Advanced 2.5D Trick

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2.5D trick basics

Calculate $\mathcal{R}_i^{2D}$, $i \in (1, ..., N)$ on 2D slice across strip/wire at coordinate z_i along the strip/wire direction.

wires each slice represents a different 2D infinite-wire model with different pitches per plane and different inter-plane phase.

strips different sampling of the "2D single hole with micro wires" geometry.

The "trick" is to combine $N\{\mathcal{R}_i^{2D}\}$ into one $\mathcal{R}_{sim}^{2D}$ and then average that over impact positions to form $\mathcal{R}_{sp}^{2D}$.
What is the *optimum combination"?

Signal processing of simulation

Simulation is fine-grained 2D convolution:

$$\mathcal{M}_{sim} = \mathcal{N}_{sim} + \mathcal{S}_{sim} \circledast \mathcal{R}_{sim}$$

Signal processing is course-grained 2D deconvolution:

$$\mathcal{S}'_{sim} = F_{sp} \circledast \mathcal{M}_{sim} \circledast \mathcal{R}_{sp}^{-1}$$

Substituting.

$$\mathcal{S}'_{sim} = F_{sp} \circledast \mathcal{N}_{sim} \circledast \mathcal{R}_{sp}^{-1} + F_{sp} \circledast \mathcal{S}_{sim} \circledast \mathcal{R}_{sim} \circledast \mathcal{R}_{sp}^{-1}$$

Ignoring noise.

$$\mathcal{S}'_{sim} \approx F_{sp} \circledast \mathcal{S}_{sim} \circledast \mathcal{R}_{sim} \circledast \mathcal{R}_{sp}^{-1}$$

What is $\mathcal{R}_{sim} \circledast \mathcal{R}_{sp}^{-1}$

Reminder of domain of the $\mathcal{R}$'s:

$$\mathcal{R}_{sim} \to \mathcal{R}_{sim}(i, w, t), \mathcal{R}_{sp} \to \mathcal{R}_{sp}(w, t)$$

- i counts impact positions around wire w
- w counts over in-range wires, eg $\in 1 \pm 10$
- t counts drift ticks

When converted to frequency space:

$$\mathcal{R}_{sim} \circledast \mathcal{R}_{sp}^{-1} \to \frac{R_{sim}}{R_{sp}}$$

$\mathcal{R}_{sim} \circledast \mathcal{R}_{sp}^{-1}$ is a kind of normalization of $\mathcal{R}$ in sample bins of impact positions.

SP+sim approximately invariant under change of $\mathcal{R}$

Ignoring noise, to first order, speaking loosely, etc:

$$\mathcal{S}'_{sim} \sim F_{sp} \circledast \mathcal{S}_{sim}$$

Output of SP on sim is approximately independent of $\mathcal{R}$

This is like the "too perfect SP on sim" problem with LArSoft 1D model. LS has 2 ignored dimensions, WCT has only 1.

So what? I'm not sure. It means that det/sim comparisons can not decide **optimum 2.5D combination**. And, that gives an idea how to use data to pick an optimum.

Simple metric on signal sensitive to $\mathcal{R}$

Invent some metric $M_x = f(\mathcal{S}'_x)$ of SP output which should be near 1.0.

- Eg: ratio of total induction charge to total collection charge for a small "blip" of ionization such as from ^{39}Ar decay.

We may form:

$\mathcal{R}_i^{2D}$ 2D response calculated on slice i of N of some 3D geometry.

M_{det}^i the metric from SP detector data event using response $\mathcal{R}_i^{2D}$

We then try to form a constraint on relative weights of each $\mathcal{R}_i^{2D}$:

$$|N_{det} - \sum_{i,det}^{N_{slice},N_{det}} w_i M_{det}^i|; \sum_i^{N_{slice}} w_i = 1.0$$

What does it mean to find $\{w_i\}$?

- We calculate $\mathcal{R}_i^{2D}$ in a pure 2D space (unrealistic).
  - This includes use of unrealistic 2D drift paths.
- Then $\{w_i\}$ are calculated using **true data 3D drift paths** to determine some kind of importance of each slice.
- This is somewhat a fiction as the $\{w_i \mathcal{R}_i^{2D}\}$ model is not perfectly realistic, but it is close.