Zenith Angle Reconstructions in AURA Data

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ARA Meeting, 2010

Outline

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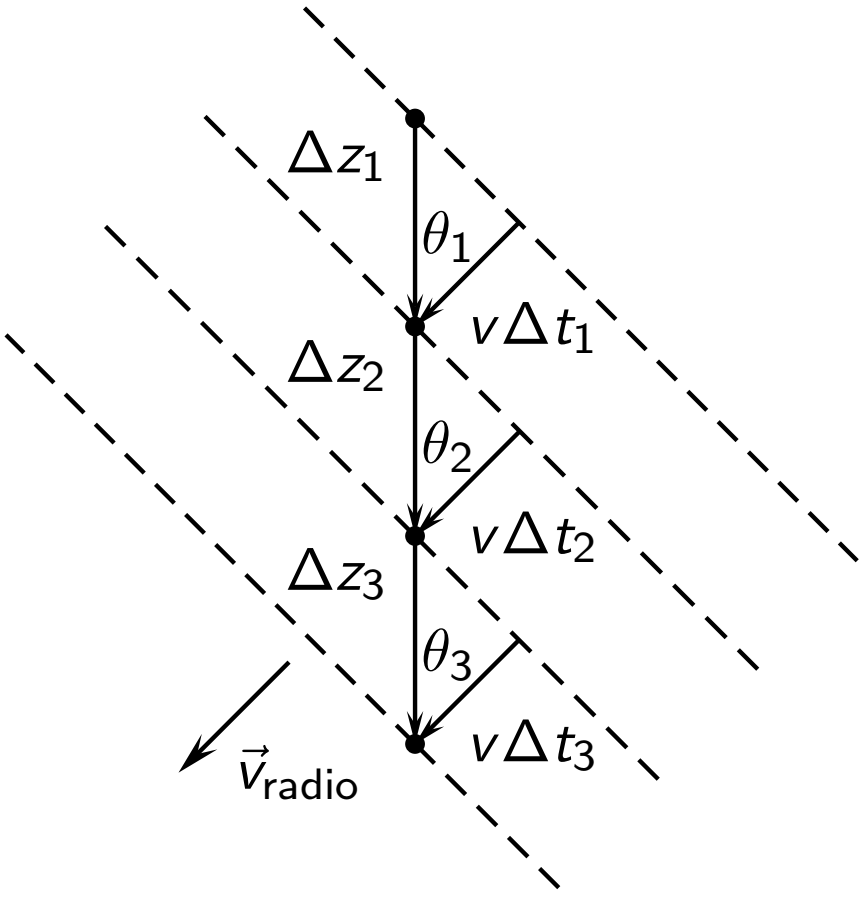
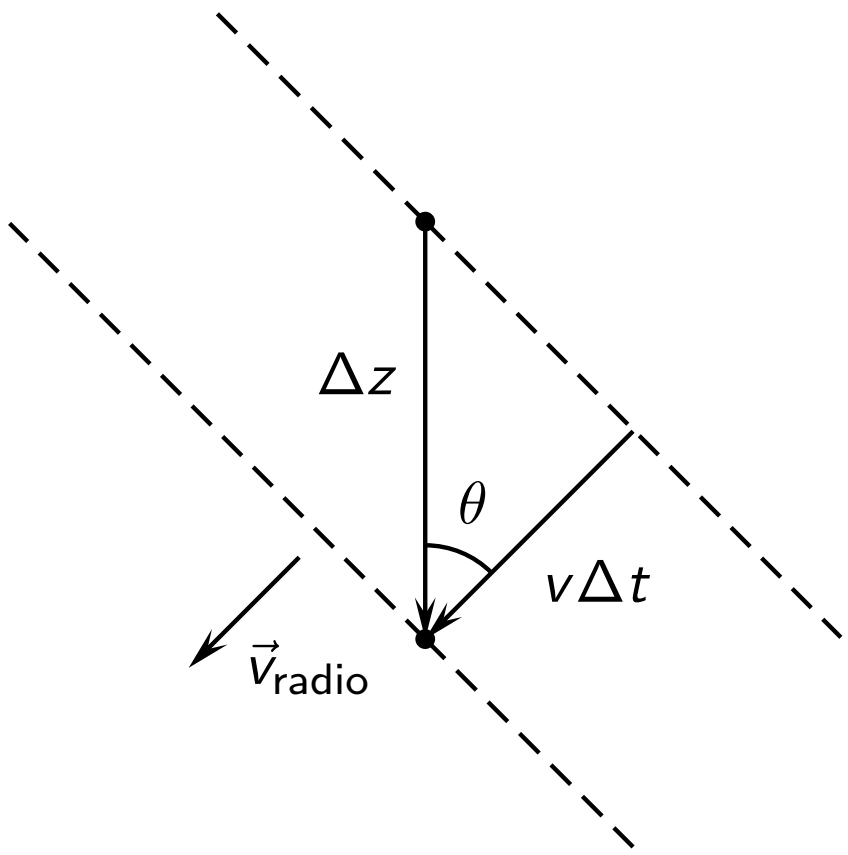
Method I



- Use single-cluster data
- Assume plane waves
- Consecutive antennas are Δz apart
- Wavefront travels $v\Delta t$ between hitting consecutive antennas

