Beam Stepping Distance

- Beam stepping angle is specified in either degrees/minutes/seconds, in decimal degrees or in gons. There are 400 gons in a circle, just as there are 360 degrees in a circle.

- Unfortunately, the specs units are not radians ($2\pi$ radians in a circle). If they were radians, a very rapid approximation of the stepping distance in meters can be made mentally. For small angles,

  Stepping Distance = (angle in radians) * distance

  e.g. Stepping Angle = 0.00005 radians (.05 mRadians)

  Stepping Distance (@800m) = 0.00005* 800 = 4 cm

  
  1 gon = 0.9 deg 
  1 deg = 1.111 gon

  1 deg = 0.01745 radians

- Minimum specs for stepping tend to be 0.0012 => 0.004 deg

  0.002 deg = 0.035 mRadians = 3.5 cm at 1000 meters
Beam Divergence

- Beam Divergence
  - Optech Ilris 0.00974 deg (0.17 mRadian)
  - Riegl LMS 620i 0.004 deg (0.07 mRadian)
  - Riegl LPM 321 0.046 deg (0.8 mRadian)

- Beam diameter at exit ranges from a few millimeters to centimeters

- Spot diameter at distance
  \[
  \text{diameter} = \text{beam at exit} + \text{divergence (radians)} \times \text{distance}
  \]
  \[
  = 2 \text{ mm} + 0.00007 \text{ radians} \times 500\text{m} = 3.7 \text{ cm}
  \]
  \[
  = 1 \text{ cm} + 0.0008 \text{ radians} \times 500\text{m} = 41 \text{ cm}
  \]
Range Measurement vs Intensity
CD Reflectors Mounted on the Wall of the Student Union

Note angle of points from wall pointing toward scanner

0.3m
Exercise

• Draw on a sheet of paper using a compass a 4x4 array of laser shots assuming the following specs and setup below
  – Angular stepping distance = 0.002 deg
  – Range = 500 m
  – Beam size at scanner = 2 mm
  – Beam divergence = 0.004 deg

• Repeat the above assuming the following specs and setup
  – Angular stepping distance = 0.02 deg
  – Range = 100 m
  – Beam size at scanner = 1 cm
  – Beam divergence = 0.8 mRadian

• Range to a reflector is 500 m, reflector diameter is a CD (12 cm). Approximately how large will the reflector appear if the angular stepping distance is 0.02 deg, the beam at the scanner is 1 cm, and the beam divergence is 0.8 mRadian? If the beam strikes the reflector it will return a signal stronger than the surrounding terrain.