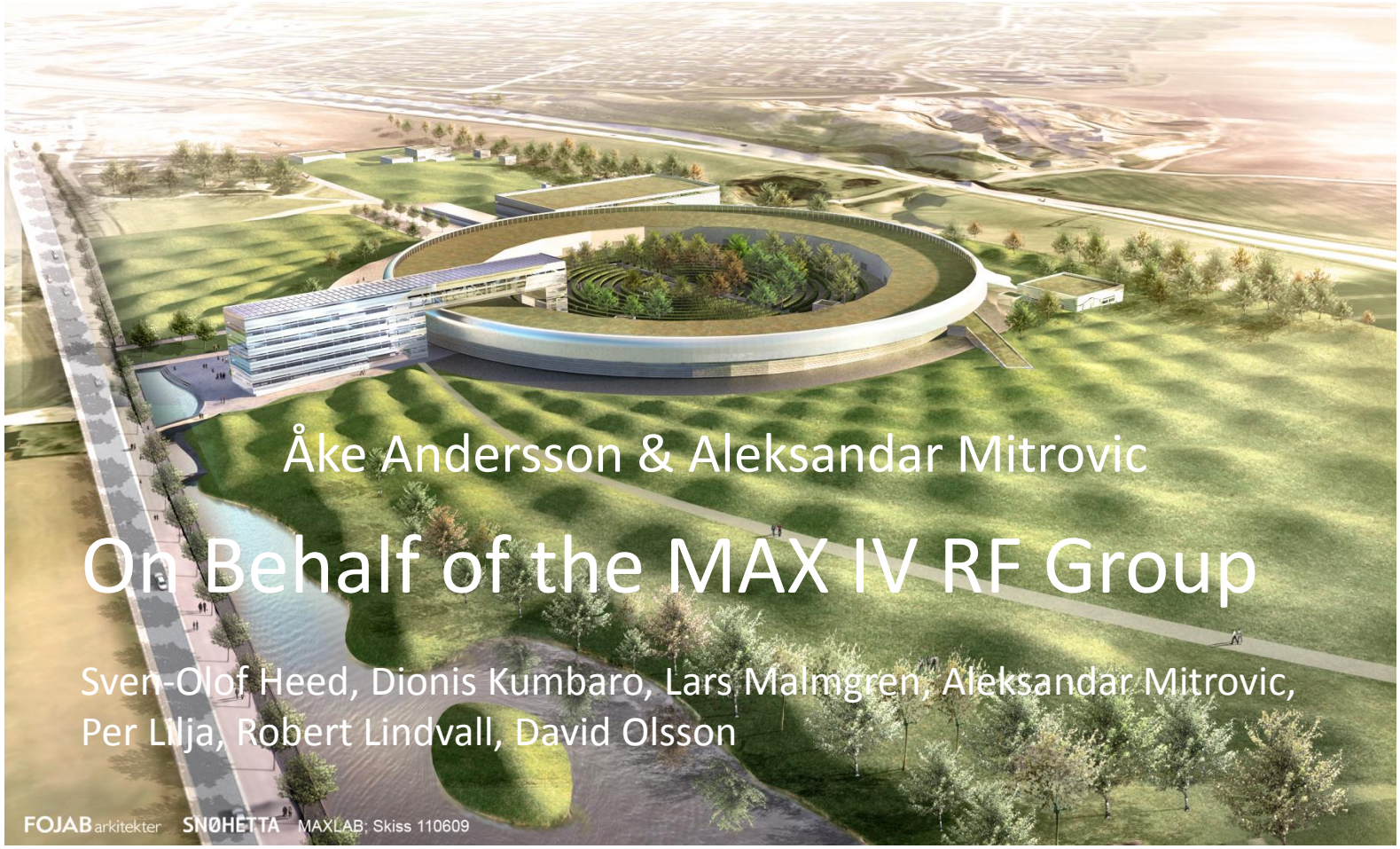
