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Tuning of the PSI 590 MeV Ringcyclotron for Accepting and Accelerating a Rebunched 72 MeV Proton beam

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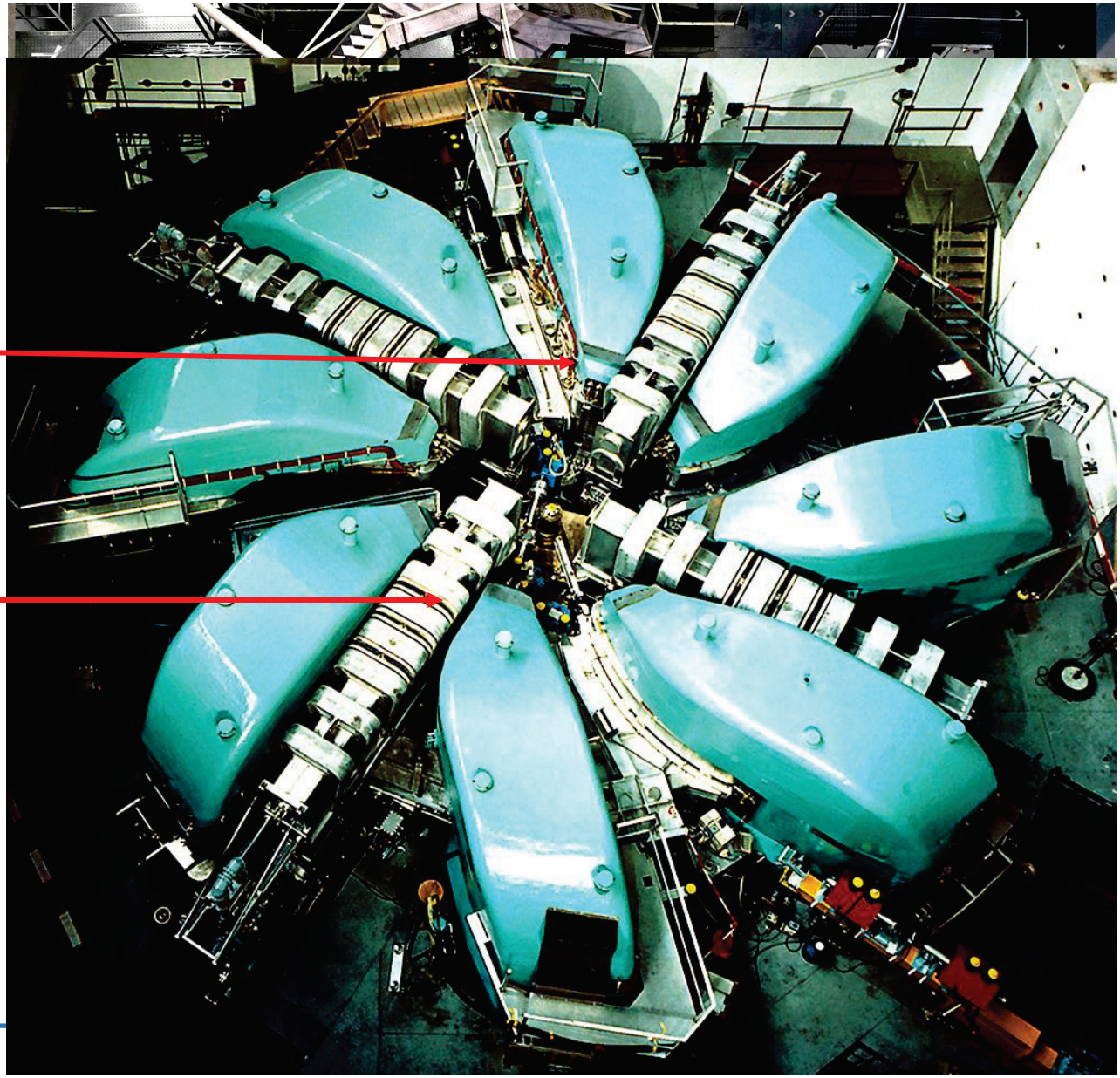
The PSI 590 MeV Ring cyclotron 1973 - 2013

RF-Flattop System:

Flattop Cavity
500 kV 150MHz, **1.9m**
Half Wave Resonator

Main Cavity
850 kV 50MHz, **5.2m**
Quarter Wave Resonator

Proton intensity: 2400μA



Success Factors for PSI Ringcyclotron

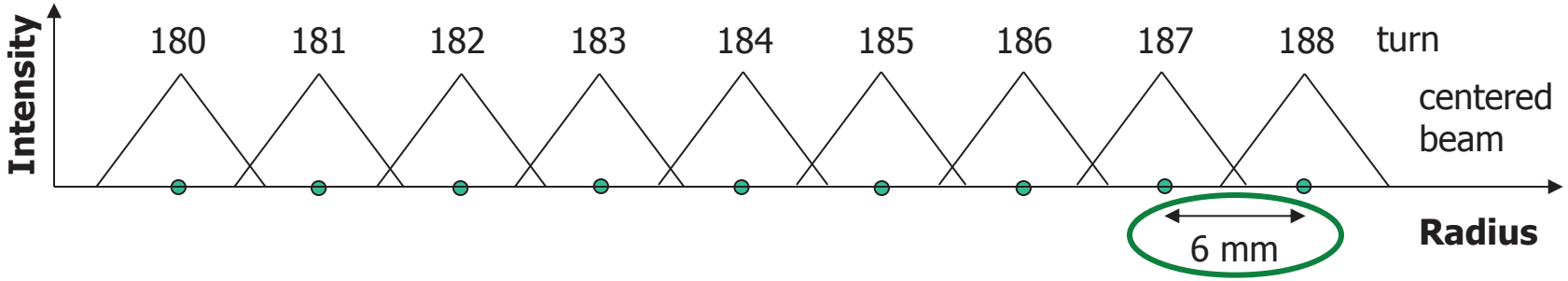
1. Magnets and RF-System are decoupled
2. 4 high voltage cavities → I max ~ V^3
3. large Radius R → high turn separation dR/dn ~ R·V
   → fast acceleration into fringe field, where Qr drops: dR/dn ~ $1/Qr^2$
4. excellent beam from Injector → separated turns
5. Flattop Cavity → high phase acceptance $\Delta\Phi$
6. eccentric Injection → Qr at extraction 1.75 => 1.5
   → wins factor 3 in dR/dn: 6 => 17mm
7. straight electrostatic Septum with 0.1mm strips → Losses at extraction ≈ 10^{-4}

