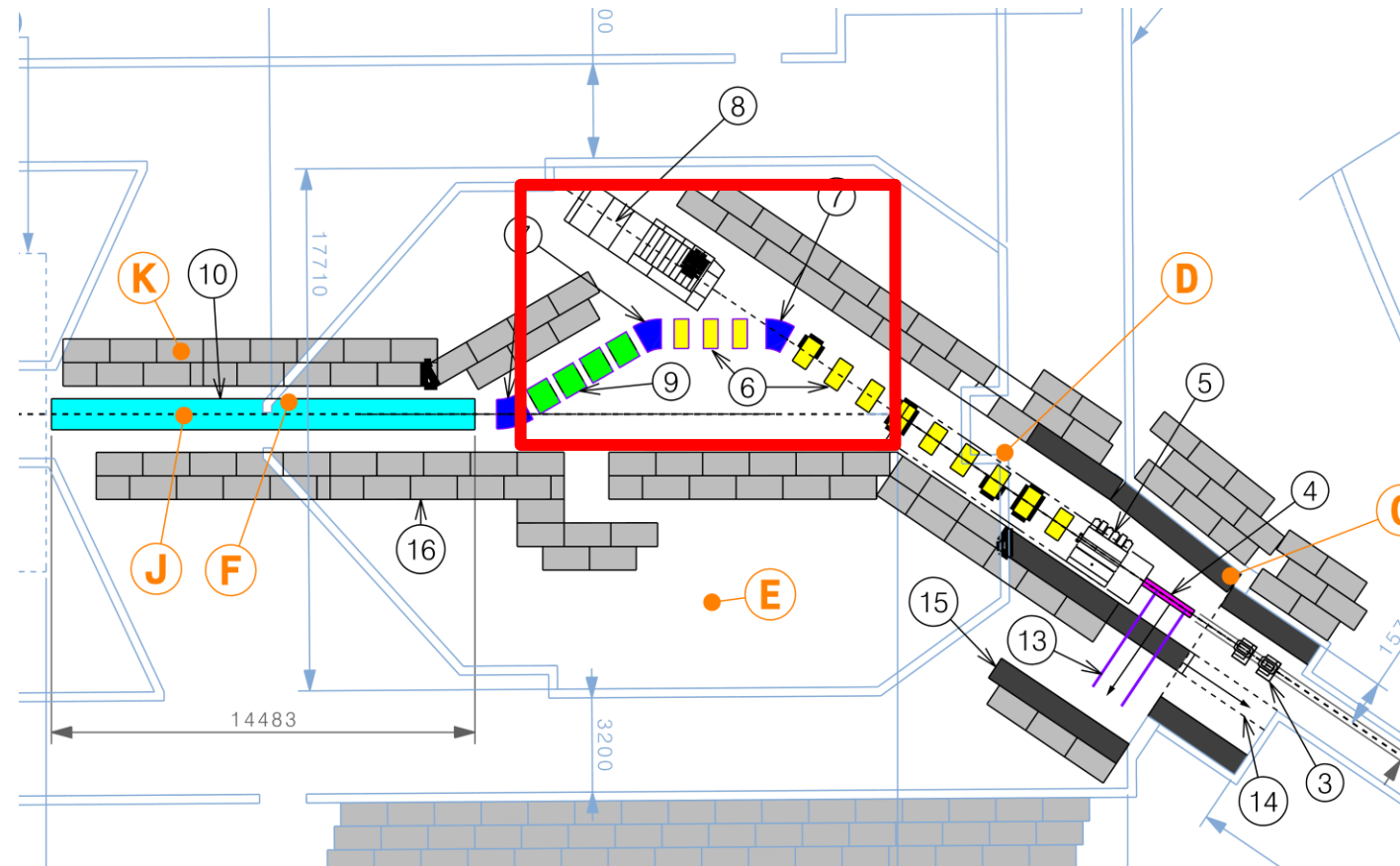
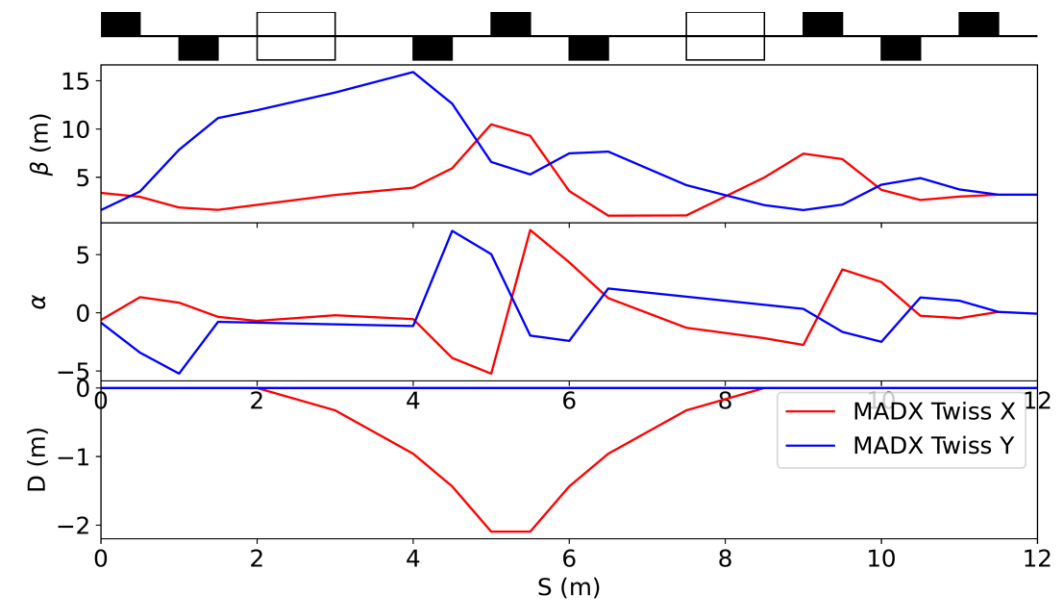
