Survey Alignment → Conditions Database

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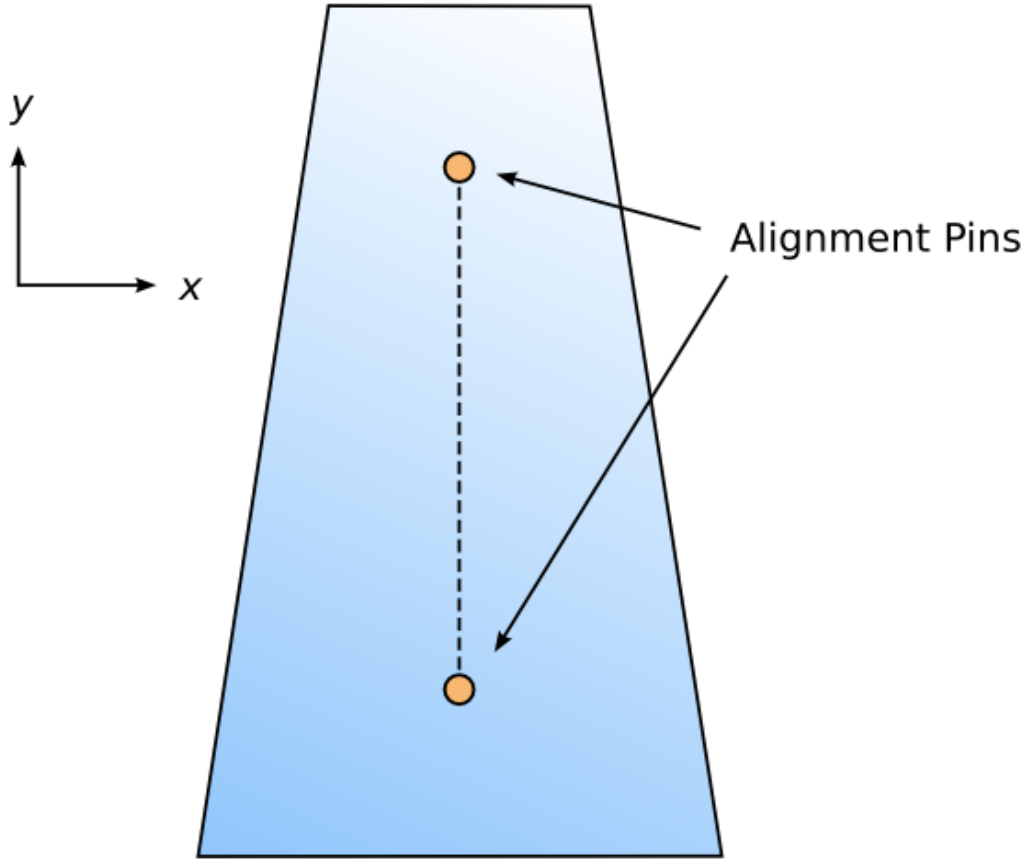
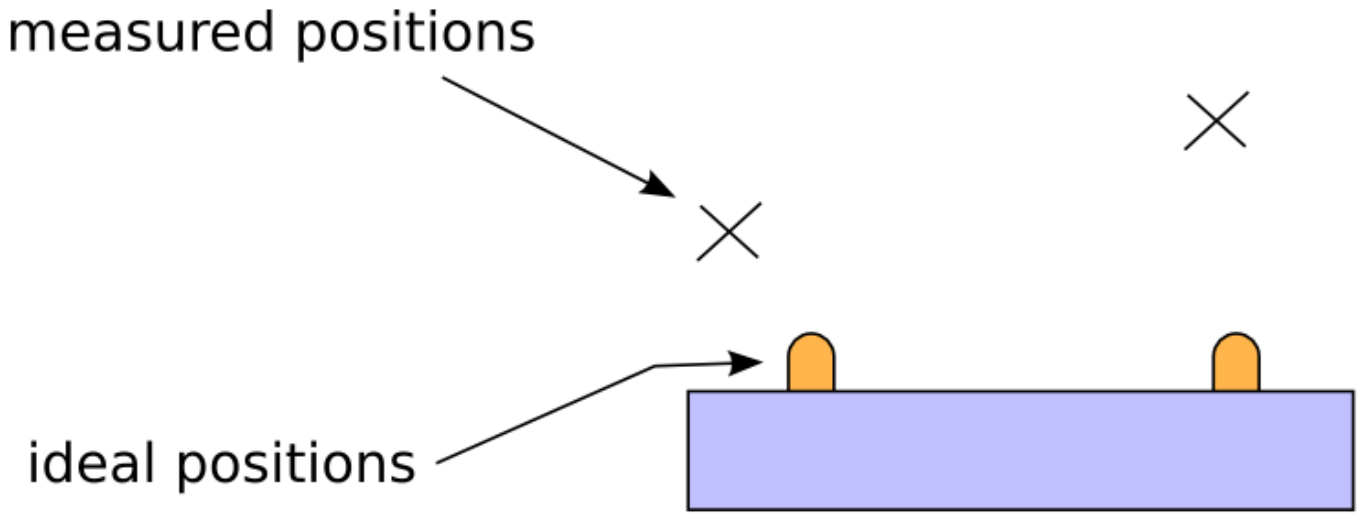
CSCs have two alignment pins, equidistant from center