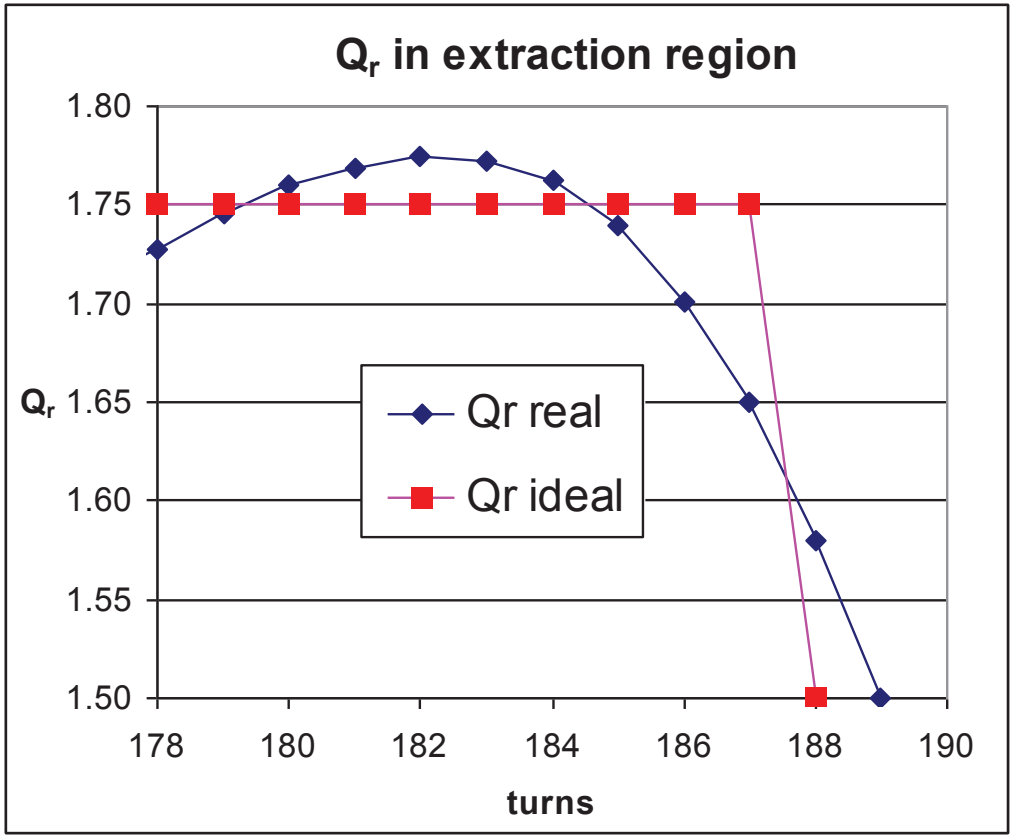
1.4 MW Beam Power

W.Joho 2013

Courtesy Werner Joho

Last turns in the Ring cyclotron

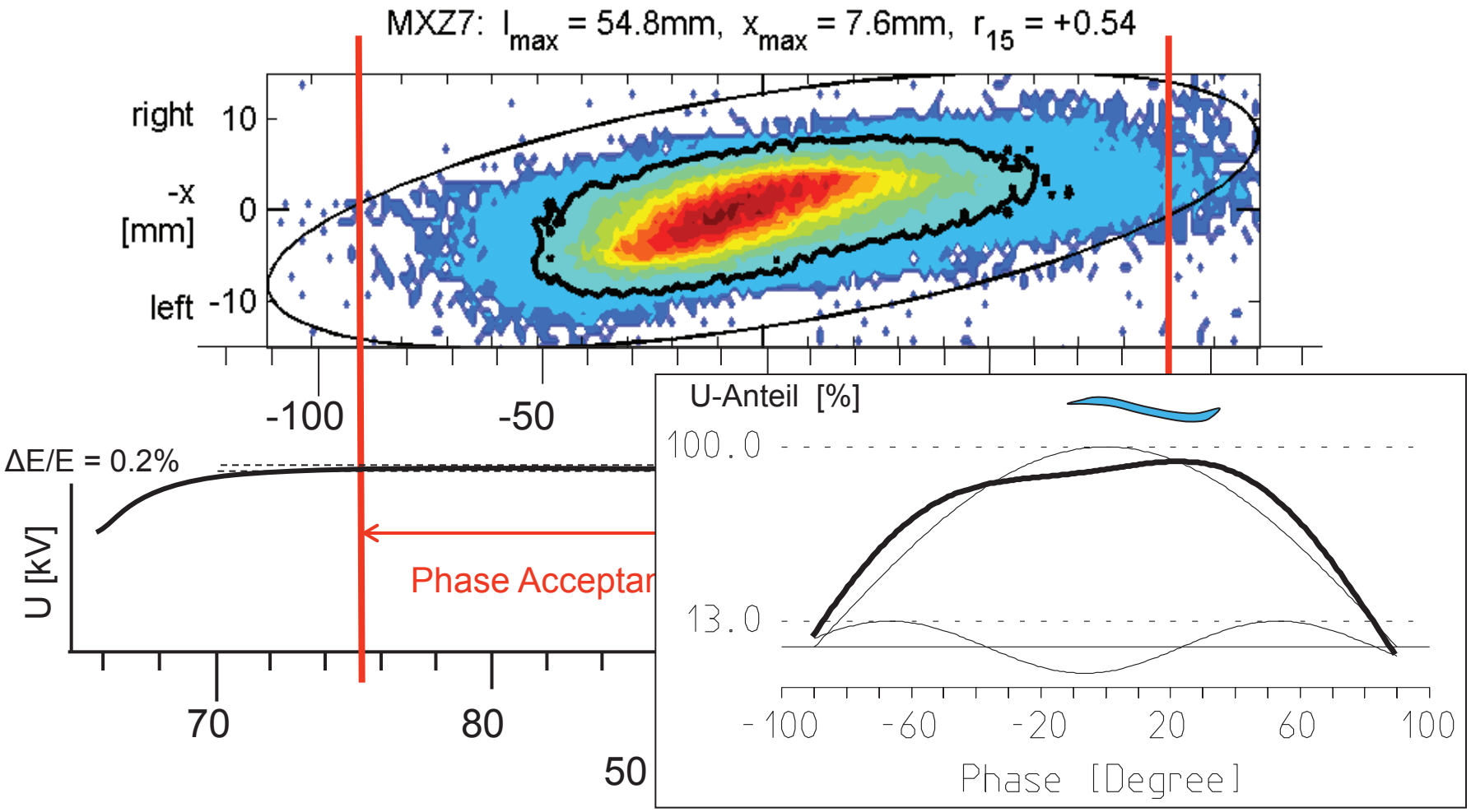




Courtesy Werner Joho

MXZ7 Bunch Shape Monitor Scan at 2.3 mA

