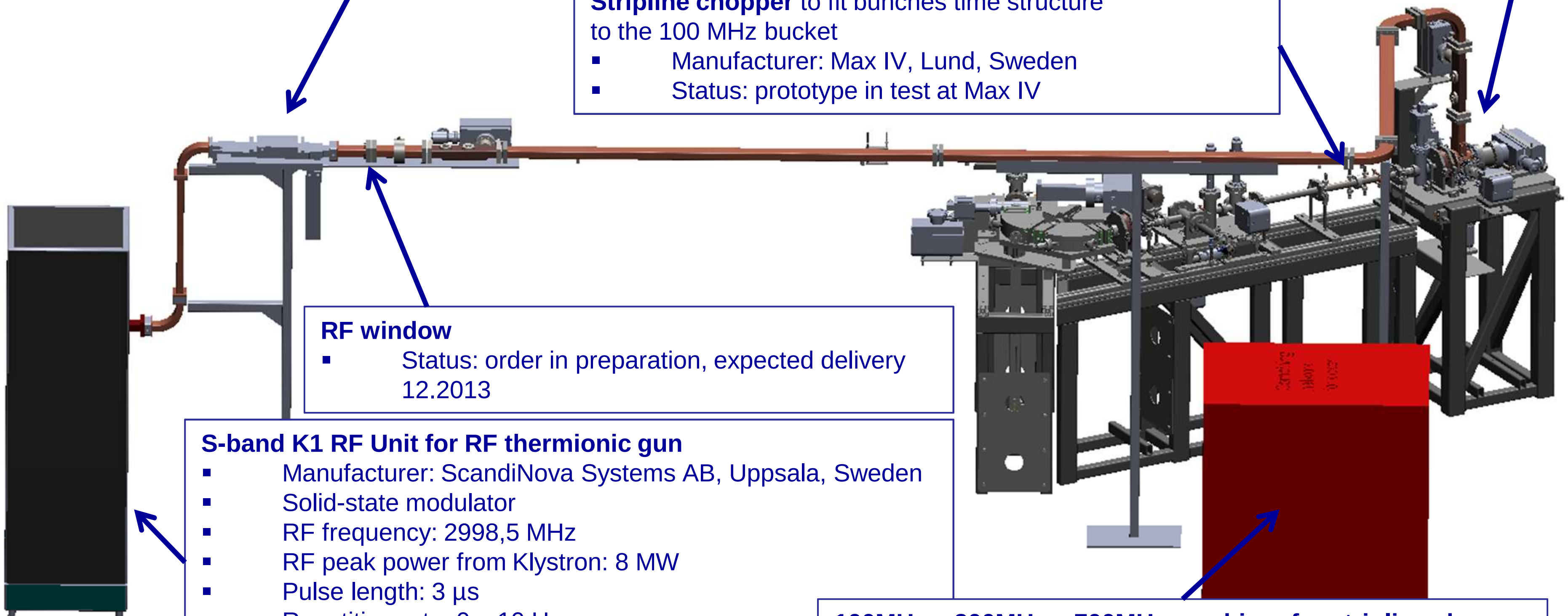
Isolator
- Manufacturer: AFT, Backnang – Waldrems, Germany
- Forward peak power: 20 MW
- Forward average power: 5 kW
- Reverse power: 100% at any phase
- Status: in production, delivery 10.2013

RF thermionic gun
- Manufacturer: Max IV, Lund, Sweden
- Status: prototype in test at Max IV

Stripline chopper to fit bunches time structure to the 100 MHz bucket
- Manufacturer: Max IV, Lund, Sweden
- Status: prototype in test at Max IV



