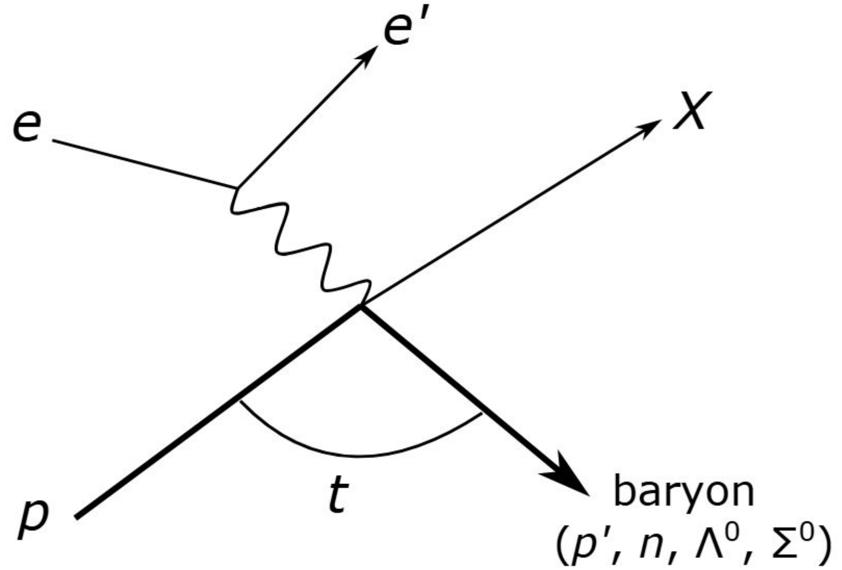
The tRECO Convention



- p^{μ}_{BA}: outgoing baryon 4-momentum.
- p^{μ}_{BE}: incoming proton beam momentum.
- $p^{\mu}_{\gamma^*}$: difference between incoming and scattered electron 4-momentum.
- p^{μ}_{X}: 4-momentum of the rest of final state.

Why is t reconstruction not trivial?

Overconstrained system, with momentum conservation, t can be measured in many different ways. Ideal way to compute t might depend on particular channel and particular kinematics

Important factors to consider:

- Beam divergence of either beam
- QED radiation. Initial and Final state radiation
- Detector resolution (in both transverse momentum, and longitudinal momentum)
- Subtraction of large numbers, etc.

Quite a bit of proliferation of methods in inclusive DIS in HERA days…

No naming convention!!!

Method name	Observables	y	Q^2	$x \cdot E_p$
Electron (e)	$[E_0, E, \theta]$	$1 - \frac{\Sigma_e}{2E_0}$	$\frac{E^2 \sin^2\theta}{1-y}$	$\frac{E(1+\cos\theta)}{2y}$
Double angle (DA) [6, 7]	$[E_0, \theta, \gamma]$	$\frac{\tan\frac{\gamma}{2}}{\tan\frac{\gamma}{2}+\tan\frac{\theta}{2}}$	$4E_0^2 \cot^2\frac{\theta}{2}(1-y)$	$\frac{Q^2}{4E_0 y}$
Hadron (h, JB) [4]	$[E_0, \Sigma, \gamma]$	$\frac{\Sigma}{2E_0}$	$\frac{T^2}{1-y}$	$\frac{Q^2}{2\Sigma}$
ISigma (IΣ) [9]	$[E, \theta, \Sigma]$	$\frac{\Sigma}{\Sigma+\Sigma_e}$	$\frac{E^2 \sin^2\theta}{1-y}$	$\frac{E(1+\cos\theta)}{2y}$
IDA [7]	$[E, \theta, \gamma]$	y_{DA}	$\frac{E^2 \sin^2\theta}{1-y}$	$\frac{E(1+\cos\theta)}{2y}$
$E_0 E \Sigma$	$[E_0, E, \Sigma]$	y_h	$4E_0E - 4E_0^2(1-y)$	$\frac{Q^2}{2\Sigma}$
$E_0 \theta \Sigma$	$[E_0, \theta, \Sigma]$	y_h	$4E_0^2 \cot^2\frac{\theta}{2}(1-y)$	$\frac{Q^2}{2\Sigma}$
$\theta \Sigma \gamma$ [8]	$[\theta, \Sigma, \gamma]$	y_{DA}	$\frac{T^2}{1-y}$	$\frac{Q^2}{2\Sigma}$
Double energy (A4) [7]	$[E_0, E, E_h]$	$\frac{E-E_0}{(xE_p)-E_0}$	$4E_0 y (xE_p)$	$E + E_h - E_0$
$E \Sigma T$	$[E, \Sigma, T]$	$\frac{\Sigma}{\Sigma+E\pm\sqrt{E^2+T^2}}$	$\frac{T^2}{1-y}$	$\frac{Q^2}{2\Sigma}$
$E_0 E T$	$[E_0, E, T]$	$\frac{2E_0-E\mp\sqrt{E^2-T^2}}{2E_0}$	$\frac{T^2}{1-y}$	$\frac{Q^2}{4E_0 y}$
Sigma (Σ) [9]	$[E_0, E, \Sigma, \theta]$	$y_{\mathrm{I}\Sigma}$	$Q^2_{\mathrm{I}\Sigma}$	$\frac{Q^2}{4E_0 y}$
eSigma ($e\Sigma$) [9]	$[E_0, E, \Sigma, \theta]$	$\frac{2E_0\Sigma}{(\Sigma+\Sigma_e)^2}$	$2E_0E(1+\cos\theta)$	$\frac{E(1+\cos\theta)(\Sigma+\Sigma_e)}{2\Sigma}$

Table 1. Summary of basic reconstruction methods that employ only three out of five quantities: E_0 (electron-beam energy), E and θ (scattered electron energy and polar angle), Σ and γ (longitudinal energy-momentum balance, $\Sigma = \sum_{\mathrm{HFS}}(E_i - p_{z,i})$, and the inclusive angle of the HFS).

