STATUS OF THE SOLEIL PROJECT

M P LEVEL on behalf of the SOLEIL team

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SUMMARY

- *History of the Project*
- *Nominal Energy*
- *New Lattice*
- *Insertion Devices*
- *Beam Stability*
- *New Developments*
- *Planning*

HISTORY OF THE PROJECT

- February 96: Team (CEA/CNRS) to realise the detailed study.
- Period 96-99: In relation with the French scientific community, a third generation 2.5 GeV Source was fully designed and the major component studies ready to be ordered.
- August 99: The project was stopped and the team dissolved.
- 11 September 2000 The new research minister announced the decision to build SOLEIL

➢ *The project characteristics are those planned in the APD :*

- Energy : 2.5 to 2.75 GeV
- Number of beam lines 24:

  4 beam lines among 24 will be dedicated to biology (instead of 2 in APD).

  Roughly 50% devoted to soft X rays and UV and 50% to hard X rays with possible evolution.
- Timetable : first photon beam in 2005 with 10 beam lines, 24 in operation after 8 years.

NOMINAL ENERGY : 2.5 GeV⇨2.75 GeV (1)

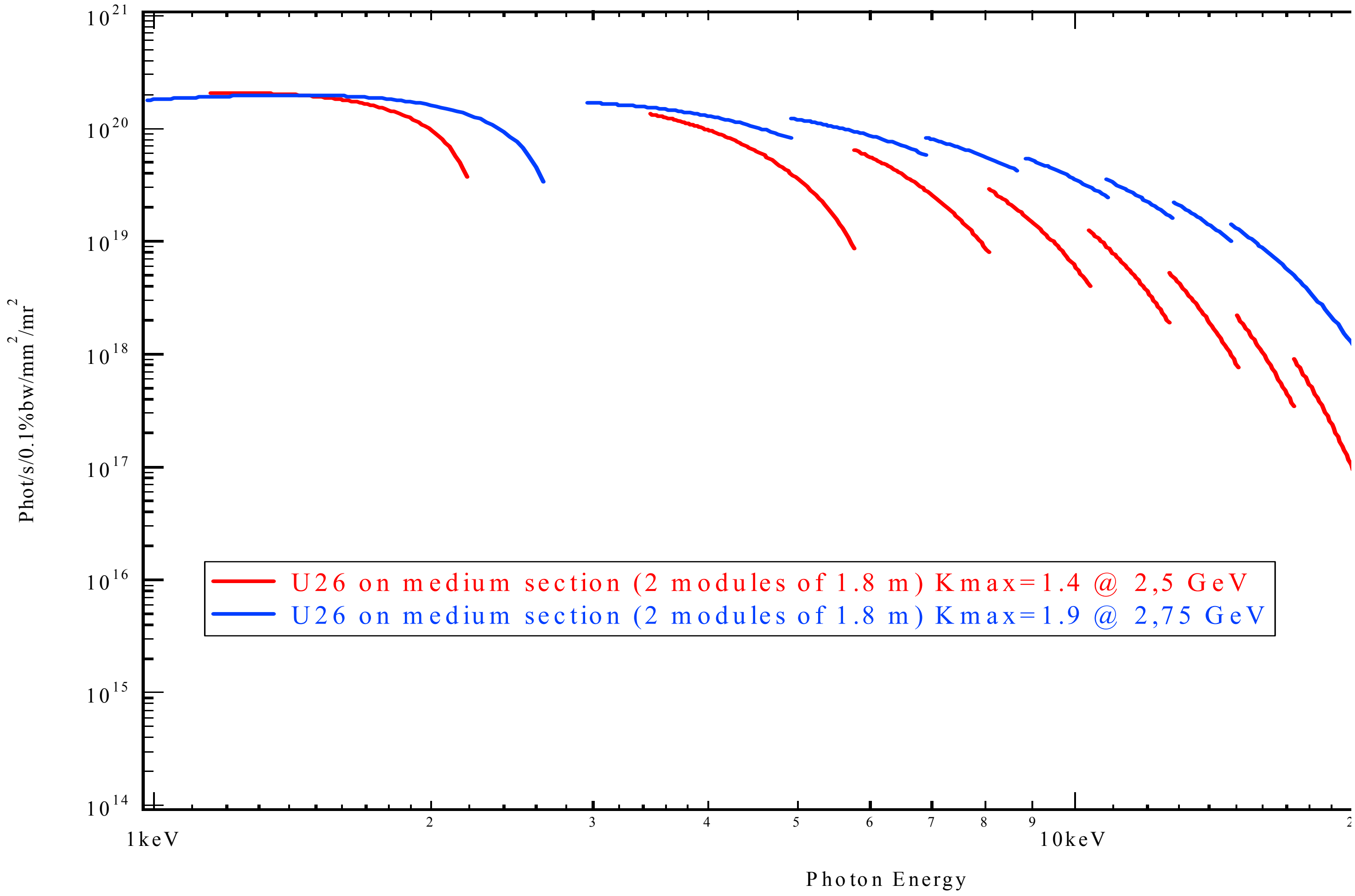
➢ High energy photon production

BL for Biocristallography and diffraction(3– 18 keV) (6 beam lines):

In-vacuum undulator U26

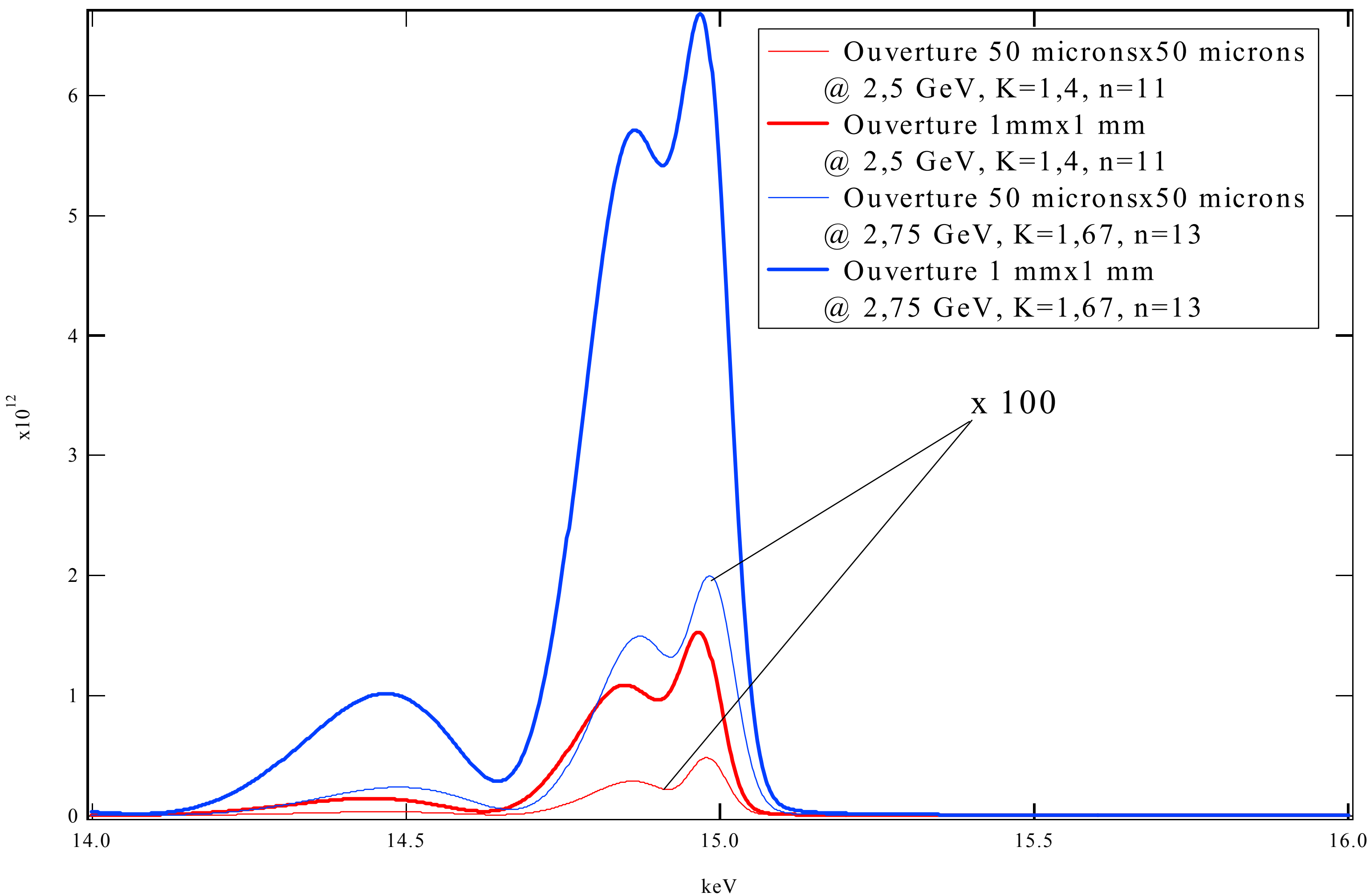
- *gap 10 mm at 2.5 GeV and 8 mm at 2.75 GeV Brilliance⇒ gain of 5*
- *Flux (slot 1mm x 1 mm at 30 m) ⇒ gain of 5*
- *13 and 15 keV are obtained on the 13 th harmonics*

