Superconductive Positron Stacking Ring for CLIC

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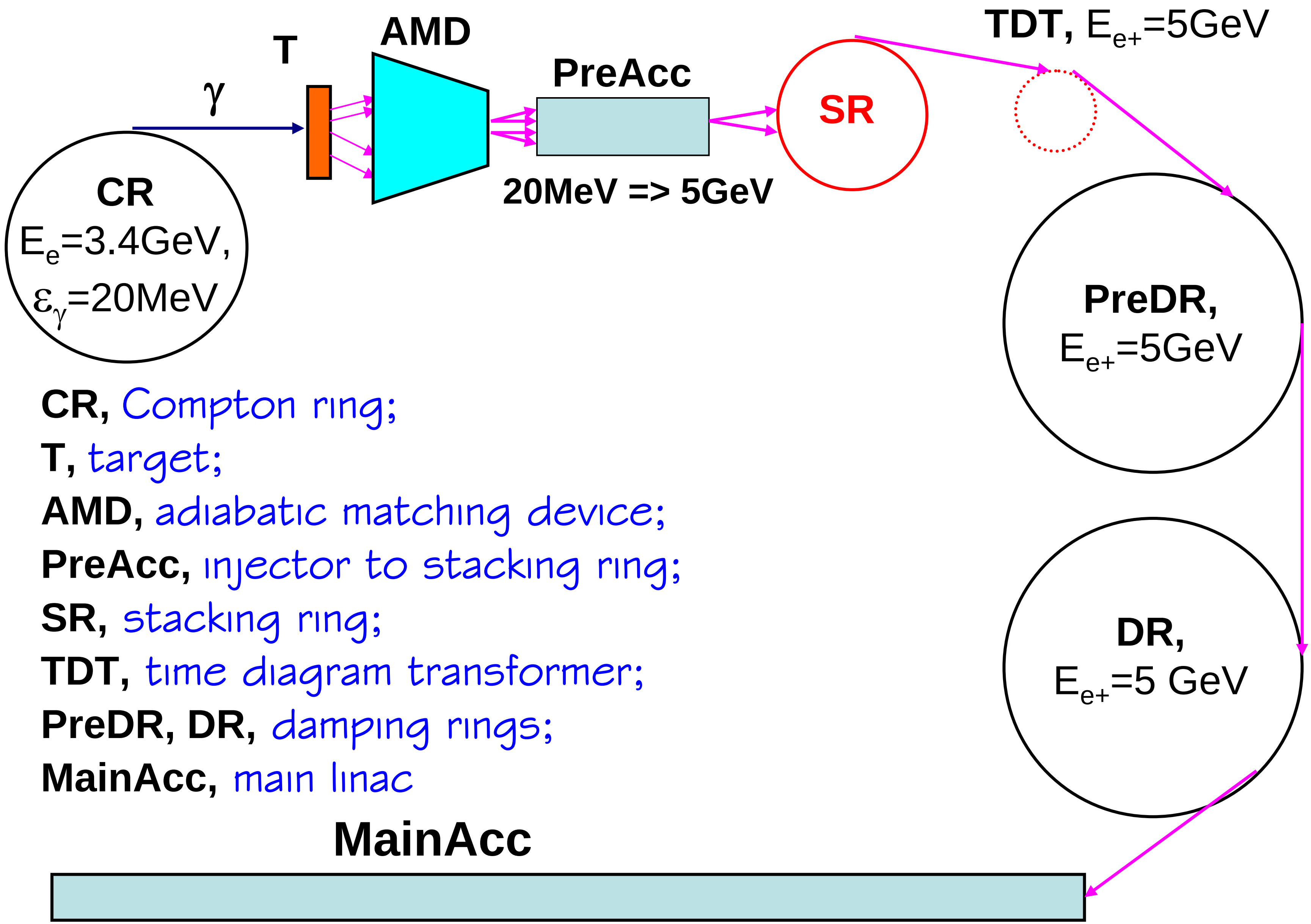


CR, Compton ring;

T, target;

AMD, adiabatic matching device;

PreAcc, injector to stacking ring;

SR, stacking ring;

TDT, time diagram transformer;

PreDR, DR, damping rings;

