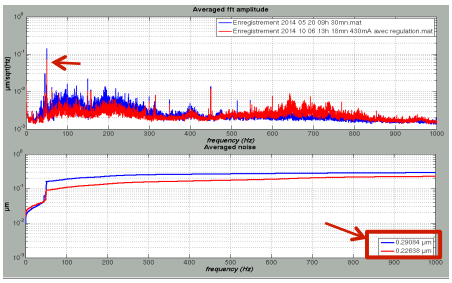
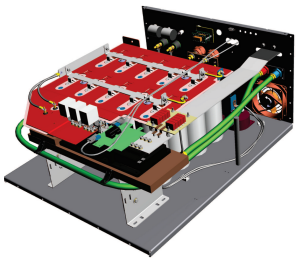


Status and on-going projects at SOLEIL

Laurent S. Nadolski
Accelerator Coordinator



On behalf of the Sources and Accelerators Division

Layout

- Introduction and SOLEIL facility overview
  - Accelerator parameters
  - Modes of operation
  - Performance and statistics
- Main events 2014 at SOLEIL
  - RF power coupler and SSA upgrade
  - Orbit Stability
  - Bunch Purity
  - Towards stable 500 mA operation
- Developments for maintaining SOLEIL operation performance
  - Solid State Amplifiers
  - Power supply reliability and spares
- On-going projects at SOLEIL
  - Femtoslicing project
  - Towards the operation of canted 5.5 mm in-vacuum undulators for long BLs
  - Optics upgrade, round beam, and towards DLSR
  - THOMX, LUNEX5/COXINEL

- Users' performance
- Bunch purity
- Orbit stability
- Power supplies

OVERVIEW AND IMPROVEMENTS OF THE ACCELERATOR OPERATION

Storage Ring main parameters

Parameters	Design	Achieved as of Oct 2013
Energy (GeV)	2.75	2.739
Circumference (m)	354	
RF frequency (MHz)	352.202	352.196
Betatron Tunes	18.20 / 10.30	18.202/10.310
Momentum Compaction α_1 / α_2	4.5×10^{-4} / 4.6×10^{-3}	4.5×10^{-4} / 4.6×10^{-3}
Emittance H (nm•rad)	3.9	3.9
Energy spread	1.016×10^{-3}	1.016×10^{-3}
Coupling, $\varepsilon_V/\varepsilon_H$	<1%	0.7% (w/o corr.) 1% (w/ V dispersion)
Current Multibunch mode (mA)	500	500 (430 for user operation)
Average Pressure (mbar)	1×10^{-9}	1×10^{-9} @ 500 mA
Beam Lifetime (h)	16 h	14h @ 500 mA

Beam schedule in 2014

janv 2014				févr 2014				mars 2014				avr 2014				mai 2014				juin 2014				juil 2014				août 2014				sept 2014				oct 2014				nov 2014				déc 2014			
mer 01	.	.	.	sam 01	M	M	M	sam 01	.	.	.	mar 01	Cp	B	B	jeu 01	.	.	.	dim 01	M	M	M	mar 01	Cp	B	B	ven 01	.	.	.	lun 01	A	A	A	mer 01	M	M	M	sam 01	S	S	S	lun 01	A	A	Tv
jeu 02	.	.	.	dim 02	M	M	M	dim 02	.	.	.	mer 02	M	M	M	ven 02	.	.	.	lun 02	A	A	Tv	mer 02	M	M	M	sam 02	.	.	.	mar 02	B	B	B	jeu 02	M	M	M	dim 02	S	S	S	mar 02	Cp	B	B
ven 03	.	.	.	lun 03	A	A	Tv	lun 03	.	.	.	jeu 03	M	M	M	sam 03	.	.	.	mar 03	Cp	B	B	jeu 03	M	M	M	dim 03	.	.	.	mer 03	M	M	M	ven 03	M	M	M	lun 03	A	A	Tv	mer 03	M	M	M
sam 04	.	.	.	mar 04	Cp	B	B	mar 04	.	.	.	ven 04	M	M	M	dim 04	.	.	.	mer 04	M	M	M	ven 04	M	M	M	lun 04	.	.	.	jeu 04	M	M	M	sam 04	M	M	M	mar 04	A	A	A	jeu 04	M	M	M
dim 05	.	.	.	mer 05	M	M	M	mer 05	.	.	.	sam 05	M	M	M	lun 05	.	.	.	jeu 05	M	M	M	sam 05	M	M	M	mar 05	.	.	.	ven 05	M	M	M	dim 05	M	M	M	mer 05	L	L	L	ven 05	M	M	M
lun 06	.	.	.	jeu 06	M	M	M	jeu 06	.	.	A	dim 06	M	M	M	mar 06	.	.	.	ven 06	M	M	M	dim 06	M	M	M	mer 06	.	.	.	sam 06	M	M	M	lun 06	A	A	Tv	jeu 06	L	L	L	sam 06	M	M	M
mar 07	.	.	.	ven 07	M	M	M	ven 07	A	A	A	lun 07	A	A	Tv	mer 07	.	.	.	sam 07	M	M	M	lun 07	A	A	Tv	jeu 07	.	.	.	dim 07	M	M	M	mar 07	8	8	8	ven 07	L	L	L	dim 07	M	M	M
mer 08	.	.	.	sam 08	M	M	M	sam 08	A	A	A	mar 08	Cp	B	B	jeu 08	.	.	.	dim 08	M	M	M	mar 08	Cp	B	B	ven 08	.	.	.	lun 08	A	A	Tv	mer 08	8	8	8	sam 08	L	L	L	lun 08	A	A	Tv
jeu 09	.	.	.	dim 09	M	M	M	dim 09	A	A	A	mer 09	M	M	M	ven 09	.	.	.	lun 09	A	A	Tv	mer 09	M	M	M	sam 09	.	.	.	mar 09	Cp	B	B	jeu 09	8	8	8	dim 09	L	L	L	mar 09	Cp	B	B
ven 10	.	.	.	lun 10	A	A	Tv	lun 10	A	A	A	jeu 10	M	M	M	sam 10	.	.	.	mar 10	8	8	8	jeu 10	M	M	M	dim 10	.	.	.	mer 10	M	M	M	ven 10	8	8	8	lun 10	A	A	Tv	mer 10	M	M	M
sam 11	.	.	.	mar 11	Cp	B	B	mar 11	M	M	M	ven 11	M	M	M	dim 11	.	.	.	mer 11	8	8	8	ven 11	M	M	M	lun 11	.	.	.	jeu 11	M	M	M	sam 11	8	8	8	mar 11	Cp	B	B	jeu 11	M	M	M
dim 12	.	.	.	mer 12	M	M	M	mer 12	M	M	M	sam 12	M	M	M	lun 12	.	.	.	jeu 12	8	8	8	sam 12	M	M	M	mar 12	.	.	.	ven 12	M	M	M	dim 12	8	8	8	mer 12	M	M	M	ven 12	M	M	M
lun 13	.	.	.	jeu 13	M	M	M	jeu 13	M	M	M	dim 13	M	M	M	mar 13	.	.	.	ven 13	8	8	8	dim 13	M	M	M	mer 13	.	.	.	sam 13	M	M	M	lun 13	.	.	.	jeu 13	M	M	M	sam 13	M	M	M
mar 14	.	.	.	ven 14	M	M	M	ven 14	M	M	M	lun 14	A	A	Tv	mer 14	.	.	.	sam 14	8	8	8	lun 14	A	A	Tv	jeu 14	.	.	.	dim 14	M	M	M	mar 14	.	.	.	ven 14	M	M	M	dim 14	M	M	M
mer 15	.	.	.	sam 15	M	M	M	sam 15	M	M	M	mar 15	Cp	B	B	jeu 15	.	.	A	dim 15	8	8	8	mar 15	Cp	B	B	ven 15	.	.	.	lun 15	A	A	Tv	mer 15	.	.	.	sam 15	M	M	M	lun 15	A	A	Tv
jeu 16	.	.	.	dim 16	M	M	M	dim 16	M	M	M	mer 16	M	M	M	ven 16	A	A	A	lun 16	A	A	Tv	mer 16	M	M	M	sam 16	.	.	.	mar 16	Cp	B	B	jeu 16	.	.	.	dim 16	M	M	M	mar 16	Cp	B	B
ven 17	.	.	.	lun 17	A	A	Tv	lun 17	A	A	Tv	jeu 17	M	M	M	sam 17	A	A	A	mar 17	S	S	S	jeu 17	M	M	M	dim 17	.	.	.	mer 17	M	M	M	ven 17	.	.	.	lun 17	A	A	Tv	mer 17	M	M	M
sam 18	.	.	.	mar 18	Cp	B	B	mar 18	Cp	B	B	ven 18	M	M	M	dim 18	A	A	A	mer 18	S	S	S	ven 18	M	M	M	lun 18	.	.	.	jeu 18	M	M	M	sam 18	.	.	.	mar 18	Cp	B	B	jeu 18	M	M	M
dim 19	.	.	.	mer 19	M	M	M	mer 19	M	M	M	sam 19	M	M	M	lun 19	A	A	A	jeu 19	S	S	S	sam 19	M	M	M	mar 19	.	.	.	ven 19	M	M	M	dim 19	.	.	.	mer 19	M	M	M	ven 19	M	M	M
lun 20	.	.	.	jeu 20	M	M	M	jeu 20	M	M	M	dim 20	M	M	M	mar 20	M	M	M	ven 20	S	S	S	dim 20	M	M	M	mer 20	.	.	.	sam 20	M	M	M	lun 20	.	.	.	jeu 20	M	M	M	sam 20	M	M	M
mar 21	.	.	.	ven 21	M	M	M	ven 21	M	M	M	lun 21	A	A	Tv	mer 21	M	M	M	sam 21	S	S	S	lun 21	A	A	Tv	jeu 21	.	.	.	dim 21	M	M	M	mar 21	.	.	.	ven 21	M	M	M	dim 21	M	M	M
mer 22	.	.	A	sam 22	M	M	M	sam 22	M	M	M	mar 22	A	A	A	jeu 22	M	M	M	dim 22	S	S	S	mar 22	Cp	B	B	ven 22	.	.	.	lun 22	A	A	Tv	mer 22	.	.	.	sam 22	M	M	M	lun 22	.	.	.
jeu 23	A	A	A	dim 23	M	M	M	dim 23	M	M	M	mer 23	L	L	L	ven 23	M	M	M	lun 23	A	A	Tv	mer 23	M	M	M	sam 23	.	.	.	mar 23	Cp	B	B	jeu 23	.	.	A	dim 23	M	M	M	mar 23	.	.	.
ven 24	A	A	A	lun 24	.	.	.	lun 24	A	A	Tv	jeu 24	L	L	L	sam 24	M	M	M	mar 24	Cp	B	B	jeu 24	M	M	M	dim 24	.	.	.	mer 24	M	M	M	ven 24	A	A	A	lun 24	A	A	Tv	mer 24	.	.	.
sam 25	A	A	A	mar 25	.	.	.	mar 25	Cp	B	B	ven 25	L	L	L	dim 25	M	M	M	mer 25	M	M	M	ven 25	M	M	M	lun 25	.	.	.	jeu 25	M	M	M	sam 25	A	A	A	mar 25	Cp	B	B	jeu 25	.	.	.
dim 26	A	A	A	mer 26	.	.	.	mer 26	M	M	M	sam 26	L	L	L	lun 26	A	A	Tv	jeu 26	M	M	M	sam 26	M	M	M	mar 26	.	.	.	ven 26	M	M	M	dim 26	A	A	A	mer 26	M	M	M	ven 26	.	.	.
lun 27	A	A	A	jeu 27	.	.	.	jeu 27	M	M	M	dim 27	L	L	L	mar 27	Cp	B	B	ven 27	M	M	M	dim 27	M	M	M	mer 27	.	.	A	sam 27	M	M	M	lun 27	A	A	A	jeu 27	M	M	M	sam 27	.	.	.
mar 28	A	A	A	ven 28	.	.	.	ven 28	M	M	M	lun 28	.	.	.	mer 28	M	M	M	sam 28	M	M	M	lun 28	.	.	.	jeu 28	A	A	A	dim 28	M	M	M	mar 28	S	S	S	ven 28	M	M	M	dim 28	.	.	.
mer 29	B	B	B					sam 29	M	M	M	mar 29	.	.	.	jeu 29	M	M	M	dim 29	M	M	M	mar 29	.	.	.	ven 29	A	A	A	lun 29	A	A	Tv	mer 29	S	S	S	sam 29	M	M	M	lun 29	.	.	.
jeu 30	M	M	M					dim 30	M	M	M	mer 30	.	.	.	ven 30	M	M	M	lun 30	A	A	Tv	mer 30	.	.	.	sam 30	A	A	A	mar 30	Cp	B	B	jeu 30	S	S	S	dim 30	M	M	M	mar 30	.	.	.
ven 31	M	M	M					lun 31	A	A	Tv					sam 31	M	M	M					jeu 31	.	.	.	dim 31	A	A	A					ven 31	S	S	S					mer 31	.	.	.