RF window
- Status: order in preparation, expected delivery 12.2013

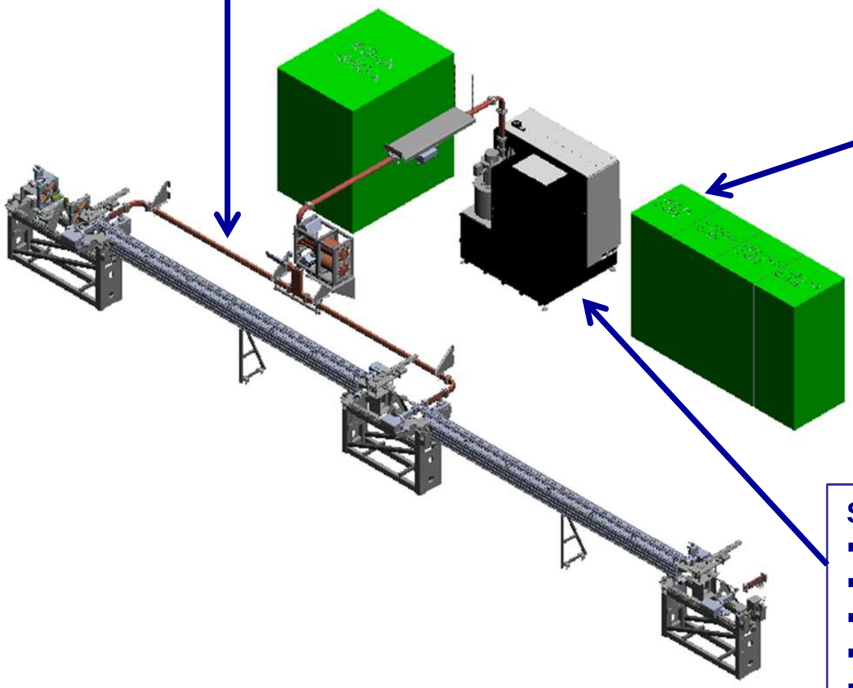
S-band K1 RF Unit for RF thermionic gun
- Manufacturer: ScandiNova Systems AB, Uppsala, Sweden
- Solid-state modulator
- RF frequency: 2998,5 MHz
- RF peak power from Klystron: 8 MW
- Pulse length: 3 µs
- Repetition rate: 0 – 10 Hz
- Klystron: Toshiba TH2175A-1
- Status: in production, delivery 12.2013

100MHz + 300MHz + 700MHz combiner for stripline chopper
- Manufacturer: Exir Broadcasting AB, Hörby, Sweden
- Status: prototype in test at Max IV

Accelerating unit

Waveguides

- Manufacturer: IHEP, Beijing, China
- Size: WR284
- Flanges: LIL for UHV, CPR for SF6
- Status: manufactured for the linac,
- order in preparation for the gun, exp. delivery 12.2013



LLRF for each RF Unit in the Linac

- Manufacturer: Max IV, Lund, Sweden
- Pulse shaping
- Phase adjustment
- 180º phase swap for SLED
- Status: manufactured

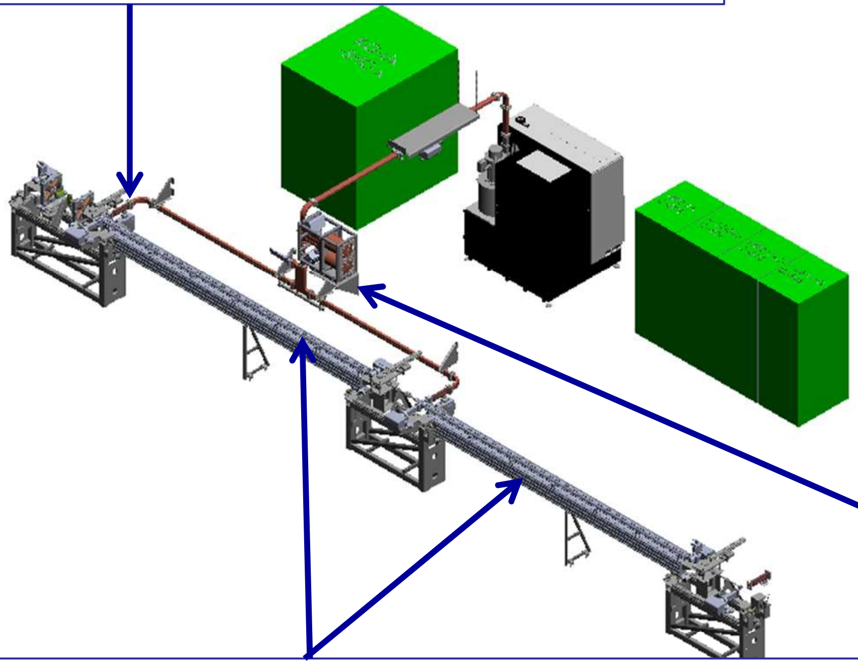
S-band K2 RF Unit for accelerating sections