MainAcc, main linac

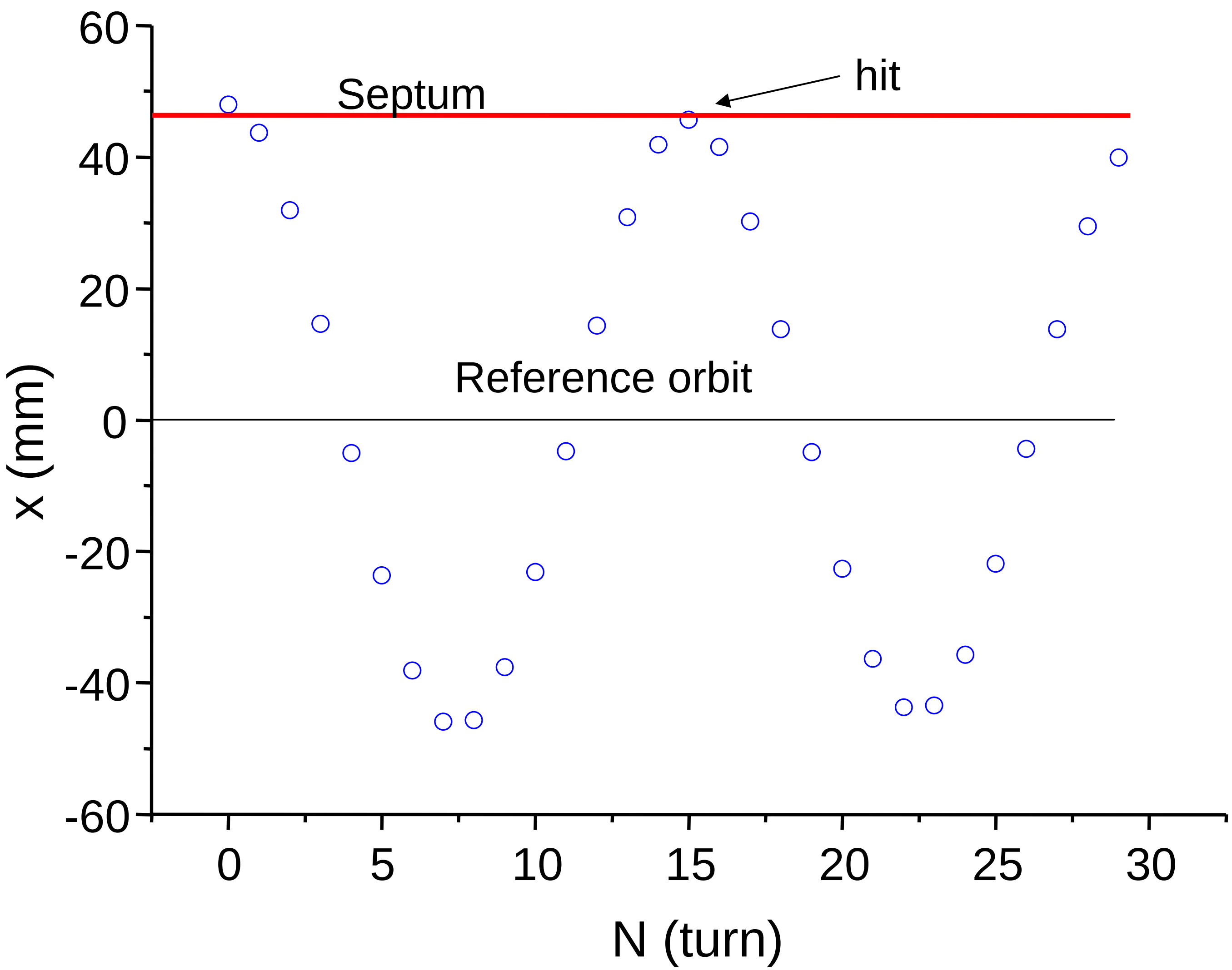
Synchrotron damping time

$$\tau_s \text{ [turn]} \approx E_0 / \Delta E$$

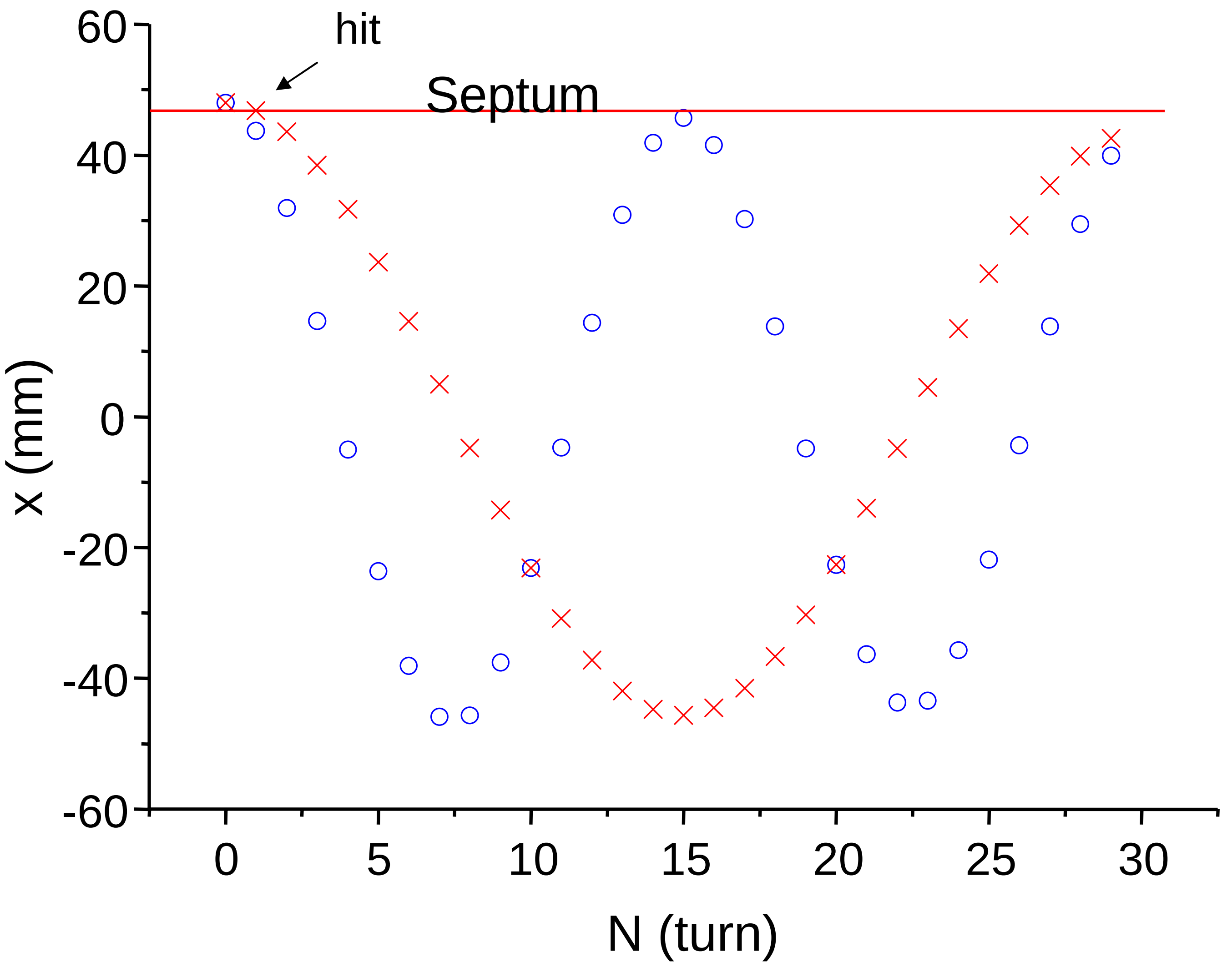
