Programm for linear horizontal tracking

Motivation

- Studying failures of LHC equipment
- What happens to the beam?

Dipole Magnet Failures

due to

1. Magnet Quenches

$$\Theta(t) = \Theta_{max} - \Theta_{max} \cdot e^{-\frac{t^2}{2\sigma^2}}$$

$$\sigma \approx 200ms$$

2. Failure of the Power Converter or Power Abort

$$\Theta(t) = \Theta_{max} \cdot \left(1 - e^{-\frac{t}{\tau}}\right)$$

$$\tau = \frac{L}{R}$$

What does the programm?

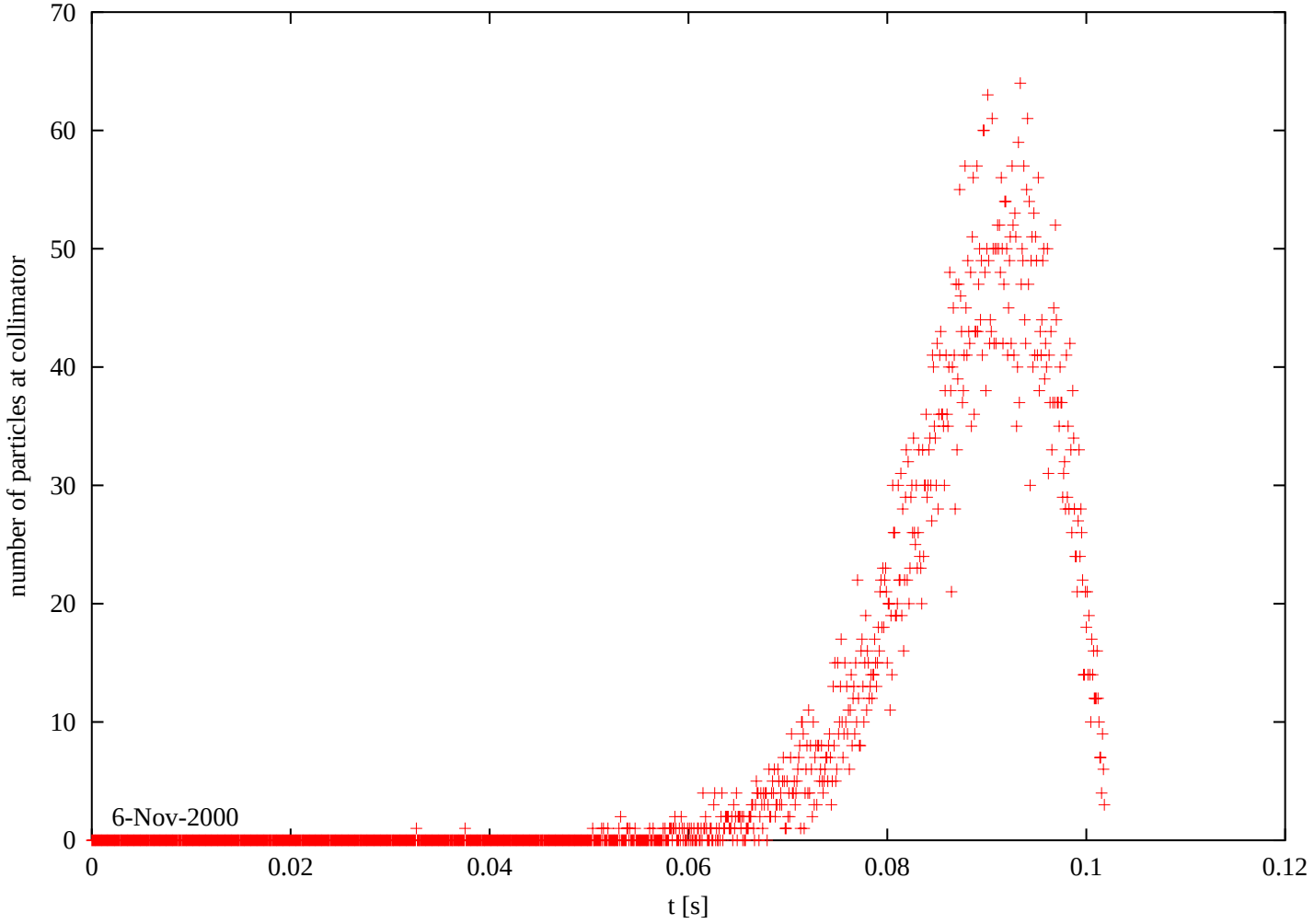
The displacement after k turns is:

$$\begin{pmatrix} x(k) \\ x'(k) \end{pmatrix} = \mathbf{M}_{k\,turns} \cdot \begin{pmatrix} x_0 \\ x'_0 \end{pmatrix} + \sum_{q=0}^{q=k} \mathbf{M}_{(k-q)\,turns} \cdot \begin{pmatrix} 0 \\ \Theta(q) \end{pmatrix}$$

The displacement due to the magnet failure is:

$$\Delta x(k) = \sqrt{\beta_{dip}\beta_{col}} \sum_{q=0}^{q=k} \sin(2\pi Q\,(k-q) + \Delta\psi)\Theta(q)$$

Beam1, Collision: Quench at D2 right of IP2, Primary Collimator in IP7



Parameters used for D2-Quench-Tracking

energy	7 TeV
emittance	0.503 nm
Q	64.310000473
σ_Θ	400 ms
$N_{particles}$	10^4
Θ_{max}	1.11 mrad

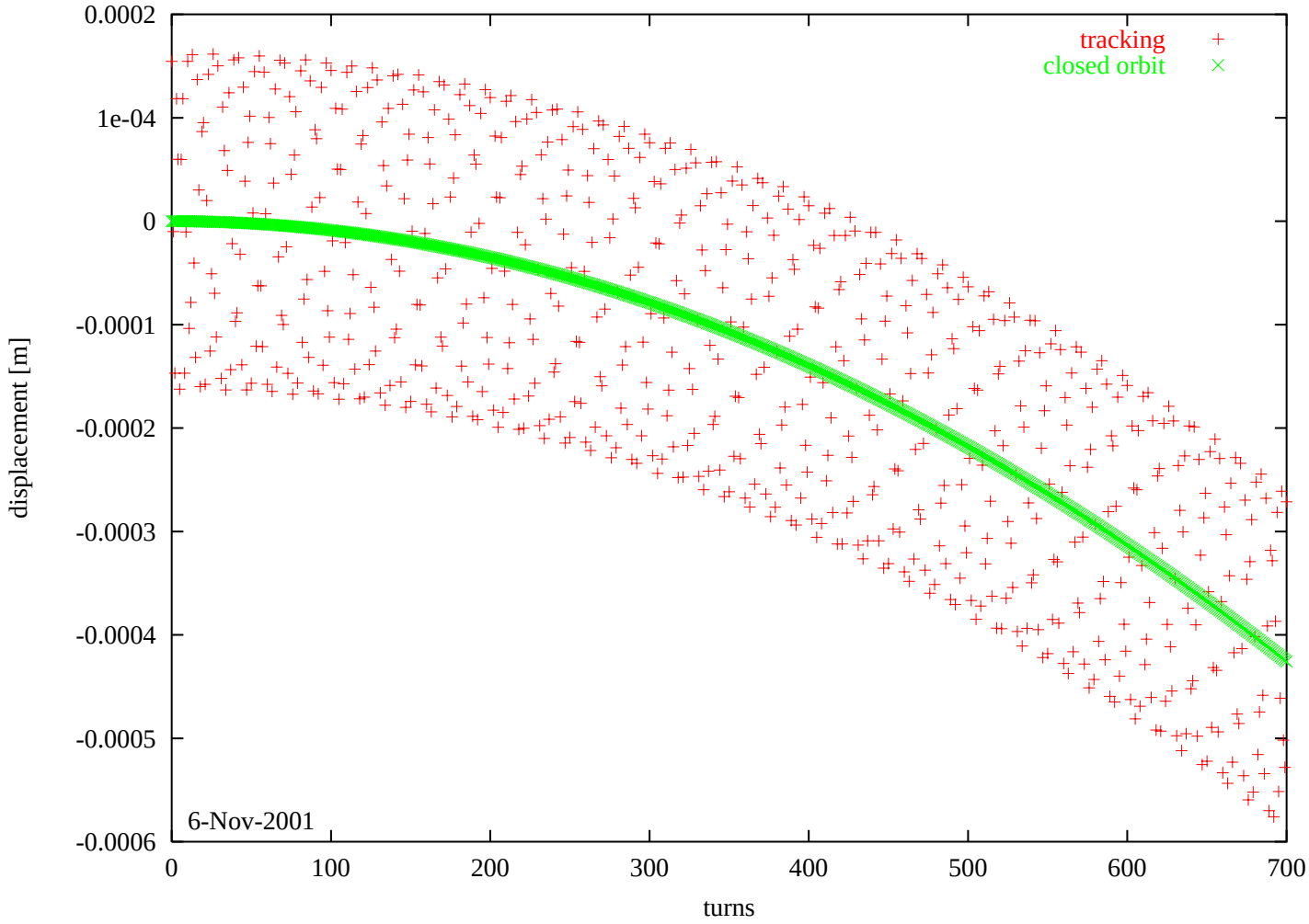
ΔB	2.742 T
l	9.45 m

$$\Theta_{max} = \frac{e}{p} \cdot \Delta B \cdot l$$

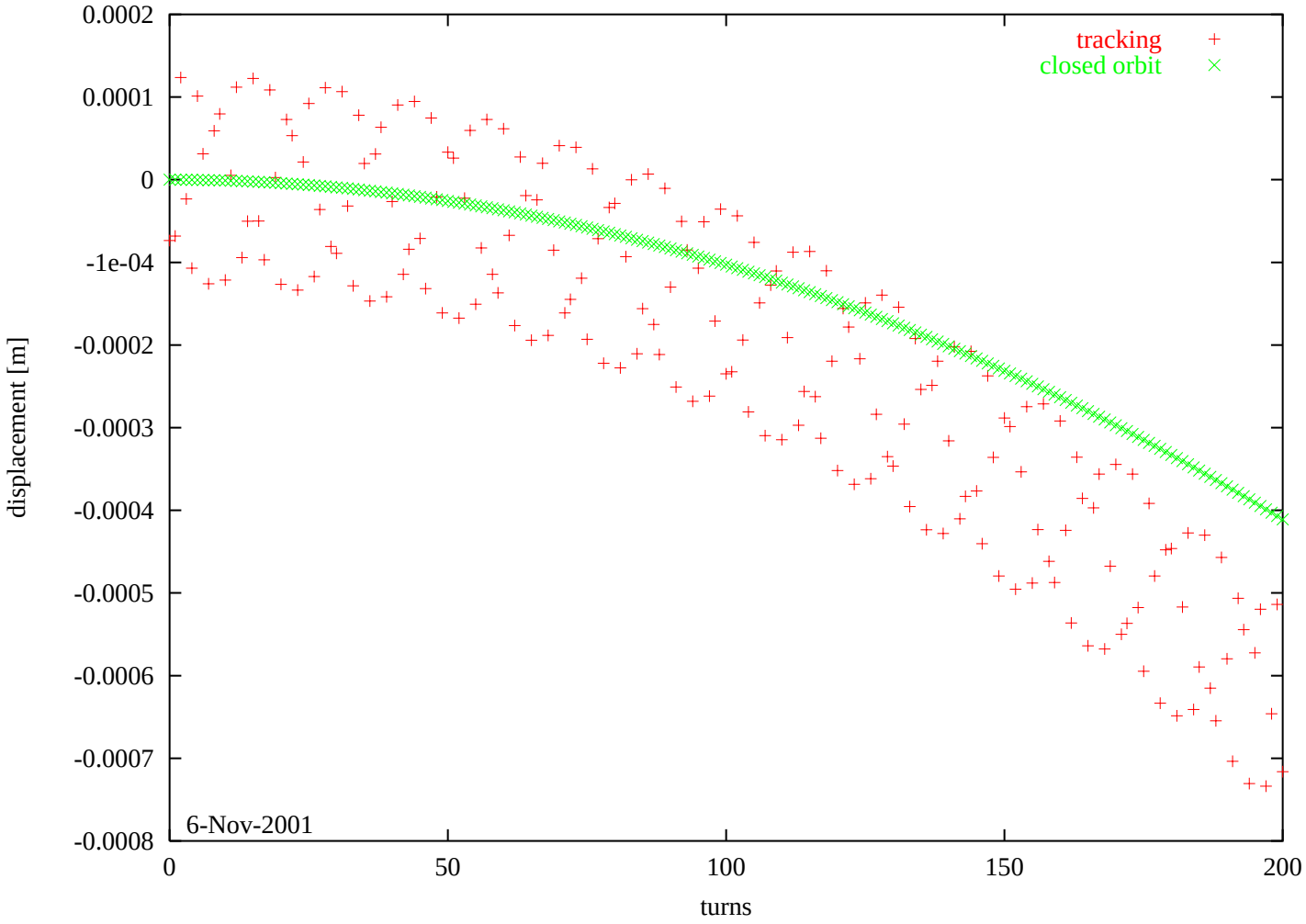
Horizontal Displacement of the Closed Orbit at Collimator-Position

