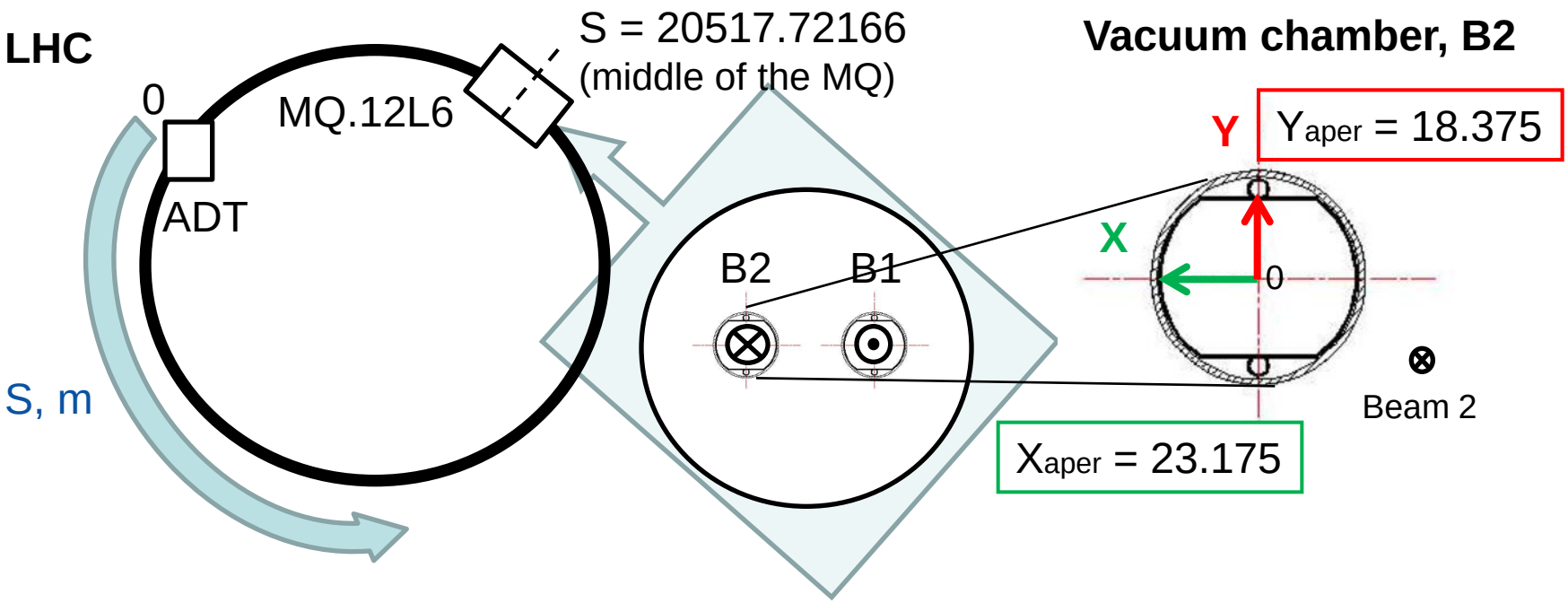
Conclusions from MAD-X simulations of fast-losses ADT QT

V. Chetvertkova, TE-MPE

Special thanks to
B. Auchmann, T. Baer, W. Höfle, A. Lechner, A. Priebe, M. Sapinski,
N. Shetty, R.Schmidt, A. Verweij, D. Wollmann

Coordinate system



Motivation

- Fast Losses Quench test aimed to reproduce **the UFO-induced beam losses** (with duration of a few milliseconds).
- UFO rate **increases with energy** and UFOs are expected to be a major **luminosity limitation** at 6.5 – 7 TeV.
- Knowing the quench limits will allow **validating the simulation** codes (QP3 etc.).
- BLM thresholds should be increased to **avoid undesirable beam dumps**.

