Pointing Update

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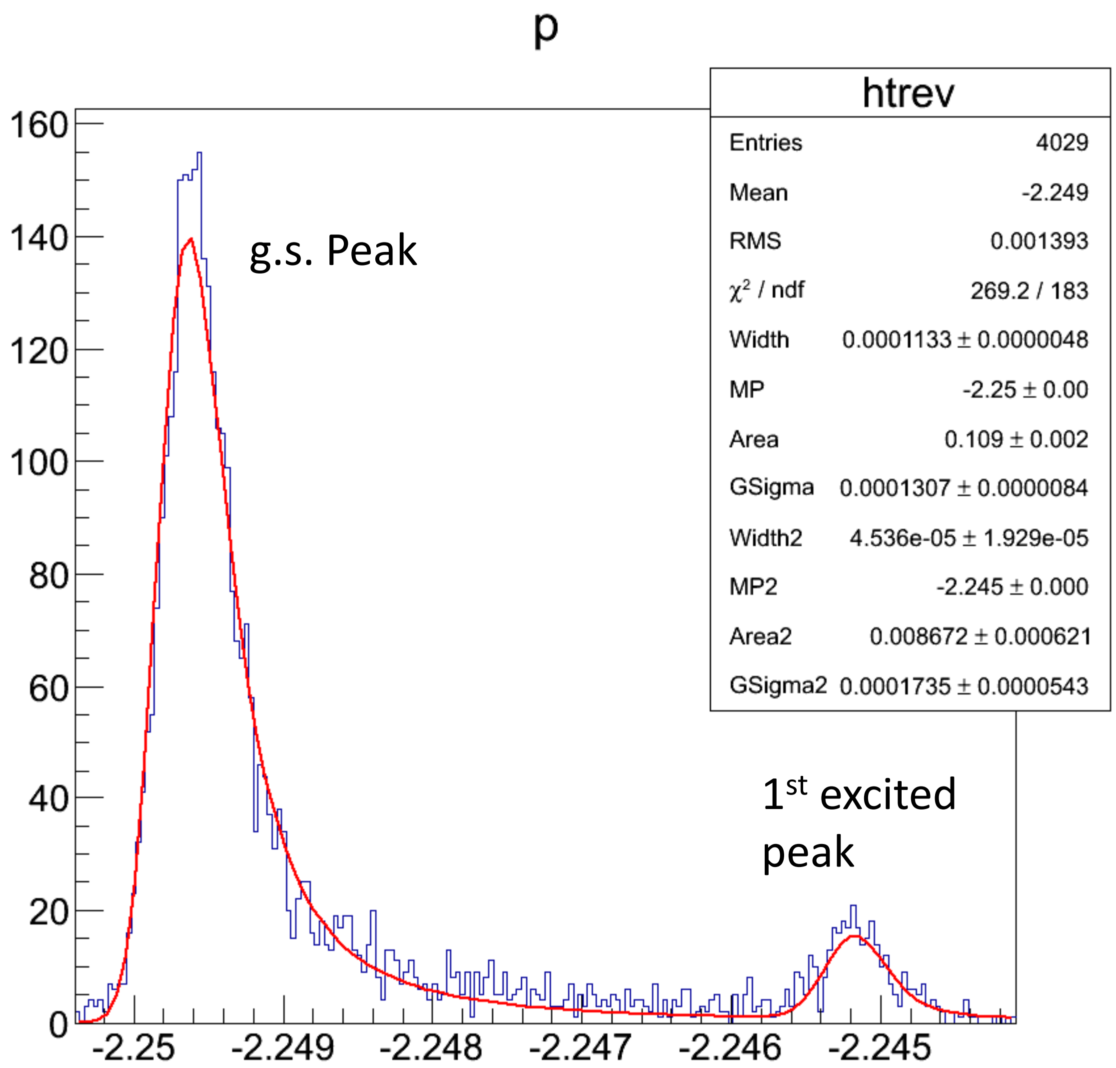
Pointing Uncertainty

- Use C12 ground state and 1st excited state to calibrate d(ΔE')
- Nominal value 4.43891 MeV ± 0.31 keV (F. AJZENBERG-SELOVE AND J.H. KELLEY, Nuclear Physics A506, 1 (1990))

Landau Gaussian convolution fit



	Value (GeV)	Error (keV)
g.s. peak (E1)	2.24963	5
1st excited peak (E2)	2.24518	16
E1-E2	4.450E-3	17

E1-E2 = 4.450 MeV
+/- 17 keV (stat.)
+/- 11 keV (syst.)

