Background Issues at SUPERDAFNE

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SUPERDAFNE (DA? NE @.51GeV/ high L)

will still be a Touschek business

(provided that vacuum is good as in DAFNE)

Main Background studies at DAFNE

the simulation reliability (proved with KLOE data)

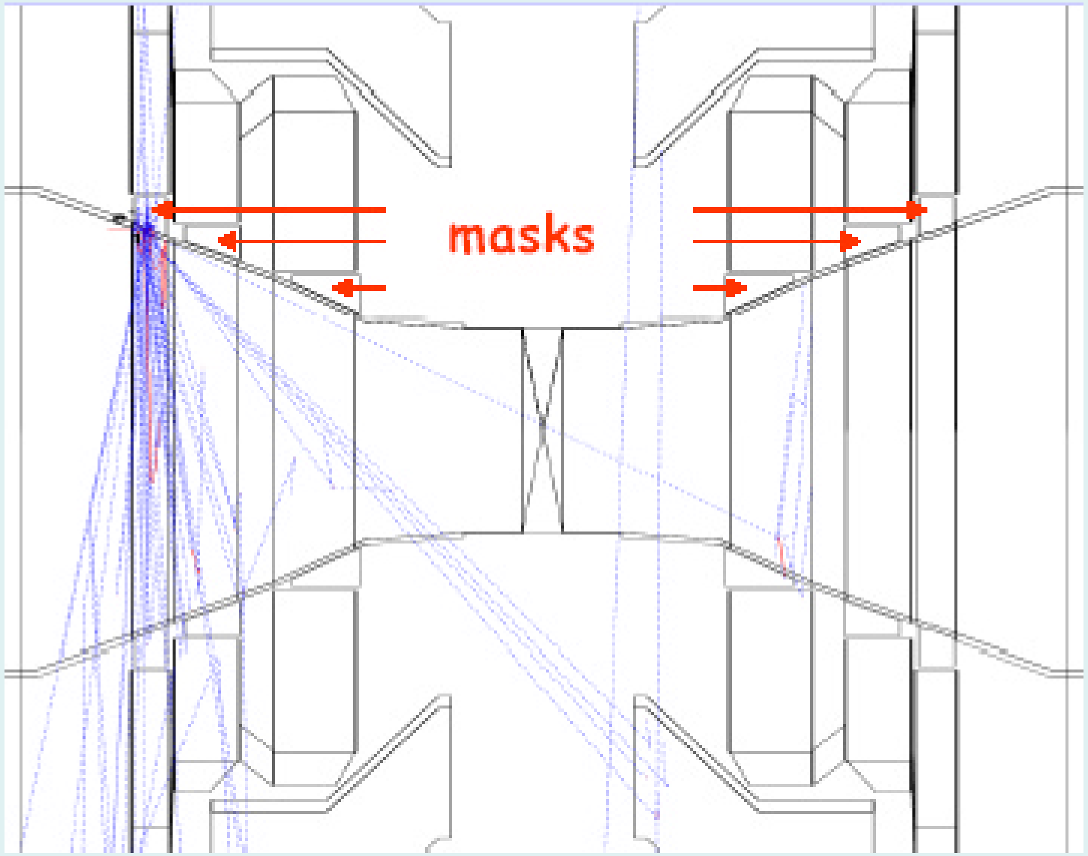
allowed DA? NE to decrease background rates by:

- the addition of scrapers in dispersive regions

-studying an optimized optics which reduced losses

(i.e. effect of low-?$_x$ optics at IP)

During the last DA? NE shut-down additional masks have been studied and implemented to shield the KLOE focusing quad, which became stronger in the IR doublet design


masks

Program Flow: basic

Optics check

(nonlinearities included)

Beam parameters calculation

(tunes, emitt, ?p,?c,ecc.)

Calculation of Touschek energy spectra

Tracking of Touschek particles:

Start with transverse gaussian distribution and proper energy spectra track over many turns or until they are lost

Estimation of total Touschek losses and induced background at IRs

Some important considerations

Most of the losses arise from Touschek scattered particles in dispersive regions

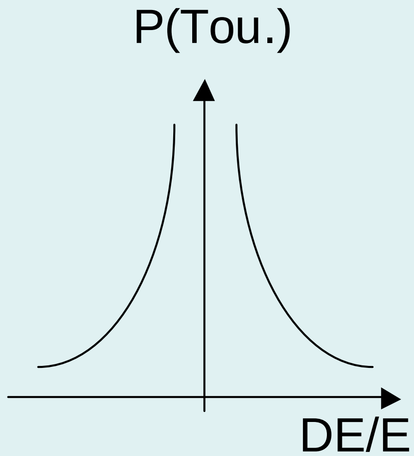
Simulate Touschek scattered particles only in dispersive regions

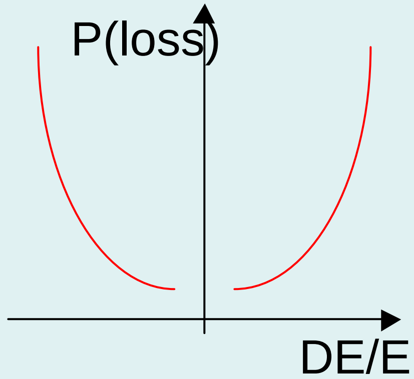
With a given energy spectrum P(E)

(see later) one can:

1. extract according to P(E) or

2. Use a uniform extraction and use P(E) as a weight





We use 2. to cope with tails of both distributions

Calculation of energy spectra

Starting formula:

Integrated Touschek probability

$$\frac{1}{?} ? \frac{\sqrt{?}\, r_e^2 c N}{?^3 (4?)^{3/2} V ?'_x ?^2} C(u_{min})$$

$$\frac{1}{?} ? ?_?^? P_{Tou}(E)\, dE$$

$$? ? \frac{?E}{E}$$

$$u_{min} ? ?\frac{?}{??'_x}?^2$$

$$?'_x ? \sqrt{\frac{?_x}{?} ? ?^2_p ? D'_x ? D_x \frac{?_x}{?_x} ?^2}$$

V = bunch volume= $?_x \cdot ?_y \cdot ?_l$

C(umin) accounts for Moller x-section (polarization is included) and momentum distribution

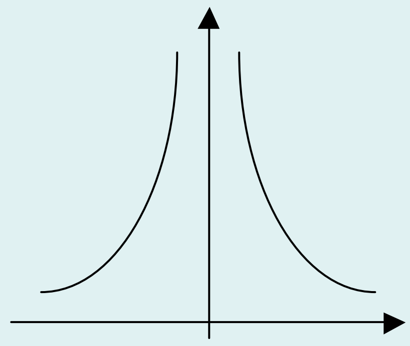
For a chosen machine section the Touschek probability is evaluated in small steps (9/element) to account for the beam parameters evolution for 100 ? values.