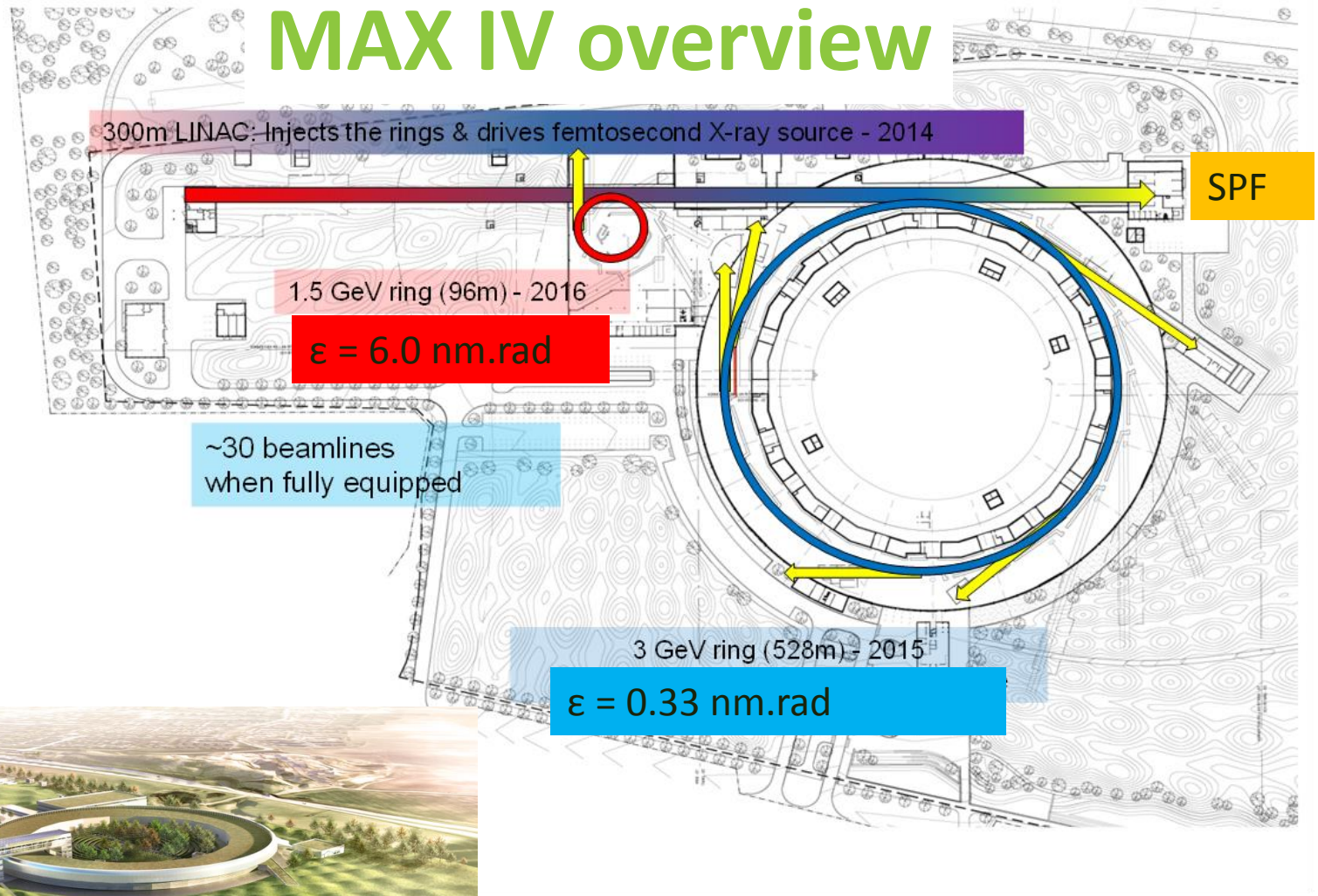
Status MAX IV



