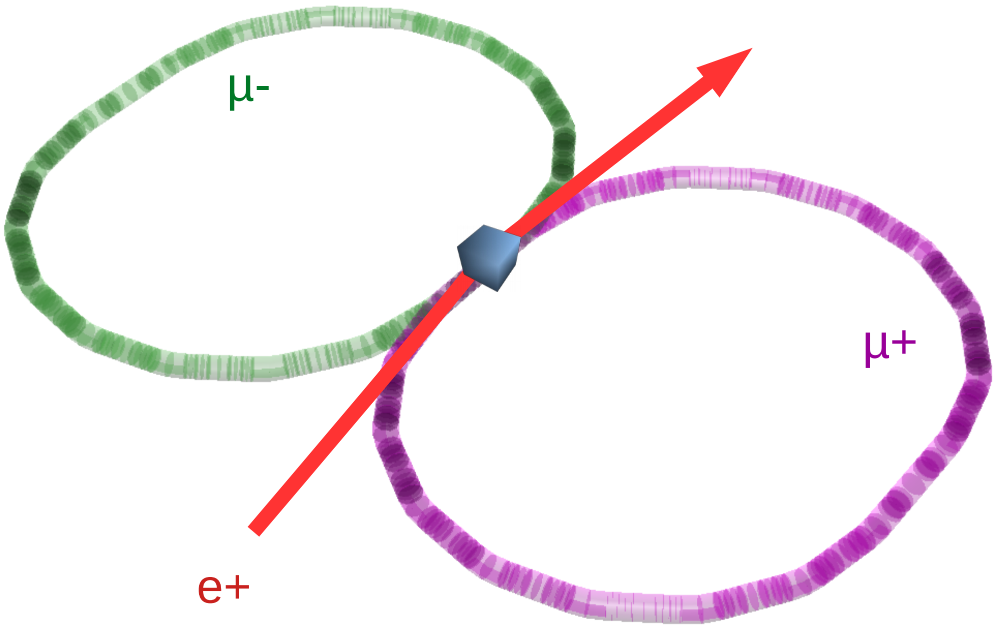
Muon Accumulator Rings

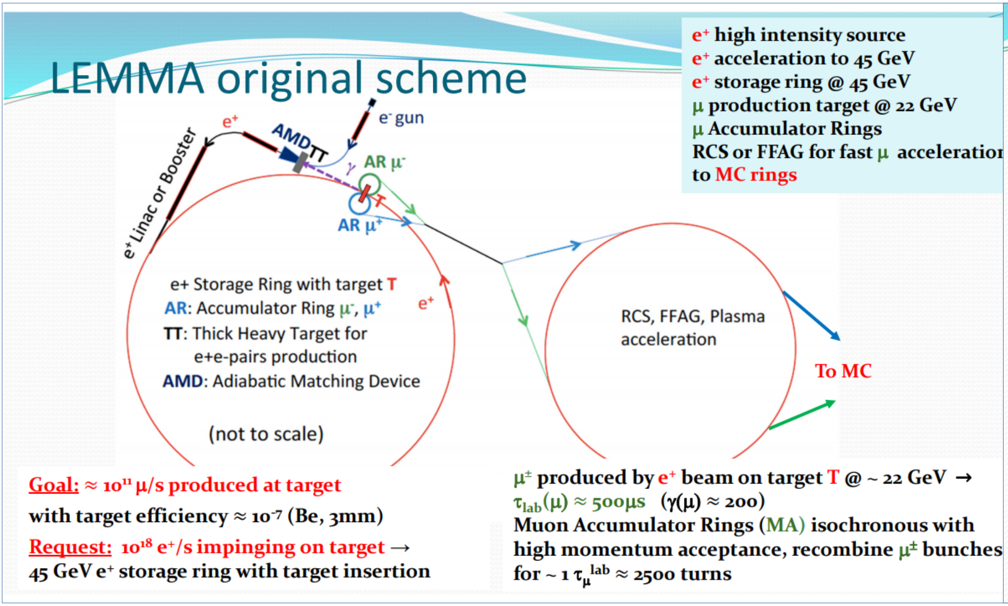


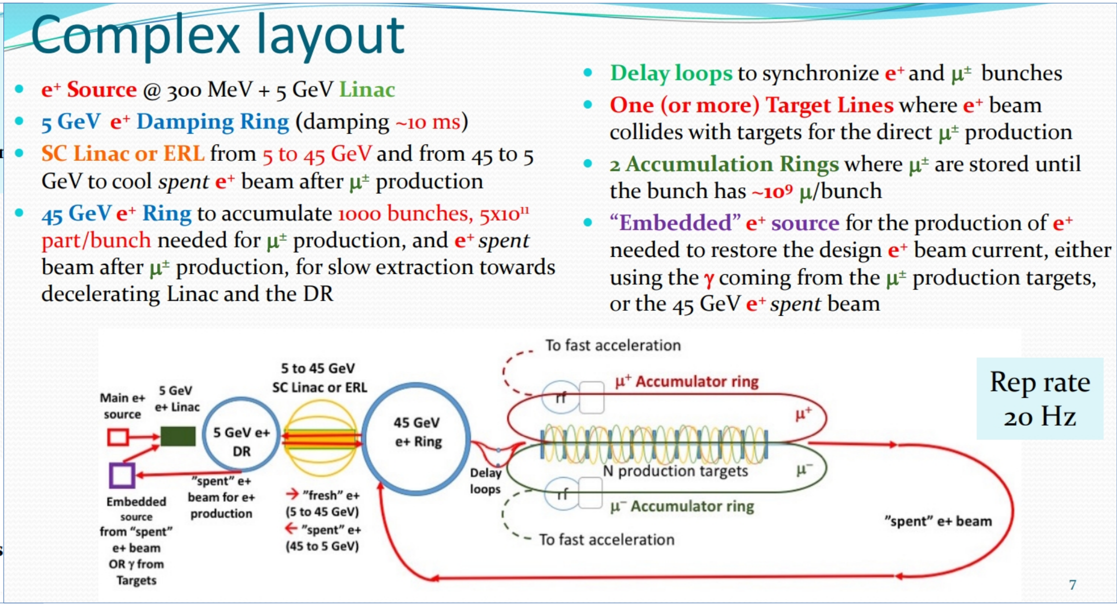
Oscar BLANCO

LEMMA

M. Antonelli. et al. Novel proposal for a low emittance muon beam using positron beam on target. NIM A 807 (2016) 101

Muon production from positrons impinging on target



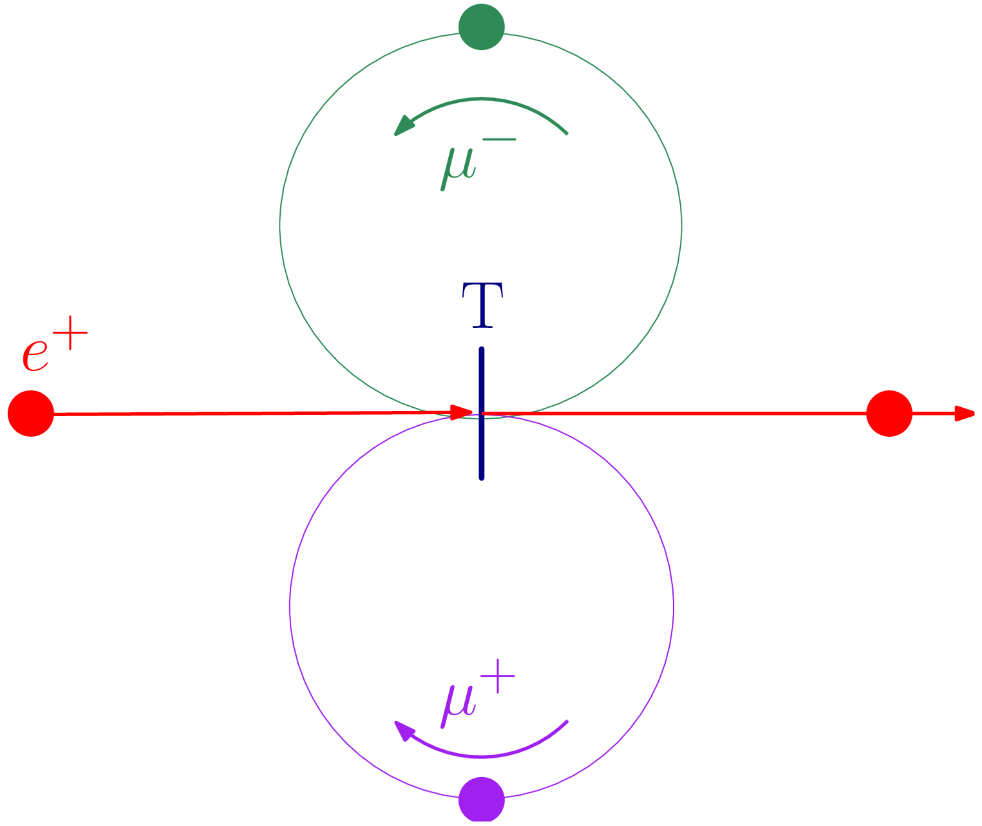


M. Biagini,et al. IPAC19. MOZZPLS2, Positron Driven Muon Source for a Muon Collider: Recent Developments

Several schemes are currently being studied

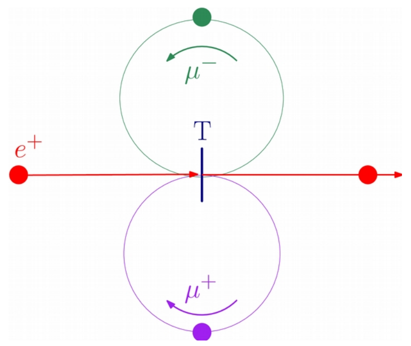
Muon Accumulator Rings

The muon accumulator rings collect and recirculate the muons produced on every positron bunch passage, increasing the muon bunch intensity



