Energy Deposition in

Dummy Septum Blade
Dummy Septum Tank
Vacuum Chamber MMU15

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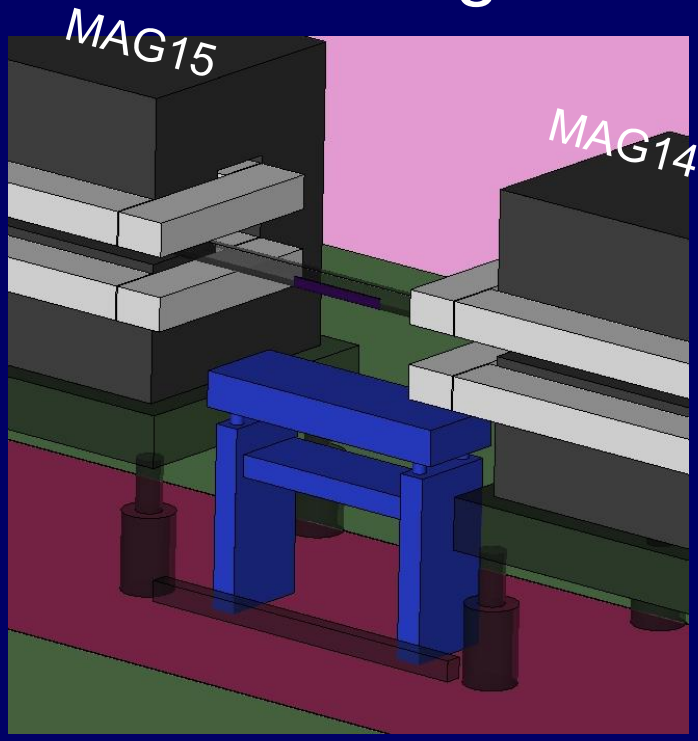
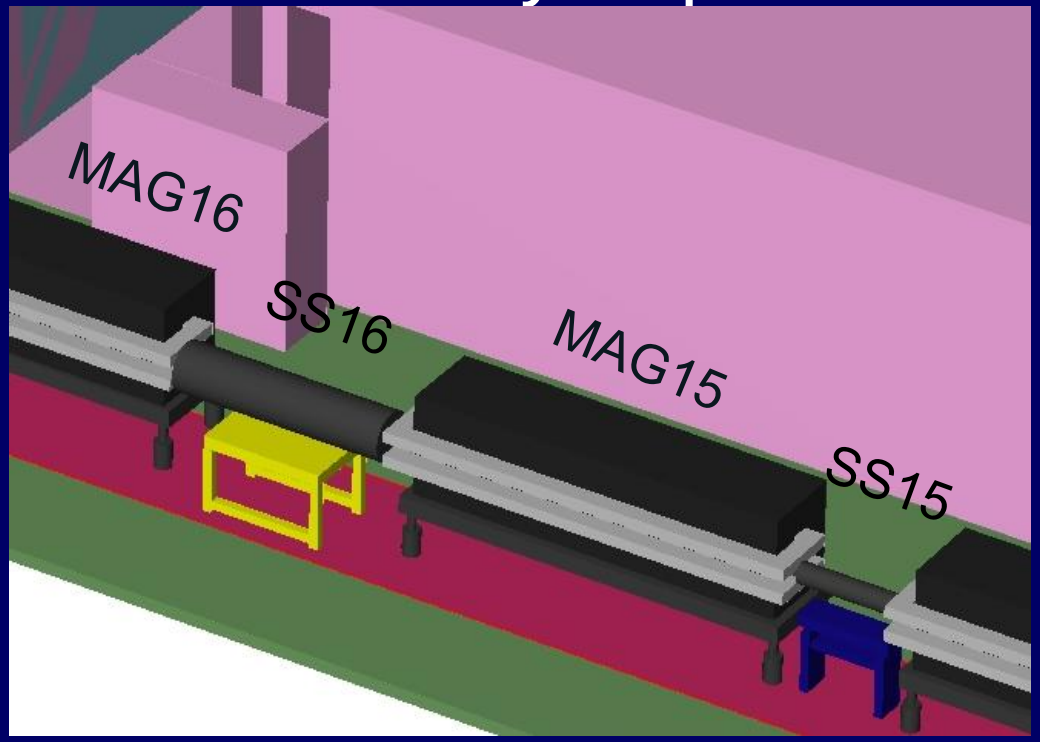
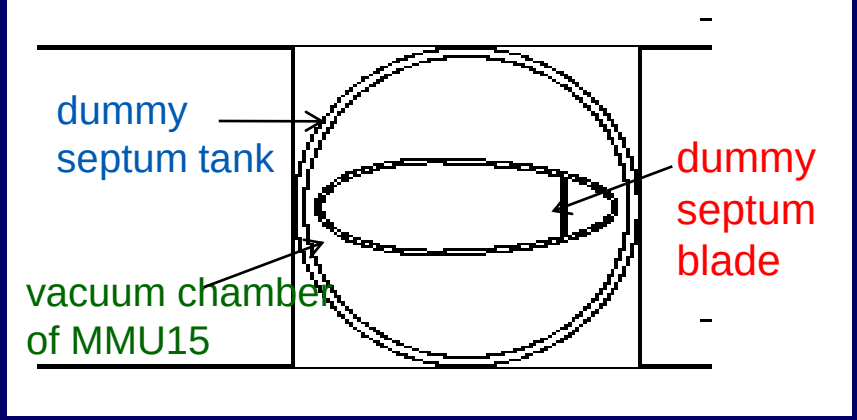
CERN, 28 February 2012

PS Straight Section 15 – Dummy Septum





position of the blade in transverse plane



dummy septum blade : 40 cm length, 3mm thickness and 3.88 cm height ; material: tungsten

dummy septum tank of cylindrical shape: inner radius R_i=10cm, outer radius R_o=10.6 cm, wall thickness 6 mm, length 115 cm; material: stainless steel 316 LN

Assumptions for the simulations

- proton beam of p=14 GeV/c
- beam loss intensity: 1.0×10^{11} p/s (~1% of the primary intensity 1×10^{13} p/s)

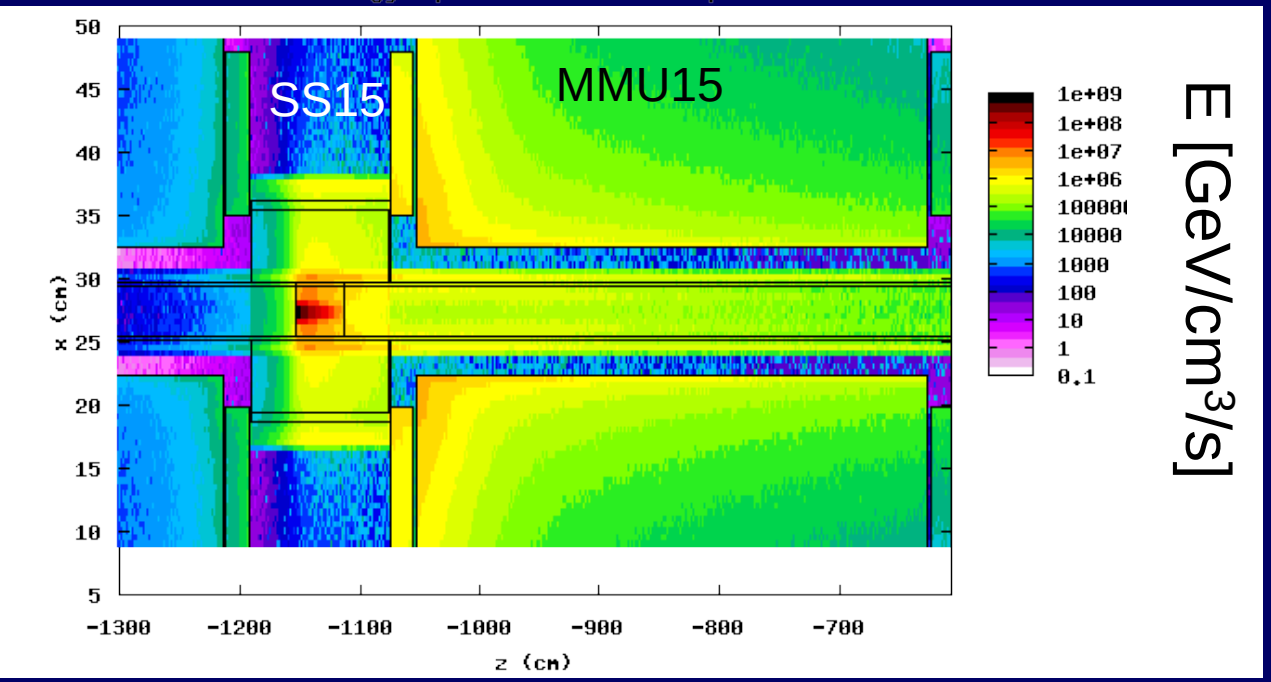
- source - dummy septum with impact points:

  along the beam direction (z) at the start of the blade

  Gaussian distribution in the vertical direction (x) with σ_x =2.5 mm centered in the middle plane

  uniform distribution in the horizontal direction (y) over 3mm thickness of the blade