Outline

- MAX IV overview
- Status MAX IV - Linac
- Status MAX IV – 3 GeV Ring
- Status MAX IV – 1.5 GeV Ring

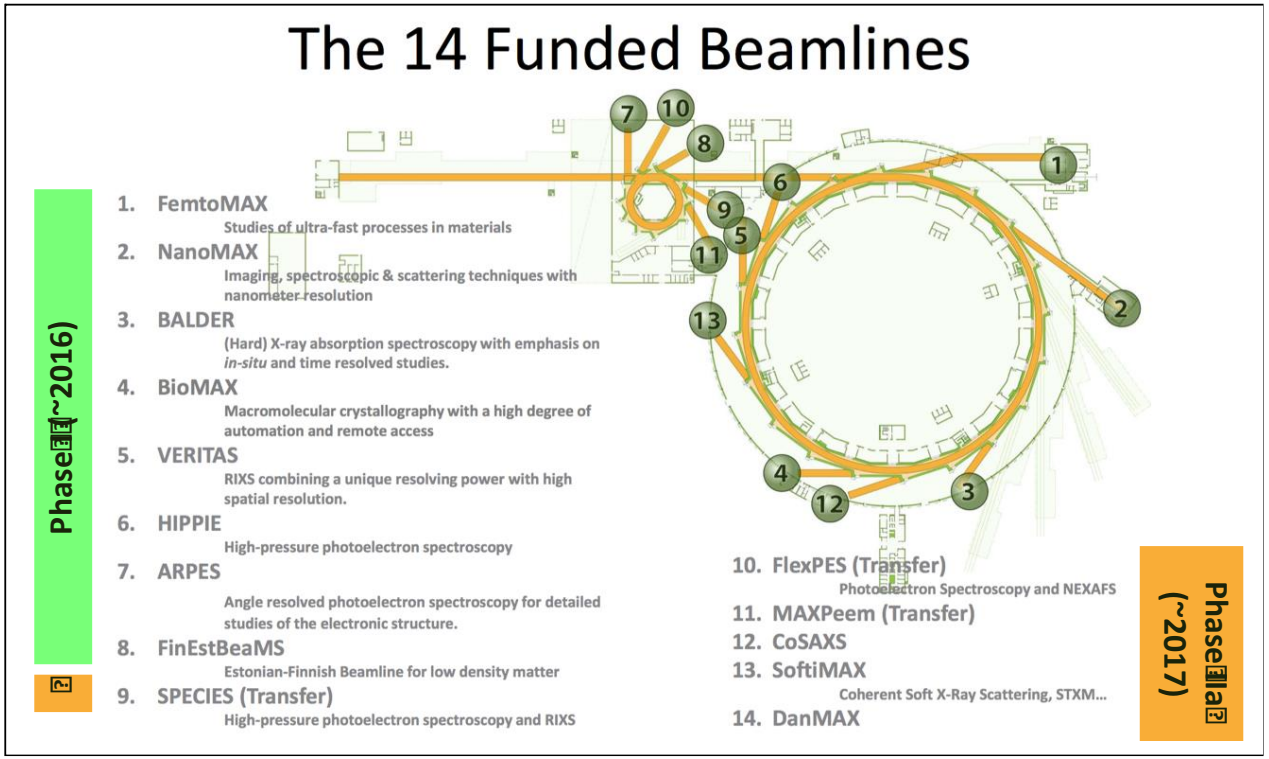
MAX IV overview



Inauguration was June 21, 2016

MAX IV Facility Overview

- Facility can accommodate up to 32 user beamlines: 3 @ SPF, 10 @ 1.5 GeV SR, 19 @ 3 GeV SR
- 14 have been funded in our first two beamline phases



Status

- **User delivery for the 3 GeV ring & SPF, 16h/7days, re-sumed this week, after a 3 month SD.**
- **We will serve 9 BLs during the rest of the year.**
- **5 in the 3 GeV ring**
- **1 in the SPF**
- **3 in the 1.5 GeV ring**

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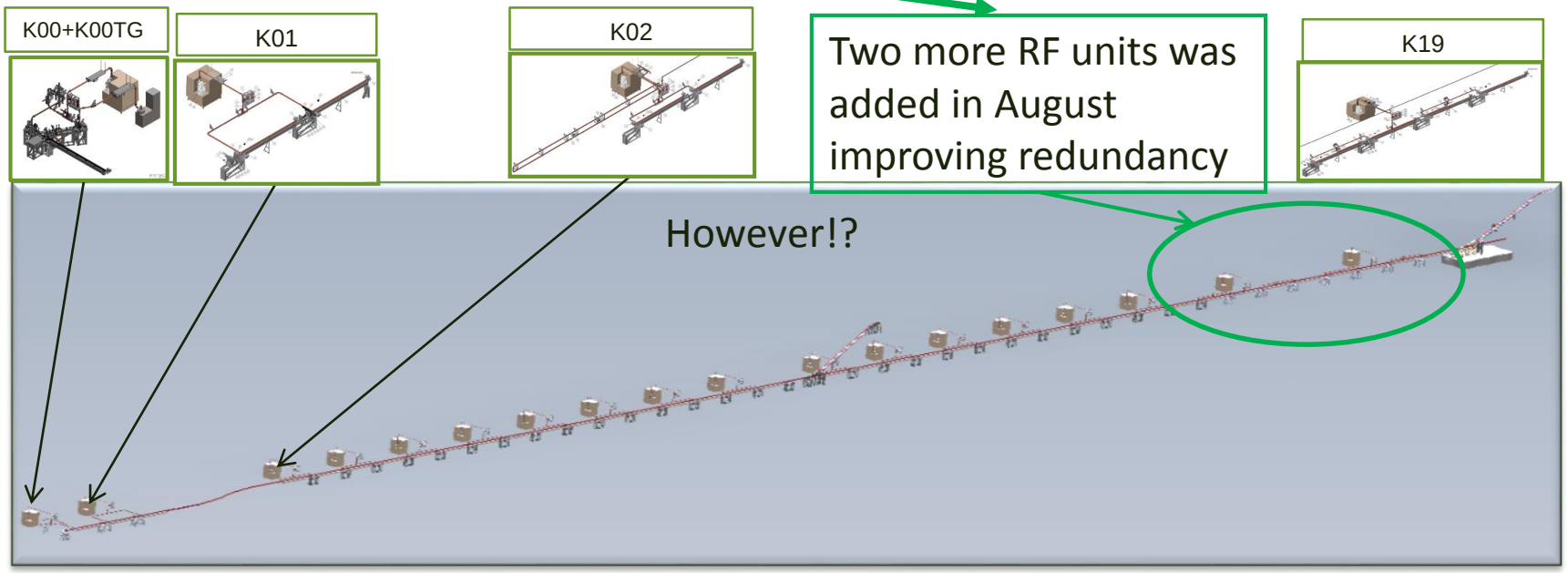
MAX IV linac

- The S-band linac is used as an injector for both the 1.5 and 3 GeV storage rings and the SPF (Short Pulse Facility).
- A thermionic RF gun (injection) & A photo RF gun (SPF & injection)
- 15 klystrons plus SLEDs drive the first 30 linac structures
- 2 klystrons plus SLEDS drove the last 8 linac structures
- Now