The t-Reconstruction (tRECO) Convention establishes a standardized nomenclature for methods used to reconstruct the Mandelstam variable t in electron-proton (or ion) scattering. This convention aims to provide a unified framework for describing a broad class of experimental techniques to be used for t reconstruction at the Electron-Ion Collider.

TABLE I. The tRECO convention: classes of methods used to reconstruct the Mandelstam variable t are defined by the observables that are at least partially utilized. Here, $p^{\mu}_{\rm BA}$ represents the outgoing baryon 4-momentum; $p^{\mu}_{\rm BE}$ denotes the incoming proton beam momentum; $p^{\mu}_{\gamma*}$ refers to the difference between the incoming and scattered electron 4-momenta; and $p^{\mu}_{\rm X}$ represents the 4-momentum of the rest of the final

Class name	Observables used	Example(s)
BABE	$p^{\mu}_{\rm BA}$, $p^{\mu}_{\rm BE}$	$-t = (p^{\mu}_{\rm BA} - p^{\mu}_{\rm BE})^2$ or $t = \lvert\vec{p}^{\,\rm T}_{\rm BA}\rvert^2$
eX	$p^{\mu}_{\gamma*}$, $p^{\mu}_{\rm X}$	$-t = (p^{\mu}_{\gamma*} - p^{\mu}_{\rm X})^2$ or $t = \lvert\vec{p}^{\,\rm T}_{\rm X} + \vec{p}^{\,\rm T}_{e'}\rvert^2$
eXBA	$p^{\mu}_{\gamma*}$, $p^{\mu}_{\rm X}$, $p^{\mu}_{\rm BA}$	$-t = (p^{\mu}_{\rm corr} - p^{\mu}_{\rm X})^2$
		$p^{\mu}_{\rm corr} = (\frac{\Sigma_{\rm XBA}}{2} - \frac{E_{e'}}{2}(1+\cos\theta_{e'}), p^{\mu}_{\gamma*}[1], p^{\mu}_{\gamma*}[2], -\frac{\Sigma_{\rm XBA}}{2} - \frac{E_{e'}}{2}(1+\cos\theta_{e'}))$
		$\Sigma_{\rm XBA} := (E_{\rm X} - p^{z}_{\rm X}) + (E_{\rm BA} - p^{z}_{\rm BA})$
eXBE	$p^{\mu}_{\gamma*}$, $p^{\mu}_{\rm X}$, $p^{\mu}_{\rm BE}$	$-t = (p^{\mu}_{\rm corr} - p^{\mu}_{\rm BE})^2$ or $t = \lvert\vec{p}^{\,\rm T}_{\rm miss}\rvert^2$
		$p^{\mu}_{\rm corr} = \left[\sqrt{\lvert\vec{p}_{\rm miss}\rvert^2 + m^2_{\rm BA}}, \lvert\vec{p}_{\rm miss}\rvert\hat{n}(\theta_{\rm miss}, \phi_{\rm miss})\right]$
		$p^{\mu}_{\rm miss} = p^{\mu}_{\gamma*} + p^{\mu}_{\rm BE} - p^{\mu}_{\rm X} = [E_{\rm miss}, \lvert\vec{p}_{\rm miss}\rvert\hat{n}(\theta_{\rm miss}, \phi_{\rm miss})]$
eBABE	$p^{\mu}_{\gamma*}$, $p^{\mu}_{\rm BA}$, $p^{\mu}_{\rm BE}$	$-t = (p^{\mu}_{\rm corr} - p^{\mu}_{\rm BE})^2$
		$p^{\mu}_{\rm corr} = (p^{\mu}_{\rm BA}[0], -p^{\mu}_{\gamma*}[1], -p^{\mu}_{\gamma*}[2], p^{\mu}_{\rm BA}[3])$
XBABE	$p^{\mu}_{\rm X}$, $p^{\mu}_{\rm BA}$, $p^{\mu}_{\rm BE}$	$-t = (p^{\mu}_{\rm corr} - p^{\mu}_{\rm BE})^2$
		$p^{\mu}_{\rm corr} = (p^{\mu}_{\rm BA}[0], -p^{\mu}_{\rm X}[1], -p^{\mu}_{\rm X}[2], p^{\mu}_{\rm BA}[3])$
eXBABE	$p^{\mu}_{\gamma*}$, $p^{\mu}_{\rm X}$, $p^{\mu}_{\rm BA}$, $p^{\mu}_{\rm BE}$	$-t = (p^{\mu}_{\rm corr} - p^{\mu}_{\rm BE})^2$
		$p^{\mu}_{\rm corr} = \left[\sqrt{\lvert\vec{p}_{\rm miss}\rvert^2 + m^2_{\rm BA}}, \lvert\vec{p}_{\rm miss}\rvert\hat{n}(\theta_{\rm BA}, \phi_{\rm BA})\right]$
		$p^{\mu}_{\rm miss} = p^{\mu}_{\gamma*} + p^{\mu}_{\rm BE} - p^{\mu}_{\rm X} = [E_{\rm miss}, \lvert\vec{p}_{\rm miss}\rvert\hat{n}(\theta_{\rm miss}, \phi_{\rm miss})]$

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You are welcome to comment, edit, and sign the convention