Target orientaion $\leftrightarrow$ effective A_N

B. Schmidke
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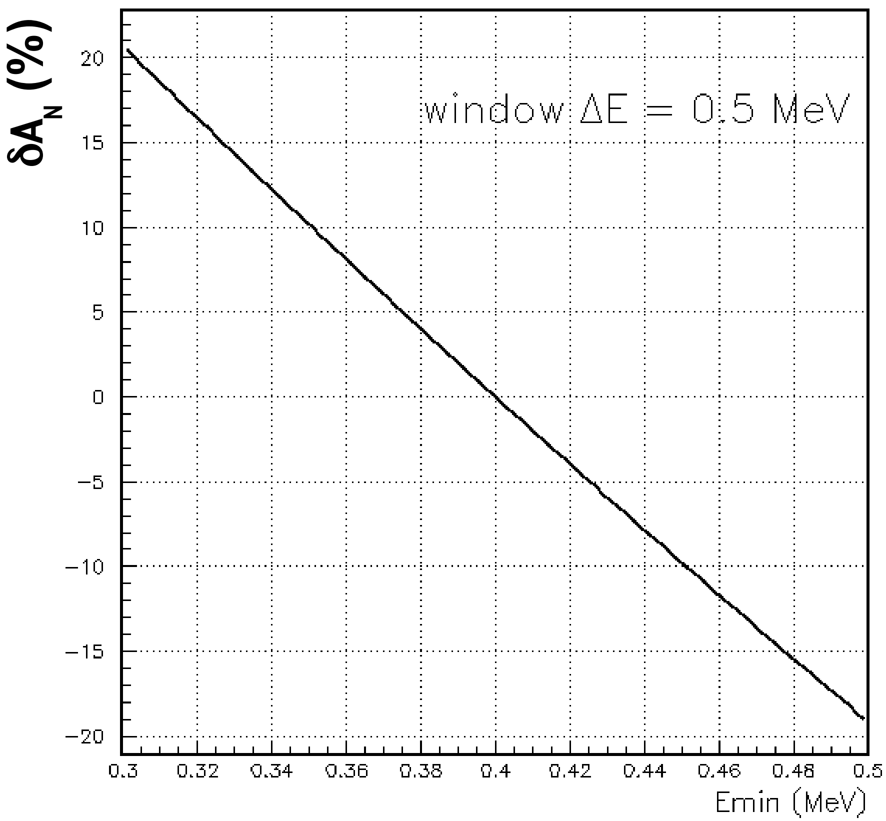
- Scattered ^{12}C nuclei lose energy in ^{12}C ribbon target enroute to Si detectors
- Measured E_{meas} down-shifted from scattered E_{scat}
- If E-loss changes (e.g. different path-length through target $\equiv$ L), a given E_{meas} window corresponds to a different E_{scat} window, with different effective A_N
- Path-length L changes as target orientation relative to detectors changes
- How big an effect on A_N?

$\Rightarrow$ some rough estimates here

Some numbers (1):

- We measure in window $E_{min} < E_{meas} < E_{min} + \Delta E$

  nominal: $E_{min} = 0.4$ MeV, $\Delta E = 0.5$ MeV
- From my slides 25.05.11, relative variation effective A_N vs. E_{min}:



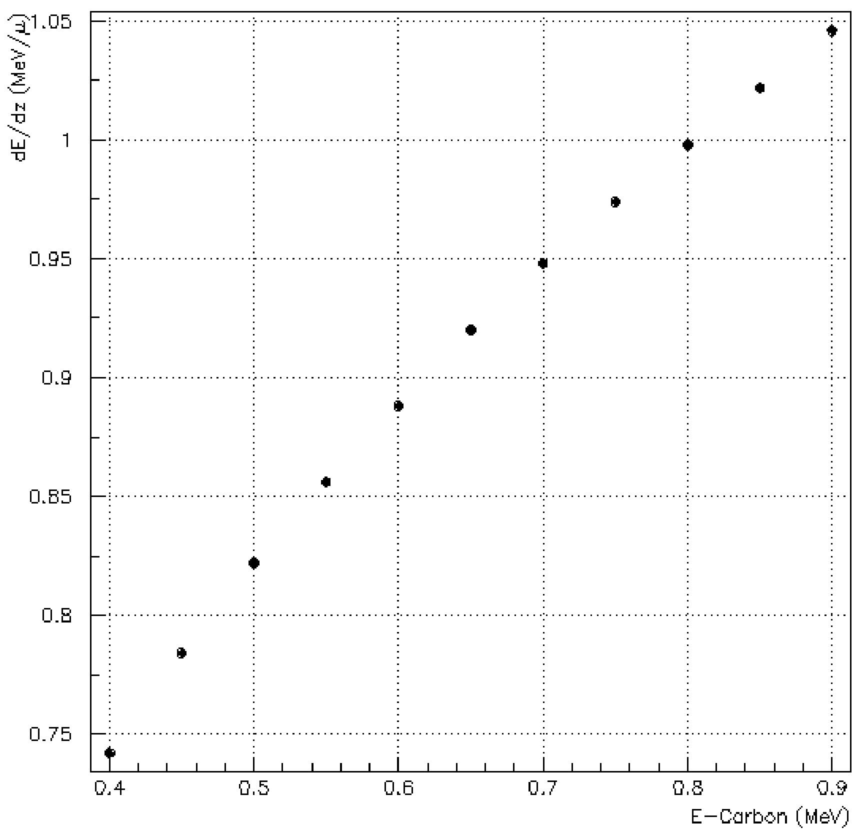
- Variation of E_{min} by δE

  $\Rightarrow$ relative variation of A_N by δA_N
- From the graph:

  $\boldsymbol{\delta A_N = 1\% \cdot (\delta E\ /\ 5\ \mathrm{keV})}$

Some numbers (2):

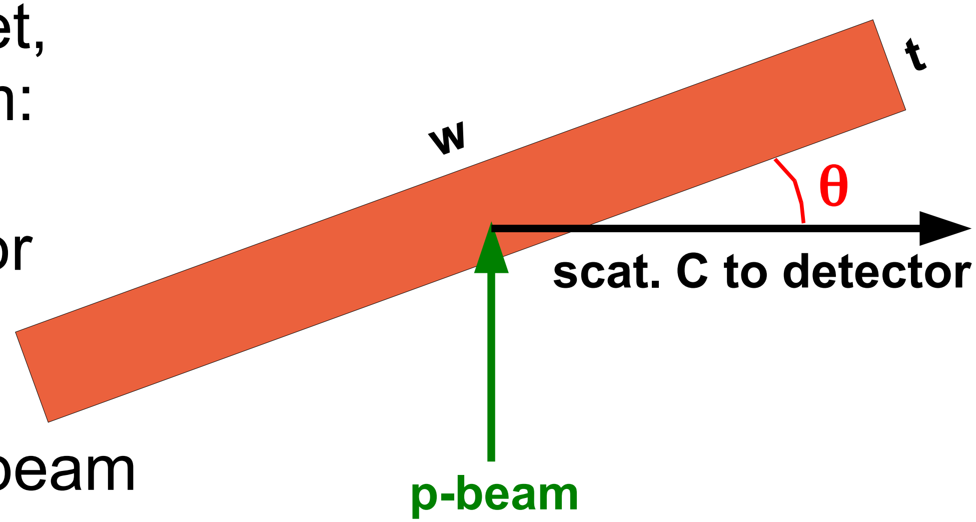
- C-C dE/dz from Santry, Werner paper (linked old CNIpol page) :



- In our C energy range:
  $\delta E/\delta z \approx 1$ MeV/μ = 1 keV/nm
- From previous slide:
  $\delta A_N = 1\% \cdot (\delta E \,/\, 5\text{ keV})$
  we have for δz=L:
  $\boldsymbol{\delta A_N = 1\% \cdot (L \,/\, 5\text{ nm})}$