Some bad surprises during October:

Damaged RF window in K02 – need to replace Klystron, rebake and recondition

Leaky RF window in K06 – need to replace Klystron, rebake and recondition

MAX IV Ring RF System

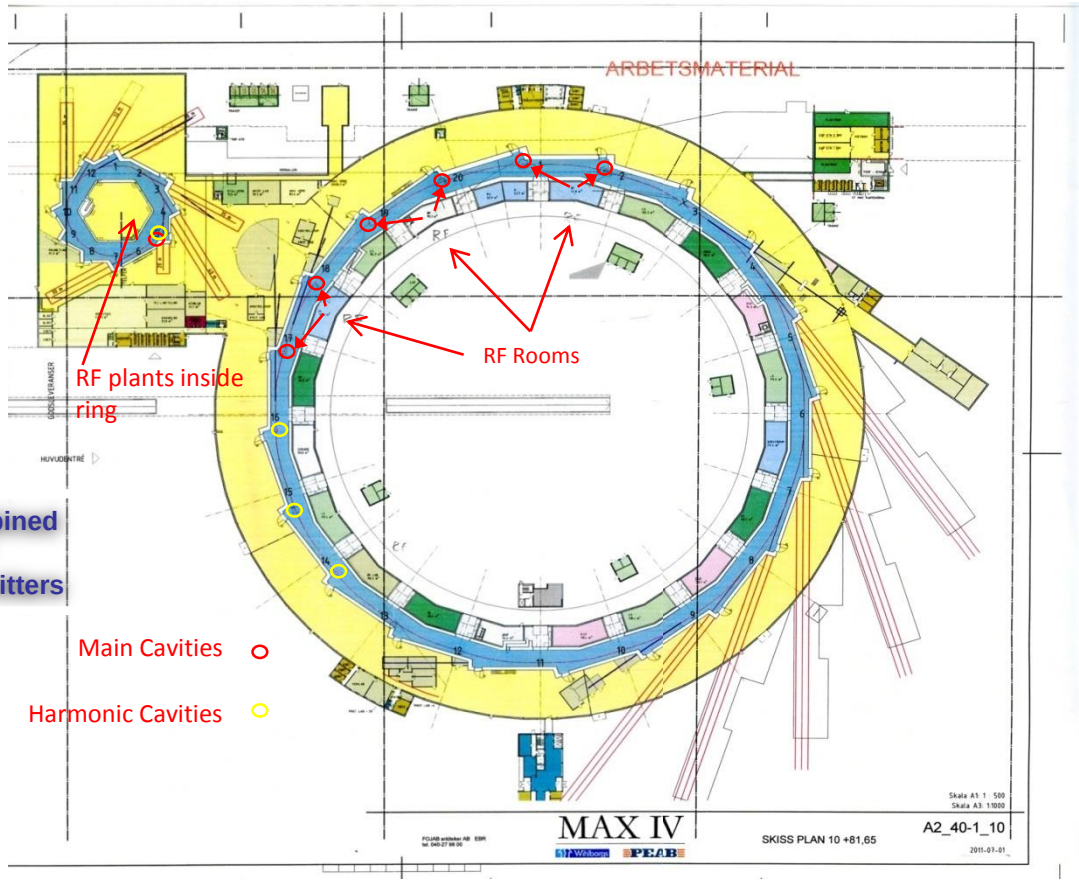
Storage Rings Parameters

Energy	1.5 GeV	3.0 GeV
RF	99.931 MHz	99.931 MHz
Circumference	96 m	528 m
Harmonic number	32	176
Current	500 mA	500 mA
No of cavities	2	6
RF station power	60kW	120kW
Cavity voltage	280kV	300kV
Coupling (beta)	2.3	4.0