Use an interpolation between the calculated ? values according to the Touschek scaling law: $A_1 ??^{?A_2}$

Touschek energy spectra

related mostly to beam parameters

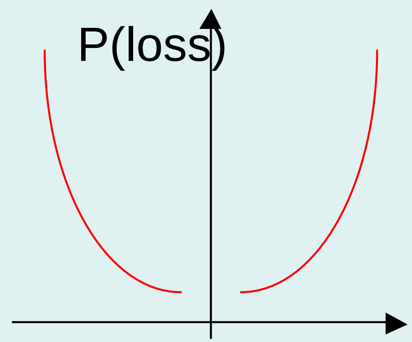
(i.e. bunch volume, ?, $?_p$, bunch current…)



Particle losses related mostly to

machine parameters/optics

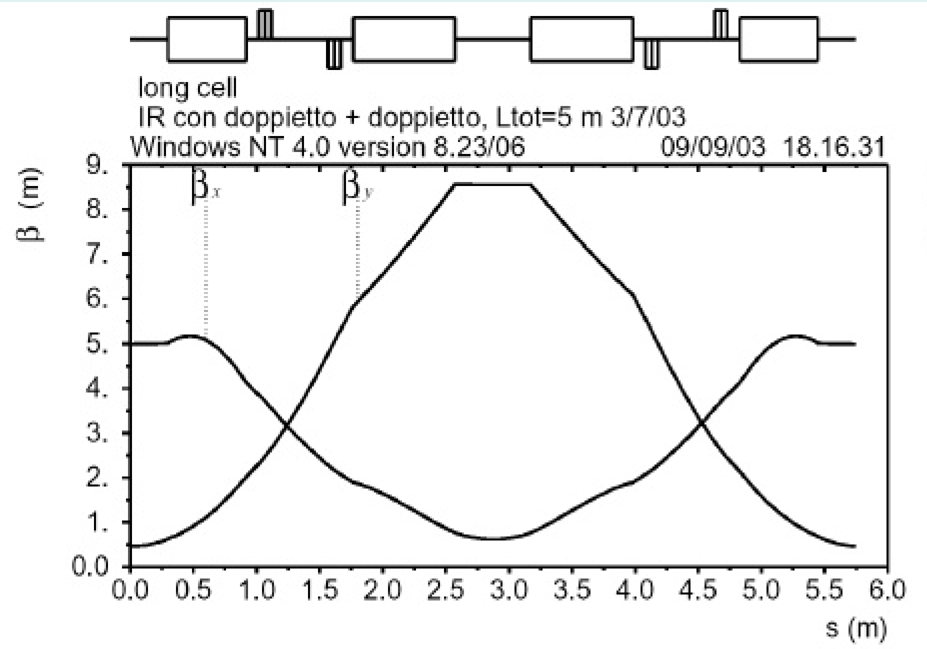
(i.e. physical aperture, phase advance, dispersion, …)

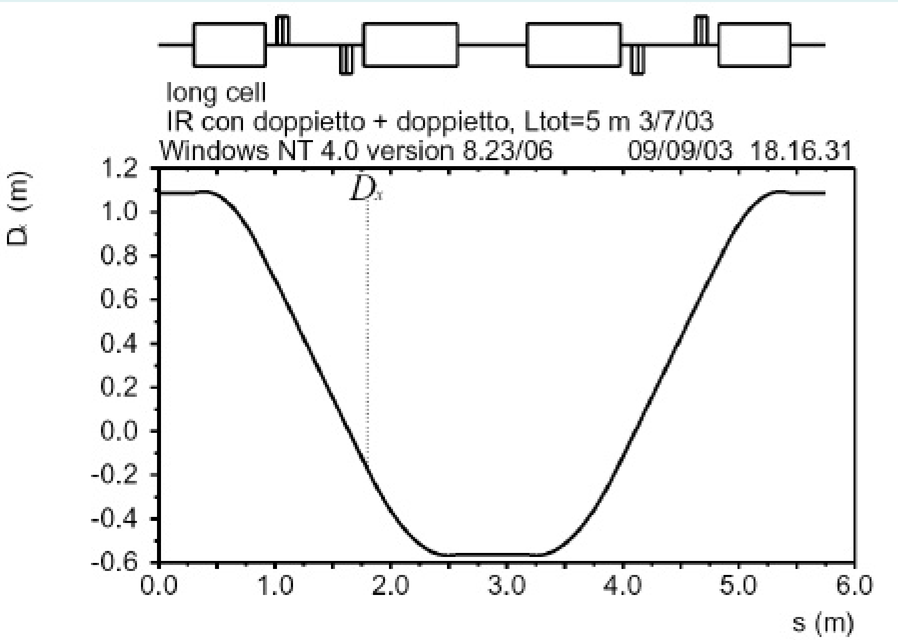


Machine is periodic ->

let's consider Touschek contributions in 1 cell and then multiply by the number of cells