NOMINAL ENERGY : 2.5 GeV⇨2.75 GeV (2)



Comparison of Brillance at 2.75 GeV and 2.5 GeV

NOMINAL ENERGY : 2.5 GeV⇨2.75 GeV (3)



NOMINAL ENERGY : 2.5 GeV⇨2.75 GeV (4)

➢Low energy photon production

Soft X rays (10 eV – 1 keV) (3 Beam lines):

HU 300, 3.6 m long (+ U 80, 1.8 m long)

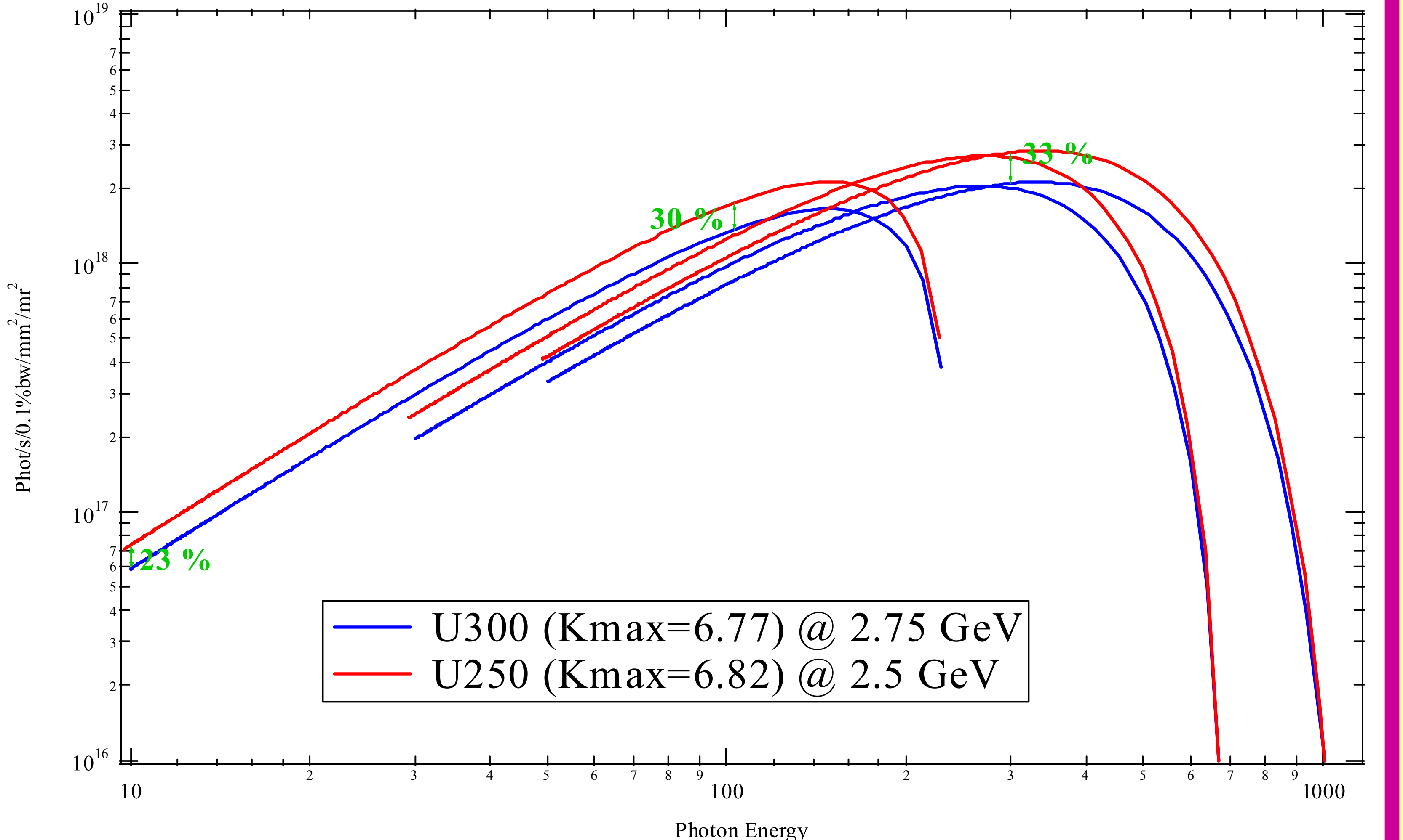
⇒ The limit comes from the power density on the vacuum chamber : 765 W/mrad^2

ΔT = 28° (modified vacuum chamber with water cooled copper slot)

The slot (±0.48 mrad for 7 mm) does not limit the useful flux (Vertical polarisation : cone ± 0.37 mrad) The power on the optics can be reduced to less than 314W with diaphragm.

⇒ **At 2.5GeV, the same limit would be reached with a 250 mm period. The difference in brilliance is ≤ 30%**

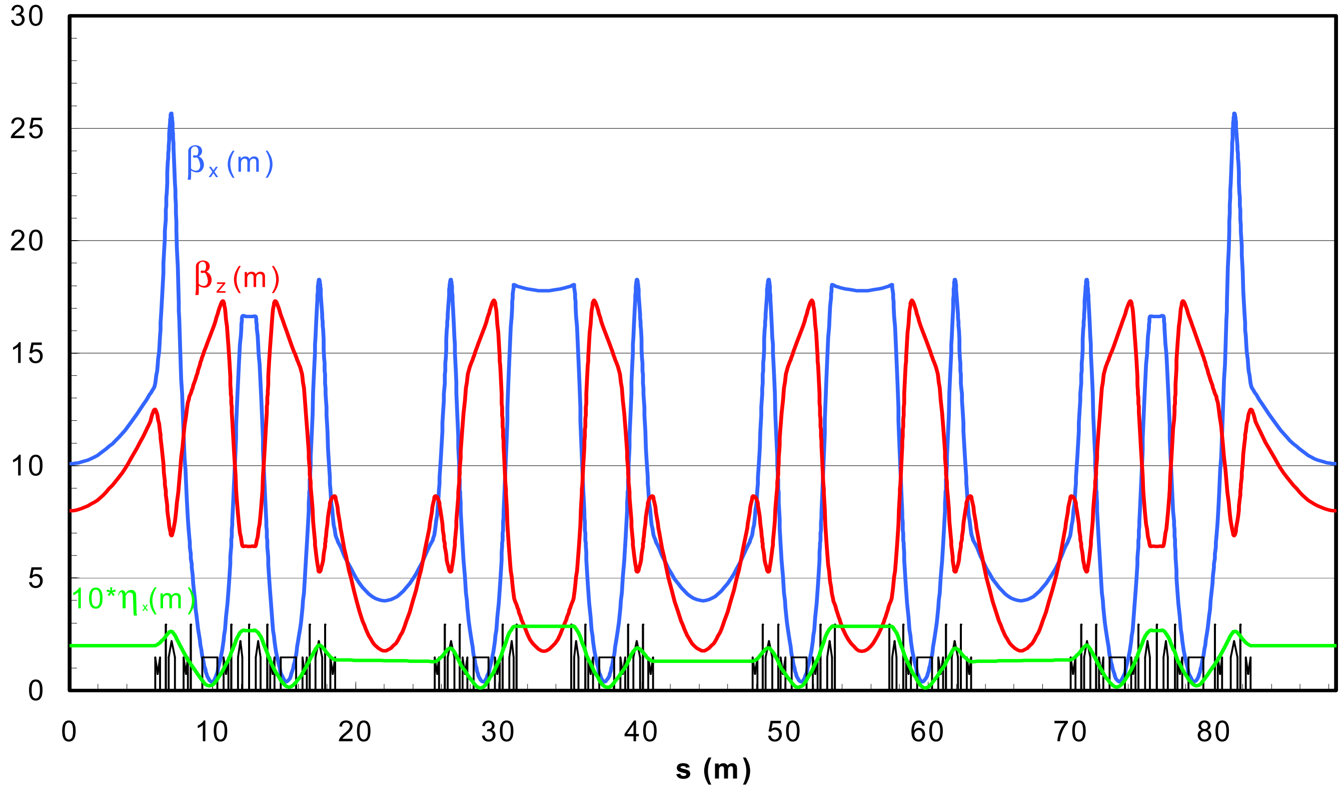
NOMINAL ENERGY : 2.5 GeV⇨2.75 GeV (5)