Possible ways

Extremely intensive Compton scattering

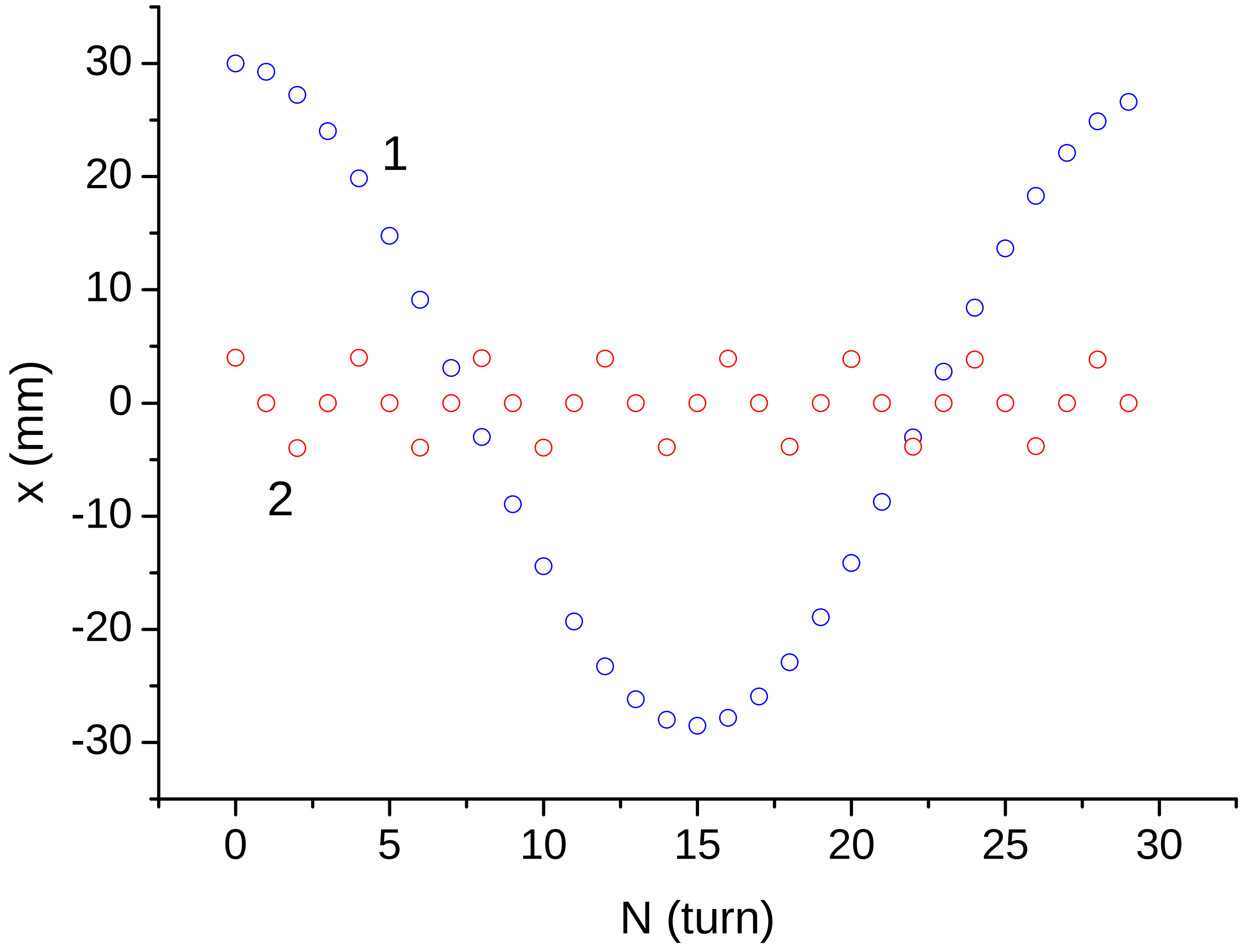
Synchrotron radiation in superconductive stacking ring



