Particle Production of Graphite Target (20 to 2 T5 m4 PDL) from Focused Proton Beam (KE of 6.75 GeV) with Different Emittance

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Target Studies
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Target Setting

• Carbon target with 20to2T5m4PDL Configuration (with resistive copper) and Fieldmap (20T ➝ 2T);
• Code: MARS15(2014) with ICEM 4 = 1;
• Proton beam: 6.75 GeV (KE) and launched at z = -100 cm, Focal beam with waist at z= 0 m and varied emittance;
• Production Collection: (50 m downstream, 40 MeV < KE < 180 MeV).
• BeamRadius/TargetRadius = ¼, at waist of carbon target
• ENRG 1 = 6.75, 2 = 0.02, 3 = 0.3, 4 = 0.01, 5 = 0.05, 6 = 0.01, 7 = 0.01 (Energy card setting)
We prefer target radius $\geq 8$ mm (beam radius $\geq 2$ mm) for viable radiation cooling of the target.

For $r_{\text{target}} = 8$ mm, same yield for any emittance $\leq 20$ $\mu$m.
Yield for target with tilt

(65 mrad to SC axis)

Yield for 50 μm emittance and target radius of 1.2 cm is only 10% less than that for the nominal case of 5 μm emittance an 0.8 cm target radius.
Yield and Beam Radius vs. Emittance

Comparison between tilt and notilt

Target radius = 4 \cdot \text{beam radius}
Beam Shift along x at z=0
(beam radius of 2.25 mm, tilt angle of 65 mrad and emittance of 20 μm)

~ 1% gain with 2 mm shift in x.
Yield vs. Beam Angle
(beam radius of 2.25 mm, beam emittance of 20 μm)

Tilt angle of 65 mm is near optimal for large beam emittance
For a fixed target radius (8 mm on this page), higher beam emittance \( \Rightarrow \) higher beam divergence, More diffuse beam at upstream end of target, \( \Rightarrow \) lower peak power deposition.

For emittance \( \geq 20 \ \mu \text{m} \) the peak power deposition is only \( \approx 1/2 \) that for 5 \( \mu \text{m} \), \( \Rightarrow \) additional advantage to use of higher emittance beams.