Solid Target Considerations

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- An order of magnitude estimate of particle absobtion and energy loss from:
  - The downstream part of a target
  - The downstream continuation of an undisturbed jet
  - The "spray" induced in the jet by previous bunches
  - The "rain" of liquid metal droplets from the spray attaching to the pipe
- A possible scheme using a "jet" of multiple solid targets

The "spray" and "rain" represent two components of the "storm" discussed by P. Thieberger (MUC-Note #0212)

Simple (2D) calculation of pion absorbtion

- Gaussian p and pt initial distribution
  $\sigma_p = 200$ MeV/c σ_{pt}= 100 MeV/c
- Track in Larmor Planes
- Assume cylindrical isotropy of tracks (ignoring effect of skew target)
- In material:
  dE/dx, including E dependence, weighted by azymuthal probability
  Reducing track weights by dz/X_L for interactions
- Correct effective X_L in "spray" or "rain" by average density
- Off center jet approximated by

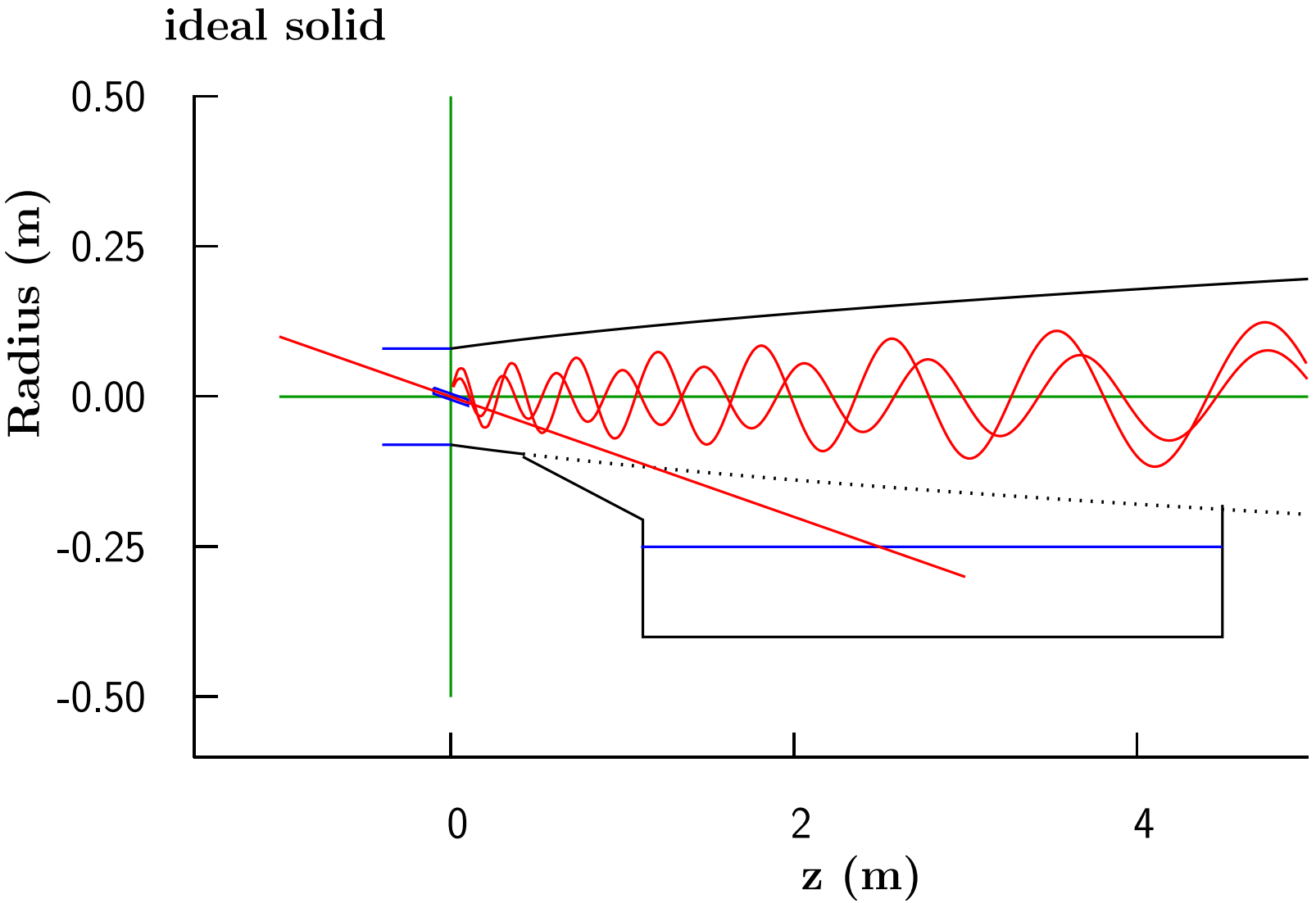
$$\Delta\phi = \pm\frac{2\ r_{jet}}{R}$$
$$\Delta R = \pm 2\ r_{jet}$$

Current approximate constants

Interaction length (X_L)	m	0.1
Minimum dp/dx	GeV/m	2
Target velocity	m/s	20
Time between pulses	ms	20
Target length	m	$2 \times X_L$
Target radius	cm	0.5
Proton beam angle	mrad	100
Liquid jet spray angle	mrad	133
Solid target angle	mrad	150
Initial pipe radius	cm	8
Initial field	T	20
Distance to window	m	5