Energy Deposition in the SS15 and along the MMU15



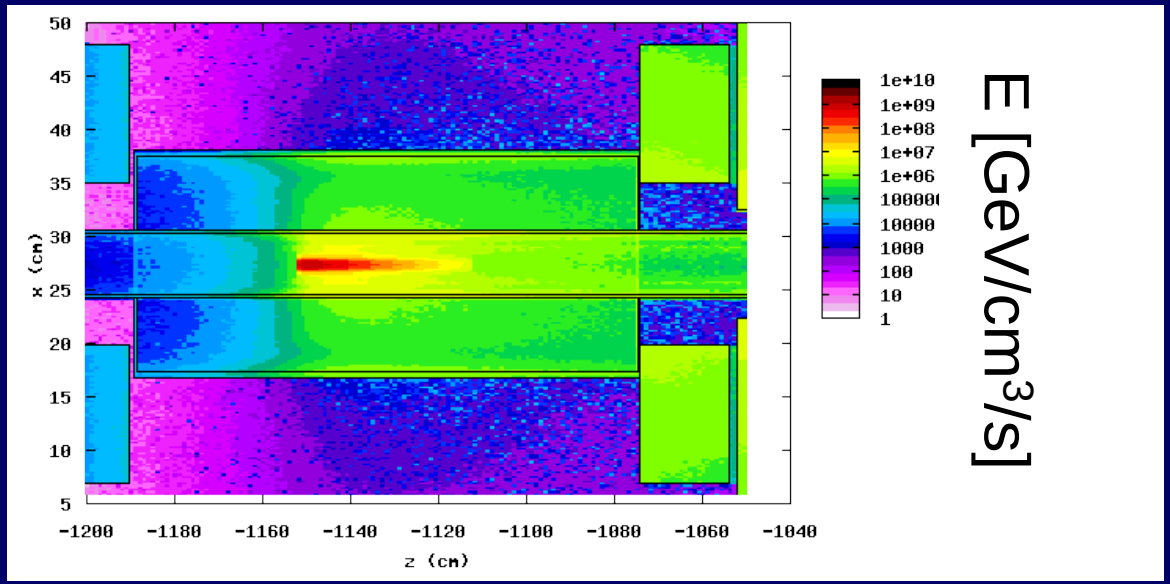
beam loss rate
10^{11} p/s

For qualitative illustration: projection into the x–z plane (x height, z beam direction)

enlarged SS15 region

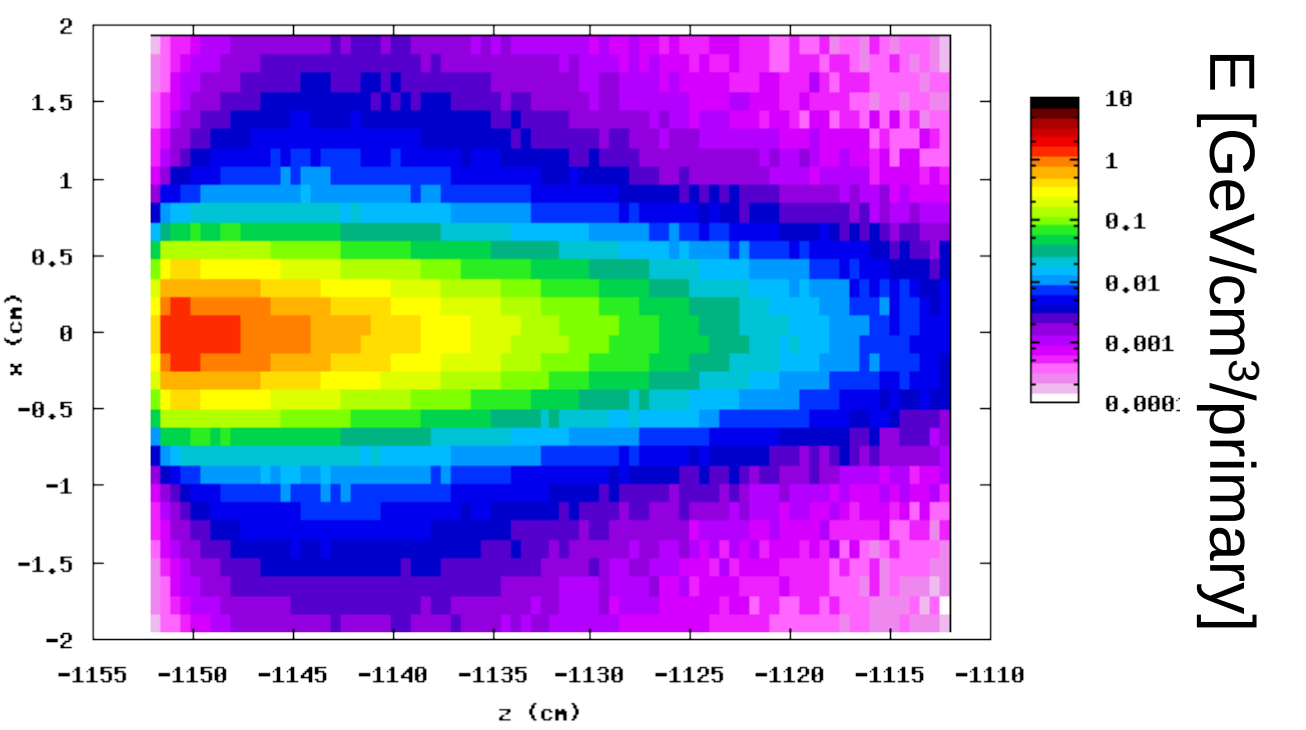
Energy deposition extracted individually for:

1) dummy septum blade
2) dummy septum tank
3) vacuum chamber of the magnet unit 15