Method II



- Basic trig gives

$$\theta = \cos^{-1}\left(\frac{v\Delta t}{\Delta z}\right)$$

- Define

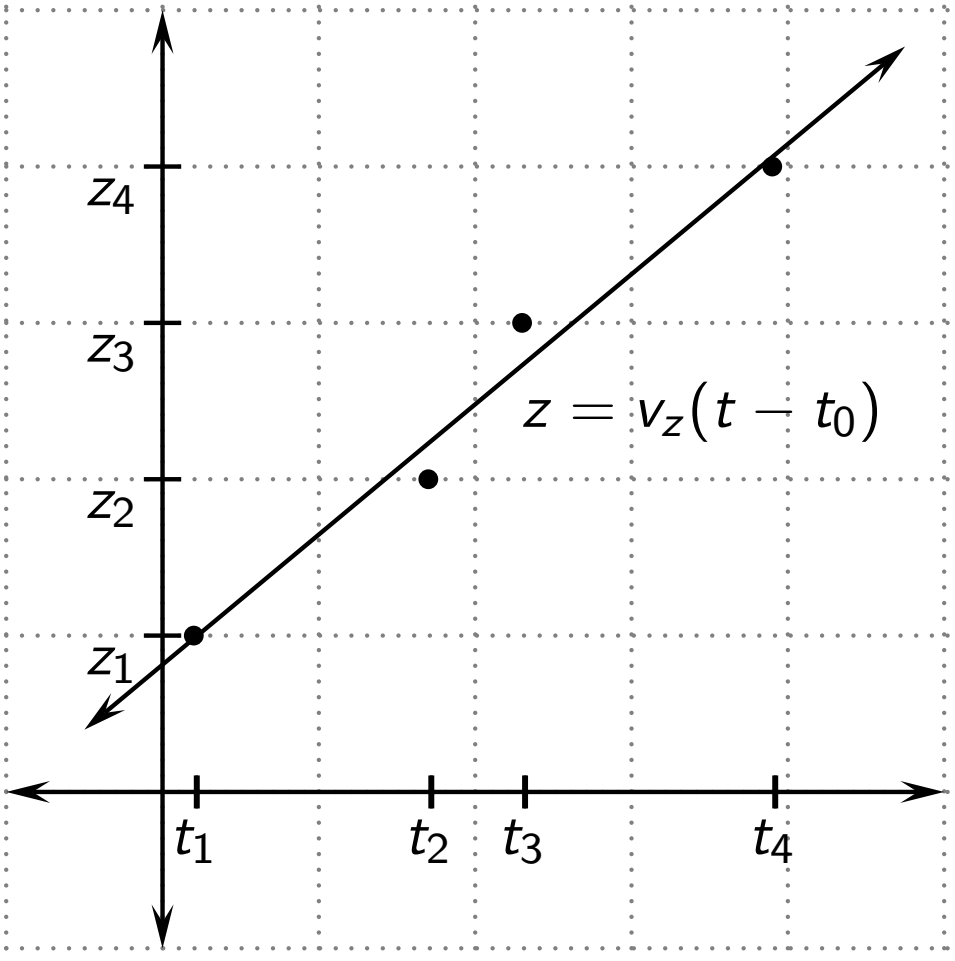
$$v_z := \frac{\Delta z}{\Delta t}$$

so that

$$\theta = \cos^{-1}\left(\frac{v}{v_z}\right)$$

- Important: $v_z > v$ and is not a physical speed

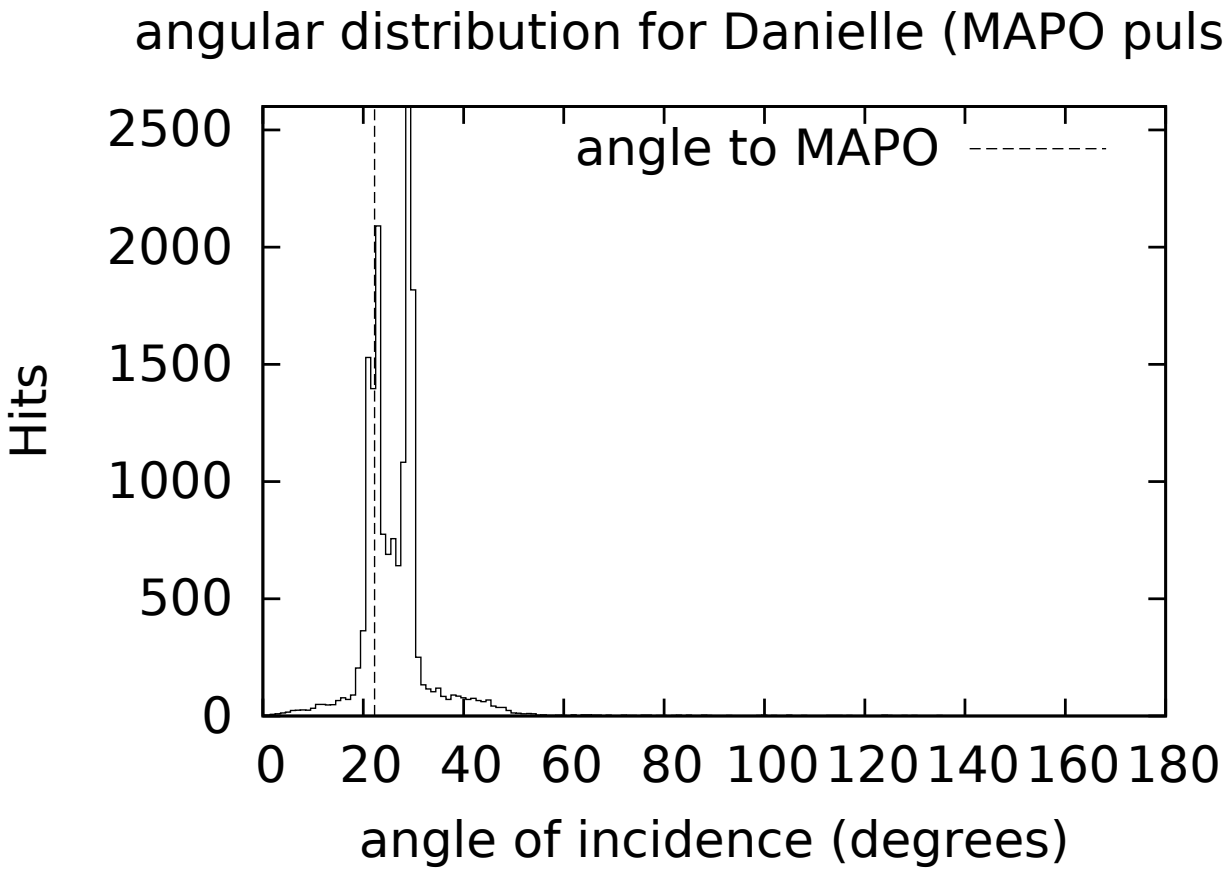
Method III



- Require $n_{\text{hit}} \geq 2$
- For $n_{\text{hit}} > 2$, use a least squares fit to get v_z
- If $v_z > v$, compute θ
- Place θ values in 1° bins