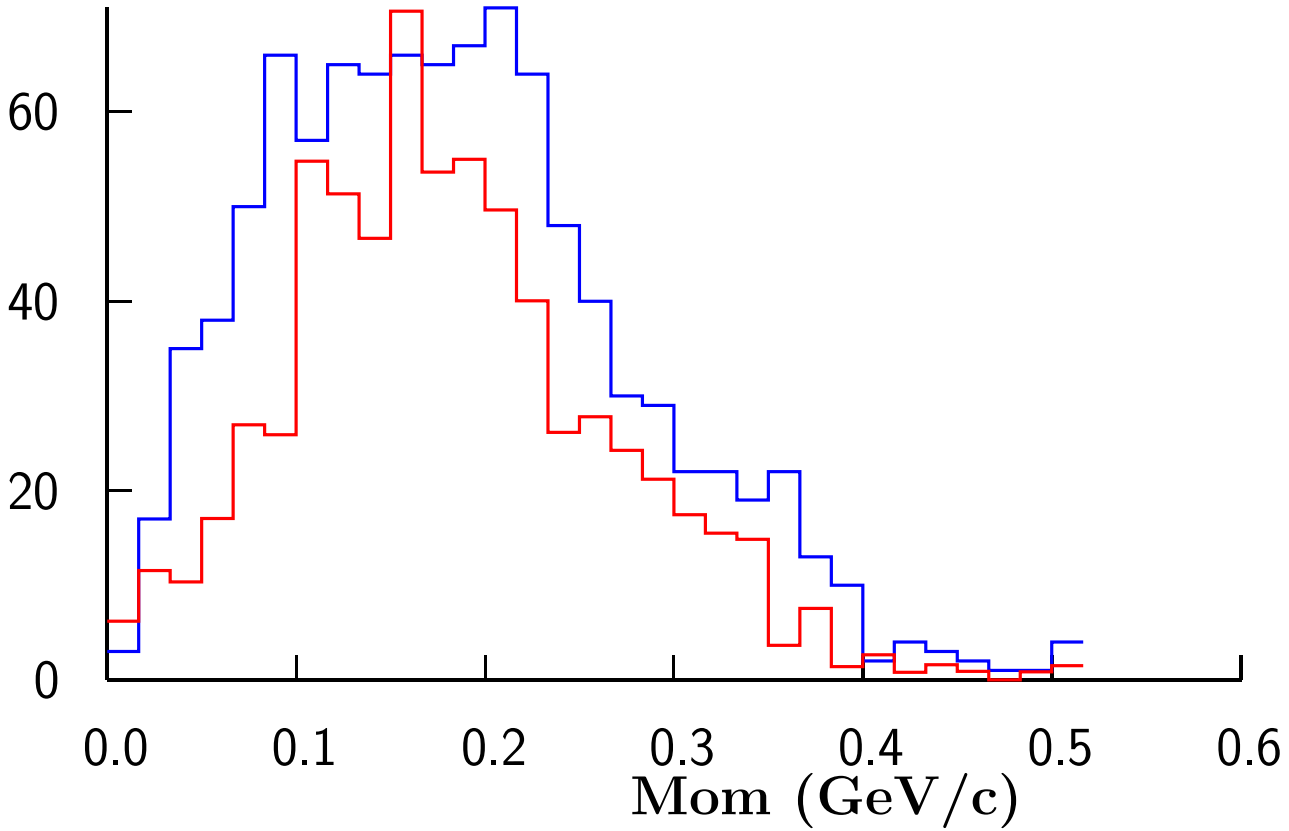
Ideal Geometry

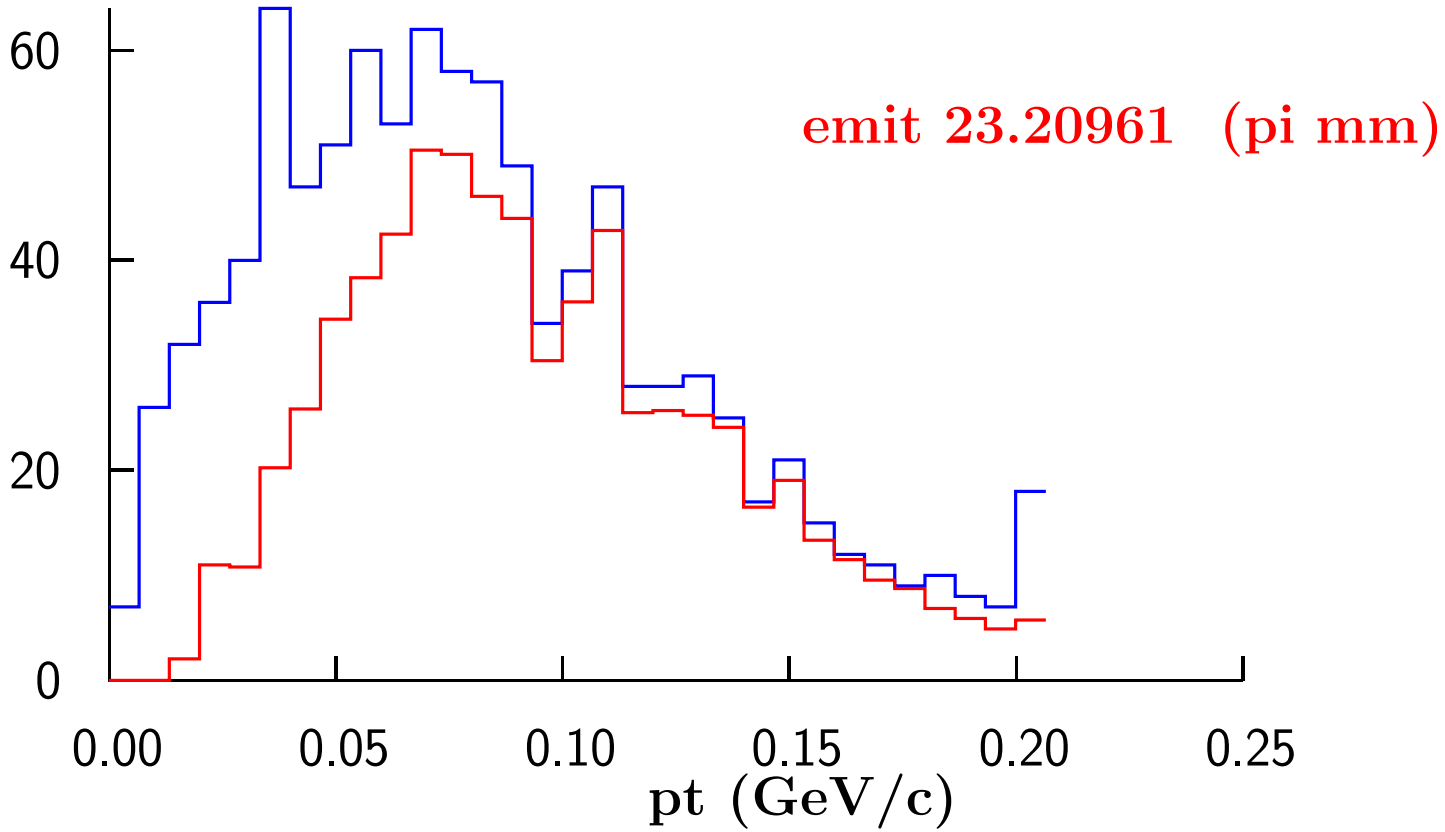
Solid target suspended in space



Effects of exiting target

- Source at center of target
- Apply dEdx in half target
- lower weights by dl/X_L (X_L = inelastic cross section)
- These effects included in all cases