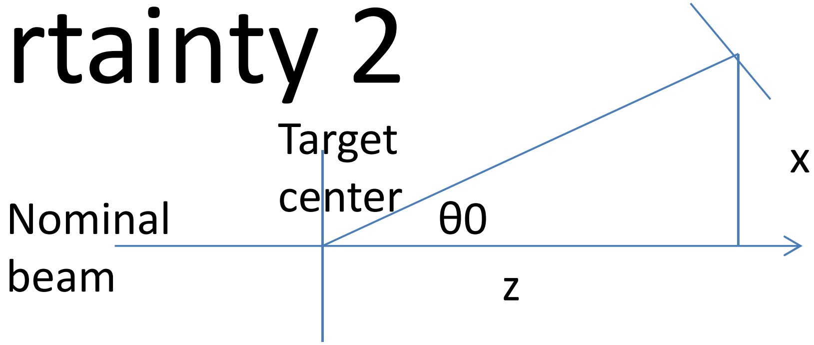
Pointing Uncertainty

- Uncertainty calculation – θ~=6°, E=2.254GeV
  - Two nuclei in the same target

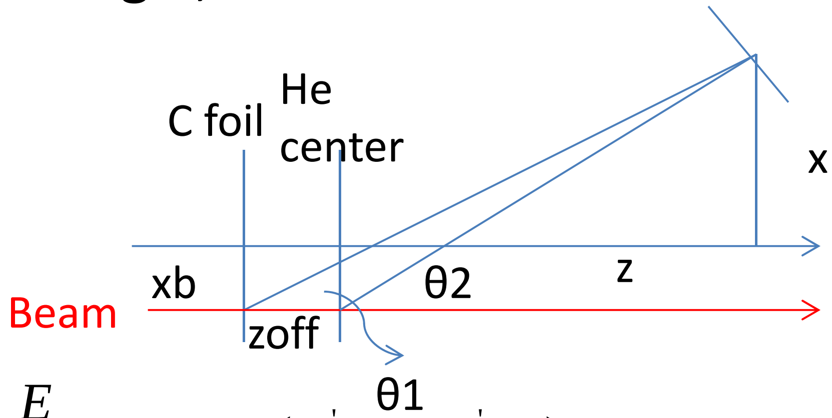
$$\sin\theta d\theta = -4.9\times 10^{-3} dE + 1.11 d(\triangle E^{'})$$

- δ(ΔE)~20 keV
- dθ~0.2mr
- Reach the requirement

Pointing Uncertainty 2



- Survey
- θ=atan(x/z)
- If just use survey to determine the angle, δθ~0.7mr



- θ_1=atan((x-xb)/z)
- θ_2=atan((x-xb)/(z+zoff))