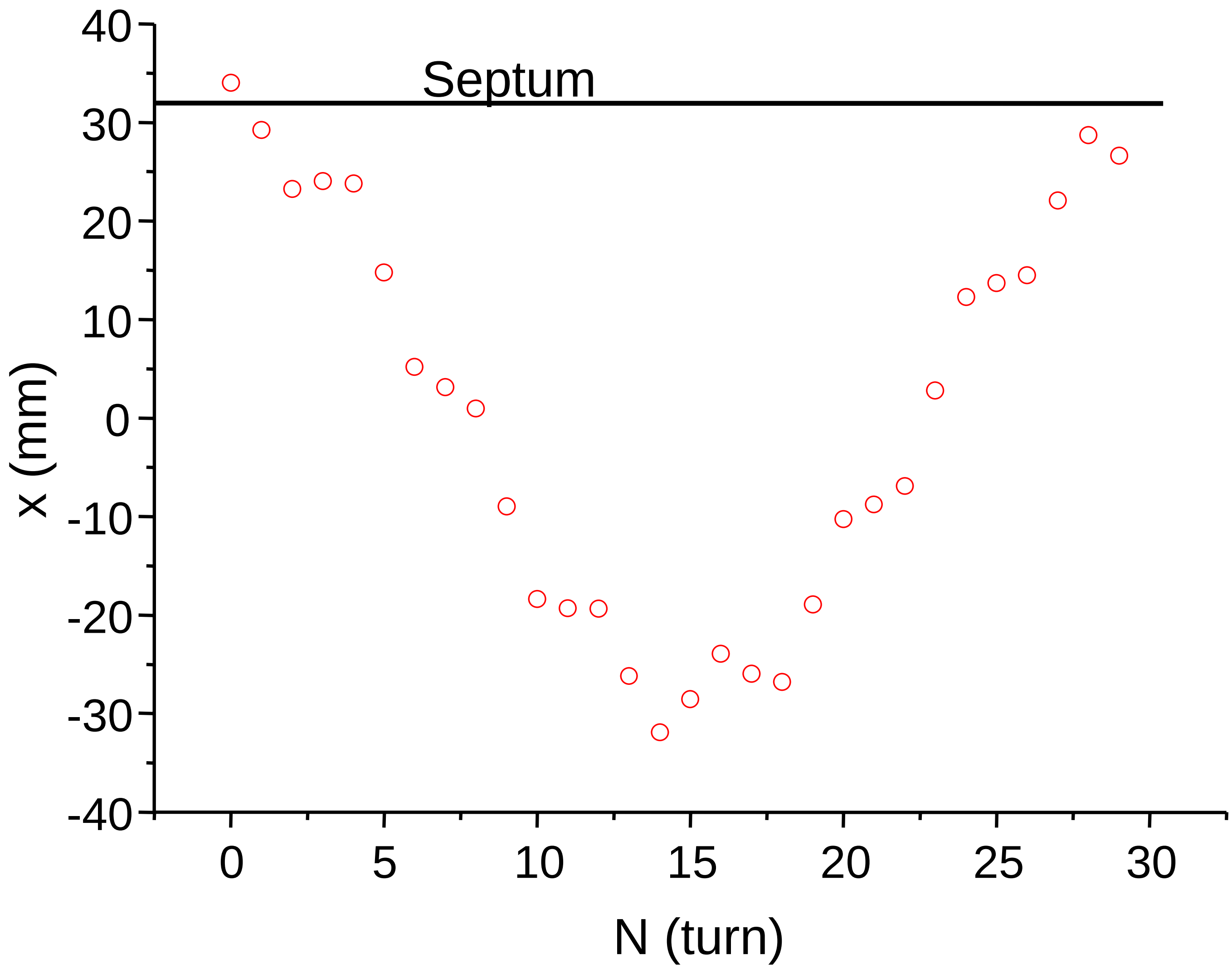
Positions of equilibrium orbit. Dispersion at injection azimuth η=0.6 m, momentum deviation $\Delta p/p$=8 %, synchrotron frequency Q_s =1/15.
Ring circumference C=100 m, synchrotron damping τ_s=100 μs (333 turns)



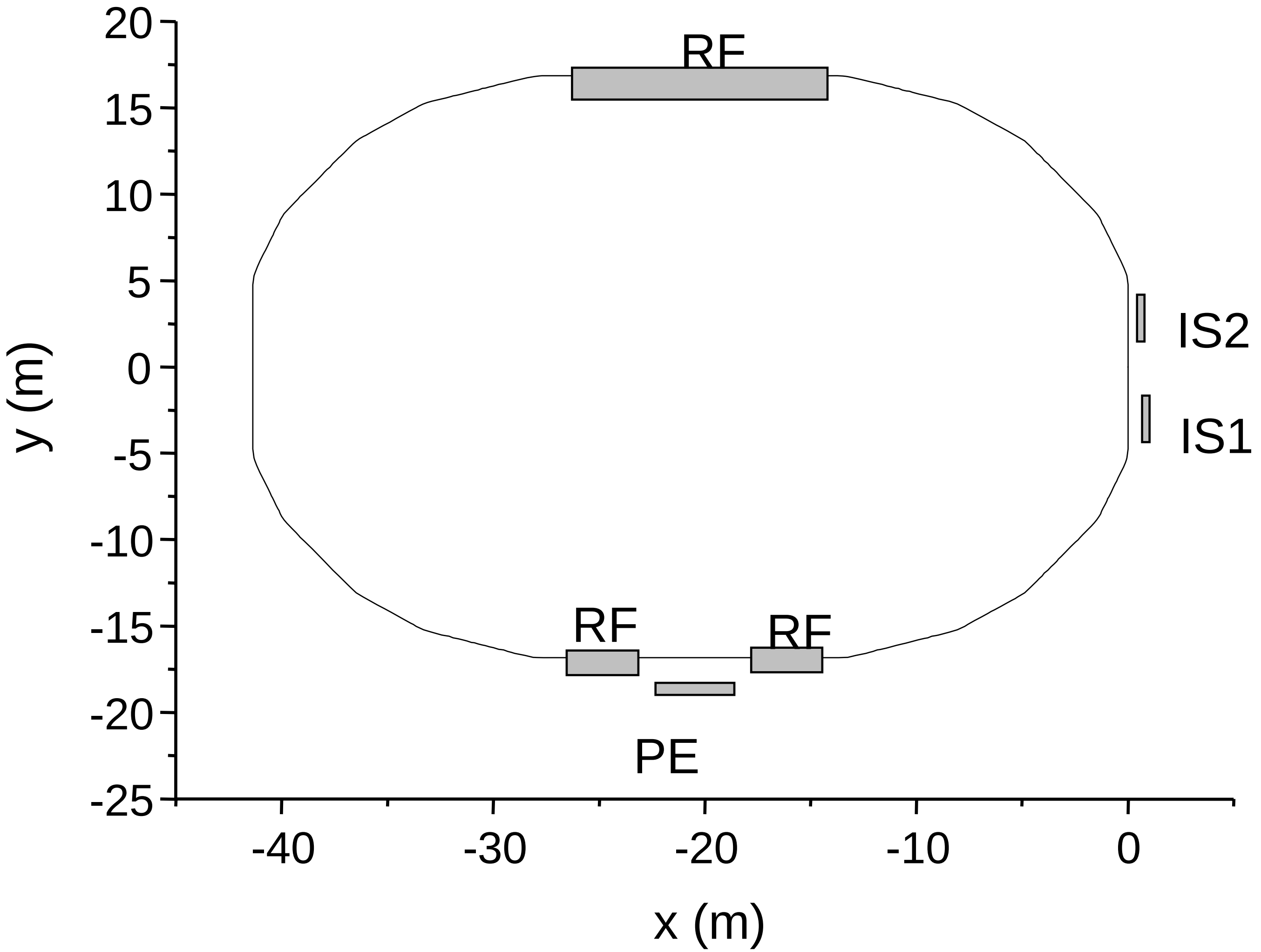
Positions of equilibrium orbit. Dispersion at injection azimuth η=0.6 m, momentum deviation $\Delta p/p$=8 %, synchrotron frequency Q_s = 1/15; 1/30.