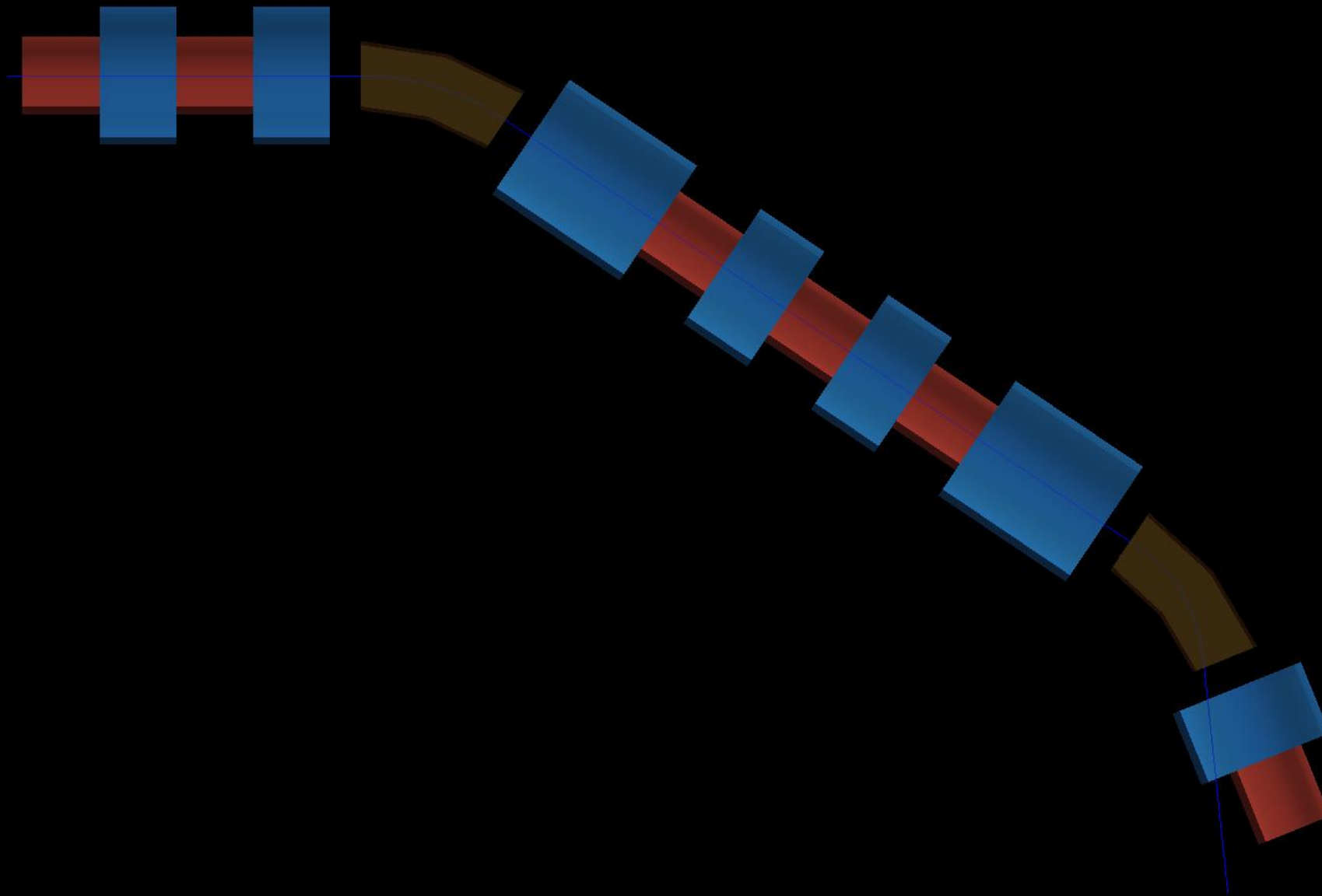