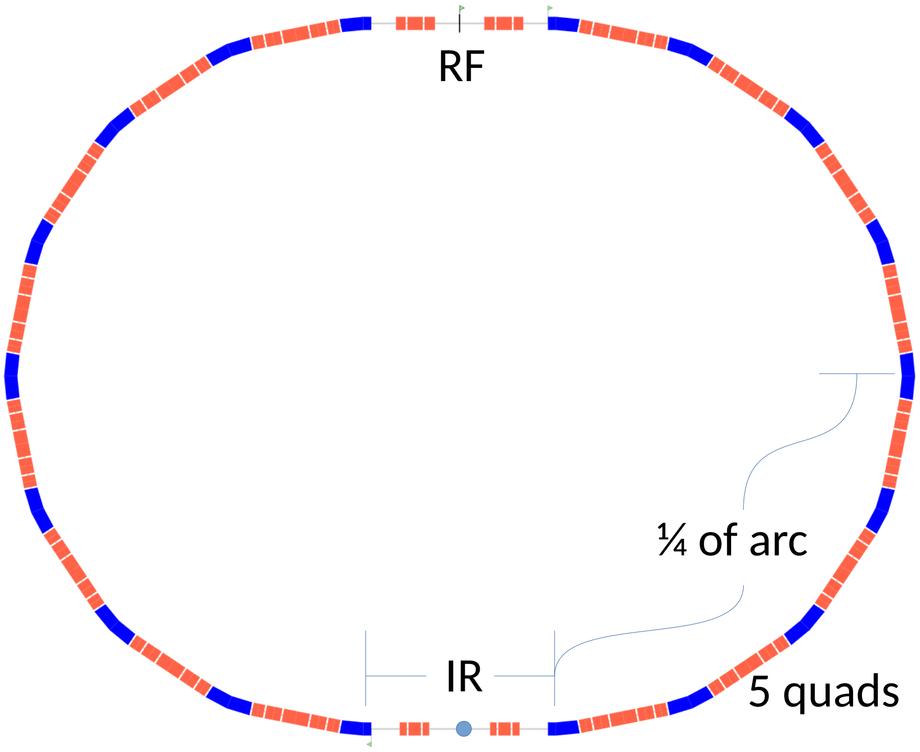
Requirements 2018 and status 2019

	Required 2018	**Optics Design Status**	
Small Length	60 m	150 m (x2.5)	To mitigate muon decay
Large Dynamic Ap.	±20%	±10%	Production efficiency and energy spread are proportional