Ekin = 72Mev => β = 0.371, v = 111.1mm/ns
Frq. = 50 MHz => T = 20 ns, v = 6.2mm/Deg.



Courtesy Rudolf Dölling

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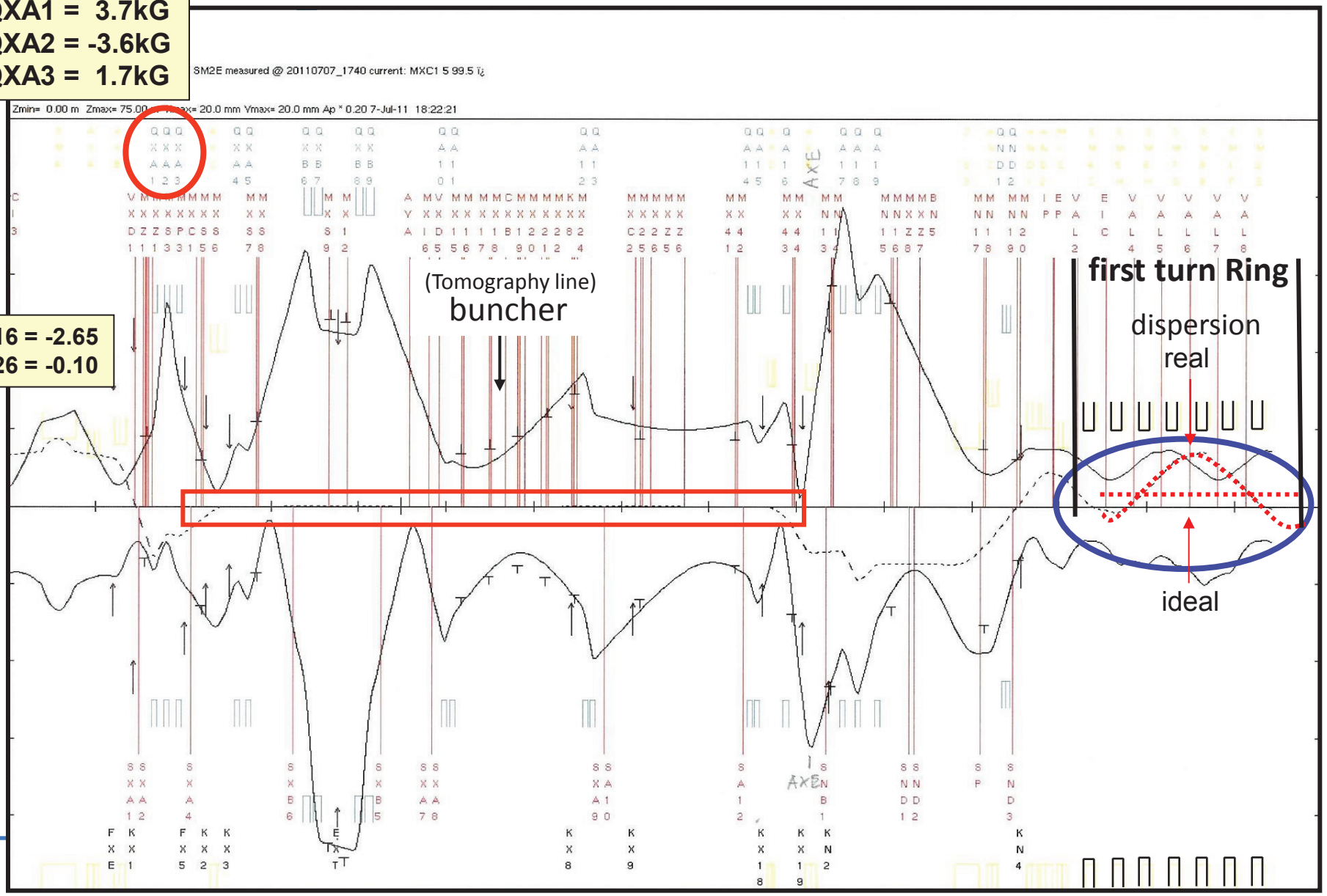
Graphic Transport-Fit of IW2-Line Setting DN01

