

Status of the SOLEIL RF System

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**6th ESLS RF Meeting
Villigen – PSI
28th and 29th November 2002**

THE SOLEIL SITE AS IT WILL BE IN 2005



THE SOLEIL SITE, END OF NOVEMBER 2002



2 klystron modulators
35 MW peak
10 Hz
5 μ s

waveguide switch

DC gun modulated at 350 MHz

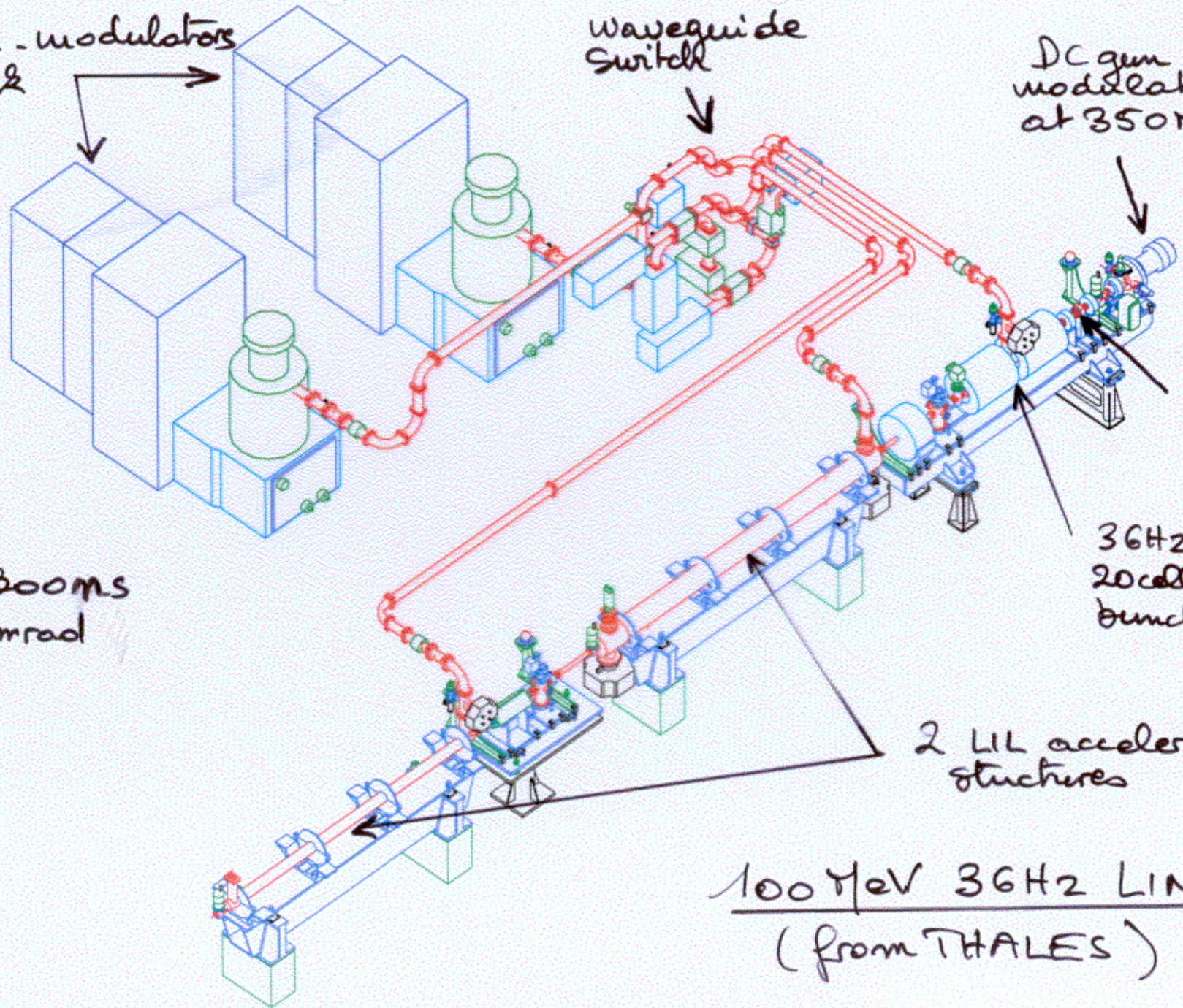
36 Hz
1 cell
prebuncher

36 Hz
20 cell
buncher

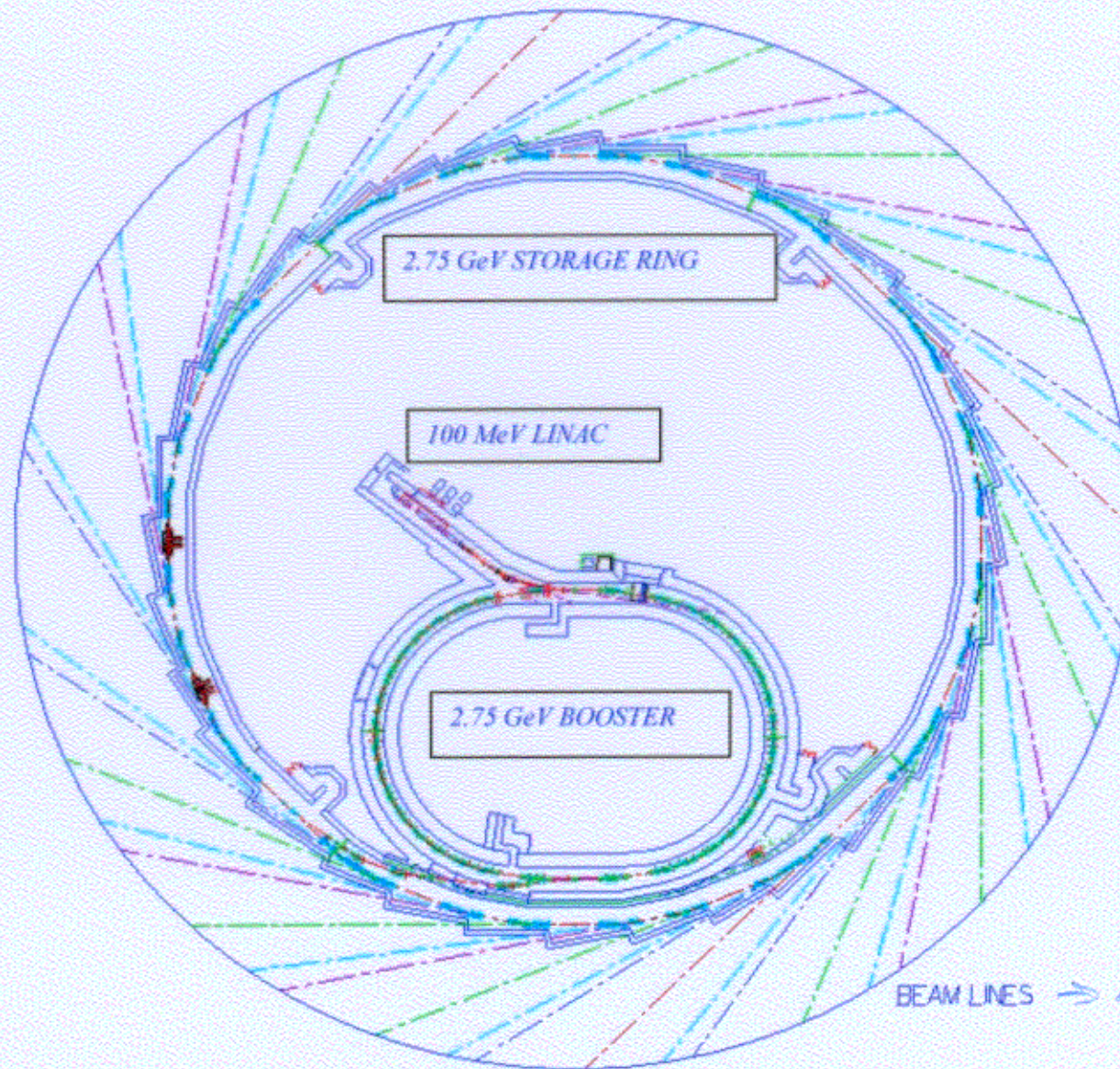
2 LL accelerating structures

100 MeV 36 Hz LINAC
(from THALES)

Perf. (spec.)
 $q: 8 nC$ in 200 ns
 $\Sigma_m: 200 mm \cdot mrad$
 $\sigma_E: \pm 1.5\%$