Experiment

Injecting to the LHC

Ramping to the nominal energy

Calibration of the beam-distance to aperture: Increasing 3-corr. orbit bump until losses occur (21.61 mm – trim value; 17.89 mm– BPM reading), then reducing the bump by 2 mm. Beam scraping on hor. collimators

Measuring the beam profile (with BWS) => ε_x = 0.5e-6; ε_y = 14.1e-6

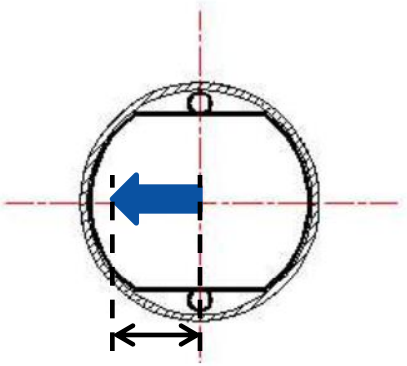
Opening the collimators

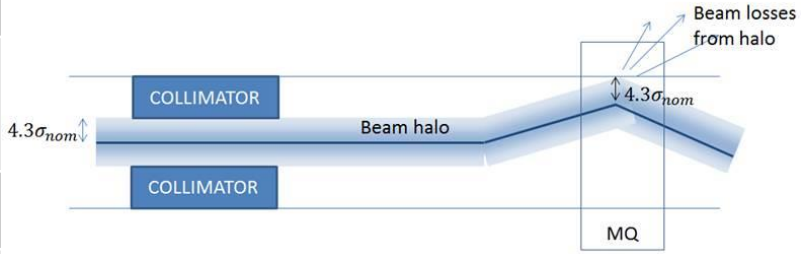
Choosing the bunch: Gating the ADT on it

Adjusting the bunch intensity: blowing up the bunch slowly in the vertical plane

Setting the bump to x=21.61 mm

Excitation of the bunch: MKQ kick and ~11ms later – ADT excitation





Simulations

Simulation parameters: Injection optics: β* are 11/10/11/10, Energy 4 TeV. Beam profile – from BWS measurements: Gaussian;

ε_x = 0.5e-6; ε_y = 14.1e-6.

3-corr. orbit bump with an offset $4.3\sigma_{nom}$ from the beam screen (~21.54 mm from the centre of the BS)

MKQ kick (single)

ADT excitation (depending on turn)

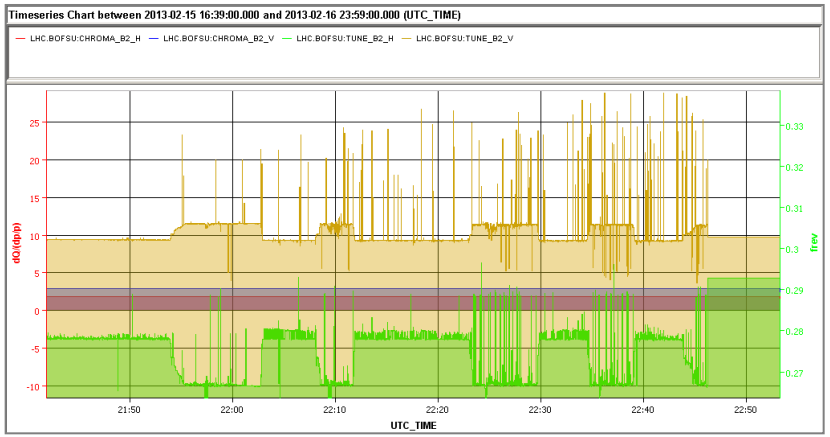
*Correcting the tune during the ADT excitation

*MQ errors are taken into account

*No matching after applying the bump

Parameters, influencing the results of the simulations

– Tune (no information about the tune change during the test)



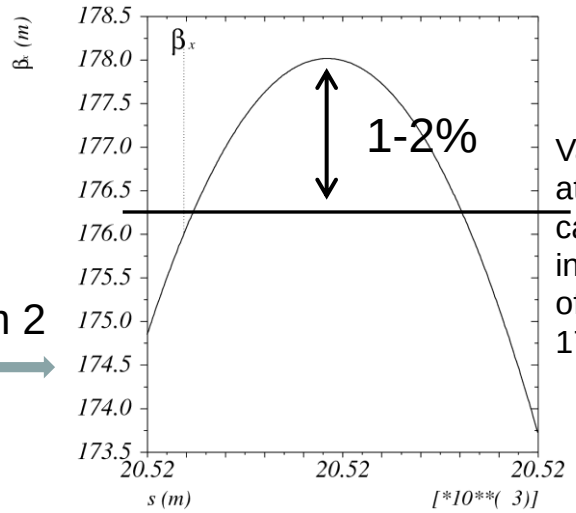
– Beam profile

- Beam emittance
- Tail population

– β-function in the MQ.12L6

β beat is <10%.