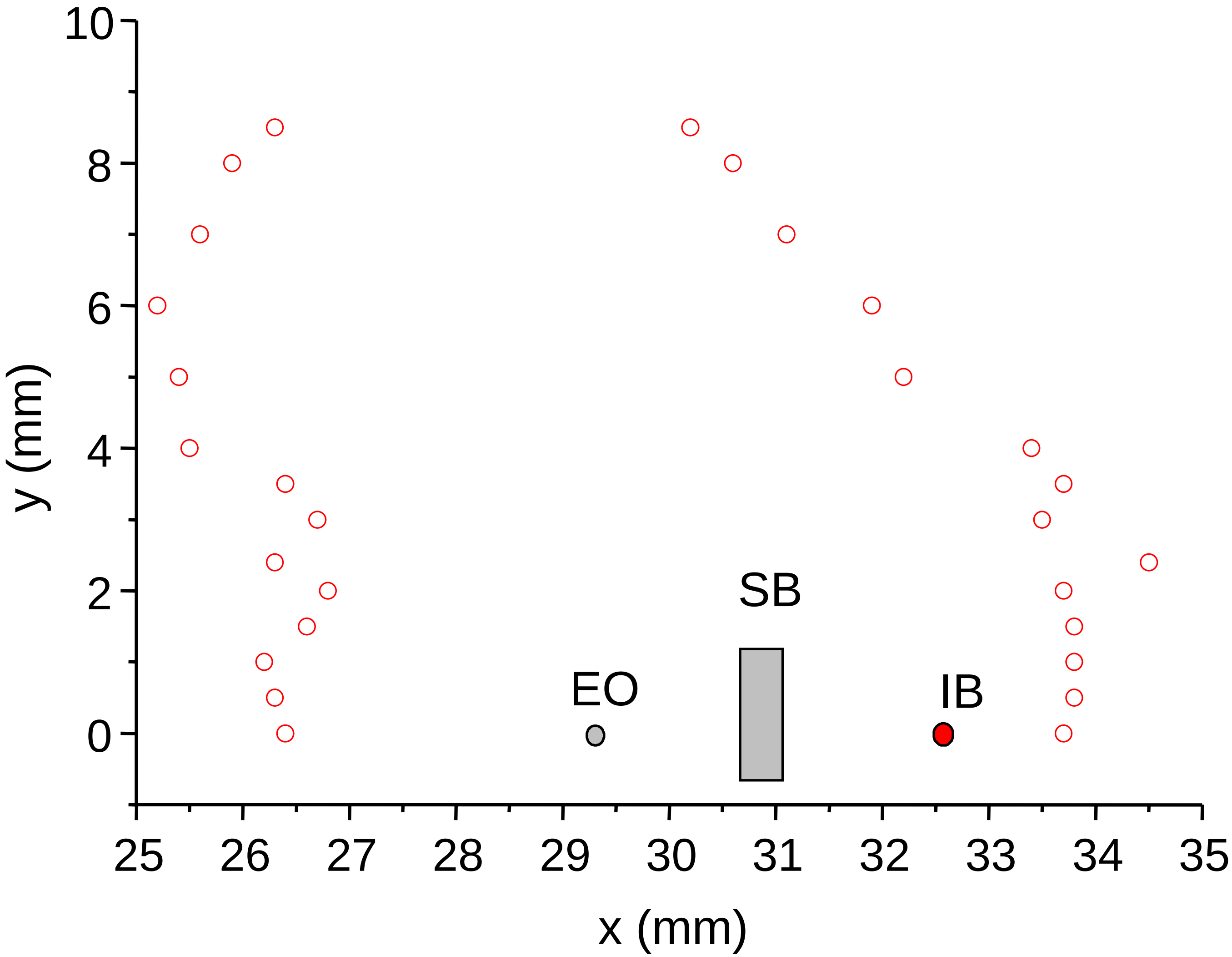
Positions of equilibrium orbit (1) and betatron oscillations (2).
Dispersion at injection azimuth $\eta = 1.0$ m,
momentum deviation $\Delta p/p = 3$ %, synchrotron frequency $Q_s = 1/30$.



