RESULTS OF THE RADIATION SAFETY COMMISSIONING SYNCHROTRON SOLEIL

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- Radiation safety goals at SOLEIL
- Shielding design of SOLEIL SR
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- Radiation Measurements around the first BL
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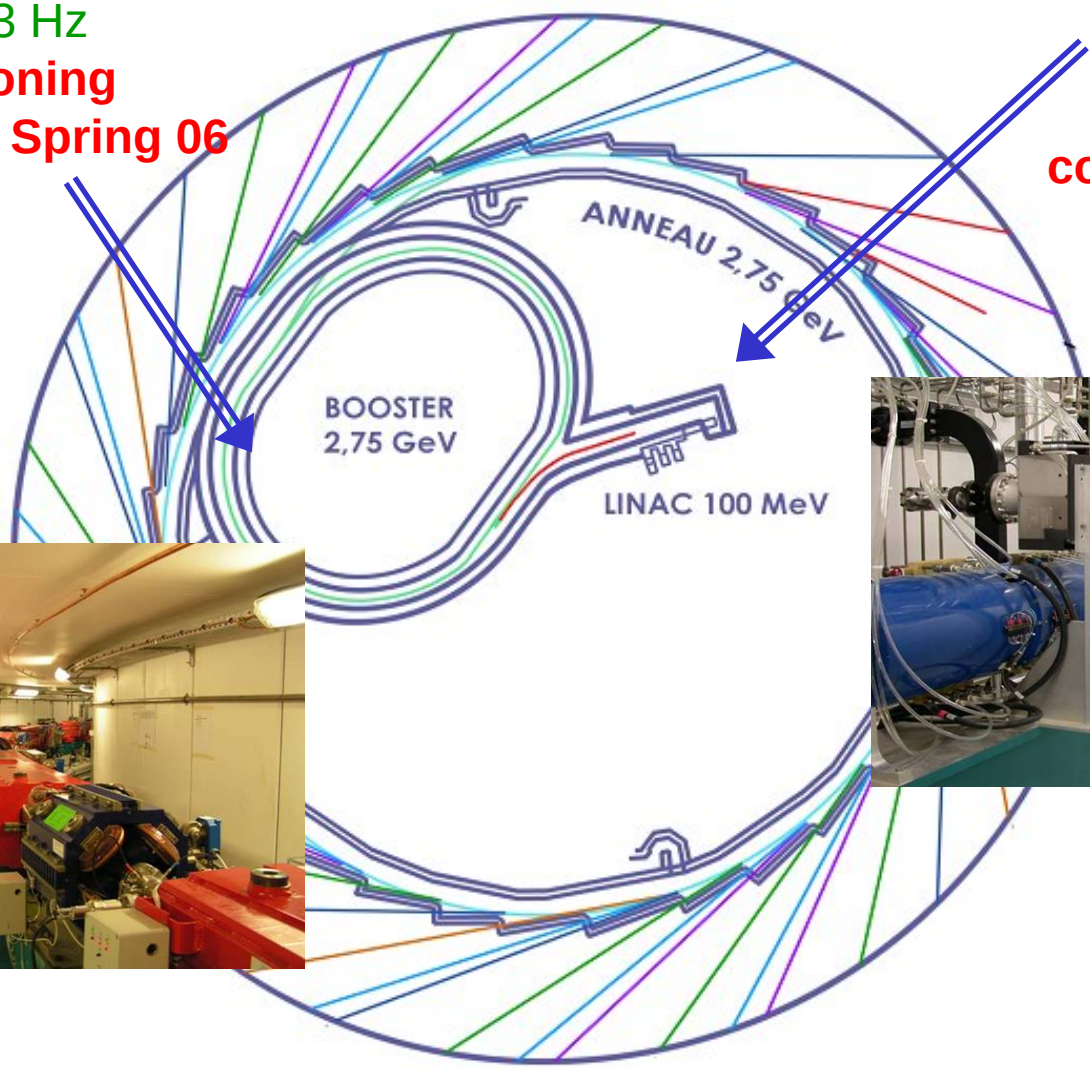
Linac and Booster designed for topping-up operation