QXA1 = 3.7kG
QXA2 = -3.6kG
QXA3 = 1.7kG

R16 = -2.65
R26 = -0.10



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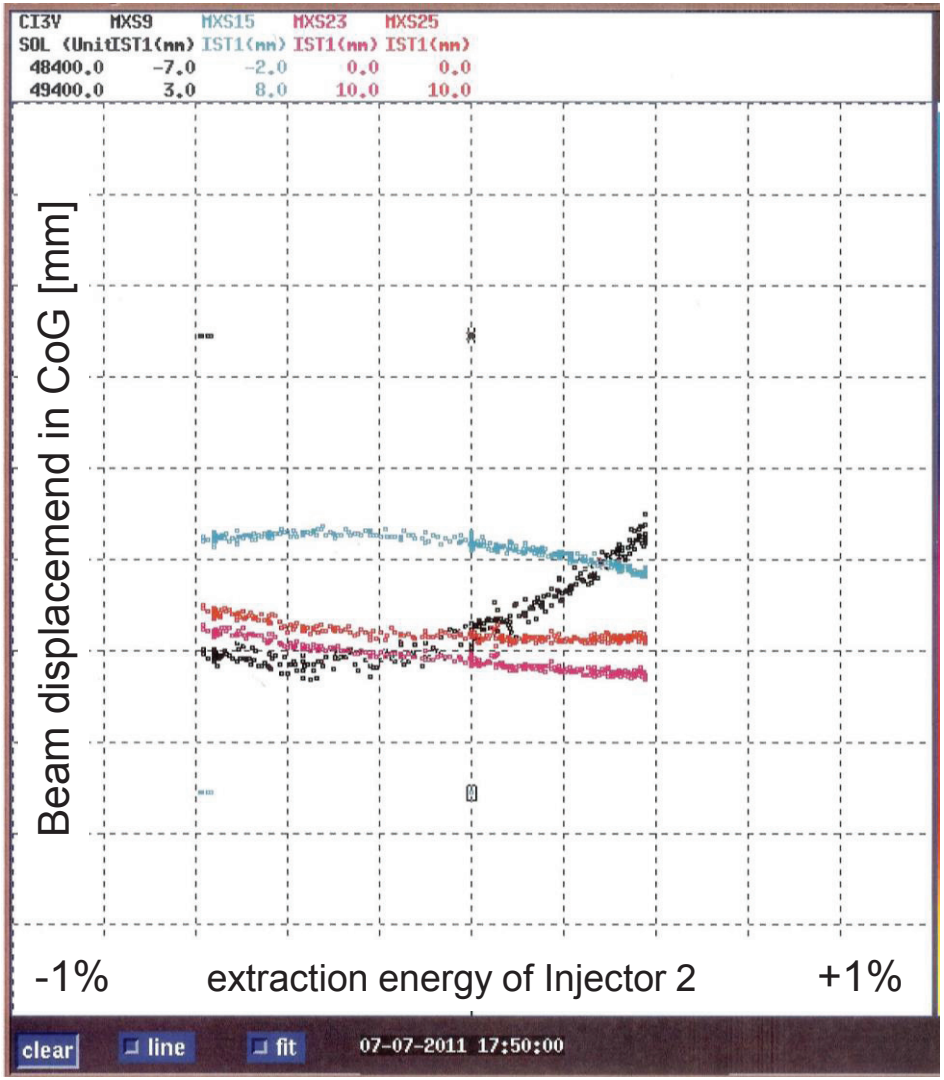
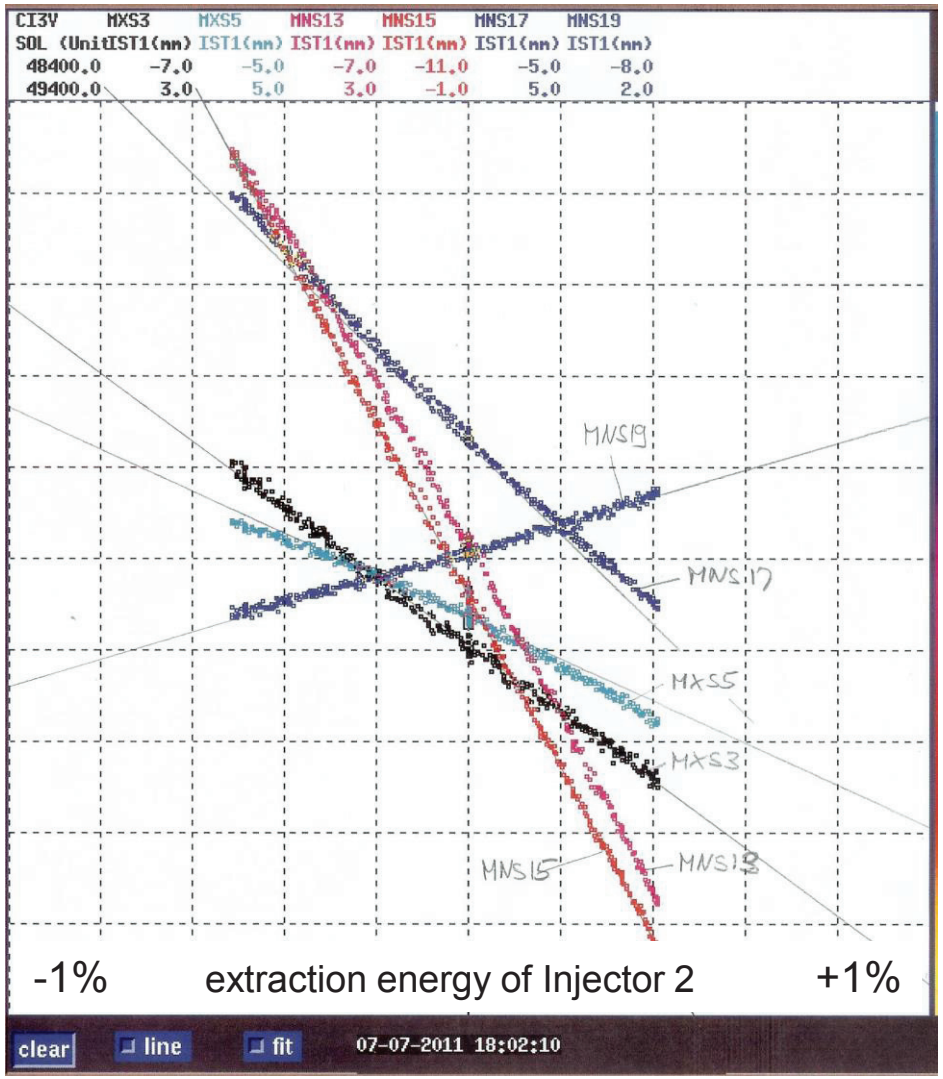
Centre of Gravity Scans of Beam Optic DN01