2 combined 60 kW transmitters

1 single 60 kW transmitters

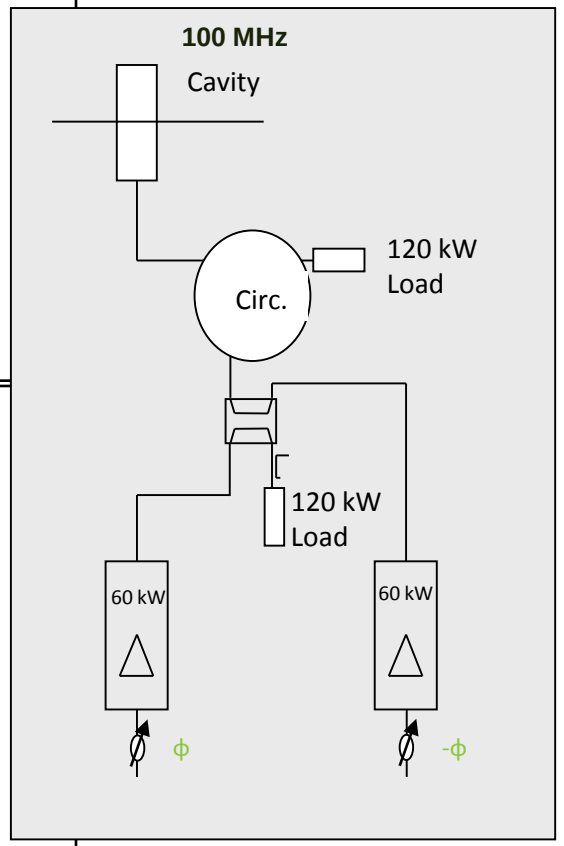
Solid State Amplifiers



Ring RF System - 3 GeV Ring

Alternative	I	II
Energy loss with Ids	756keV	1020keV
Circulating current	0.5A	0.5A
Total beam power	378kW	510kW
Total RF voltage	1.5MV	1.8MV
Number of cavities	6	6
Cavity shunt impedance	3.2Mohm	3.2Mohm
Cu losses	117kW	169kW
Total RF power needed	495kW	679kW
Nr of RF stations	6	6
Nr of transmitters	12	12
Transmitter power	41.5kW	56kW
Power to cavity	83kW	113kW
Cu losses/cav	20kW	28kW
Coupling (beta)	4.2	4.0
Cavity voltage	250kV	300kV
Cavity gap	4cm	5cm
Bucket height	4.5 %	4.5 %

Chosen!



Alt I: Represents a solution for a 60% ID equipped ring, with the present MAX II/ MAX III cavities.
Alt II: Represents a solution for a fully ID equipped ring, with slightly modified MAX II/MAX III cavities.

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Cavities in the 3 GeV ring

Photo courtesy S. C. Leemann

Status 3 GeV - Storage Ring

Before shutdown in July:

- Delivered regularly 50 mA beam to the beam lines. Five user beam lines, but only two have external users.
- Top-up interval several hours since gating is necessary (simple dipole injection kicker)
- The wiggler beam line could not close the gap due to overheating of a chamber part downstream the wiggler, hit by the ID light.

RF related:

- Longitudinally unstabe beam above 120 mA due to HOM driven coupled bunch instabilities. The Bunch-by-Bunch feedback system (DimTel) had a very weak longitudinal actuator.
- No good setting yet found for full lengthening (*5) with HHCs, only stable operation up to roughly twice the natural bunch length.
- One main cavity show vacuum spikes at nominal field levels, when it sees stored beam above ca 50 mA.
- Beam survives a trip, but we need to re-adjust the BbB feedback.

Status 3 GeV - Storage Ring

During shutdown August to October:

- Installation of a Multipole Injection Kicker (MIK). Collaboration with SOLEIL. Should allow more transparent injection and more frequent top-up.
- The chamber part downstream the wiggler exchanged.

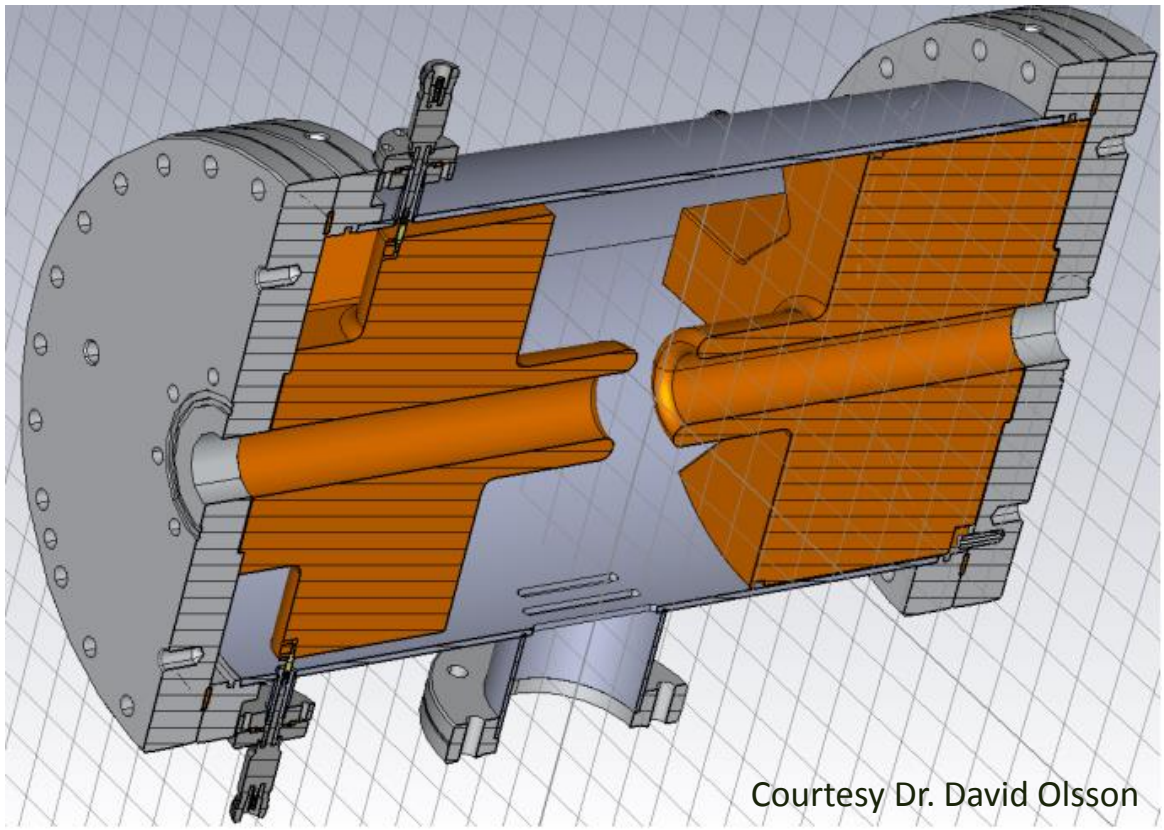
RF related:

- Installation of a waveguide loaded longitudinal kicker cavity. To be used by the Bunch-by-Bunch feedback system, opposing the HOM driven CBIs.
- We continously ran the 5 main cavities in the 3 GeV ring during evenings and nights for further conditioning. We settled for approximately 250 kV (0.93*Kilpatrik limit).
- One 120 kW circulator failure, even though < 35 kW. Exchanged.

Status 3 GeV - Storage Ring

RF related:

- Installation of a waveguide loaded longitudinal kicker cavity. To be used by the Bunch-by-Bunch feedback system, opposing the HOM driven CBIs.



Courtesy Dr. David Olsson

PhD Thesis: Design and implementation of RF kickers in MAX IV
ISBN: 978-91-7753-350-4 (electronic version)
https://lup.lub.lu.se/search/publication/79fd33b7-9557-417a-bb52-1e938d7286d6

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Status 3 GeV - Storage Ring

Start-up in November:

- Verified that the Multipole Injection Kicker (MIK) chamber do not heat up due to 70 mA of stored current. No time yet for pulsing and injection tests.
- The chamber part downstream the wiggler was verified not to heat up.

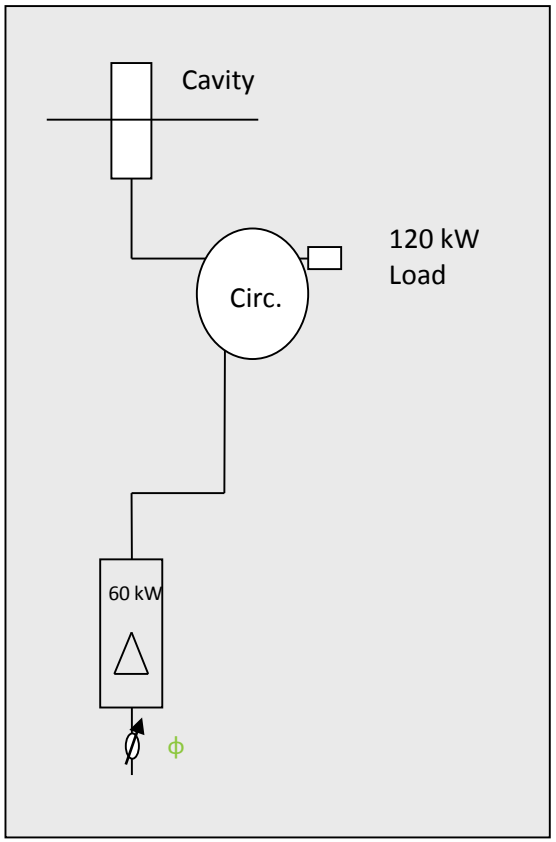
RF related:

- The waveguide loaded longitudinal kicker cavity was connected as actuator to the Bunch-by-Bunch feedback system. Stable beam verified up to 50 mA, at which current the users have settled for the first weeks.
- Out of the 5 main cavities in the 3 GeV ring we still have difficulties with one, once it sees currents above ca 50 mA.

Ring RF System - 1.5 GeV ring

	Lund	Krakow
Case	I	II
Energy loss with Ids	130keV	150keV
Circulating current	0.5A	0.5A
Total beam power	65kW	75kW
Total RF voltage	0.56MV	0.5MV
Number of cavities	2	2
Cavity shunt impedance	3.2Mohm	3.2Mohm
Cu losses	49kW	39kW
Total RF power needed	114kW	114kW
Nr of RF stations	2	2
Nr of transmitters	2	2
Transmitter power	28.5kW	28.5kW
Power to cavity	57kW	57kW
Cu losses/cav	24.5kW	19.5kW
Coupling (beta)	2.3	2.9
Cavity voltage	280kV	250kV
Bucket height	4.0%	3.5%

Table 1: Two anticipated RF scenarios for the 1.5 GeV ring.