2.75 GeV BOOSTER
Cycling @ 3 Hz
Commissioning completed Spring 06

100 MeV LINAC
3 Hz rep Rate
Commissioning completed End 05

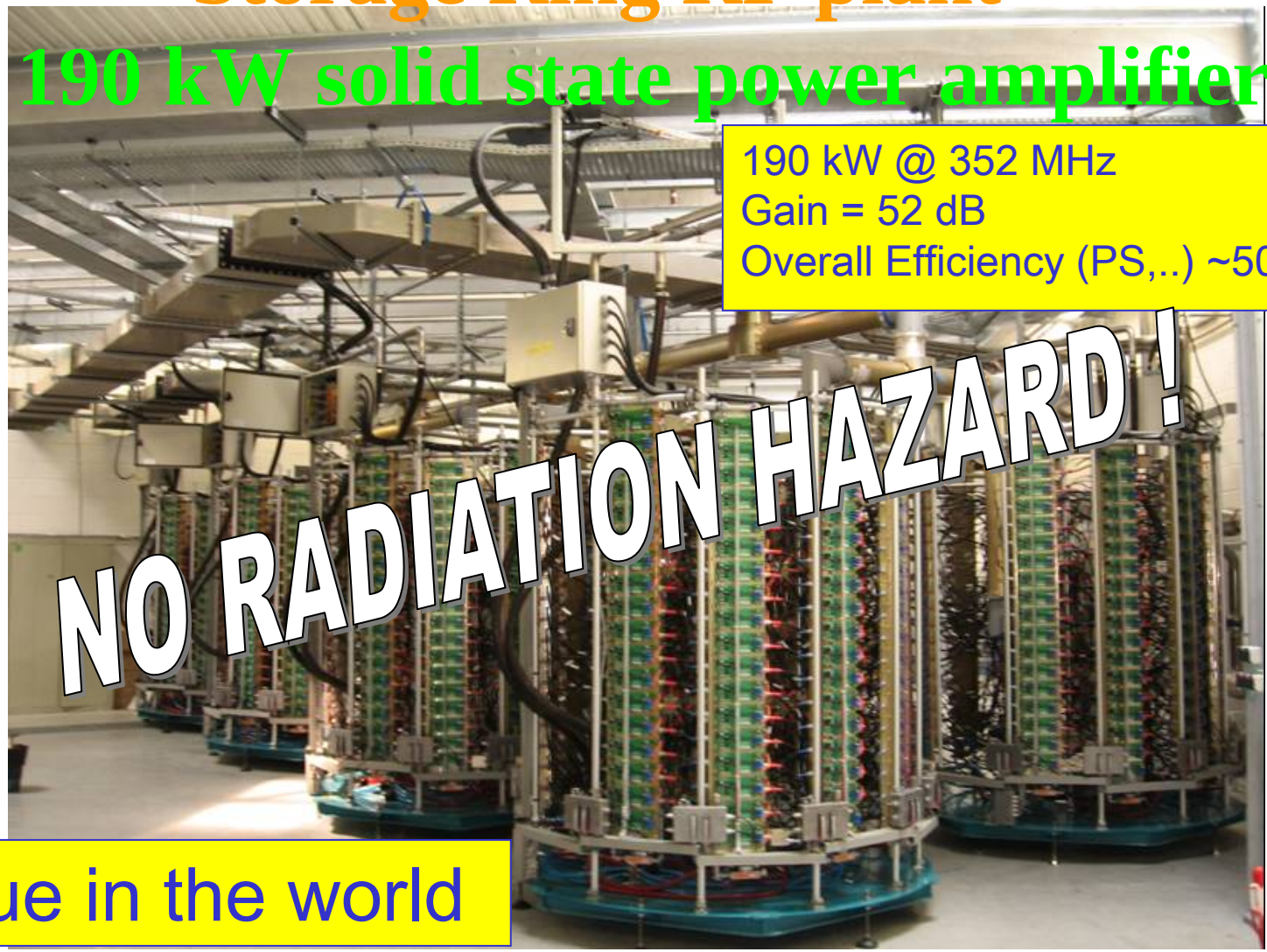


STORAGE RING PARAMETERS

Energy	**2.75 GeV**
Circumference	**354 m**
Number and length of straight sections (24)	**4 x 18,5 m** **12 x 12,4 m** **8 x 7,7 m**
Horizontal emittance Vertical emittance	$3.7\ 10^{-9}$ m.rad $37\ 10^{-12}$ m.rad
Multibunch mode **Lifetime**	**500 mA** **18 h, 4h(top-up)**
8 bunch (30 ps every 148 ns) **Lifetime (10% coupling)**	**90 mA** **18 h**

Storage Ring RF plant

4 x 190 kW solid state power amplifiers



190 kW @ 352 MHz
Gain = 52 dB
Overall Efficiency (PS,..) ~50%

Unique in the world

BEAMLINES

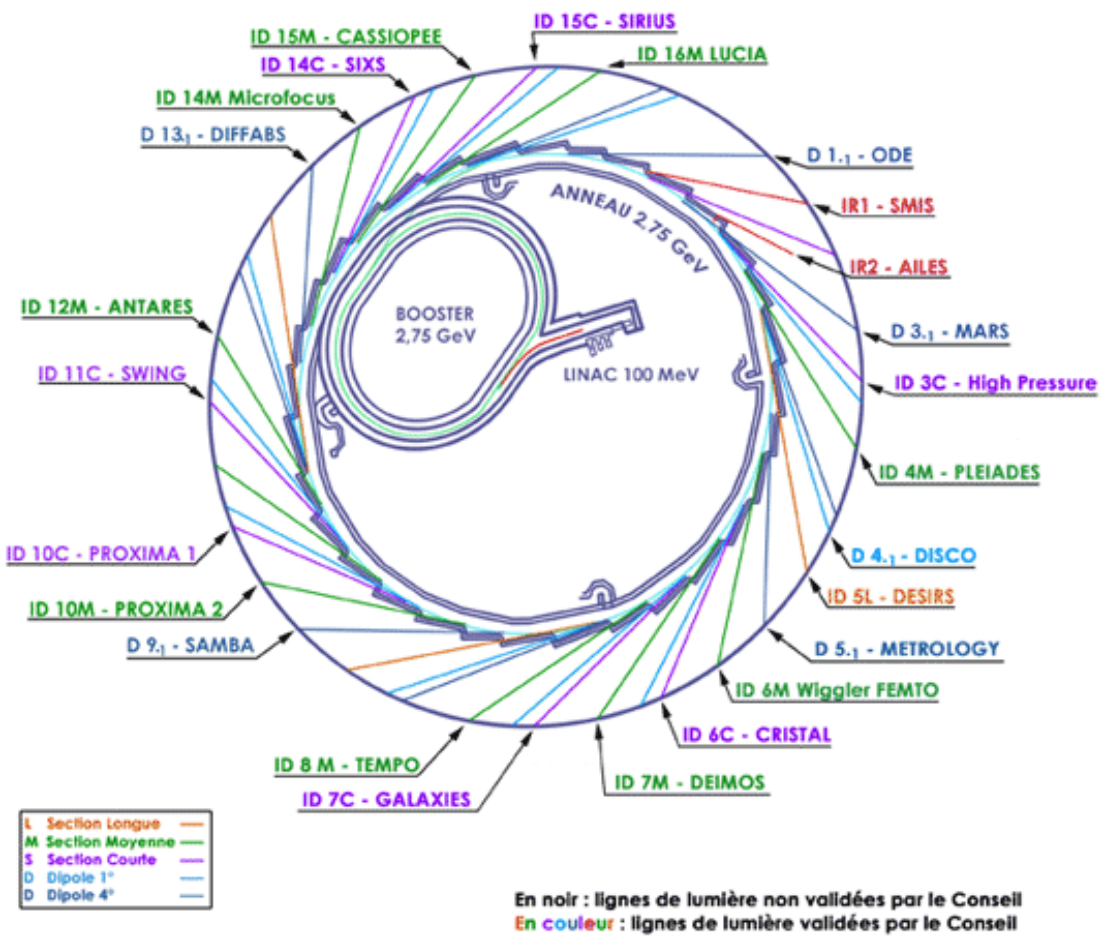
- **22 Beamlines approved by the Council + 2 beamlines to be defined:**
- 16 on insertion devices and 6 on bending magnets

- **Phase 1: 11 beamlines being built =>open to external Users in 2007**
- 6 on insertion devices and 3 on bending magnets **+ 2 IR**

- **Phase 2: 8 beamlines open to external Users in 2008**
- **5** on insertion devices and 3 on bending magnets
- **+ 5 beamlines on ID open to external Users in 2009**

- **5 Straight sections still free + 15 bending magnet beamports**

BEAMLINES STATUS



- 6 ID BL built, 5 on operation
- 3 BM BL built, all on operation
- 2 IR BL built not yet ready to take beam
- 1 ID and 1 BM BL under construction