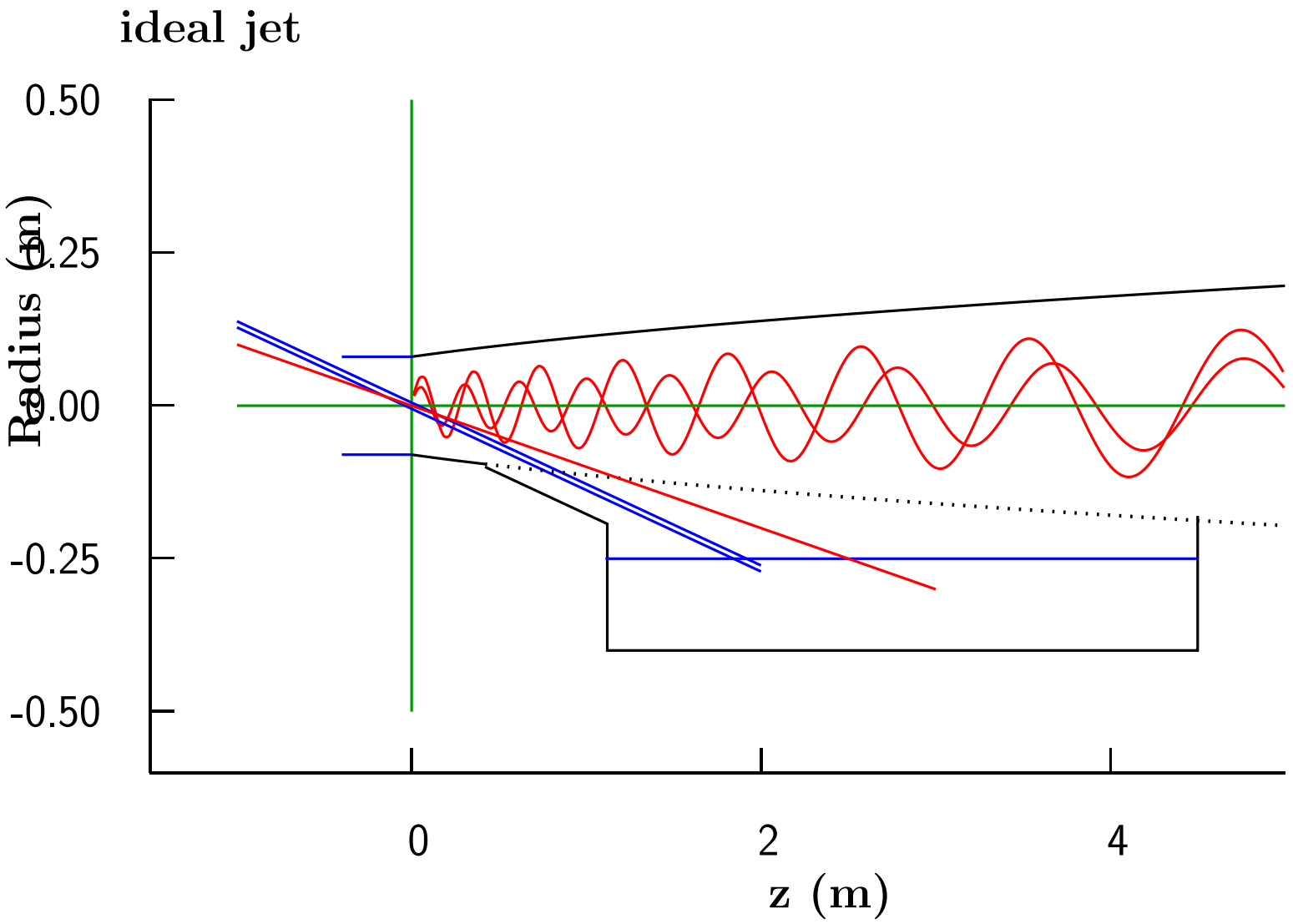


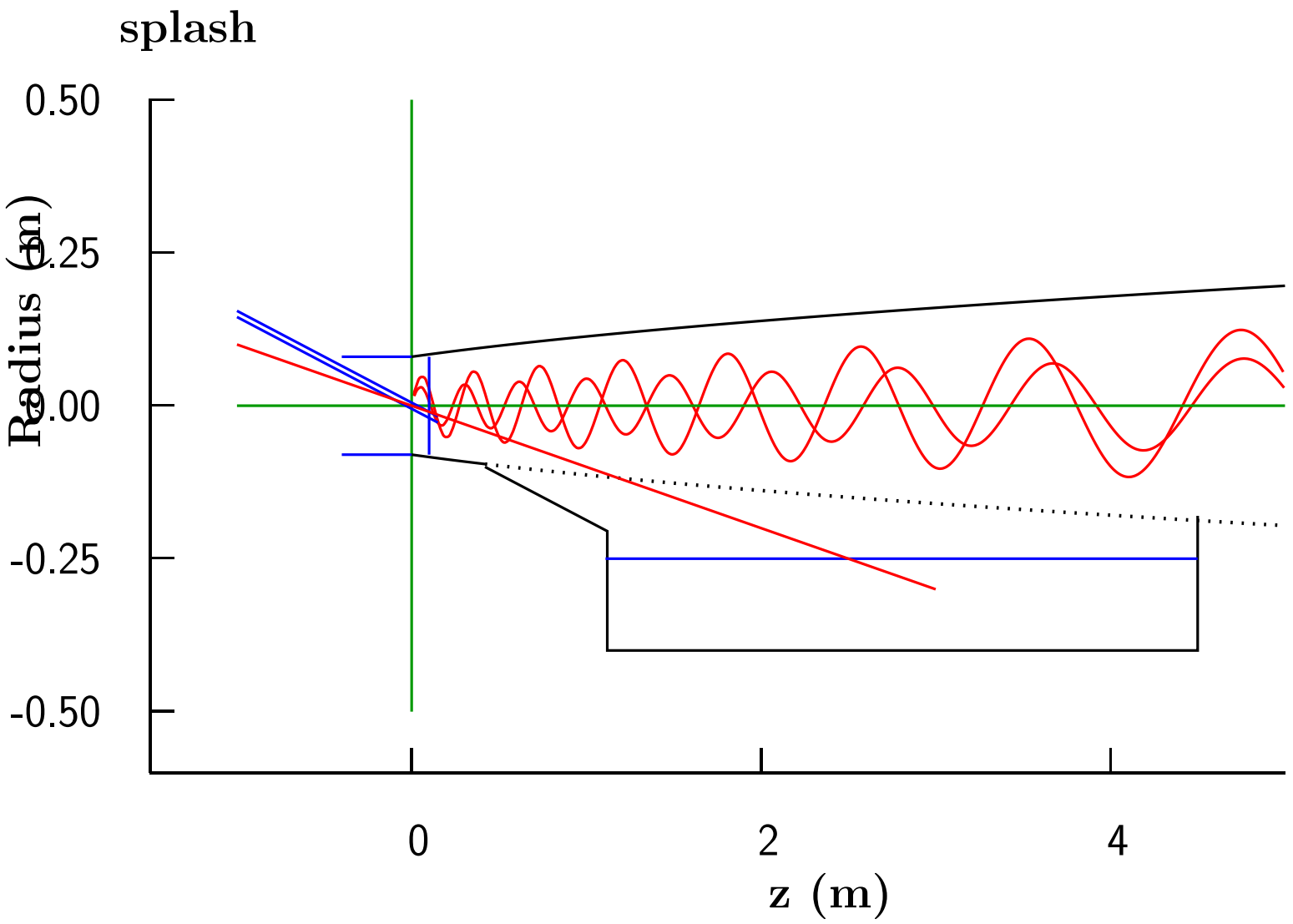


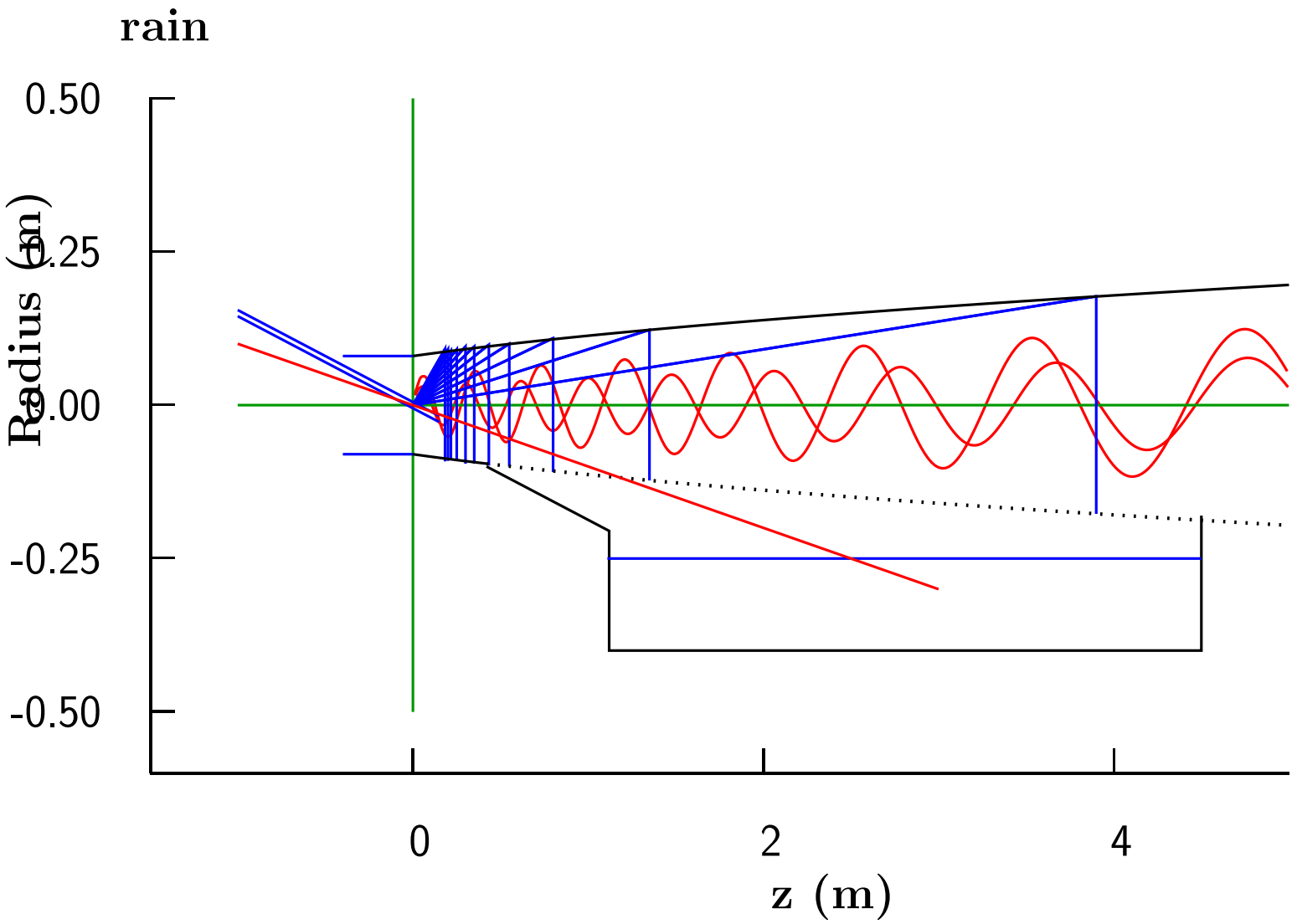
- Note that high pt tracks get out of sides of target
- Lower pt, forward, tracks get absorbed more

