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mail



The Accelerator

Outline

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- Introduction
- Thom-X layout
- Linac
- Transfer line
- Ring
- Some beam dynamics

Introduction

Thom-X is a light source based on Compton Back Scattering (CBS)

Thom-X target is a high AVERAGE flux so we need many electrons and photons colliding in a small volume at high frequency

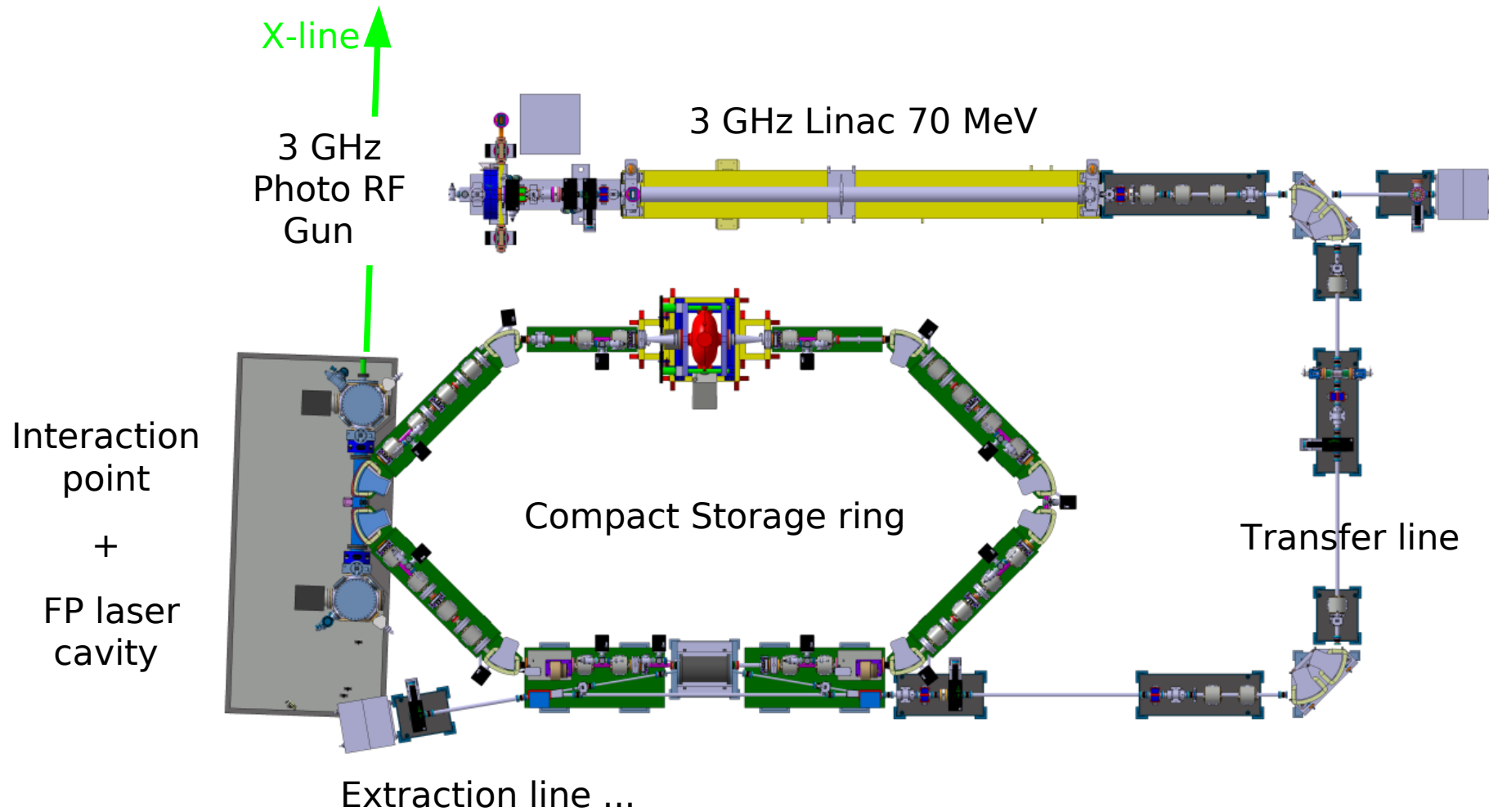
Solution based on a low rep. Rate RF-Gun + warm linac + Compact Storage Ring is adopted

- High rep. Rate by electron bunch storage**
- “Standard” sub-components**
- No deep R&D ... Know-how in place ...**