SOLEIL ACCELERATOR COMPLEX



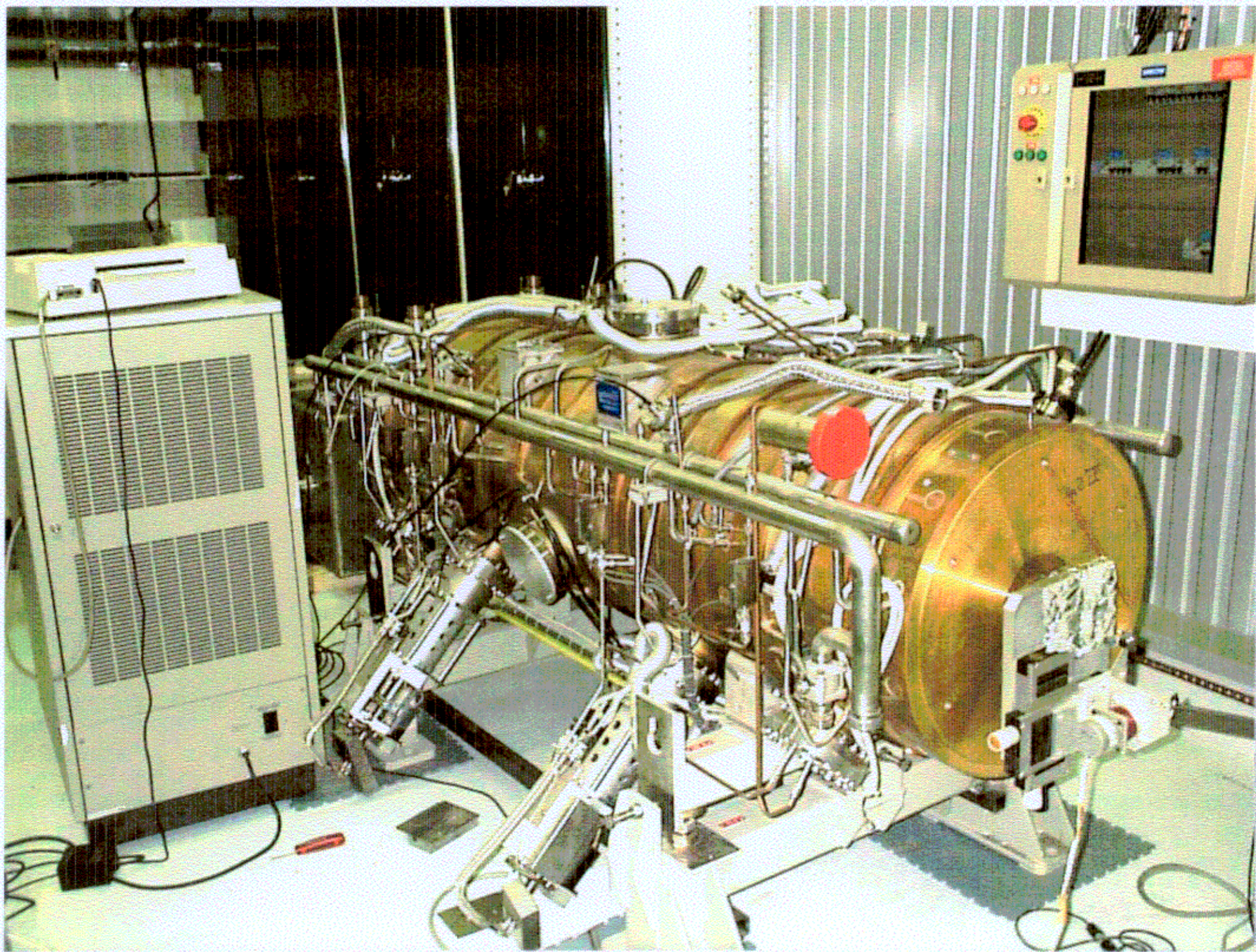
Main parameters of the SOLEIL Booster

circumference	156.6 m
repetition rate	3 Hz
injection energy	100 MeV
final energy	2.75 GeV
beam current	12 mA
revolution frequency	1.91 MHz
RF frequency	352.2 MHz
harmonic number	184
nb of 5-cell-cavities *	1
shunt impedance	26. MΩ
At final energy	
RF voltage	0.9 MV
cavity dissipation	16 kW
radiation loss/turn	410 keV
RF power into the beam	5 kW
RF acceptance **	± 0.35 %
lifetime	60 s

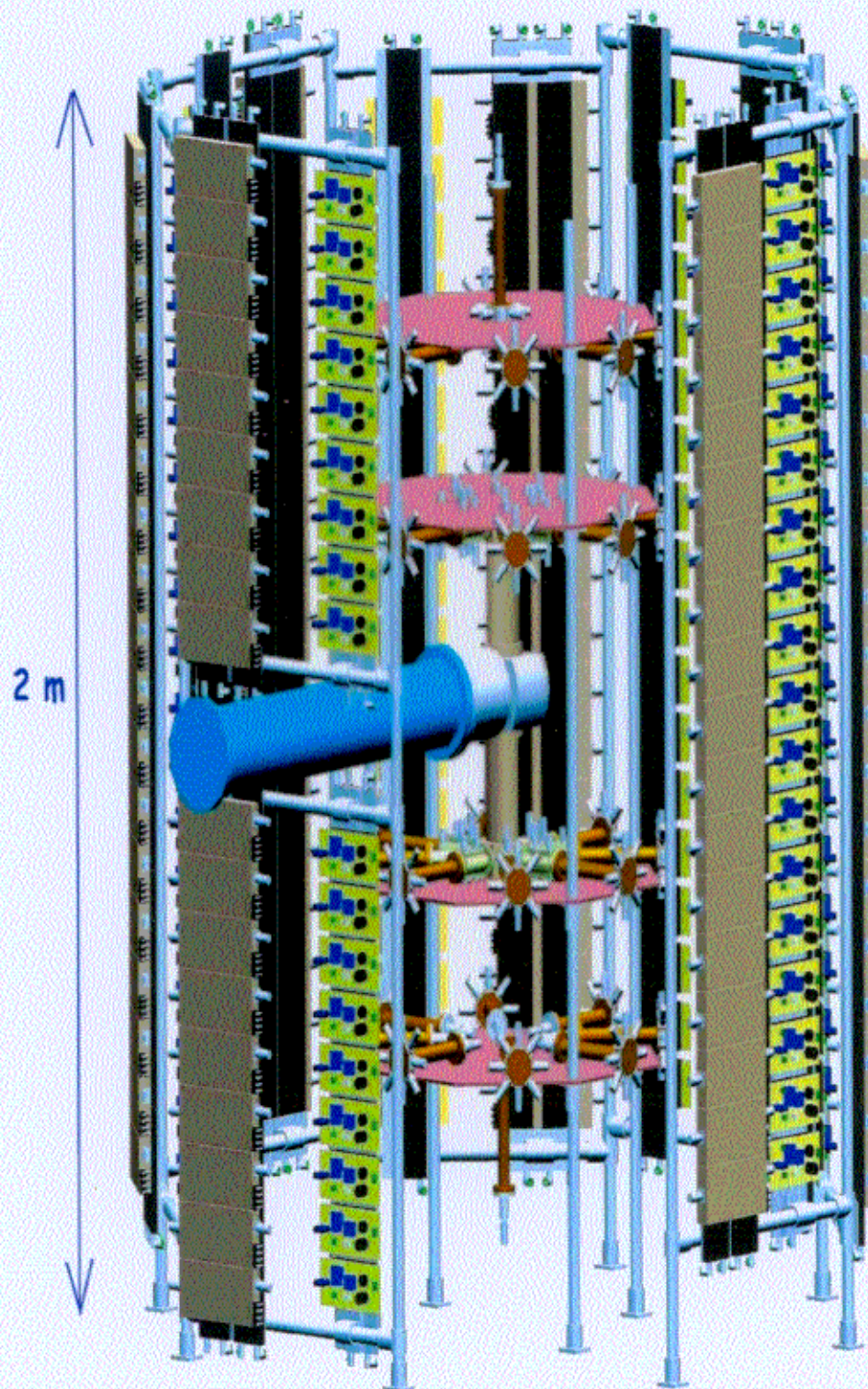
** 1.5 % at injection with $V_{RF} = 200$ kV (ramping)