5 008 hours: Users' run

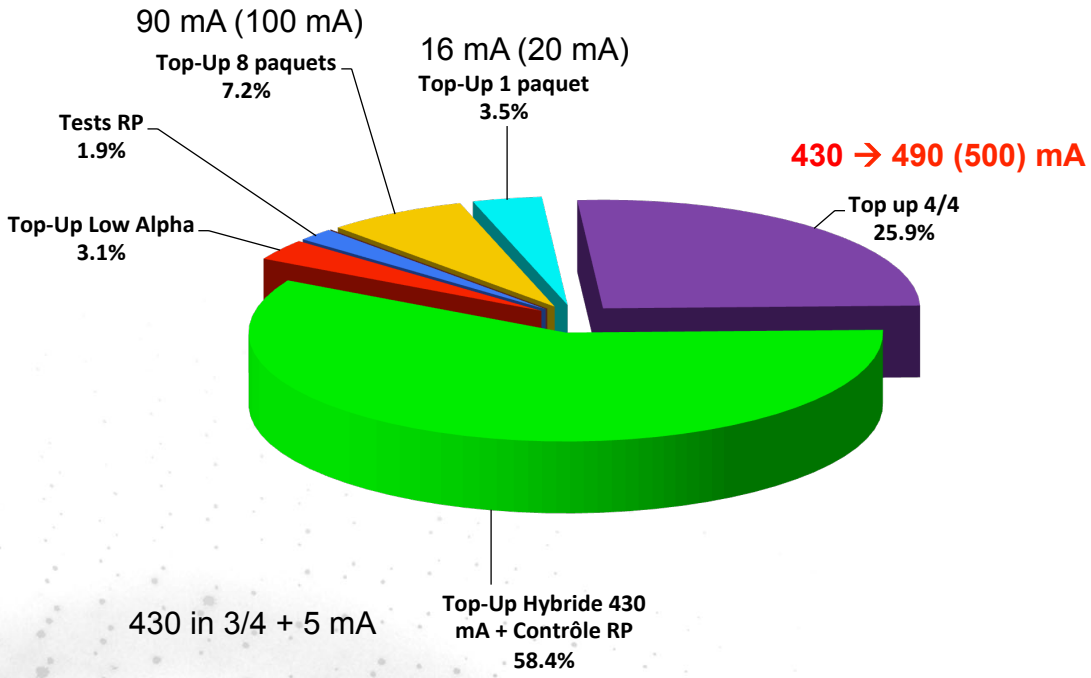
1 296 hours: Machine

5 Shutdowns: 2 x 5 w + 2 x 11 d + 1 x 18 d

A Machine R&D
M Multibunch
8 8 bunches
S Single bunch
L Low α
Cp Rad Saf. tests
Tv