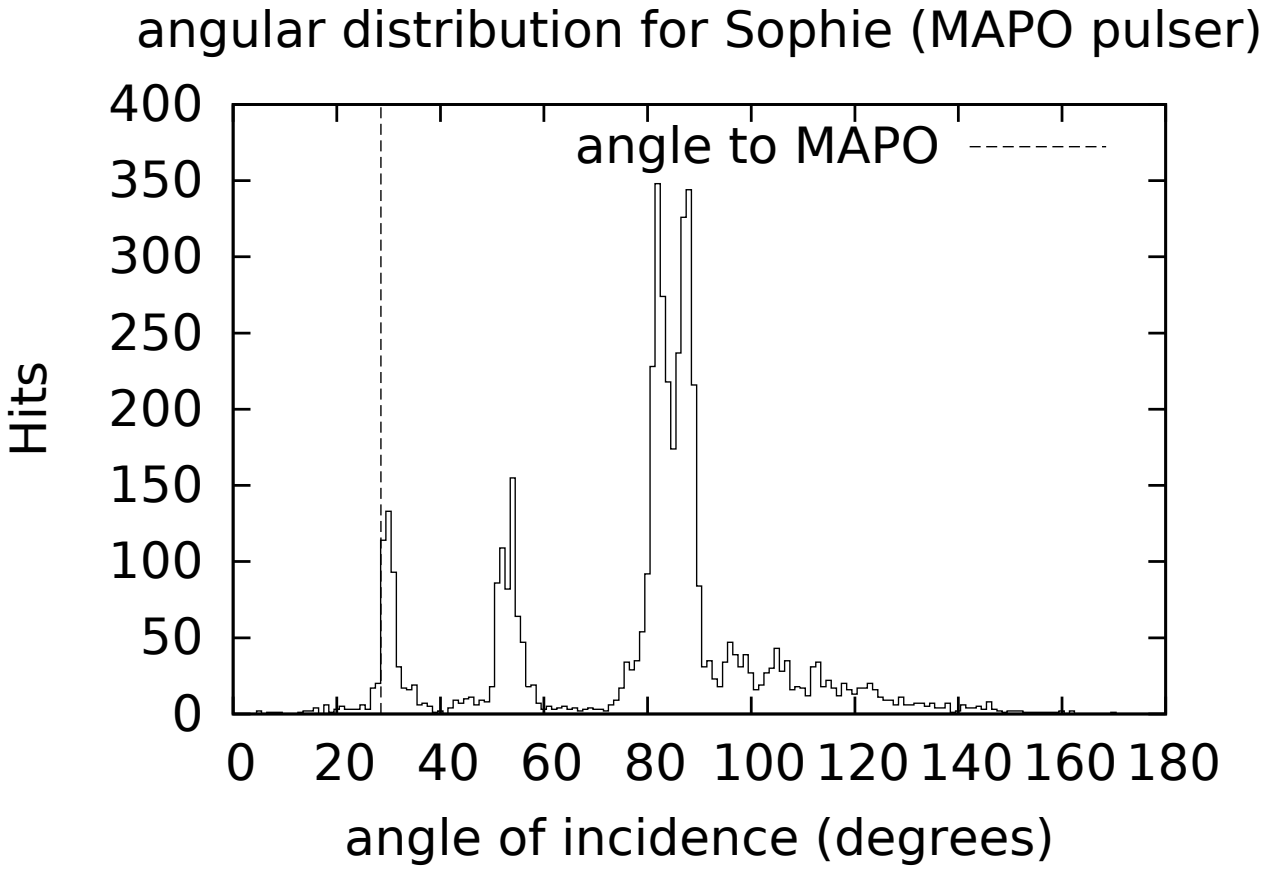
Outline

Pulser data for single clusters I



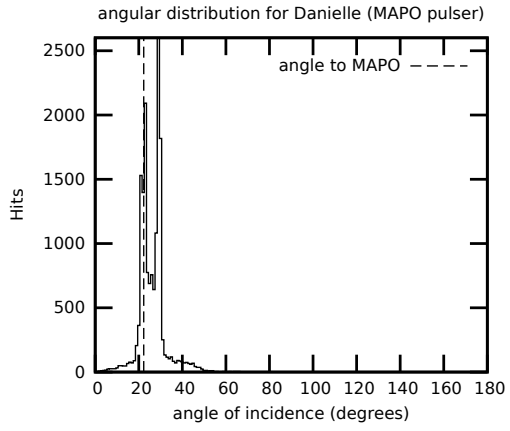
- Why this double peak?
- Feature exists in both individual runs and combined many-run data.

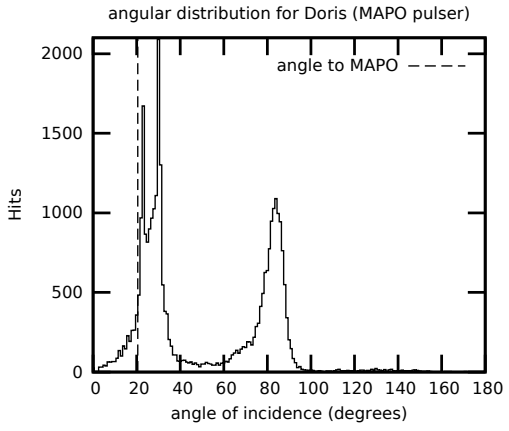
Pulser data for single clusters II

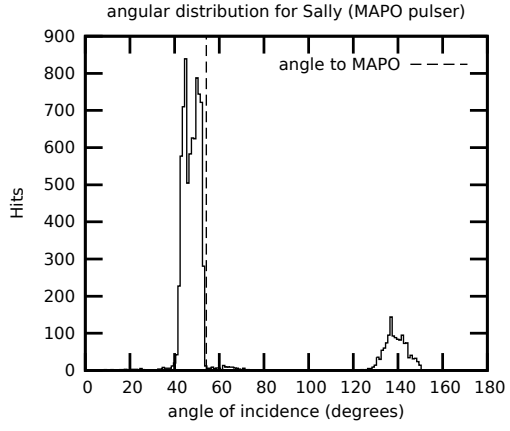


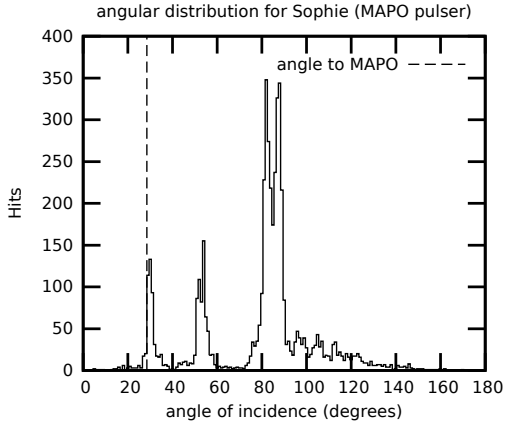
- Why discrete peaks here?
- Note: Vertical line is straight-line zenith angle (no ray tracing)

