LBS-Line
Old Design Vs. New Approach

Bottlenecks

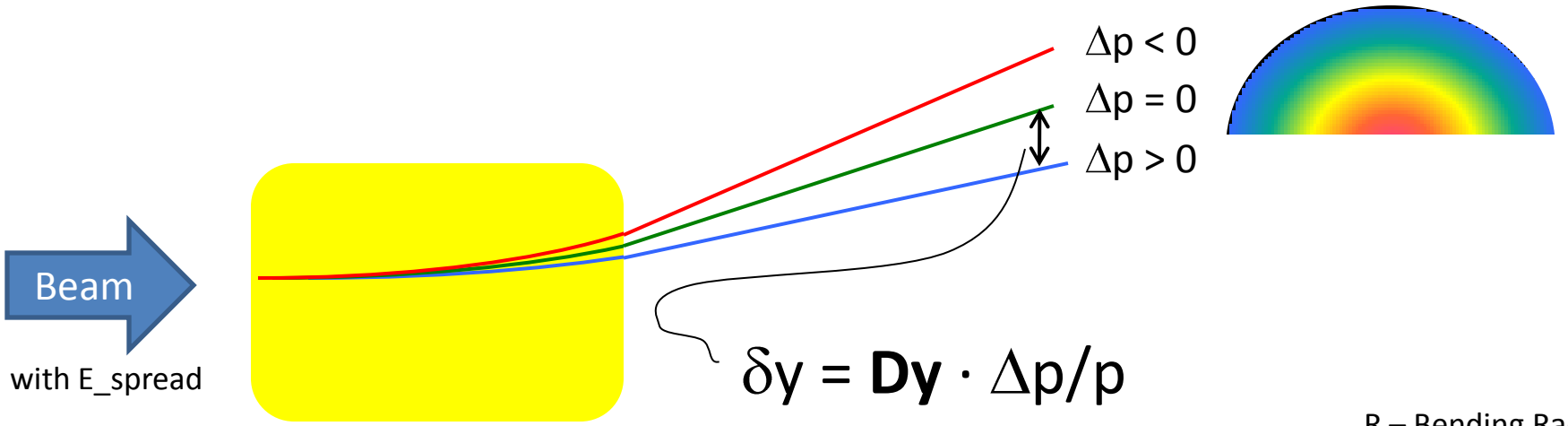
- Spectrometer Magnet
- Slit required?

Agenda

- What is Dispersion?
- What do we need?
- Present Design
- Alternative Scenario 2
- Alternative Scenario 3
- Summary

Theory - Insertion

Bending Dispersion – 1:1 Analogon – Light in X-tal

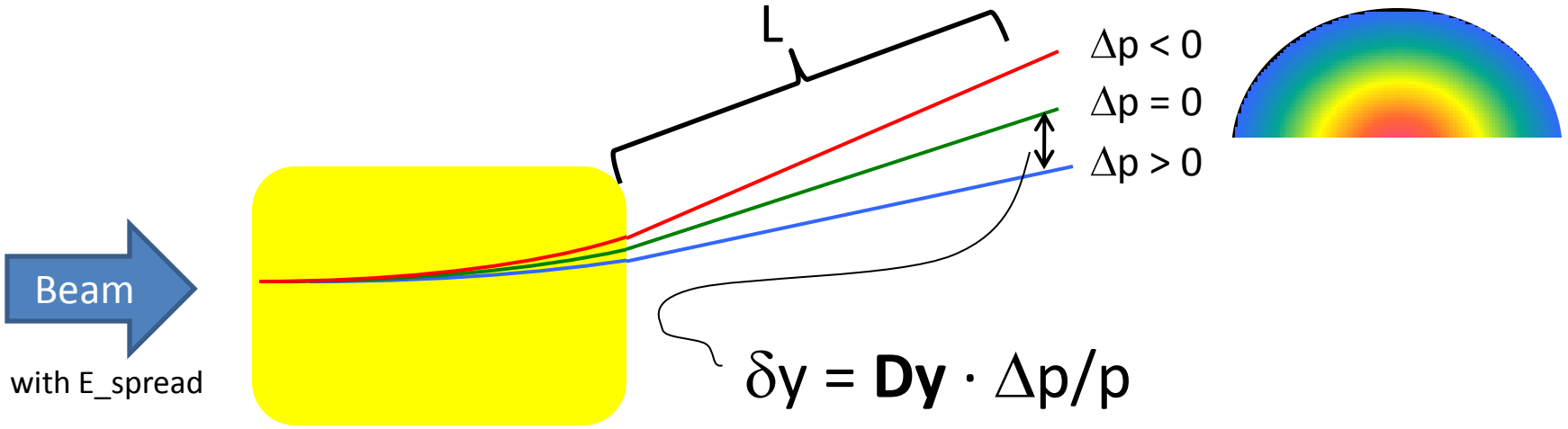


R – Bending Radius
(s/R) – Bending Angle

$$R_{SBEND} = \begin{pmatrix} cos(\frac{s}{R}) & Rsin(\frac{s}{R}) & 0 & 0 & 0 & R(1-cos(\frac{s}{R})) \\ \frac{-1}{R}sin(\frac{s}{R}) & cos(\frac{s}{R}) & 0 & 0 & 0 & sin(\frac{s}{R}) \\ 0 & 0 & 1 & s & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 \\ -sin(\frac{s}{R}) & -R(1-cos(\frac{s}{R})) & 0 & 0 & 1 & -\frac{s}{\gamma^2}+(Rsin(\frac{s}{R})-s) \\ 0 & 0 & 0 & 0 & 0 & 1 \end{pmatrix}$$

Theory - Insertion

Bending Dispersion – 1:1 Analogon – Light in X-tal

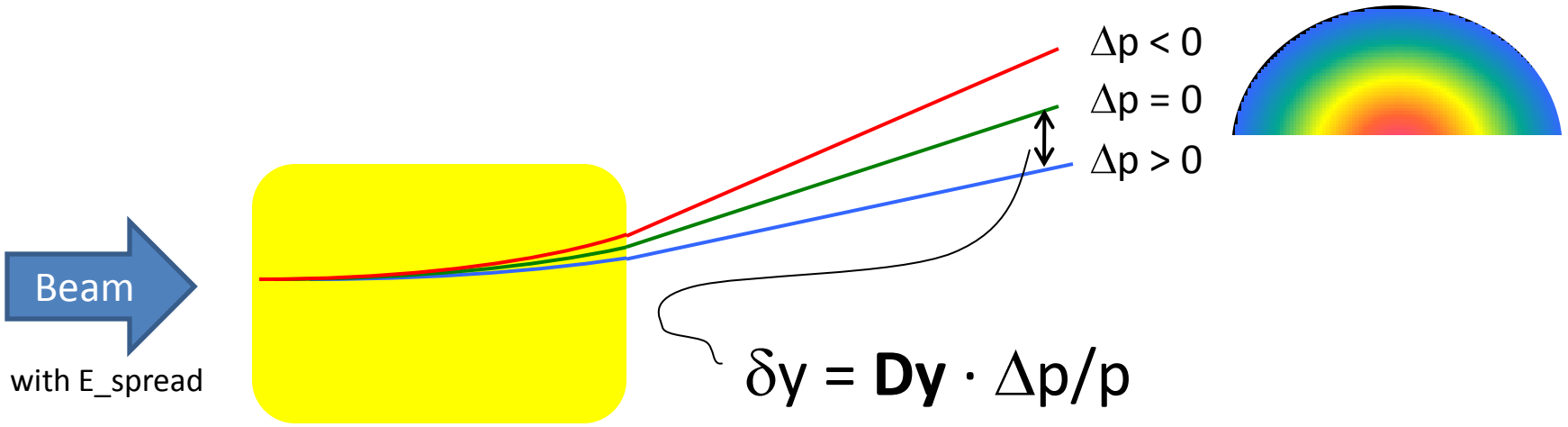


$Dy(@SEM) = Dy(@Bend) + D'y(@Bend) \cdot L$

$Dy(@SEM) = R_{16} + R_{26} \cdot L$

Theory - Insertion

Bending Dispersion = Light in Crystal

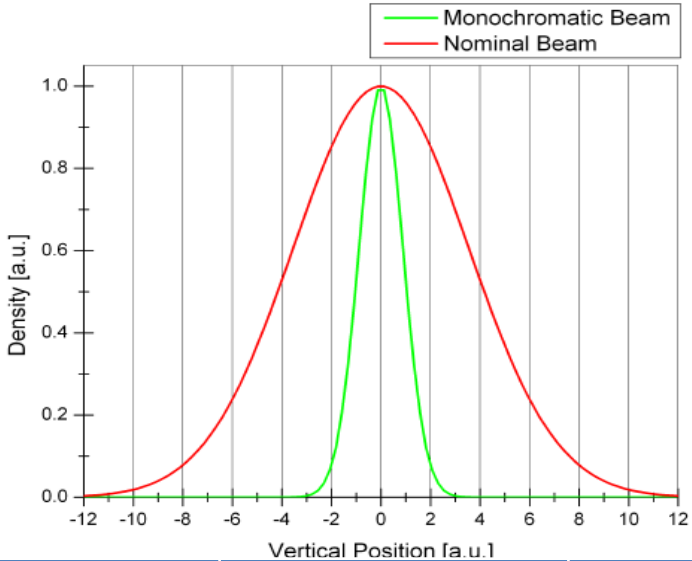


Dy(@SEM) = 2.87m (Present Layout)

Δp/p = 2.69 E-4 (Nominal Energy Spread Linac4)

=> δy = 0.8 mm

Want2Have List

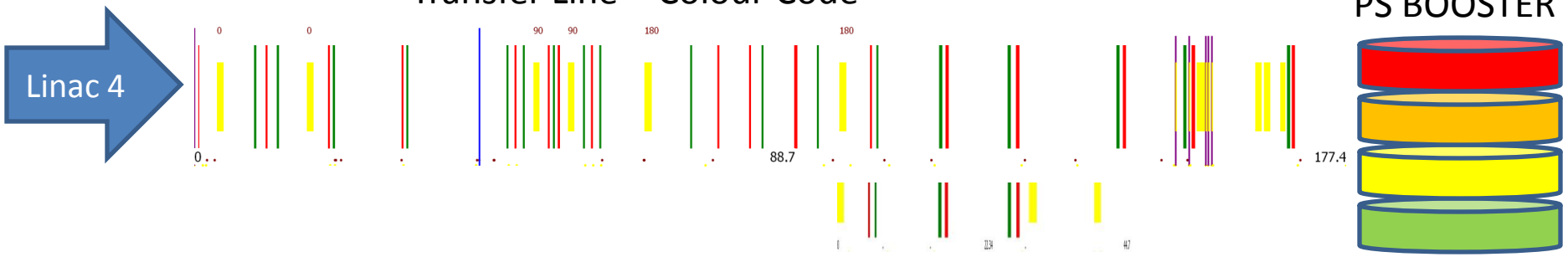


Assume (No Slit):
Beam Spot of Monochromatic Beam
σ =1mm

Modus	Energy Deviation [keV]	Momentum dp/p	Wanted Displacement	Required Dispersion
Energy Swing	±1200	±4.0 E-3	±5mm	1.25m
Energy Spread (Cavity Off)	350	1.17 E-3	±3mm	2.56m
Energy Spread (Cavity On)	80..90	2.69 E-4	±3mm	**11m**