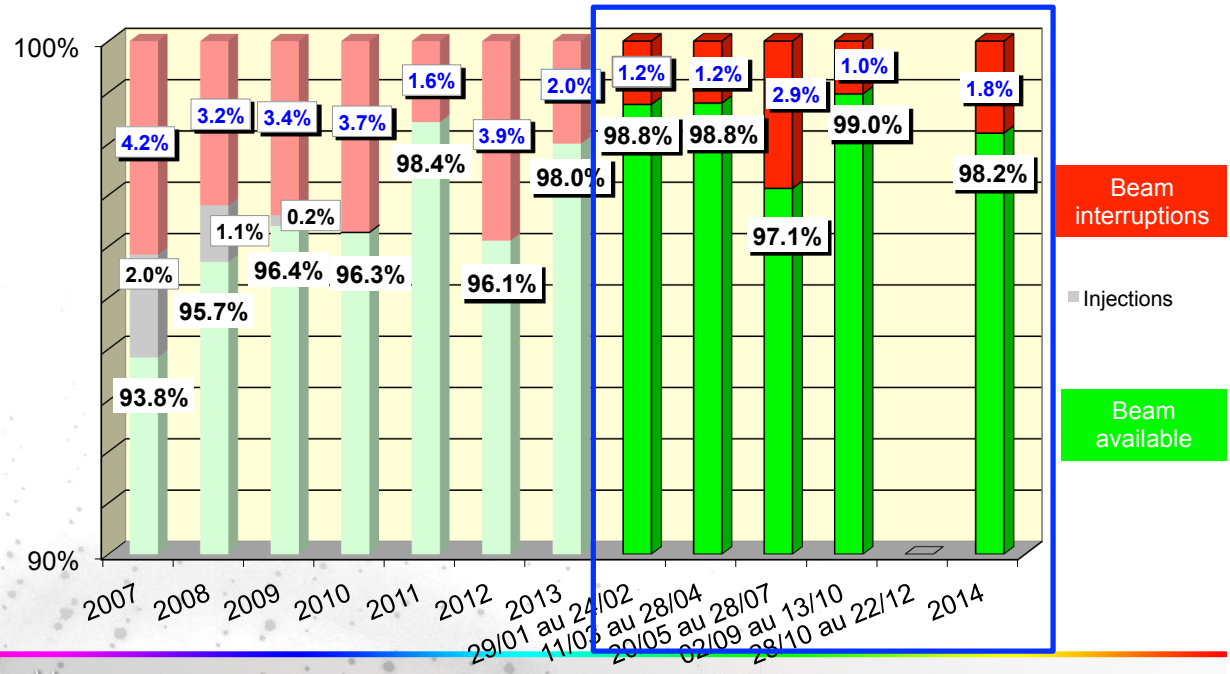
Filling mode distribution (up to RUN4)

27 Beamlines are taking photons



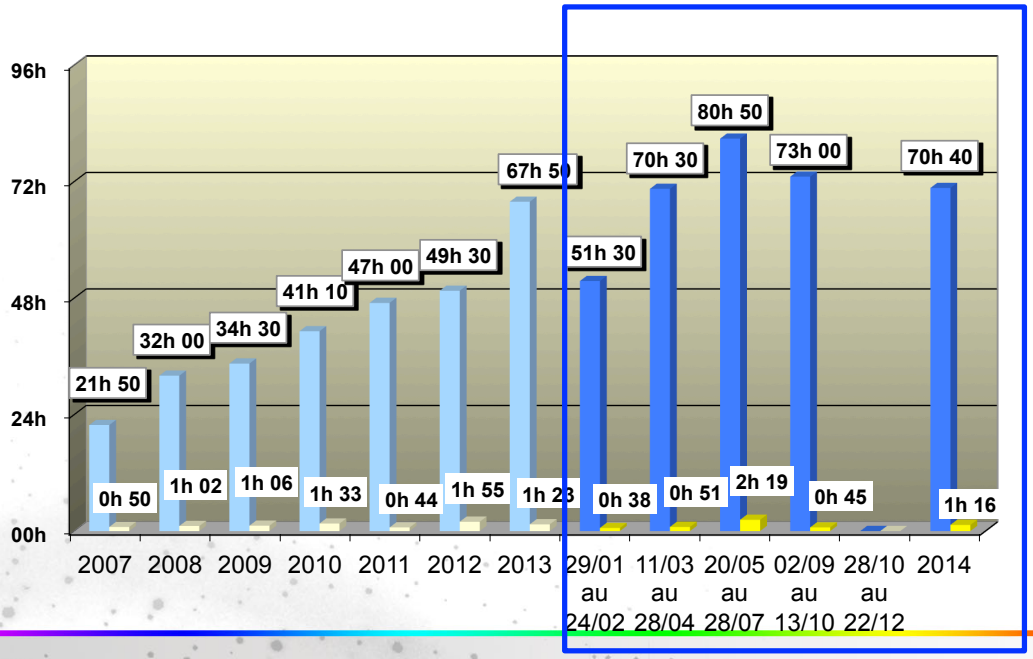
PHOTON BEAM Availability in 2014

→ **98.2 % up to RUN 4**

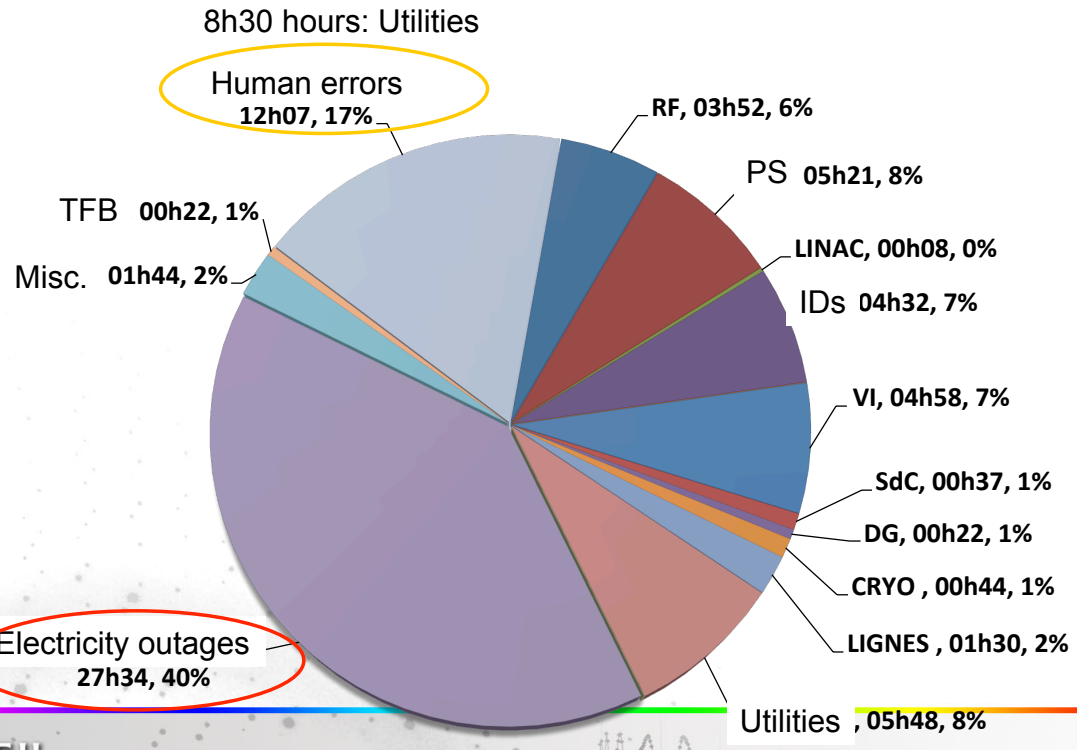


Mean Time Between Failure And Mean Time To Recover

→ **70 hours up to RUN 4**



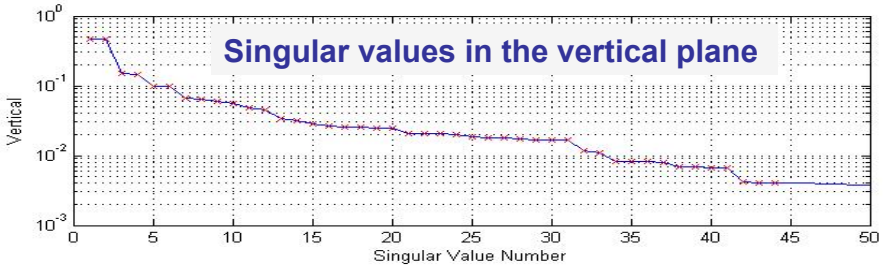
Origin of the BEAM TIME LOST in 2014: 69h (up to RUN4)