Pulser data for all clusters — MAPO surface pulser

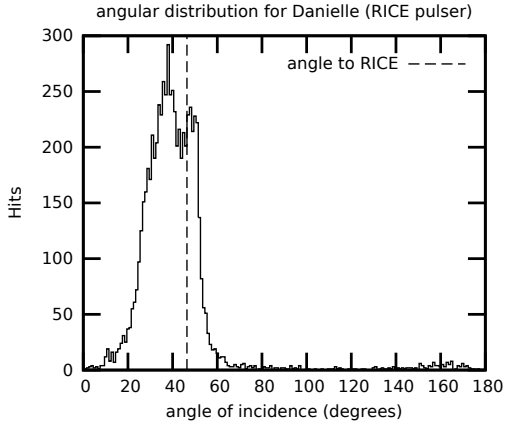


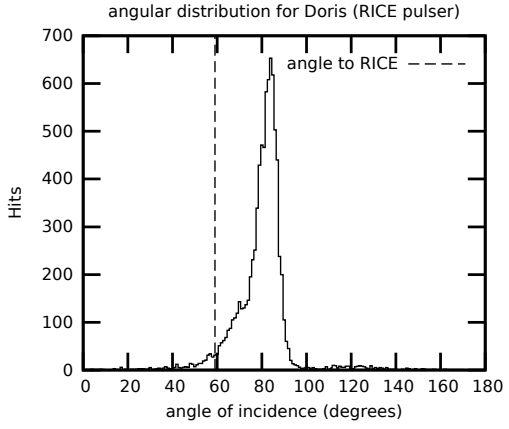


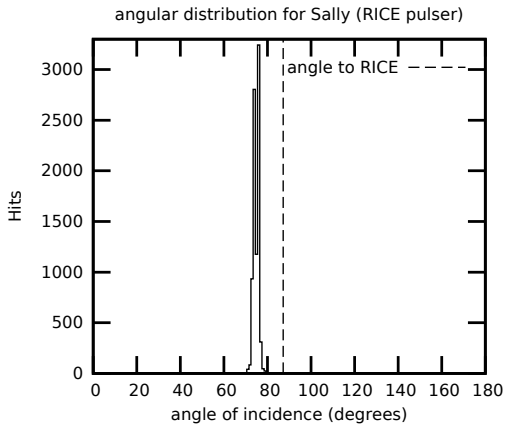


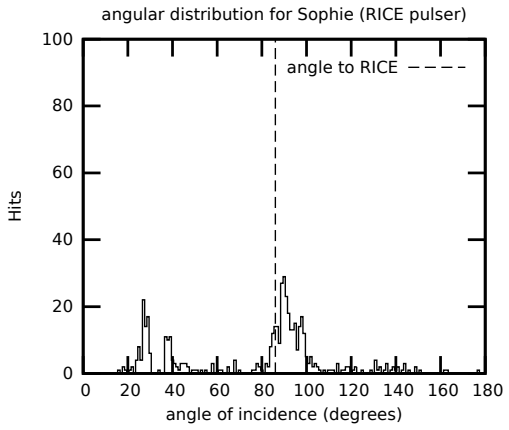


Pulser data for all clusters — RICE in-ice pulser

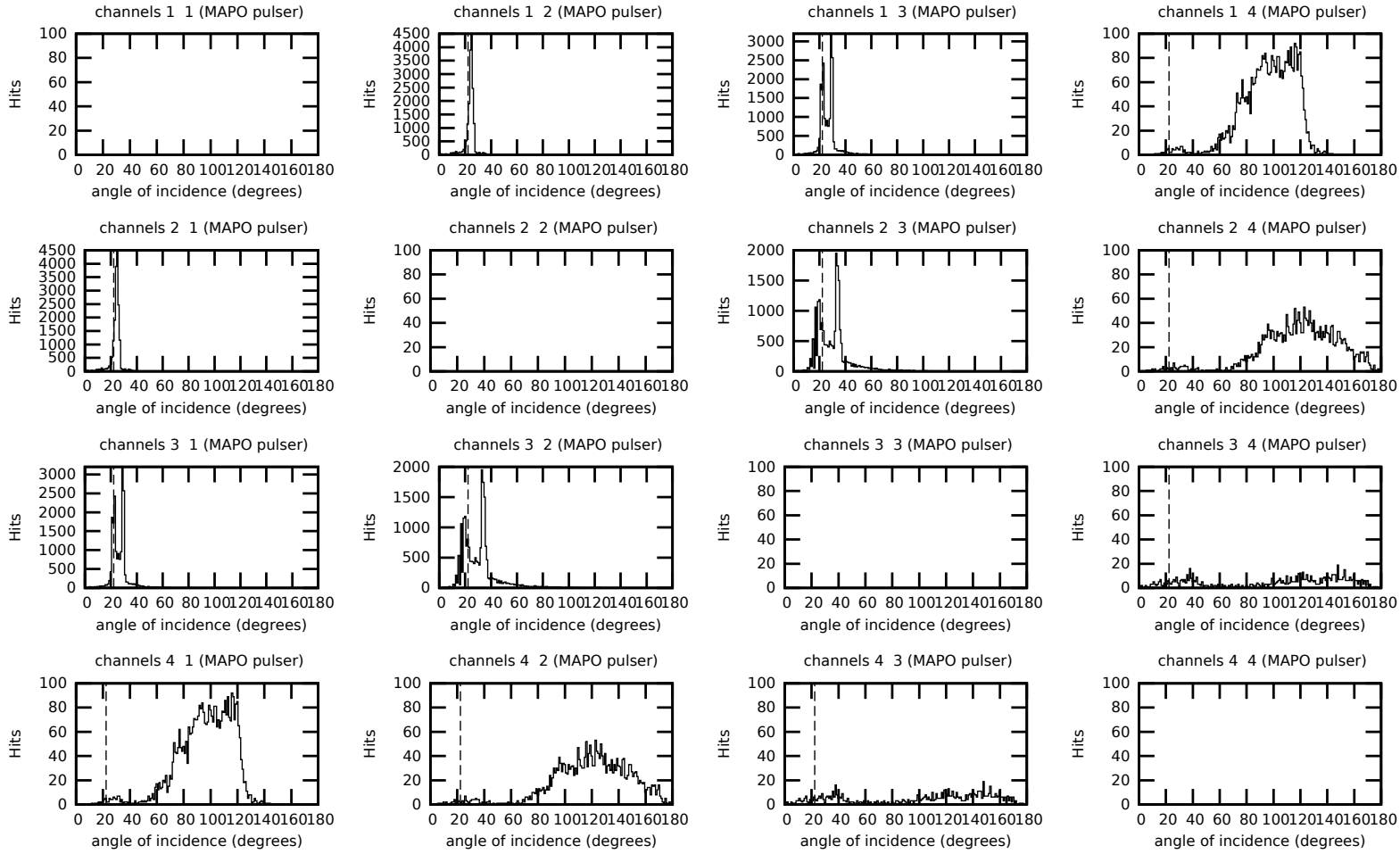








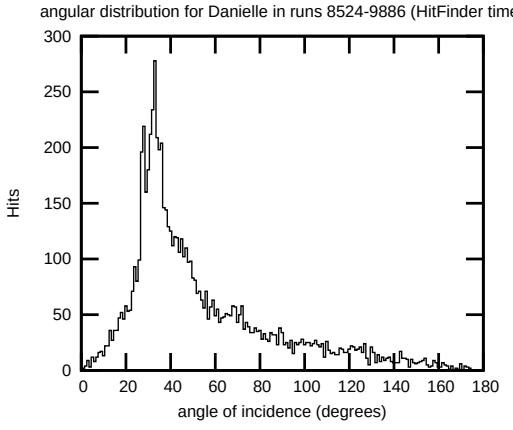
MAPO surface pulser data per antenna pair in Danielle

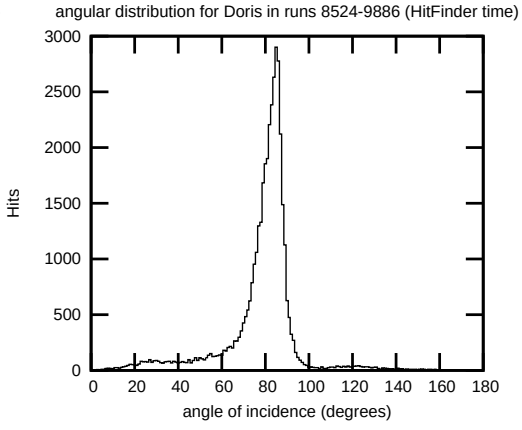


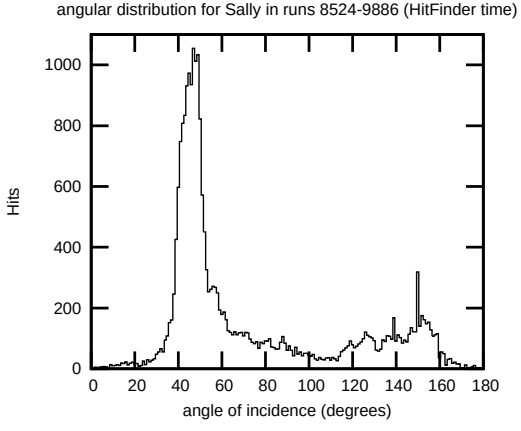
- Low frequency channels may skew some combinations

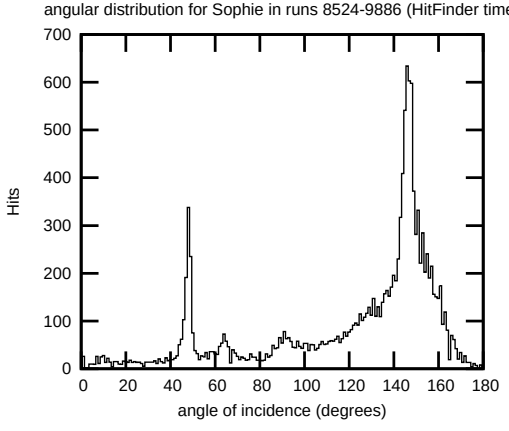
▸ Other clusters & plots for RICE in-ice pulser

Regular data for single clusters









More plots available online

- Also tried using the first 5σ time and the last 5σ time
- For normal runs, also tried 2D angle$\times$time histograms
- Additional plots are available online:
  - .../~mrichman/angular-distributions
  - .../~mrichman/angular-distributions-first-5-sigma-times
  - .../~mrichman/angular-distributions-last-5-sigma-times
  - .../~mrichman/pulser-ang-dists-by-cluster
  - .../~mrichman/pulser-ang-dists-by-pulser
  - .../~mrichman/pulser-pairwise-ang-dists-by-pulser

