Vacuum at the ESRF

current activities that benefit from simulation models
Vacuum at the ESRF

• Overview of the ESRF
• Vacuum group activities
• MC simulation for Coating
• Time based MC simulation for pressure bursts
• Cell pressure profile simulation
Vacuum at the ESRF

• The ESRF in numbers
  • 3<sup>rd</sup> generation synchrotron
  • 6 GeV e⁻
  • 845 m long
  • 32 cells
  • 35 active beam lines

• For a uniform filling mode
  • 200 mA beam current
  • Average pressure < 10<sup>-9</sup> mbar
  • Beam life time ~50-60 h dominated by Tousheck scattering
    ~200h due residual gas scattering
  • ~ 120 000L/s pumping speed installed
Vacuum at the ESRF

- ESRF Vacuum Group
- Vacuum diagnostic tools and interlocking systems
- Vacuum systems dimensioning and simulation
  - for the beam lines users and the accelerator complex
- Vacuum chambers coatings (NEG, Gold, TiN)
- Vacuum measurements
  - Pumping speed
  - Pressure gauges calibration
  - Photo desorption
  - Thermal desorption (outgassing)
  - NEG coating characterization
Sputtering Simulation

Sputtering from 3 cathodes at (-19, 0, 19 mm) at 5e-8mbar
50mA.h/m
Sputtering Simulation Results

Gold cathodes (-16, 16 mm)

Vanadium sputtering from 3 cathodes at (-19, 0, 19 mm)
Sputtering Simulation Issues

![Graph showing the number of particles at different distances from the center (mm)].

- **N. Particles**
- **Distance from center (mm)**
  - 2e-3
  - 1e-2
  - 8e-2

Legend:
- Blue line: 2e-3
- Red line: 1e-2
- Green line: 8e-2
Pressure Bursts
Simulation of a pressure burst in an ID
Electrical circuit equivalent

CV6000 Chamber
250mm sections

European Synchrotron Radiation Facility
Difficult shapes
Simulated pressure profile (no beam)
Cell 30
Cell 30 Pressure Profile (no beam)

Pressure (mbar)

Ion pump reference

ip1 ip3 ip5 ip6 ip7 ip8 ip9 ip10 ip11 ip12

Exp
Cell 30 Pressure Profile (no beam)
Cell 18 Pressure Profile (no beam)
Adding beam effects

- Thermal load
- Beam mode / Current
- Photo desorption
- Conditioning
Thermal load

Temperature °C

- no beam
- 7/8 + 1
- 7/8 + 1
- 16 bunch
Filling modes

Pressure (mbar)

Ion pump reference

- no beam
- 7/8 + 1
- 7/8 + 1
- 16 bunch
Adding photo desorption

- **Bakeout**
- **Activation 5h @180°c**
- **after installation**
- **after 1st venting**
Usual procedure for new machines

- Estimate total photon flow
- 90% stopped in the absorbers and 10% lost to chamber walls
- Using a PSD yield of $1 \times 10^{-6}$ mol/ph to estimate a total gas load
Cell 30 pressure profile simulation

• It is difficult to make these simulation work in a machine that has been in service for long.

• Nevertheless it may be helpful to have a reference to which to compare against real data.
ESRF users demands

\[ \tau = PS \]
\[ = 10^{10} \times 300 \]
\[ = 3 \times 10^8 \text{ mbl/s} \]

Ch. + meca + joint + thermique
(dynamique)
ESRF users demands

Chamber surface area:
25000 cm²

1×10⁻¹¹ mbar/L/cm²

Q = 2.5 ×10⁻⁷ mbar/L !
Summary

• Vacuum modeling is fundamental to the services provided by the vacuum group.

• No single tool, or technique, can provide all the answers to the demands of ESRF accelerator and its users

• To model the accelerator vacuum profile, knowledge of surface outgassing, specially in dynamic conditions, seems more important than a accurate model of the vacuum system