Fast Orbit Feedback Singular Values Regularisation

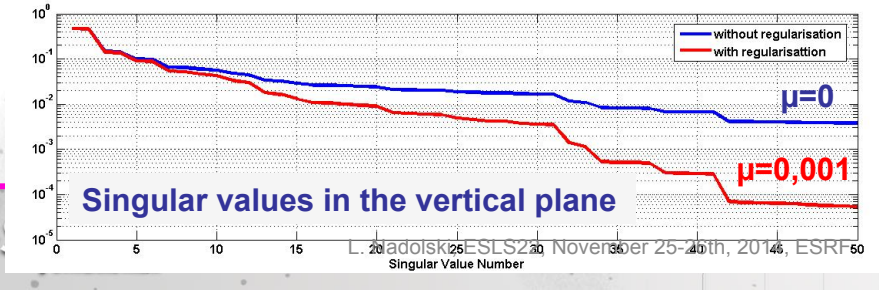
Short term stability

- FOFB algorithm is based on **BPM response matrix (B):** → $\mathbf{B = U\,\Sigma\,V^T}$
  - Inversed using singular value (SV) decomposition. → $\mathbf{B^{-1} = V\,\Sigma^{-1}\,U^T}$
  - Up to now, singular values were sorted and high order modes truncated to avoid adding some noise on the beam.



- **Tikhonov regularisation:**
  - Each **SV is weighted** (d_n) depending on its amplitude to determine the inverse response matrix ($\mathbf{B^{-1}}$).

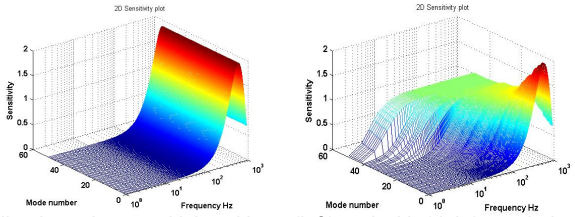
$$d_n = \frac{\sigma_n^2}{\sigma_n^2 + \mu}$$



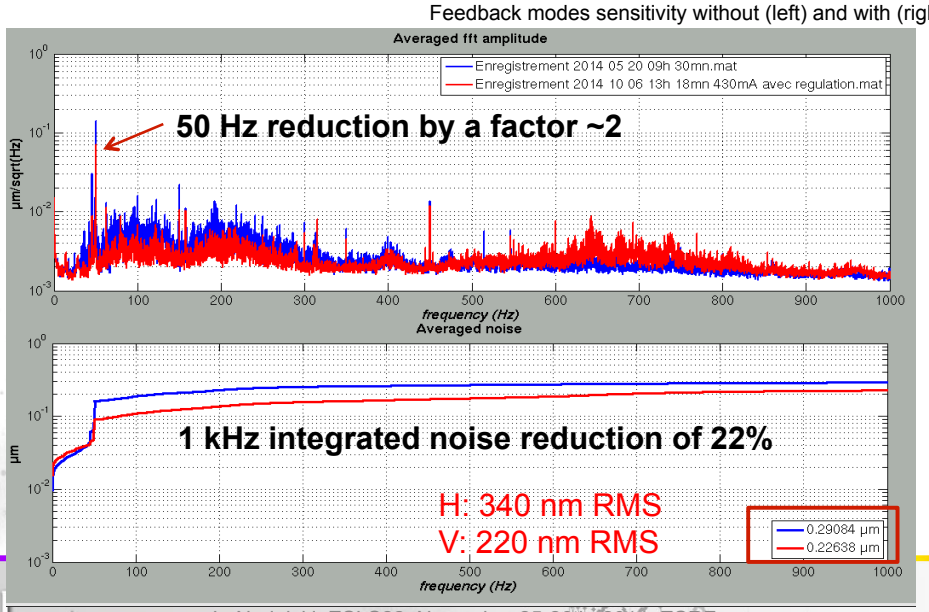
$\mathbf{B^{-1} = V\,D\,\Sigma^{-1}\,U^T}$

Fast Orbit Feedback Singular Values Regularisation

- Benefits of SV regularisation:
  - **All modes are corrected**
  - **Different dynamics** apply on modes
    -> **Feedback gain can be increased without adding noise**



Feedback modes sensitivity without (left) and with (right) regularisation



Picture: vertical plane

Bunch purity improvement (a few 10^{-5}) thanks to an upgrade of the LINAC cleaner generator

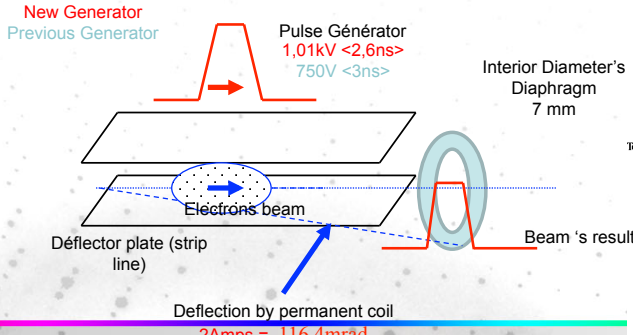
SPM, Single Pulse Mode ; Beam Charge=0,5nC/1,4ns by bunch

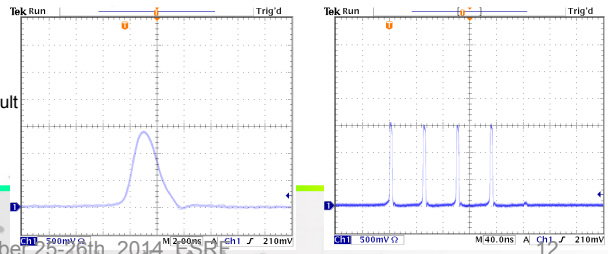
FID GmbH's solution

SPECIFICATIONS

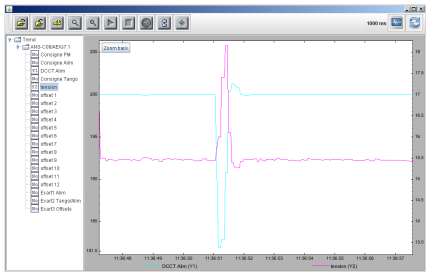
Maximum amplitude into 50 Ohm	-	1,5 kV
Amplitude adjustment range	-	0,6-1,5 kV
Polarity	-	positive
Rise time	-	1-1,1 ns
Pulse duration at 50%	-	2-4 ns, adjustable
Fall time	-	1,2-1,3 ns
Maximum PRF	-	10 Hz
Burst operation	-	max 4 output pulses with delay 50-300 ns between them
Triggering	-	Internal and External 5 V, 100 ns
External triggering to output delay	-	not more than 100 ns
Jitter	-	better than 30 ps RMS
Variation of trigger/output delay	-	+/- 500 ps between 20-30° C
Remote control	-	ampliuse and pulse duration by 0-10V DC

The function





- Storage Ring Quadrupole Power Supplies incidents = Erratic and transient current spikes at the converter output on several power supplies.