Outline

Caveats

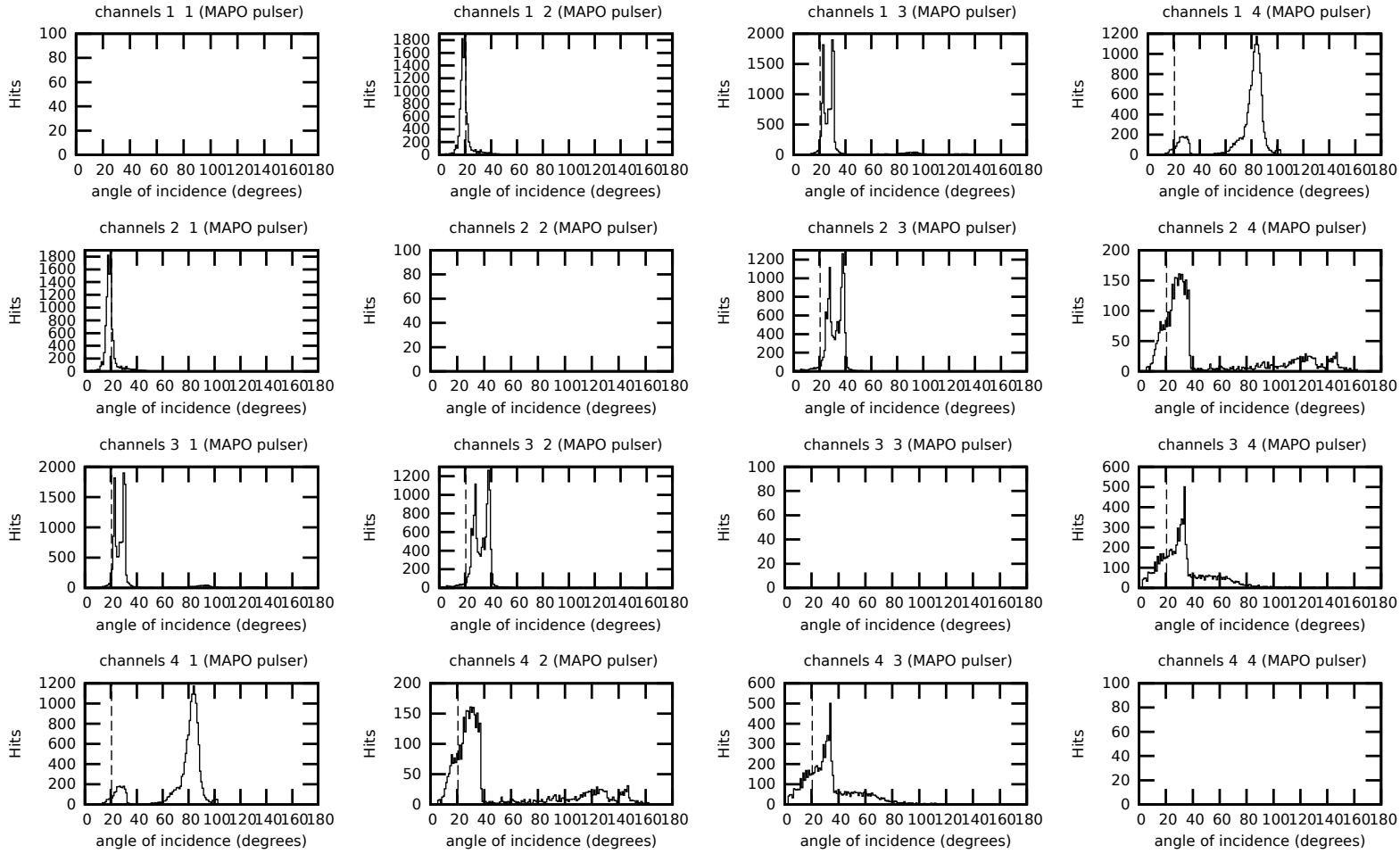
- Haven't filtered events with wrong periodicity from pulser hits
- Haven't accounted for varying $n(z)$ (is this needed?)

Next steps

- Address those caveats
- Try plotting Δt distributions directly
- Check for hardware crosstalk
- Try scatterplots of zenith angle, antenna pair vs. antenna pair
- More stuff TBD