Real positions of these pins measured by photogrammetry

Goal: translate, rotate chamber to match measured

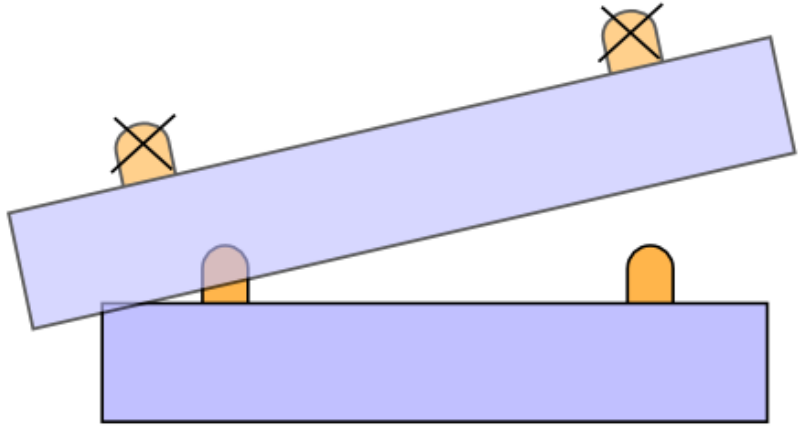


Analytic solution: we apply only one motion to the Alignable

Rotation around y is unconstrained, so we don't touch ϕ_y

Goal: translate, rotate chamber to match measured