**Target 10^{12} - 10^{13} average flux up to 90 KeV
1 nC versus 25 mJ @ 20 MHz**

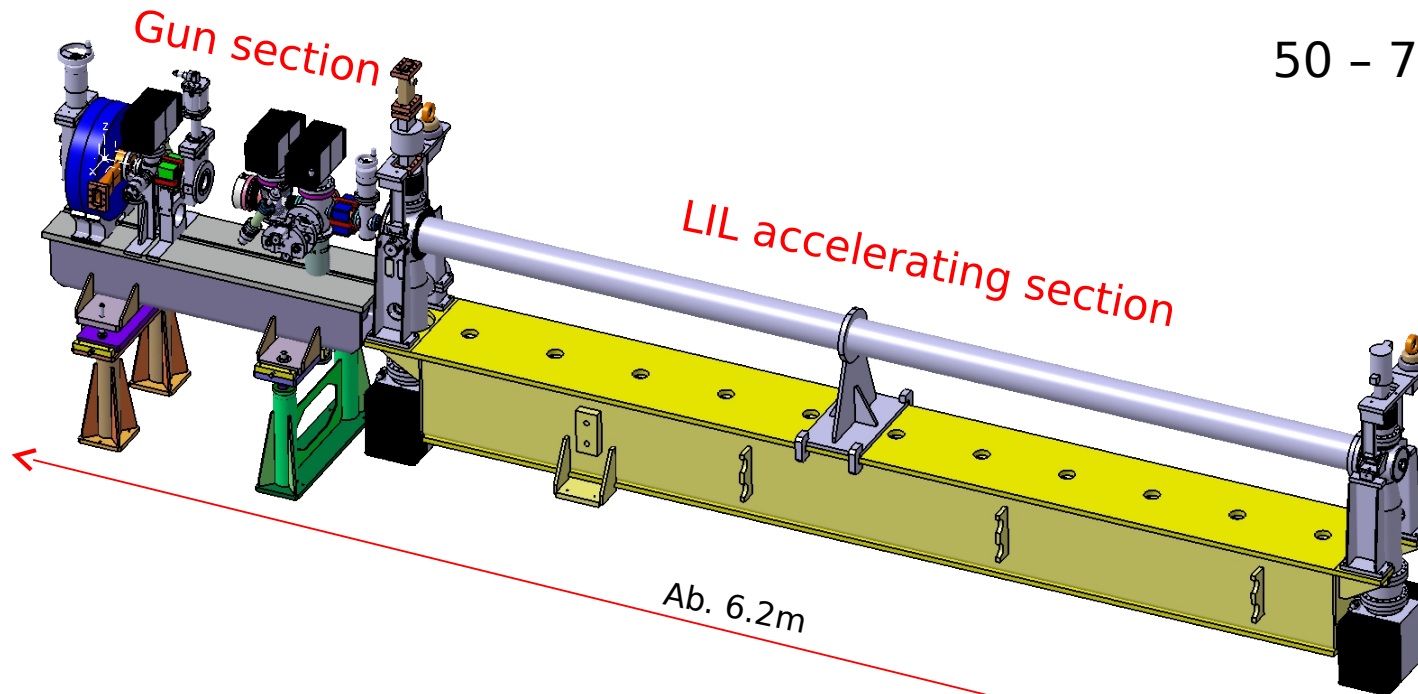
Thom-X is a demonstrator

Thom-X layout

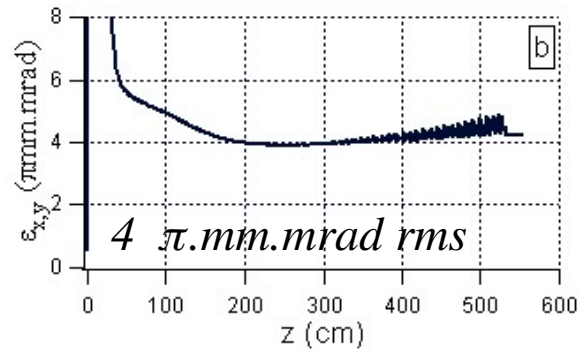
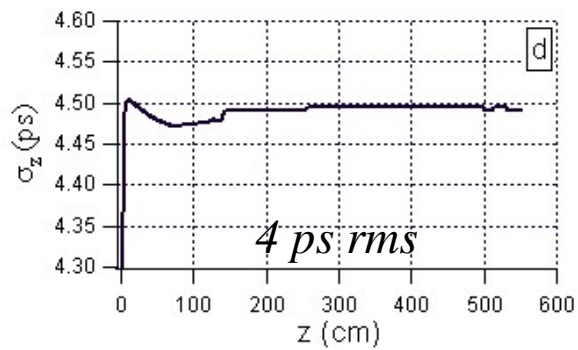


LINAC

50 - 70 MeV 50 Hz



1 nC

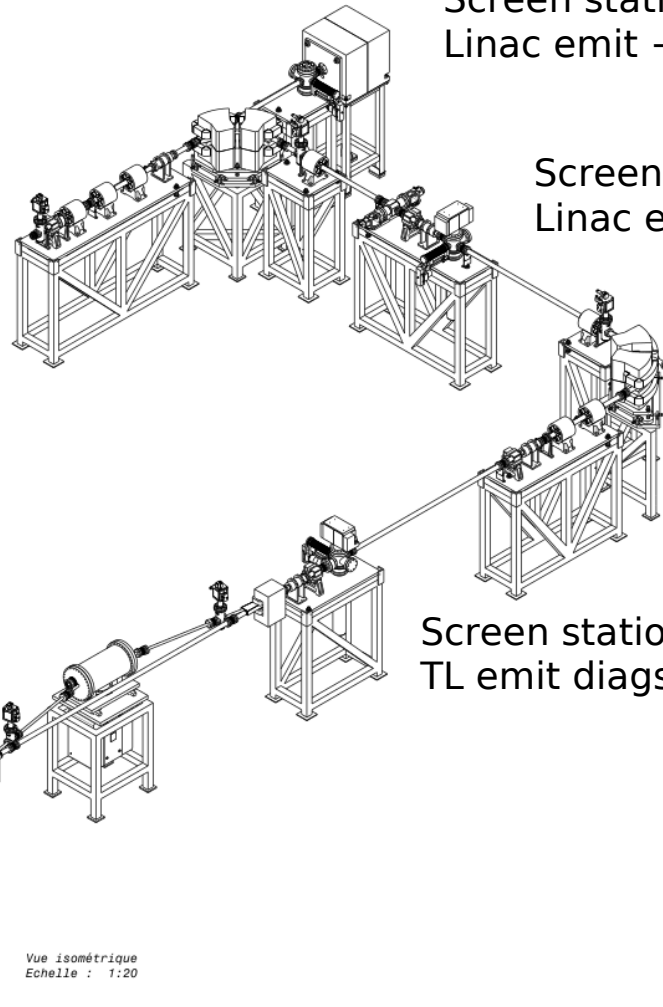


More on R. Roux talk

Transfer line

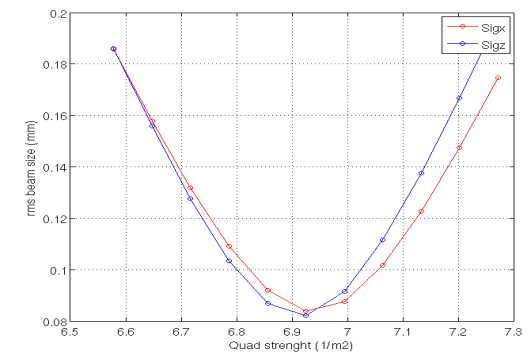
To transfer, match and diagnose the linac beam.