Radiation Safety Goals
at
SOLEIL Synchrotron Light Source

- **Non classified SOLEIL Staff and SOLEIL Users regarding ionizing radiation hazards in the Experimental Hall**
- **Radiation Safety Requirements so as to avoid personal dosimeter for all SOLEIL staff and Users**
- **Assess that in all conditions the radiation doses outside the tunnels are below the maximum dose authorized for non classified people :**
  - Annual Dose < 1 mSv ⇔ average dose rate < 0.5 µSv/h

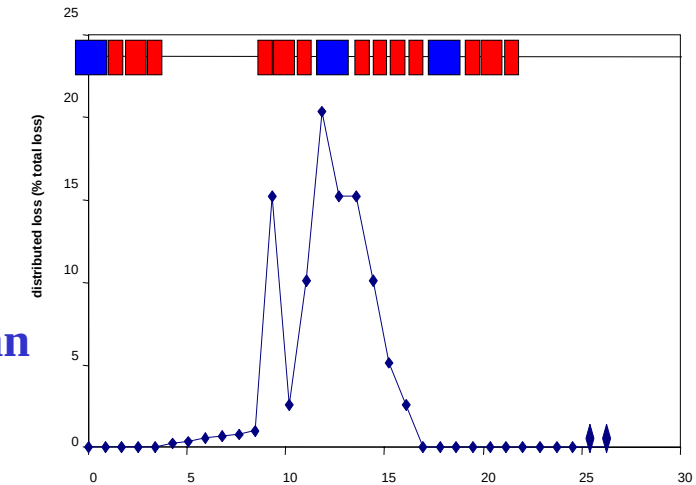
Storage Ring Beam Losses

- SOLEIL SR parameters retained for the shielding design
  - Storage ring parameters
    - 354 m circumference, 16 cells
    - 4 long straight sections (including injection region), 12 medium and 8 short straight sections
  - Electron beam of 2.75 GeV
    - Up to 500 mA
    - Life time up to 25 hours in multi bunches mode
    - Life time of 4 hours in top-up mode with 500 mA stored
  - Normal electron beam losses assumed
    - 15.6 mW (500 mA, τ = 25 h)
    - 113 mW (500 mA, τ = 4 h, top-up mode)

Storage Ring Beam Losses

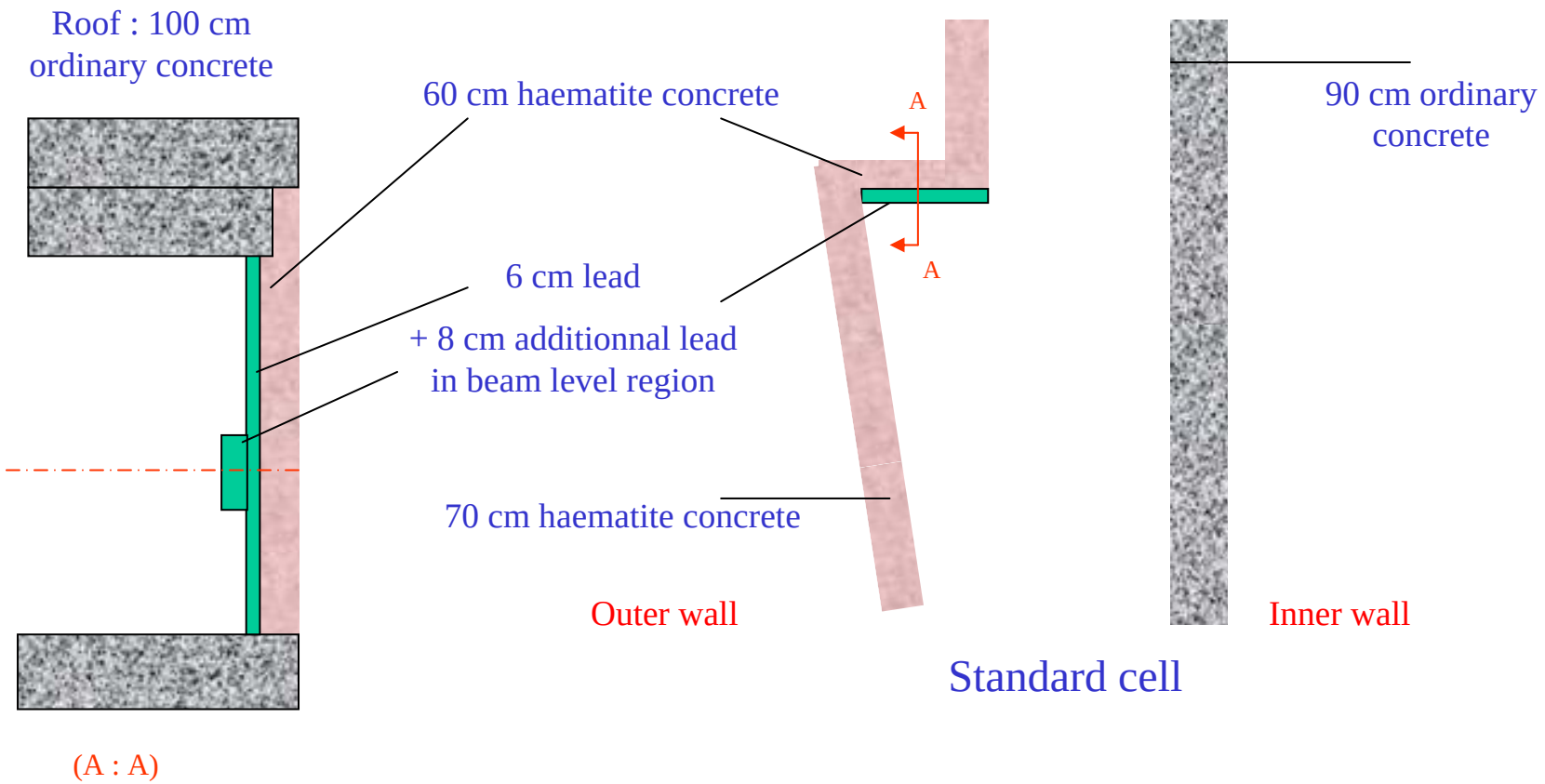
- **Normal Beam losses distributed all around the SR with standard filling mode at 500 mA**
  - 20% of total losses localised in one cell (3.1 mW)
- **Continual beam losses localised but with a typical electron loss pattern along a straight section for top-up mode with 500 mA stored**
  - 6% of total losses localised in one cell (7 mW)

(in accordance with beam losses dose profile measurements inside the ESRF storage ring)