Used Colour Code

Transfer Line – Colour Code



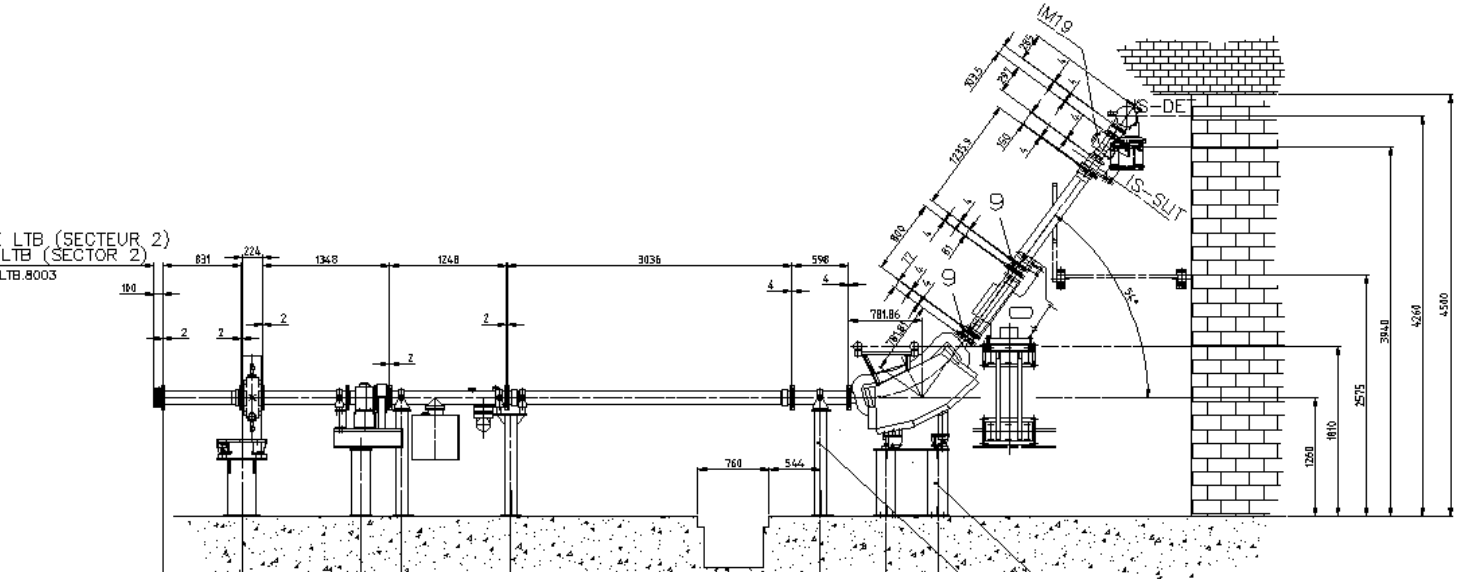
LBS Line – Colour Code

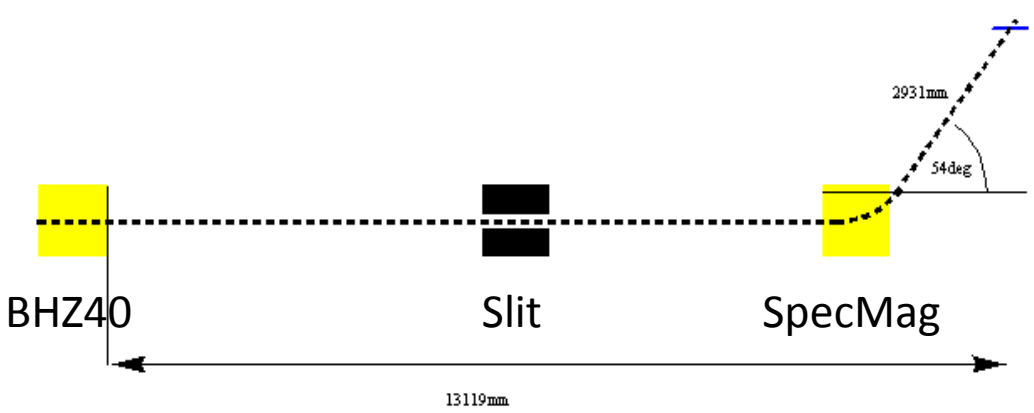
Bending Magnet

Quadrupole – vertical defocusing

Quadrupole – vertical focusing

Present Design



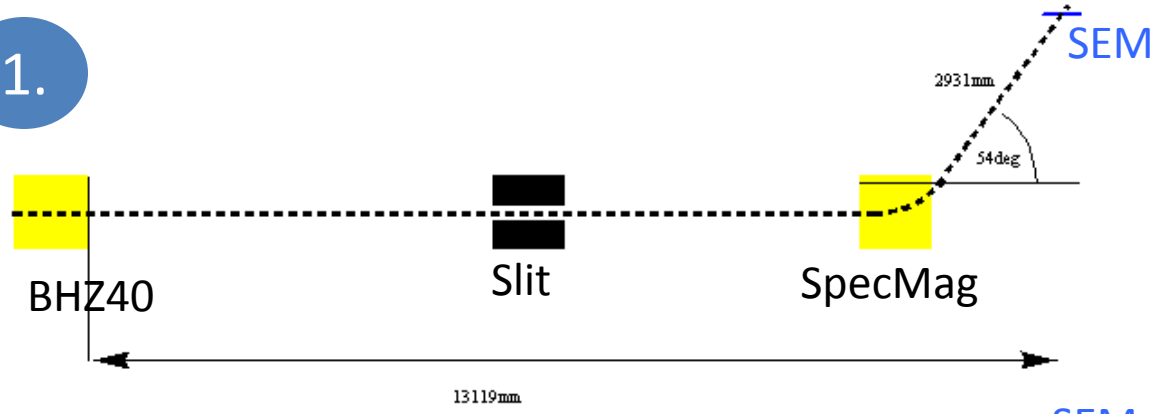


α = 54 deg

ρ = 1.2m (**1.6T**)

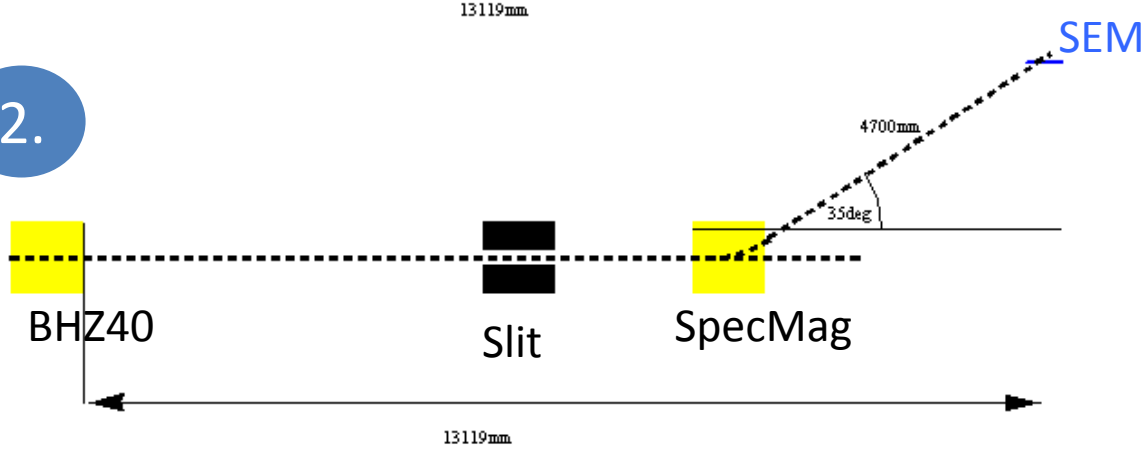
D(@SEM) = 2.87m

1.



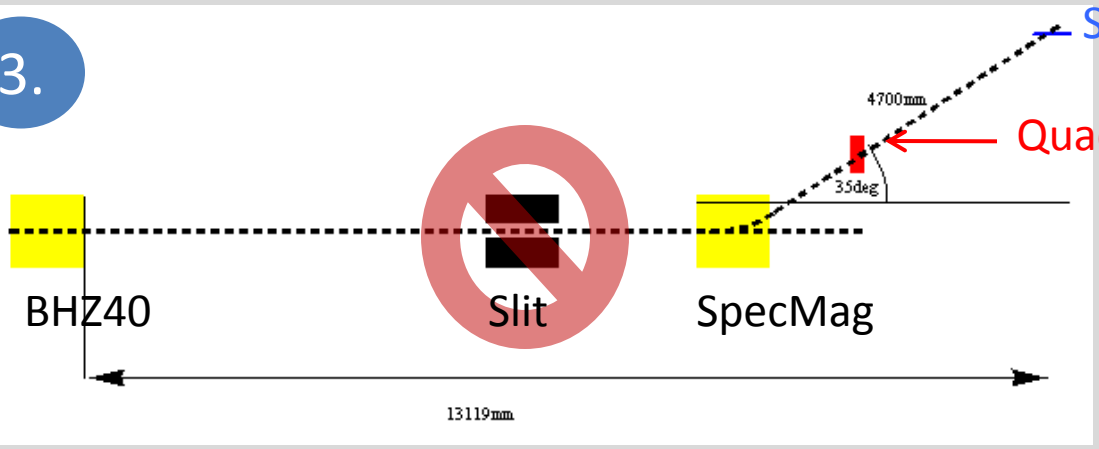
α = 54 deg
ρ = 1.2m (**1.6T**)
D(@SEM) = 2.87m

2.