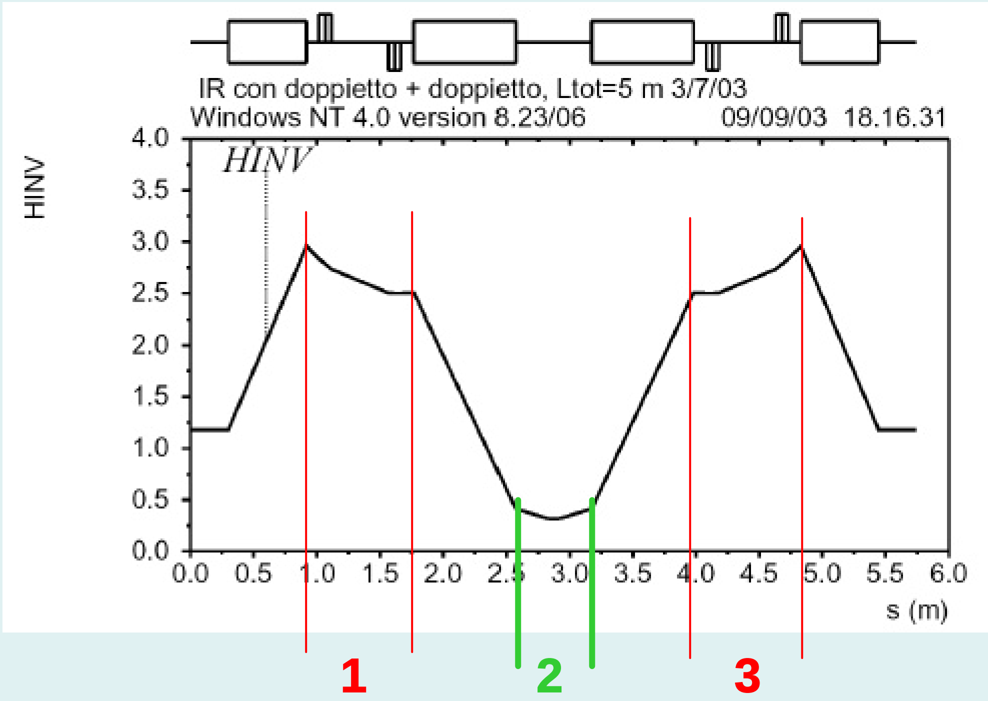
One cell Lattice
(cell phase advance = ?)





One cell Lattice H-invariant

Most of the losses arise from
Touschek scattered particles
in dispersive regions

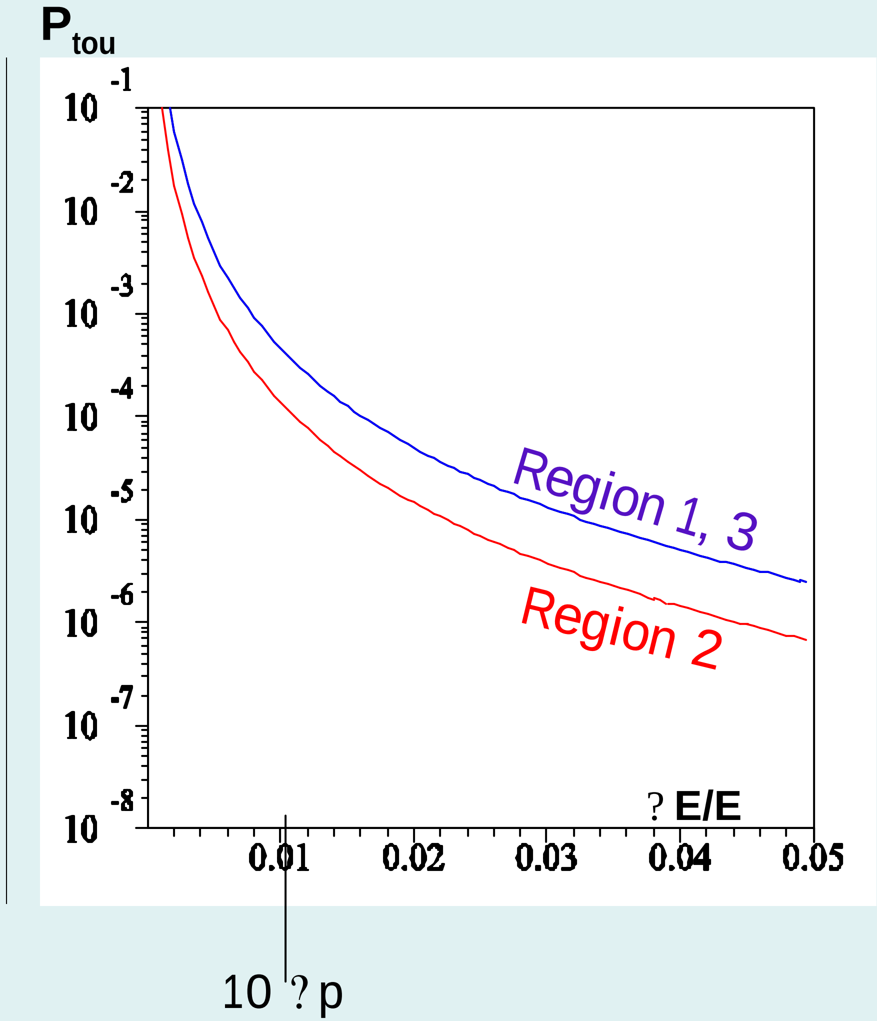


Regions 1 and 3:

In each cell: 2 regions in which Touschek scatterings are more dangerous

have equal weights but the scattered particles will have different phases

Touschek probability density function in the two high H-regions



Region 1 and 3:

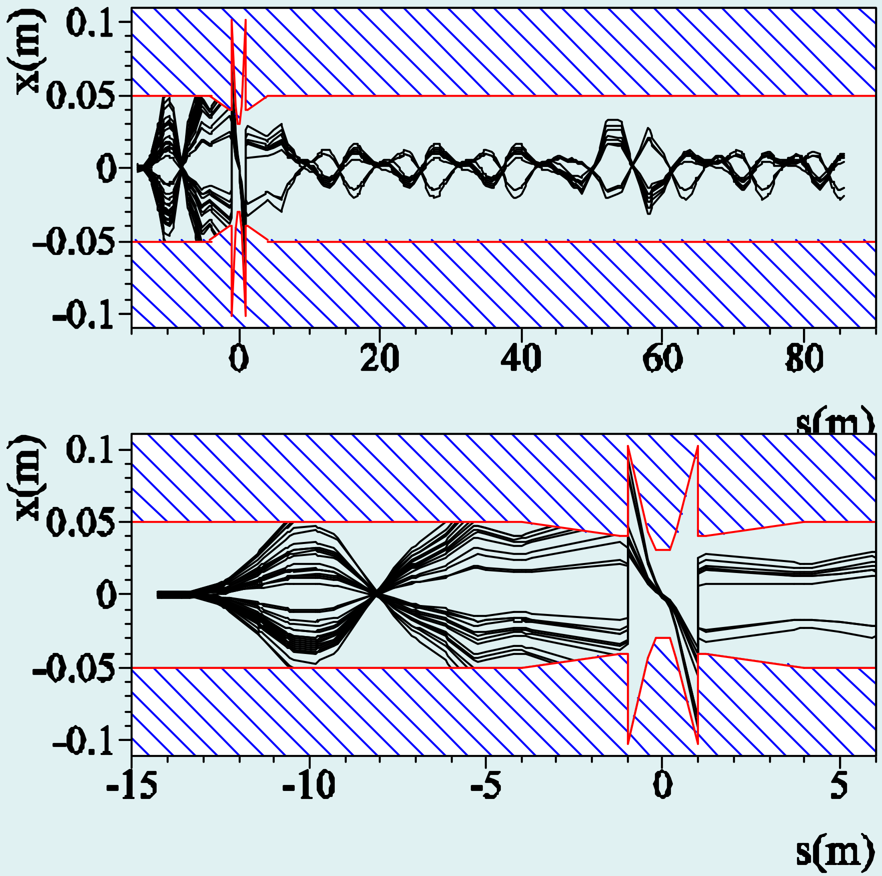
have equal weights

Region 1 and 3:

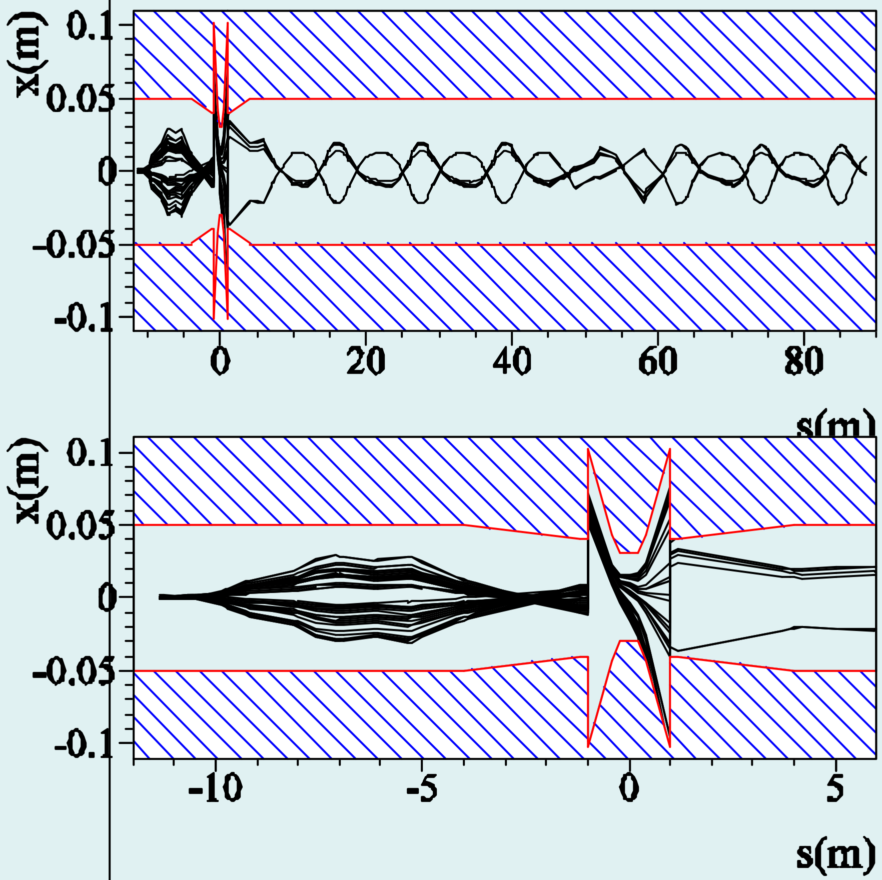
H-invariant is higher, weight is higher than in region 2

Touschek particles trajectories

Region 1



Region 3



Same Touschek probability but scattering occurs at different positions,

scattered particles have different phase

E_{beam} [MeV]	510
I_{bunch} [mA]	20
$?_{x}$ [m rad]	$0.3\ 10^{-6}$
?	0.01
$<?_{l}>$ [cm]	1
$?_{p}$	10^{-3}
$?_{c}$	-0.23
h	175
V_{RF} [MV]	8.5
$?_{x}^{*}$ [m]	0.5
$?_{y}^{*}$ [mm]	4
$?_{z}$ (@IP) [mm]	3.7
L_{tot} [m]	100.11343