$$x_{closed}(t) = \frac{\Theta(t)}{2}\sqrt{\beta_{dip}\beta_{col}} \cdot \frac{cos(\pi Q - \Delta\psi)}{sin(\pi Q)}$$

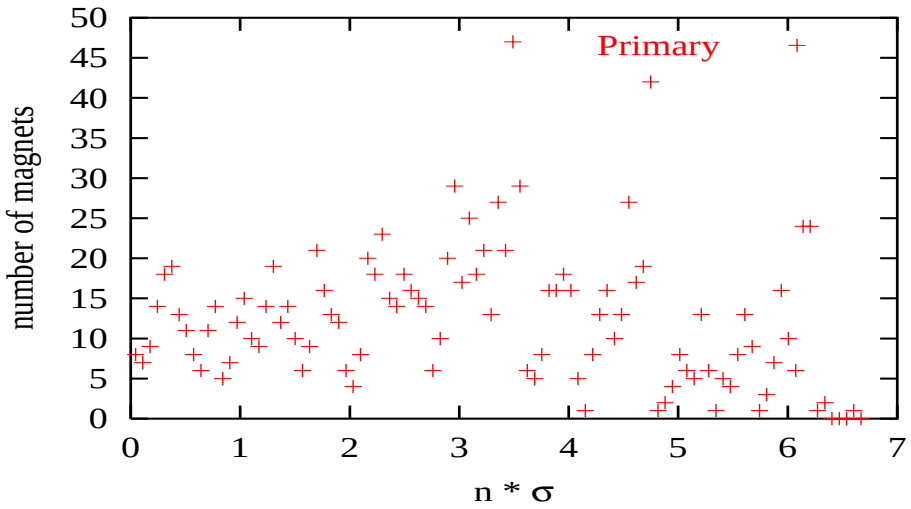
D2: It is sufficient to look at the closed orbit