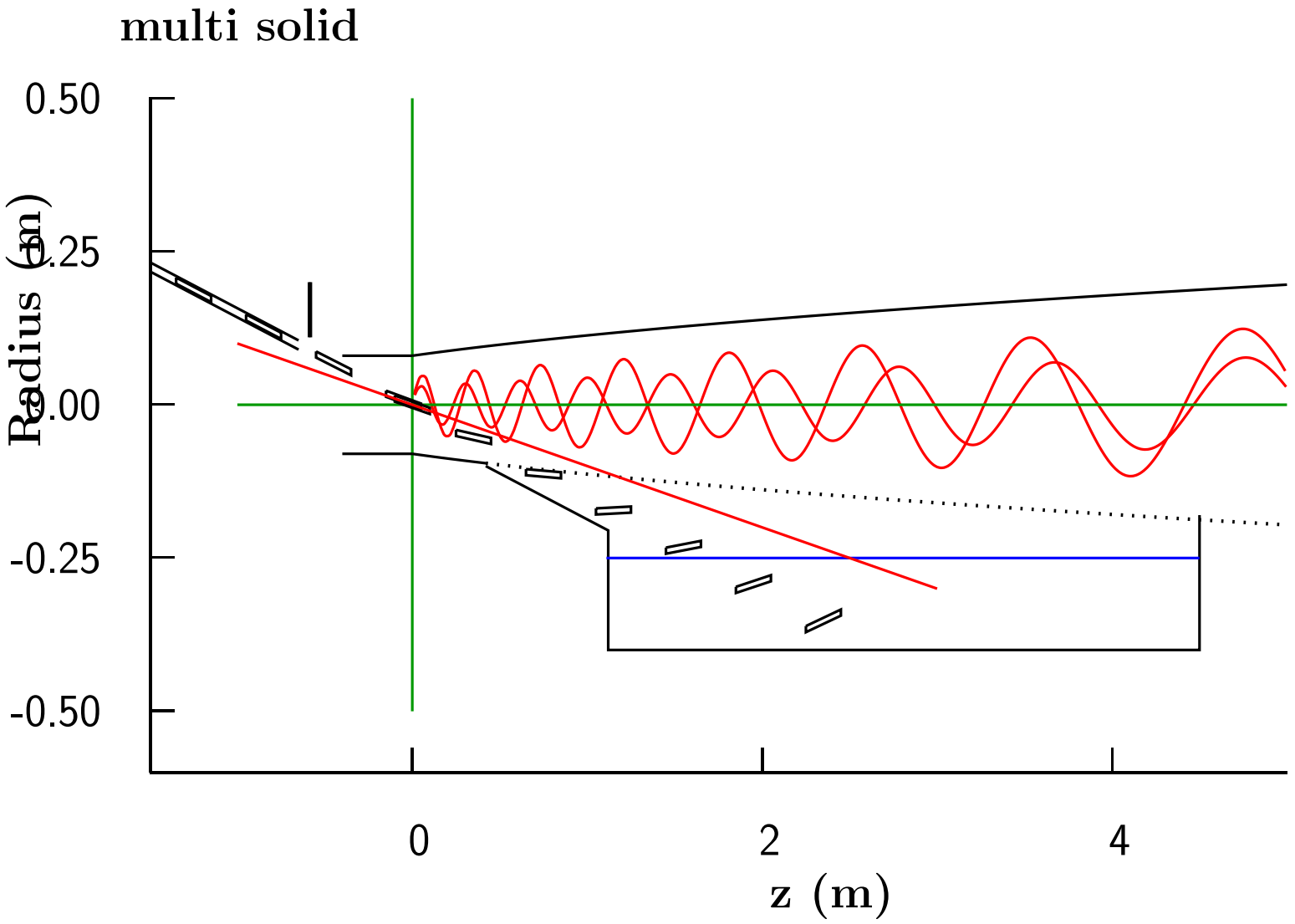
Other Situations

1. "ideal Jet"
   - jet remains undisturbed to the dump
   - include dEdx and interactions
2. "Splash"
   - Liquid target is fully dispersed
   - pt unuform to 20 m/sec
   - droplets "bounce/splash" off walls maintaining v_z
3. "rain" (P. Thieberger)
   - Liquid target is fully dispersed
   - pt unuform to 20 m/sec
   - Droplets "stick" to walls, then fall under gravity
4. "Multi-Target "
   - Targets fired from "blow pipe"
   - Gas jet adds "crab"
   - Targets stopped in liquid dump