- 4 dipoles (45°)
- 7 quads
- # correctors

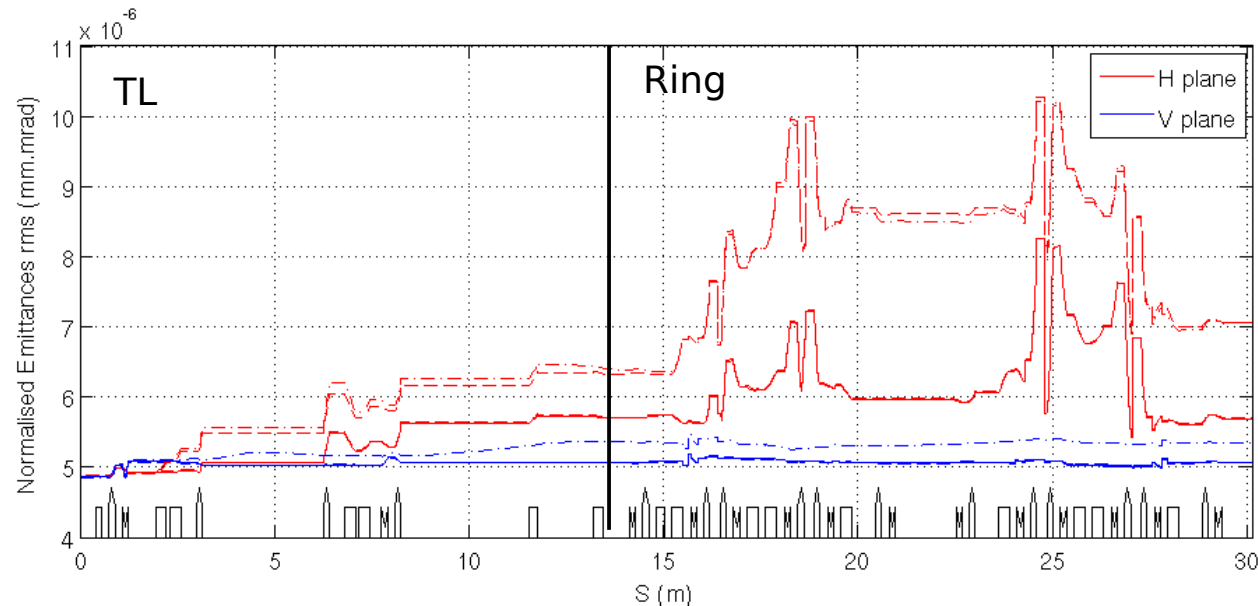


More on M. Labat talk

Quad scan



Transfer line optics



1 nC / 50 MeV
Eps = 5 mm.mrad
4 ps rms

— Chromatics effects
- - + CSR
· · · · + SC

~Versatile optics

- Matching # Linac to # ring optics
- Matching the diags

Others

- Low H function
(Emit increase limited to ~20 %)

The ring layout

2 fold symetry / 16.8 m Circ.

**2 possible IP accommodated
in arcs in between dipoles**

2 free straight sections :

→ Inj / Extr

→ RF & Feedbacks

8 dipoles (45°)

24 quads

12 sextupoles

12 correctors

And :

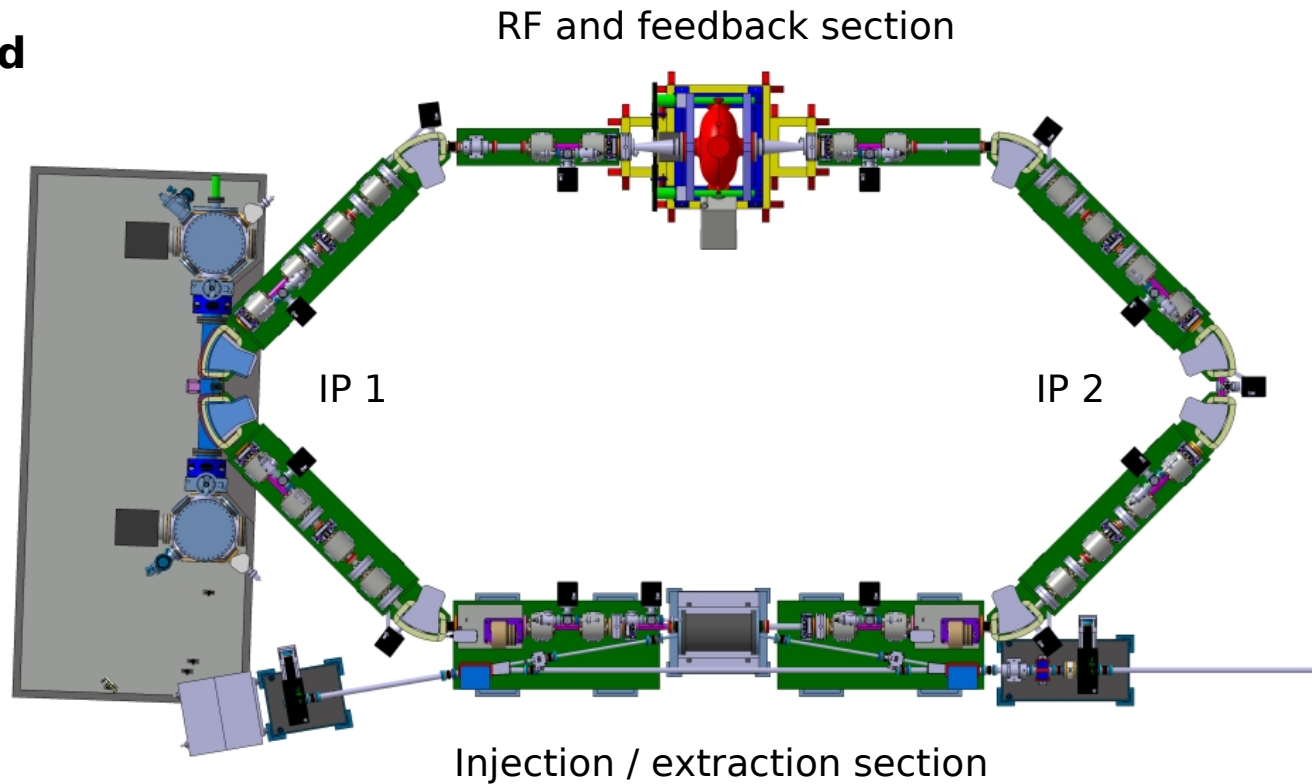
Button BPMs / Light port

Vac. Chambers / Belows

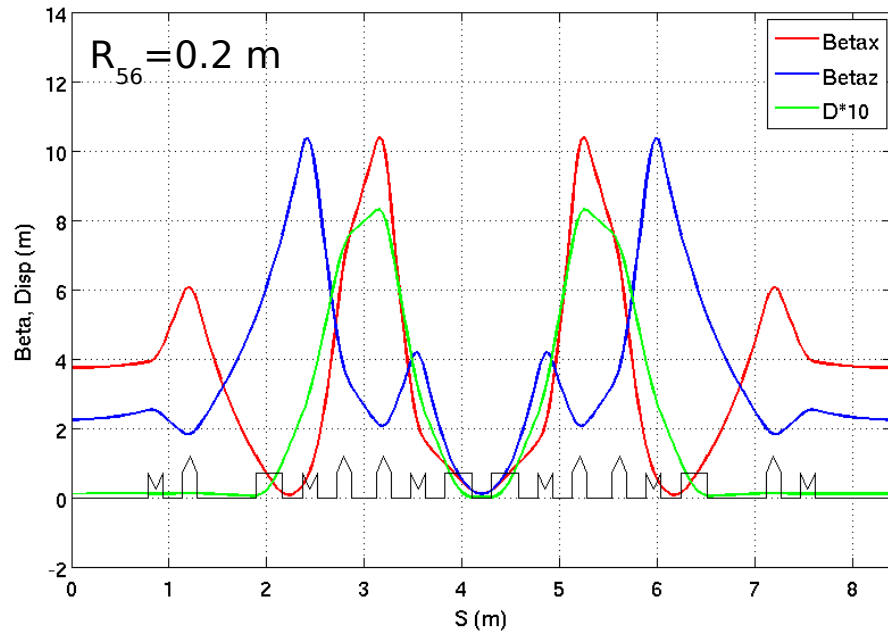
Pump ports

Support / Alignment

Etc ...