Comparison of Brillance at 2.75 GeV and 2.5 GeV

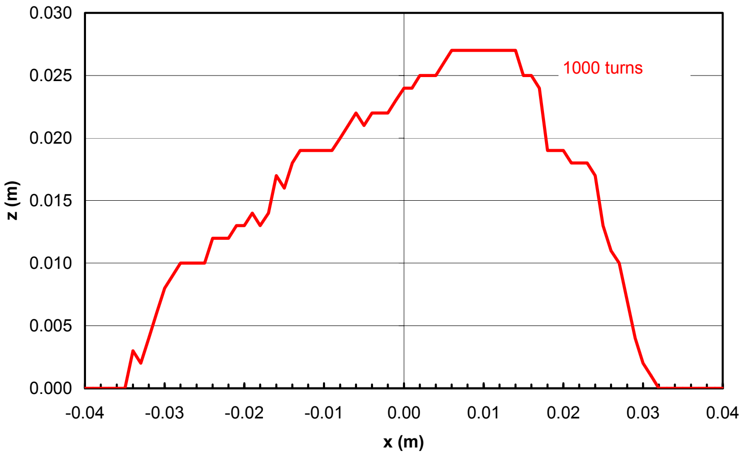
New Lattice

The idea was to create new straight section by drifting apart the two quadrupole doublets located between the two bending magnets of the DB cell.