Dummy Septum Blade

Energy Deposition in the material of the dummy septum blade

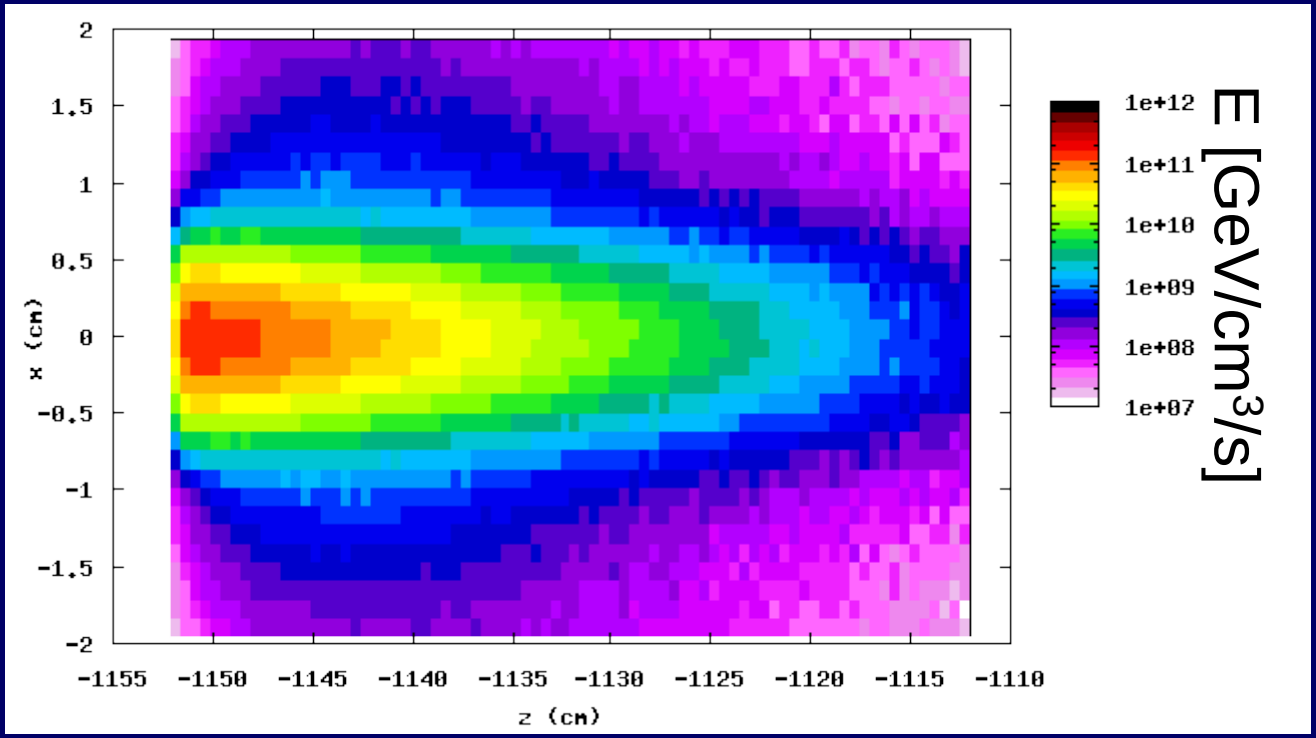


projection of deposited energy E [GeV/cm^3/primary] into the x-z plane, averaged over the blade thickness Δy=3mm

Maximum value E_{max} = (1.31±0.01) GeV/cm^3/primary

Energy Deposition Rate in the dummy septum blade

beam loss intensity of 10^{11} p/s

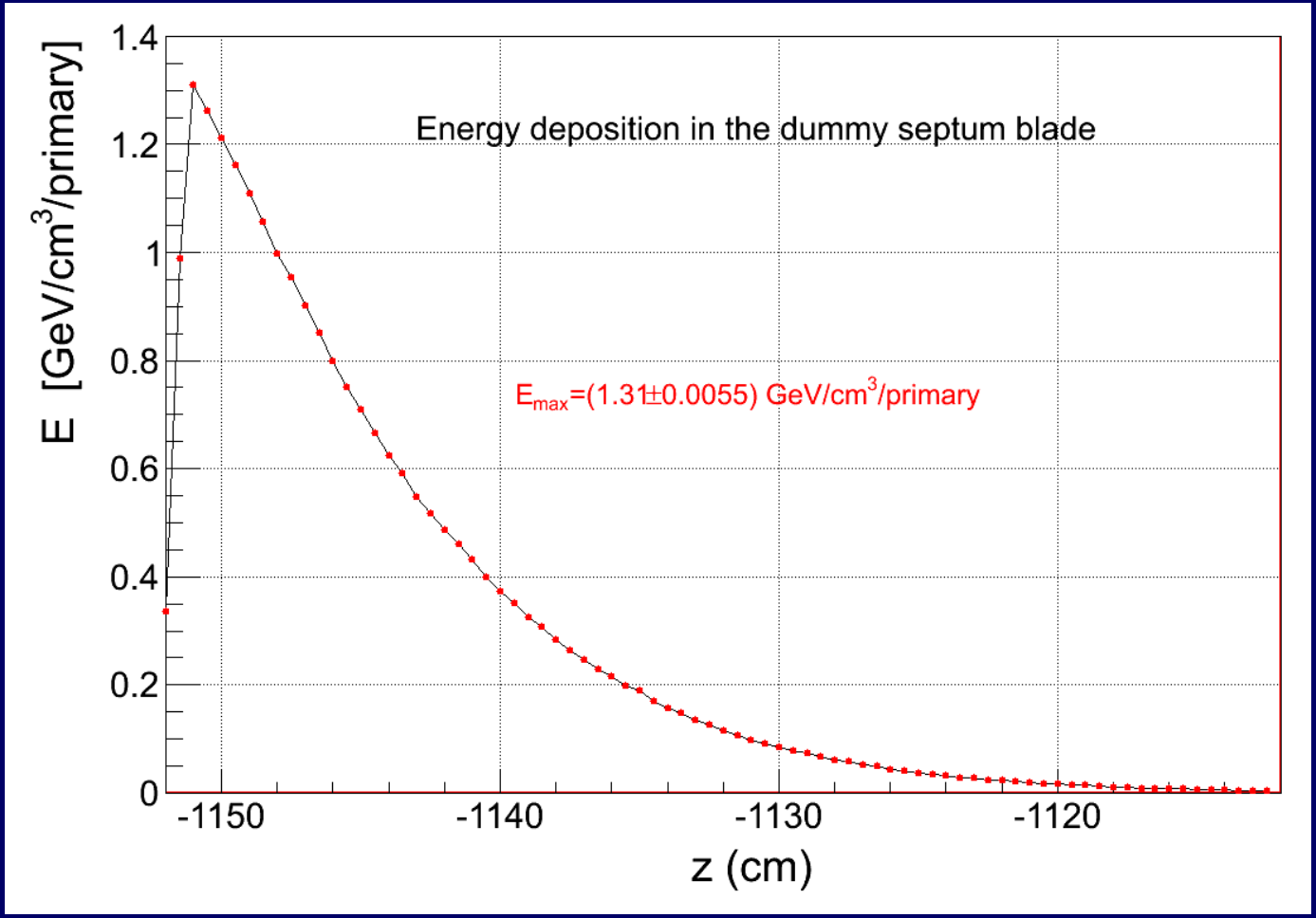


projection of deposited energy rate E [GeV/cm^3/s] into the x-z plane, averaged over the blade thickness Δy=3mm

Maximum value E_{max} = (1.31±0.01)×10^{11} GeV/cm^3/s

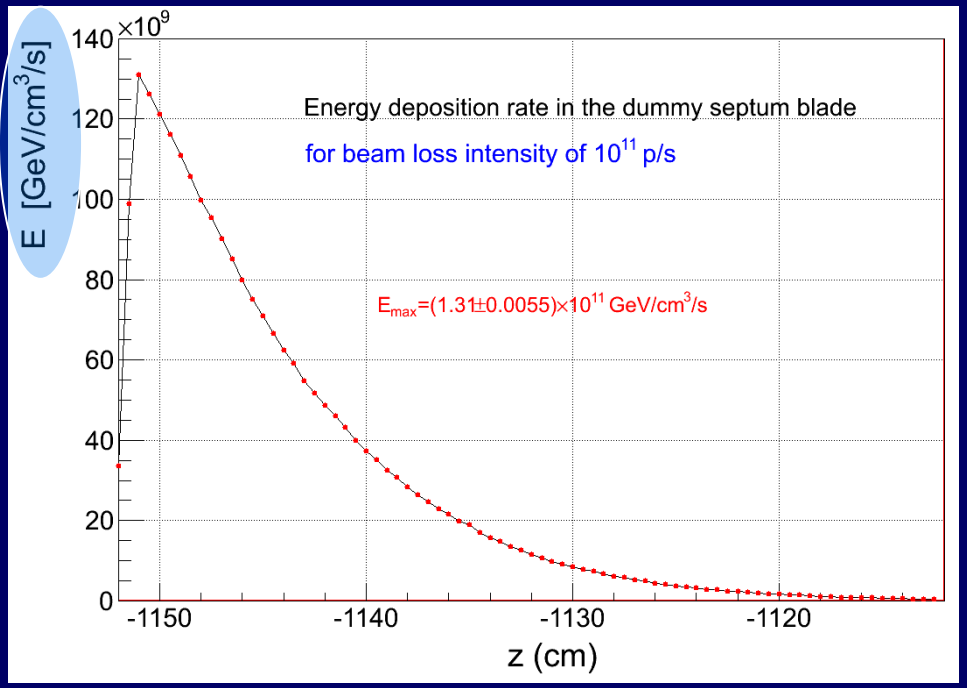
Maximum Energy Deposition in the dummy septum blade