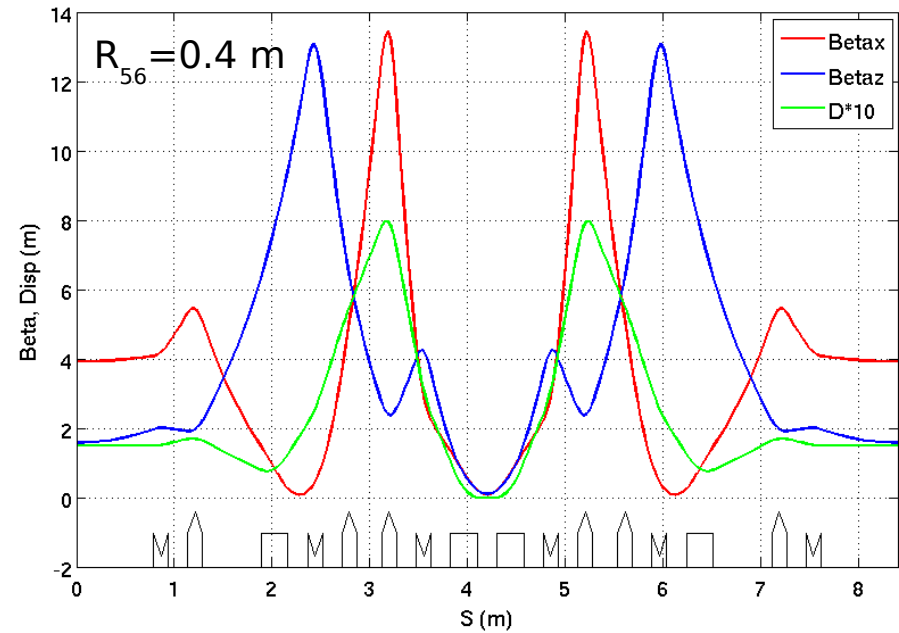


The ring optic



Versatile optics

- Working points
- Momentum Compaction Factor



Others

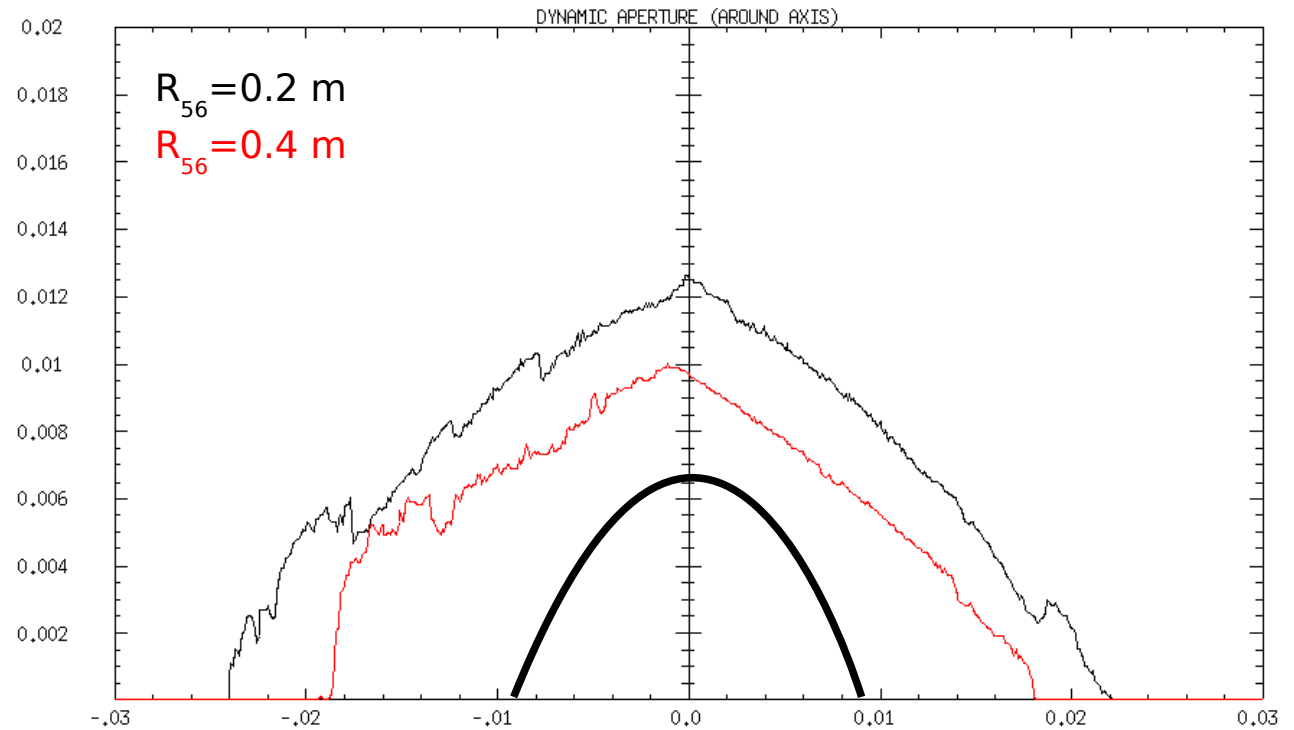
- Low H function
- Beta = 10 cm @ IP

The ring dynamics

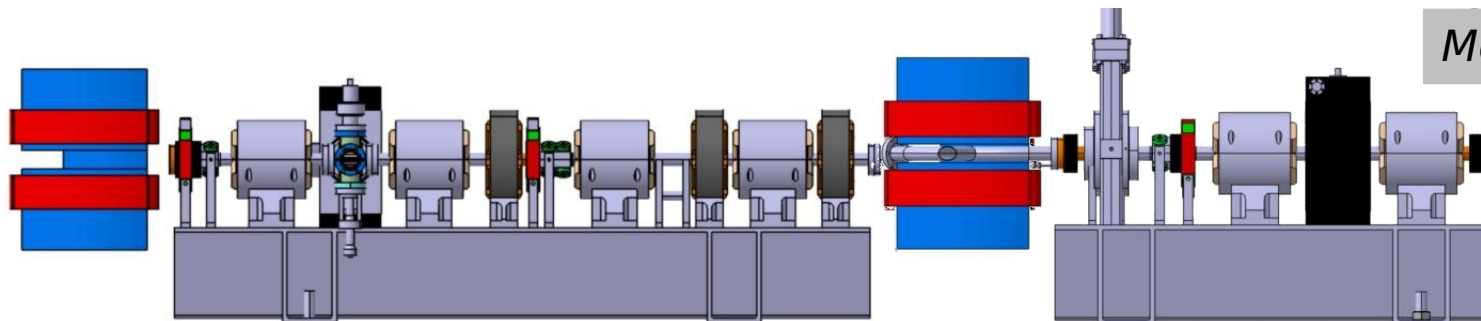
Dynamics Aperture at ring entrance

Thin sextupole + quadrupole fringe field

Other magnets multipoles under way ...

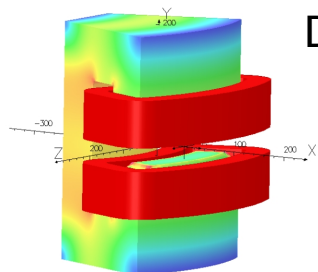


The ring dynamics / Magnets

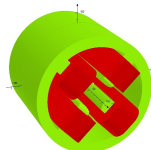


More on A. Gonnin talk

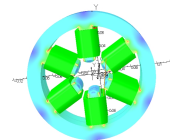
Compact integration



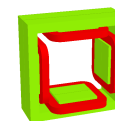
Dipole



Quad