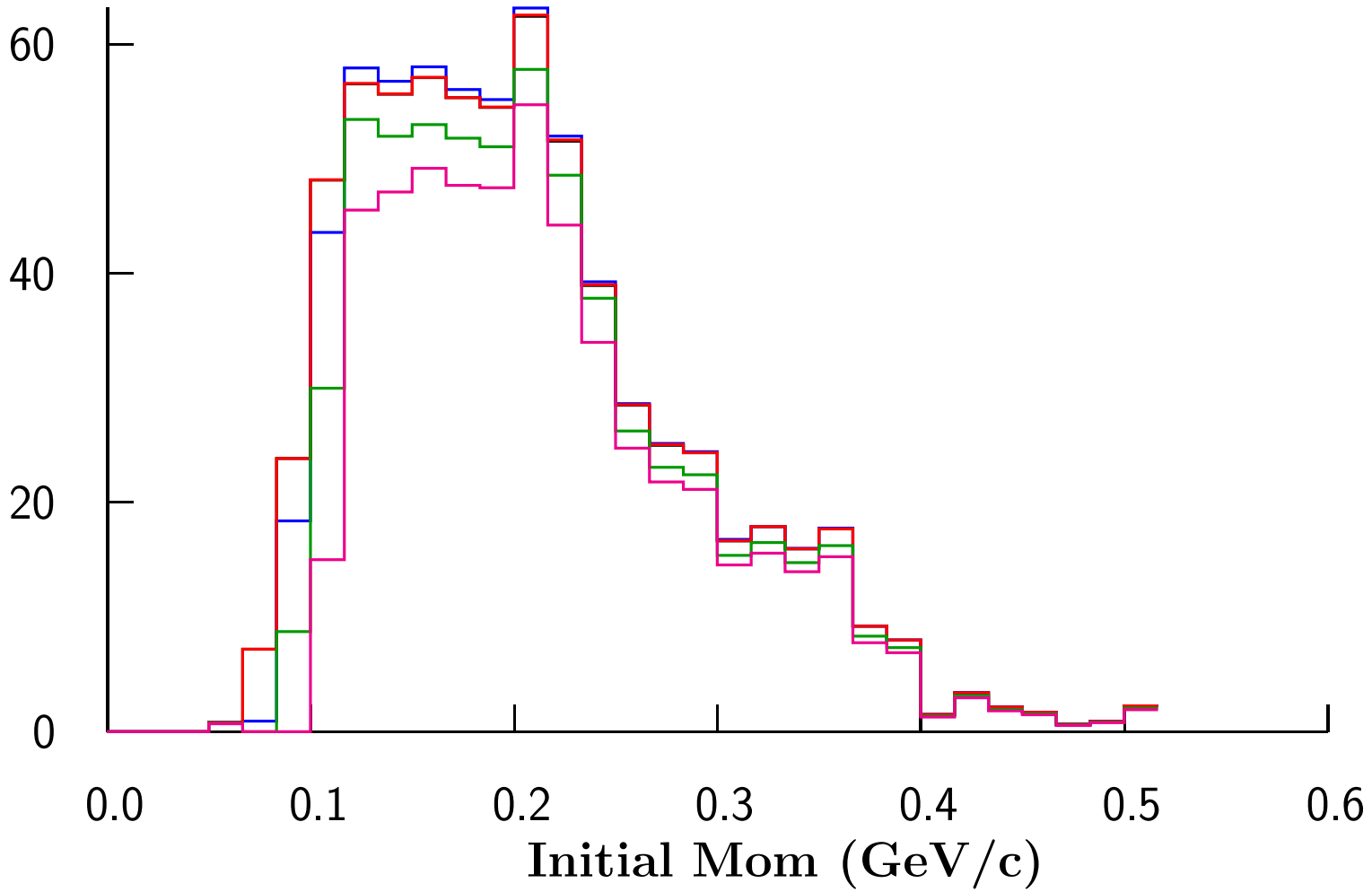

ideal jet
0.50
0.25
0.00
-0.25
-0.50
Radius (m)
0
2
4
z (m)


splash
0.50
0.25
0.00
-0.25