Preliminary parameter set for SUPERDAFNE

KHz @10mA	SUPER DAFNE	DAFNE
TOTAL RATES	2500	1800

Rates vs IR aperture

First background estimates indicate that most of losses occur at IR

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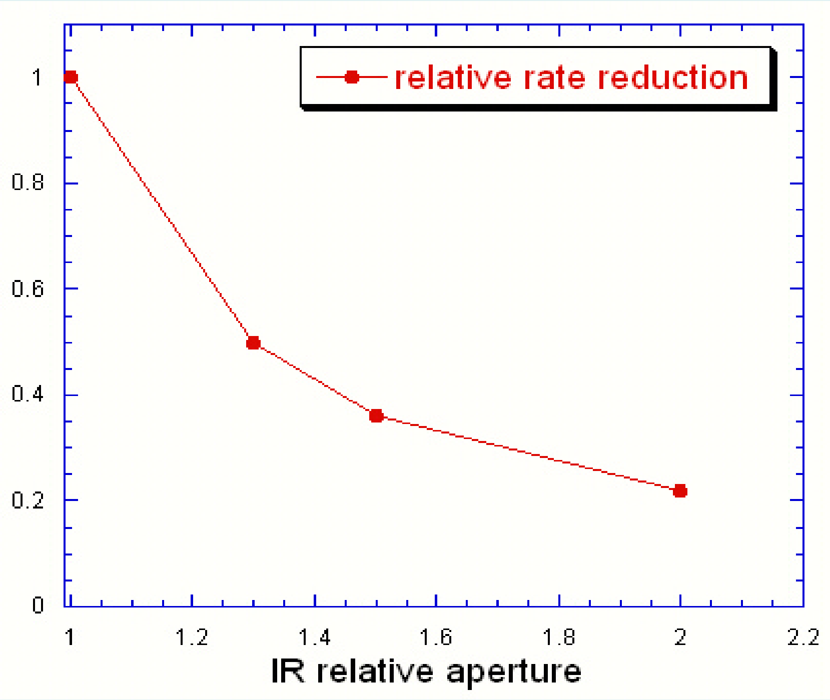
IR shape must be carefully chosen to minimize particle losses

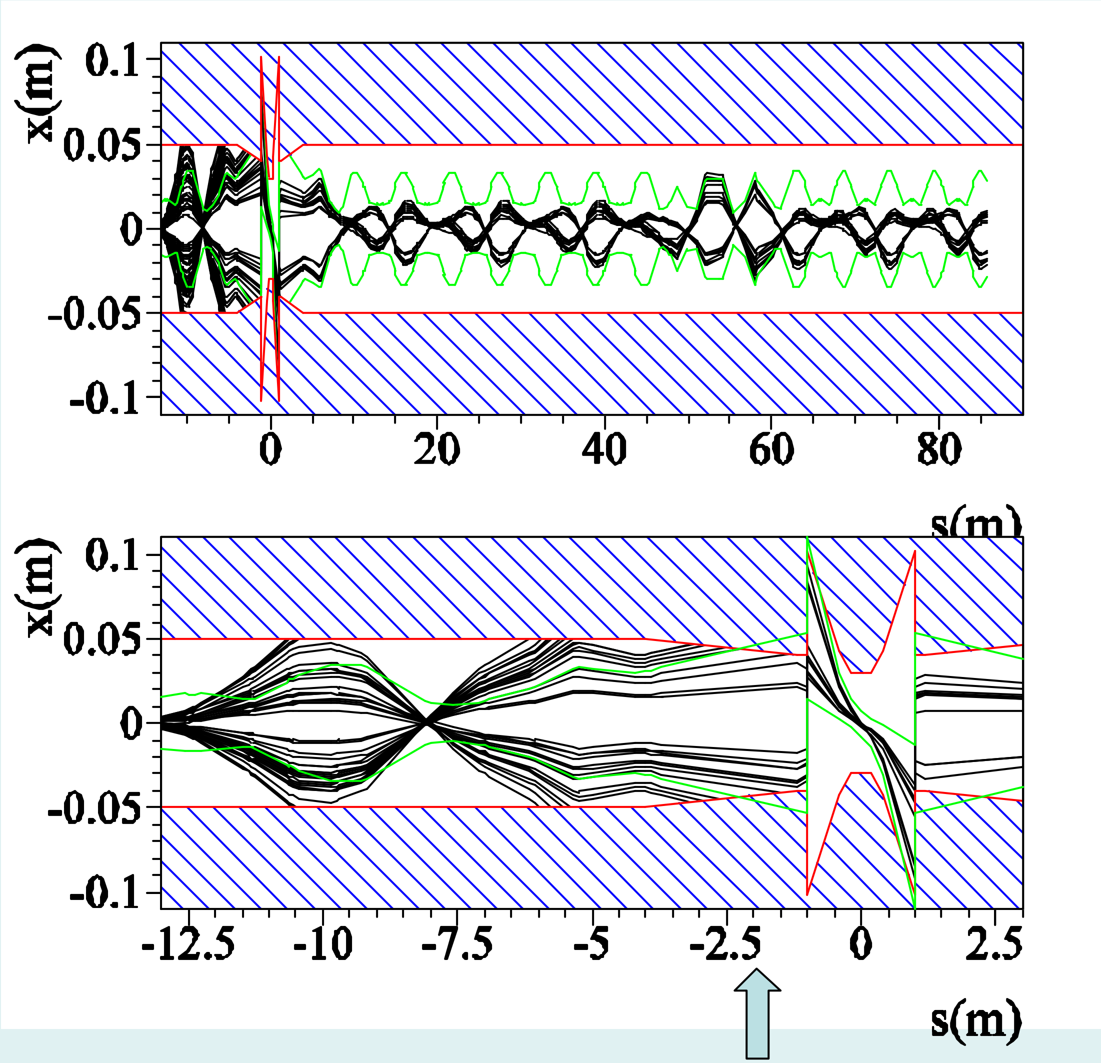


For example:

by increasing IR aperture by 30%

losses are decreased by 50%

Touschek particles trajectories



GREEN: 20 ?$_x$

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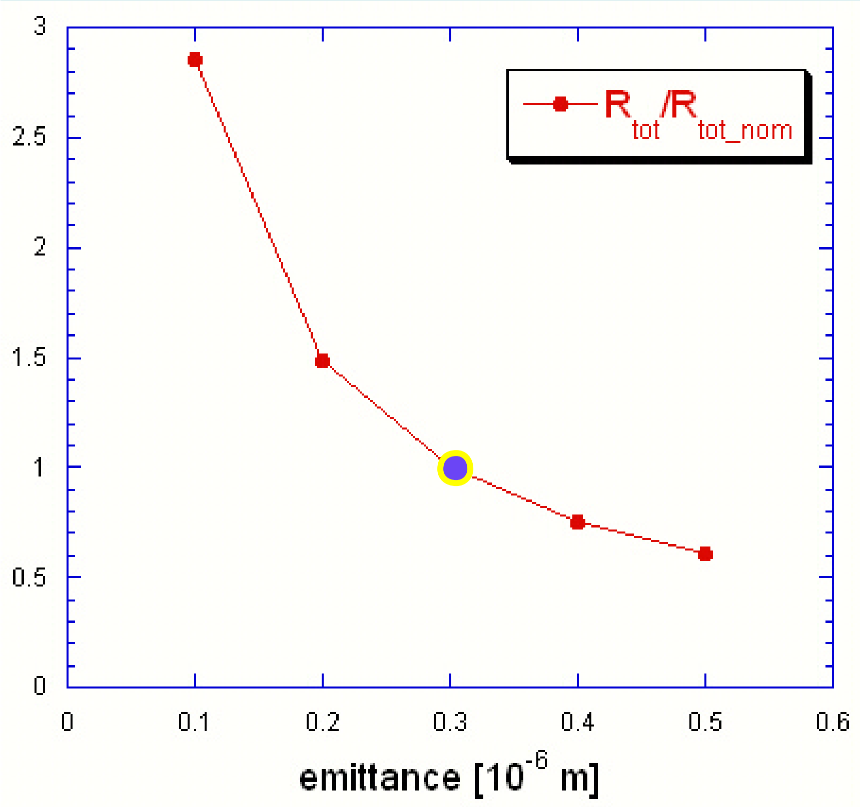
20 ?$_x$ of physical aperture is not enough at IR

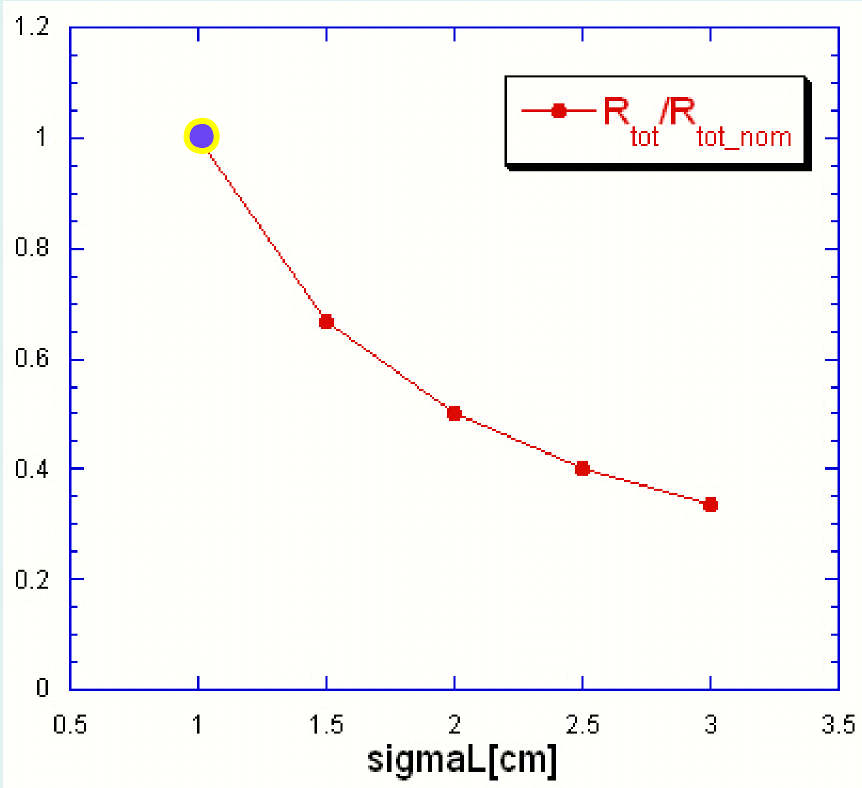
to cut all particles with all phases they have to be at least 2 at a 90°-phase between them