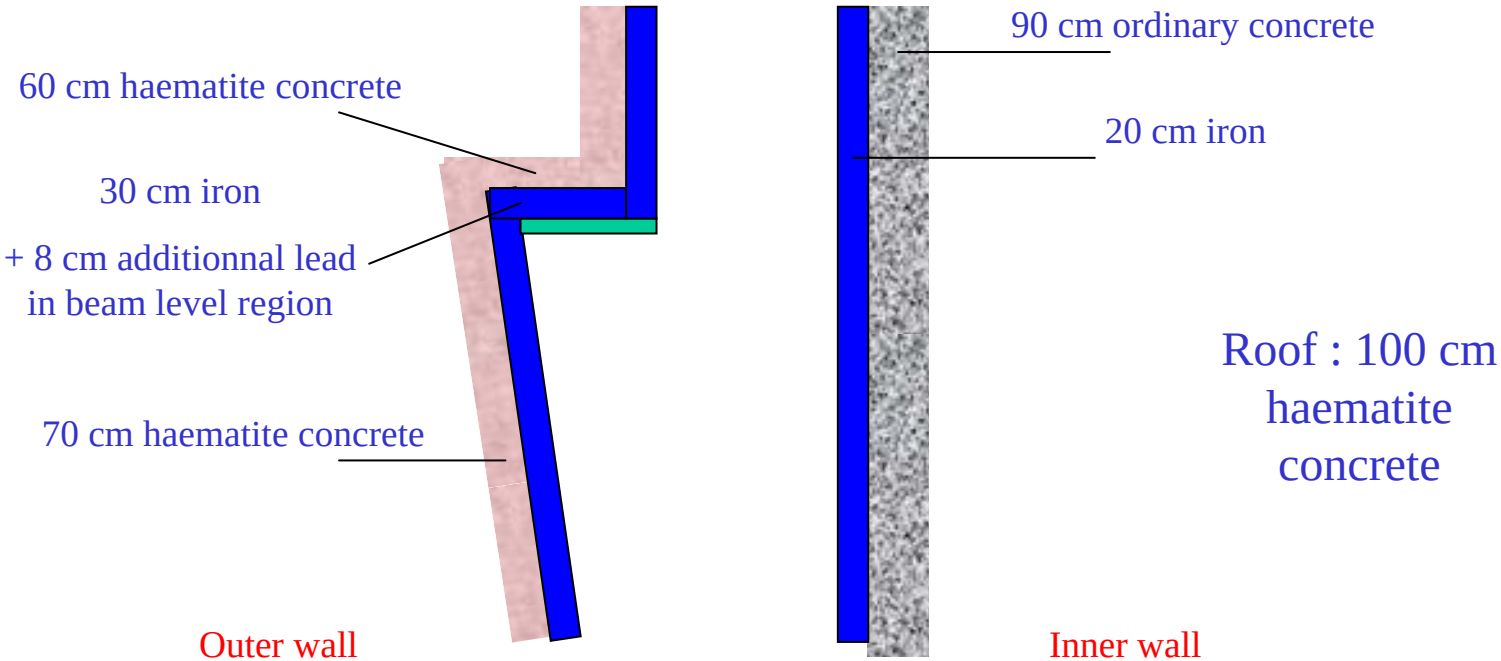


- **All calculations made by Swanson/Sullivan and MC code (P. Berkvens, J-B Pruvost)**