Booster RF system

- 1 CERN-LEP type 5-cell cavity (without storage)
- 1 Solid state amplifier ($P_{max} = 40$ kW)
- LURE type regulation loops (amplitude, phase, frequency)

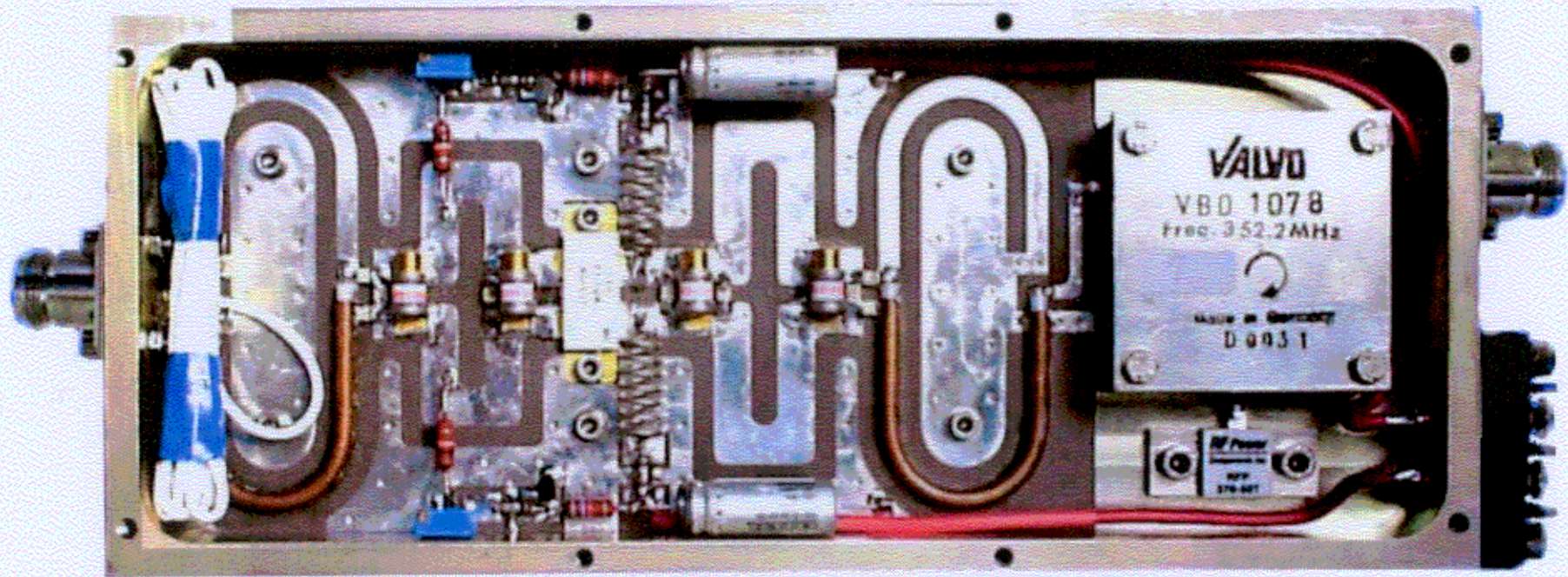


PRIMEZ L'AUTRE FACE * ANDERE SEITE DRUCKEN * PRINT OTHER SIDE * IMPRIMEZ L'AUTRE FACE * AND



40 kW solid state amplifier for SOLEIL Booster

146 x 330 Watts



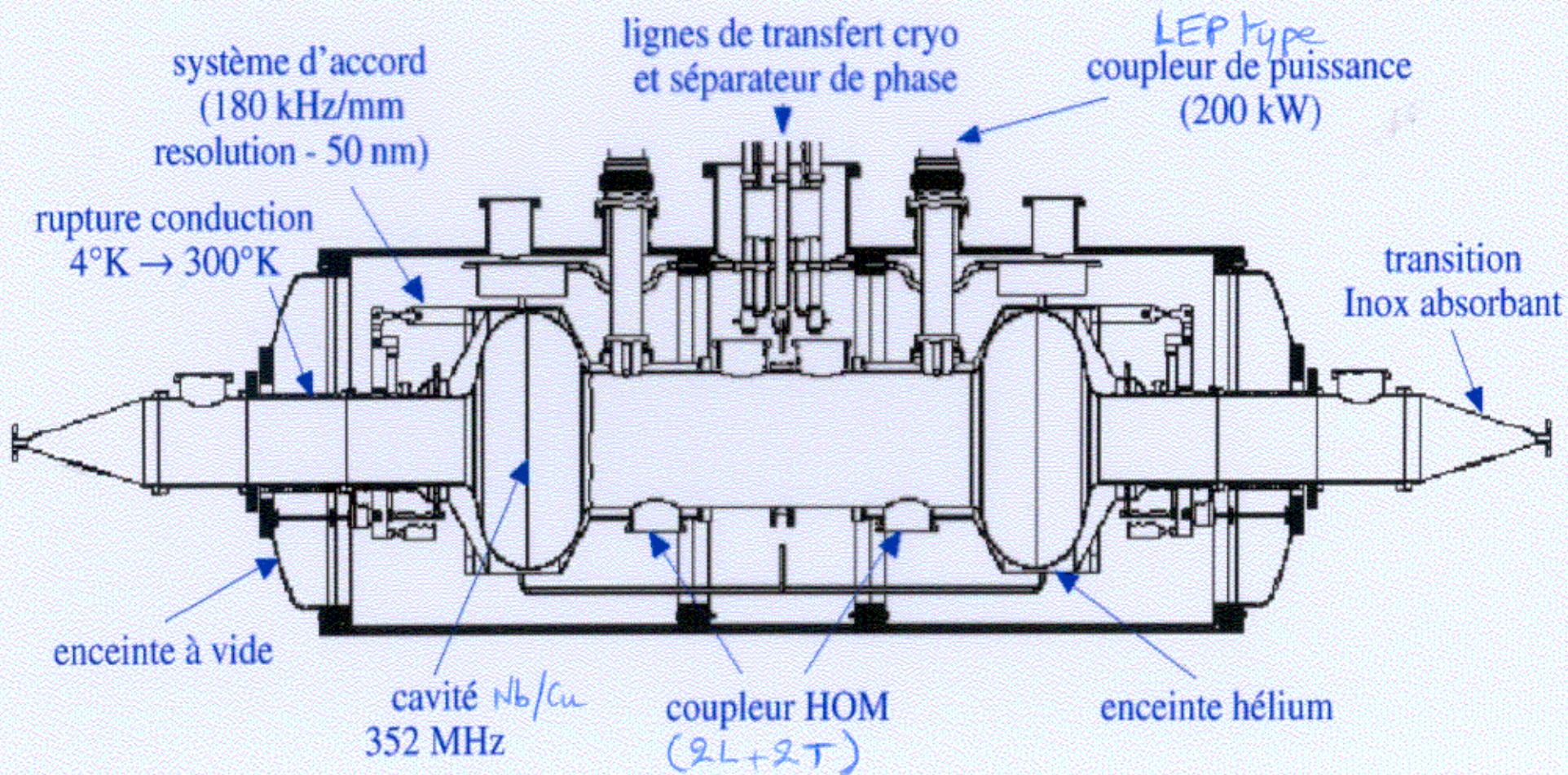
330 W 352 MHz Amplifier Module

Basic parameters of the SOLEIL storage ring

Circumference L [m]	354.
Revolution frequency, f_0 [MHz]	0.85
Energy, E [GeV]	2.75
Radiation loss / turn, ΔU [MeV]	1.3 *
Beam current, I_b [A]	0.5
Beam power loss, P_b [kW]	650.
Momentum compaction, α	4.4 E-4
Momentum spread, σ_p [%]	0.1
Longitudinal damping time τ_s [ms]	3.3
Transverse damping times, $\tau_x \approx \tau_y$ [ms]	6.6
RF frequency, f_{RF} [MHz]	352.2
Harmonic number, $h = f_{RF} / f_0$	416
RF voltage, V_{RF} [MV]	4.8
Overvoltage, q	3.8
RF acceptance, ϵ_{RF} [%]	± 6.15
Bunch length, σ_s [mm]	4.2
Synchrotron frequency, f_s [kHz]	5.9
Synchrotron tune, $Q_s = f_s / f_0$ [E-3]	6.93
Synchronous phase, ϕ_s [degree]	15.

* 0.95 (B) + 0.3 (ID) + 0.05 (HOM)

SOLEIL Cryomodule



200 kW / coupler ⇒ need for 2 cryomodules @ 2.75 GeV / 500 mA

SOLEIL CRYOMODULE

In 1998, decision to develop a 350 MHz cryomodule for
SOLEIL (CERN/CEA collaboration)

In 2002, tests of the “prototype” in ESRF storage ring
(cf J. Jacob presentation)



200 kW per coupler
Vacc > 3 MV

The achieved performance should allow to store
up to **400 mA with a lifetime of about 30 hours**
(24 hours with 2.5 MV)