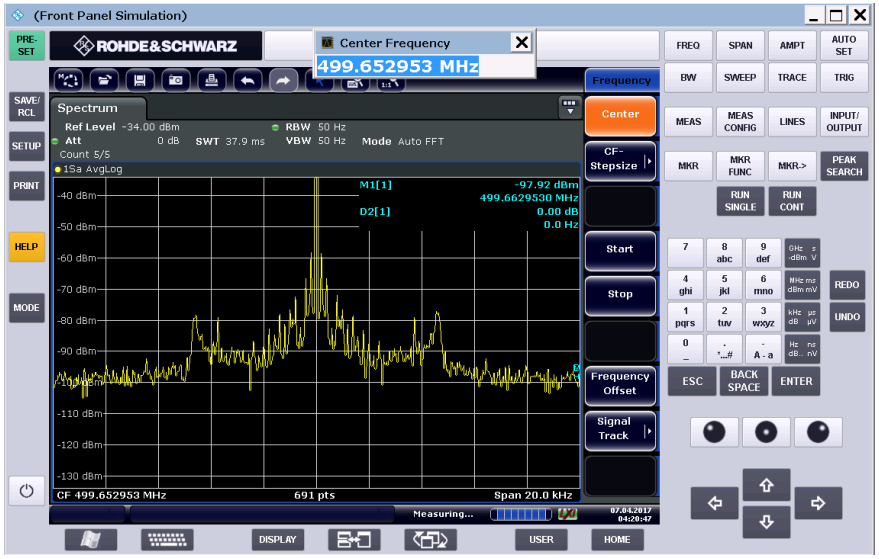
MAX IV 1.5 GeV - Storage Ring

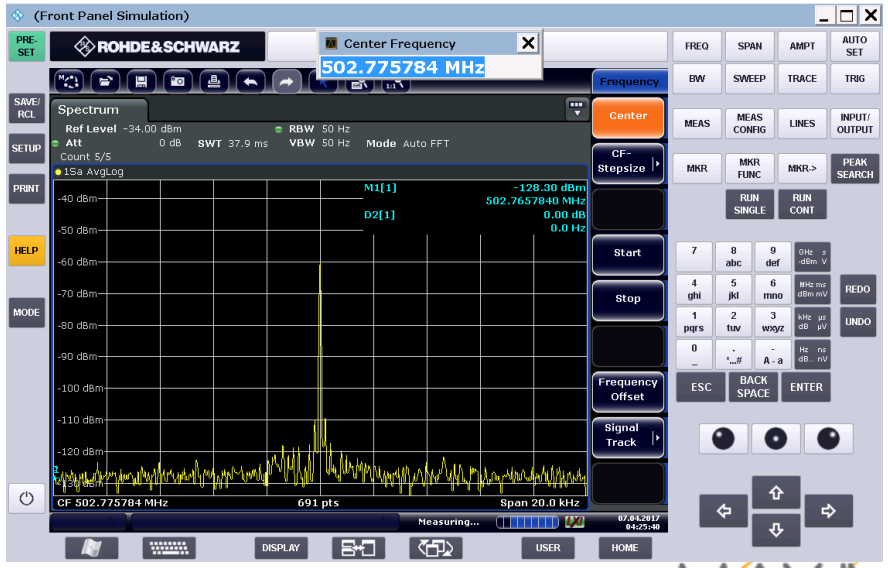
Before shutdown in July:

- No delivery to beam lines, since commissioning scheduled till August 2017.
- Top-up at at 170 mA with stable beam was achieved spring this year.

RF related:

- Longitudinal stability with help of the HHCs alone, 200 mA - 120 mA. Behavior very similar to the SOLARIS case with decaying beam. No Bunch-by-Bunch longitudinal kicker cavity yet foreseen.





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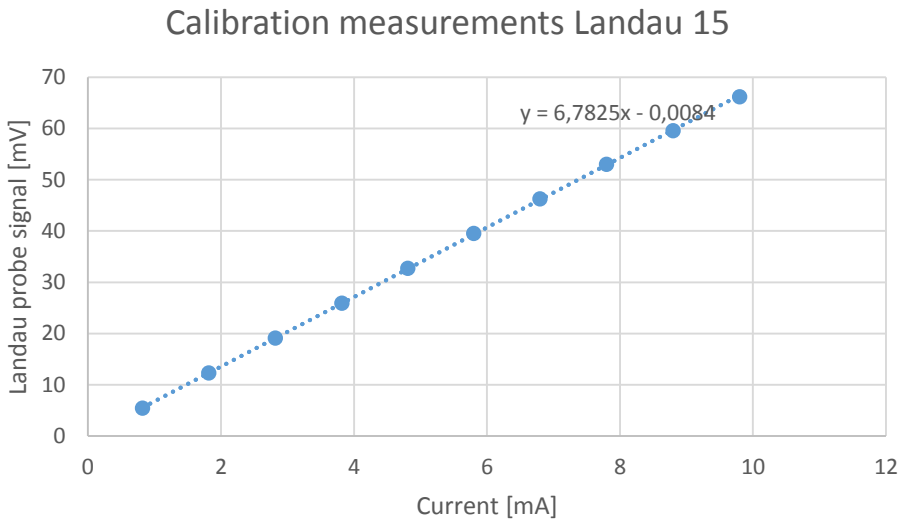
MAX IV 1.5 GeV - Storage Ring

Before shutdown in July:

- No delivery to beam lines, since commissioning scheduled till August 2017.
- Top-up at at 170 mA with stable beam was achieved spring this year.