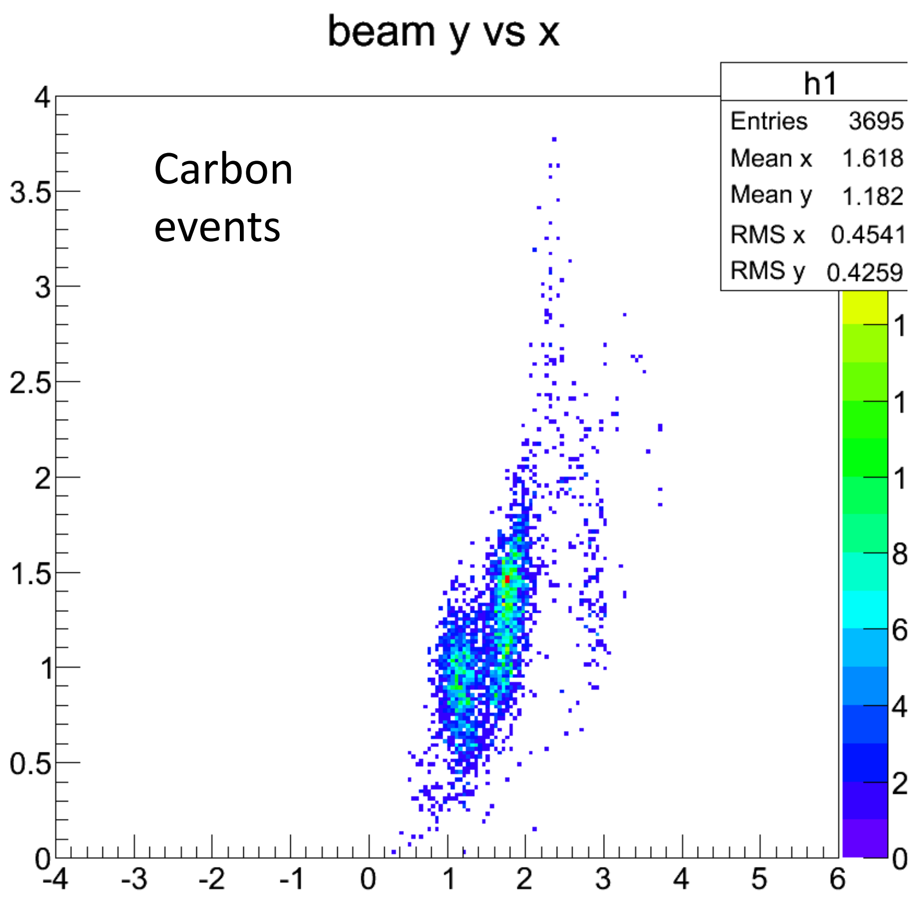
$$\Delta E' = E_1' - E_2' = \frac{E}{1+\dfrac{2E\sin^2(\theta_1/2)}{M_1}} - \frac{E}{1+\dfrac{2E\sin^2(\theta_2/2)}{M_2}} - (E_{1loss}' - E_{2loss}')$$

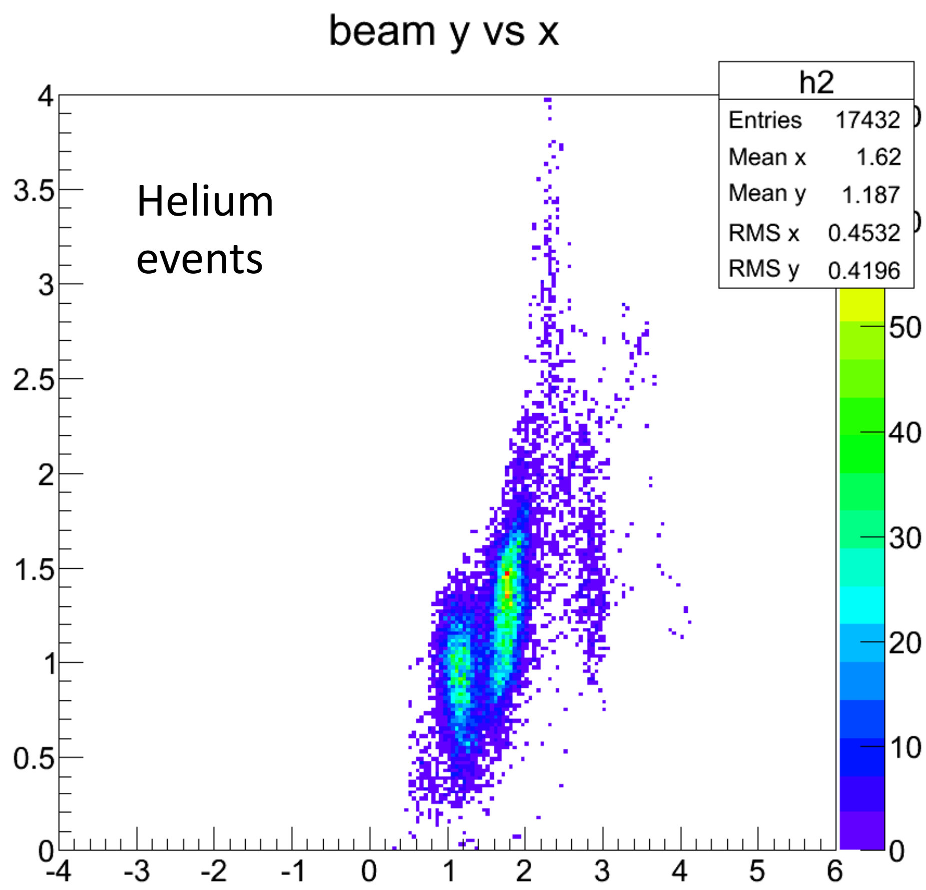
- θ1 = θ + (θ1-θ) vs. θ1 = θ * (θ1/θ)
- Do similar substitution for θ2

Obtained from x, xb, z, zoff

Beam Position at Target

Thanks Pengjia!