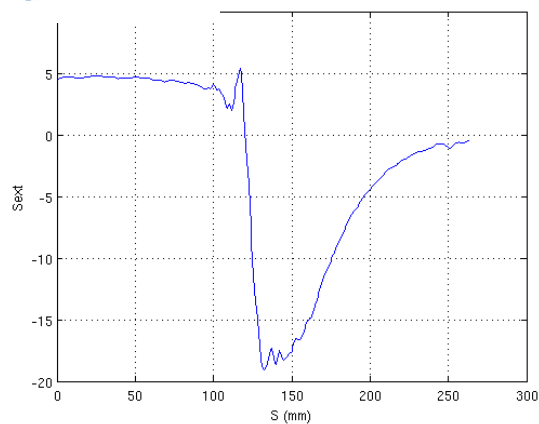


Sext



Corr

TOSCA 3D modelling



Dipole strong multipoles ...

More on F. Marteau talk

More on C. Bruni talk

The ring dynamics

Without low energy and any damping, the ring beam dynamics is much more delicate :

- 1) Injection miss steering & jitters** **tour 1**
- 2) Transition time : strong collective effect** **~ first 1000 turns**
- 3) Storage time : HOM + other collective effects** **over 20 ms**

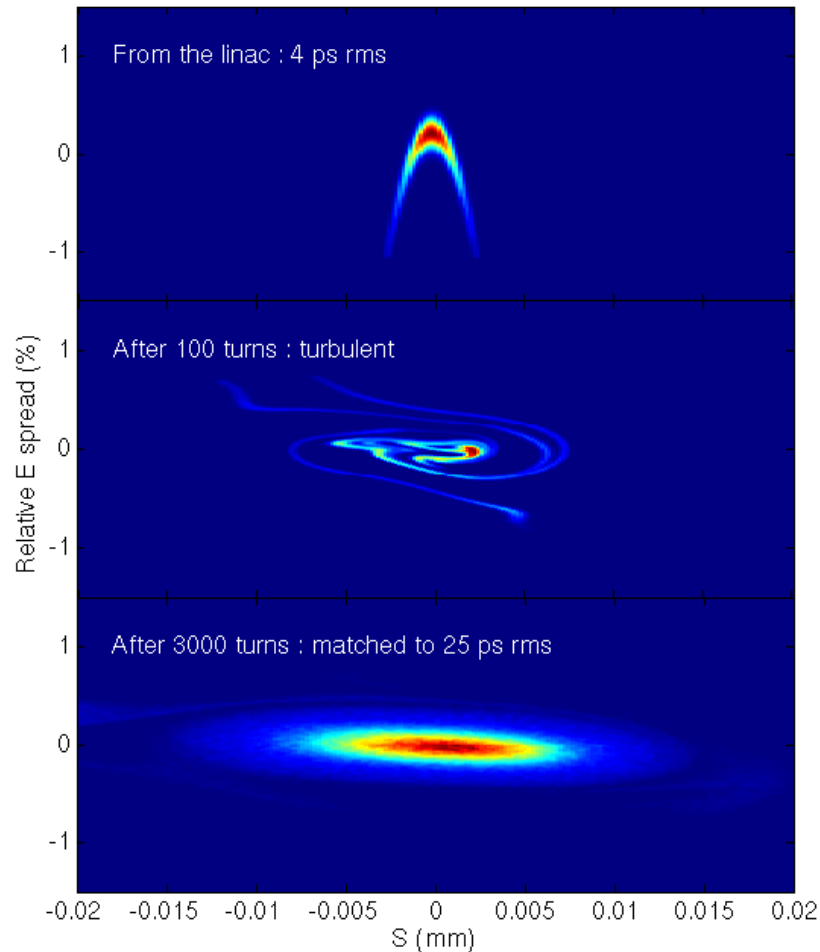
**Investigation off beam dynamics / impedances
Feedback systems H & V & L
Synchronisation scheme**

Also a matter of reliability and stability

==> To preserve the high flux !