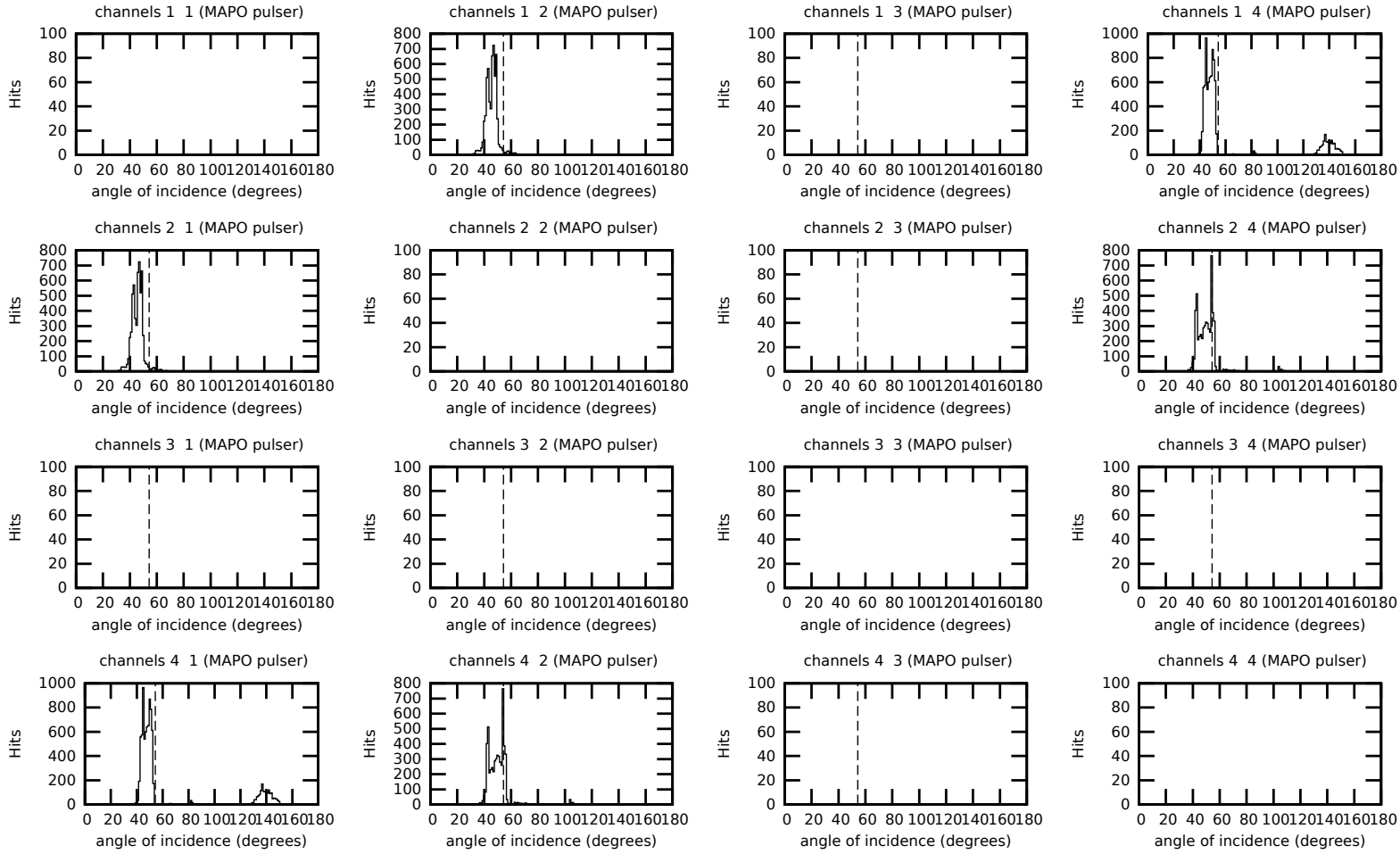
Backup Slides

MAPO surface pulser pulser data per antenna pair in Doris



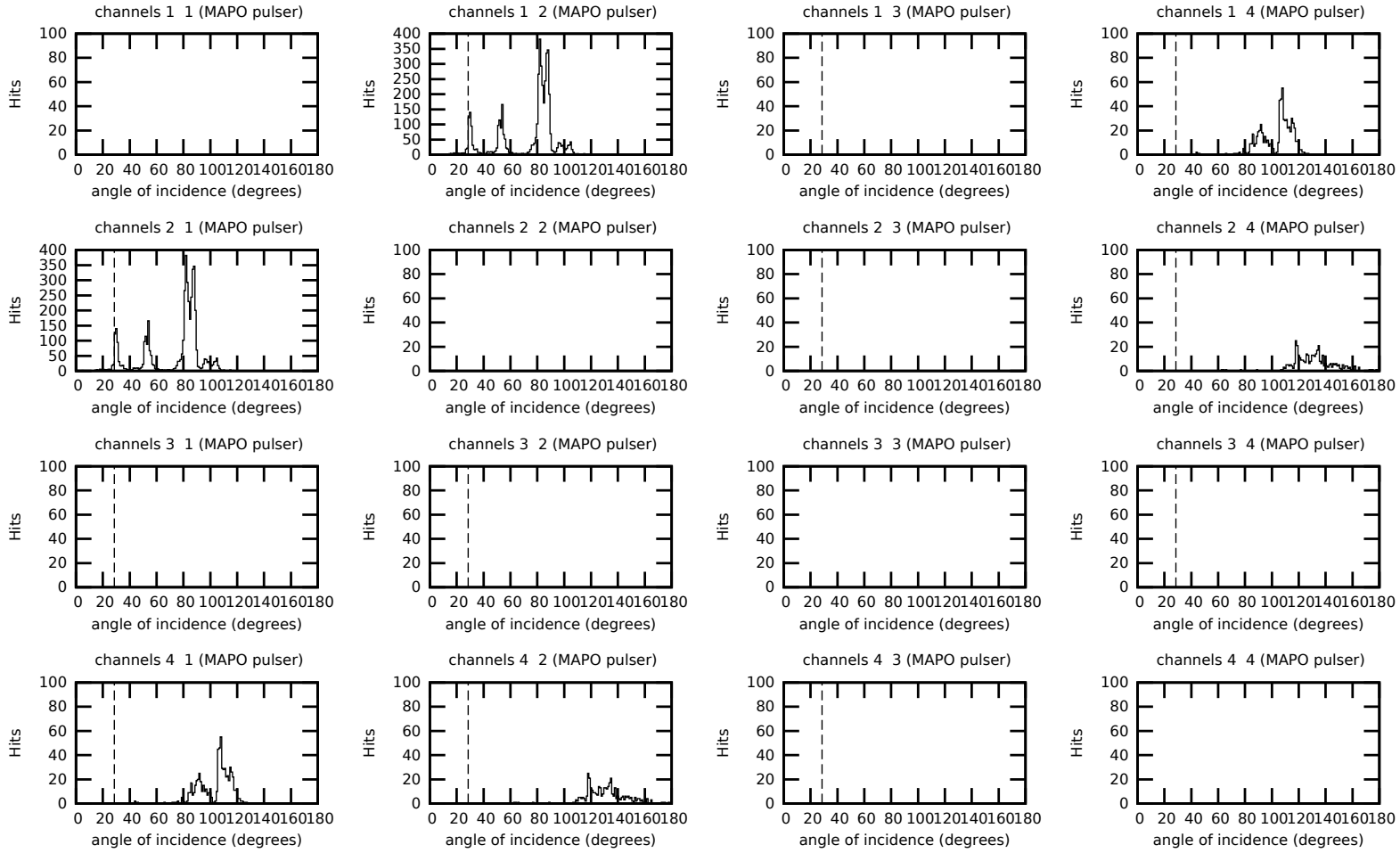
◂ Back to Danielle's MAPO surface pulser data