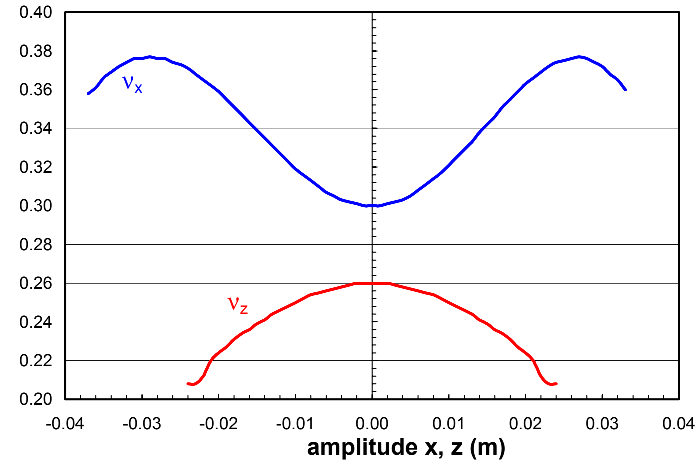


Lattice and optical functions for a super period of the storage ring

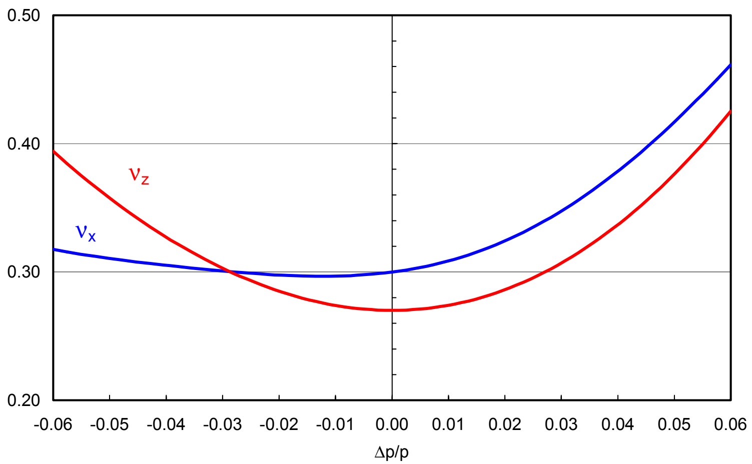
OPTICS : Dynamic aperture



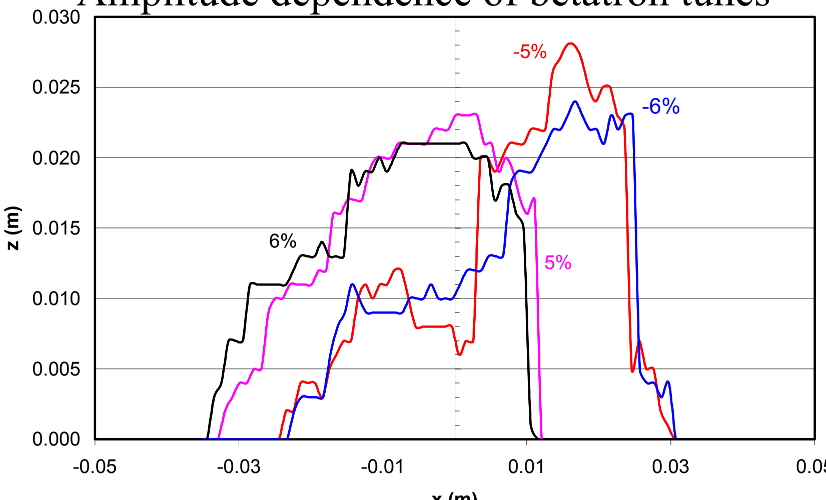
On momentum dynamic aperture



Amplitude dependence of betatron tunes

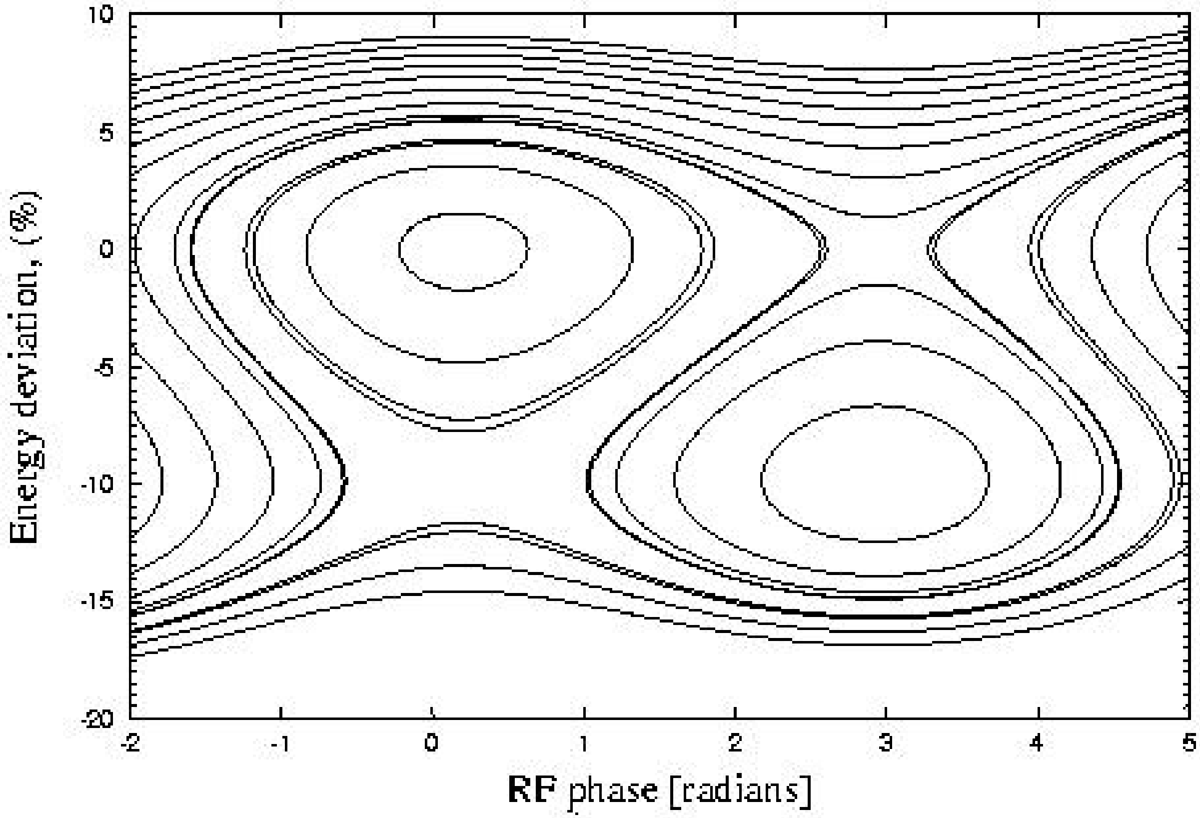


Tune variation with energy



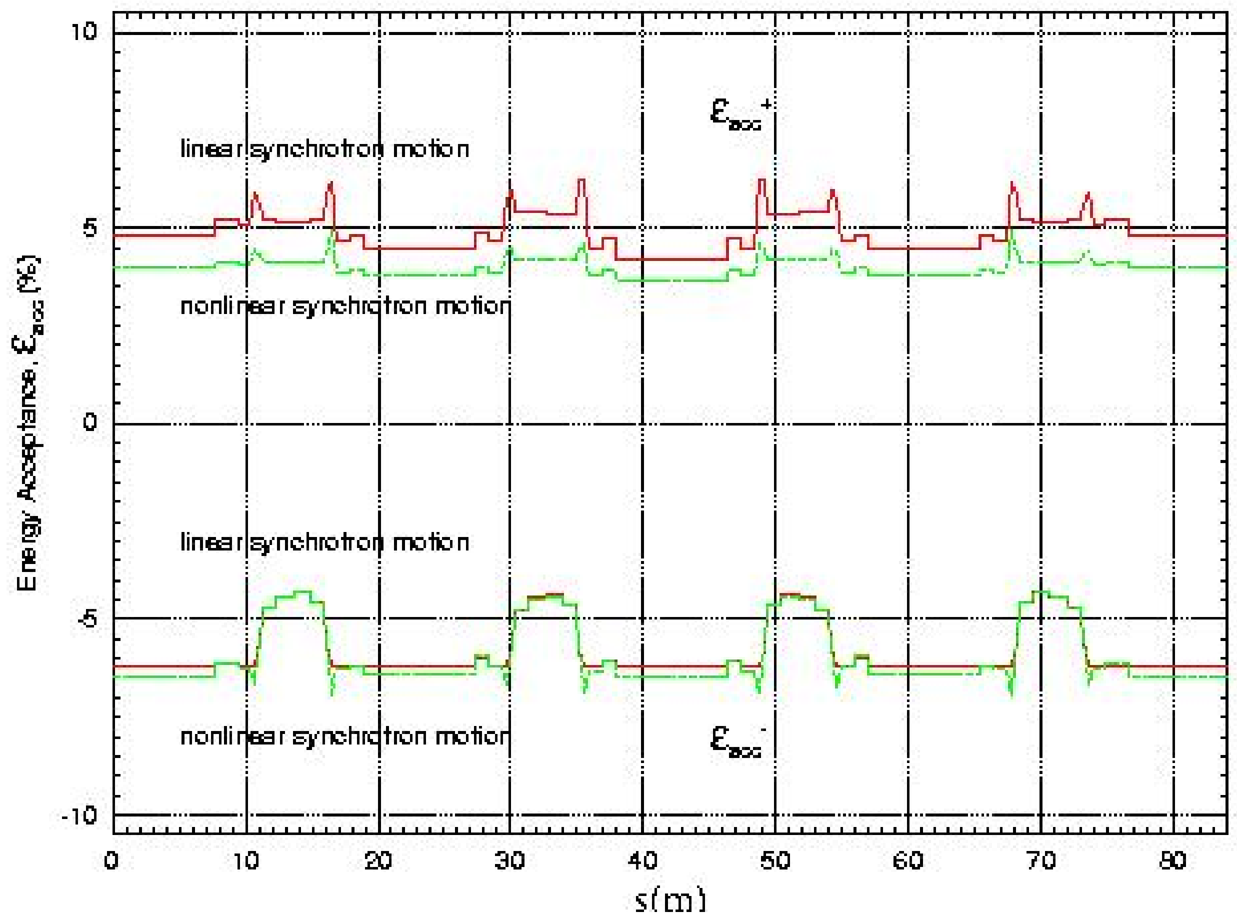
Dynamic aperture for large variation energy

OPTICS: Synchrotron motion



Longitudinal phase space

OPTICS : Energy Acceptance



Energy Acceptance

Main parameters of the storage ring (1)

Energy:	*2.75 GeV*
Circumference:	*354.097m*
Emittance (rms):	*3.73 nmrad*
N. of cells / super periods:	*16 / 4*
Straight sections:	*12m x 4 ; 7 m x 12 ; 3.6 m x 8*
N. of dipoles / Nominal field	*32 / 1.71 T*
N. of quad. / Max. gradient	*160 / 23 T/m*
N. of sextu. / Max. strength	*120 / 320 T/m^2*

Main parameters of the storage ring

Betatron tunes, Q_x/Q_z:	*18.28/10.26*
Natural Chromat. ξ_x/ξ_z:	*- 2.84/-2.23*
Momentum compaction:	*4.38×10^{-4}*
Energy dispersion:	*1.16×10^{-3}*
Harmonic number:	*416*
Radio Frequency:	*352.202 MHz*
RF Voltage:	*4.8 MV*
Energy Loss per Turn(IDs):	*1300 keV*