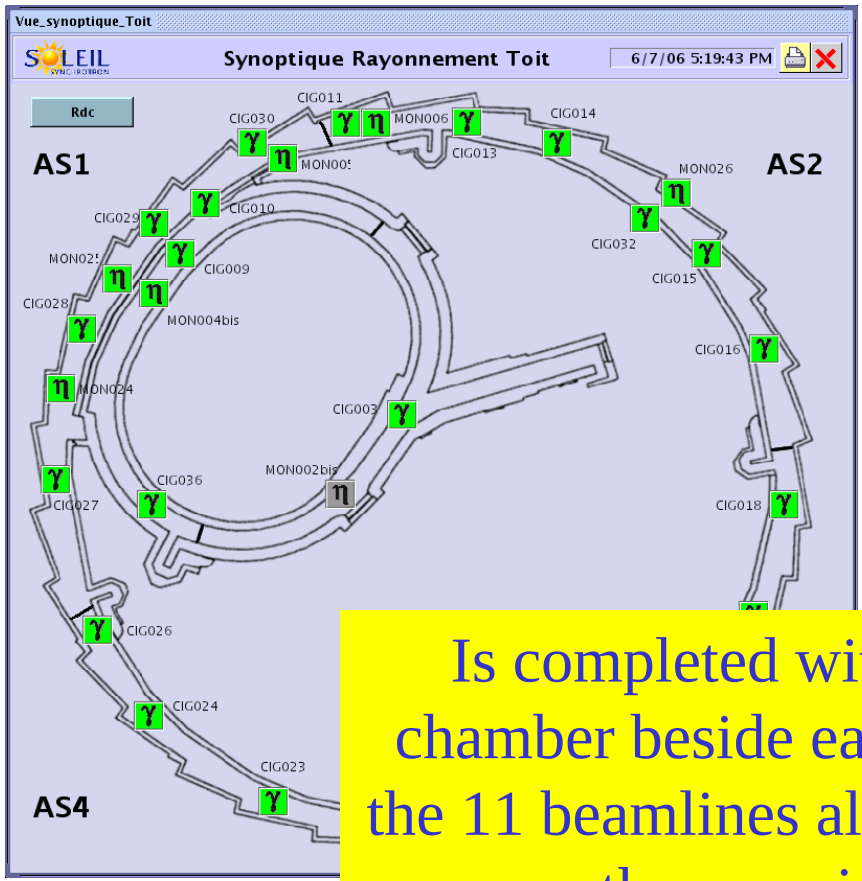
Storage Ring Shielding

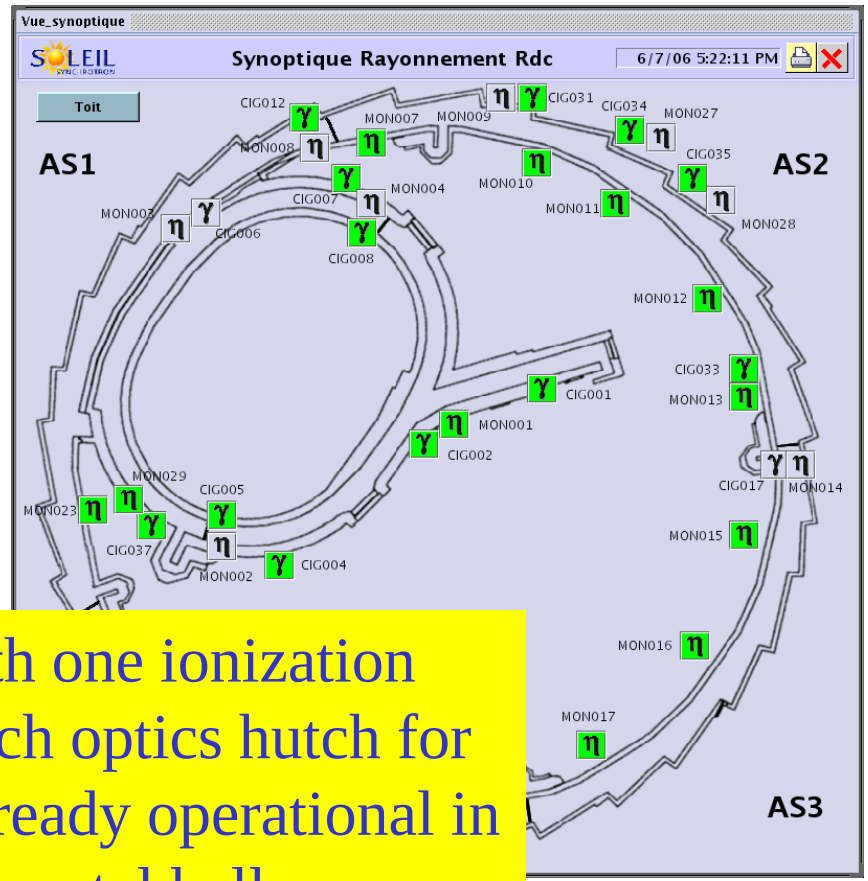


Storage Ring Shielding



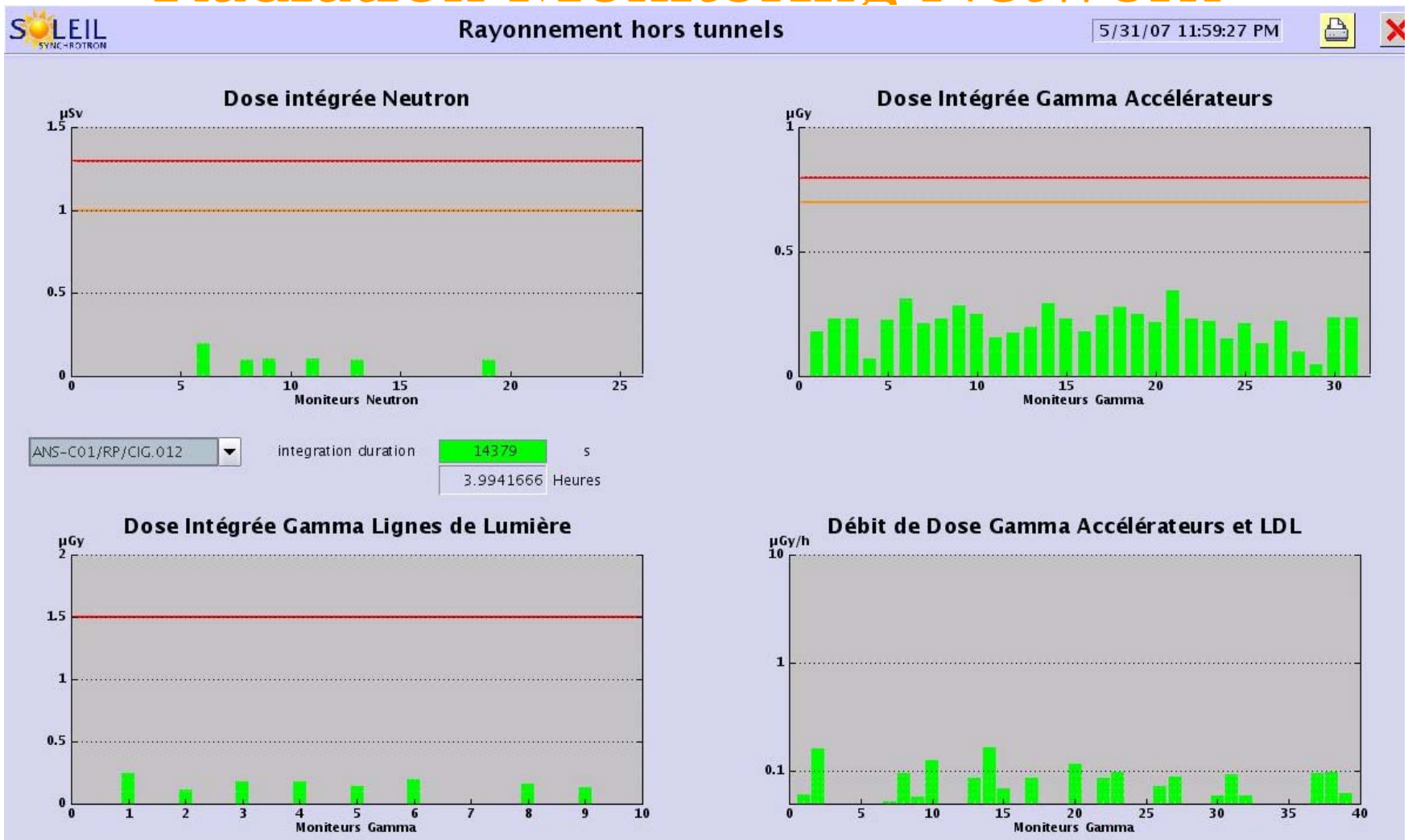
Radiation Monitoring Network





Is completed with one ionization chamber beside each optics hutch for the 11 beamlines already operational in the experimental hall

Radiation Monitoring Network



Gamma Radiation Monitors

- About 40 Ionization Chambers type A20 from Centronics(UK) outside the tunnels
- With Electrometers type DAIP-P from Novelec/Saphymo(F)
- All gamma detectors interlocked with the Personal Safety System

Neutron Radiation Monitors

- 26 Superheated drop neutron detectors all around the tunnels
- ABC 1260 type neutron detectors from Framework Scientific (USA)

Radiation monitoring and interlocks

$$\int_0^t \dot{H}_{total}\, dt < 2\ \mu Sv,\ t \leq \text{4 hours}$$

$$\dot{H}_{total} = \dot{H}_{back} + \dot{H}_{\gamma} + \dot{H}_{n}$$

$$\dot{H}_{n} = 1{,}9 \times \dot{H}_{\gamma}$$

Radiation monitors interlocked to the Personal Safety System :

Doses are integrated during 4 hours periods
Total integrated dose < 2 µSv

From the first measurement results, the gamma dose threshold was set to 0.80 µSv, taking into account the neutron dose level.