-0.50
Radius (m)
0
2
4
z (m)

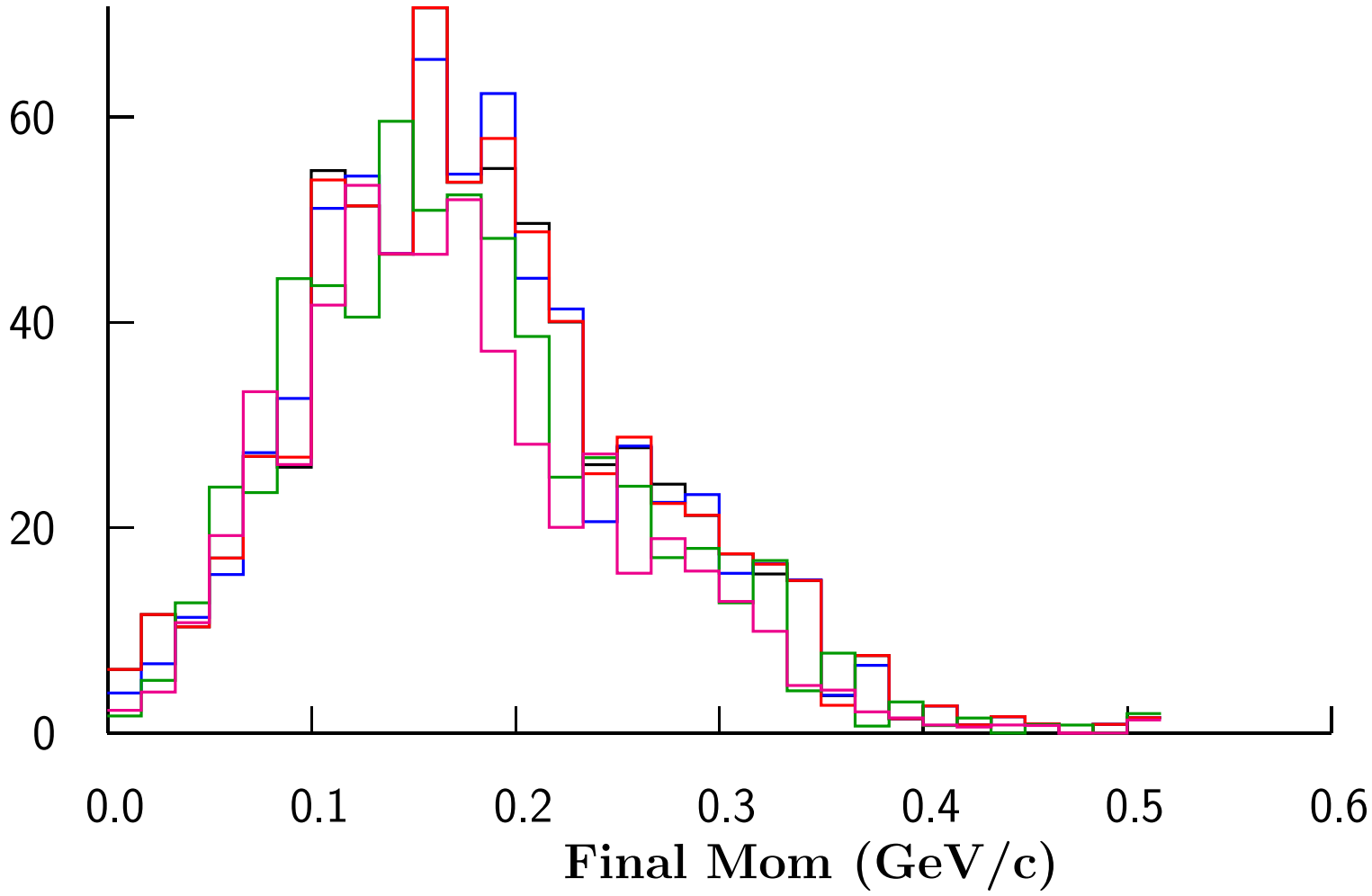

rain
0.50
0.25
0.00
-0.25
-0.50
Radius (m)
0
2
4
z (m)