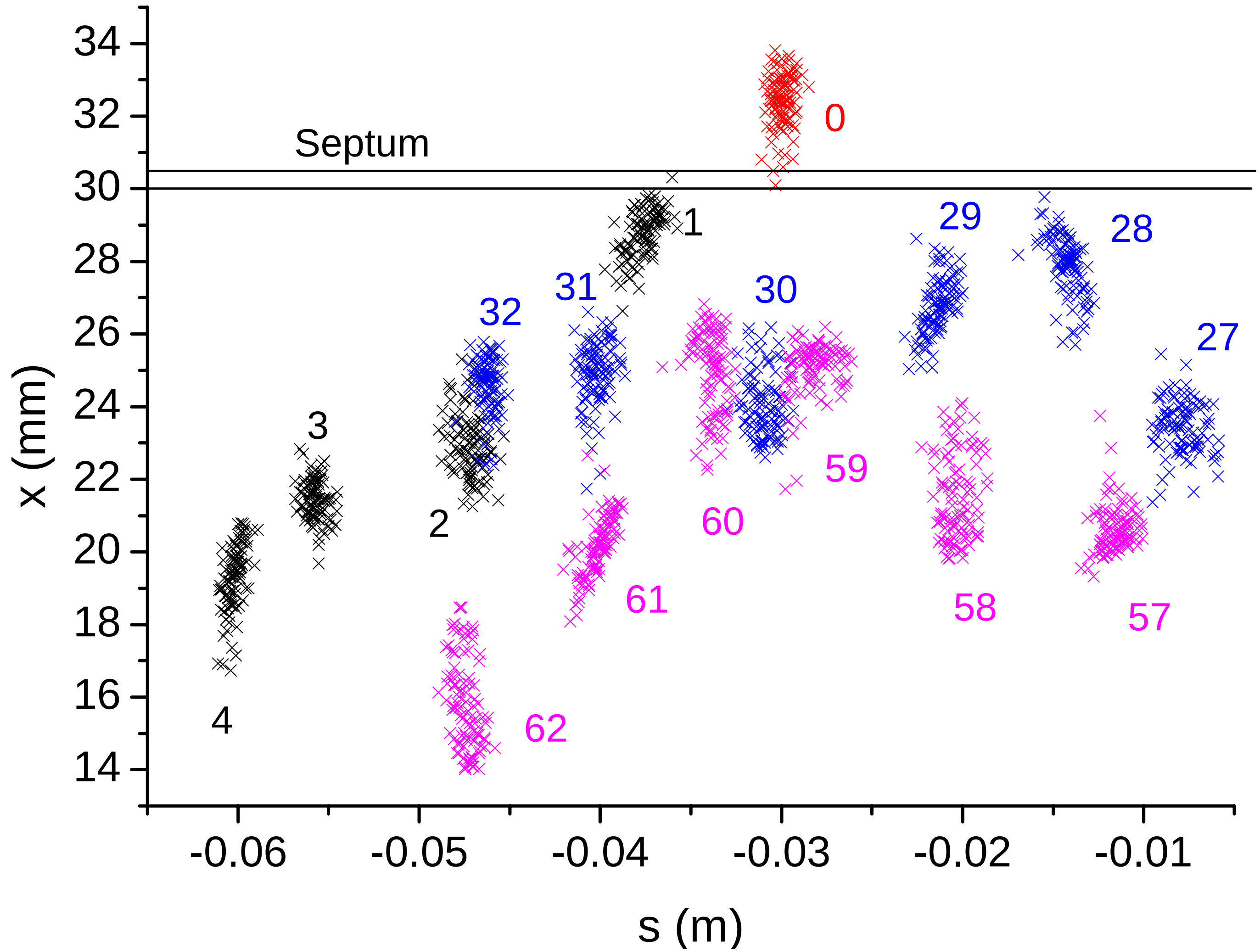
Positions of injected particle. Dispersion at injection azimuth η= 1 .0 m, betatron amplitude X_b=5 mm,momentum deviation $\Delta p/p$=3 %, synchrotron frequency Q_s = 1/30.



Ring layout. Energy E_0=5 GeV, circumference C≈125 m, bend.field B=6 T, energy losses ΔE≈20 MeV / turn, synchrotron damping time τ_s=104 μs. IS1,IS2, injection septums; RF, rf-sections; PE, positron extraction.



Dynamic aperture at injection azimuth. IB, injected beam; EO, equilibrium orbit; SB, septum blade. Momentum deviation $\Delta p/p_0=3$ %, dispersion at injection azimuth $\eta = 1$ m.