Studies on Muon Collider's Target with G4Beamline (10/07/2025)

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Parameters (BDSIM→G4Beamline)

Beam Definition

BDSIM:

```
beam, particle="mu+", momentum=200*MeV,  
    distrType="gauss", sigmaX=50*mm, sigmaY=50*mm,  
    sigmaXp=50*mrad, sigmaYp=50*mrad, sigmaP=0.05;
```

→ G4Beamline:

```
beam particle=mu+ momentum=200 sigmaX=50 sigmaY=50 sigmaXp=0.05 sigmaYp=0.05 sigmaP=0.05
```

- Units: G4Beamline assumes **mm** and **radians**.
- $\text{sigmaXp}=50\text{ mrad} \rightarrow 0.05$, same for Y.

Collimators

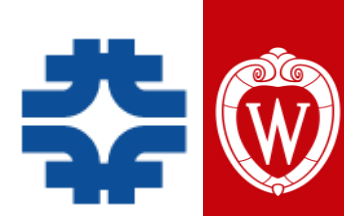
BDSIM:

```
c1: ecol, l=0.001*mm, xsize=300*mm, ysize=300*mm, material="graphite", outerDiameter=1500*mm;
```

→ G4Beamline:

```
tube c1 innerRadius=150 outerRadius=750 length=0.001 material=Graphite kill=1 color=0.5,0.5,0.5
```

- $\text{outerDiameter}=1500\text{ mm} \rightarrow \text{outerRadius}=750$
- xsize/ysize map to aperture radius.
- $\text{kill}=1$ mimics absorber behavior ($\text{beamPipeIsInfiniteAbsorber}=1$).



Parameters (BDSIM→G4Beamline)

Quadrupoles

BDSIM:

ch_q1: quadrupole, l=0.5*m, k1=1.31029, aper1=200*mm;

→ G4Beamline:

multipole ch_q1 fieldLength=500 quadrupole=1.31029 apertureRadius=200 kill=1 fieldMaterial=Vacuum
ironMaterial=Fe

Conversion notes:

- $l=0.5\text{m} \rightarrow \text{fieldLength}=500$
- k_1 directly equals **quadrupole gradient**
- **(T/m)** $\text{aper1}=200\text{ mm} \rightarrow \text{apertureRadius}=200$
- Add $\text{kill}=1$ for the iron boundary.
- Repeat with sign changes for Q2–Q8.

Drifts

BDSIM:

d_500: drift, l=500*mm;

d_1000: drift, l=1000*mm;

→ G4Beamline:

tube d_500 length=500 innerRadius=400 outerRadius=450 material=Vacuum

tube d_1000 length=1000 innerRadius=400 outerRadius=450 material=Vacuum

- Use pipe or tube for drifts.
- No magnetic field; just free drift space.

Conversion Formula

$$\text{Gradient (T/m)} = k_1 \times (B\rho)$$

where

$$B\rho = \frac{p}{q} = \frac{p [\text{GeV}/c]}{0.299792}$$

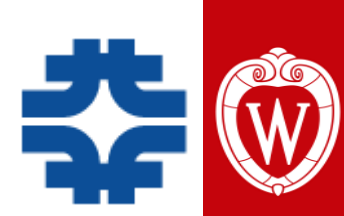
and p is the beam momentum.

Example (200 MeV/c beam)

$$B\rho = \frac{0.200}{0.299792} = 0.667 \text{ T} \cdot \text{m}$$

so

$$\text{Gradient} = k_1 \times 0.667$$



Parameters (BDSIM→G4Beamline)

Dipoles (sbend)

BDSIM:

s_dp_1: sbend, l=1000*mm, angle=-(3.14159/180)*34;

→ G4Beamline:

param Rc=1000/0.5934 # bending radius from Bp relation

param **Bdip=0.396 T**

genericsectorbend s_dp_1 fieldLength=1000 fieldCenterRadius=\$Rc DipoleField=\$Bdip \
fieldHeight=400 fieldInnerRadius=\$Rc-130 fieldOuterRadius=\$Rc+130 angle=-34

place s_dp_1 z=\$z_b1

cornerarc z=\$z_b1 centerRadius=\$Rc angle=-34 radiusCut=400

Magnetic field:

$$B = \frac{p}{0.299792 R}$$

where

p = beam momentum (GeV/c)