Low ß*	According to target length	1.3 m	To avoid emittance growth from multiple scattering
Time of accumulation	1000 turns	-to be checked with the targets	To get ~10^9 muons in one bunch in less than 0.4 ms



Layout (One Ring)

By Pantaleo Raimondi



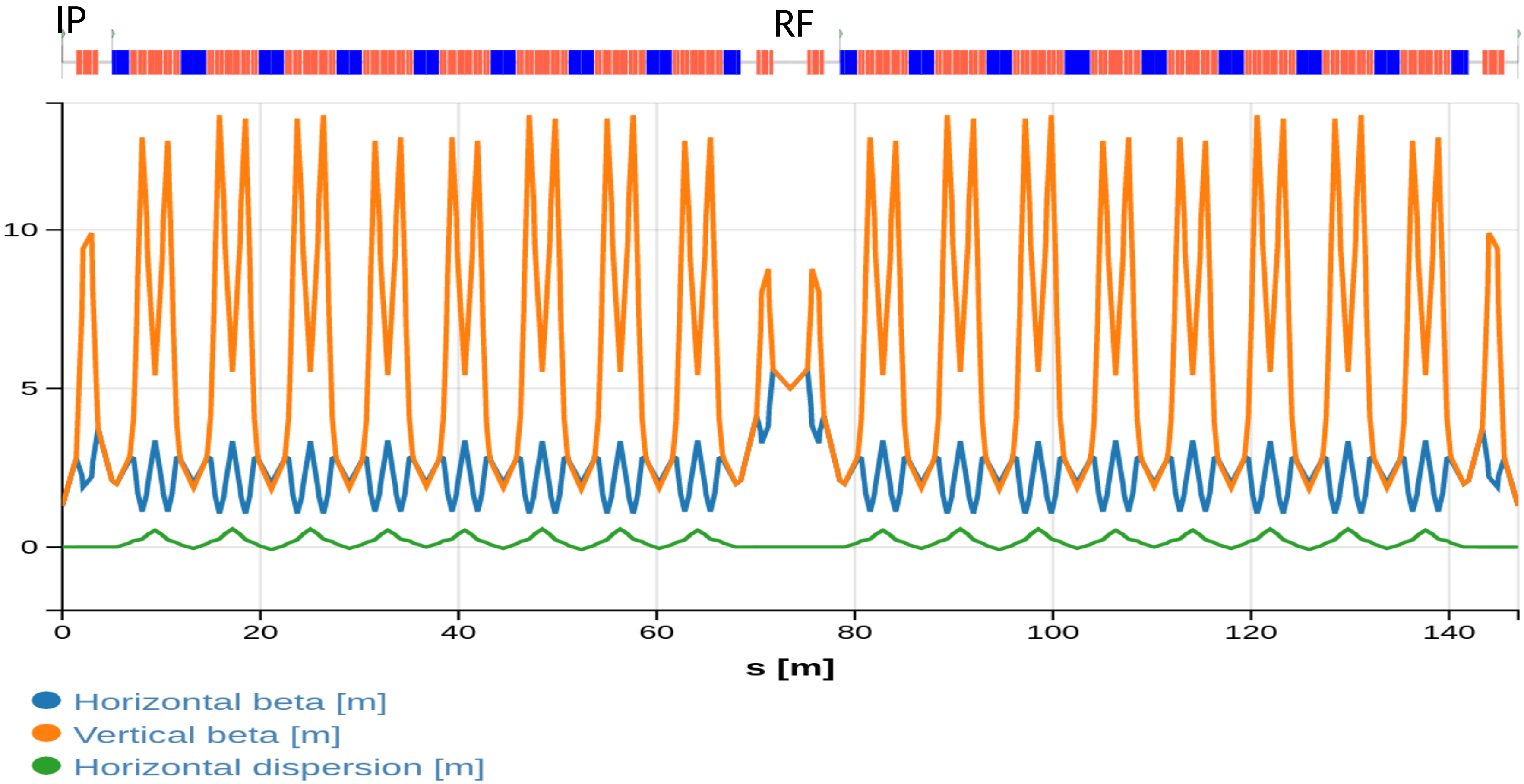
survey from SIREPO
(online zgoubi interface)