measured positions



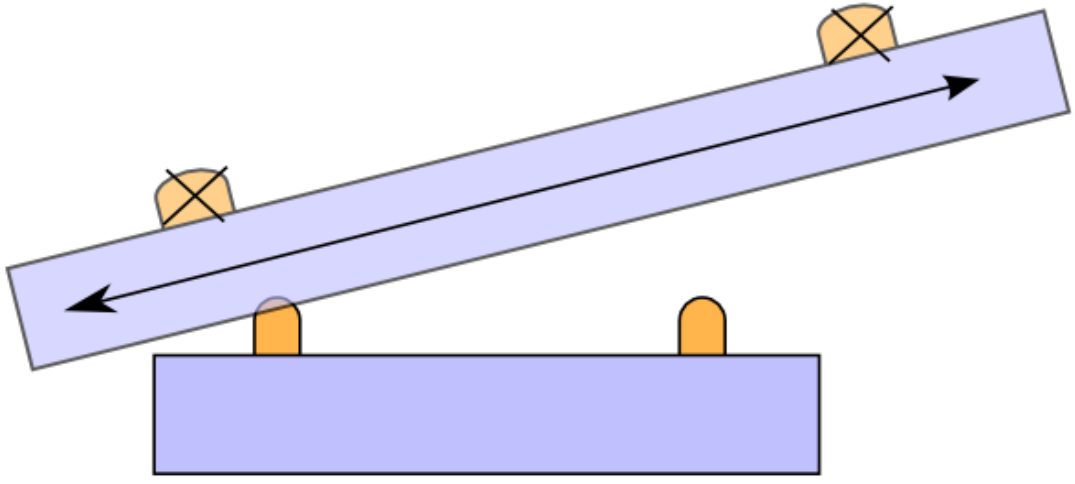
ideal positions

Analytic solution: we apply only one motion to the Alignable

Rotation around y is unconstrained, so we don't touch ϕ_y

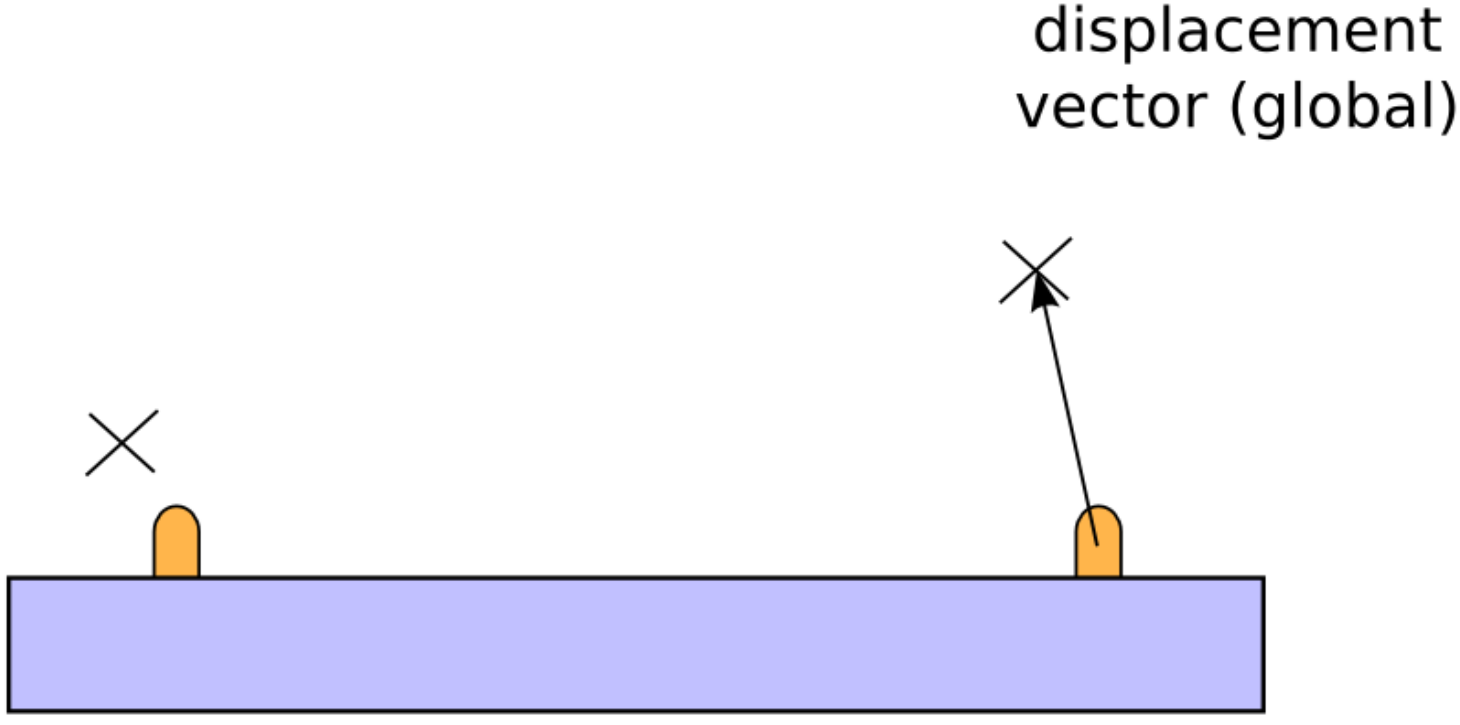
Goal: translate, rotate chamber to match measured

stretch factor
(unphysical)