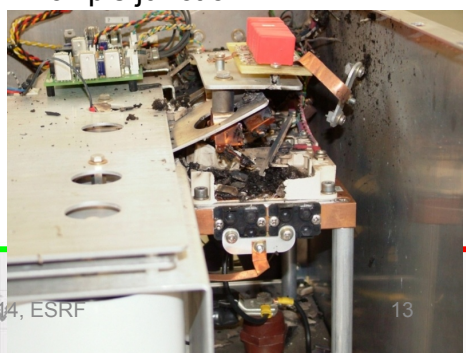


Software bug in the ADC card !: Solved

- Booster Power Supplies troubleshooting: The lifetime of the IGBT modules used in the converter 4-Q output stage is 2-3 years: This short lifetime is caused by the high thermal stress generated by the 3Hz excursion of the IGBT chip's junction temperature .

10 millions 3Hz cycles every year.

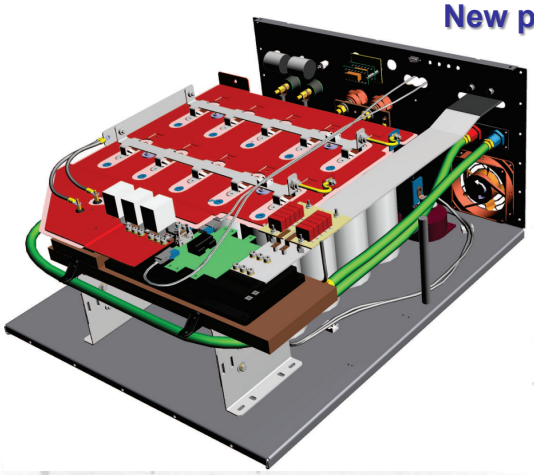
- ✓ 2007-2012 → Heavy maintenance to avoid this:
  - ❑ Preventive replacement of IGBT modules > 20 Millions cycles
  - ❑ Power crate turnover

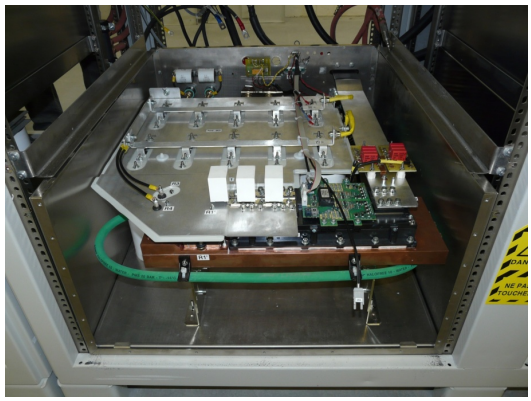


Booster Power Supplies troubleshooting

❑ End 2012: Decision to upgrade the power crates: Based on 1200V/2500A IGBT modules with high thermal/power cycling capability

New power crate design:





Upgrade of the RF input power couplers

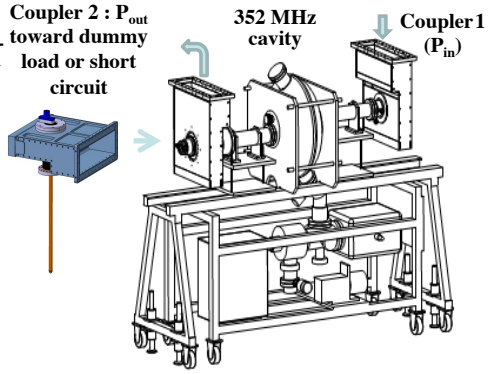
Upgrade of SSAs

Hybrid filling pattern and instabilities

TOWARDS 500 MA OPERATION

Cavity input power coupler (IPC) R&D

- Cavity IPC's of higher power capability (up **to 300 kW** CW) have been developed in collaboration with CERN and ESRF
- The IPC's are pre-conditioned with RF power in the ESRF test-stand, per pair, on a copper cavity from CERN, up to 300 kW in transmission into a dummy load and 200 kW in full reflection on a short circuit
- Then they are mounted on the SOLEIL CM, **in situ**, without removing the CM out of the ring, under external laminar air flow and slight N_2 gas overpressure inside the cavity
  → *"Clean room" onto the CM !*
- A recalcitrant multipactor level ~110 kW, has been overcome by applying a bias DC voltage



- The 1st pair was implemented on CM1 (Aug. 2013 & 2014); the installation of the 2nd pair on CM2 is scheduled for 2015
- That will open the possibility of storing 500 mA using a single CM and combining two amplifiers per cavity → full redundancy availibity

Upgrade of the SOLEIL 352 MHz SSAs

After ~8 years of operation with outstanding availability (overall MTBF for the 4 amplifiers > 1.5 year), reliability and flexibility, the home made SOLEIL SSA's have demonstrated that they can advantageously replace the vacuum tubes (extreme modularity, absence of HV, very low phase noise, …)

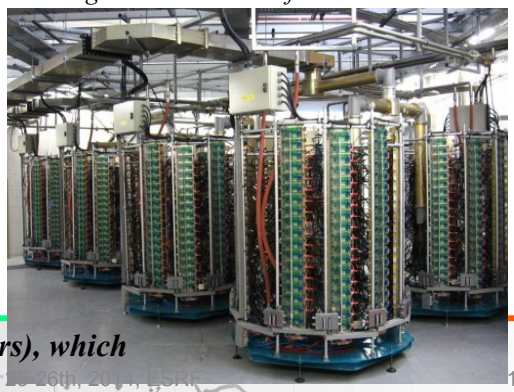
In spite of these quite good results, an upgrade was planned in order to take advantage of **using a transistor of 6th generation** (Vdc = 50 V), which is much **more robust and has higher performance** than the previous one, at relatively low cost (change only the transistor and a few components → expense ~10% of amplifier cost) *

- + 8 % in overall efficiency → Electrical power savings compensate for upgrade costs in ~ 3 years
- More robust transistor & lower temperature → Lower failure rate → Lower maintenance cost
- Higher power capability → Additional operational flexibility (500 mA with 3/4 active cavities)