- The IR region is shared among three beams :
  μ+, μ- at 22.5 GeV, and e+ at 45 GeV
  Two triplets focus the beam around the IP (target location)
- Each ¼ of arc, is composed by 4 units of two halves of a sector bend dipole, and 5 quadrupoles. Zero-length multipoles (2nd, 3rd, and 4th order) are located inbetween quadrupoles.
- L* is long to make space for a H_2 target of $0.3X_0$ in total
- The lattice is matched to cancel α_c
  Sextupoles cancel chrom., 2nd order disp.
  Oct, Dec, Doc opt. to cancel α_c at higher orders

Length	147 m
Energy Acceptance	±10 %
Max. Dipole field	12 T
Quad field gradient	<151 T/m
ß*	1.3 m
Target space (2 x L*)	2 x 1.4 m
RF Freq	1.2 GHz
RF Voltage	100 MV

Linear Optics

First order optics agreement among MAD, MAD-X, MAD-X PTC and ZGOUBI



Chromaticity

- Natural chromaticity agrees among simulation codes

MAD (Qx’,Qy’)	MAD-X (DQ1,DQ2)	MADX PTC (DQ1,DQ2)	ZGOUBI (DQ1,DQ2)
-9.37	-	-9.41	-9.37
-19.69	-	-19.47	-19.69

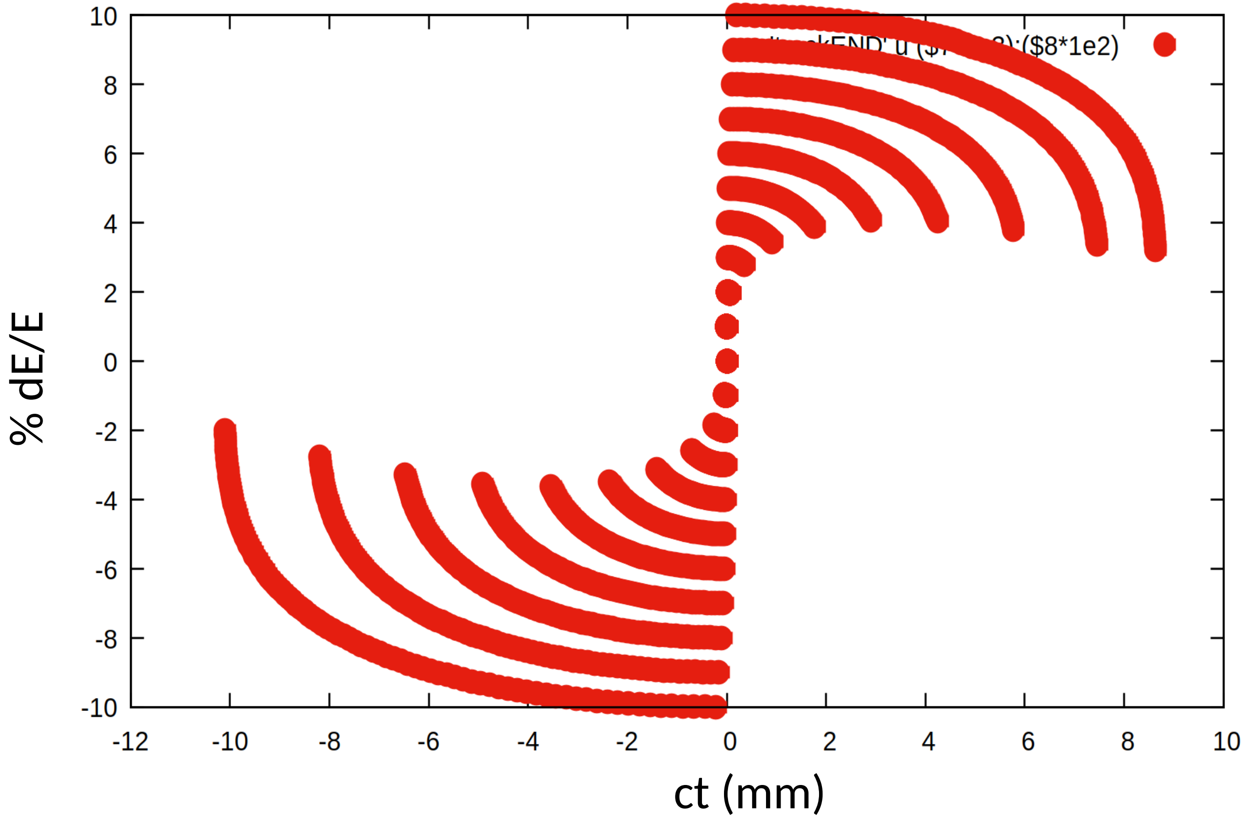
- The multipole optimization done by Pantaleo in MAD does not automatically work in PTC, therefore, a new multipole optimization has been carried out after the translation from MAD to MAD-X.

The differences in the optimization change the dynamics

MAD (Qx’,Qy’)	MAD-X (DQ1,DQ2)	MADX PTC (DQ1,DQ2)	ZGOUBI (DQ1,DQ2)
-0.08	-	-0.03	-0.08
0.06	-	0.00	0.05

Longitudinal Phase Space

100 turns, No Energy loss, PTC model



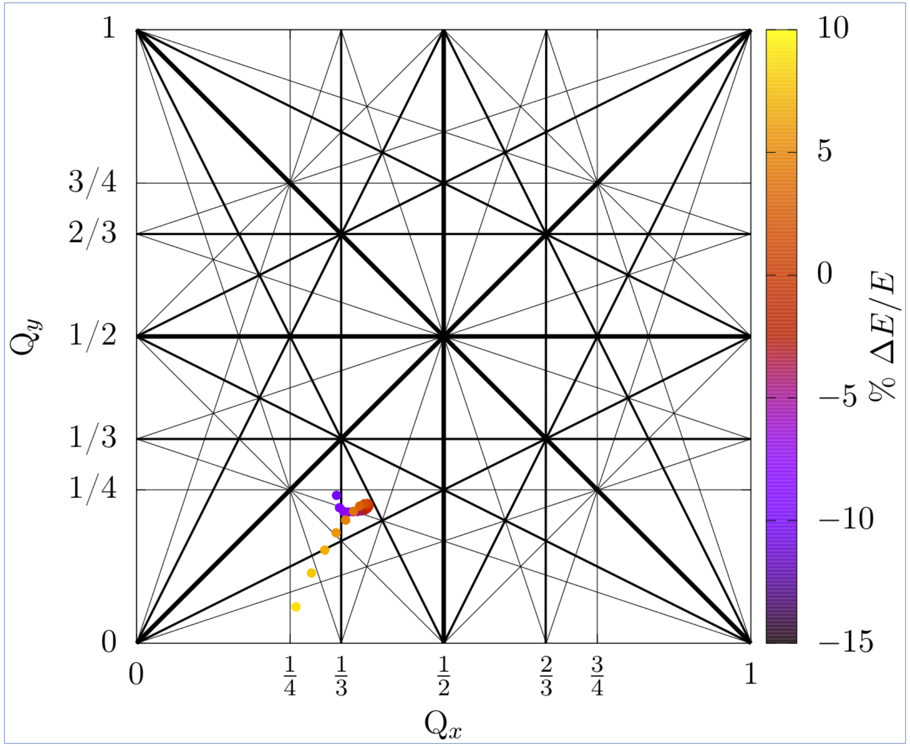
IF MUONS DO NOT RADIATE AND α_c IS ZERO , WHY DO WE NEED A CAVITY ?