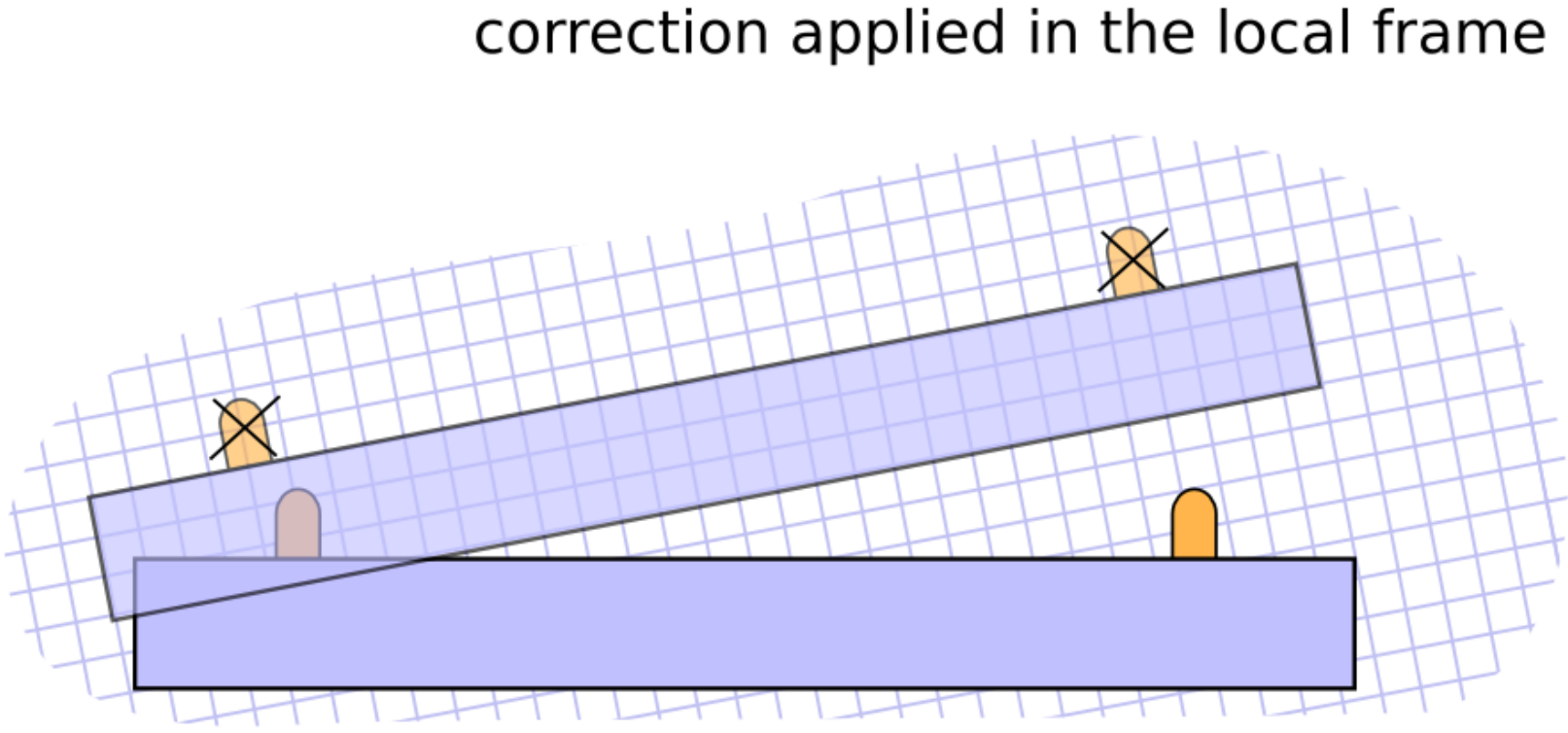
Measurement error can stretch a chamber. Stretch is included in formal solution but not applied to Alignable.