Main operation modes

- ***Multi-bunch operation***

Beam Current: 500 mA

Beam Lifetime (Coupling factor K^2 =1%): 20 h

- ***Temporal structure***

Beam Current: 8 x 10 mA

Beam Lifetime (Coupling factor K^2 =10%):18 h

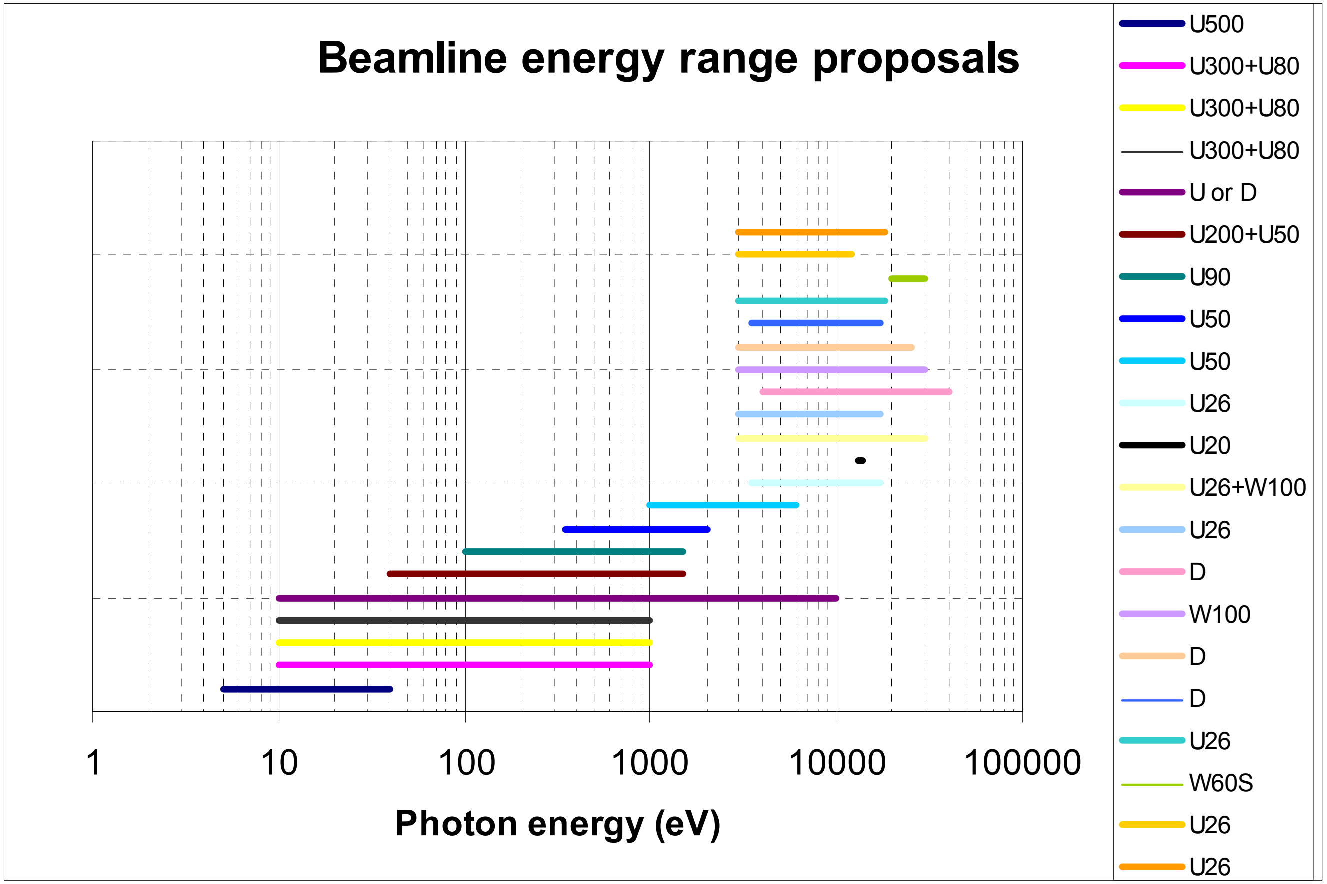
Bunch Length (I= 0) (rms) σ_s :14 ps

Bunch Length (I_b= 10 mA) (rms) σ_s< 30 ps

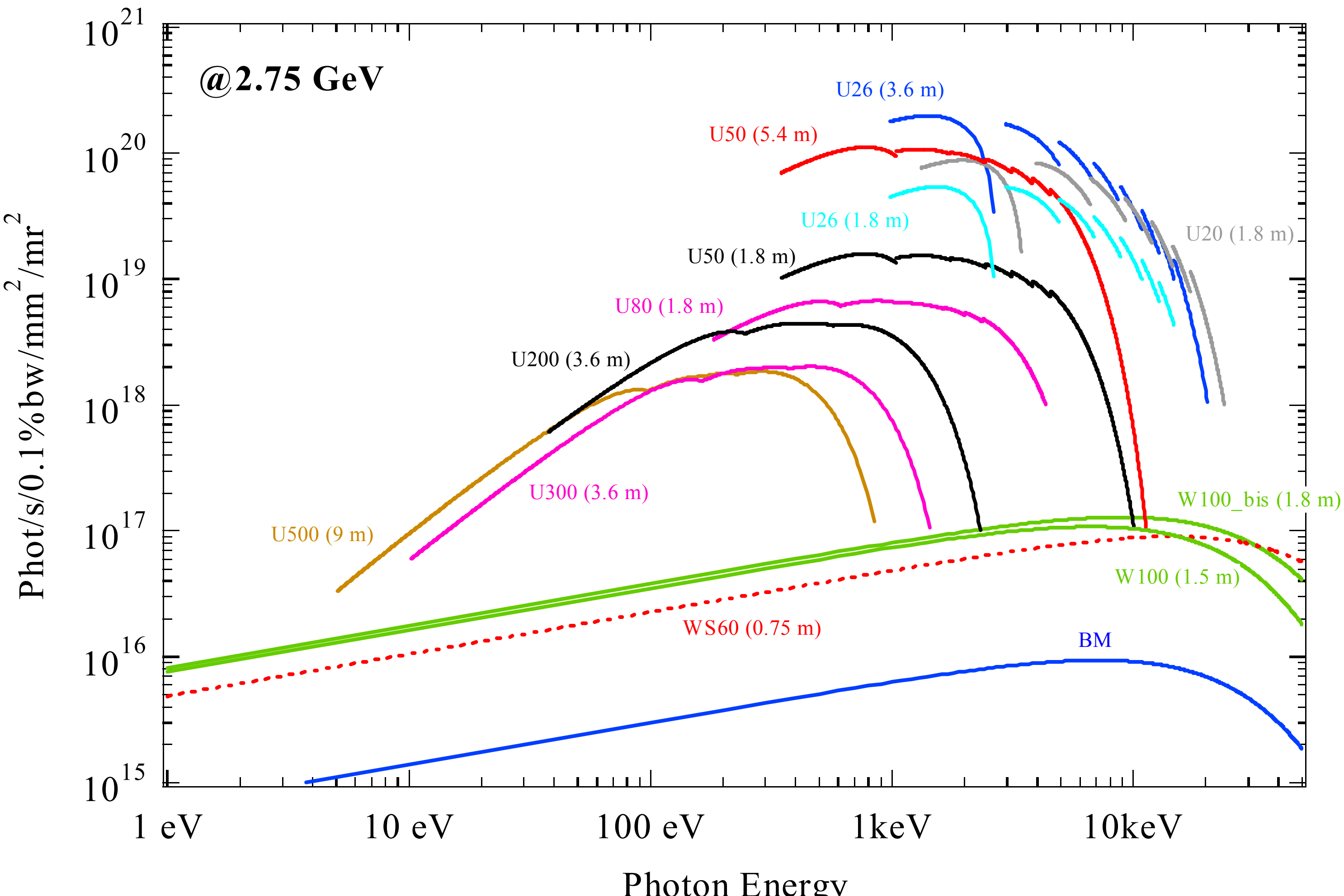
Note: Beam gas and Touschek lifetimes are calculated with the following hypothesis:

- *The pressure is 10^{-9} torr for 500 mA.*
- *The vertical aperture is 13 mm (respectively 8 mm) for an undulator of 6 m long (respectively 3.6 m).*
- *Touschek lifetime is calculated for natural bunch length (σ_s = 14 ps).*

Insertion Devices (1)