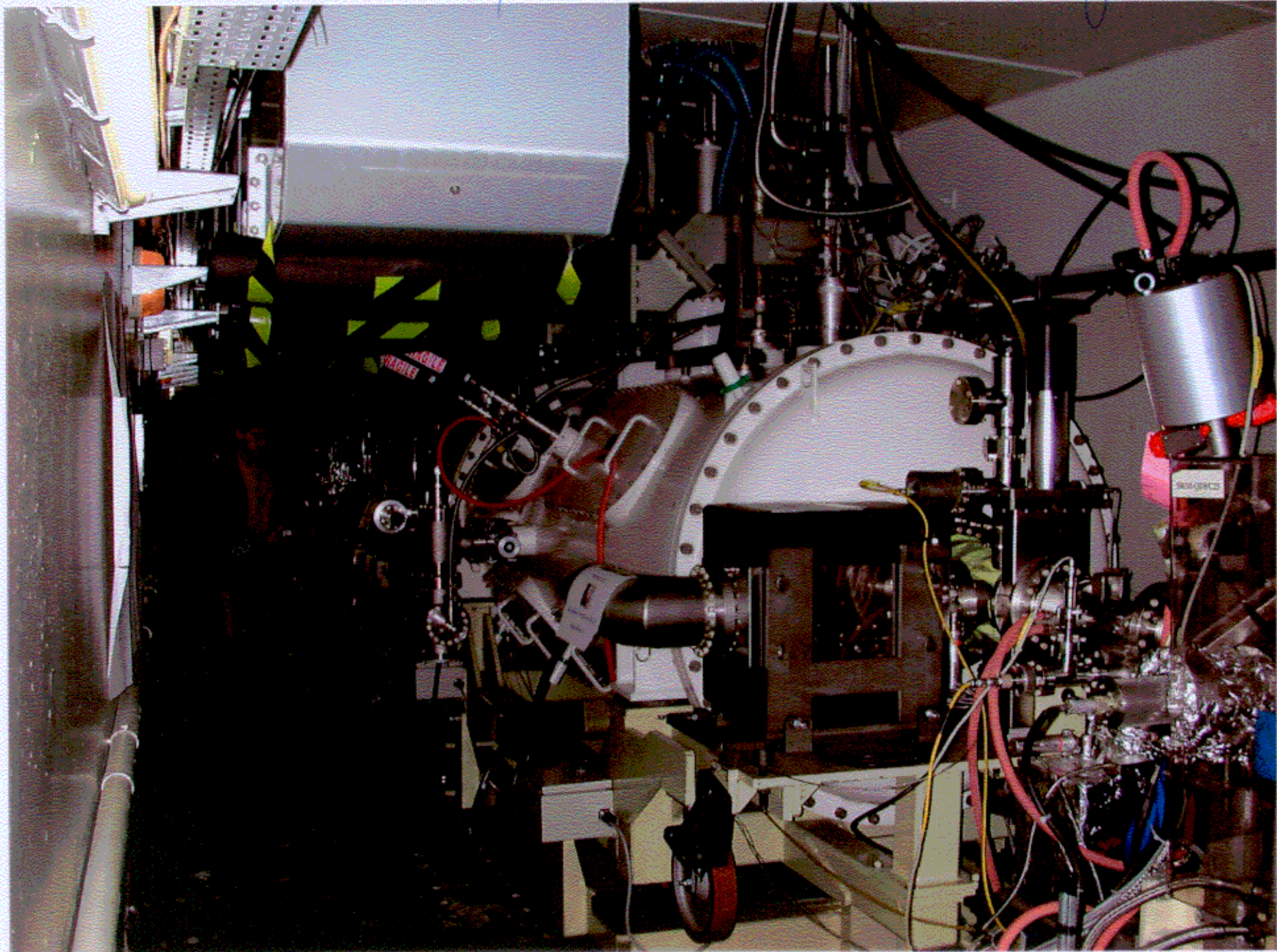
**Use of the “prototype” for the SOLEIL
commissioning in 2005**

Start to build a “new” cryomodule in
collaboration with CEA and CERN
+ improvements of the “prototype”
before the installation in SOLEIL

CRYOGENICS

Specifications for the order of one or two
refrigerators (1 x 500 W or 2 x 250 W)

The SOLEIL cryomodule in the ESRF ring



350 MHz POWER SOURCES

MODULARITY

For SOLEIL, most likely 4 x 200 kW
(one transmitter per cavity)