Calculation in detail



Inputs: $\vec{P_1}^{\text{global}}$ and $\vec{P_2}^{\text{global}}$

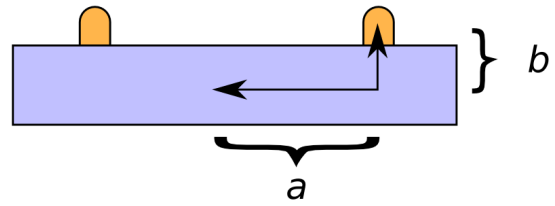
Calculation in detail



Inputs: $\vec{P_1}^{\text{global}}$ and $\vec{P_2}^{\text{global}}$

Convert $\vec{P_1}^{\text{global}}$ and $\vec{P_2}^{\text{global}}$ to local frame (Alignable::surface)

Displacement in local frame: $\vec{P_1}, \vec{P_2}$



$$\Delta x = \frac{P_{1x} + P_{2x}}{2} - \sin\phi_z \sin\phi_x b$$

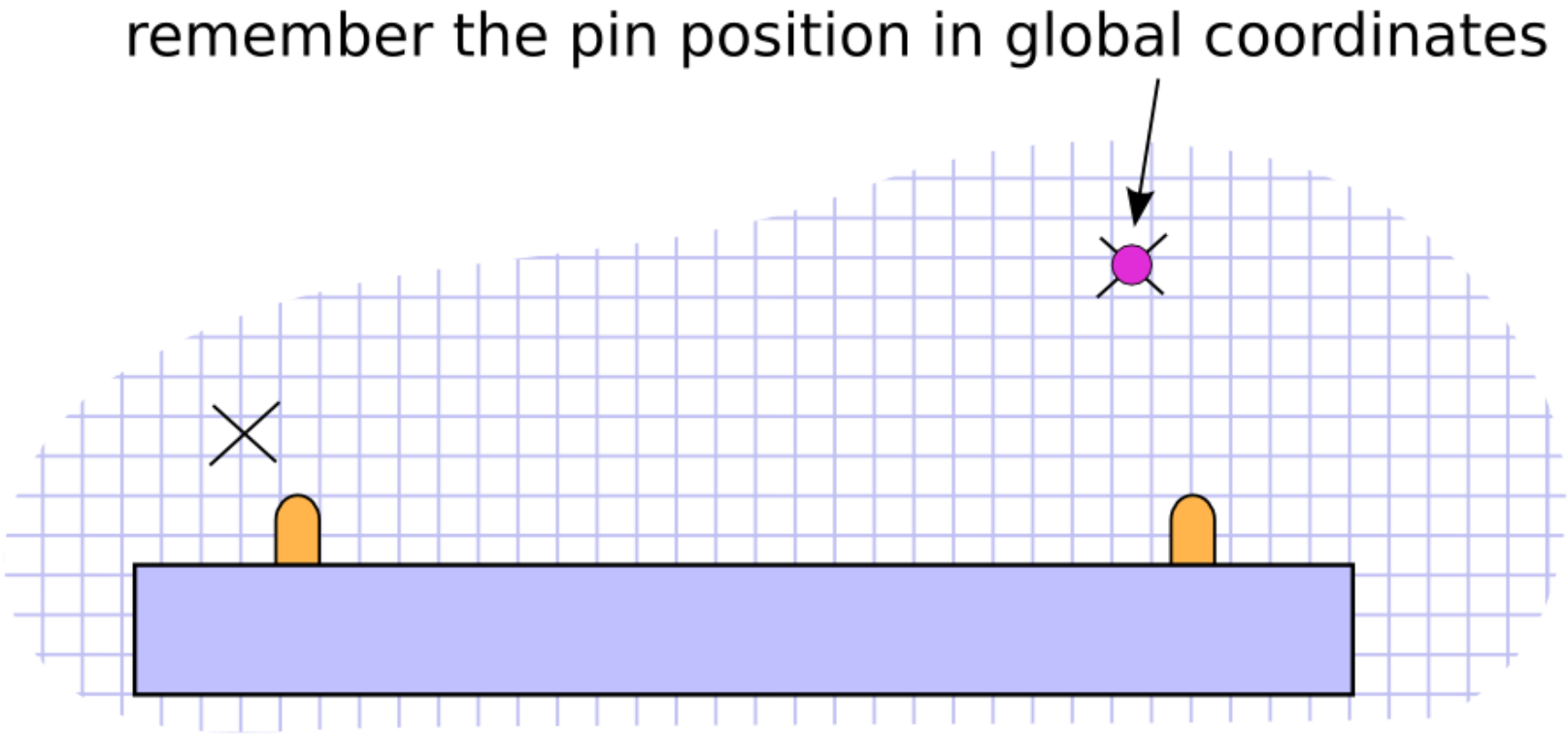
$$\Delta y = \frac{P_{1y} + P_{2y}}{2} + \cos\phi_z \sin\phi_x b$$