α = 35 deg
ρ = 1.6m (**1.1T**)
D(@SEM) = 2.99m

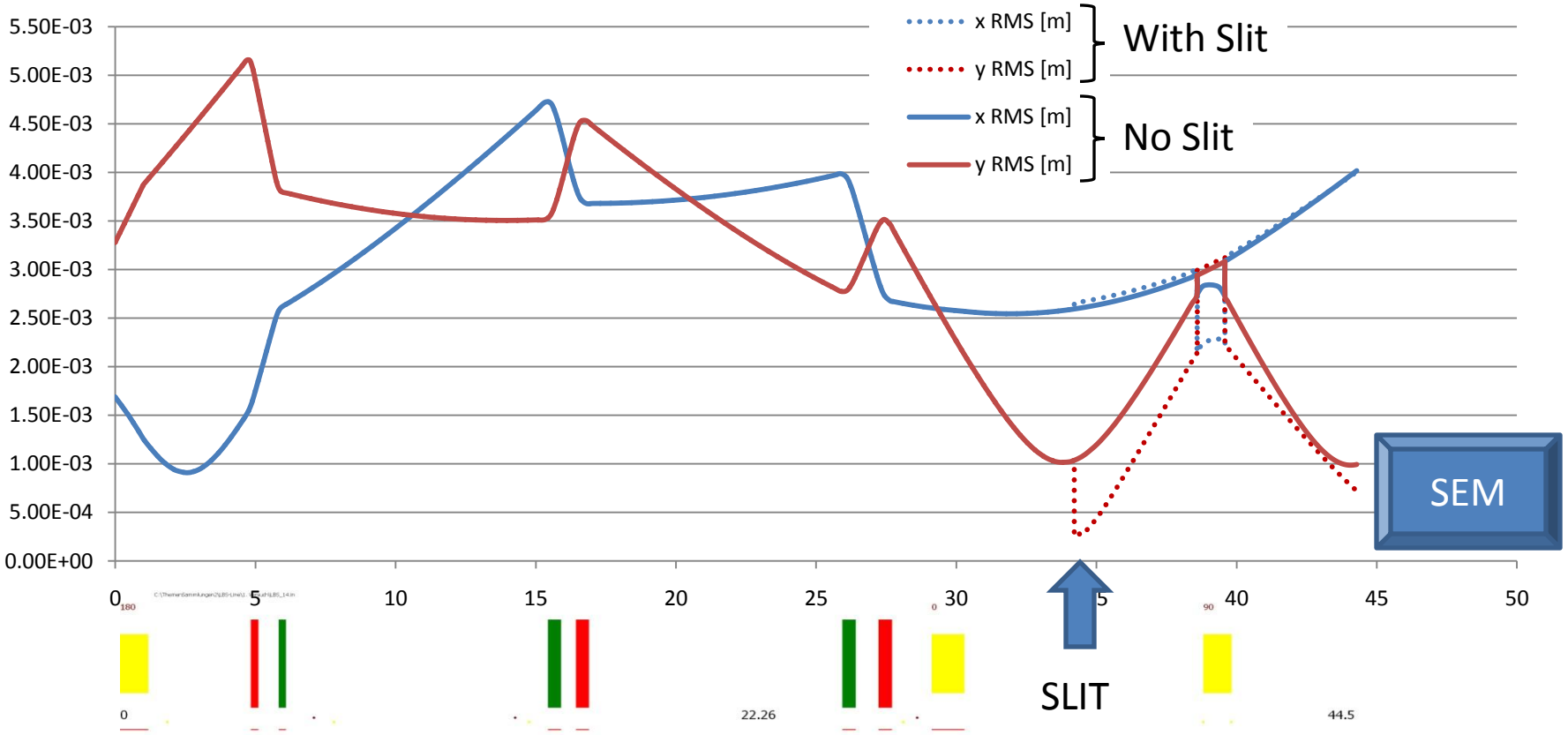
3.



α = 35 deg
ρ = 1.6m (**1.1T**)
g = +3 ... -12 T/m
D(@SEM) = 1.0m ... 10m

Scenario 2

Beam Optics – Vertical&Horizontal Beam Size

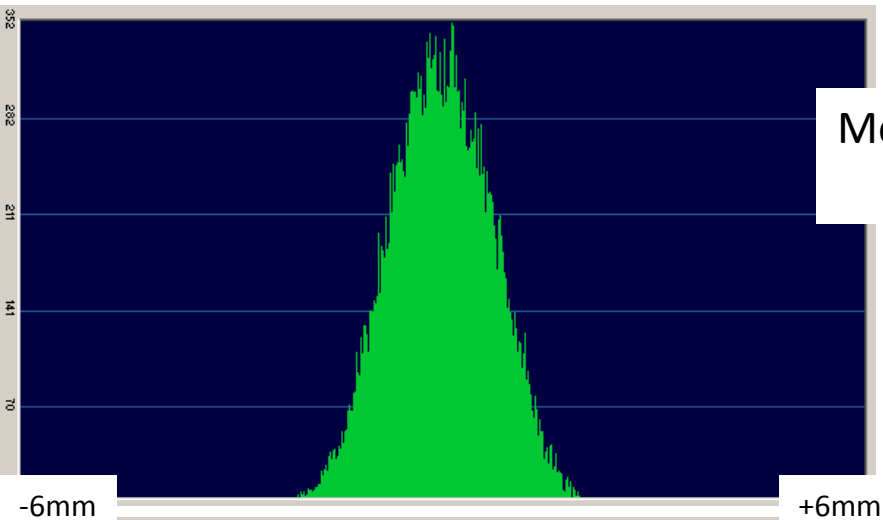


Scenario 2

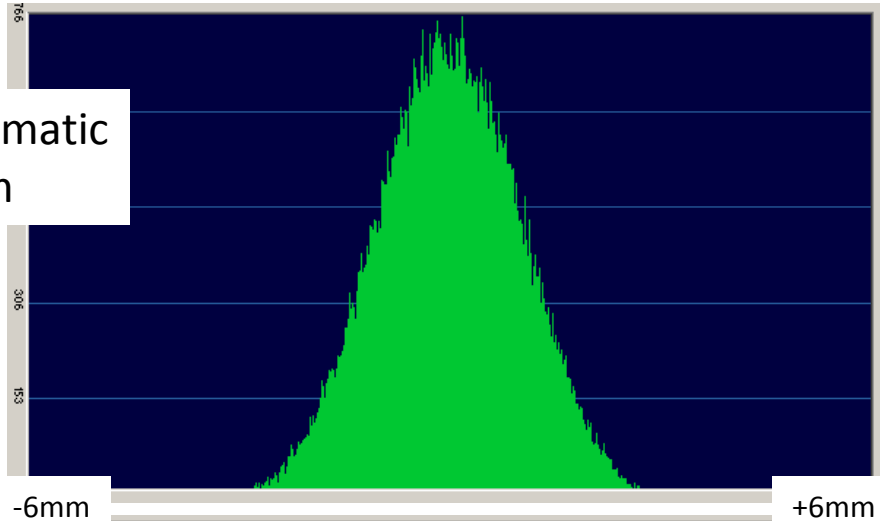
Distributions – Nominal Energy Spread

Slit (65% dumped)

No Slit

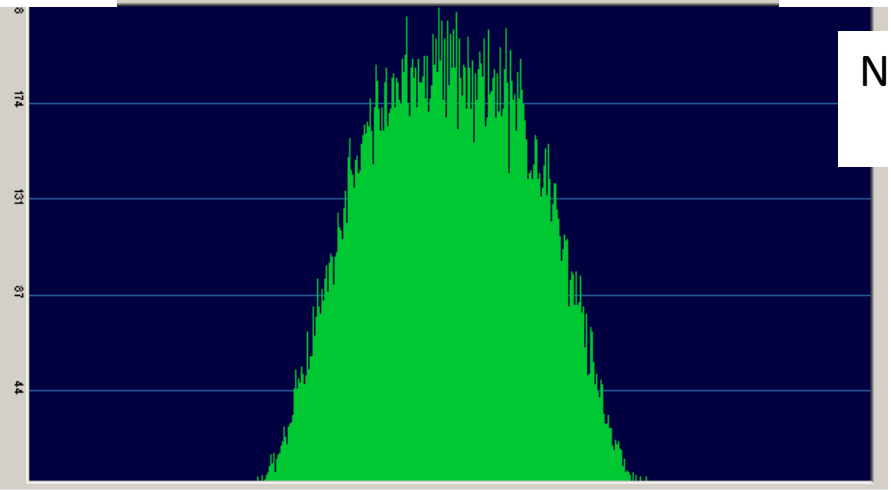


Monochromatic Beam

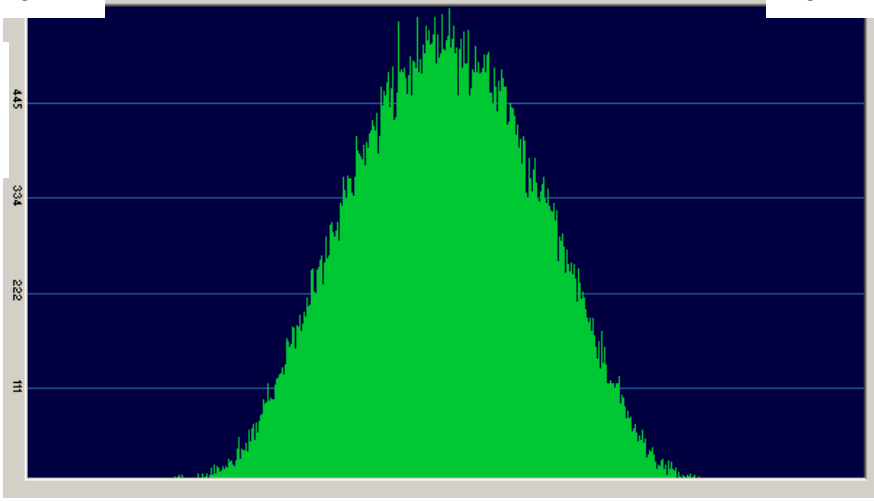


-6mm +6mm

-6mm +6mm



Nominal Beam



Scenario 2

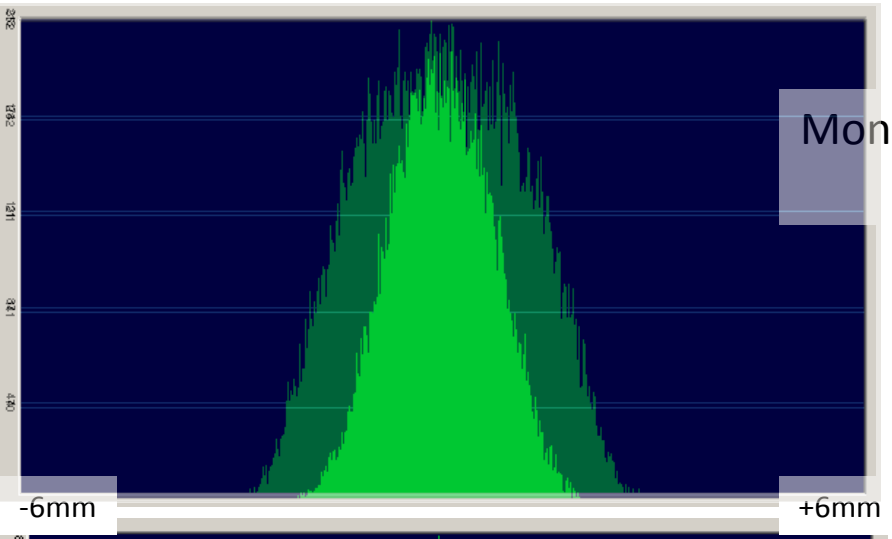
Distributions – Nominal Energy Spread

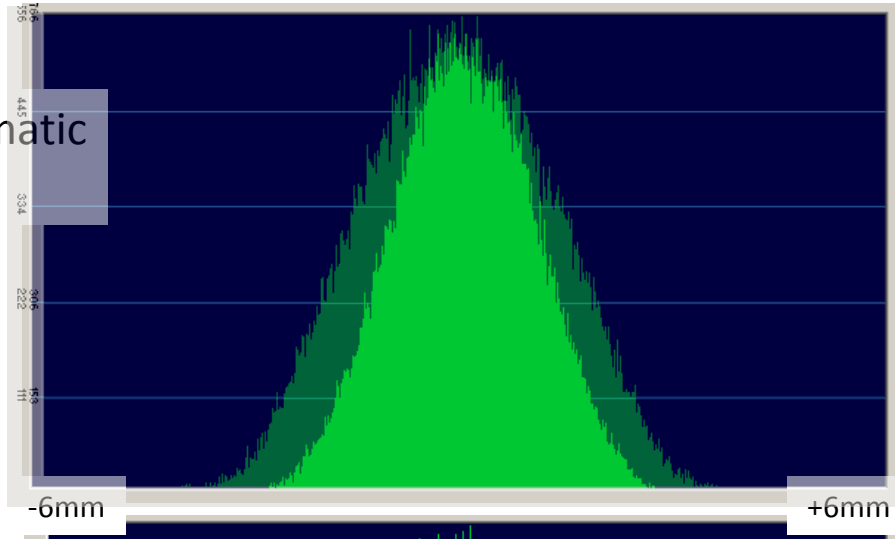
Slit required for Scenario 2

Slit (65% dumped)