R = bending radius (m)

B = magnetic field in tesla

Example (200 MeV/c beam, $R = 1.67$ m):

$$B = \frac{0.200}{0.299792 \times 1.67} = 0.396 \text{ T}$$

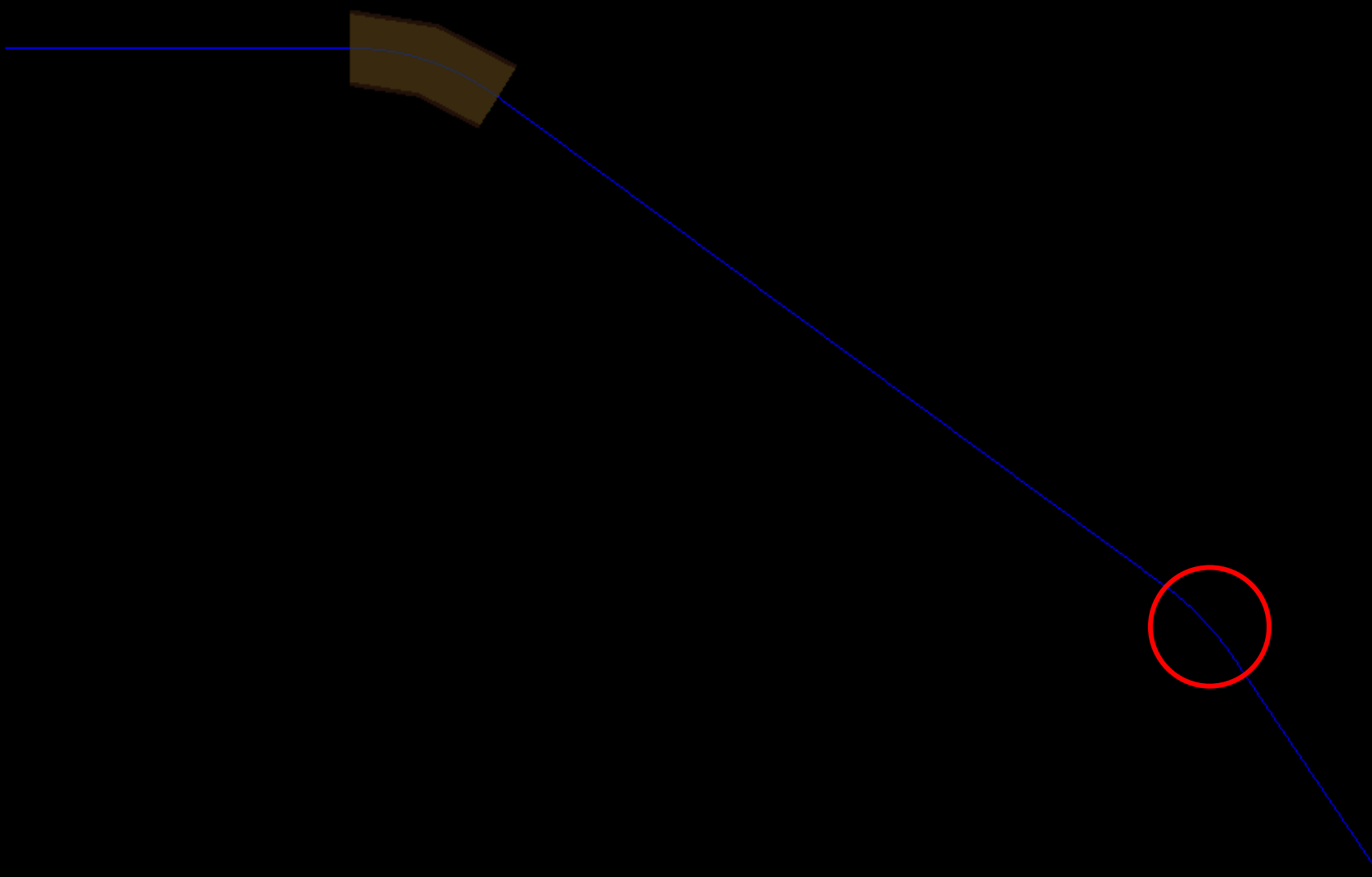
→ hence param Bdip=0.396

About the constant 0.299792:

This factor comes from the Lorentz force relation $p = qBR$.

Expressed in GeV/c, T, and meters:

$p[\text{GeV}/c] = 0.299792 \times B[\text{T}] \times R[\text{m}]$
0.299792= $c/10^9/e$ — essentially the **speed of light in convenient accelerator units**.



Pion Decay Channel