$$\Delta z = \frac{P_{1z} + P_{2z}}{2} - \cos\phi_x b$$

$$\cos^2\phi_z = \frac{\left(\frac{P_{1y}-P_{2y}}{2a}\right)^2}{\left(\frac{P_{1x}-P_{2x}}{2a}\right)^2 + \left(\frac{P_{1y}-P_{2y}}{2a}\right)^2}$$

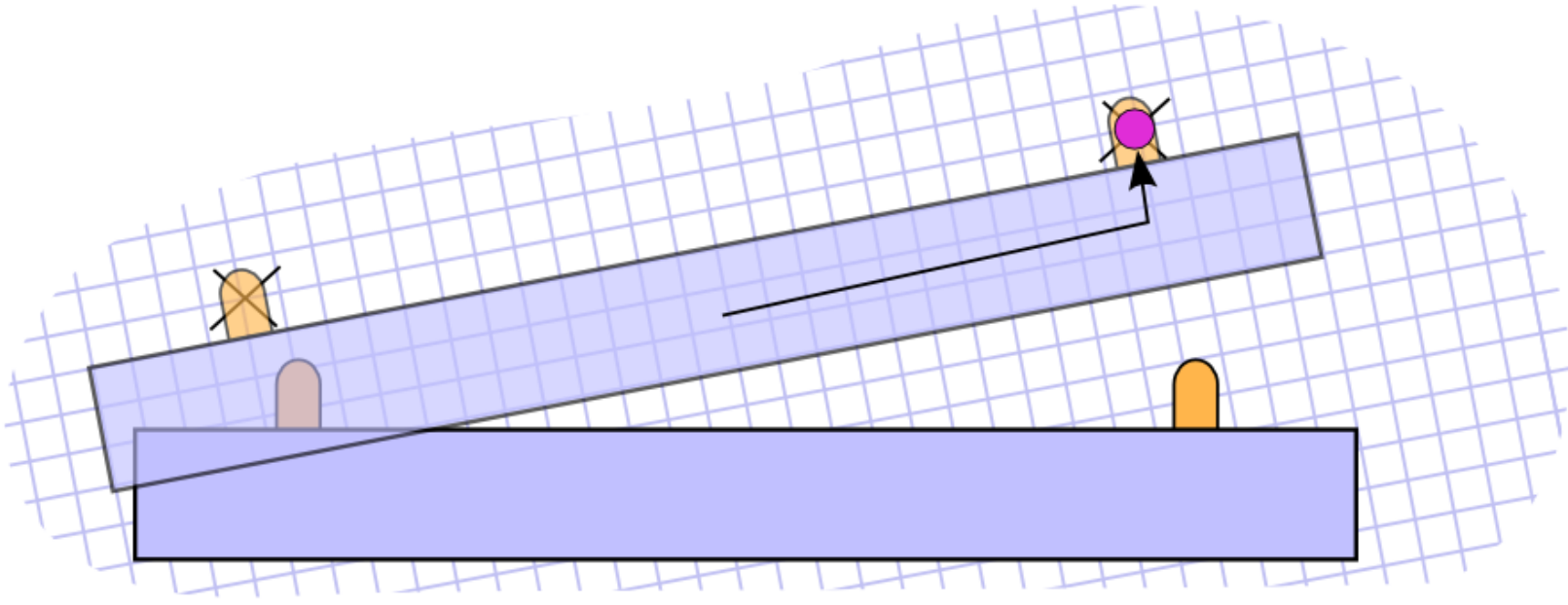
$$\cos^2\phi_x = \frac{\left(\frac{P_{1x}-P_{2x}}{2a}\right)^2 + \left(\frac{P_{1y}-P_{2y}}{2a}\right)^2}{\left(\frac{P_{1x}-P_{2x}}{2a}\right)^2 + \left(\frac{P_{1y}-P_{2y}}{2a}\right)^2 + \left(\frac{P_{1z}-P_{2z}}{2a}\right)^2}$$