RF related:

- Longitudinal stability with help of the HHCs alone, 200 mA - 120 mA. Behavior very similar to the SOLARIS case with decaying beam. No Bunch-by-Bunch longitudinal kicker cavity yet foreseen.
- Calibration:



On resonance:

$V_{cav} = I * (R/Q)*Q_{meas}*F$

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MAX IV 1.5 GeV - Storage Ring

During shutdown in August to October:

- Five new ID chambers (NEG coated), and front-ends, installed.
- Three IDs installed.

RF related:

- We continously ran the two main cavities in the 1.5 GeV ring during evenings and nights for further conditioning. We settled for approximately 250 kV (0.93*Kilpatrik limit).

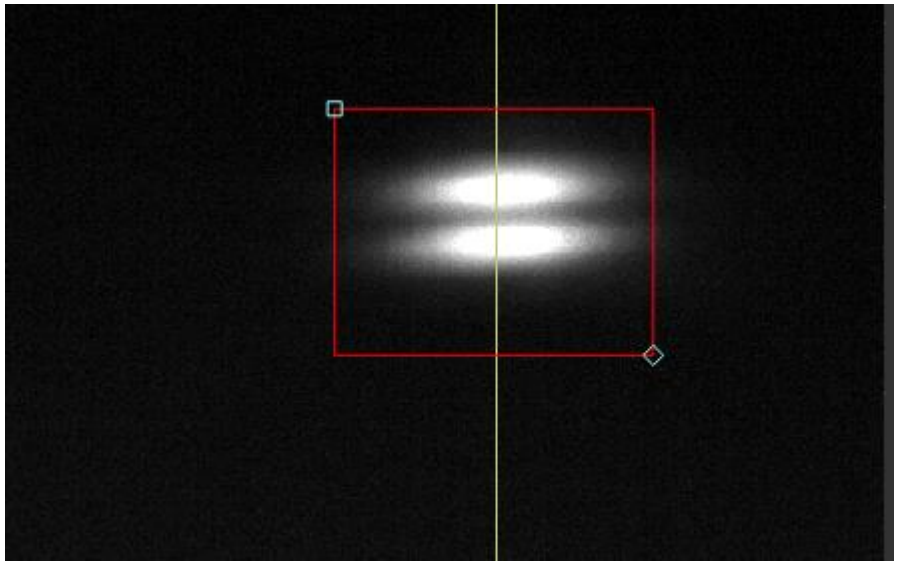
MAX IV 1.5 GeV - Storage Ring

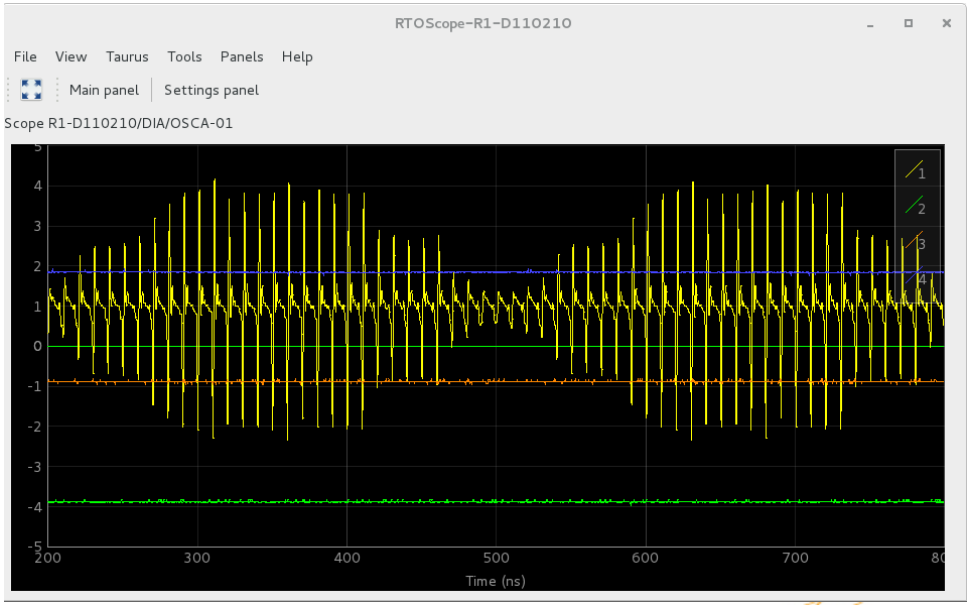
Start-up in November:

- Injection efficency verified to be similar as before the new ID chambers were installed.
- Top-up at 140 mA verified

RF related:

- Vertical stability achieved with an uneven filling pattern (see below). Due to worse vacuum conditions at start-up an even fill resulted in ion trapping and vertical blow-up. I*tau = 800 mAh at present. Fast conditioning.





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Thank You

Photo Perry Nordeng