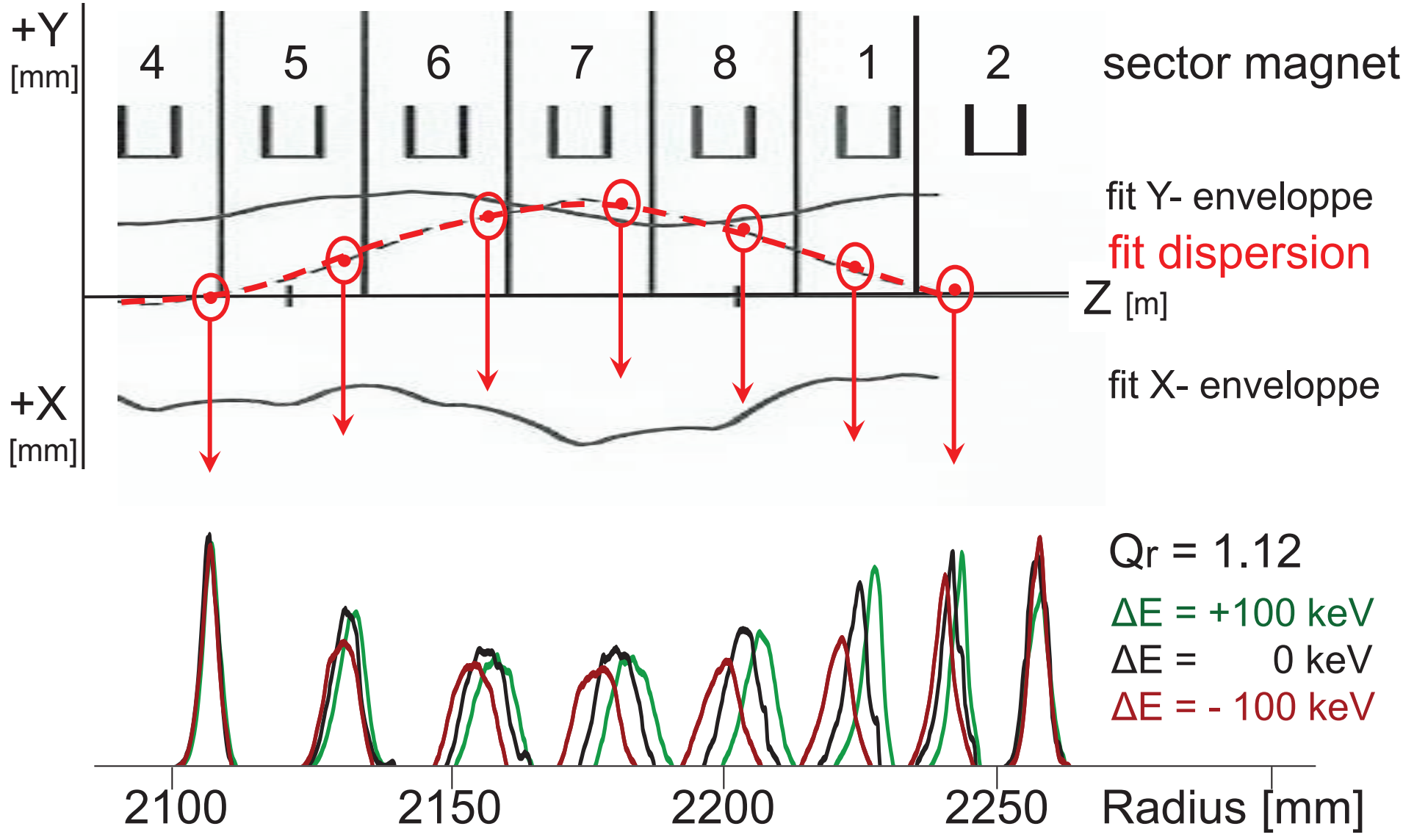
monitors in the dispersion free section



monitors off the dispersion free section

ΔCI3V = 1000
ΔP/P = 0.23x1000/49400 = 4.6%

Dispersion-Fit and RRI2 Current Probe