** Re-use same power combination and dc PS with modified cabling → 50 V instead of 28 V at each module*

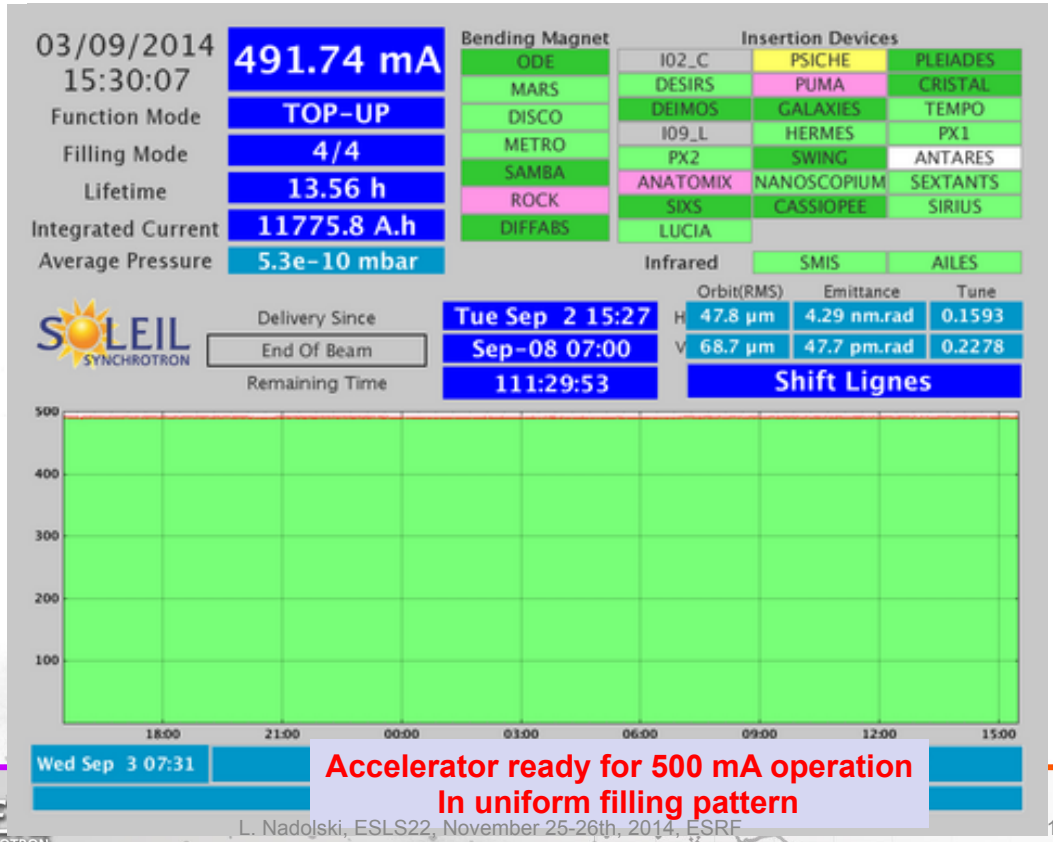
Upgrade schedule

- In 2013 modification of 160 pre-amplifier modules (1st & 2nd stages of the 4 amplifiers)
- From 2014, modification of the 3rd stage modules at a rate of 1-2 towers a year
- In Aug. 2014, the 1st modified tower was implemented on amplifier_1, where it well co-exists with the three « old » ones



The two 180 kW SSA's (2 x 4 towers), which power the two cavities of CM1

One week @ 490 mA



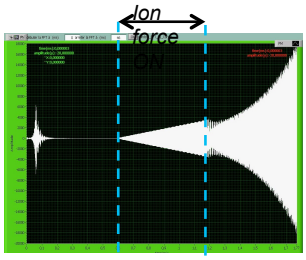
Accelerator ready for 500 mA operation
In uniform filling pattern

500 mA limitation

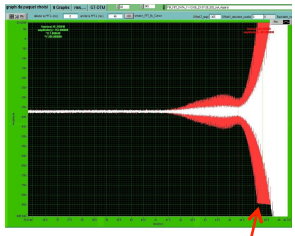
- **Providing the users with hybrid mode (3/4 filling + 5 mA bunch)**
  - New demand: filling the gap between 430 mA and 500 mA
  - Easy of operation for switching hybrid to uniform filling pattern (thermal load on BLs' optics)

- **Fast ion instabilities**
  - **Combined effect** of RW, beam-ion instabilities and transverse feedback.
  - Upgrading the Fast Bunch per Bunch Transverse Feedback?
  - **Lowering the RF voltage to lengthen the e-bunch**? (see RF upgrade)
  - Under investigation

- **Radiation safety**. Assuring that 505 mA is never exceeded even by accident (double injection)
  - Upgrade for a **faster** interlock system compliant with 3Hz Booster to switch off the LINAC gun
  - **Expected in 2015**



***Simulation**: Transverse feedback fighting against RW with temporal "shaker" excitation at F_{ion}*



***Measured** beam loss at 500 mA White: Beam, Red: Feedback kick*

Coupling correction at SOLEIL

- **Feedback on beam size (50 pm.rad ~1% beam coupling)** using 32 skew quadrupole
  - Vertical dispersion wave added to minimum of coupling (LOCO)
  - Al chambers
  - Speed: Bandwidth limitation -3dB @ 9 Hz

Beamline	PX2	ANATOMIX (2014)	Nanoscopium (2014)
Size H &V	-	±5%	±2 %
Div. H &V	±10%	±5%	±2 %
Duration	30 mn	6 hours	8 hours

- **User requests**
  - HU640 (fast switching) 200 ms instead of 40 s today
  - HU36 (gapscan) 8 mm/s instead of 1 mm/s today

- **Target vertical beamsize stability**: 10% (**New demand from Nanoscopium and Anatomix BLs**)
  - Reached at low speed
  - First experimental results with Nanoscopium:
    10% OK (but before the monochromator). To be continued.

- **Perspectives for faster correction**
  - Looking for location with high cut-off frequency surrounding HU640 and HU36 IDs
  - Speed up Pinhole Camera beamsize measurement
  - Local, fast (50-100 Hz), analog coupling correction (FFWD)

FEMTO-SLICING COMMISSIONING

Motivation for a Femto-Slicing project

Pump-Probe experiments:

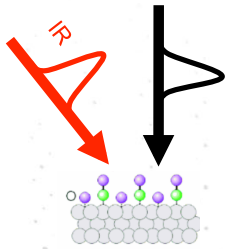
Hard X-ray

Time-resolved (ps, fs) diffraction
- transition phase dynamics
- order → disorder
- coherent phonons

Soft X-ray

Time-resolved photoemission (ps, fs)
- chemical reactivity on surfaces
- charge transfer in molecular solids
- magnetic dichroism
- spin dynamics in ferromagnetic materials

IR pump / X-rays probe



Optics	FWHM bunch length (ps)	Filling mode / dedicated time		
Normal α	60 - 90	Hybrid filling Half time	8 bunches 2 weeks	1 bunch 2 weeks

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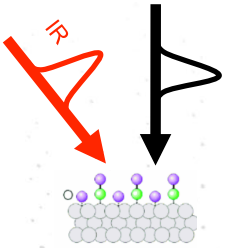

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Low-α	7 - 12	Hybrid filling 2 weeks		

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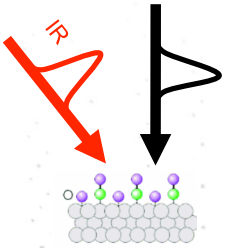
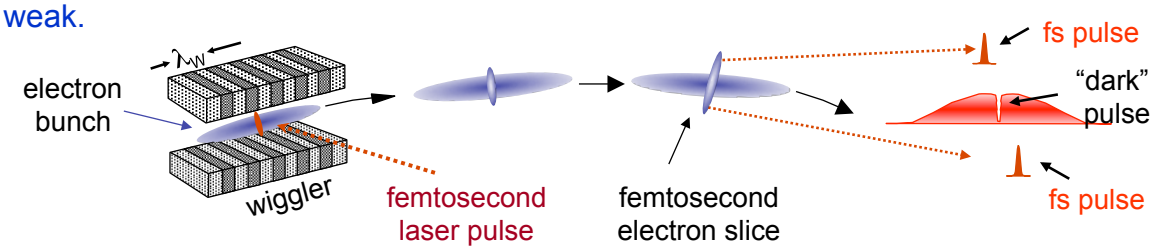


Optics	FWHM bunch length (ps)	Filling mode / dedicated time		
Normal α	60 - 90	Hybrid filling Half time	8 bunches 2 weeks	1 bunch 2 weeks
Low-α	7 - 12	Hybrid filling 2 weeks		
Slicing	**0.1 - 0.2**	**Hybrid filling TBD**	**TBD**	

- ❑ Use of the SLS and BESSY facilities, but present installations cannot answer to the demand of beam time
- ❑ Wish to establish a step to the future French FEL « Coxinel »

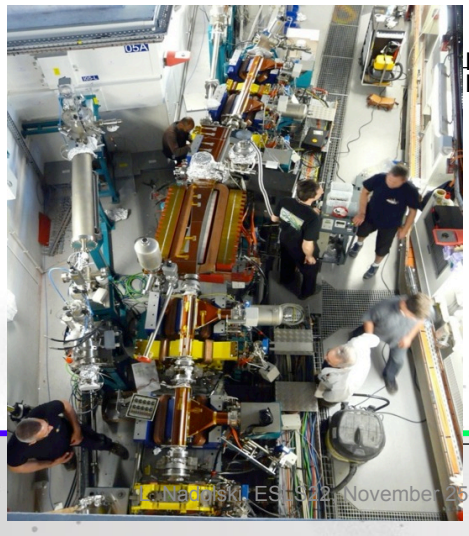
Short pulse

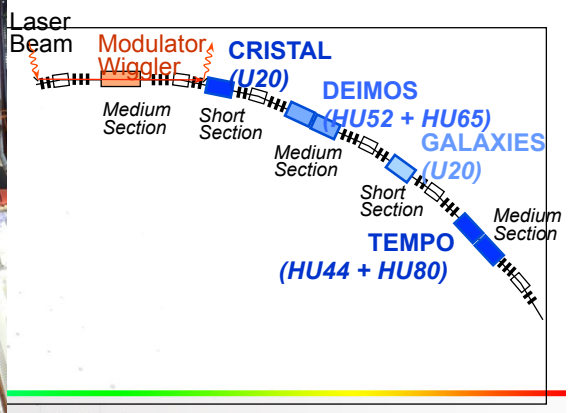
Femto-Slicing enables to produce **100 fs** bunch "slices" using an energy modulation induced by a laser (ALS, SLS, BESSY, and soon SOLEIL). The photon flux is rather weak.