Beam 2



Value of the β-function at MQ.12L6 when calculated with nominal injection optics and the official LHC sequence : 176.3 m

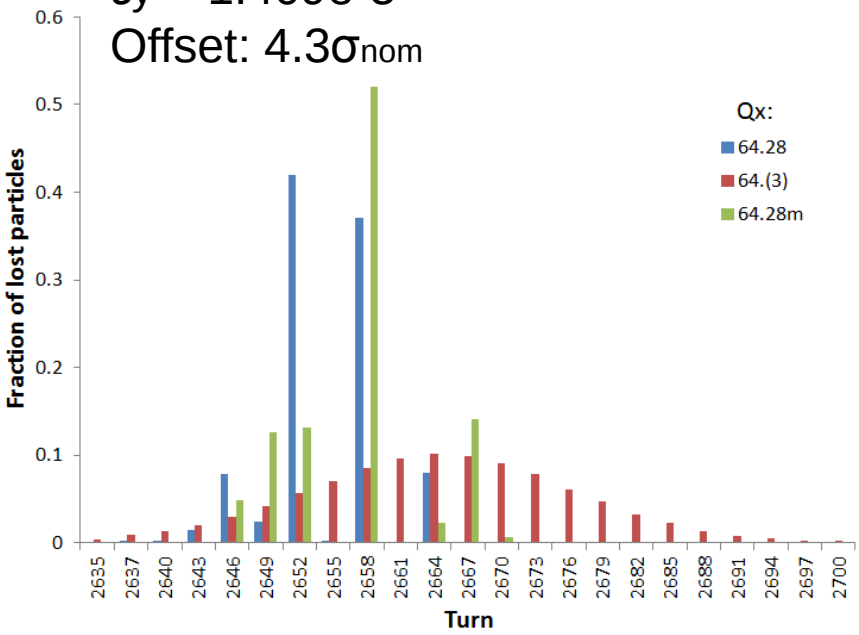
β-function along the MQ.12L6

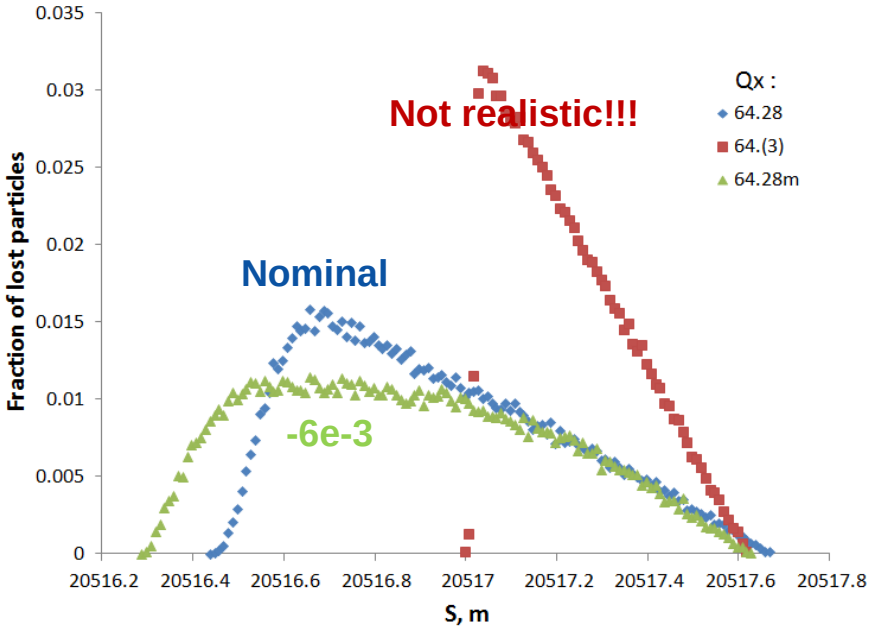
– Bump amplitude

Dependence on the tune

Nominal tune spread < 1e-3

εx = 5.195e-7
εy = 1.409e-5
Offset: 4.3σ_{nom}