- Manufacturer: ScandiNova Systems AB, Uppsala, Sweden
- Solid-state modulator
- RF frequency: 2998,5 MHz
- RF peak power from Klystron: 37 MW
- Pulse length: 4,5 µs
- Repetition rate: 0 - 100Hz
- Klystron: Toshiba E37310
- Status: all 3 RF units manufactured

Accelerating unit

Waveguide directional couplers

- Manufacturer: Max IV, Lund, Sweden
- Flanges: LIL
- Coupling: 50 dB
- Some have CF40 port for ion pump connecion
- Status: manufactured



SLED cavity with 3dB hybrid coupler

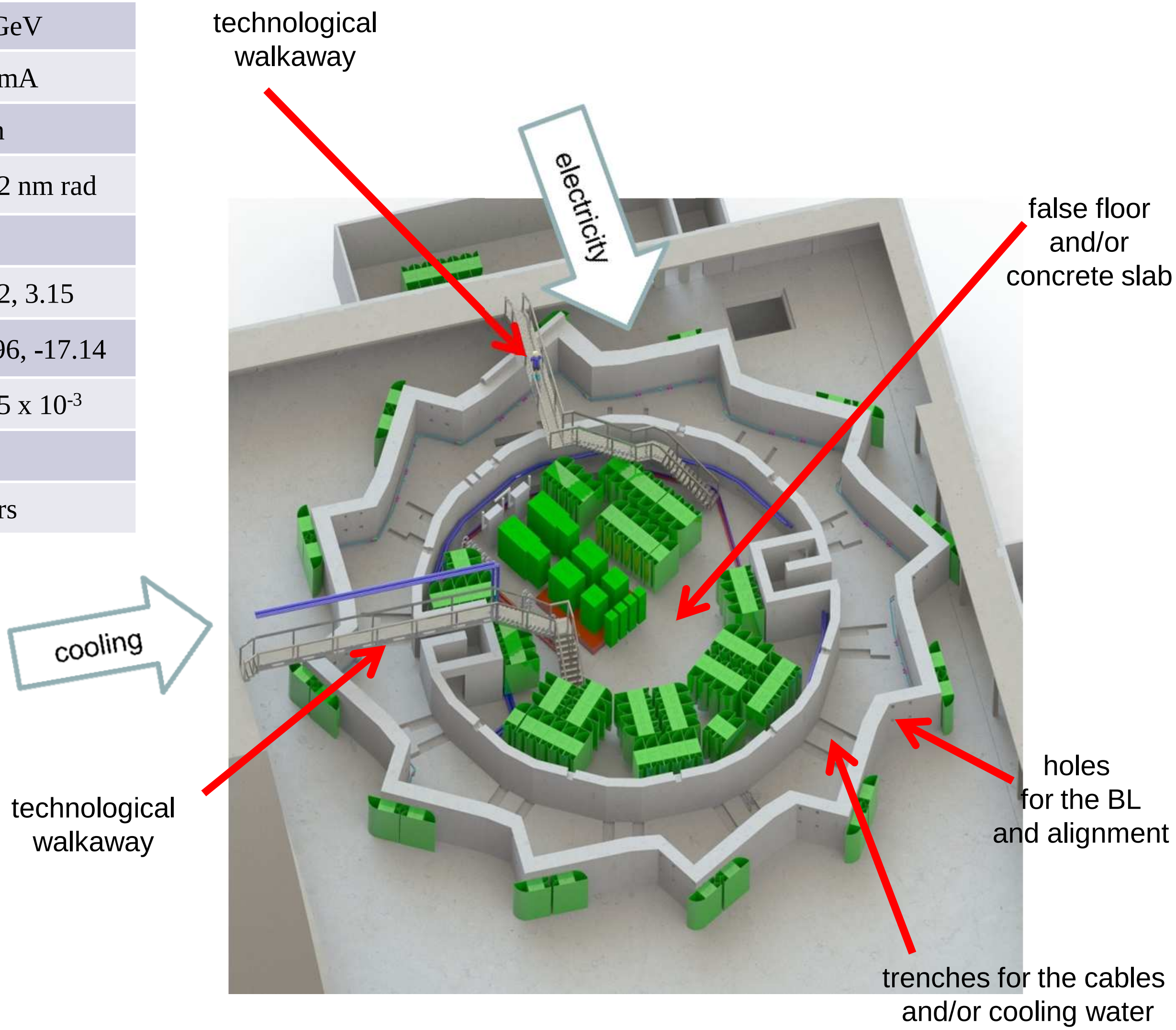
- Manufacturer: Research Instruments GmbH, Bergisch Gladbach, Germany
- SLED gain: up to 5
- Status: all cavities manufactured and conditioned