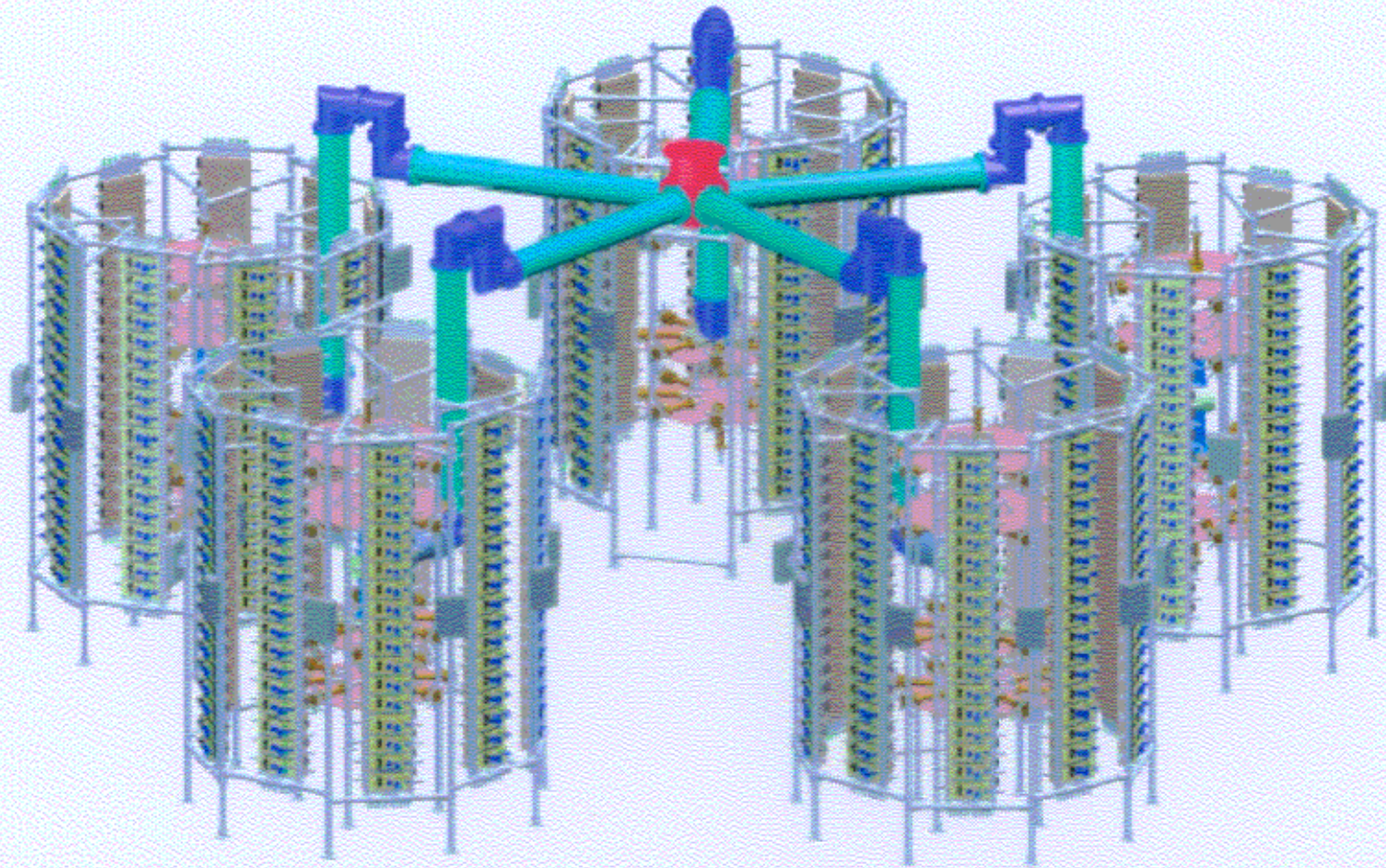
TECHNOLOGICAL OPTIONS

- *Klystron* : only 1.3 MW version existing at 350 MHz,
from THALES
- *IOT* : existing tubes with max power of 80 kW,
cavities could be modified for 350 MHz
→ combination of 3 units
- *Diacrode* : Thales product presently in 2 versions :
1 MW at 200 MHz and 50 kW at 500 MHz
a 200 kW - 350 MHz version could be
developped by Thales
- *Solid state* : combination of 5 « booster » units
5 x 40 kW per cavity

**Not yet decided,
but favoured solution is the solid state version
modularity, redundancy, low voltage**



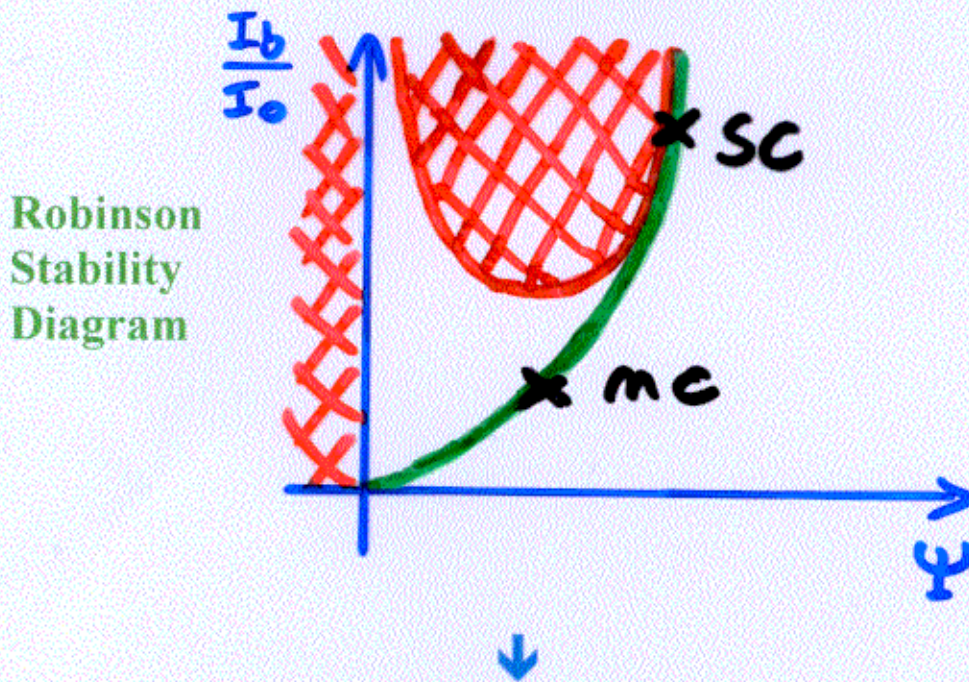
**High reliability and easy maintenance
Cost ?**