If this dose threshold is reached within 4 hours interval, then the PSS will interlock the LINAC injector

Radiation Measurements

- Active Gamma and Neutron dose and dose rates with the radiation monitoring network
- Active Gamma and Neutron dose rates measurements with portable detectors all around the SR tunnels
- Passive Gamma dose measurements with about 250 LiF dosimeters displayed on the concrete surfaces

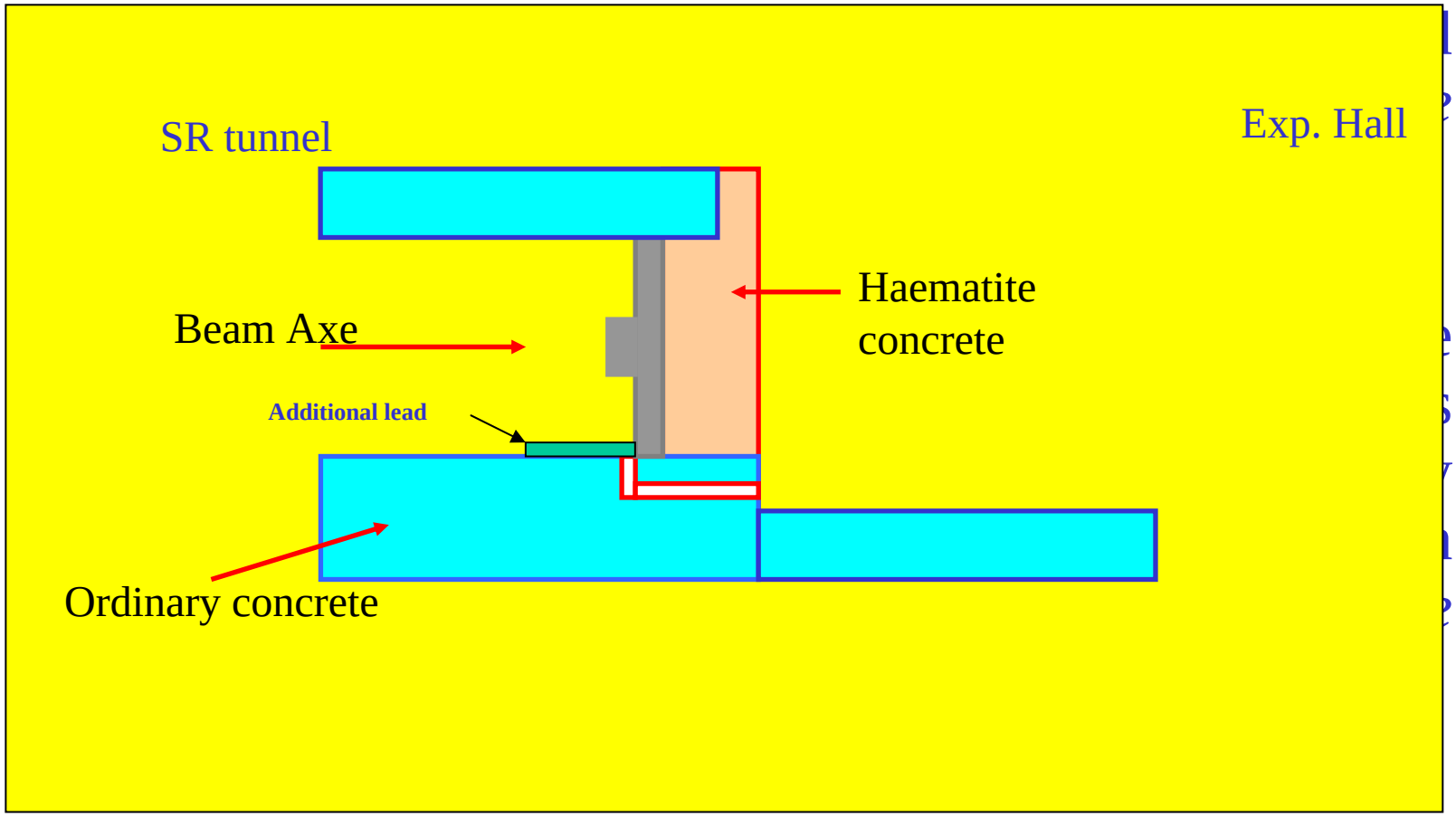
Radiation Measurements

- Continuous Measurements with the radiation monitoring network
- Exhaustive measurements (outer & inner walls and roof) with portable detectors for each level of stored beam reached, with poor lifetime because of the small conditioning time
- Plus Exhaustive measurements with portable detectors for 1 mA/s induced losses (V & H bumps) on typical points (septum, scrapers, straight sections)