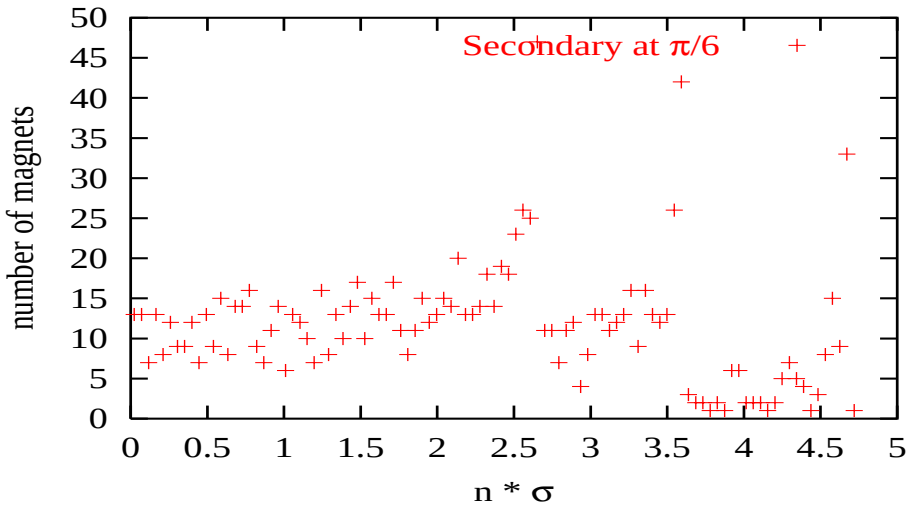


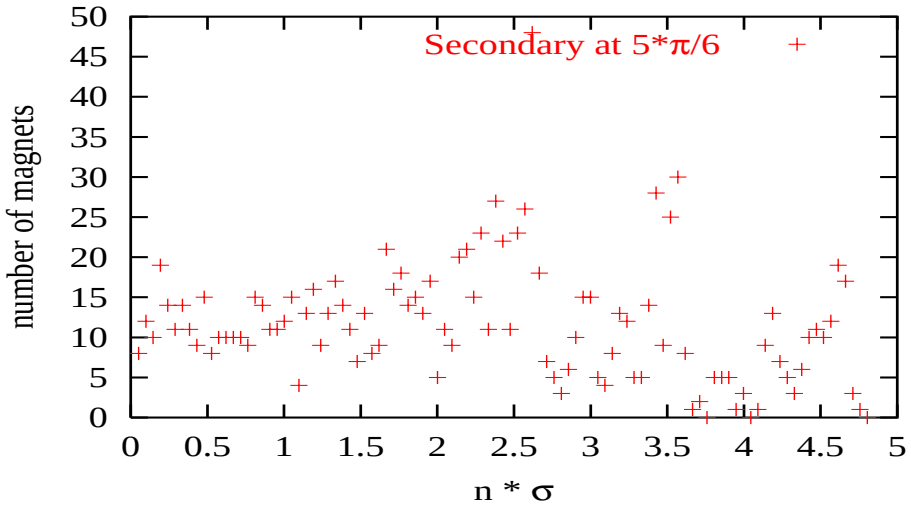
$\sigma_\Theta = 200$ ms, $\Theta_{max} = 5.11$ mrad: Tracking becomes necessary



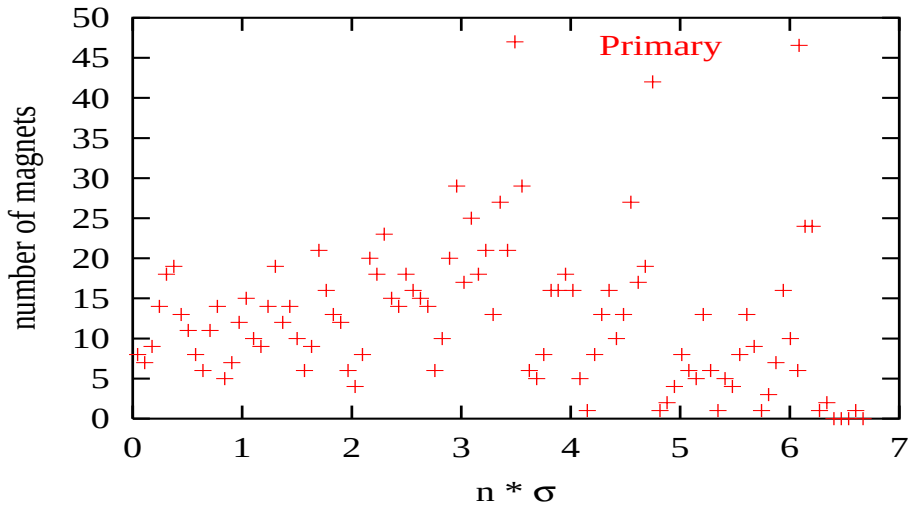
Secondary Collimators at ∼ 30° and at ∼ 150°