Built-in sanity check



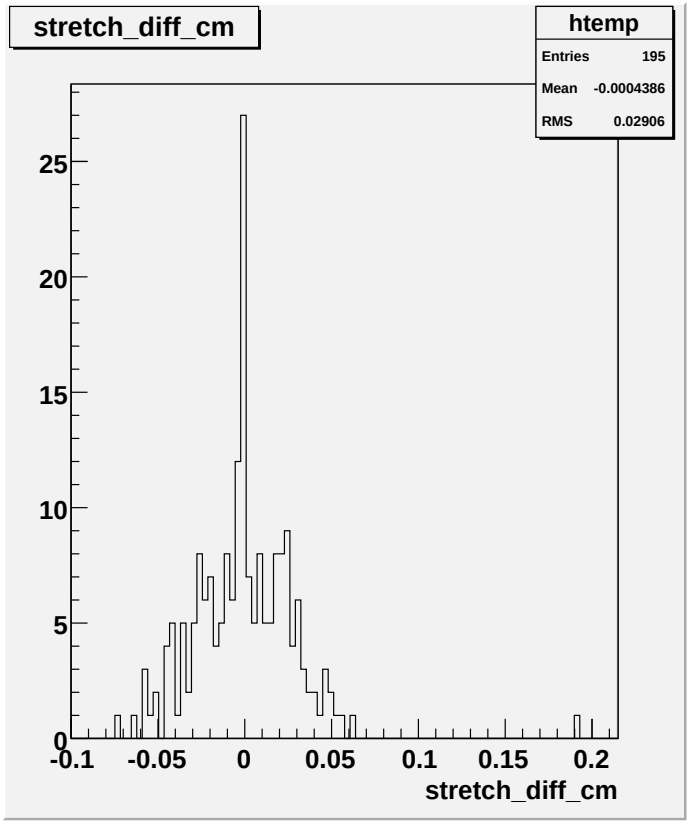
Built-in sanity check

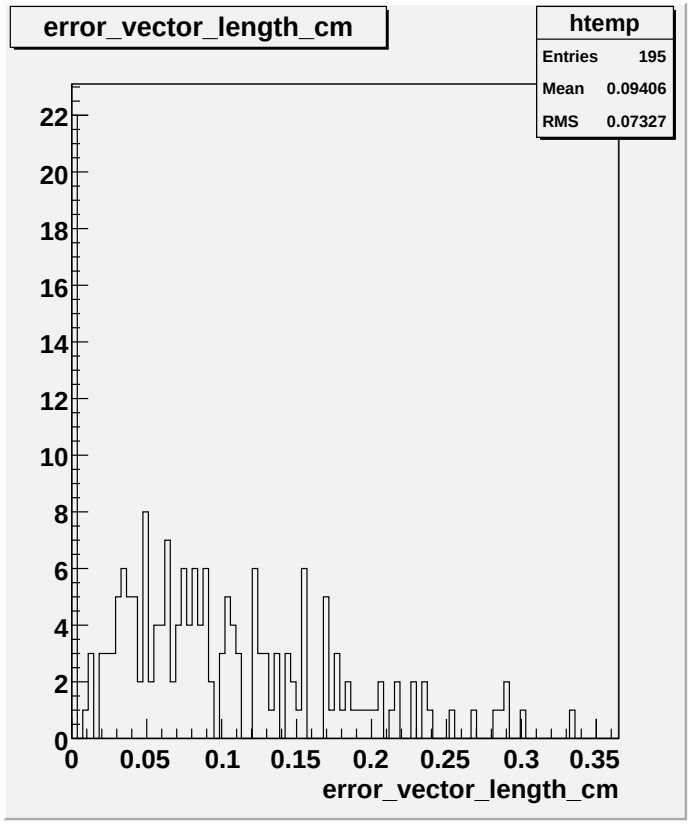
now it should match local expected position



(This is a tautology.)

Two ways of measuring error





(stretch factor − 1) × length
→ error in survey constraints

|mismatch of global point|
→ error in our computation