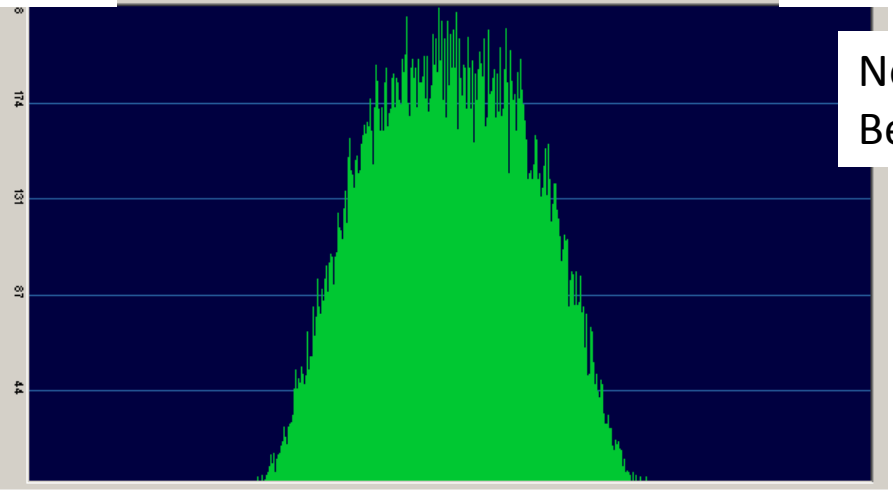
No Slit

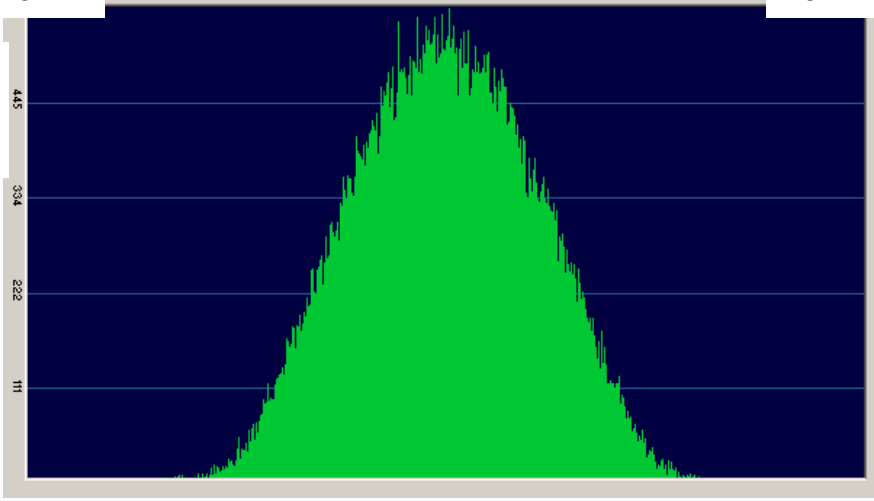
Monochromatic Beam



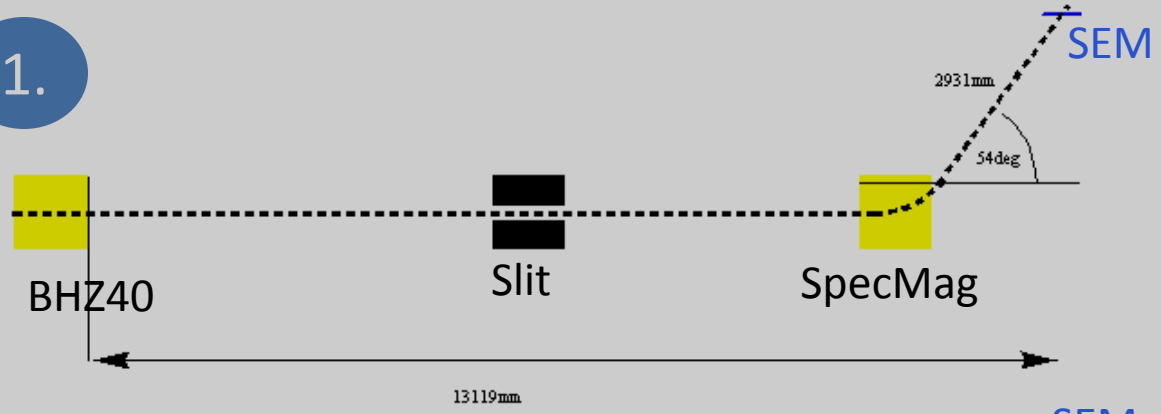


Nominal Beam



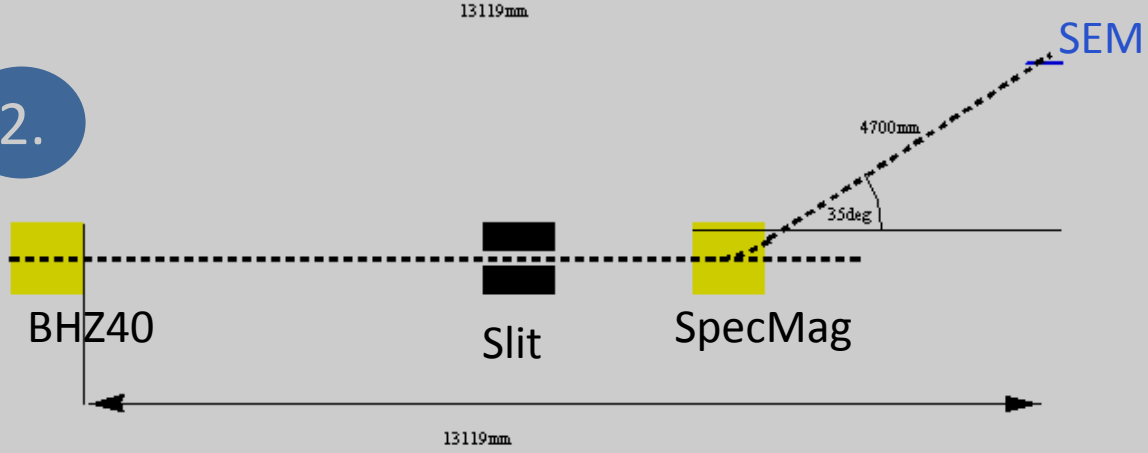


1.



α = 54 deg
ρ = 1.2m (**1.6T**)
D(@SEM) = 2.87m

2.



α = 35 deg
ρ = 1.6m (**1.1T**)
D(@SEM) = 2.99m

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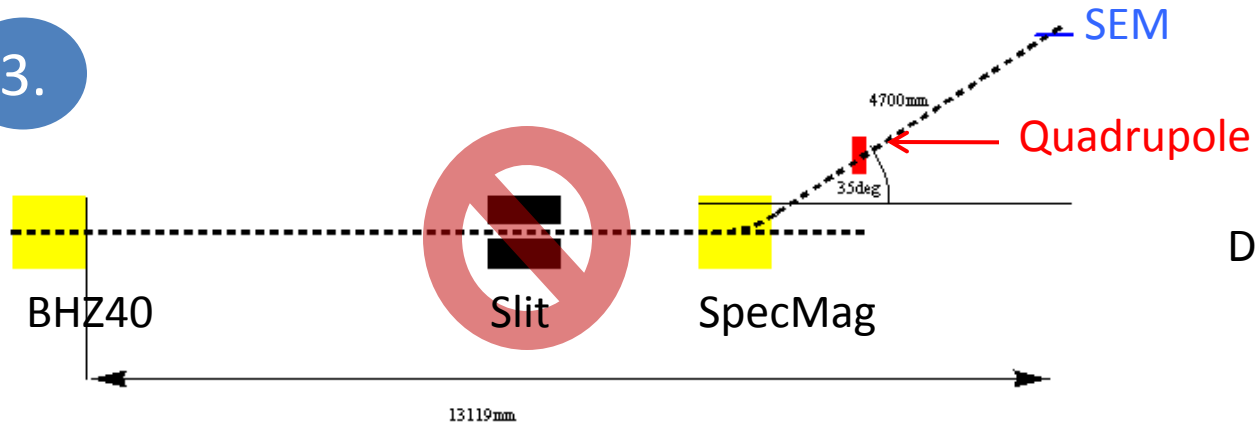
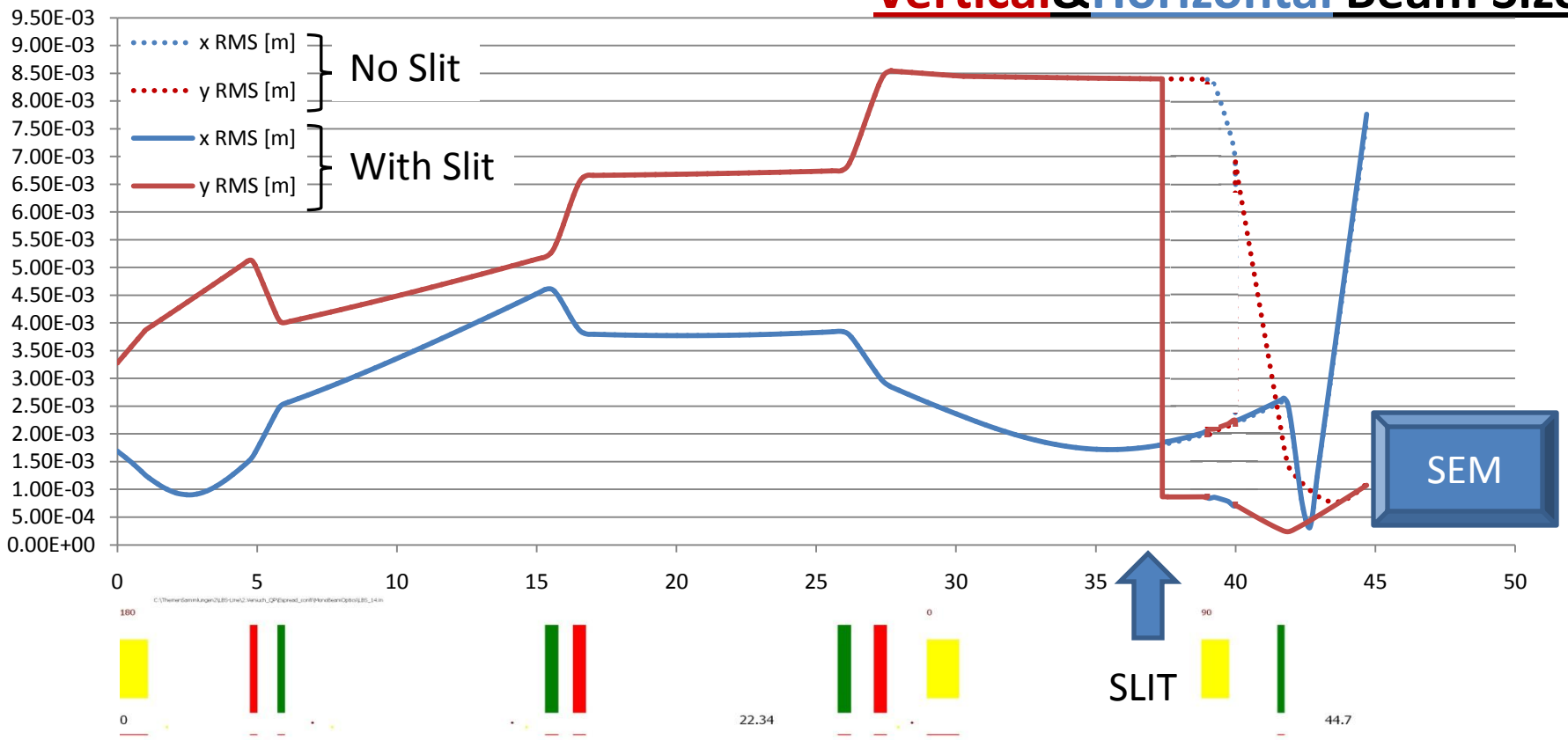