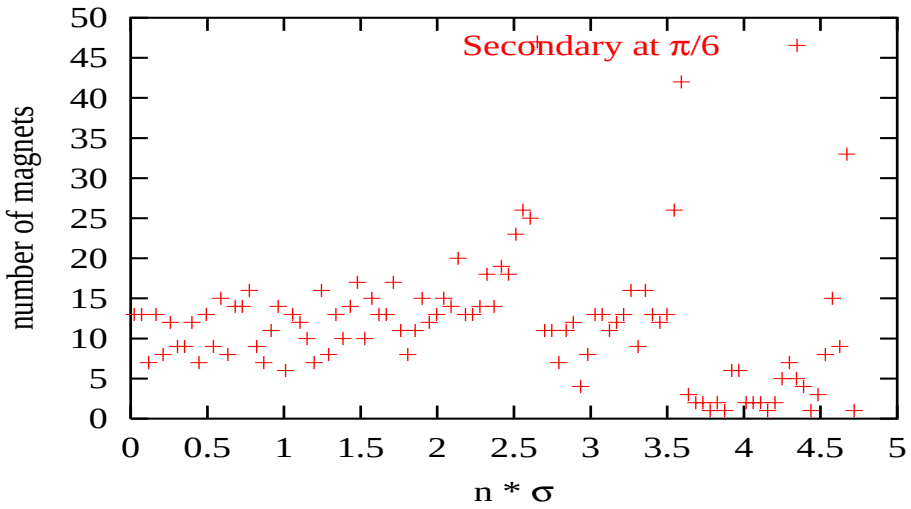


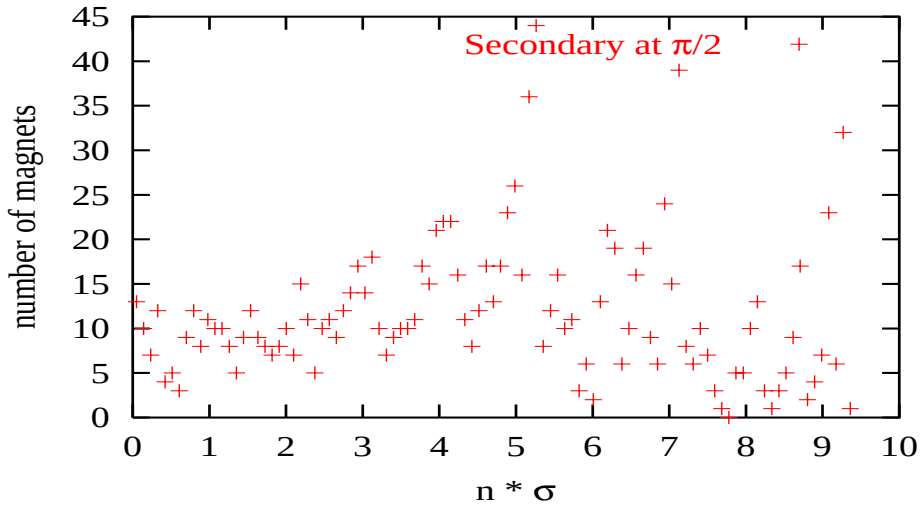


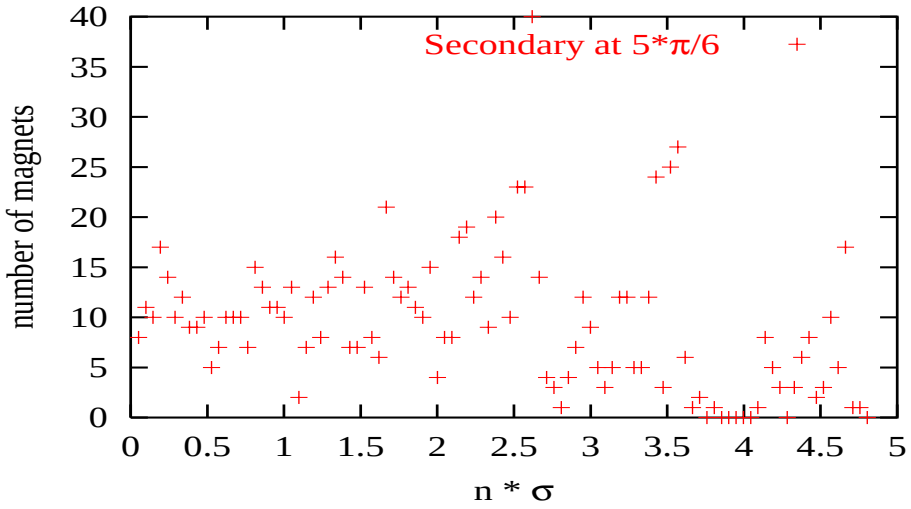


Secondary Collimators at ∼ 30°, ∼ 90° and at ∼ 150°









Parameters used for closed orbit–calculation at horizontal collimators at IP7, MB-magnet–Quench

energy	7 TeV
emittance	0.503 nm
Q	64.310000473
σ_Θ	400 ms
Θ_{max}	5.11 mrad

ΔB	8.33 T
l	14.3 m

total number of MB-magnets in the ring: 1232

after 360 turns: $\Theta = 1.7 \cdot 10^{-5}$ rad

Plans

- Including the vertical plane in my studies
- What happens to the beam, if there are more dipole magnet failures at the same time?