A.A. Zholents and M.S. Zolotorev, Phys. Rev. Lett. 76 (1996) 912.

Under commissioning
See M.-A. Tordeux Talk

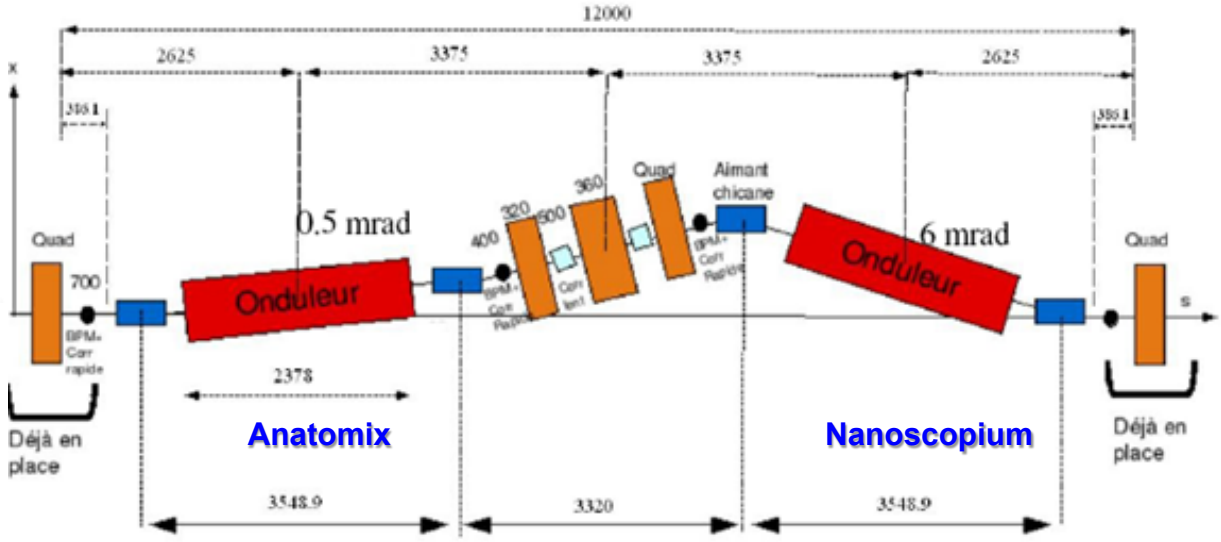




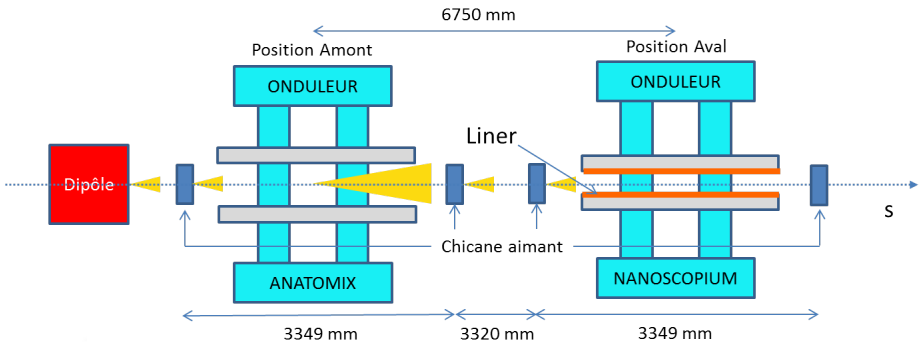
Status and project update

OPERATION WITH 2 IN-VACUUM UNDULATORS

SDL13 schematic



Reminder

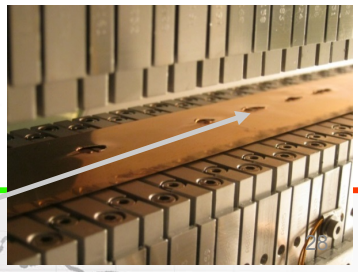


- **September 2011**: First test with both IDs simultaneously closed at minimum gap (5.5 mm) and 500 mA stored beam to prepare the Radiation Safety tests.

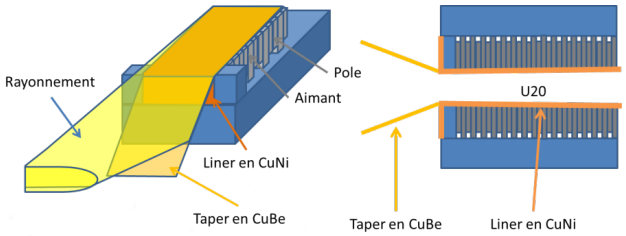
  Observation of strong vertical instabilities and vacuum increase in the downstream ID.

- **January 2012** : U20 downstream ID removed and opened:

  Lower liner melt in some spots!

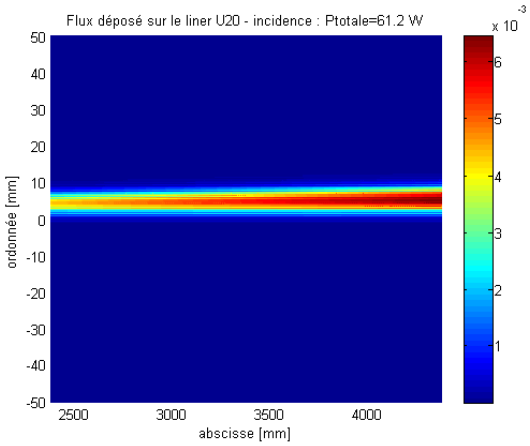


Power deposit: what we expected



500 mA
Both IDs at gap min 5.5 mm

~ 60 W over one liner



Low density < few mW / mm2

Investigation

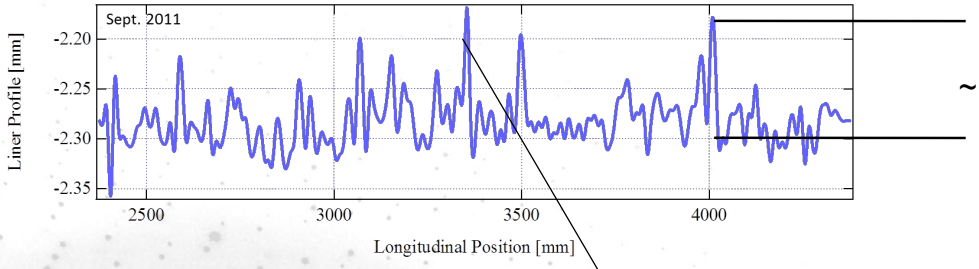
1. Vertical mis-positioning by 400 µm

Total power increased from 60 W to 95 W for the lower liner

⇒ Not excessive

2. The strong impact of the liner vertical profile imperfection has not been taken into account

⇒ Mechanics + Shimming

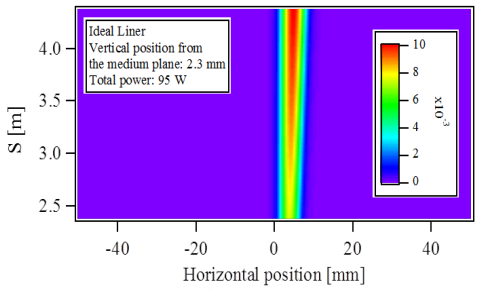


~ 120 µm

Photon flux interception
Locally the power is multiplied by **40!**

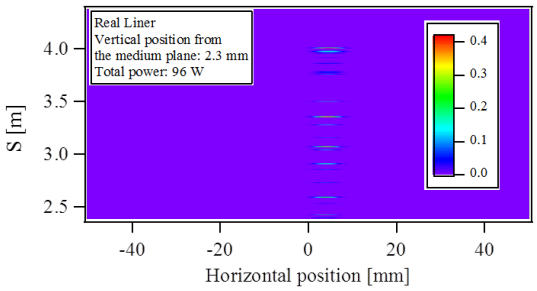
Solutions under investigation

Vertical shift by 400 µm



Peak = 10 mW / mm^2
Still OK !