S-band travelling wave accelerating structure

- Manufacturer: Research Instruments GmbH, Bergisch Gladbach, Germany
- Resonant mode: $2\pi/3$
- Accelerating gradient : 20MV/m
- Length: 5m
- Status: all 6 sections manufactured and conditioned

Storage Ring

Storage Ring Parameters	Value
Energy	1.5 GeV
Current	500 mA
Circumference	96 m
Horizontal emittance (bare lattice)	5.982 nm rad
Coupling	1%
Tunes Q_x, Q_y	11.22, 3.15
Natural chromaticities ξ_x, ξ_y	-22.96, -17.14
Momentum compaction	3.055 x 10^{-3}
Momentum acceptance	4%
Overall Lifetime	13 hrs



Courtesy: A.Wawrzyniak

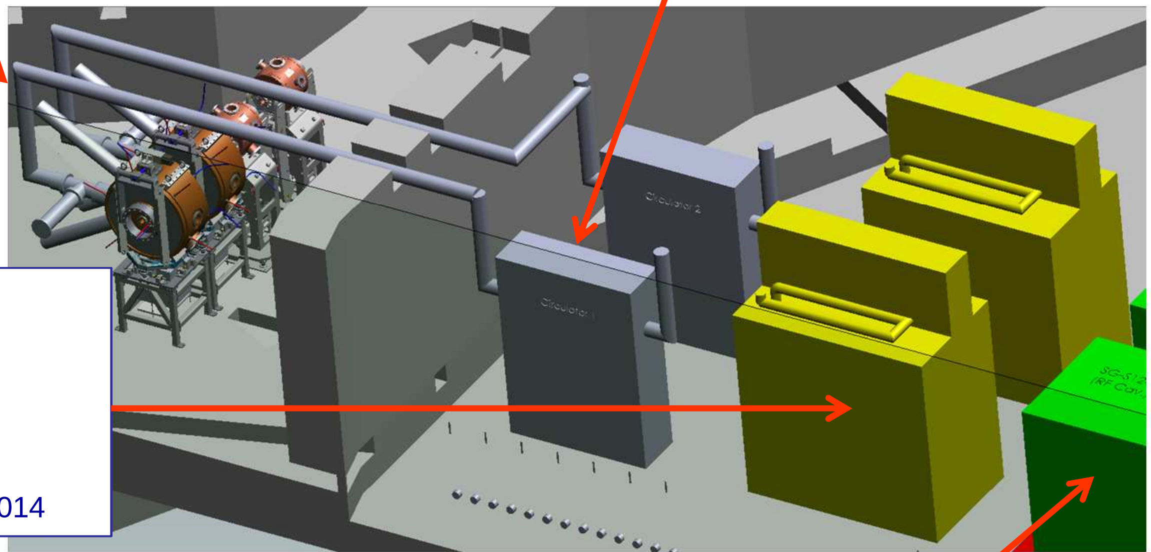