Collimators must be inserted upstream the IR

Touschek background rates vs emittance

Touschek background rates vs bunch length

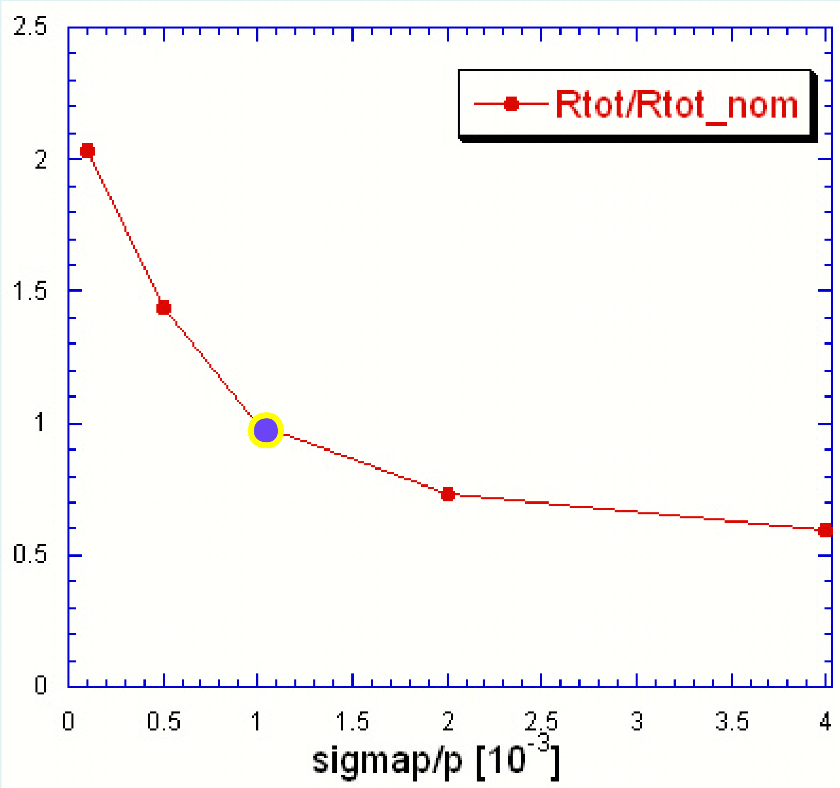




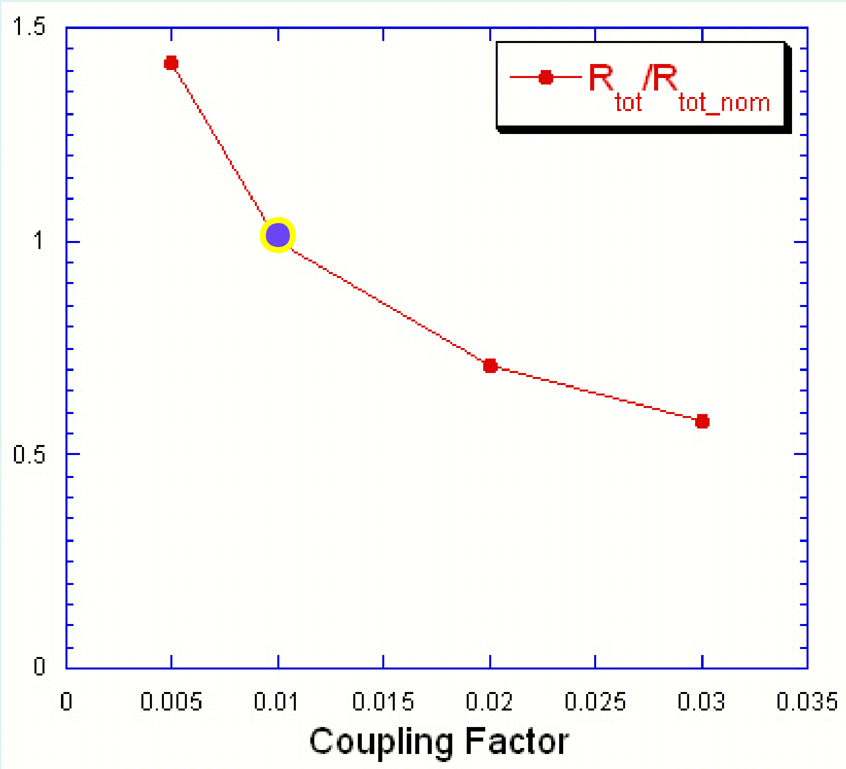
N? 1/?

N? 1/? l

Touschek background rates vs energy spread

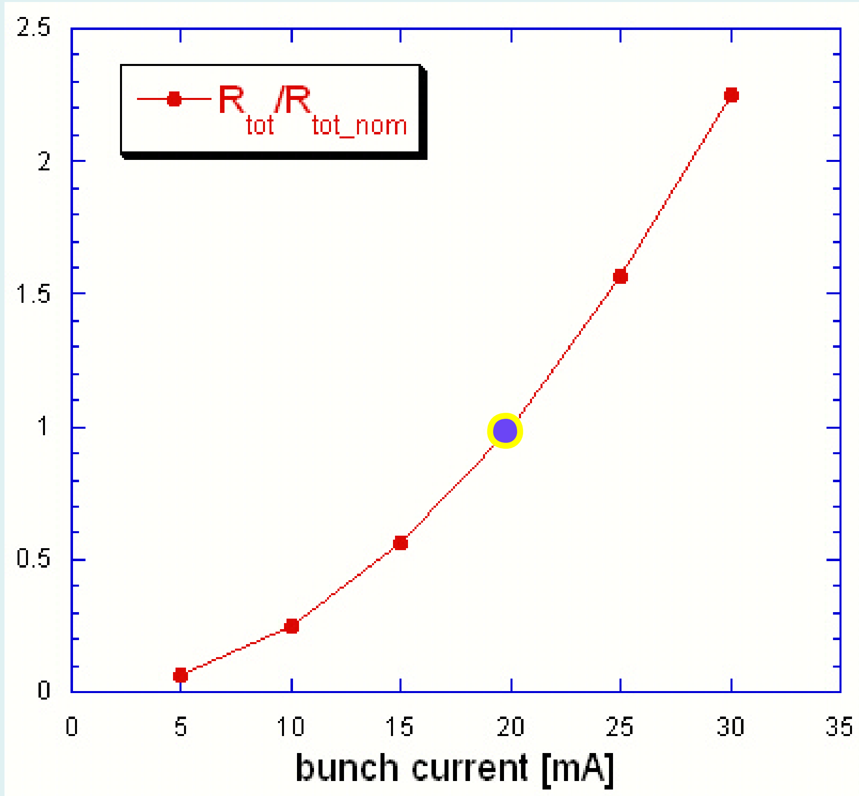


Touschek background rates vs coupling factor



N ? $1/\sqrt{?}$

Touschek background rates vs bunch current



N? I^2

CONCLUSIONS

The Touschek simulations successfully used at DAFNE

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The same tool can be used for the SUPERDAFNE design