→ *40 times higher loss rate than in top-up mode*

Results of the machine commissioning

- No high radiation level detected all around the SR



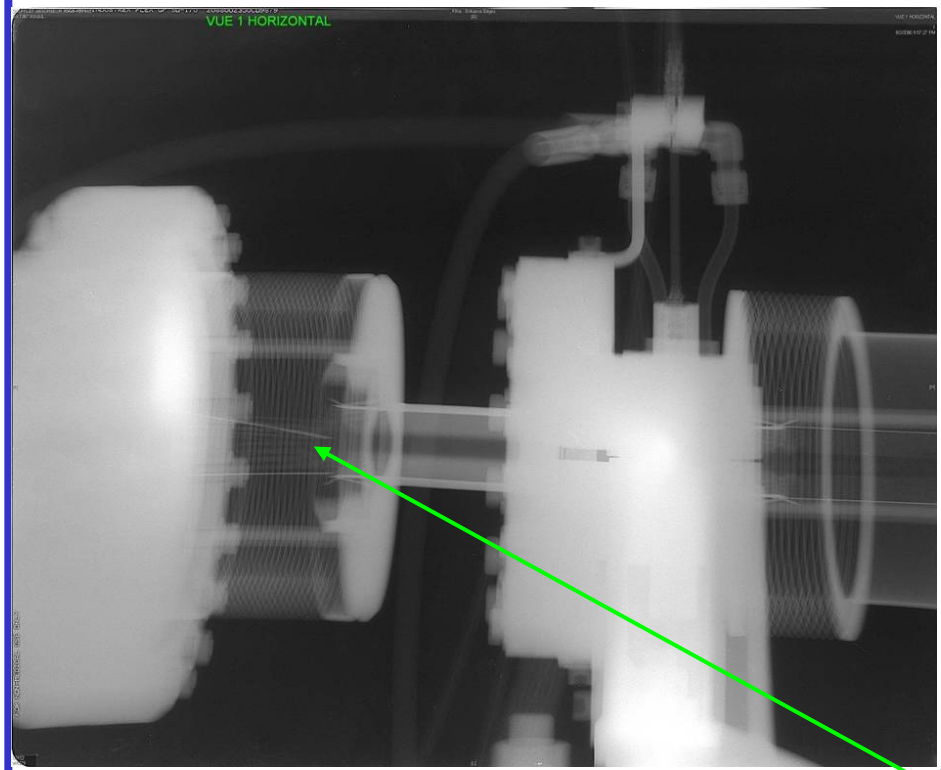
Results of the machine commissioning

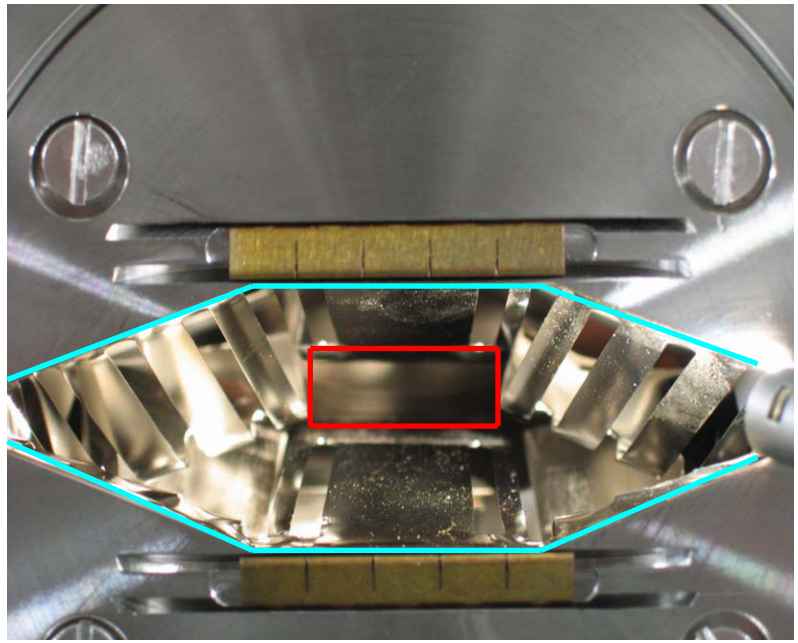
- Detection of another shielding weakness at the outer corner of an access labyrinth in front of a long straight section → *Additional concrete shielding displayed outside the storage ring tunnel*
- Detection of several obstacles in short straight sections (damaged RF fingers) by external radiation monitors in accordance with induced activation detected on the vacuum pipes inside the SR

(all damaged RF fingers already replaced now → no more dose rate detected around these areas)

Unexpected obstacles :

Bad mounting of some RF Fingers in short straight sections



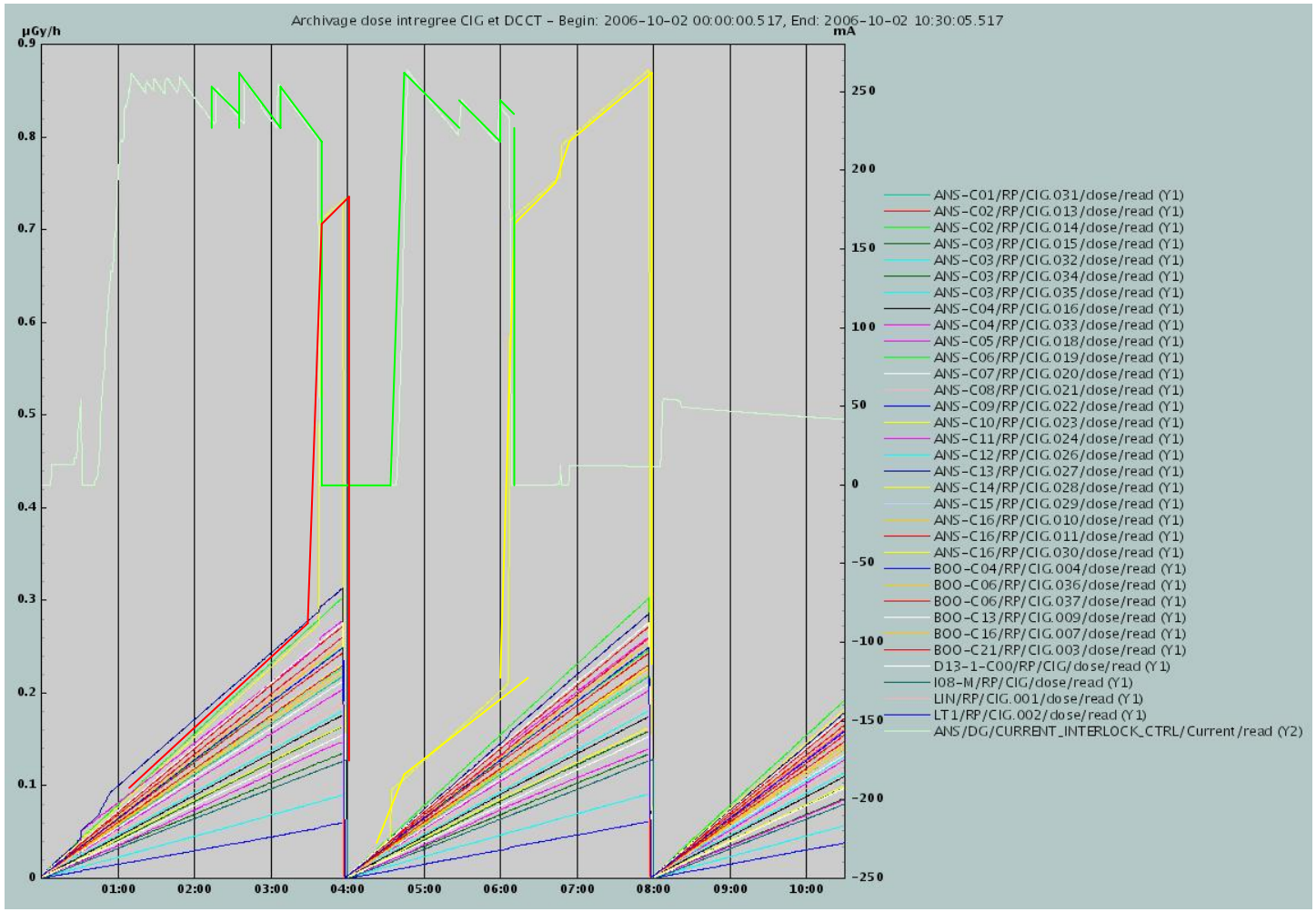


RF finger at <u>1.5 mm</u> from beam axis !