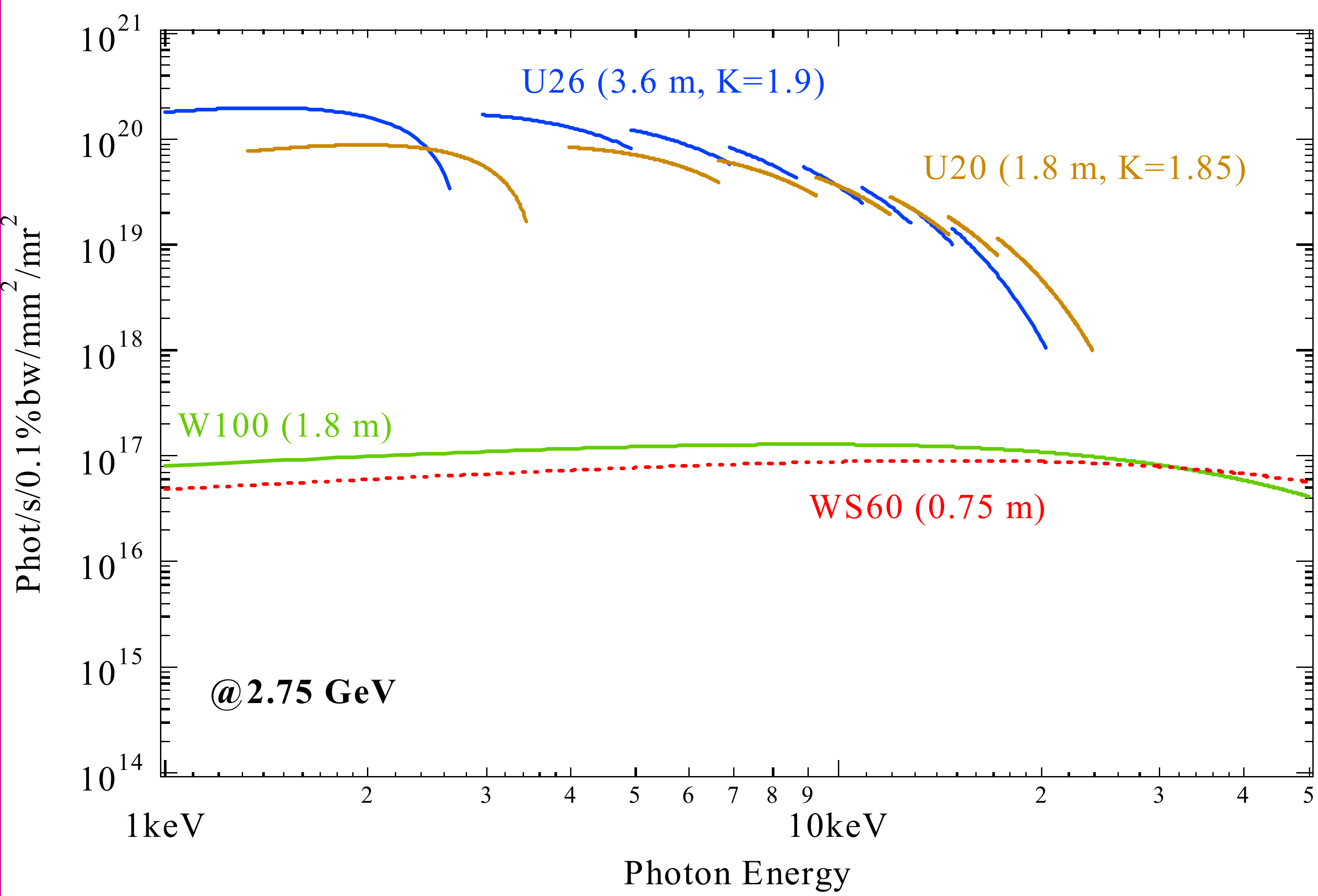


Insertion Devices (2)



Brillance in all the energy domain at 2.75 GeV

Insertion Devices (3)



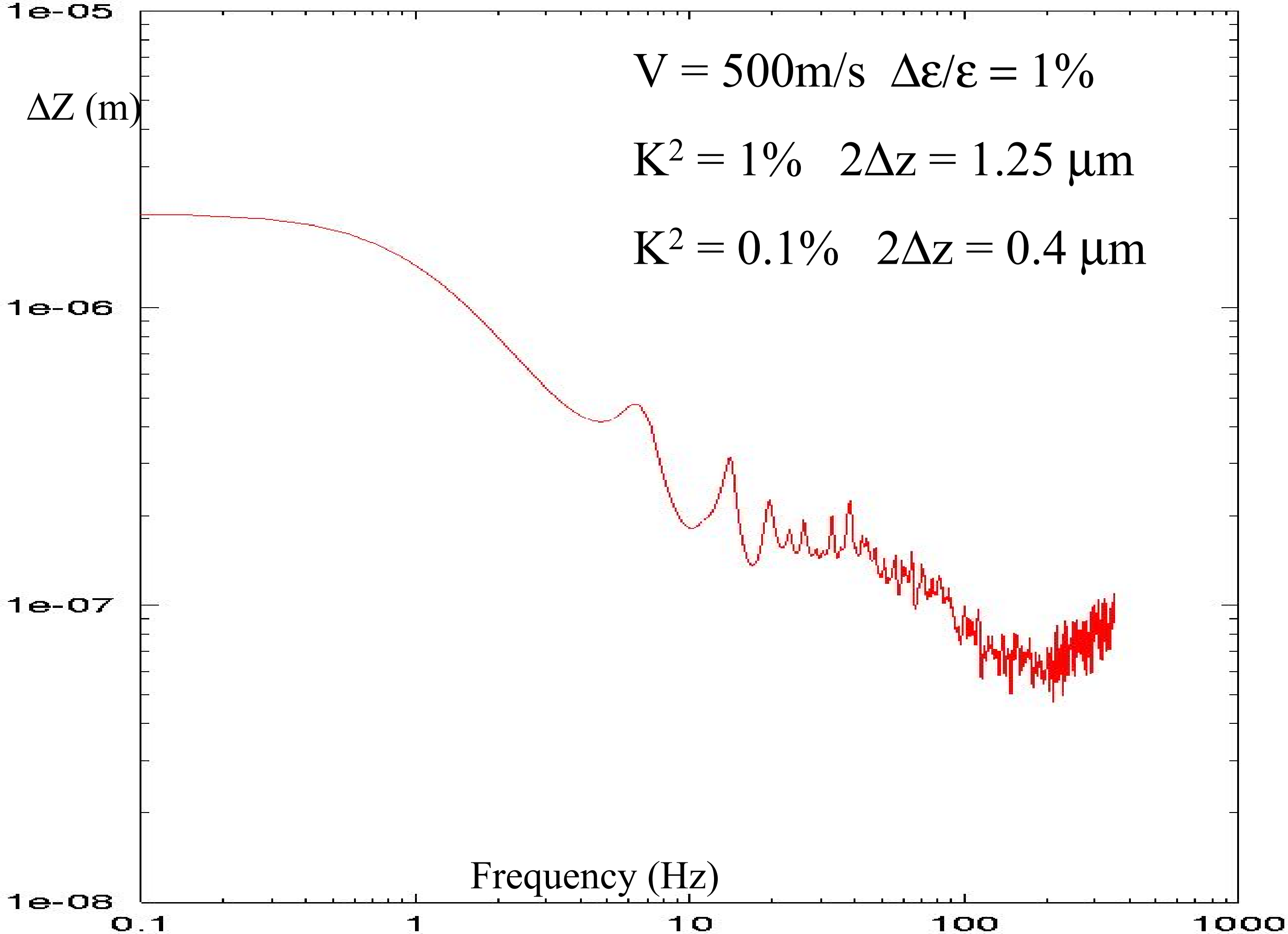
Beam Position stability (1)

Vibrations :

3 campaigns of measurements : sinusoidal noise with in the daytime a maximum elongation peak to peak of 0.35 µm + some accidents of 0.5-0.7µm (planar wave 2.5 Hz).

In the worst case(slow motion versus data acquisition time) and for 1% emittance coupling there is a margin of 1.8 in vertical and 10 in Horizontal.