Liner profile



Peak = 400 mW / mm^2

Thermal + mechanical simulations exhibit strong liner deformation at power deposit locations

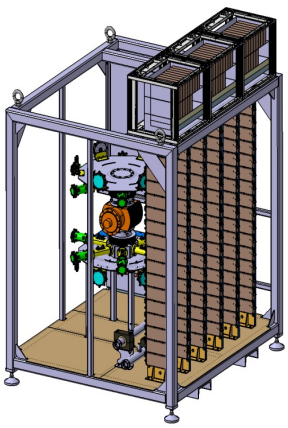
- **Thicker liner**: Less temperature increase and more rigidity: from 100 to 150 µm
- **Thicker liner with higher percentage of Cu**
- **Better profile**: Less local power deposition: **swapping** instead of shimming !
- **Liner Blackening**: Better power emissivity, less temperature increase
- **Interlock** on the angle of the orbit inside the undulator.
- **Vertical absorber in front of the second undulator**

SSA R&D and transfer of technology

→ **7 amplifiers of 150 kW (14 x 75 kW towers) at** 352 MHz **in operation at ESRF (transfer of technology)**

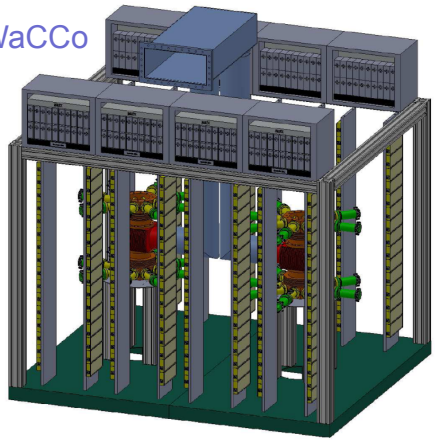
→ **2 amplifiers of 50 kW at** 476 MHz **in operation at LNLS, the Brasilian LS (collaboration)**

500 MHz amplifiers developped by SOLEIL

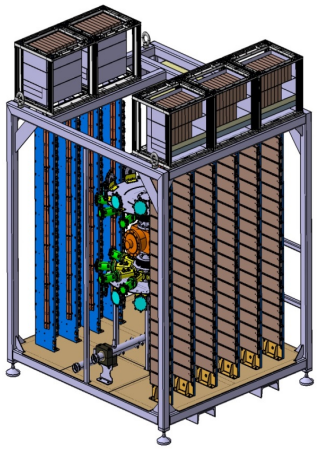


50 kW SSA for ThomX

WaCCo



150 kW SSA initially designed for SESAME



80 kW SSA finally designed for SESAME

- **The 50 kW amplifier for ThomX is being built at SOLEIL**
- **The 1st SESAME 80 kW amplifier is being built at SOLEIL (SESAME-SOLEIL collaboration);**

SIGMAPHI ELECTRONICS, exclusive SOLEIL licensee since Dec. 2013, will supply the 3 other ones

Selection of on-going projects

- **RF upgrade**: Solid State Amplifiers, new Input Couplers, cryogenic
- **PX2**: U24 @ 7.8 mm → 5.5 mm: Waist in the center of medium straight section
- **WSV50 (PSICHE)**: towards a minimum gap of 5.5 mm → 4.5 mm
- **ID Construction**: **U18** Cryogenic-in vacuum undulator (Anatomix), **WSV50 aperiodic** (MAXIV & SOLEIL collaboration), **U15 Cryo-ready** in-vacuum undulator (MAXIV & SOLEIL collaboration)
- **Spare power supplies** for SR sextupole and LT2 dipole; EM IDs
- Design and construction of a **Multipole Injection Kicker** (MAXIV & SOLEIL collaboration)
- **Local round and ultra low emittance beam in SDL9**
- **Preliminary studies for a DLSR**
- **ThomX**
- **Coxinel**

Conclusions

Thanks to continuous effort, SOLEIL operation continues to improve **approaching 99% of reliability**, with **sub-micrometer stability**. Key points of this success are for example the refurbishment of power supplies and the RF system performance.

After ~ 8 years of operation with outstanding availability (overall MTBF for the 4 amplifiers > 1.5 years), reliability and flexibility, the home made SOLEIL SSA's have demonstrated that they can advantageously replace the vacuum tubes (extreme modularity, absence of HV, **very low phase noise**, …)

Further R&D's have allowed **to improve the original 352 MHz** design and extend it to other frequencies. This technology has now reached maturity, being adopted by several other facilities and taken up by the industry for applications ranging **from 80 MHz up to 1.5 GHz**.

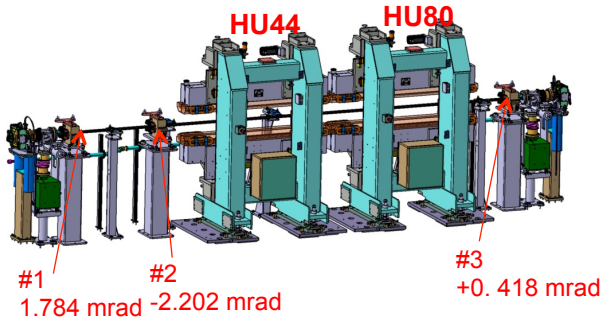
New challenges are still ahead from us:

- **Finding a way to operate 2 in-vacuum undulators** in a single straight section
- Delivering **500 mA in hybrid mode**
- Making **femtoslicing a users' mode of operation**
- Answering new requirements from users (crystallography, 150 m long beamlines)
  - **Beamsize** stability (**2-10%**)
  - Sub-micrometer orbit stability **over 8 hours**

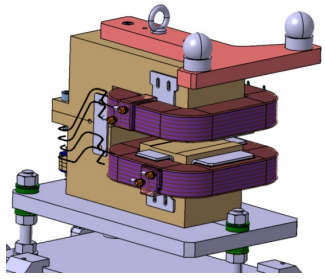
THANK YOU FOR YOUR ATTENTION

TEMPO chicane for femtoslicing project

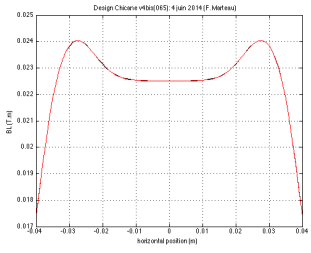
3 magnet chicane for 19.6 MeV



3 identical **electromagnetic** magnet



- **Purpose of the magnetic chicane**:
  - Bring the 19.6 MeV sliced beam at center of TEMPO M1A mirror on axis. Angle deviation corrected by tuning BL first mirror
- 3 magnet electromagnetic chicane (1.8/-2.2/0.4 mrad)
- Turn off/on with beam
- No need of additional absorber
- Magnet design done
- Draft office on going
- Call for tender magnet and power supplies by the end of 2014
- Magnetic measurement: summer 2015
- Installation and commissioning fall 2015



- Installation for 6 months of low charge diagnostics on TL1 for testing:
  - 1 cavity BPM: 16 mm SwissFEL type
  - 1 Bergoz Turbo-ICT (charge measurement)
- Can perform measurements down to 10 pC
- To be installed in the future on the transport line of a plasma accelerated electron beam (COXINEL project)