Q_x = 64.28 → (3CB) → Q_x = 64.274

Q_x = 64.28 → (3CBm) → Q_x = 64.268

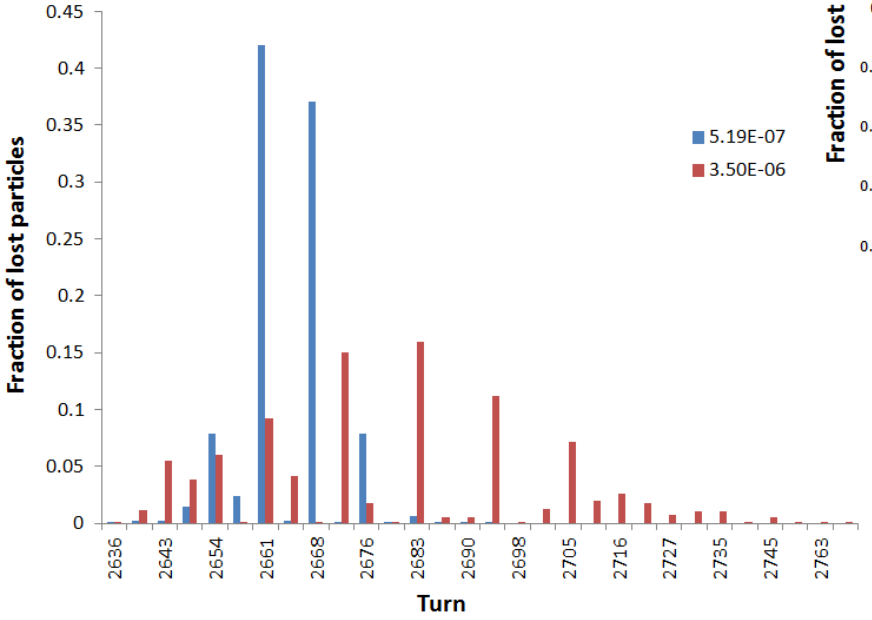
Q_x = 64.(3) → (3CB) → Q_x = 64.3330

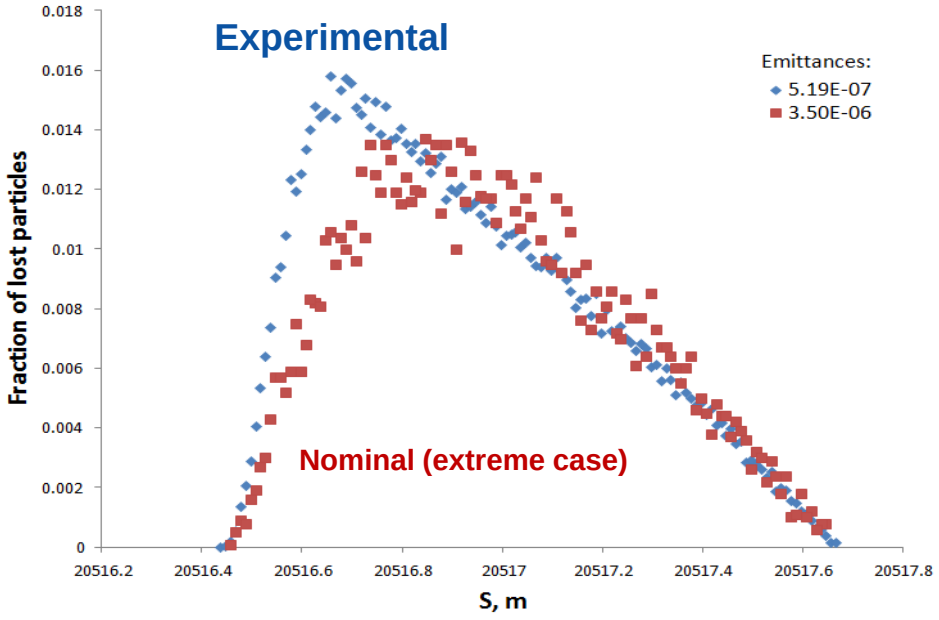
3CBm – matching the tune

<u>Conclusion</u>:
Tune variation influences longitudinal loss distribution, however the **maximum for realistic cases varies ~ 20%**