Beam Position stability (2)



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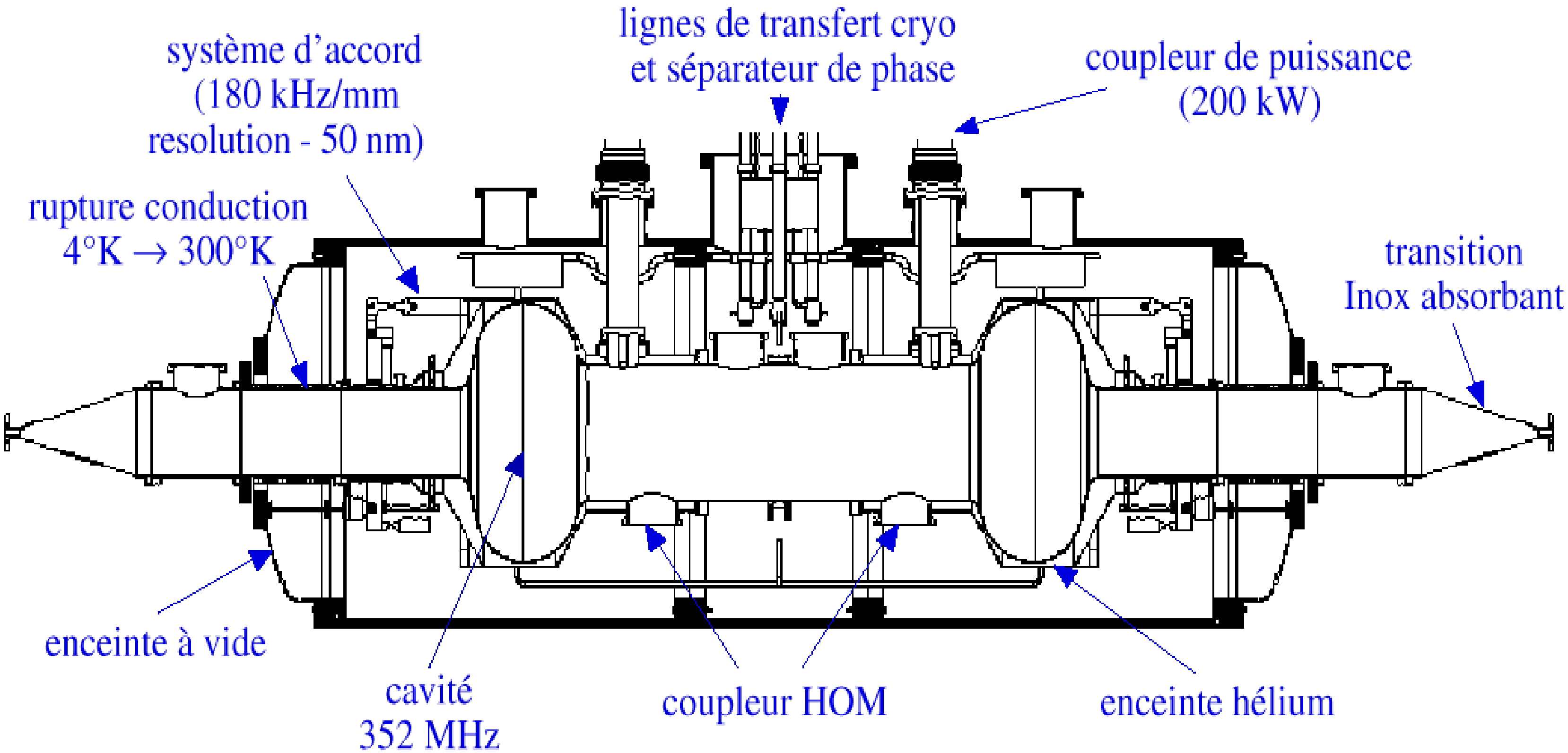
Beam Position stability (3)

These accidents have been identified as waves produced by some kind of public work trucks in correlation with some kind of irregularities of the two adjacent roads (2.5 Hz)

The repair of theses roads and the maintenance of the quality of their surface in the time will get us rid of these vibrations which should guaranty a very good beam position stability.

Longitudinal Stability



WEBLA002 Test on ESRF Ring J. Jacob et Al

New Developments

Different improvements in study :

•Aluminium vessels with NEG coating for all straight parts of the machine (quadrupoles, sextupoles and insertions).

• New type of BPMs (DSP based electronics) better adapted for fast feedback and turn by turn measurements.

•Switching type power supplies with digital regulation loop.

TOP-UP injection: To compensate a lifetime as bad as 4 hours by injecting every 2 min.

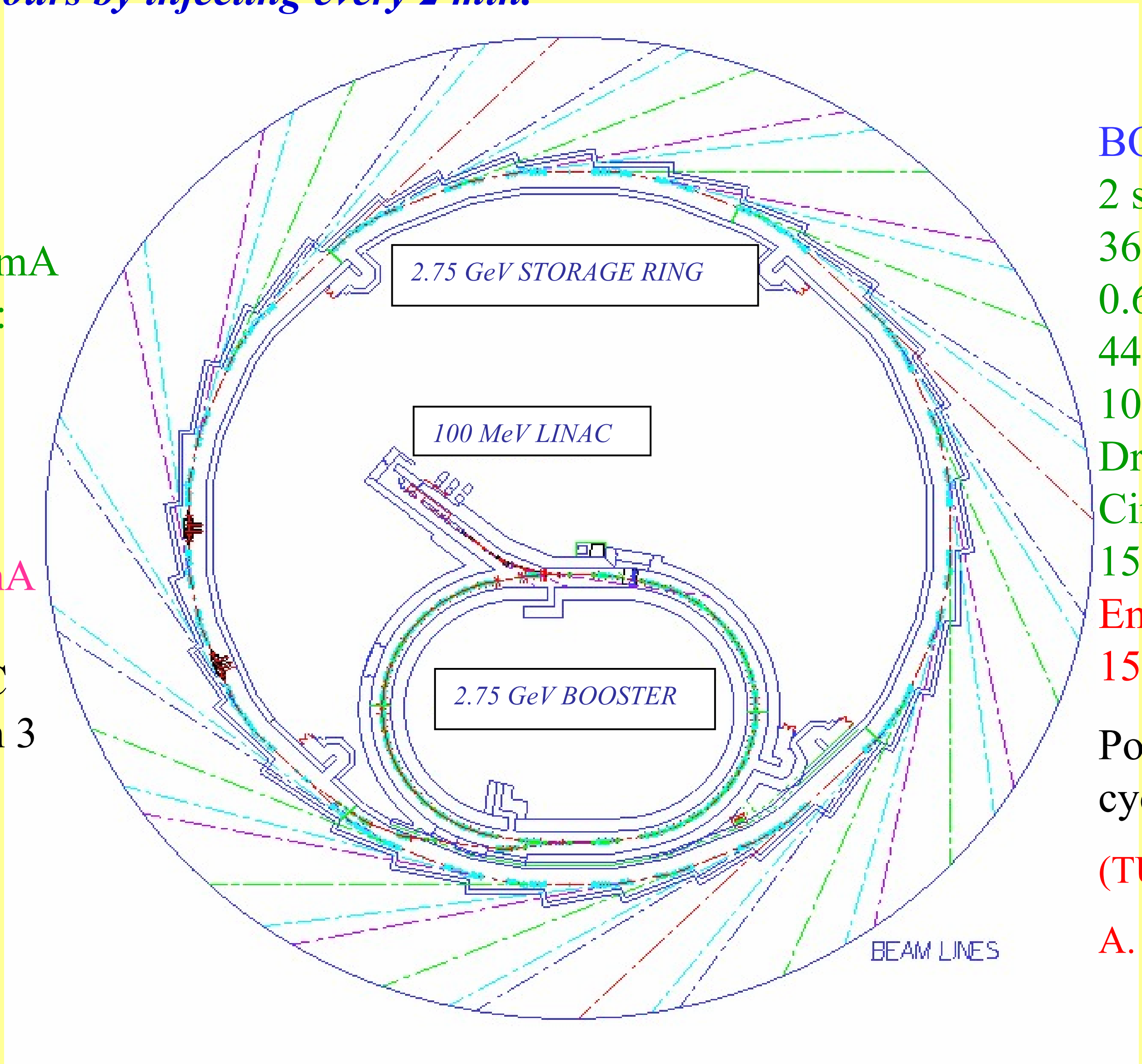
LINAC specif. :

• In multibunch operation (500 mA in 416 bunches):

Output LINAC charge 8 nC in 300 ns

• In temporal structure (100 mA in 8 bunches):

• Output LINAC charge 1.5 nC in 3 bunches



BOOSTER:

2 super periods

36 Dipoles :

0.67 T / 2.17 m

44 Qpoles:

10.3 T/m/0.4 m

Drifts: 3.17 m

Circumference: 157 m

Emittance: 150 nm

Power supplies cycling at 3 Hz

(TUPRI096)