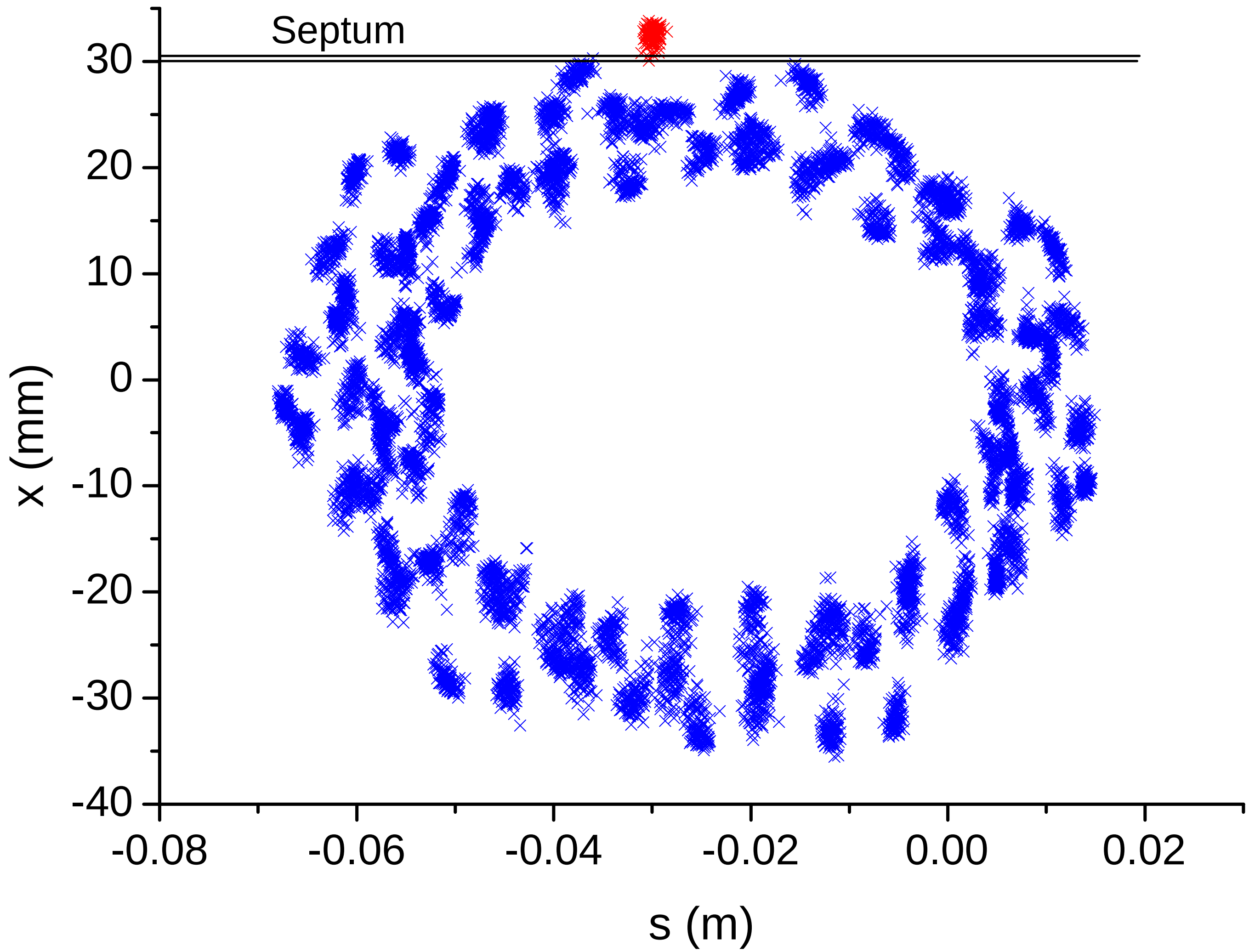
Injection simulation. Numbers near bunch position indicate turn number (0 labels injected bunch)

Simulation parameters&results:

Injected particles number 100;
Transversal beam emittance $2000*10^{-6}$ m*rad (normalized);
Energy distribution is Gaussian $\Delta p/p_0=0.2\ \% > (20-15)/5000$;
Septum thickness 0.5 mm;
Pulse deviation of injected beam from reference $(p_{inj}-p_o)/p_o=3\ \%$.

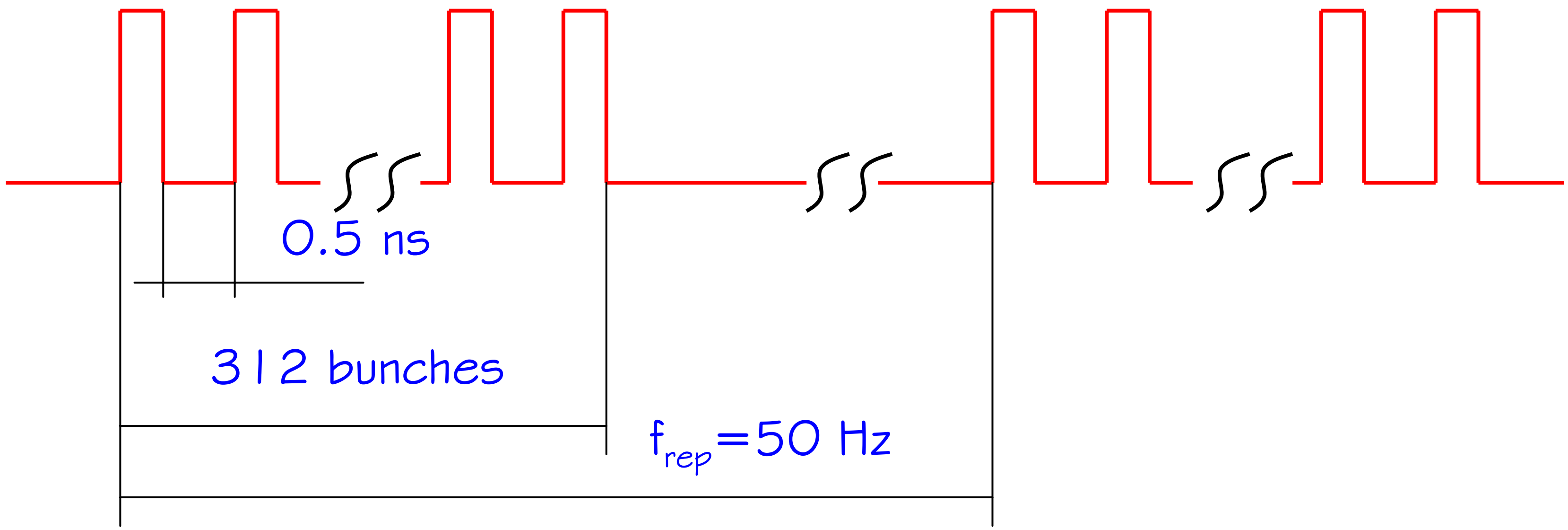
Two particles are out of the dynamic aperture and are being lost during the injection;
One particle of the injected bunch is being lost on septum at the beginning of the first turn;
Two particles are being lost on septum blade after the first turn;
At a latter time particles are not being lost.

Thus, 95 particles are successfully injected, i.e. the injection efficiency is equal to 95 %.