1-dim projection along the blade length (z), averaged over $\pm 1\sigma_x$ in x and over the blade thickness of 3mm (y)



Maximum value E_{max} = (1.31±0.01) GeV/cm³/primary

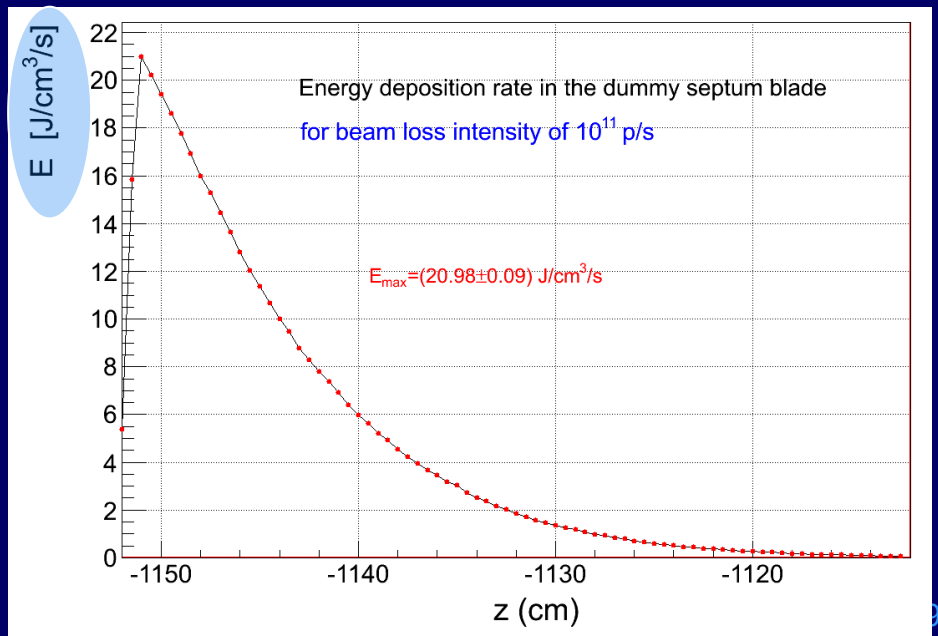
Maximum Energy Deposition Rate in the dummy septum blade



1-dim projection along the blade length (z), averaged over $\pm 1\sigma_x$ in x and over the blade thickness of 3mm (y)

Maximum value
$E_{max} = (1.31 \pm 0.01) \times 10^{11}$ GeV/cm³/s

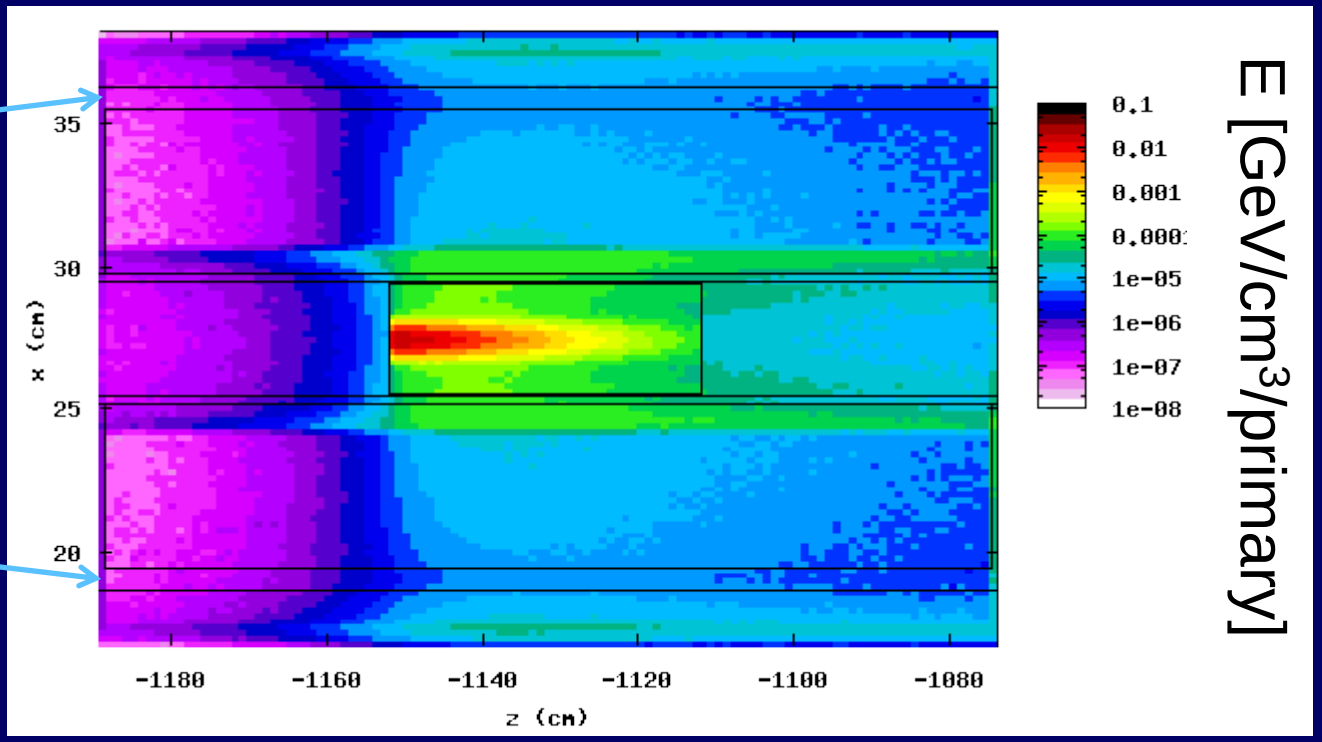
Maximum value
$E_{max} = (21.0 \pm 0.1)$ J/cm³/s



Dummy Septum Tank

Energy Deposition in the material of the dummy septum tank

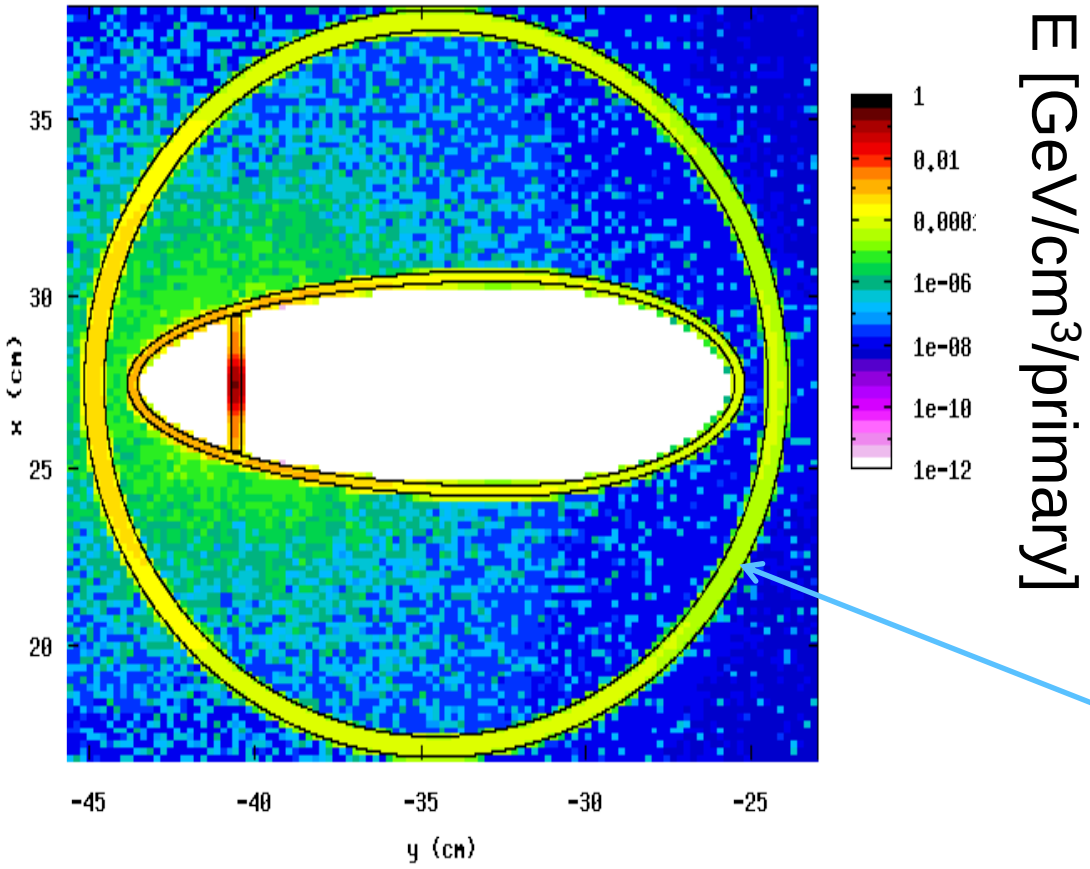
dummy septum tank



2-dimensional projection of Energy Deposition [GeV/cm^3/primary] in the x-z plane, averaged over y=±R_{tank}