- **A_N changes 1% for every 5 nm of path-length through target**

Ribbon target geometry



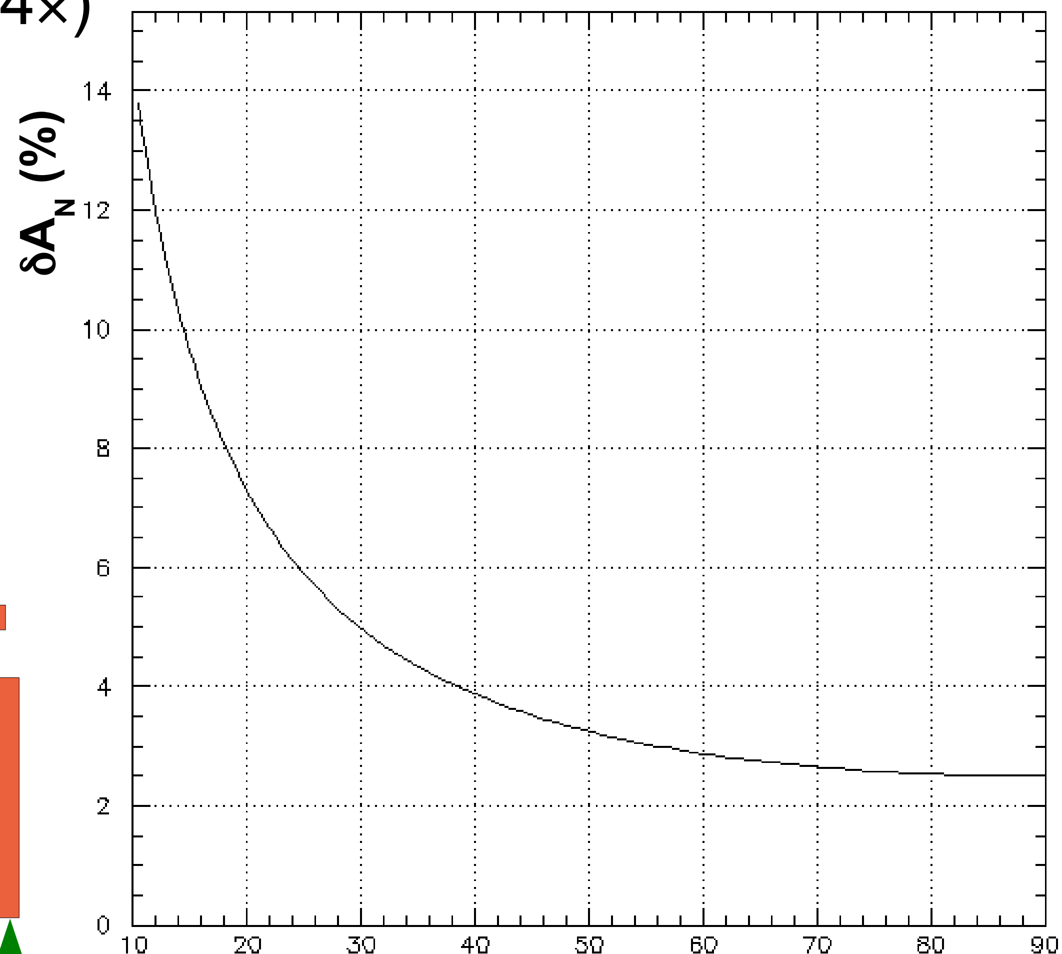
- Top view of vertical ribbon target, width w≈7μ, thickness t≈25nm:
- Angle θ flat w-side w.r.t. detector
- Entire ribbon (w,t) is bathed in beam (beam $\sigma_{x,y}$ = 0.5-1 mm)
- Mean path length: $L = t / (2 \cdot \sin\theta)$
- Consider effect on A_N as θ, hence L, varies
- Note: there is a spread of path lengths $0<L<t/\sin\theta$ with a spread of E-windows, A_N etc.

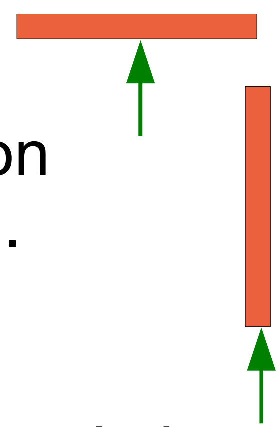
 2nd order effect, focus on means for now

$\theta \leftrightarrow$ effective A_N

Taking:

- t=25 nm (nominal, worse for 2×, 4×)
- δA_N = 1% · (L / 5 nm)
- Relative shifts in A_N vs. θ:
- e.g. θ = 20°→30°, ΔA_N = 2%
  θ = 20°→10°, ΔA_N = 7%