200 kW Solid state amplifier

REGULATION LOOPS

Superconducting system → very high beam loading
→ limit of Robinson instability



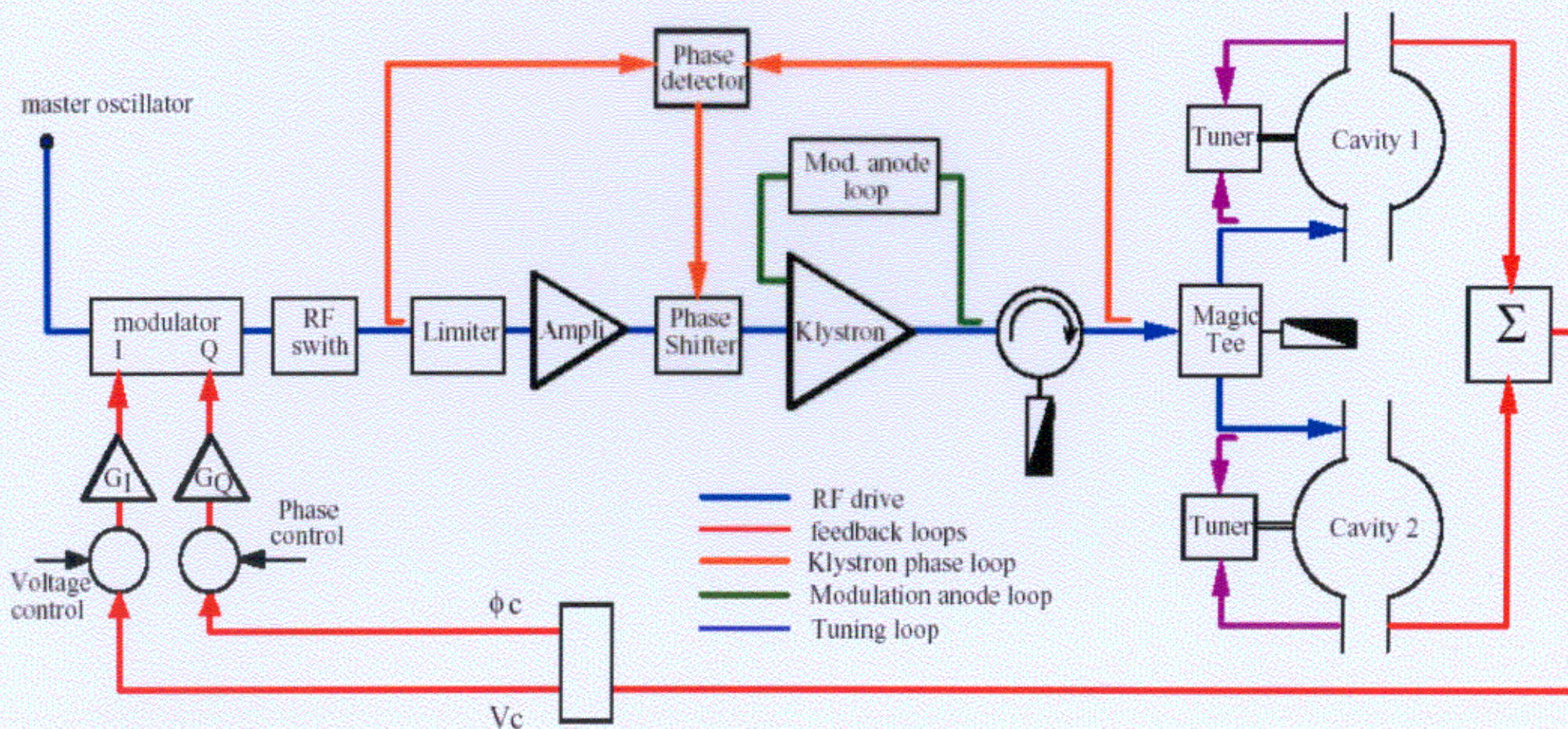
Cure :

- either RF feedback
- or fast amplitude and phase loops

INTERLOCKS AND CONTROLS

Depend on the selected type of RF power source
(for solid state amplifier, cf F. Ribeiro presentation)

RF SYSTEM REGULATIONS (APD proposal)



RF SYSTEM MILESTONES / RESSOURCES

BOOSTER RF

- Mid 2004 : Complete RF plant tested at LURE
- End 2004 : RF plant installed and tested in SOLEIL
Start of commissioning

SR CRYOMODULES

- End 2003 : Modif. of prototype completed (at CERN)
- April 2005 : Prototype installed and tested in SOLEIL
Start of commissioning
- In 2006 : Installation of the 2nd cryomodule

SR CRYOGENICS / RF POWER SOURCES

- Mid 2003 : Order
- Mid 2004 : Delivery
- April 2005 : Installation and tests completed
Start of commissioning

BUDGET

0.32 M Euro for the Booster RF
6.10 M Euro for the SR RF

RF GROUP STAFF

Presently : 6 p
2003 : 11 p
2004 : 13 p