Dependence on the beam size

Q1 = 64.28
Q2 = 59.31
Offset: 4.3σ_{nom}





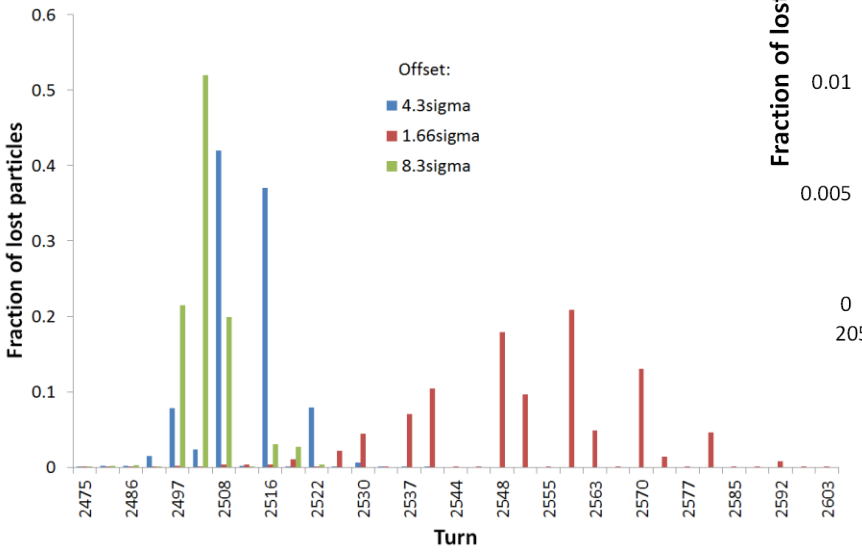
$\varepsilon_{n,x}$ = 5.19e-7

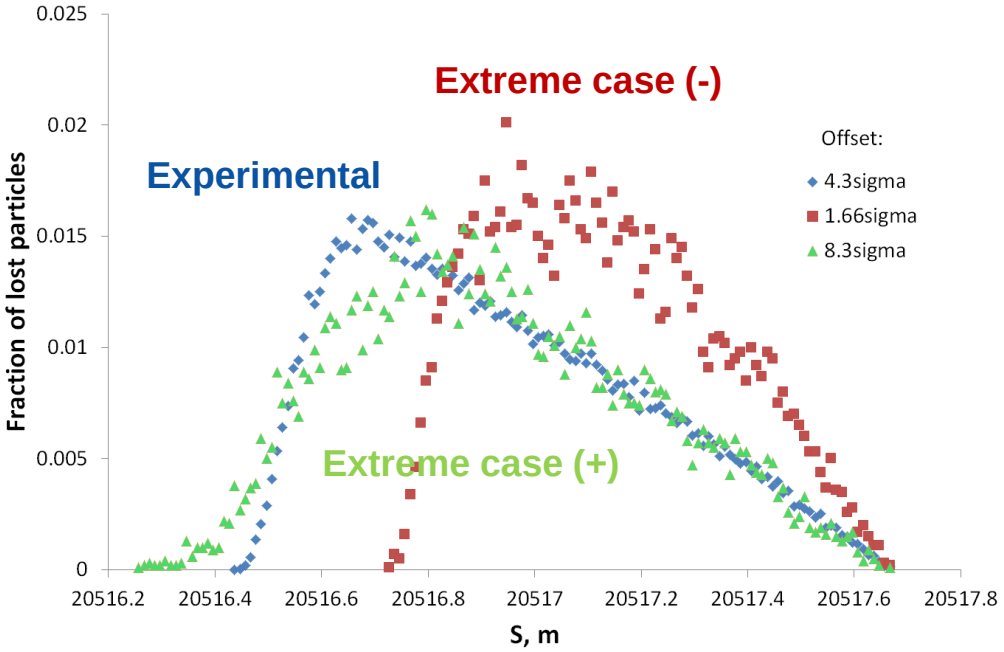
$\varepsilon_{nom,x}$ = 3.5e-6

<u>Conclusion</u>:
Influence of beam size on longitudinal loss distribution **is small**.