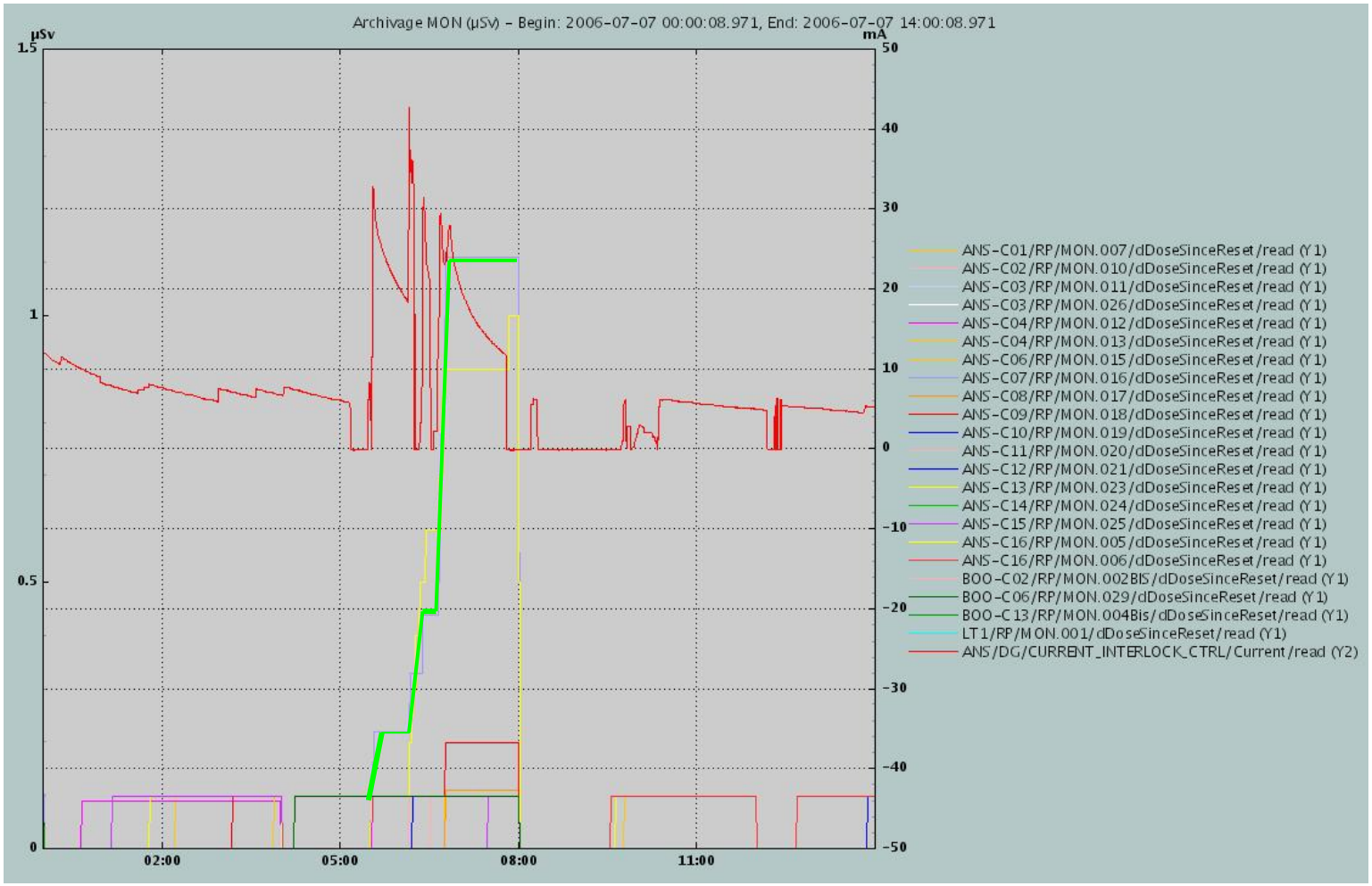
But the beam went nicely through these very small apertures!

Problem fixed now (they all have been replaced)

Gamma Radiation Monitoring



Neutron dose monitoring



Accelerator RP commissioning Conclusion

- **The more the conditioning is progressing, the lower doses and dose rates we record during SR operation**
- **Now significant dose measurement (but low) only during injection period or in case of a beam trip (highest)**
- **Storage Ring operation authorized with maximum current of 300 mA**
- **Induced activation is also decreasing step by step in the standard cells with the progress of the conditioning**
  - Numerous Radioactive points with contact dose rates up 600 µSv/h after the very first beams, few hours after shutdown
  - Now the highest dose rates in contact of vacuum pipes are below 10 µSv/h a couple hours after the shutdown, located only in SR injection region and TL1 (linac to booster)

RADIATION MEASUREMENTS FOR BEAMLINES SHIELDING VALIDATION

RADIATION MEASUREMENTS FOR BEAMLINES SHIELDING VALIDATION

- Active Gamma dose rates with the radiation gamma monitor beside the OH sidewall, linked to the global monitoring system
- Active Neutron dose measurements for straight sections BL
- Active Gamma dose rates measurements with portable detectors all around the hutch panels for each optic element in the FOE.
- Repeated for each new current level available or for each new optic element add along the BL

Results of the beamlines commissioning

- One small leakage observed behind the shutter of the dispersive BL on BM (80 c/s at 300 mA of Xrays E<60 keV) → now solved by a small additional piece of lead welded
- Observation of gas-Bremsstrahlung on the roof and the side wall of an in vacuum ID BL because the ID vessel was put to the air just few days before the first beam on the BL (→ poor vacuum level, 3.5 .10^{-8} mbar instead of 10^{-9} mbar)

BEAMLINES AUTHORIZATION AVAILABLE

Beamline	Port	
DIFFABS	D13-	
TEMPO	I08-M	
ODE	D01-	
SAMBA	D09-	
DESIRS	I05-L	200
CASSIOPEE	I15-M	100
PROXIMA 1	I10-C	100
SWING	I11-C	200
CRISTAL	I06-C	300
SMIS (IR1)	D02	300
AILES (IR2)	D03	300

Reduced current because cooling system problems on the first optics

RADIATION MEASUREMENTS FOR BEAMLINES SHIELDING VALIDATION

- Phase 2 BL OH will be tested without any optic element installed
- Using a cooled copper scatterer
- New tests will be scheduled in order to allowed higher beam current up to 500 mA

THANK YOU FOR YOUR ATTENTION