Storage Ring RF

6 1/8” EIA rigid coax line

- Manufacturer: Exir Broadcasting AB, Hörby, Sweden
- Status: order in preparation, expected delivery 06.2014

Isolator

- Manufacturer: AFT, Backnang – Waldrems, Germany
- Forward peak power: 120 kW CW
- Reverse power: 100% at any phase
- Status: in production, delivery 06.2014



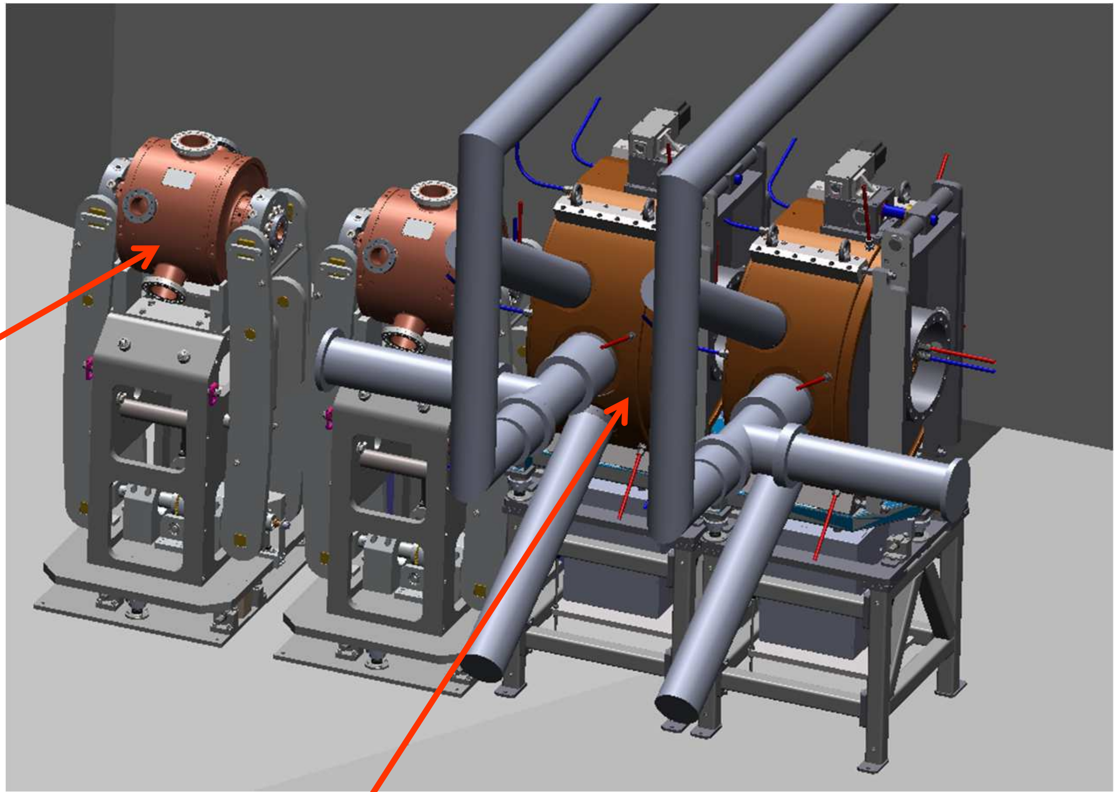
100MHz RF Transmitter TT2C60K

- Manufacturer: Electrosys S.r.l., Orvieto, Italy
- Tetrode transmitter
- RF frequency: 99,93 MHz
- RF peak power: 60 kW CW
- Tetrode: Thales TH595
- Status: order in preparation, exp. delivery 06.2014