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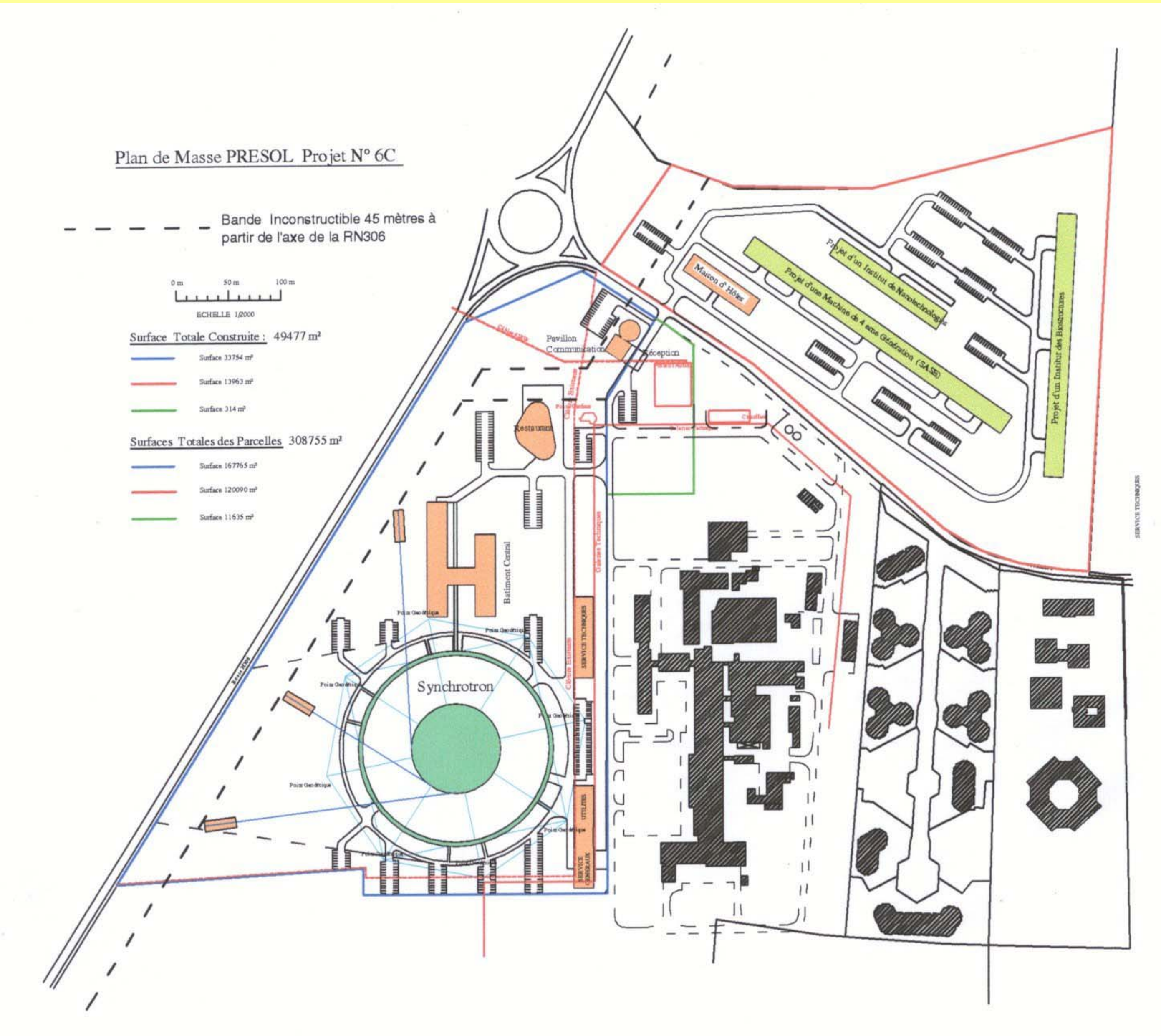
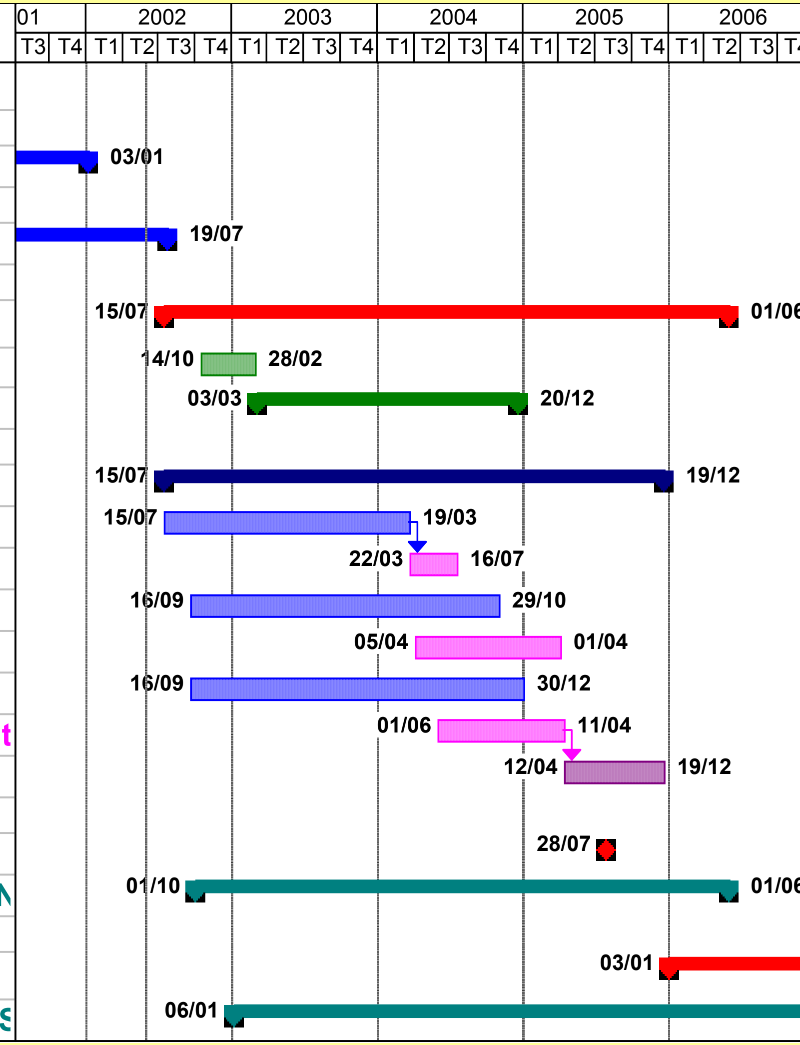

Plan de Masse PRESOL Projet N° 6C
Bande Inconstructible 45 mètres à partir de l'axe de la RN306
0 m 50 m 100 m
ECHELLE 1/2000
Surface Totale Construite : 49477 m²
Surface 33754 m²
Surface 13963 m²
Surface 314 m²
Surfaces Totales des Parcelles 308755 m²
Surface 167765 m²
Surface 120090 m²
Surface 11635 m²
Pavillon Communication
Réception
Restaurant
Batiment Central
Synchrotron
SERVICE TECHNIQUES
UTILITES
Maison d'Hôtes
Projet d'un Institut de Nanotechnologie
Projet d'une Machine de 4 eme Génération (SASE)
Projet d'un Institut des Biostructures

GENERAL PLANNING

Nº	Nom de la tâche
1	**DECISION TO BUILD SOLEIL**
2	
3	**SOLEIL PRIVATE COMPANY CREATION**
13	
14	**UPDATING DESIGN (APD finalising)**
18	
19	**PHASE 1 : Construction**
20	Landscaping and excavation
21	**BUILDINGS CONSTRUCTION**
26	
27	**MACHINE CONSTRUCTION**
28	**PRE-INJECTOR construction**
29	**PRE-INJECTOR installation and tests**
30	**BOOSTER equipment construction**
31	**BOOSTER installation and tests**
32	**STORAGE RING construction**
33	**STORAGE RING installation and equipment**
34	**STORAGE RING commissioning**
35	
36	**FIRST PHOTONS ON BEAMLINES**
37	**Construction and Commissioning of 10 BEAMLIN**
46	
47	**PHASE 2 : Operation and Construction**
49	**Construction and Commissioning of 14 BEAMLINES**



EPAC 2002

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BUDGET

The total cost was reevaluated leading to an investment cost of 207 M€ of which 59 M€ for the accelerators and sources.