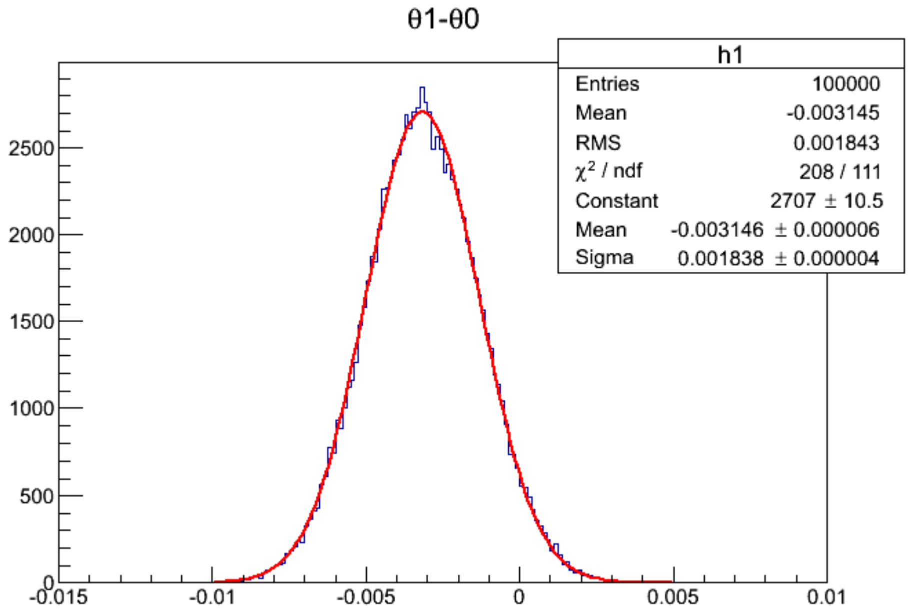




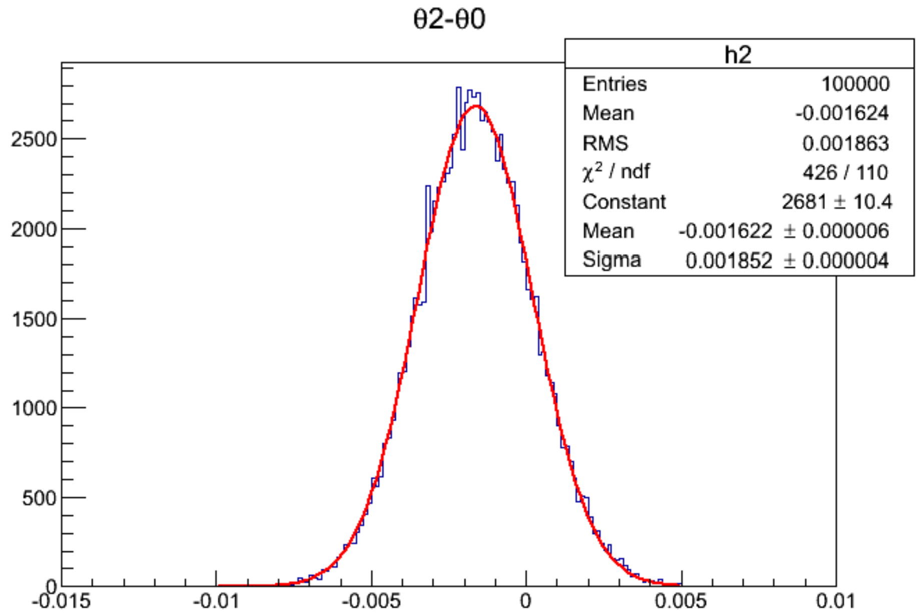
- Beam positions look identical

MC Simulation

- Uncertainty
  - sieve (survey) δx=0.5mm δz=1mm
  - Beam_x δxb=1.5mm
  - Target position δz=1.5mm
  - C relative position δzoff=0.15mm