Maximum energy values for -1144<z<-1118 cm

Maximum Energy Deposition in the dummy septum tank



2-dimensional projection of Energy Deposition [GeV/cm^3/primary] in the x-y plane, averaged over -1144 <z< -1118 cm

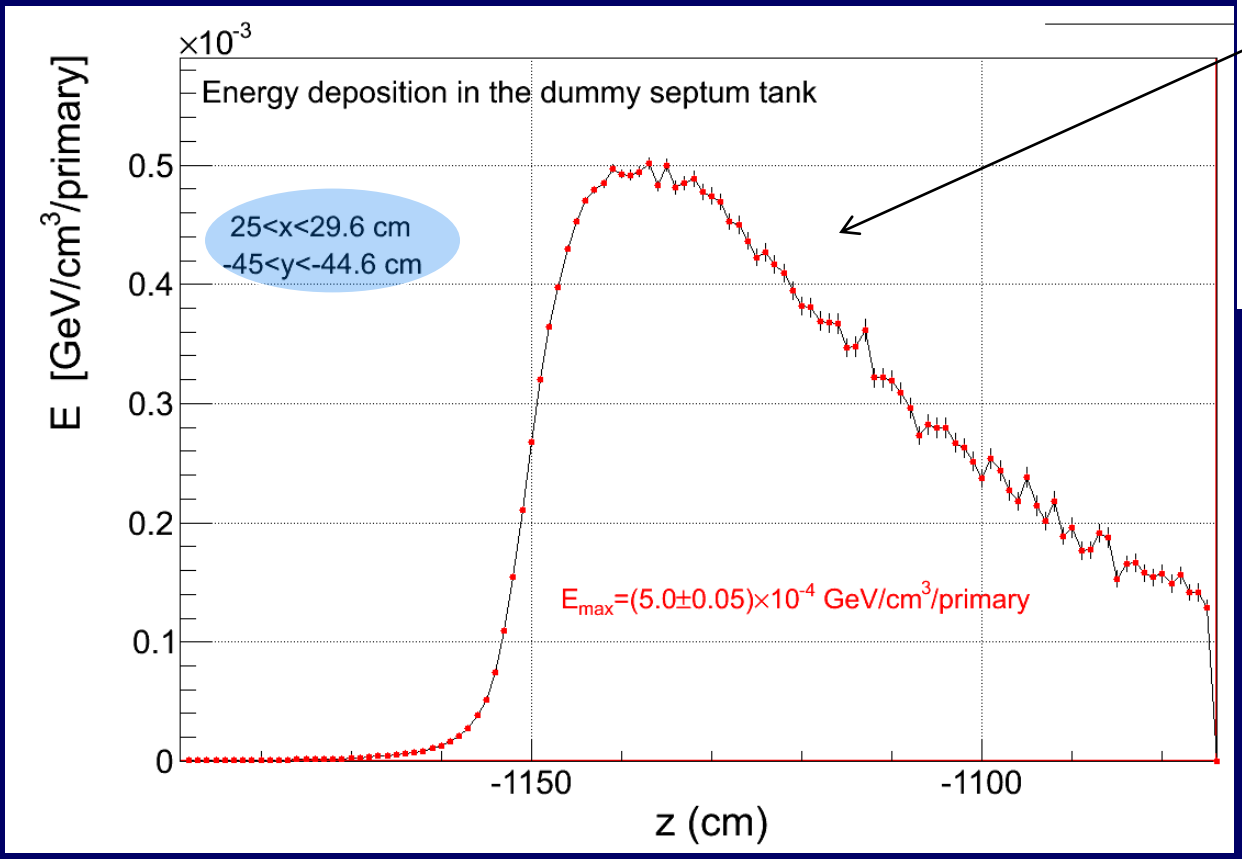
dummy septum tank

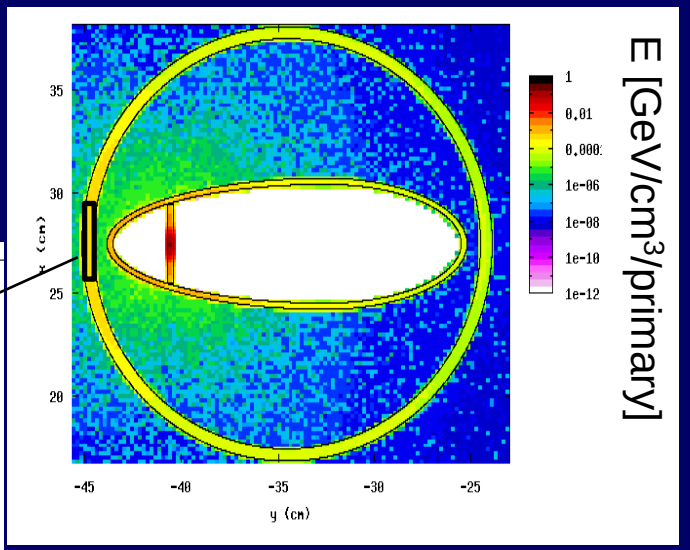
azimuthal asymmetry in the energy deposition:

variation in the medium plane by a factor of 10 between left and right

azimuthal average smaller by a factor of 3 than the maximum

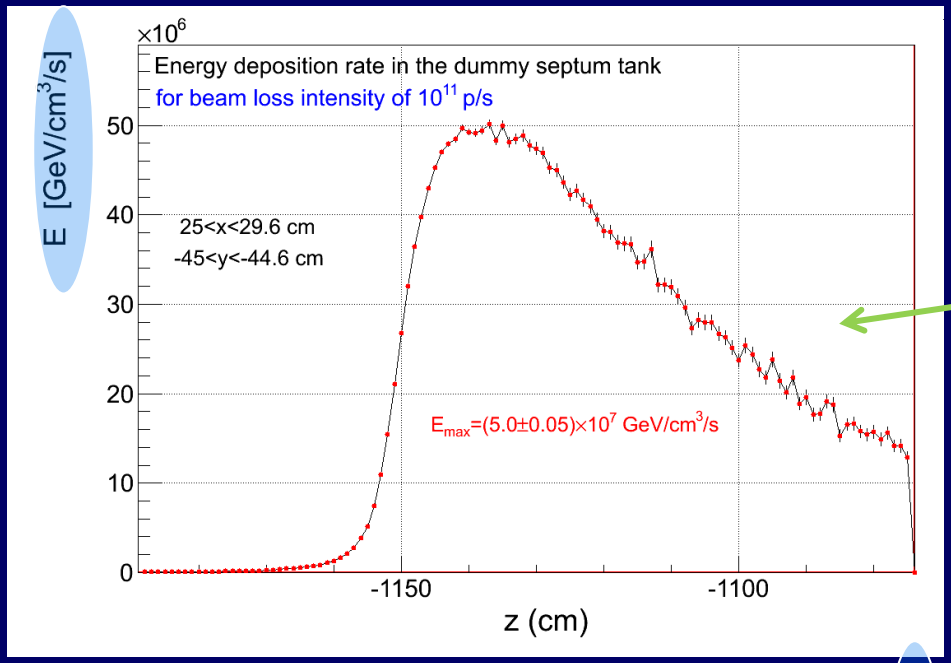
Maximum Energy Deposition in the dummy septum tank