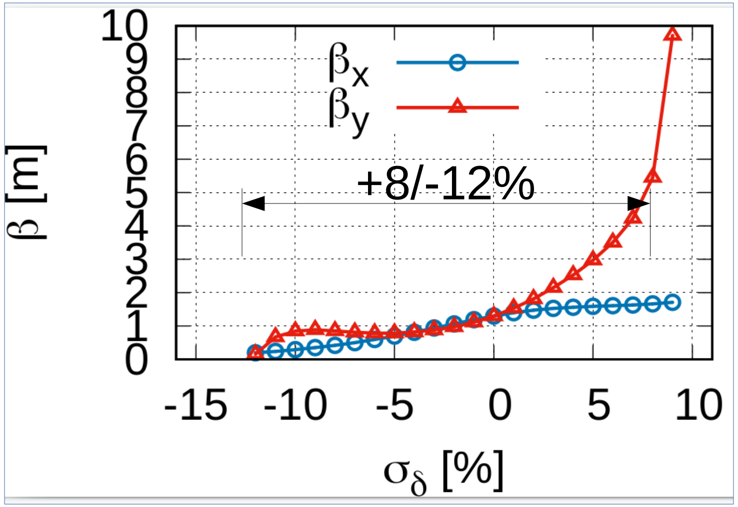
We expect to have approximately 0.1~0.2% energy loss per passage through the target due to bremstrahlung.

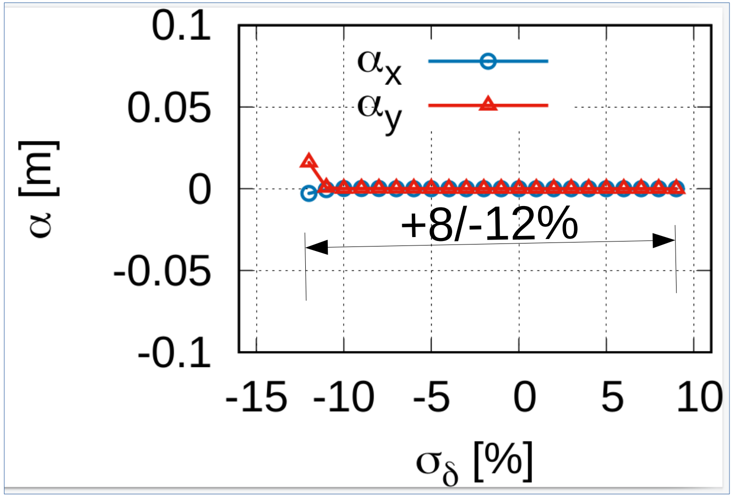
The cavity is tuned to recover the energy loss, which along all accumulation period of 1000 turns is 1~2 times the initial 22 GeV