Positions of injected bunch during
3 synchrotron cycles

Crazy SR (RF) power

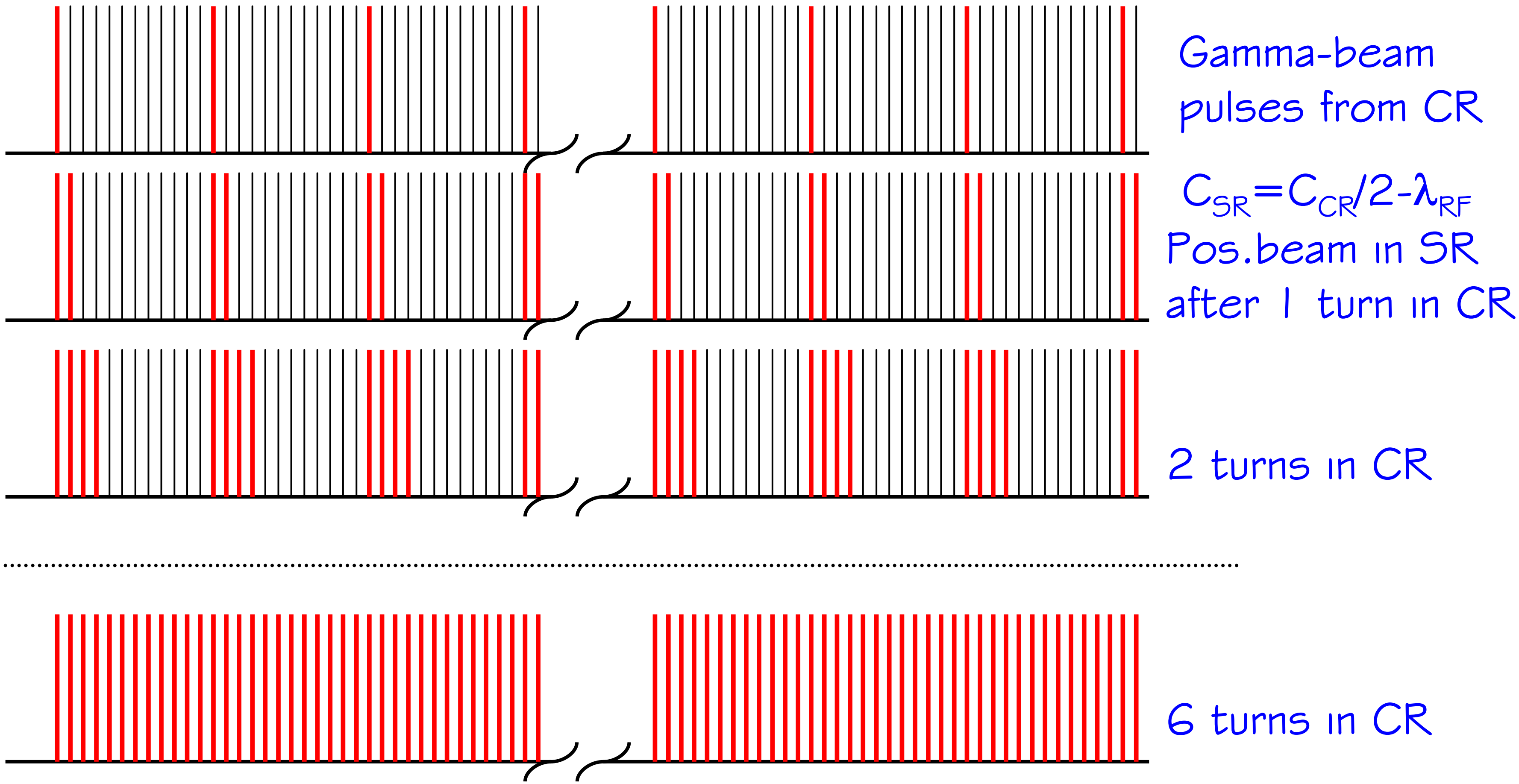


$N_{eb}=7*10^9$ => $Q_b \approx 1.125$ nC => $I_{stor}=2.25$ A,

$\Delta E=20$ MeV, $P_{SR}=45$ MW !!!

Operation mode

CR: circumference C_{CR} ~300 m, bunch spacing 6 ns ;
SR: circumference C_{SR} ~ 150 m, bunch spacing 0.5 ns, bunch number N_b ~ 960;



Operation mode

CR: repetition rate f_{rep}=2.5 kHz (T_{rep}=400 μs => 400 turns = 100 turns (gamma generation) + 300 turns (beam damping);

SR: 200 turns (positron injection) + 600 turns (beam damping);

TDT: C_{TDT} ~ 50 m, bunch number Nb ~ 320, bunch spacing 0.5 ns;

Quick positron beam extraction (3 turns in TDT) to TDT and to pre-damping ring from TDT immediately after that .

As a result: stored current in SR 2.25 A /(3*50)= 15 mA =>
P_{SR}=300 kW

Main parameters of stacking ring

Parameter	Value
Positron energy, GeV	5
Ring circumference, m	125.012
Bending field, T	6
RF frequency, GHz	2
RF voltage, MV	50
Harmonics number	834
Bunch spacing, ns	0.5
Beam energy losses, Mev/turn	19.8
Synchrotron damping time, μs	104
Normalized emittance of injected beam, m*rad	$2000*10^{-6}$
Dispersion at injection azimuth, m	1
Pulse deviation of injected beam, %	3
Injection efficiency, %	>90

Summary

Stacking ring with the superconductive bendings
for the continuous positrons stacking is proposed .

The injection efficiency into proposed
stacking ring is greater than 90 %

The proposed ring can be used
as the base for the further R&D