α = 35 deg
ρ = 1.6m (**1.1T**)
g = +3 ... -12 T/m
D(@SEM) = 1.0m ... 10m

Scenario 3

Beam Optics – Nominal Energy Spread – 2

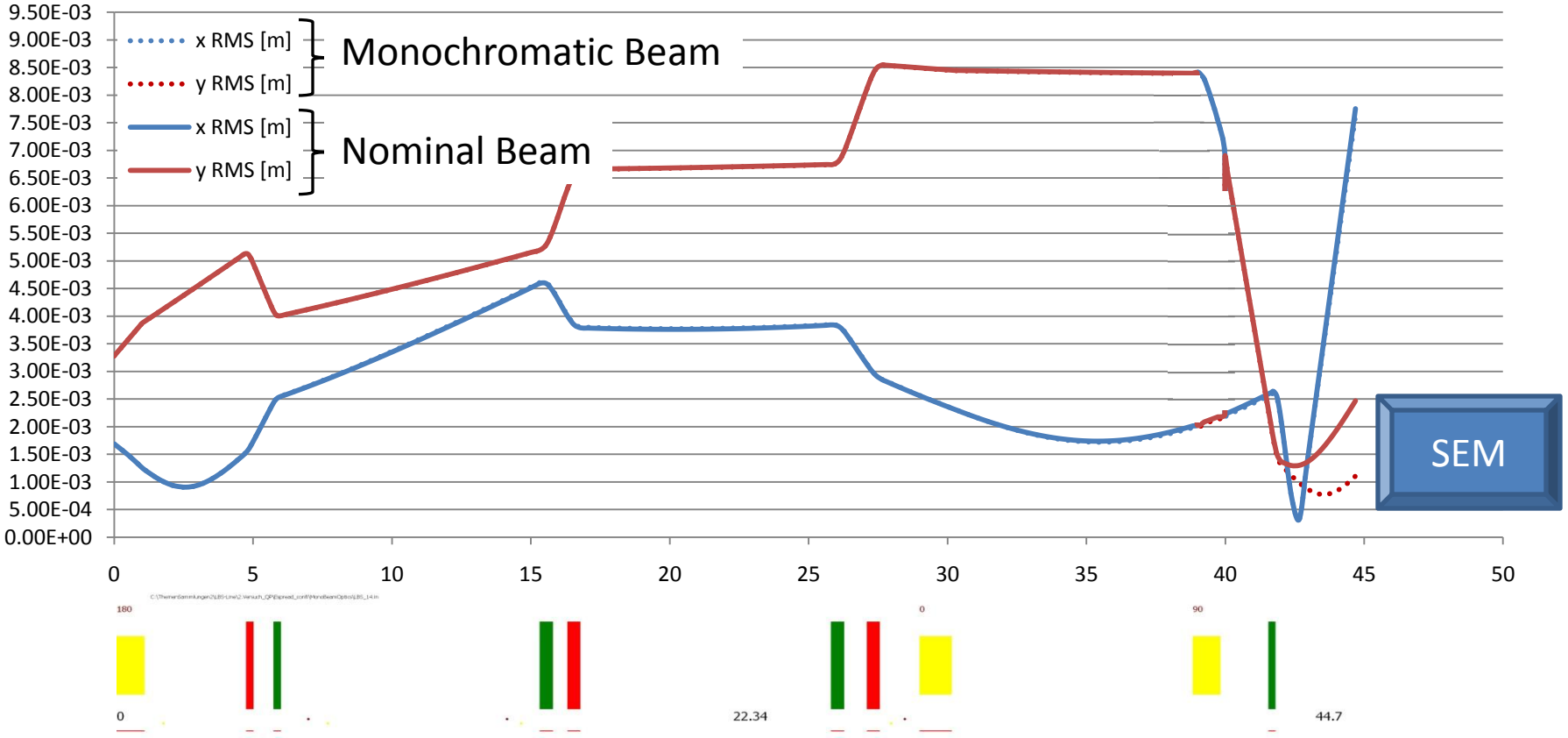
Vertical&Horizontal Beam Size



-12T/m -> Dy = 10m

Scenario 3

Beam Optics – Nominal Energy Spread – 2

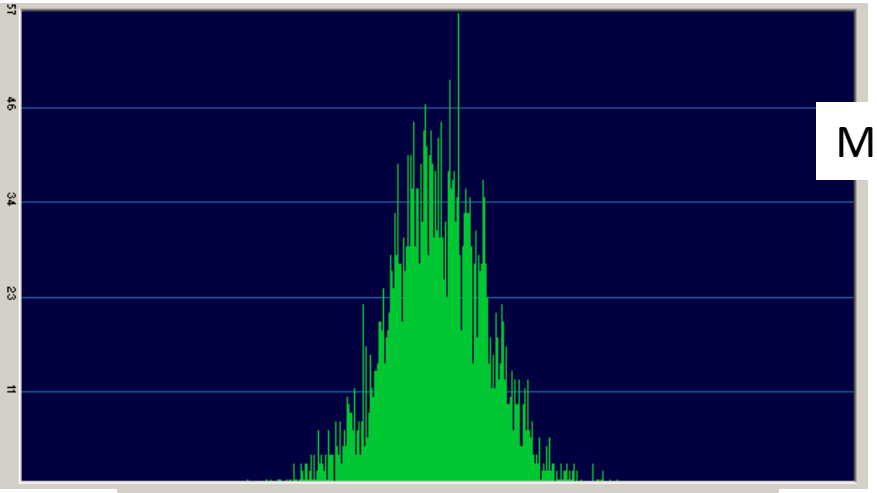


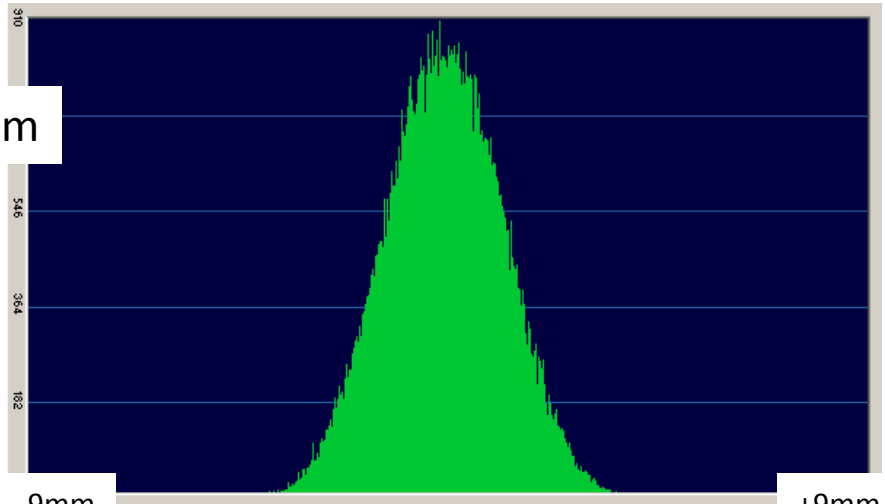
Scenario 3

Distributions – Nominal Energy Spread

Slit (85% dumped)