The ring dynamics

1 nC – 50 MeV



Typical longitudinal shape from the linac

Strongly mismatch in the ring
Undergoes “turbulent” dynamics
Strong collective effects

Strong Needs: Position feedback in the 3 planes

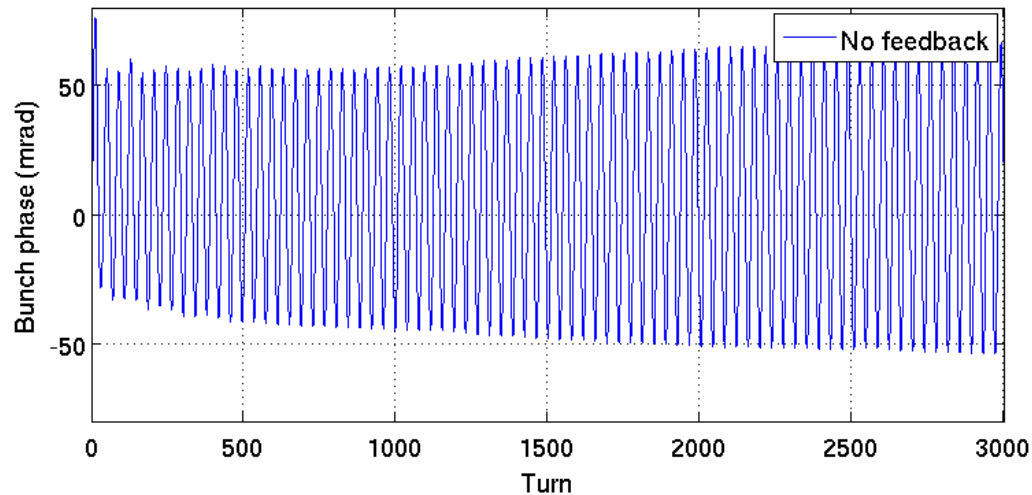
Side effects : Horizontal emittance increase

Main risk : To brake the bunch / losses

Finally reach a ring matched form
Still subject to some head tail effects

Longitudinal feedback

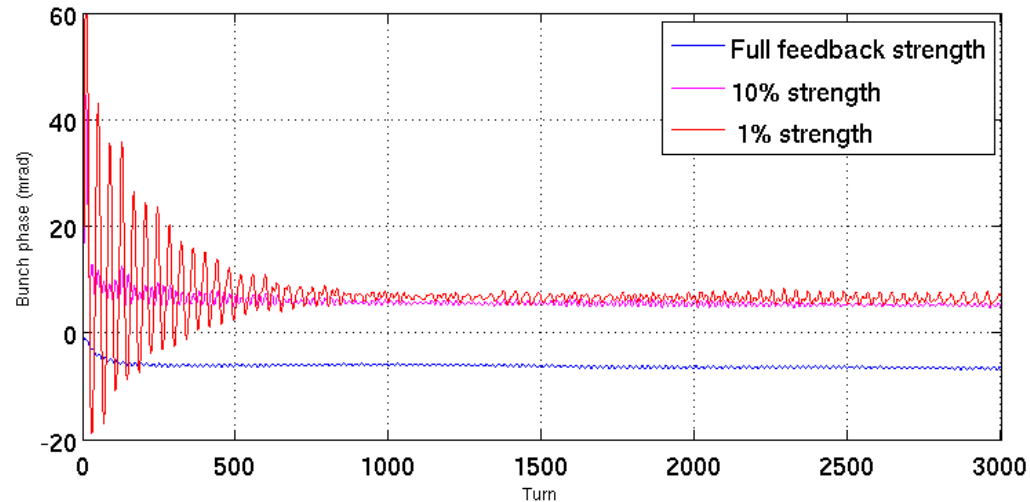
1 nC - 50 MeV



No damping

Strong Wakefield at injection

==> Strong oscillations



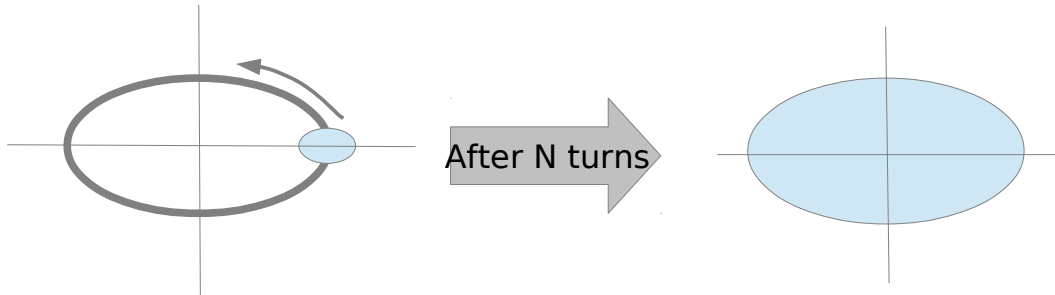
Phase Feedback on

Damping $< 50 \mu\text{s}$ (1000 turns)

Operate at ~ 400 kHz (center of mass)

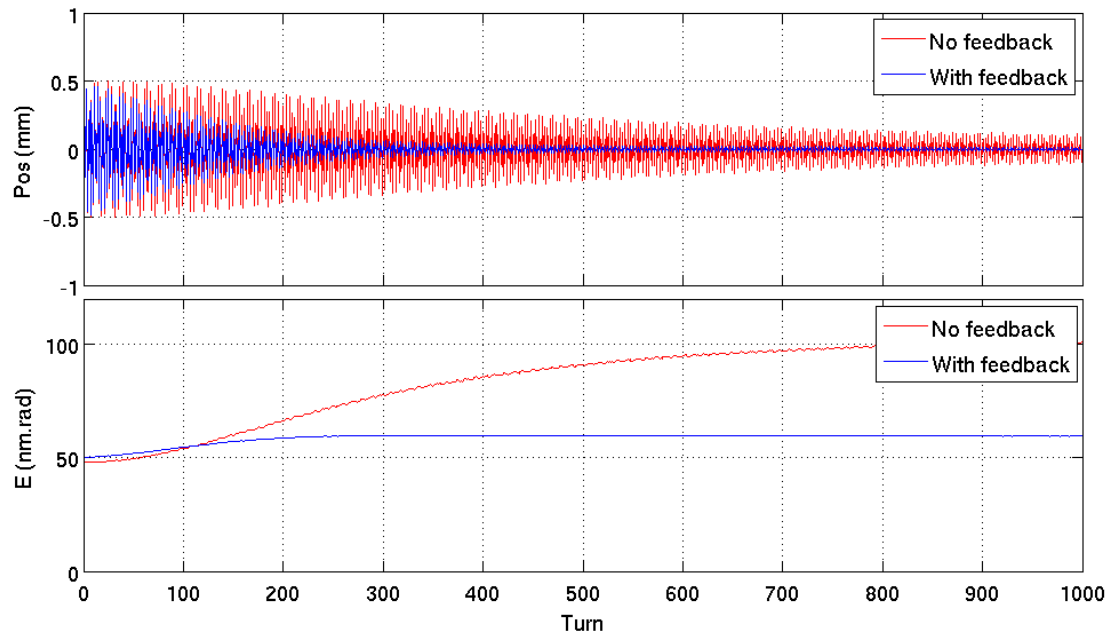
Possible at or ~ 800 kHz (quadrupole mode)