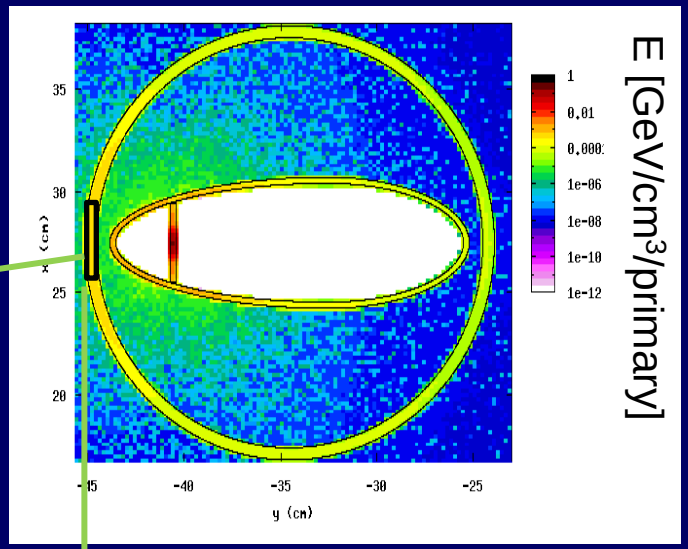




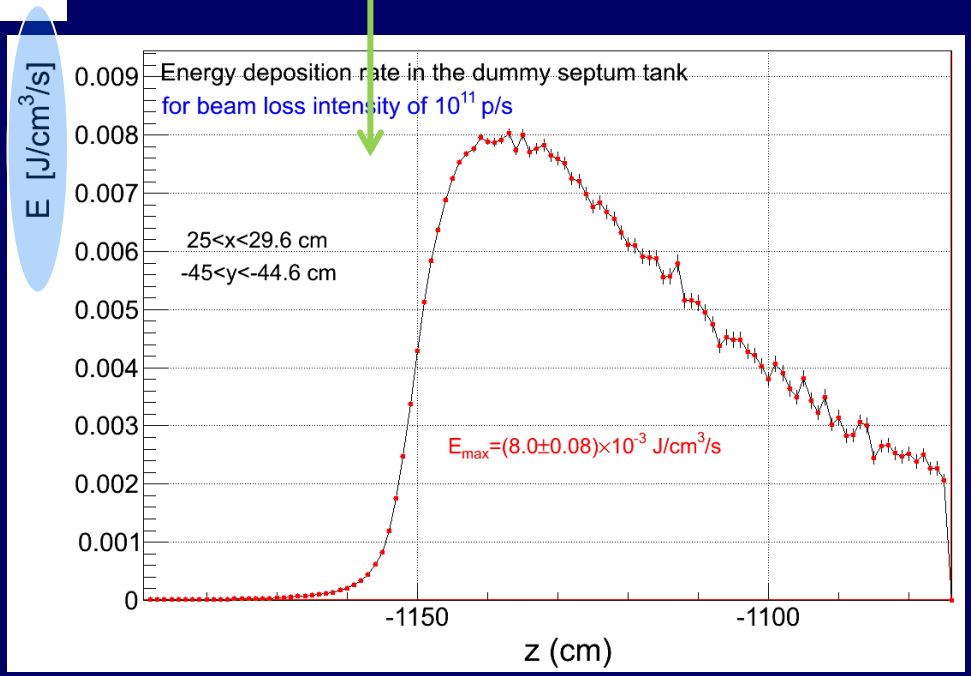
Maximum value E_{max} = (5.0±0.05)×10^{-4} GeV/cm^3/primary

Maximum Energy Deposition Rate in dummy septum tank





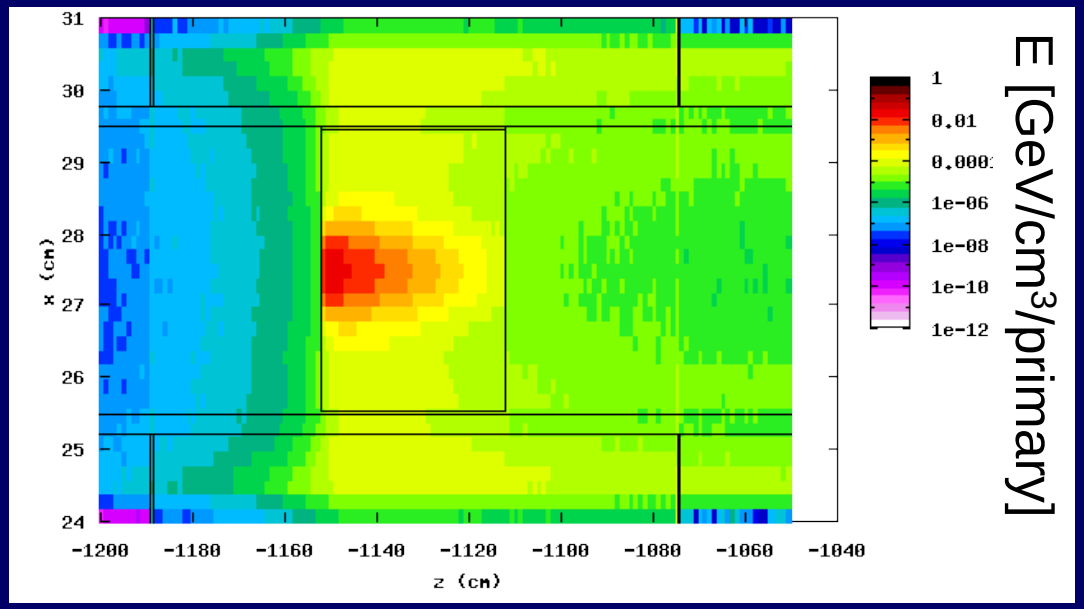
Maximum value
$E_{max} = (5.0\pm0.05)\times10^{7}$ GeV/cm^3/s



Maximum value
$E_{max} = (8.0\pm0.1)\times10^{-3}$ J/cm^3/s

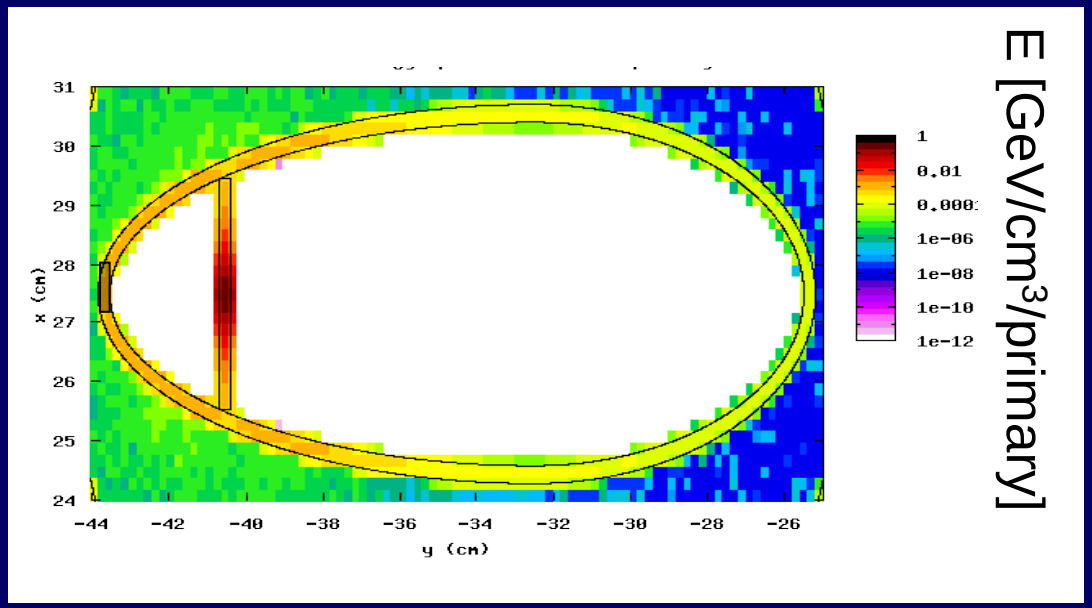
Vacuum Chamber of the MMU15

Energy Deposition in the vacuum chamber of the MMU15



2-dimensional projection of E [GeV/cm^3/primary] in the x-z plane, averaged over -44<y<-24 cm (z range here length of SS15)