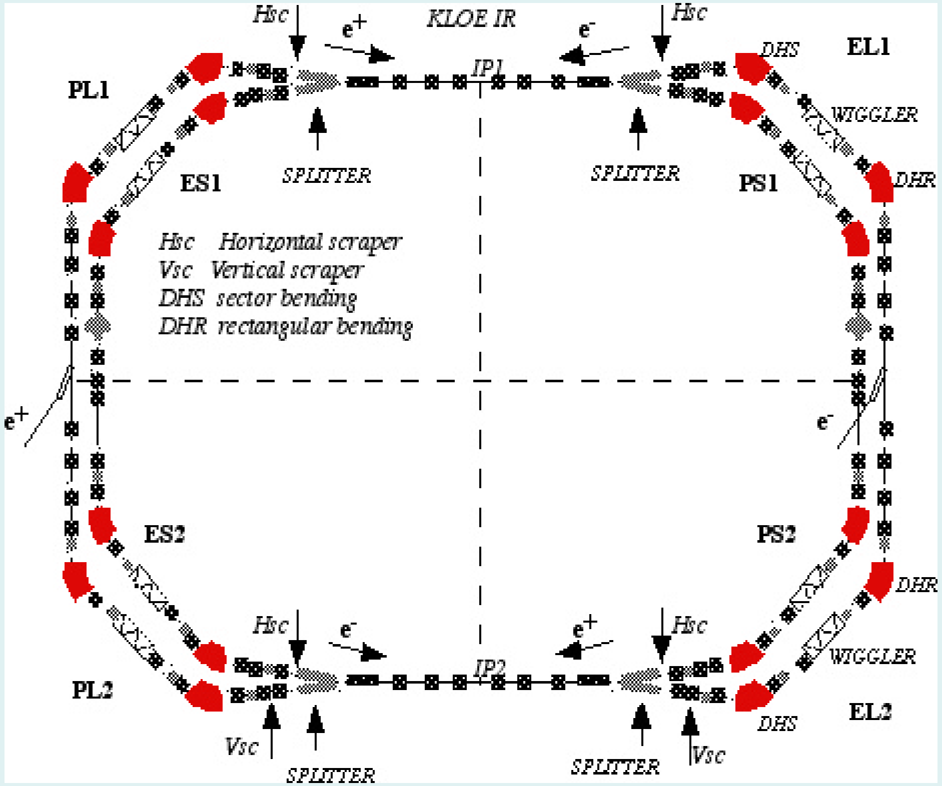
-to define position and shape of collimators, masks,…

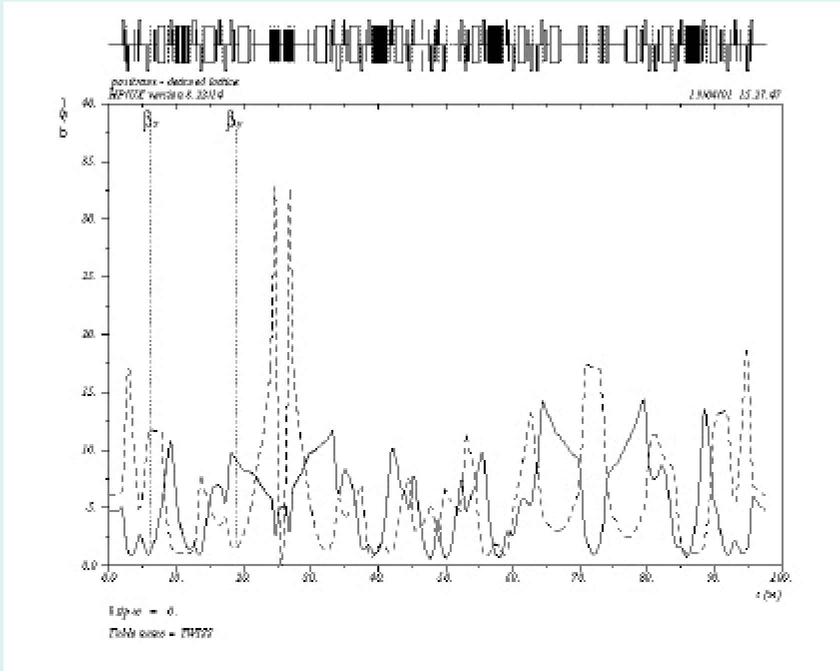
- to design the beam pipe in the ring - especially at IR

-to optimize the horizontal phase advance between

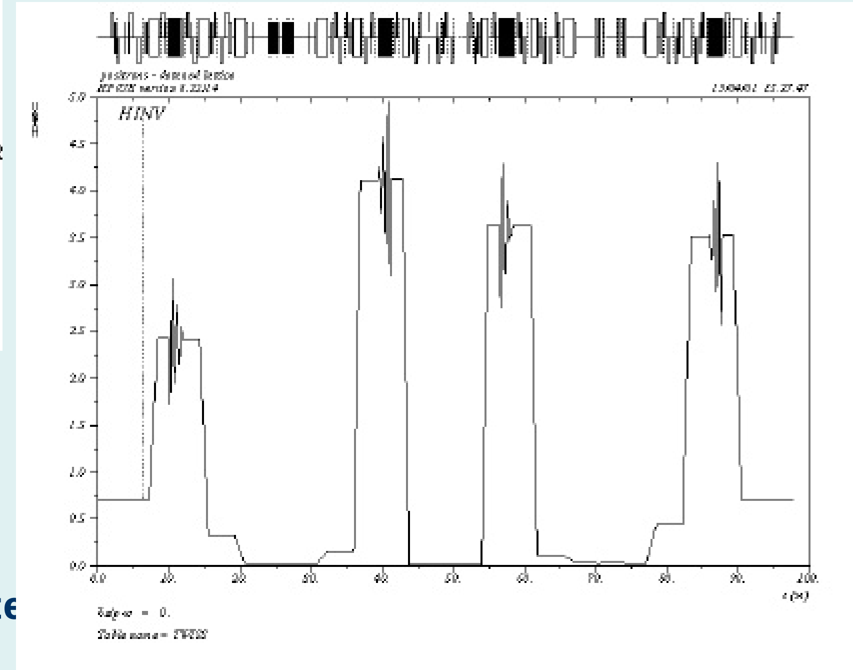
last cell and IP.

DAFNE





PL1 PS1 PS2 PL2



Touschek background SCALING

Lifetime scales like ✍ $? ? \; ?_l \, ?_x ?_y / I$

where $?_l \; ? \; I^{1/3}$

and the horizontal and vertical rms beam sizes are related by the roundness $R = ?_y / \; ?_x$

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for a constant $?_x$ lifetime goes like $? ? \; R/I^{2/3}$

and the background rate $dN/dt \; ? \; I/? \; ? \; I^{5/3}/R$