Tune and optics functions at the IP

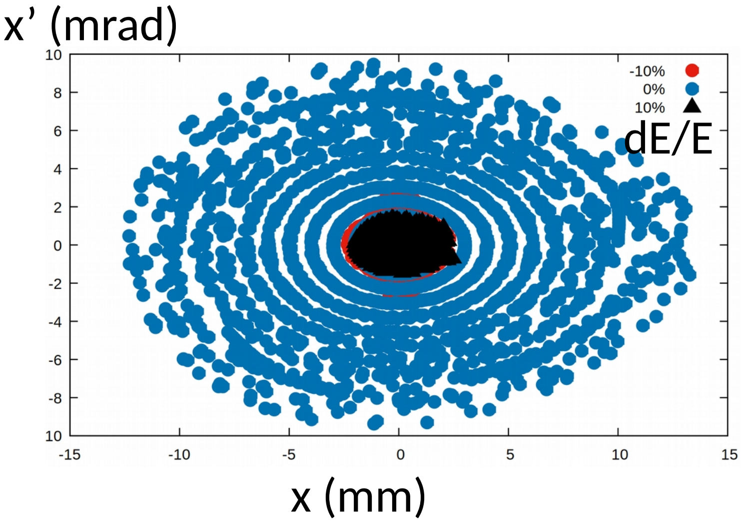
Using the PTC model we achieved +8/-12% energy acceptance, although, tune footprint crosses 3rd and 4th order resonances pointing to possible particle losses in a lattice with errors.

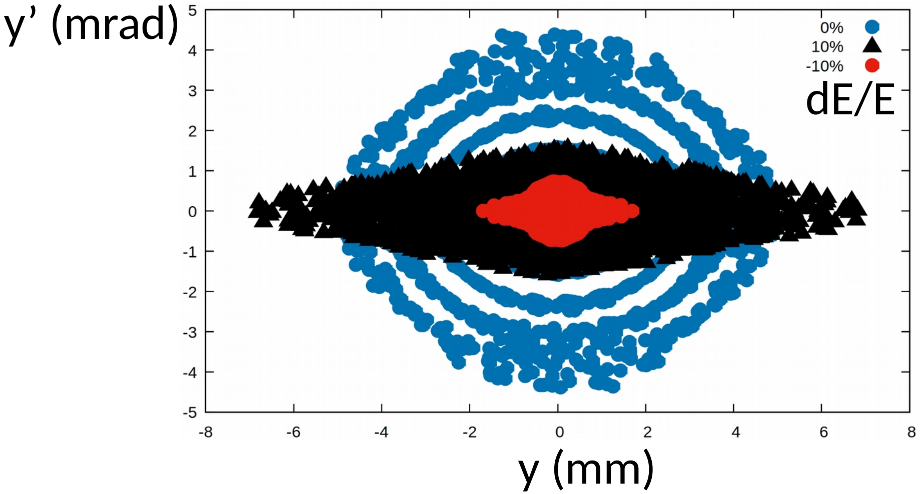






Admittance (100 turns)





- From multiturn tracking, we have estimated an admittance of 1~10 μm.rad.
- This is expected to be far larger than needed as the typical muon beam emittance is much less than 1μm.rad

Open Questions on Optics

- Beams separation and combination scheme,
- Radiation from positron beam crossing strong magnets in the accumulator,
- Further optimization of the lattice : length reduction, increment energy, considerations on multipoles,

10% energy aceptance in the model is already a great achievement and this lattice could be used for initial studies with target.

CONCLUSIONS

The goal for LEMMA is the production of a large lifetime and small emittance muon beam from positrons impinging on a target.

LEMMA design foresees to increase the muon bunch intensity by recirculating muons on an accumulator over a fraction of the muon lifetime.

I have presented the lattice by P. Raimondi of the accumulator ring: circumference of ~150 m and ±10% of energy acceptance.

I used several accelerator codes (MAD,MAD-X, PTC, ZGOUBI) in order to perform the analysis and optimization of the lattice.

The plan is to continue with optimizations to reach ±20% energy acceptance. We are planning to study a FFA design