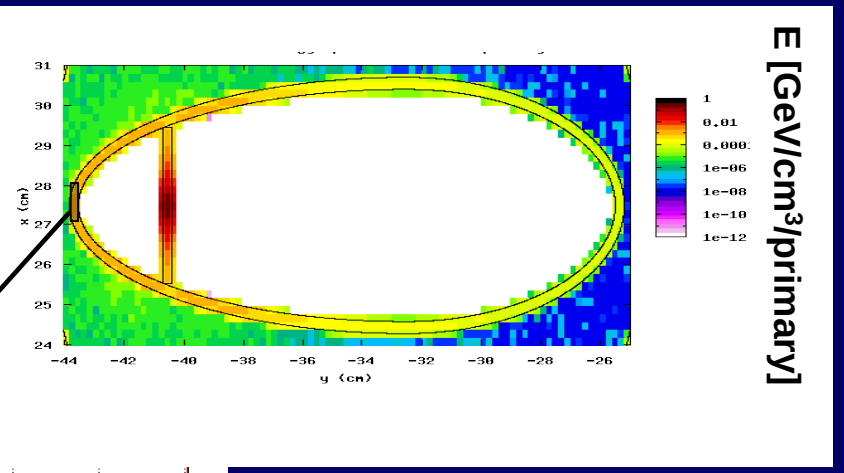
Maximum energy values for -1144<z<-1122 cm

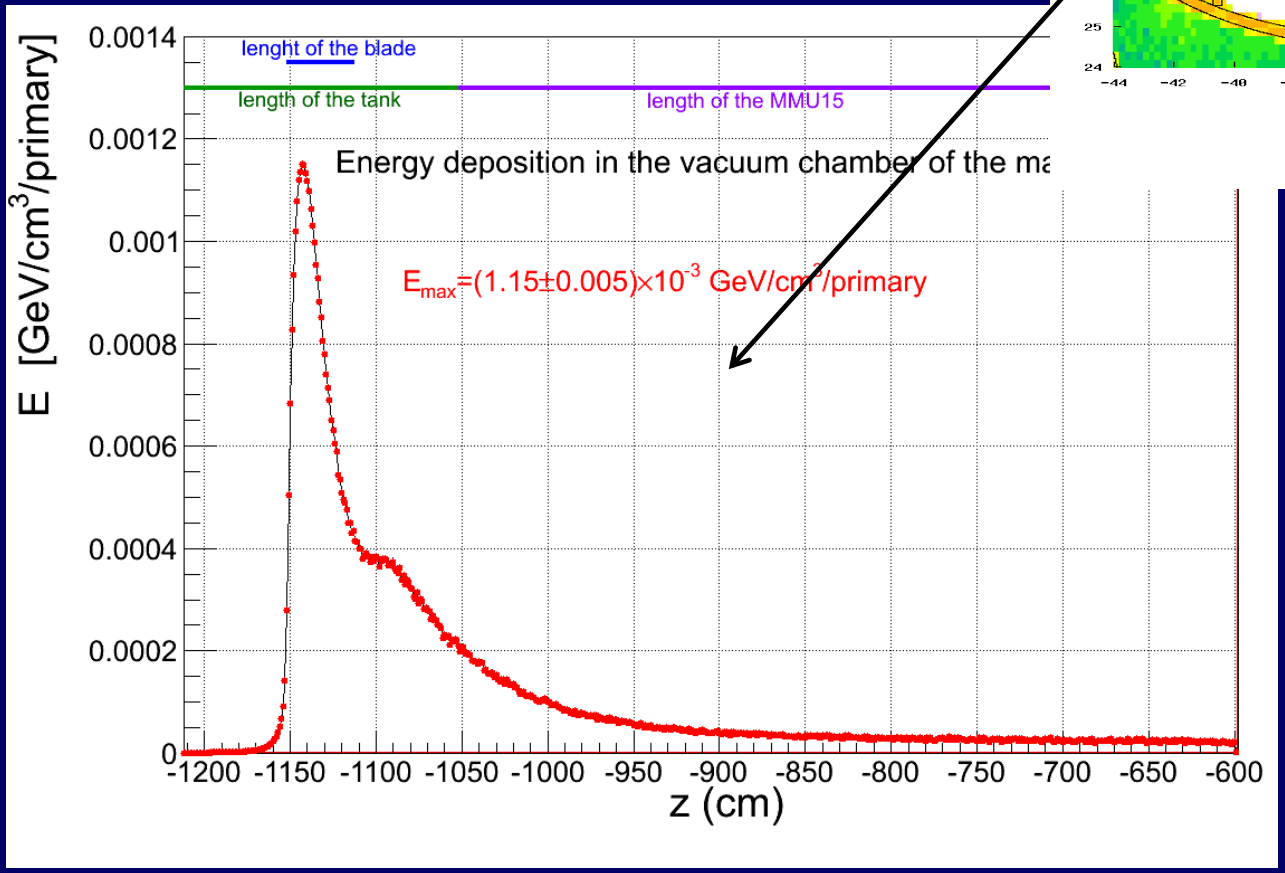


2-dimensional projection of E [GeV/cm^3/primary] in the x-y plane, averaged over -1144 <z< -1122 cm