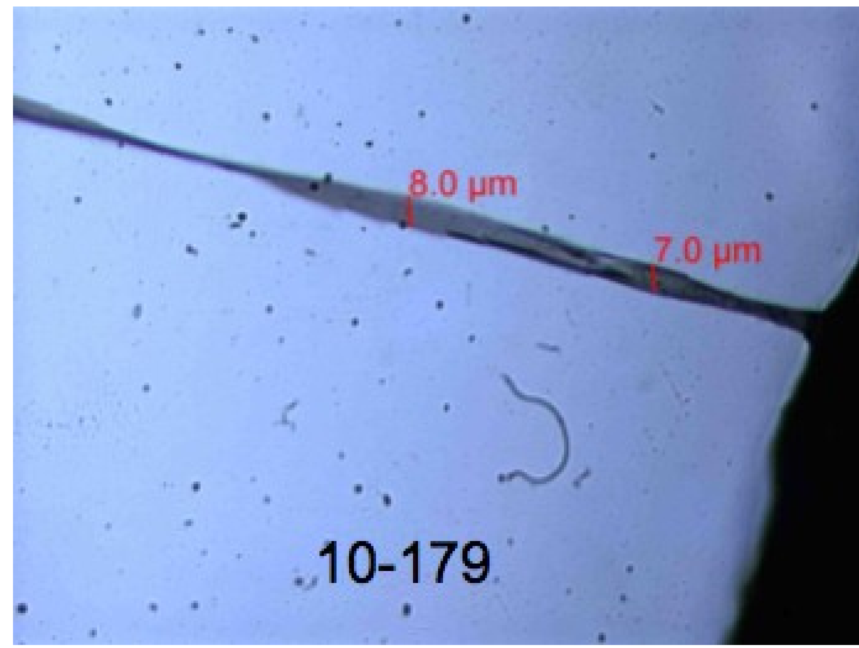


- Singularity as θ→0 **!**
- Is our nominal orientation near θ=0? Dangerous...
- Best is near θ = 90° :
  - same rate (whole ribbon in beam)
  - but beam in target E-loss via dE/dz ~300× greater; tolerable?
  - increased beam p_T spread via muliple scattering in target ~20× greater; tolerable?

Control of orientation?

- But in reality we have little control over θ

- Example of twisted ribbon from Dannie's slides:
- Length scale of twists $\approx$ 150 μ
- A few crossings of θ=0° divergence across beam 0.5-1 mm

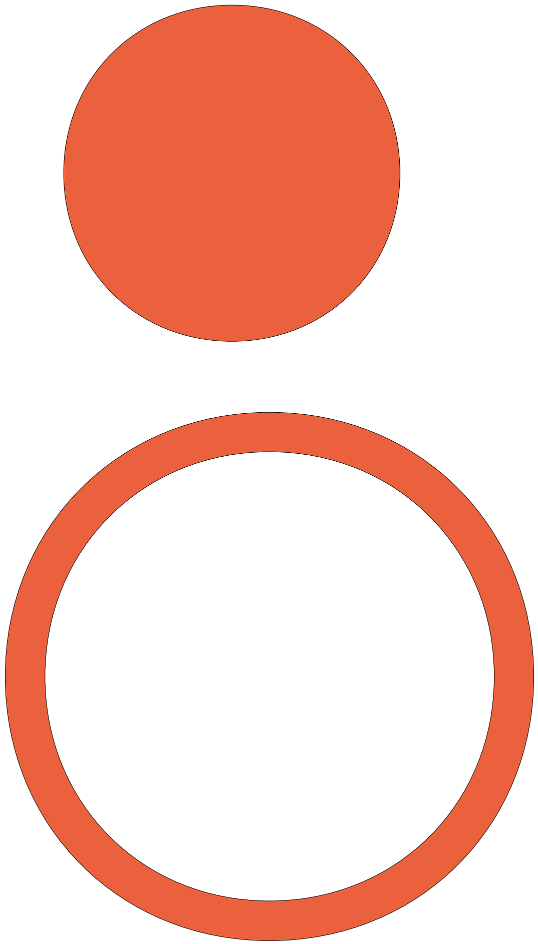


- Loose ribbons swaying in the breeze: orientation ill-defined

- Perhaps consider alternatives to ribbon geometry...

Alternate geometries?

- Circularly symmetric targets would have largely stable path-length to detectors
- E.g. a carbon wire:
- To keep same rate as present ribbon would need diameter ~0.5 μ
- But mean energy loss in target ~250 keV
- Or a carbon tube (Dima):
- Thinner walls, less energy loss
- For same rate, increased diameter $\leftrightarrow$ transverse position resolution
- Now we are starting to look like nanotubes
- To set the scale, present ribbons ~115 C atoms thick
- ?????...



Summary

- Scattered carbon path length through target en route to detectors is a sizable effect
- Varying targets, orientation instability could explain much of the instabities in P measurements
- We should consider alternative geometries, technologies