No Slit

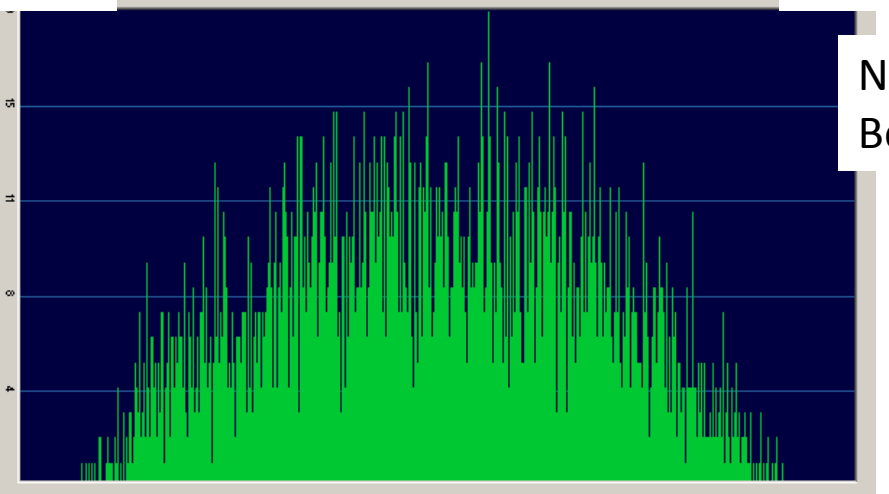


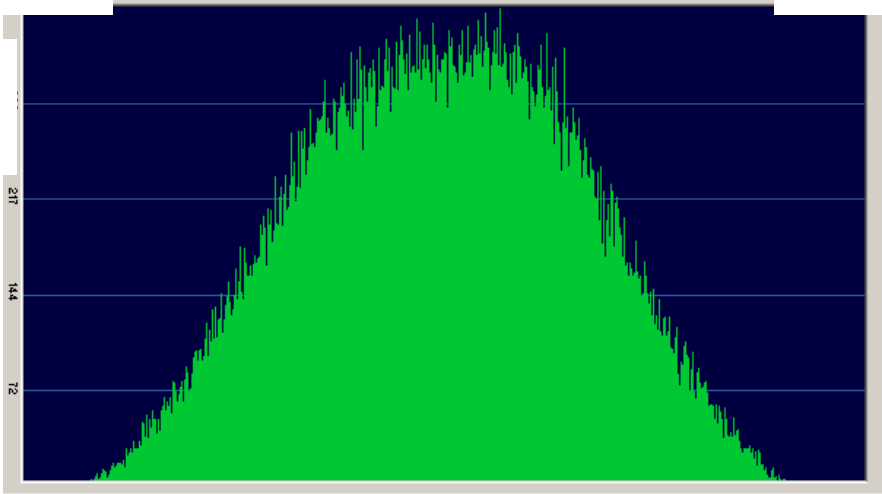


Mono Beam

-9mm +9mm

-9mm +9mm





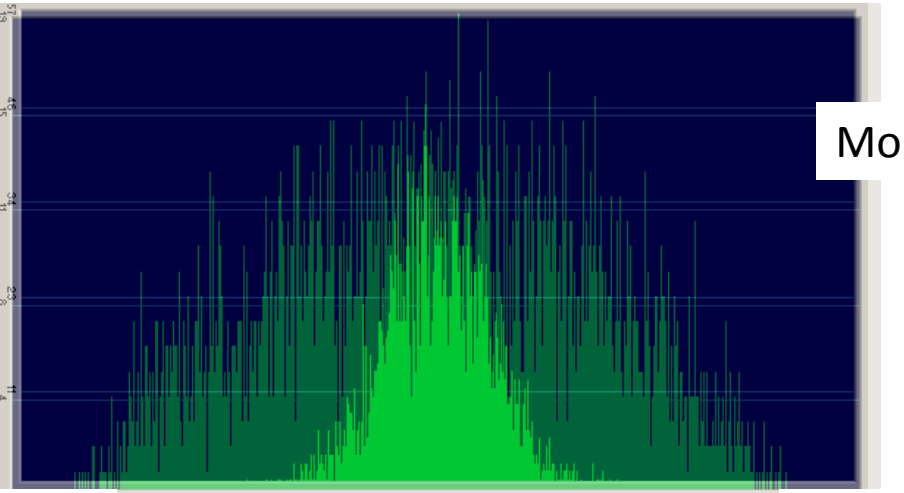
Nominal Beam

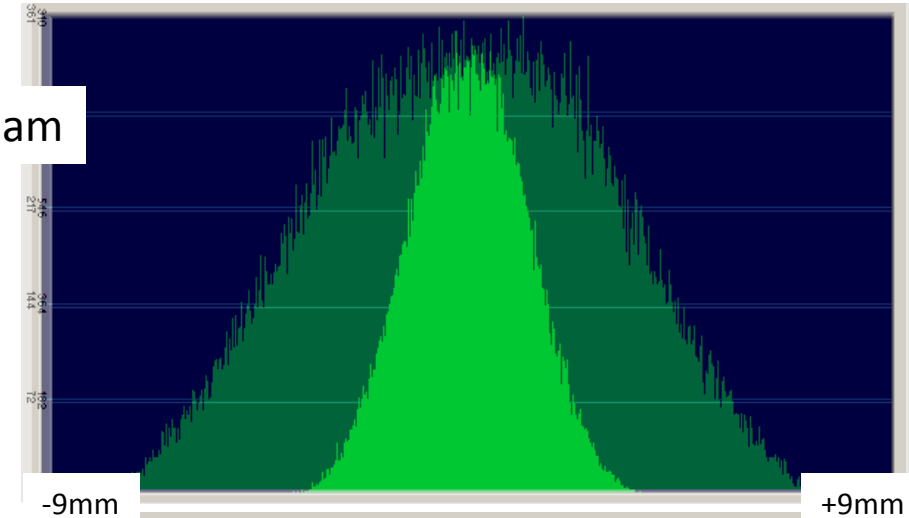
Scenario 3

Distributions – Nominal Energy Spread

Slit (85% dumped)

No Slit





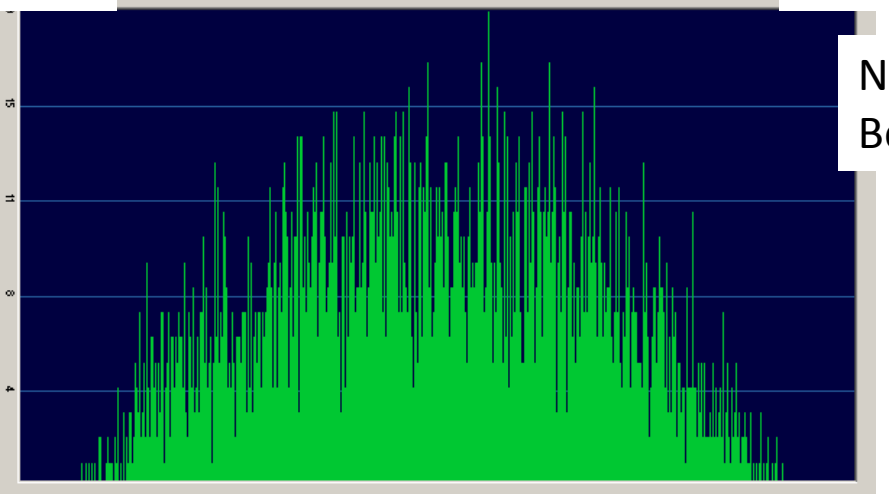
Mono Beam

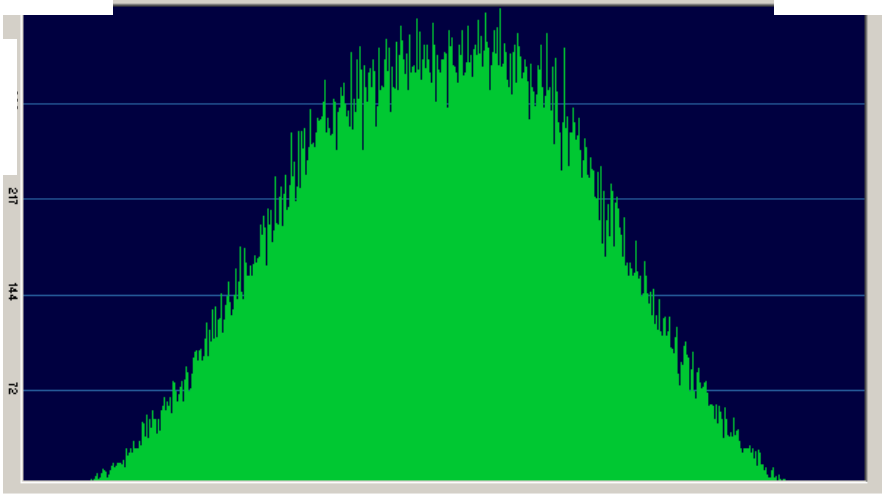
-9mm

+9mm

-9mm

+9mm



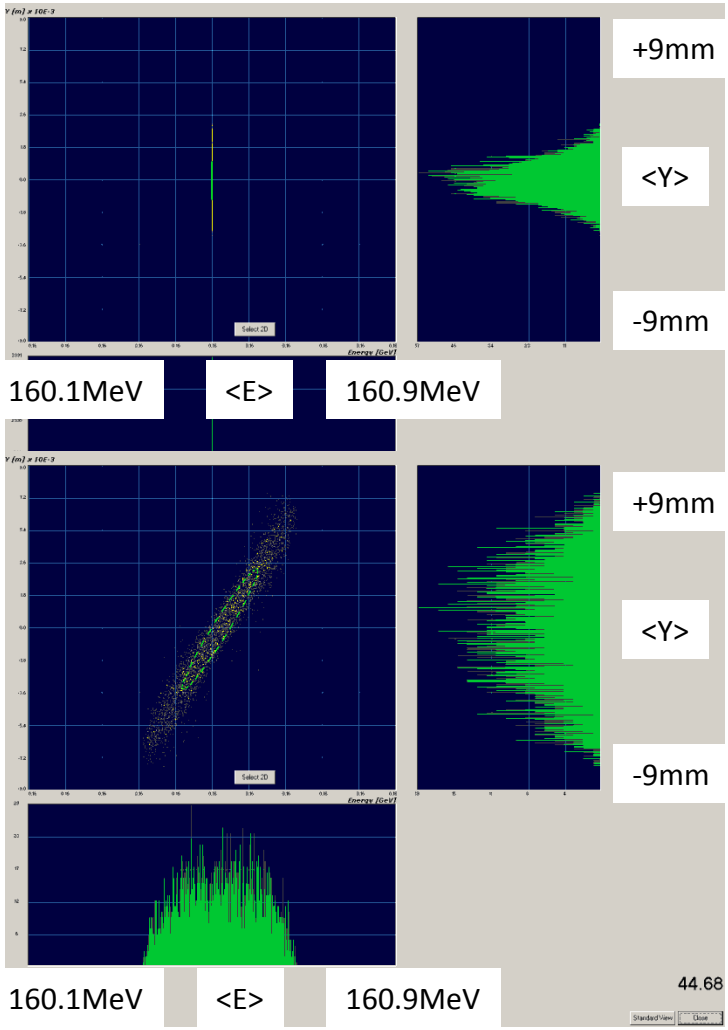


Nominal Beam

Scenario 3

Distributions – Norminal Energy Spread

Slit (??% dumped)