Transverse feedback



No damping

Filamentation = emittance increase



Miss steering of 0.5 mm

==> Emittances * 2

==> ~ 500 turns / 25 μ s

Feedback :

==> Emittances * 1.1

==> 2 μ rad / 20 MHz

==> Tau damping ~ 5 μ s

Transverse impedance

1 bunch 1 nC / 20 mA 25 ps rms

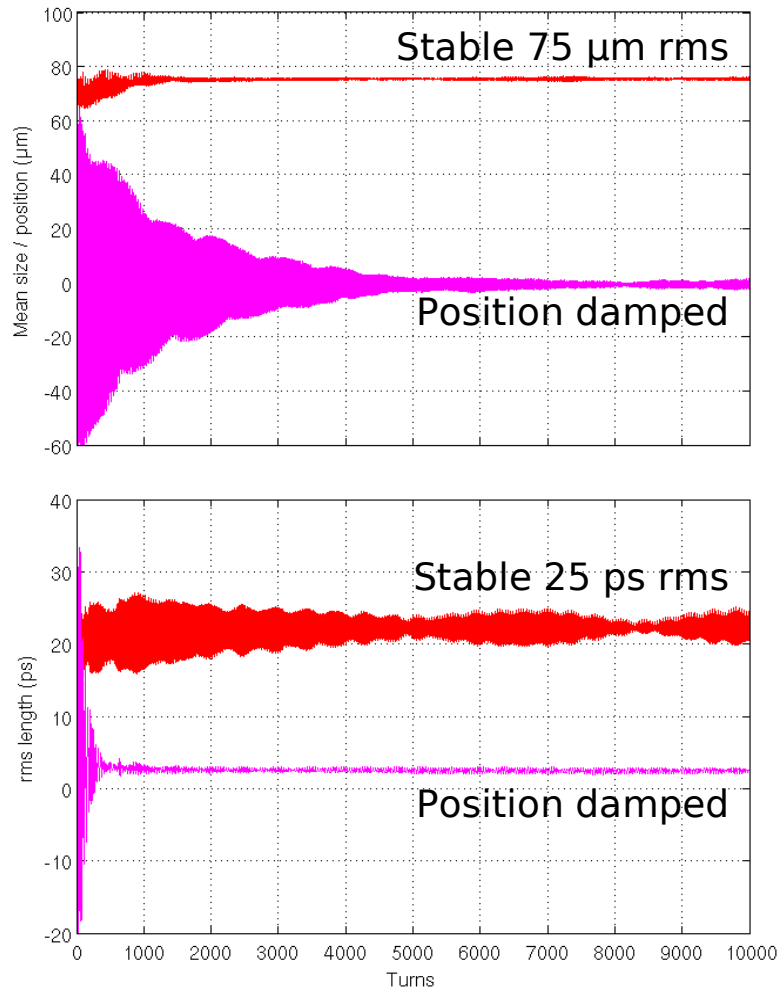
RN estimations ...

Source	Type	Growing time τ	Kicker strength $\Delta x'$
Beam pipe geometrie	TMCI Head-Tail	- 160 μ s	>10 nrad
RW		600 μ s	> 2 nrad
Ions		< 100 μ s	>20 nrad

Jitter - 5 μ s 2 μ rad

==> FBT Dominated by injection jitter source

Introduction



6D tracking over 0.5 ms (10000 turns)
1nC / 50 MeV + Coll. Effects & feedback

Get stabilized over $\sim 50 \mu\text{s}$ (1000 turns)

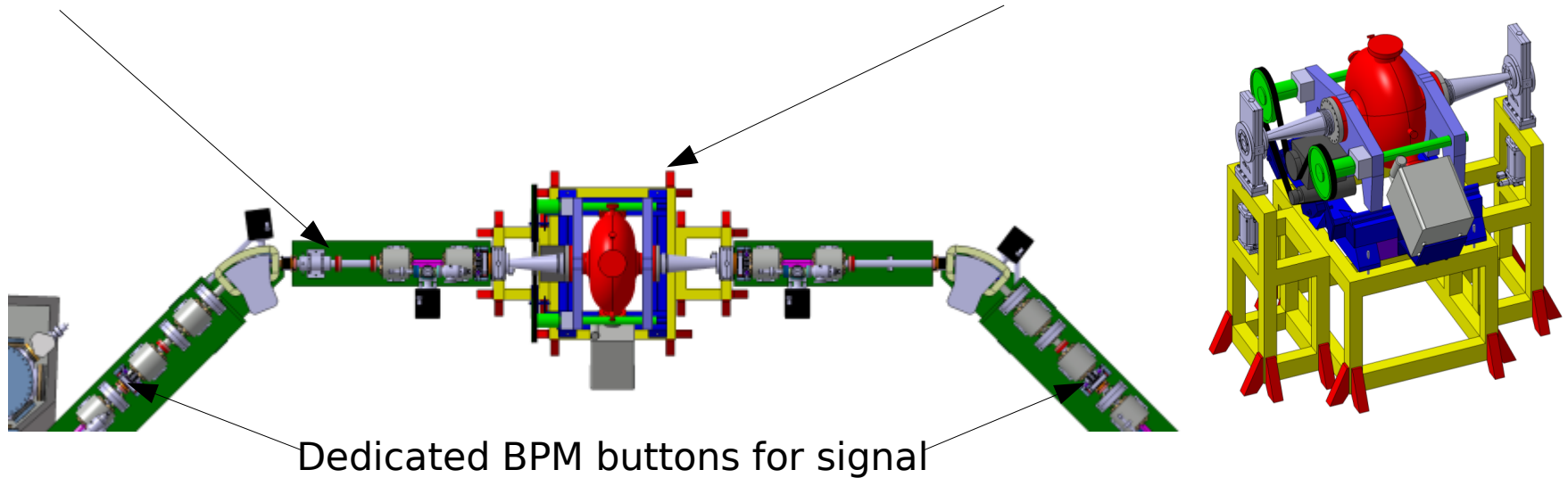
Others long terms effects up to few 10 ms :
CBS & IBS
Smoothly enlarge emittances & E-spread