Digital LLRF for Storage Ring

- Manufacturer: ALBA, Barcelona, Spain
- Commercial µTCA board
- Control of amplitude and phase cavity voltage and resonance frequency control (Tuning)
- Safety Interlock and Diagnostic
- I/Q demodulation technique
- Status: in development, exp. delivery spring 2014

Storage Ring RF



300MHz Landau Cavity
- Manufacturer: Research Instruments GmbH, Bergisch Gladbach, Germany
- Tuning range: ±550 kHz
- Total voltage: 487 kV
- Status: in production, delivery 02.2014

100MHz Main Cavity
- Manufacturer: Research Instruments GmbH, Bergisch Gladbach, Germany
- Upgraded MAX-Lab cavity
- Resonant frequency: 99,93 MHz
- Tuning range: ±540 kHz
- Gap voltage: 300 kV
- Status: in production, delivery 02.2014

Differences - machine

Differences between MAX IV and Solaris 1.5 GeV

- **Linac** – Solaris will us a reduced number of accelerating sections and injection will not be at full energy.
- **Transfer line** – layout and support systems (beam heights and transfer line lengths) will be different although the same magnets will be used as for MAX IV.
- **Injection energy** – the beam will be injected at ~550 MeV and will be energy ramped in the storage ring. Power supplies for magnets will have to be ramped and the control system adjusted for this. Tune and optics feedback may have to be implemented. Studies of ramping procedures, instabilities, ion trapping, cavity tuning will need to be performed and appropriate beam dynamics programs implemented.
- **Injection** with dipole kicker - MAX IV 1.5 GeV will use a pulsed kicker to the first vertical deflection magnet, this option will not be used for Solaris.
- **Front ends** – differences may arise between Solaris and MAX IV, in terms of components and distances between machine and the inner side of the shielding wall, the thickness (and type of concrete) and continuation into the experimental hall.
- **Beamline** – the bending magnet beamline will be unique to Solaris and will require it own components, control system and electronics.
- **Future insertion devices** – SCW (placement, installation, beam dynamics)

Courtesy: A.Wawrzyniak

Differences - machine

Differences between MAX IV and Solaris 1.5 GeV

- **Building and Services** – Buildings, shielding, general services, access areas, transportation on the site and logistics are different.
- The layout of the storage ring will be identical to MAX IV but its placement within the tunnel and its connection to services (power, water, compressed gases,..) will be unique to the Solaris site.
- **Installation** – Machine installation and logistics will be unique to Solaris, which has a removable roof to the ring tunnel and linac access area, cranes will be used for component placement. Component preparation areas are unique.
- **Control Access** – The system will be unique for Solaris and its shielding architecture and access.
- **Control system** – Although the control systems for both Solaris and MAX IV are identical and based on the TANGO operating system, differences will arise from operations (energy ramping for Solaris, Short Pulse Facility operation for MAX IV linac) and physical layout including beamlines. Supplementary code and electronics will need to be covered.
- **Alignment** – Although machine components are identical the network will not be, nor will the transfer line. Dedicated alignment procedures will be required for Solaris.
- **Layout and drawings** – creation and maintenance of the drawings database for Solaris systems, plants and infrastructures.
- **Support laboratories** – Layout, services, equipment, logistics

Courtesy: A.Wawrzyniak

Quality Control

Components of the machine will be delivered by different manufacturers.
It is necessary to assure smooth transition from production, through installation to commissioning phase. According to quality policy which was established, each RF component is marked and has individual log-file.

Quality control consists of:

- Factory Acceptance Test;
- Incoming visual inspection;
- Site Acceptance Test;
- Measurements of characteristic parameters before and after installation.