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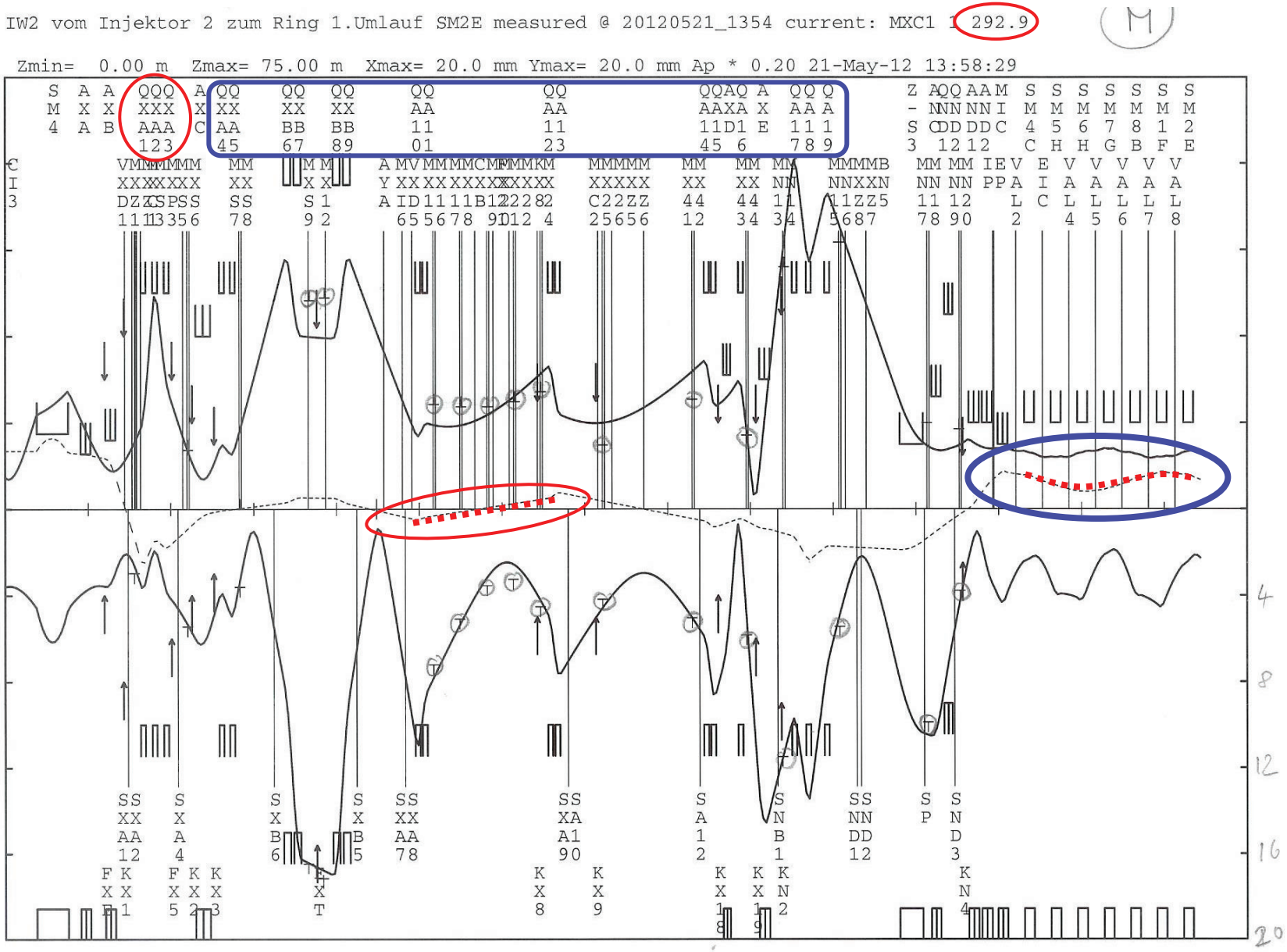
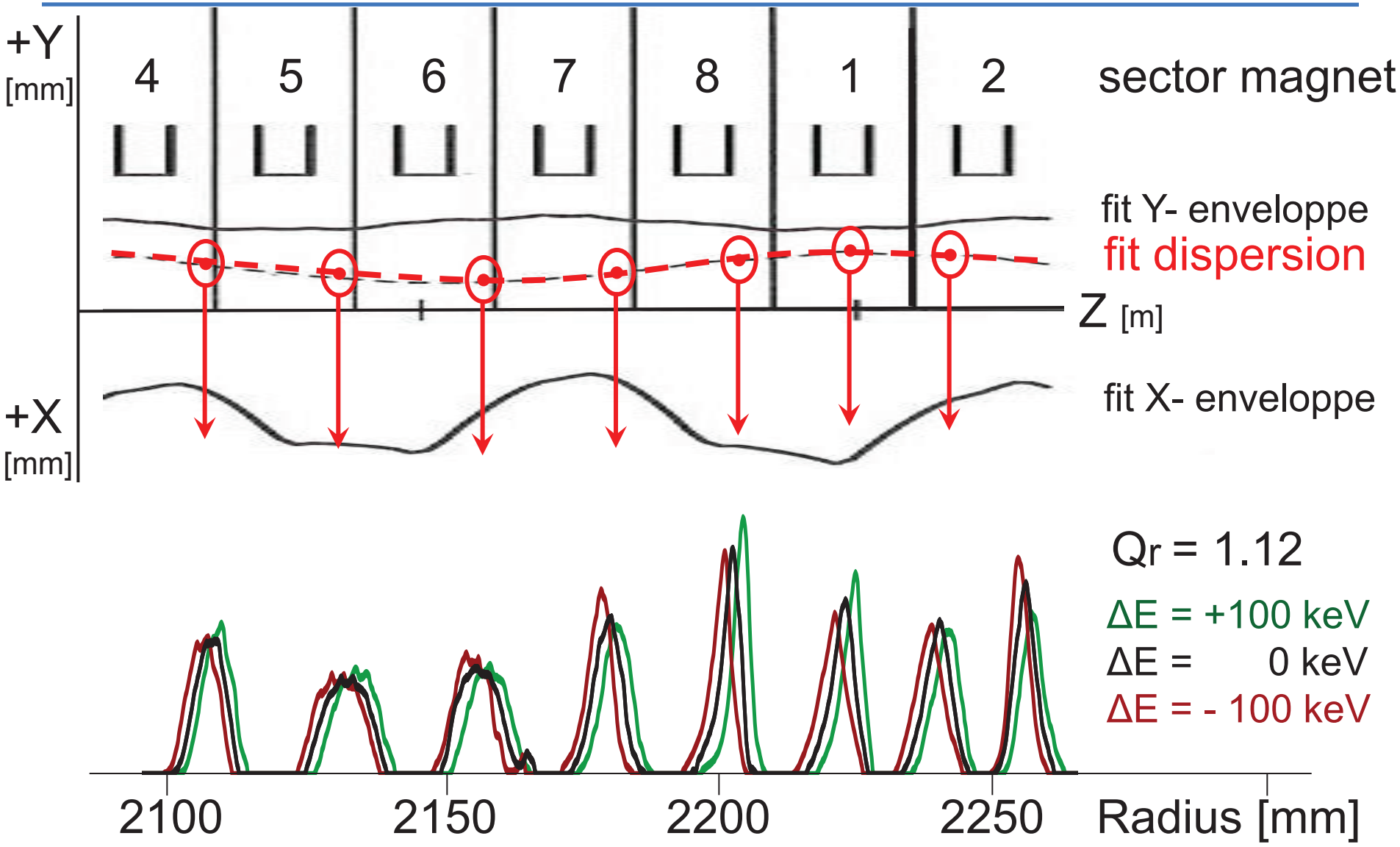
Matched Ring Injektion (Setting DN05b)