azimuthal asymmetry in the energy deposition

Maximum Energy Deposition in the vacuum chamber of the MMU15

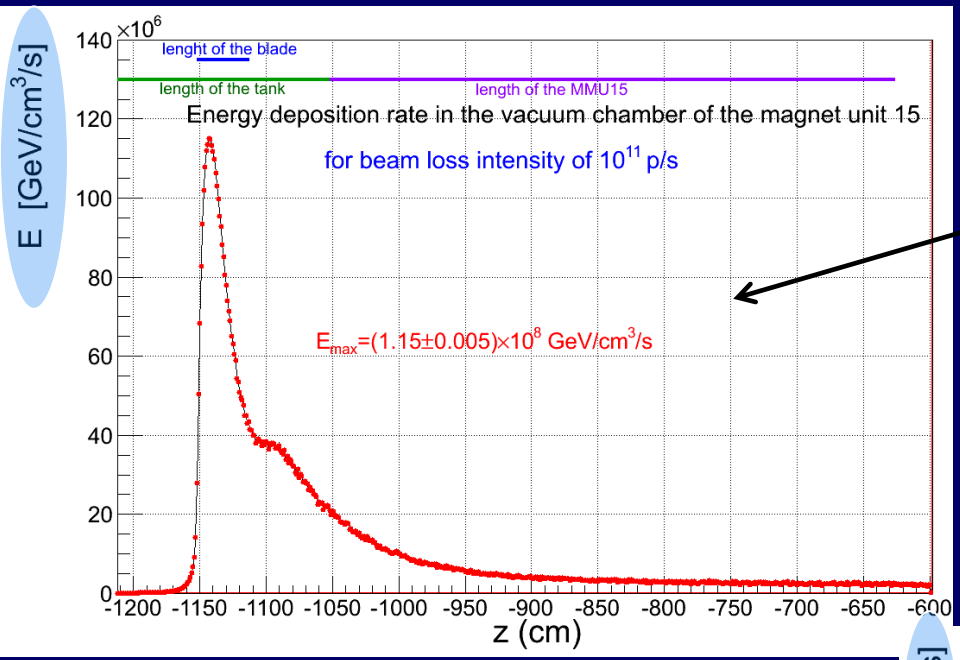


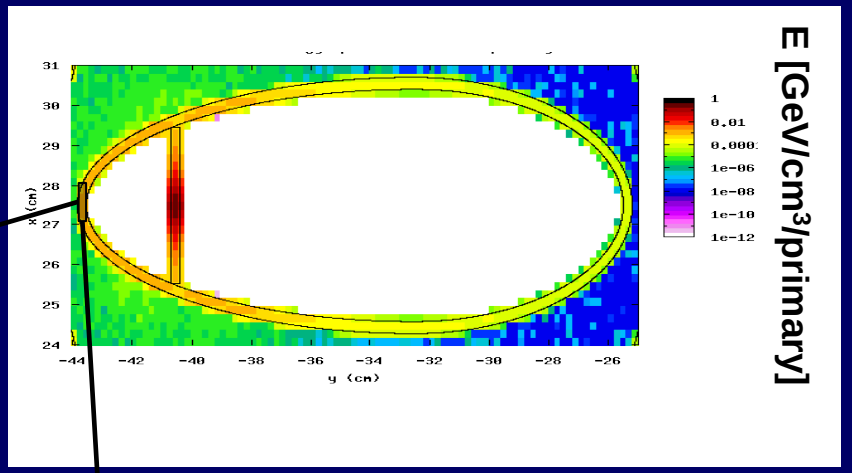


z range now over full length of SS15 and MMU15

Maximum value E_{max} = (1.15±0.005)×10^{-3} GeV/cm^3/primary

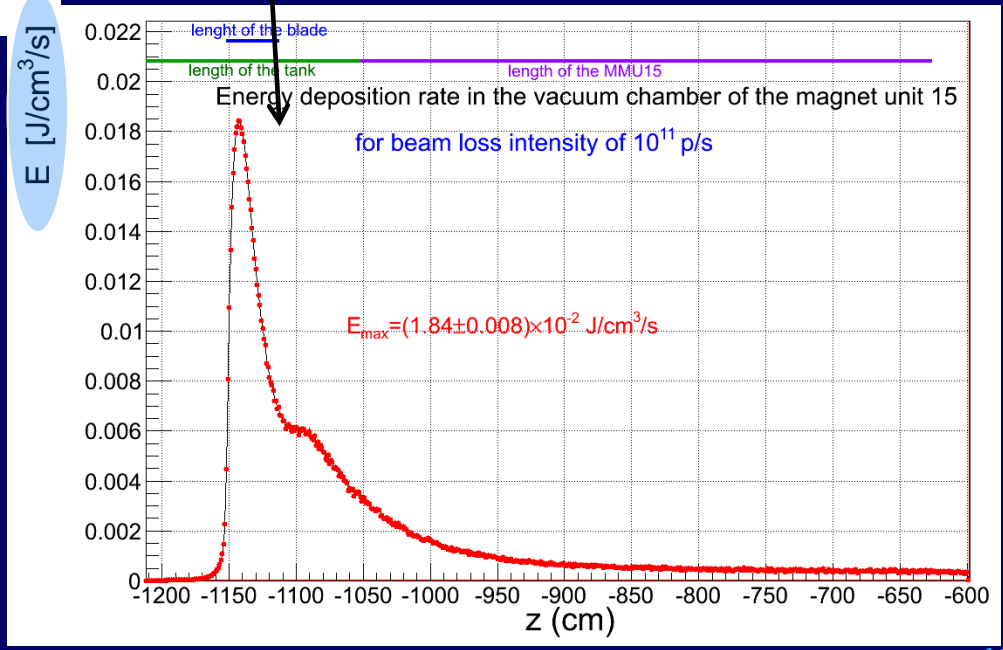
Maximum Energy Deposition Rate in the vacuum chamber of the MMU15





Maximum value

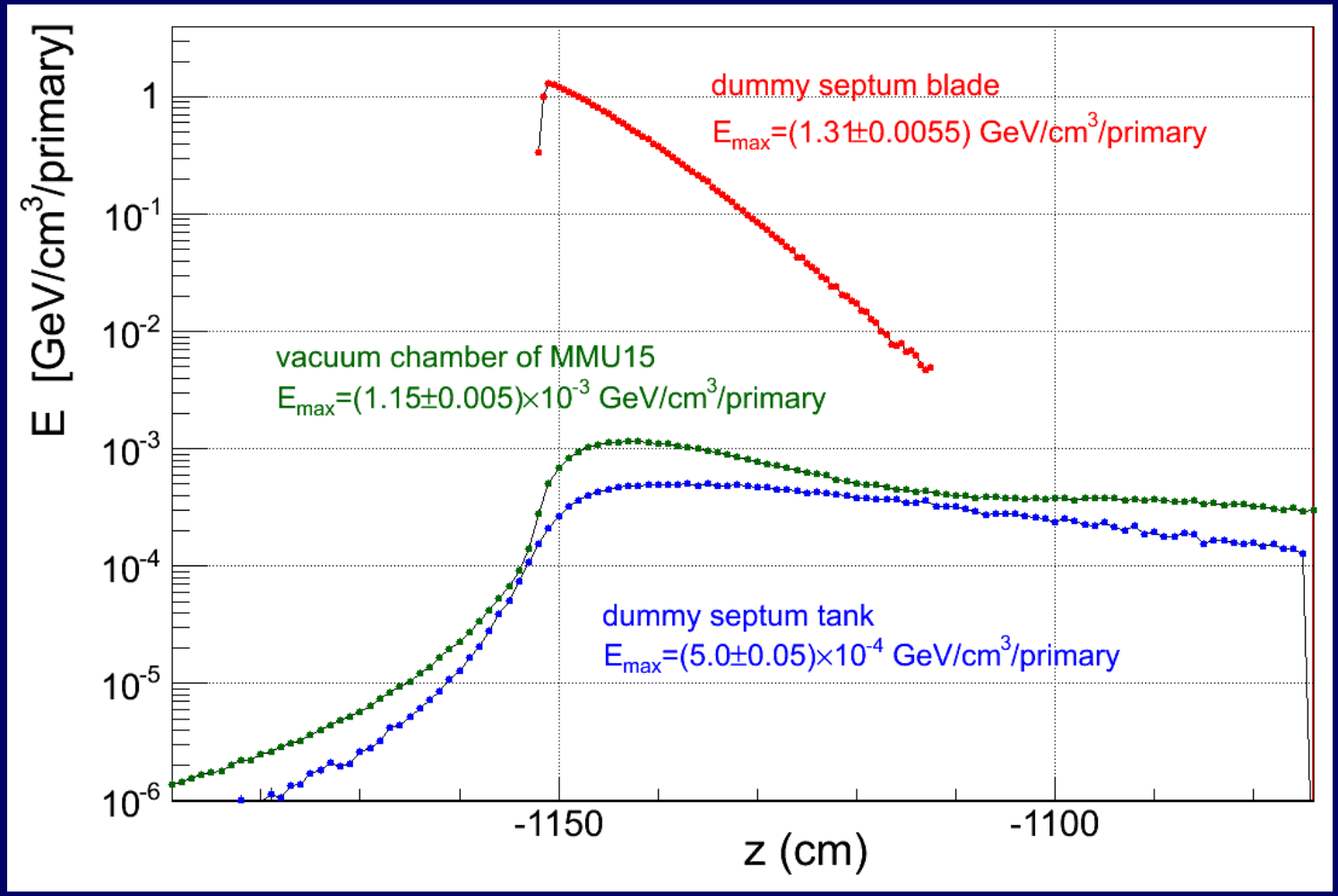
E_{max} = (1.15±0.005)×10⁸ GeV/cm³/s



Maximum value

E_{max} = (1.84±0.008)×10⁻² J/cm³/s

Comparison of Maximum Energy Deposition



Comparison of Maximum Energy Deposition

Rate for beam loss intensity of 10^{11} p/s

Material	maximum Energy [GeV/cm^3/primary]	maximum Energy Rate [GeV/cm^3/s]	maximum Energy Rate [J/cm^3/s]
dummy septum blade	1.31±0.01	(1.31±0.01)×10^{11}	21.0±0.1
dummy septum tank	(5.0±0.05)×10^{-4}	(5.0±0.05)×10^{7}	(8.0±0.1)×10^{-3}
vacuum chamber of the magnet unit 15	(1.15±0.01)×10^{-3}	(1.15±0.01)×10^{8}	(1.84±0.02)×10^{-2}

Conclusion

- Maximum energy deposition in the material of the dummy septum blade, dummy septum tank and vacuum chamber of MMU15 determined by FLUKA simulations

- Only instantaneous temperature increase can be deduced from FLUKA, using the specific heat capacity of the material

- Stationary temperature distribution requires thermomechanical simulations by dedicated software, e.g. ANSYS, using the FLUKA results as input