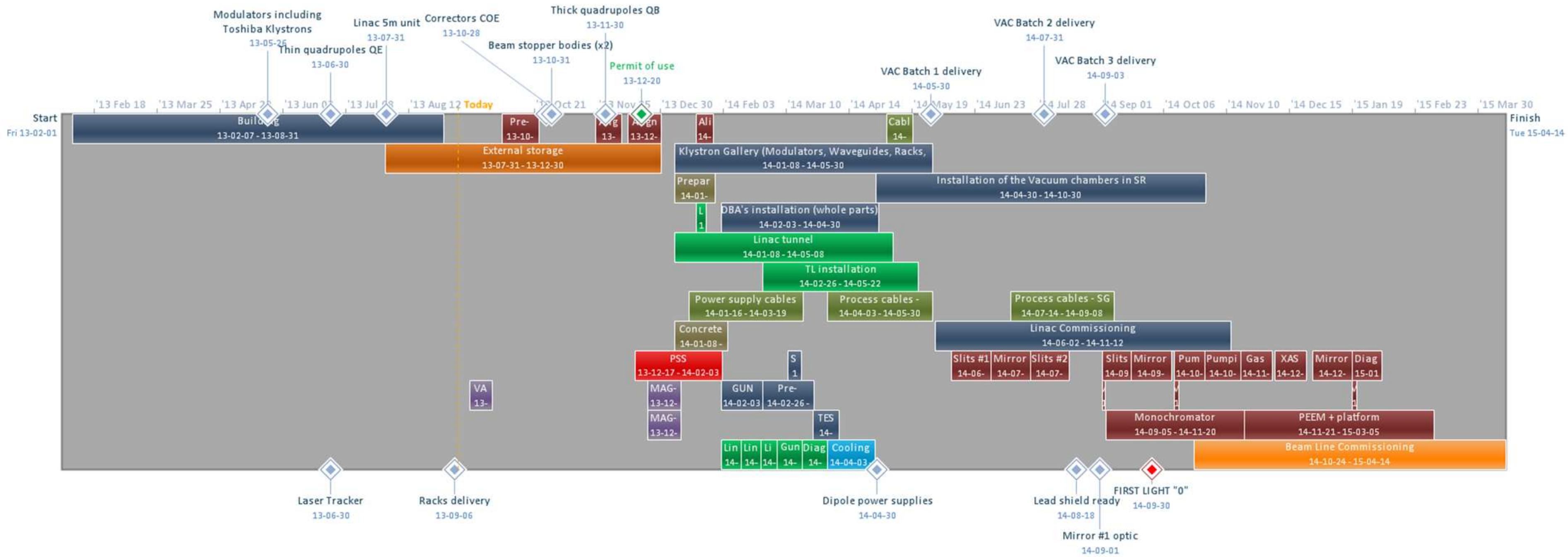
Since many RF elements are working under UHV conditions, leak test will be performed.

Quality Control

Engraved mark => baking proof

E-bends have been sent to RI for accelerating structures conditioning.
Re-check will be done after conditioning.

Installation



Beginning of installation: **December 2013**

Personal Safety System: **December 2013- February 2014**

Installation of linac: RF units, waveguides, …: **January – May 2014**

Installation of transfer line: **March – May 2014**

Installation of storage ring components (service gallery, stands): **March – April 2014**

Installation of storage ring components: magnets, vacuum chambers: **May - November 2014**

Installation of first beamline: **June – December 2014**

Installation of second beamline: **February - April 2015**

Courtesy: A.Wawrzyniak

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Acknowledgment

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I WOULD LIKE TO EXPRESS SPECIAL THANKS TO ALL THE
MAX IV TEAM FOR SHARING THEIR TECHNOLOGY AND KNOW-HOW

AND

ELETTRA TEAM FOR THE ASSISTANCE AND CONSULTANCY IN VARIOUS AREAS OF THE PROJECT.

Thank you for your attention