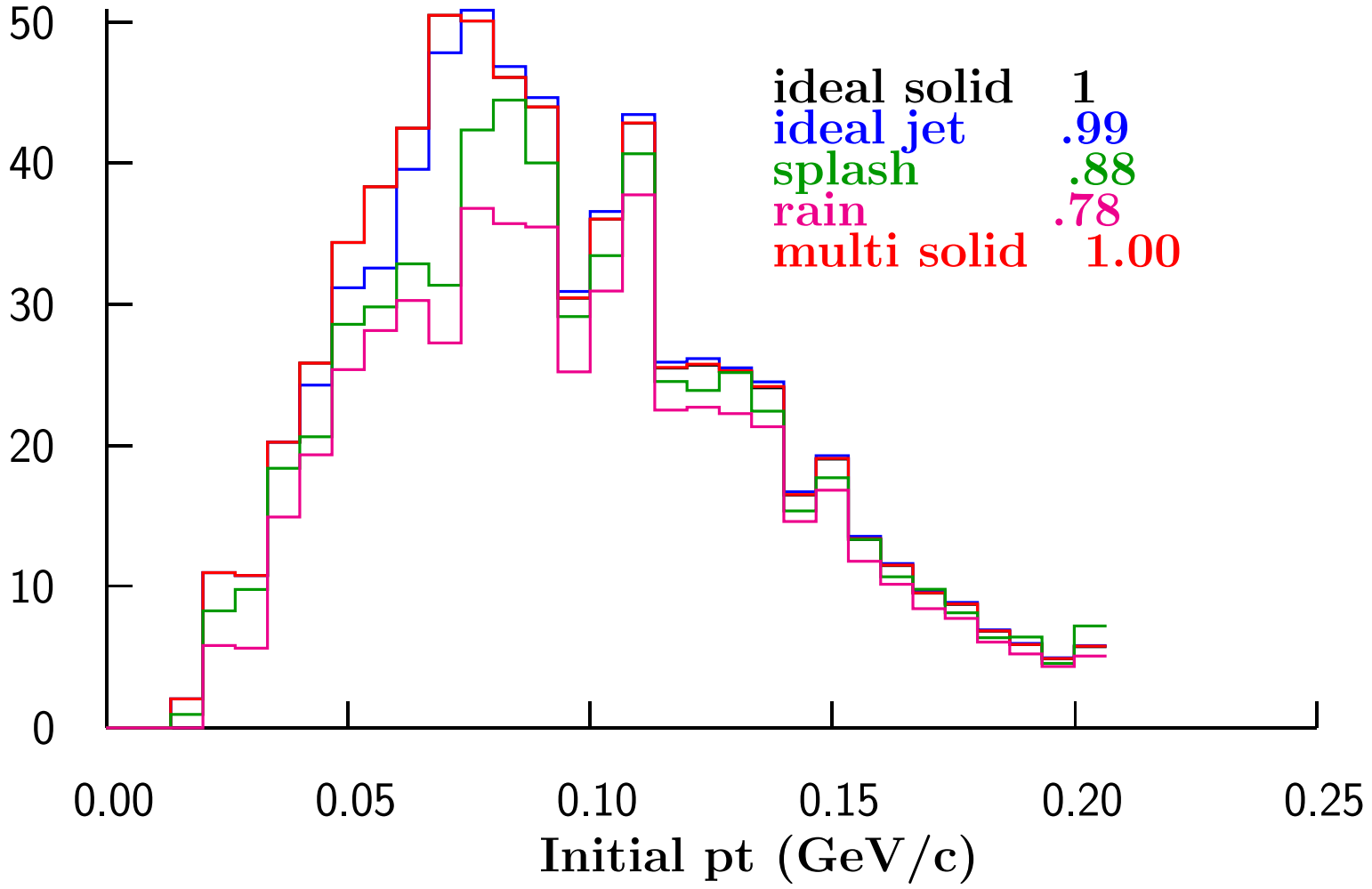

multi solid
0.50
0.25
0.00
-0.25
-0.50
Radius (m)
0
2
4
z (m)

Compare Performances



- Lower initial momenta have higher dE/dx and stop in materials


60
40
20
0
0.0
0.1
0.2
0.3
0.4
0.5
0.6
Final Mom (GeV/c)


50
40
30
20
10
0
0.00
0.05
0.10
0.15
0.20
0.25
Initial pt (GeV/c)
ideal solid 1
ideal jet .99
splash .88
rain .78
multi solid 1.00

Transmission compared to "Ideal solid" target

	Transmission	loss
ideal jet	0.99	-1%
splash	0.88	-12%
rain	0.78	-22%
multi solid	1.00	0

- Splash effect worse if "splash angle less than 45 deg. assumed
- Rain effect worse if droplets become small and fall slowly in gas ("Fog")

If such problems are serious, the "Multi-Solid" target concept could be considered

Conclusion

- "Splash" or Rain" could loose 10-20 % of beam
- Solid targets fired from "Blow Pipe" avoid this loss
- little gain from "crab" of solid target

Assuming 50 Hz 4 MW

- Solid targets fired from blow pipe:
  - should survive single shock
  - Can be used for whatever time radiation or shock damage demands
  - Cooling is automatic