More on C. Bruni talk
I. Drebot talk

RF & Feedbacks

Strip-line Feedback
Both planes H & V

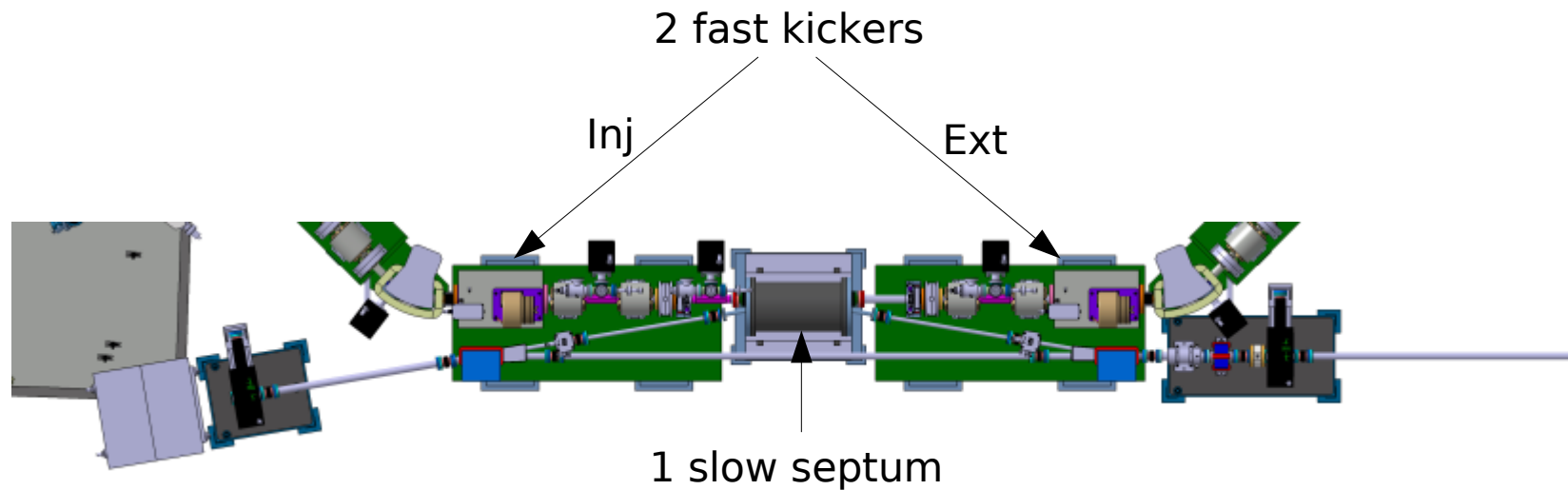
500 MHz RF / HOM tuning
Dedicated Long. feedback



More on R. Sreedharan talk

More on P. Marchand talk

Injection / Extraction scheme



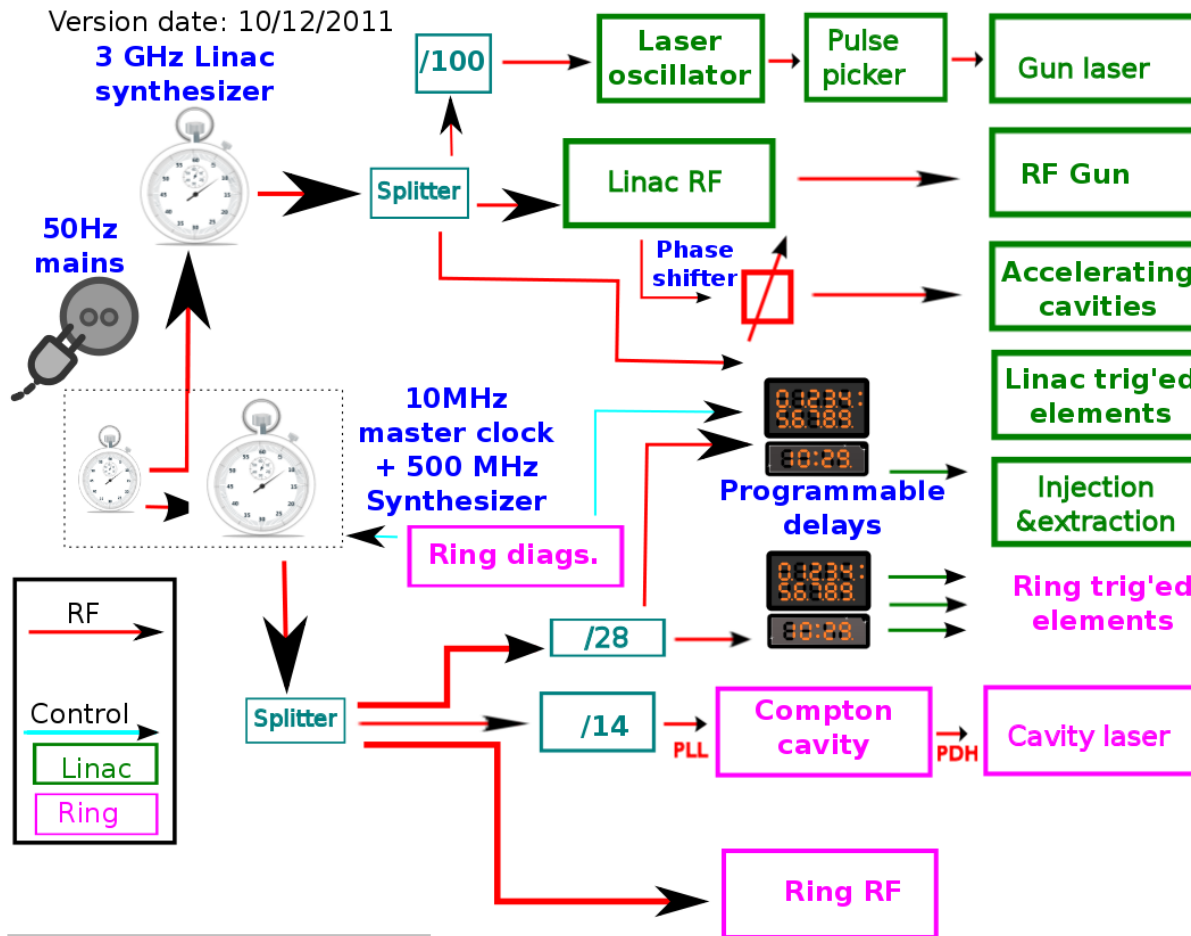
Septum : symmetric & double pass

Kicker : very fast ~ 50 ns

Extraction : to prevent from X-ray pollution + activation

More on P. Lebasque talk

Synchronisation scheme



To ensure linac to ring injection timing

To ensure laser pulse synchronisation in FP cavity

To ensure electron vs laser collision at IP

To compensate ring circumference drift

Other triggering :

Diags / Pulsed elements /

X_lines / etc ..

From N. Delerue

End !

Other points :

- **Vacuum vs ion effects**
- **Impedance calculations**

- **IGLOO Integration**
- **Radio safety**

- **Command controls / Electronics**
- **Commissioning tools !!**

- ...