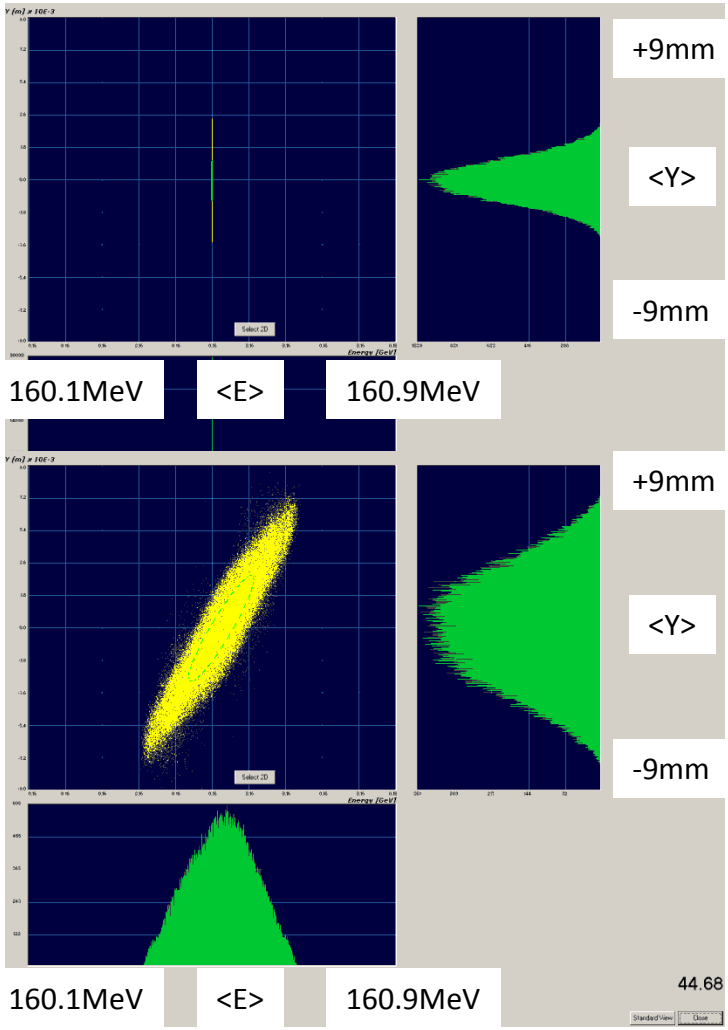


Monochromatic Beam

Nominal Beam

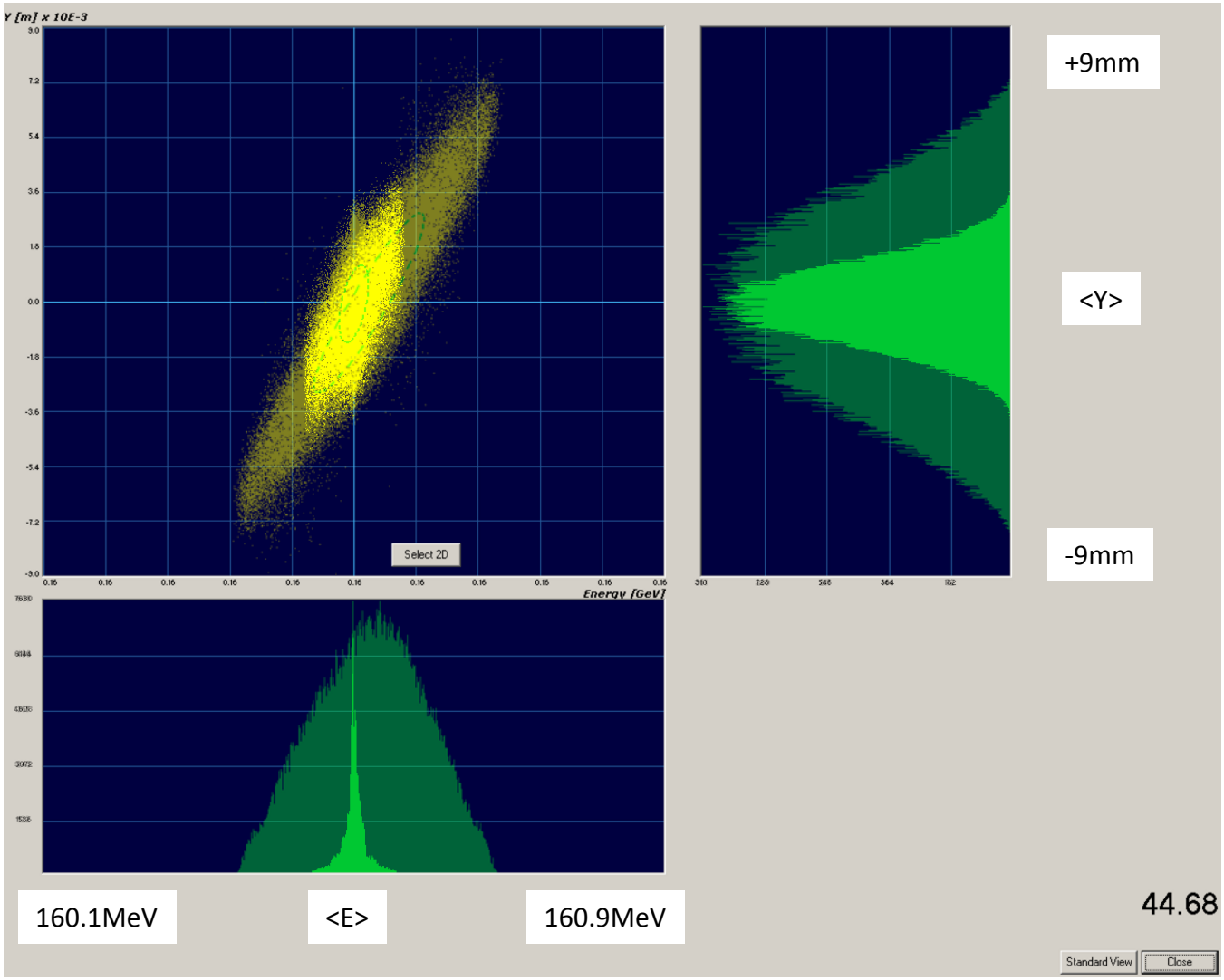
Energy [MeV]
160.1 .. 160.9

No Slit



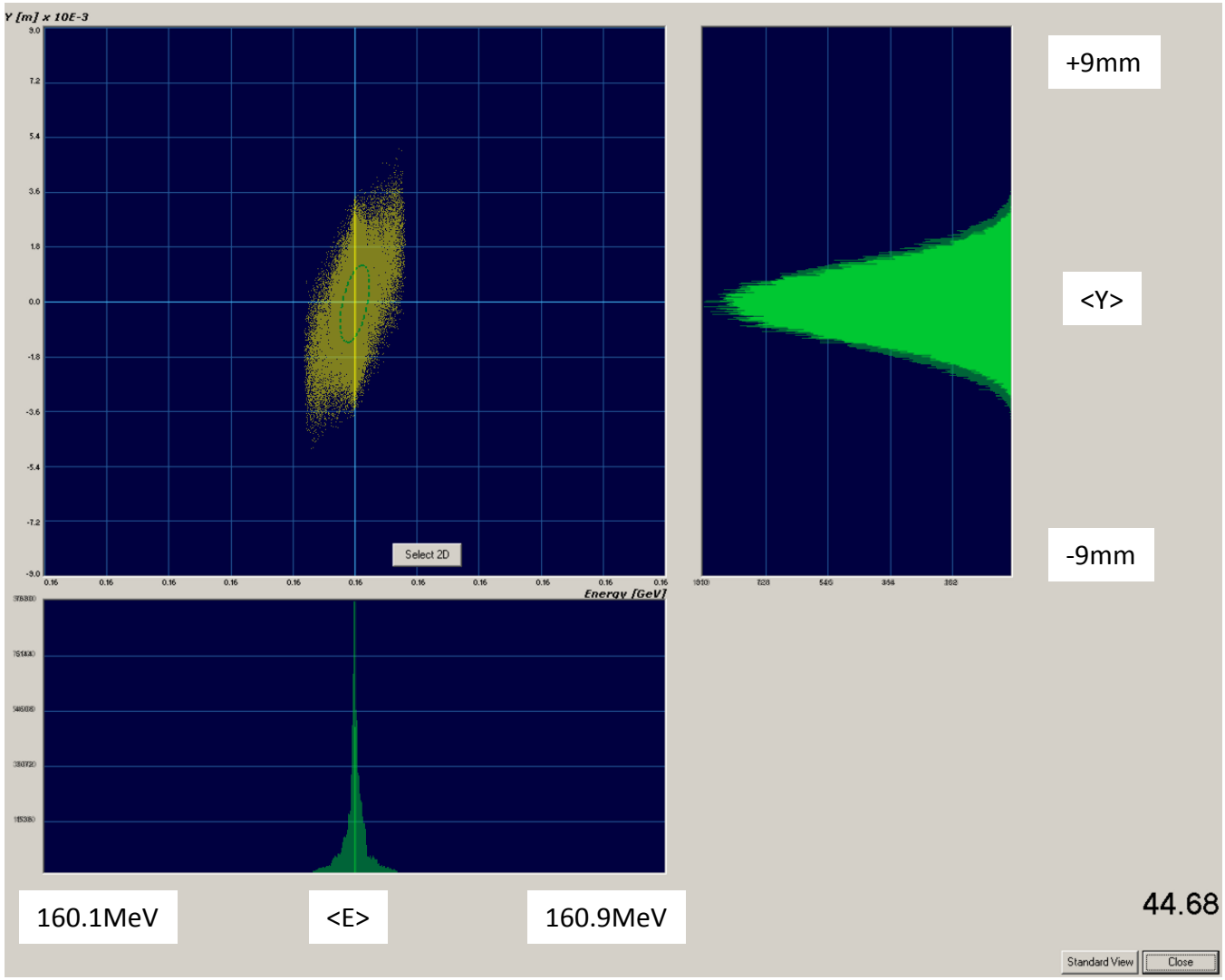
Scenario 3

Distributions – Nominal Beam (90keV)