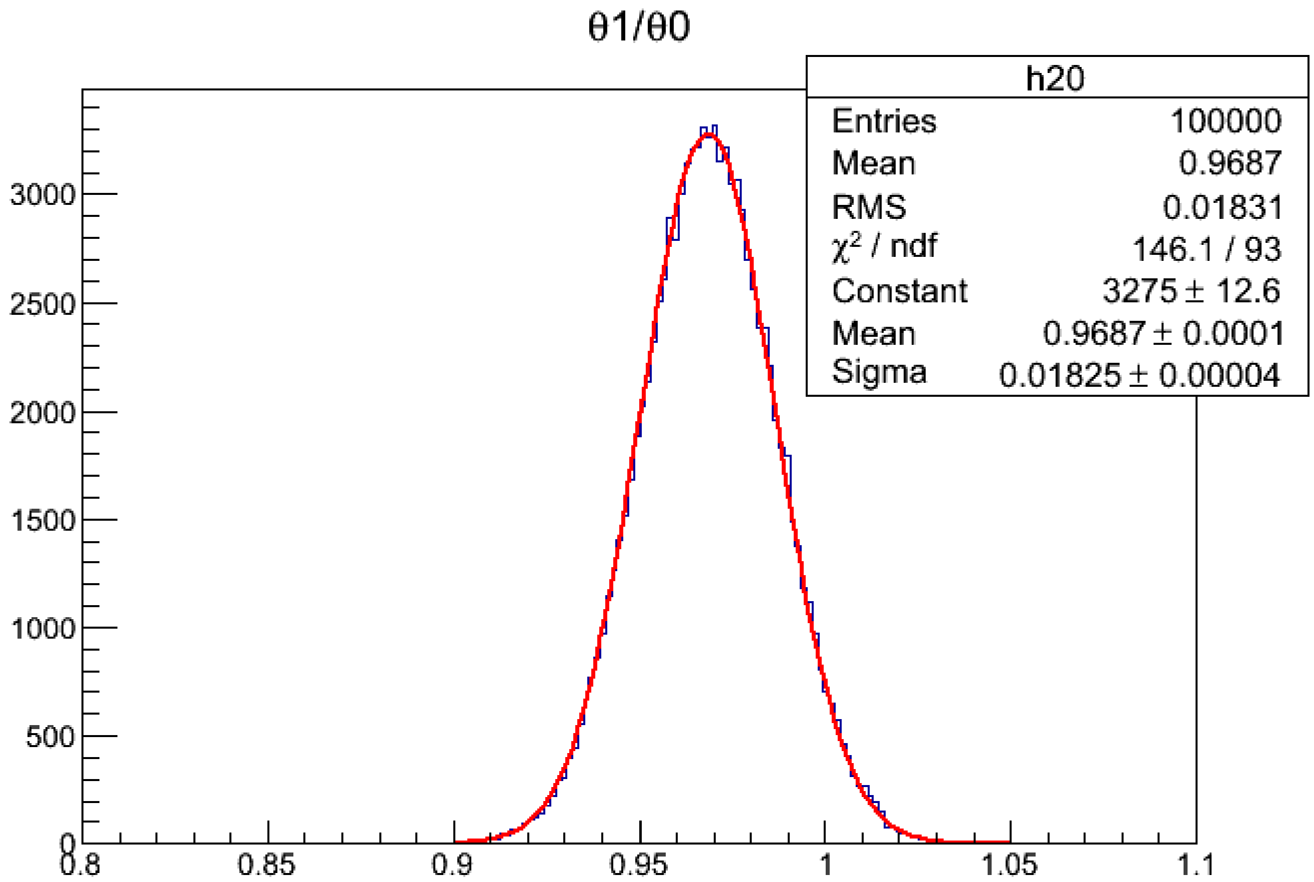
sigma = 1.8mr



sigma = 1.9mr

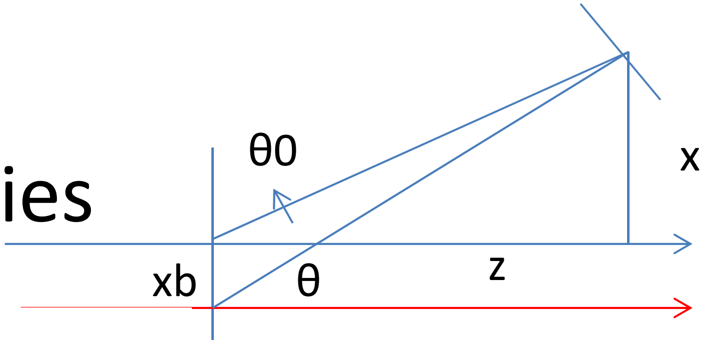
MC Simulation

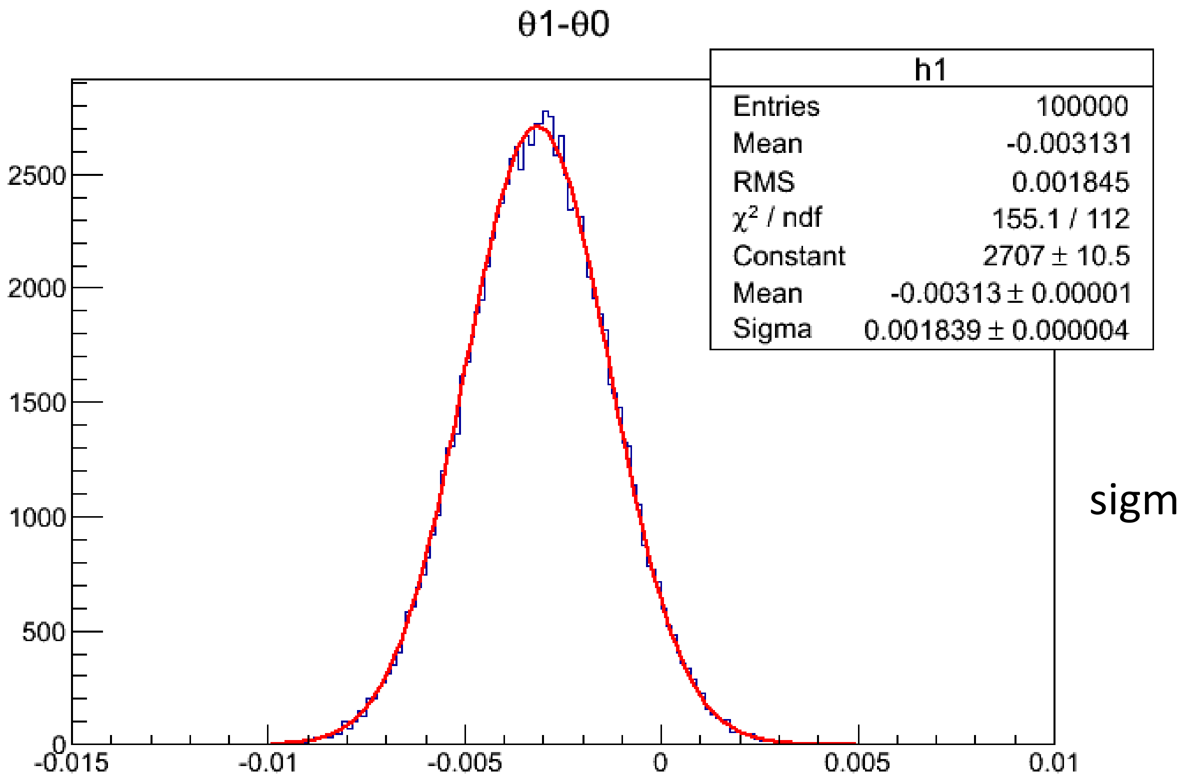
If using θ1/θ0



CH2 run

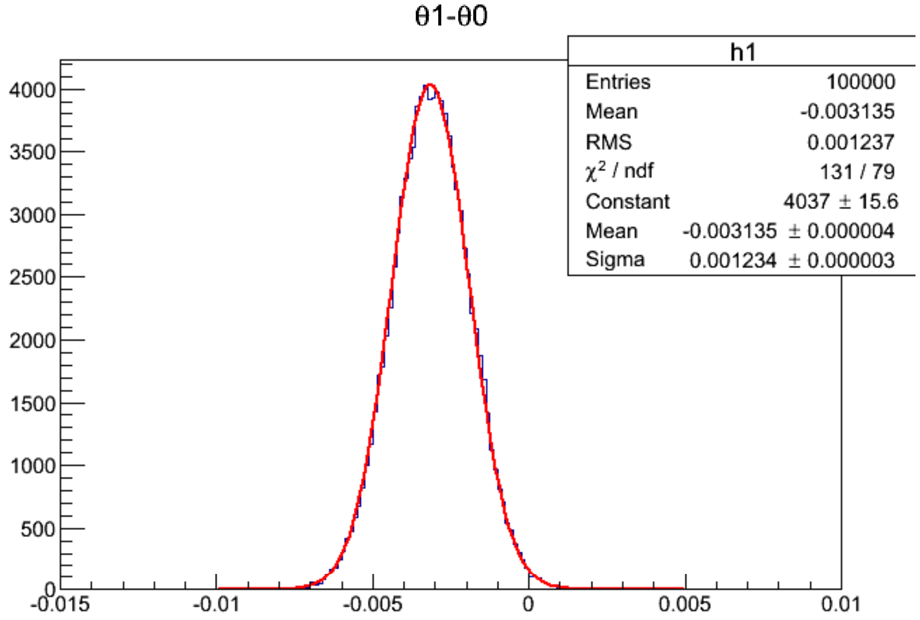
- If assuming same uncertainties

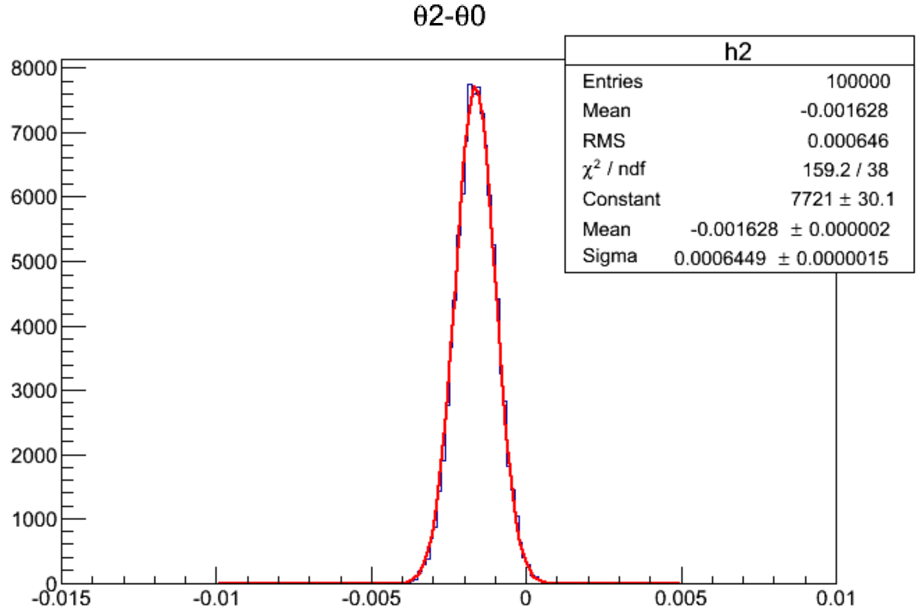




sigma = 1.8mr

If beam x uncertainty gets smaller





δbeam_x = 1mm
sigma = 1.2mr

δbeam_x = 0.5 mm
sigma = 0.6mr

Conclusion

- In the current situation, pointing cannot provide more accurate results than survey

	Survey	Pointing
Angle uncertainty	0.7 mr	1.8 mr

Backup

Pointing

- Determine the center scattering angle
- Elastic scattering off a target of mass M

$$E^{'} = \frac{E - E_{loss}}{1 + \frac{2(E - E_{loss})\sin^2(\theta/2)}{M}} - E^{'}_{loss}$$

- Use the difference in E' between two nuclei

$$\Delta E^{'} = E_1^{'} - E_2^{'} = \frac{E}{1 + \frac{2E\sin^2(\theta_1/2)}{M_1}} - \frac{E}{1 + \frac{2E\sin^2(\theta_2/2)}{M_2}} - (E^{'}_{1loss} - E^{'}_{2loss})$$

If two nuclei are in the same target, like CH2, θ1=θ2=θ, Eloss cancels each other
If not, like C in LHe, more steps need to be considered