Dependence on the bump amplitude

εx= 5.195e-7 Q1 = 64.28
εy= 1.409e-5 Q2 = 59.31





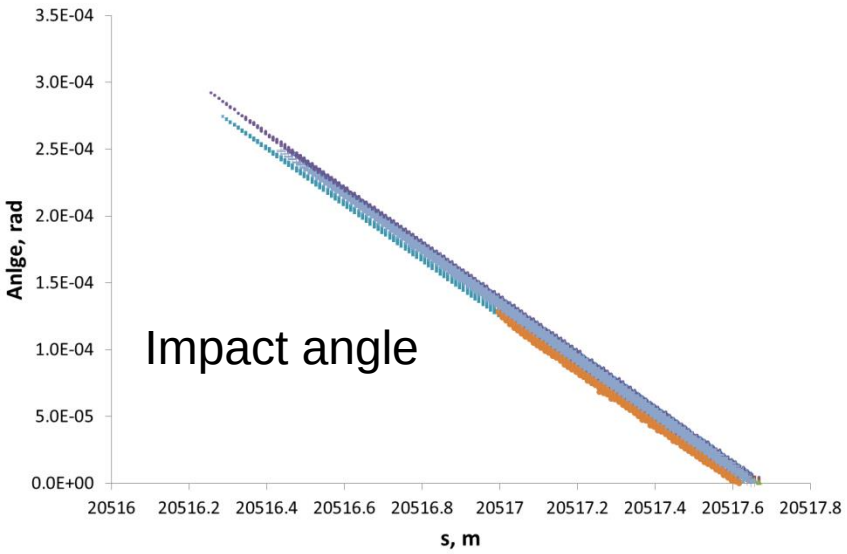
Offset = 4.3σ_{nom}

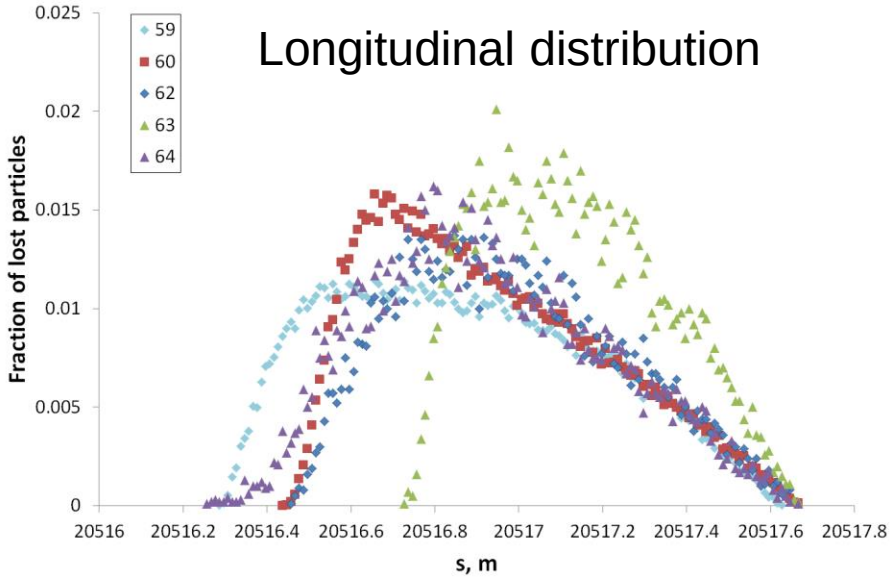
Offset = 1.66σ_{nom}

Offset = 8.3σ_{nom}

Conclusion:
Size of orbital bump has only **small influence** on maximum of lost-particles distribution

Dependency of impact angle





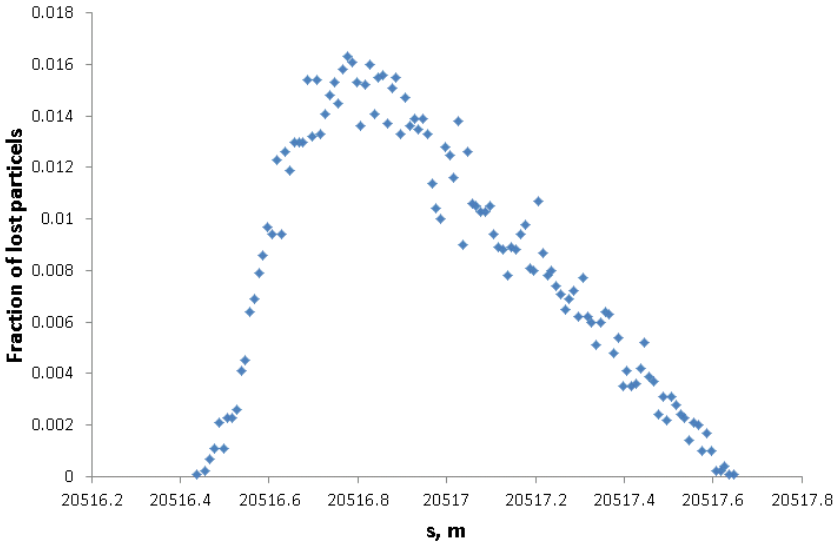
Conclusion:

Impact angle **depends only on magnetic field** and **not on excitation** scenario.

For realistic cases impact angle of maximum loss **varies within 50 urad**.

Conclusion

- **Tune variation** influences longitudinal loss distribution, however the maximum for realistic cases varies **~ 20%**.
- Influence of **beam size** on longitudinal loss distribution is **small**.
- **Size of orbital bump** has only **small** influence on maximum of lost-particles distribution.
- **Impact angle** depends only on magnetic field and **not on excitation** scenario.
- **Time distribution** is extremely **sensitive** to all variations. Experimental one **not reproduced**.



Q_x; Q_y	64.271; 59.301
Orbital bump	$4.3\sigma_{nom}$
ε_x; ε_y	0.5195e-6; 14.09e-6
Matching tune after applying bump: No	
MQ errors	Yes