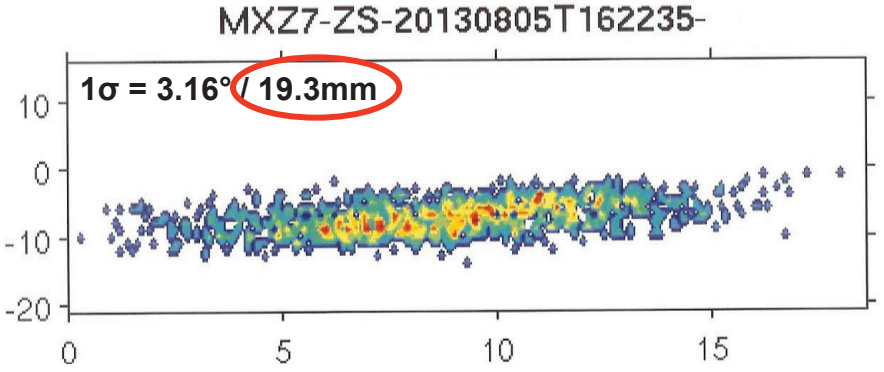
Dispersion-Fit and RRI2 Current Probe

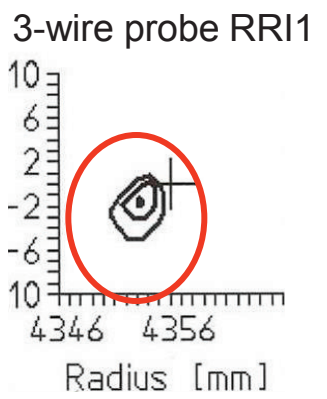


Bunch Shape Monitor Scans at I_p = 200 µA

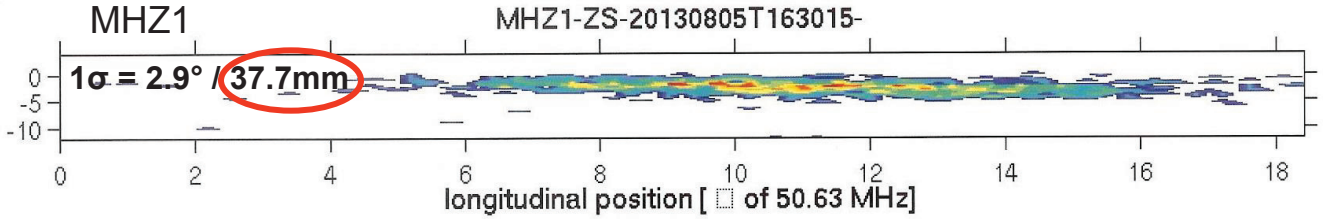
Buncher off

before injection into the Ring cyclotron



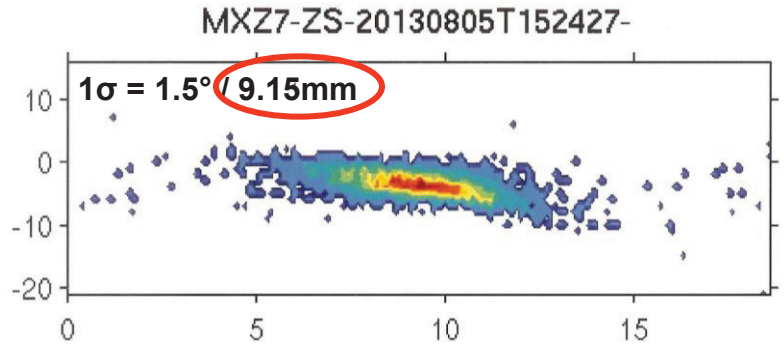


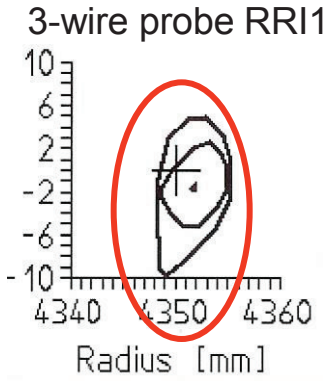
after extraction from Ring



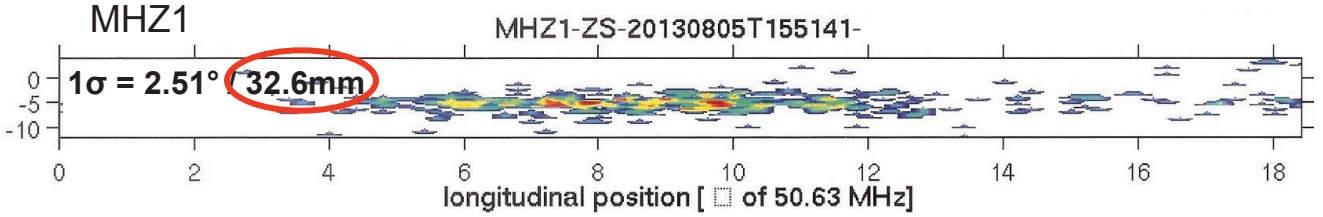
Buncher 200 kVp

before injection into the Ring cyclotron





after extraction from Ring



The 72 MeV transfer line is sufficiently equipped for the buncher based beam injection into the Ringcyclotron, the appropriate device settings are successfully tested.

In order to accelerate properly a bunched high intensity beam, more insight by means of additional equipment, as well as by a substantial effort in precision simulation is needed.

Conclusions

The 72 MeV transfer line is sufficiently equipped for the buncher based beam injection into the Ringcyclotron, the appropriate device settings are successfully tested.

In order to accelerate properly a bunched high intensity beam, more insight by means of additional equipment, as well as by a substantial effort in precision simulation is needed.


Thank You for Your Attention!