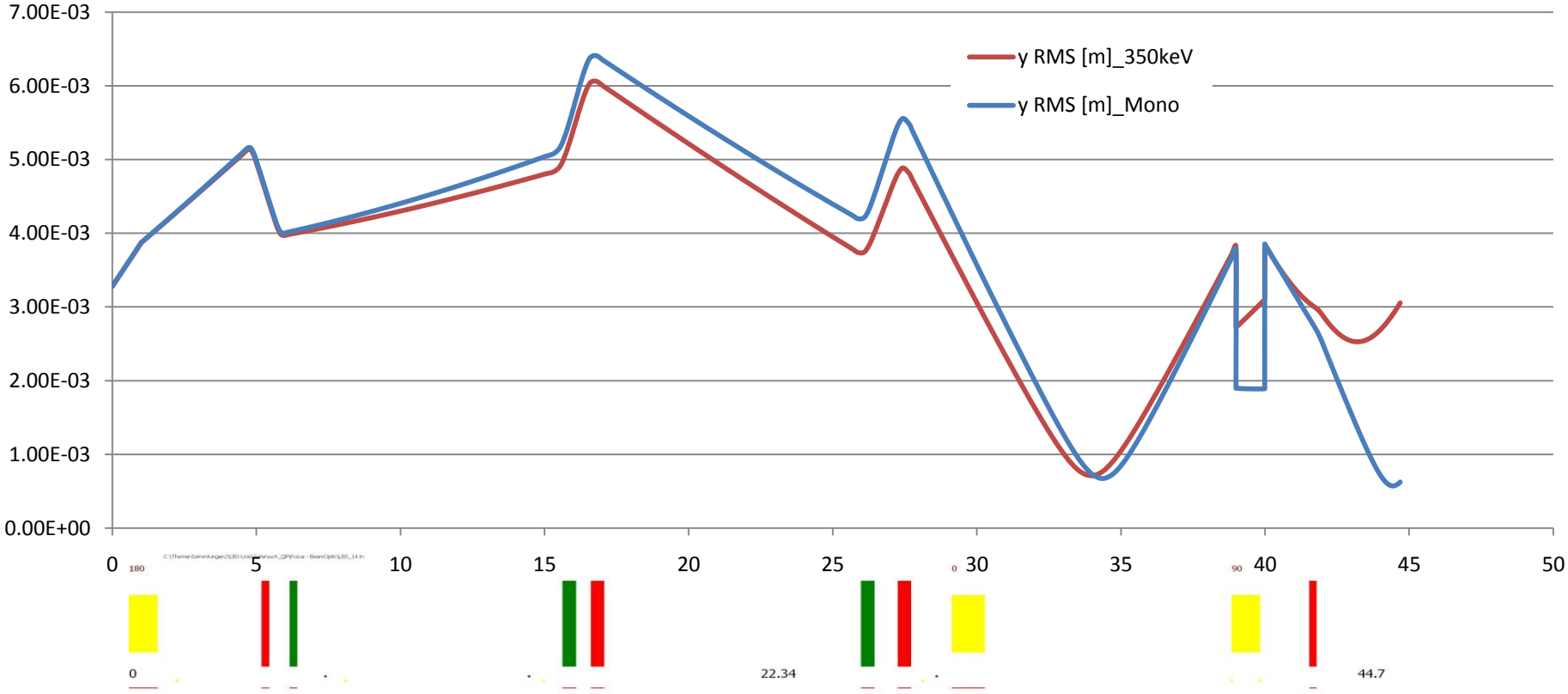
Scenario 3

Distributions – ‘Mono‘-Beam (25keV)



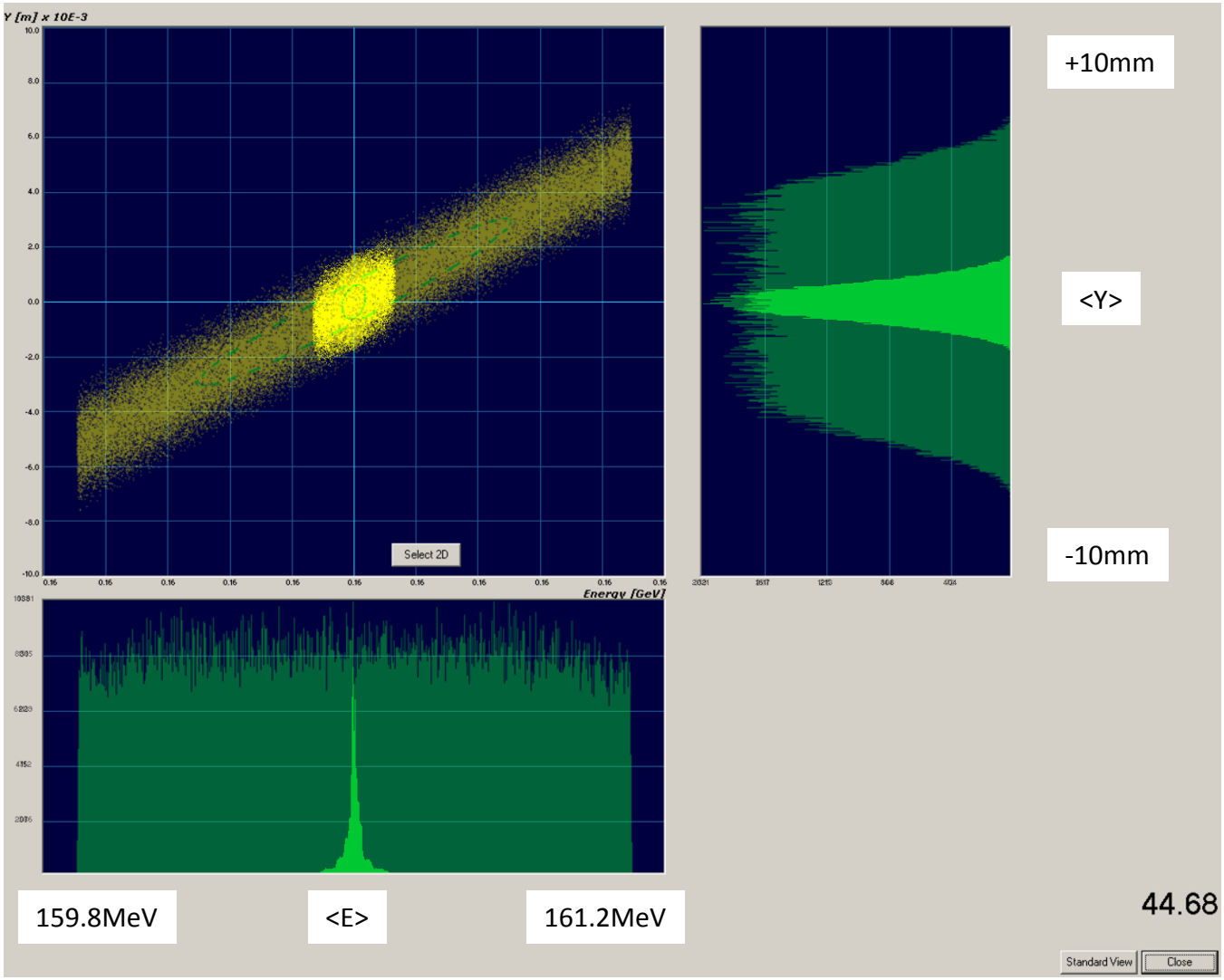
Scenario 3

Beam Optics – Cavity OFF



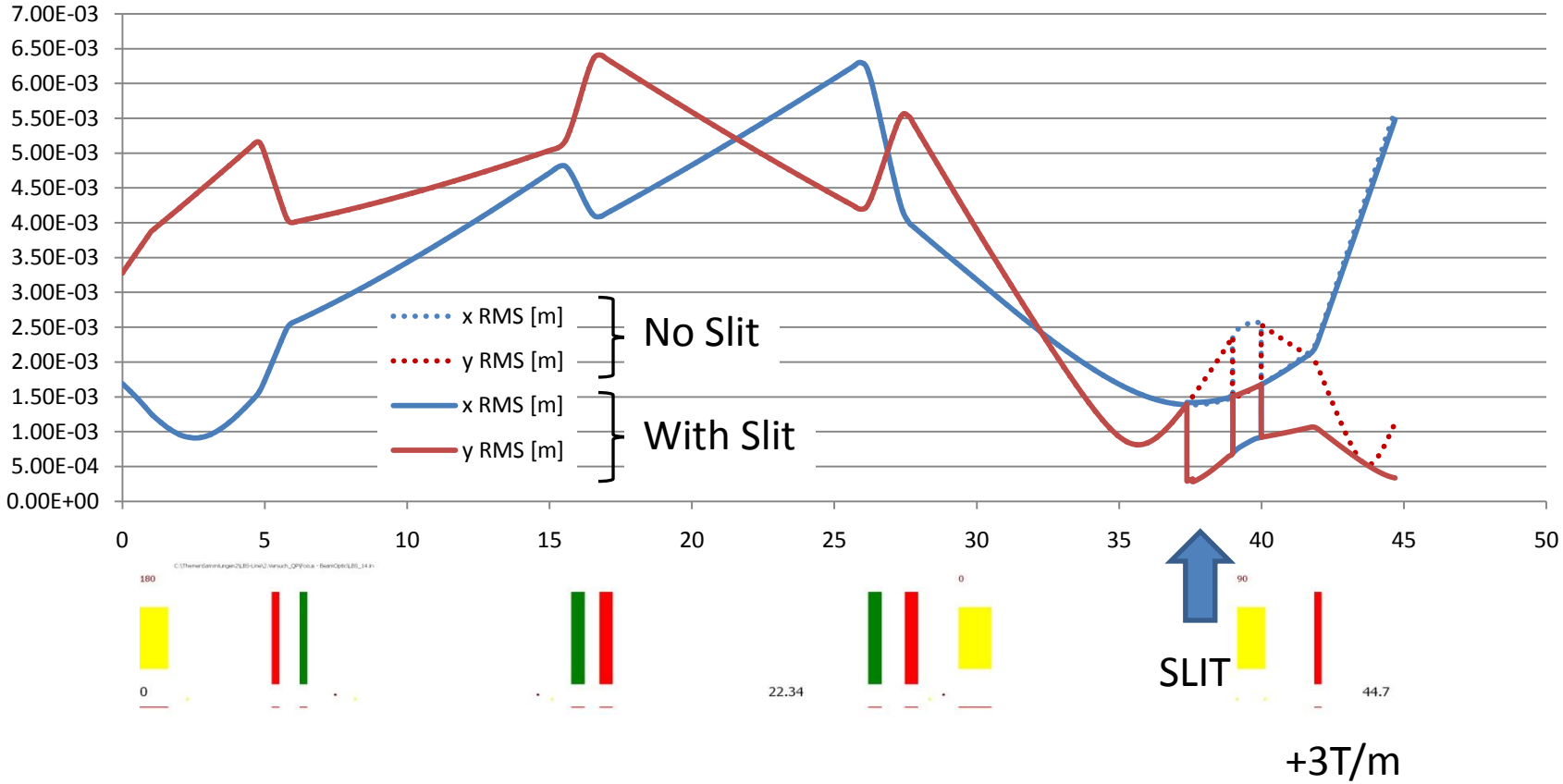
Scenario 3

Distributions – Cavity OFF



Scenario 3

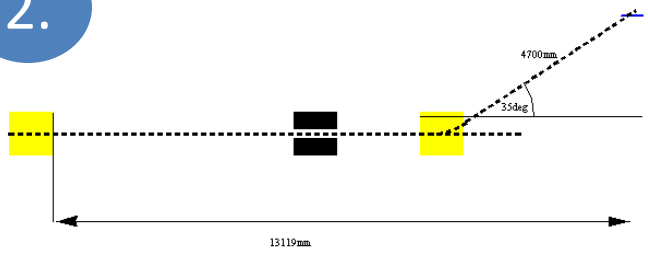
Beam Optics – Energy Swing



Summary

- The use of TL-Bending Magnet is possible
- If we “just“ exchange the bending Magnet (Scenario2) a slit for 160MeV H- ions is required
- With the installation of a TL-Quadrupole (Scenario3) the slit is not longer required

2.



3.