MAPO surface pulser pulser data per antenna pair in Sally



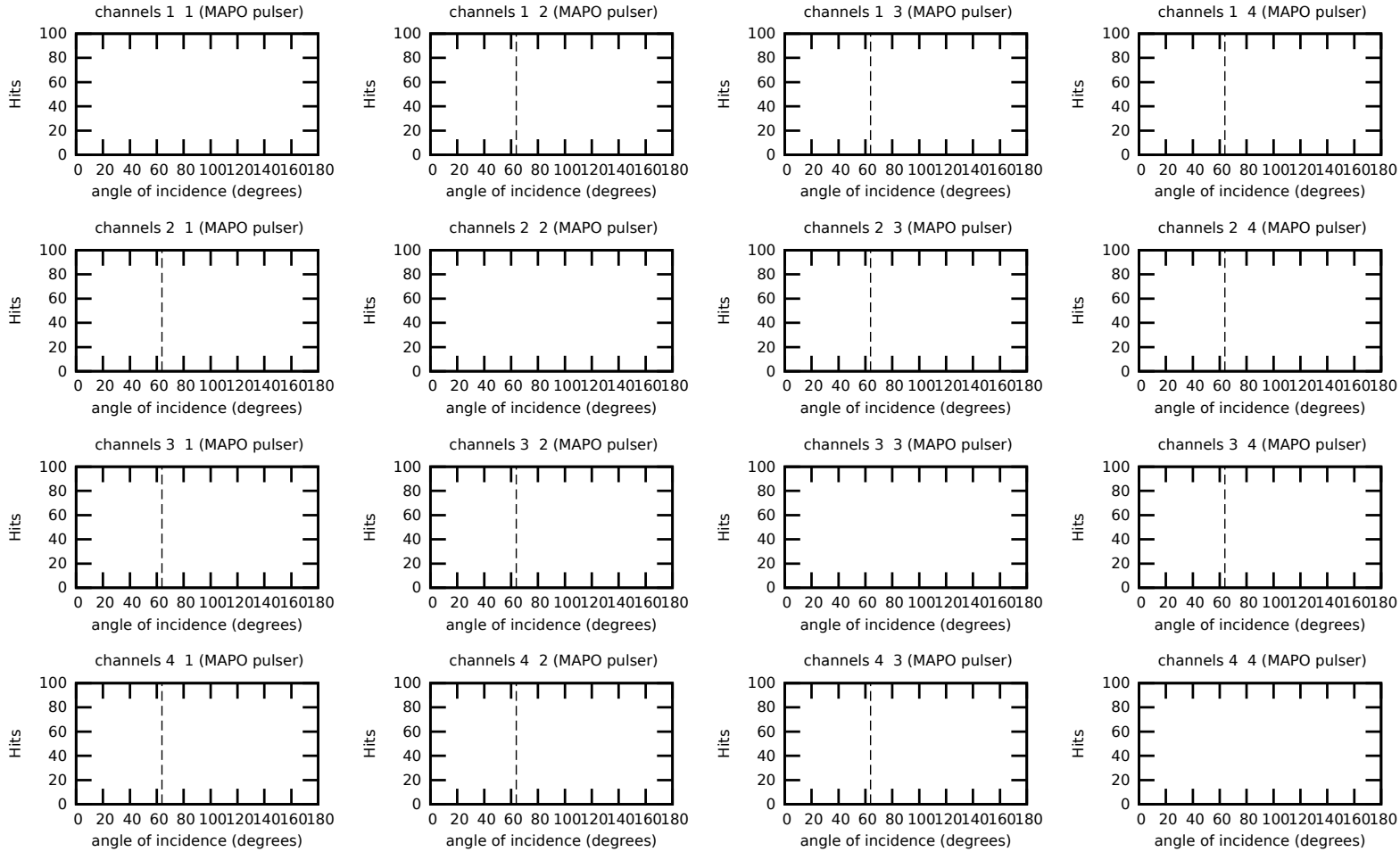
◂ Back to Danielle's MAPO surface pulser data

MAPO surface pulser pulser data per antenna pair in Sophie



◂ Back to Danielle's MAPO surface pulser data

MAPO surface pulser pulser data per antenna pair in Susan



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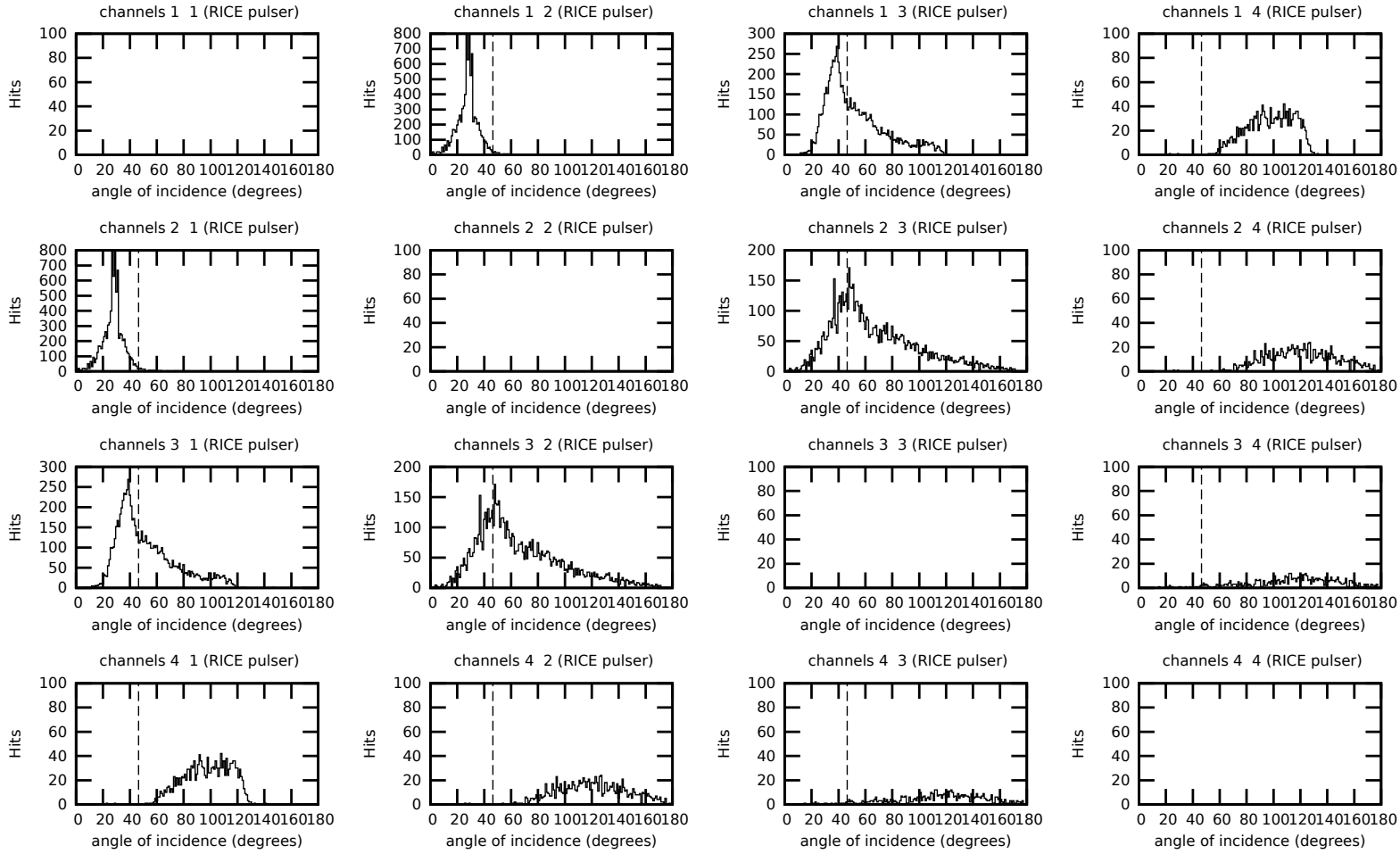
RICE in-ice pulser pulser data per antenna pair in Danielle



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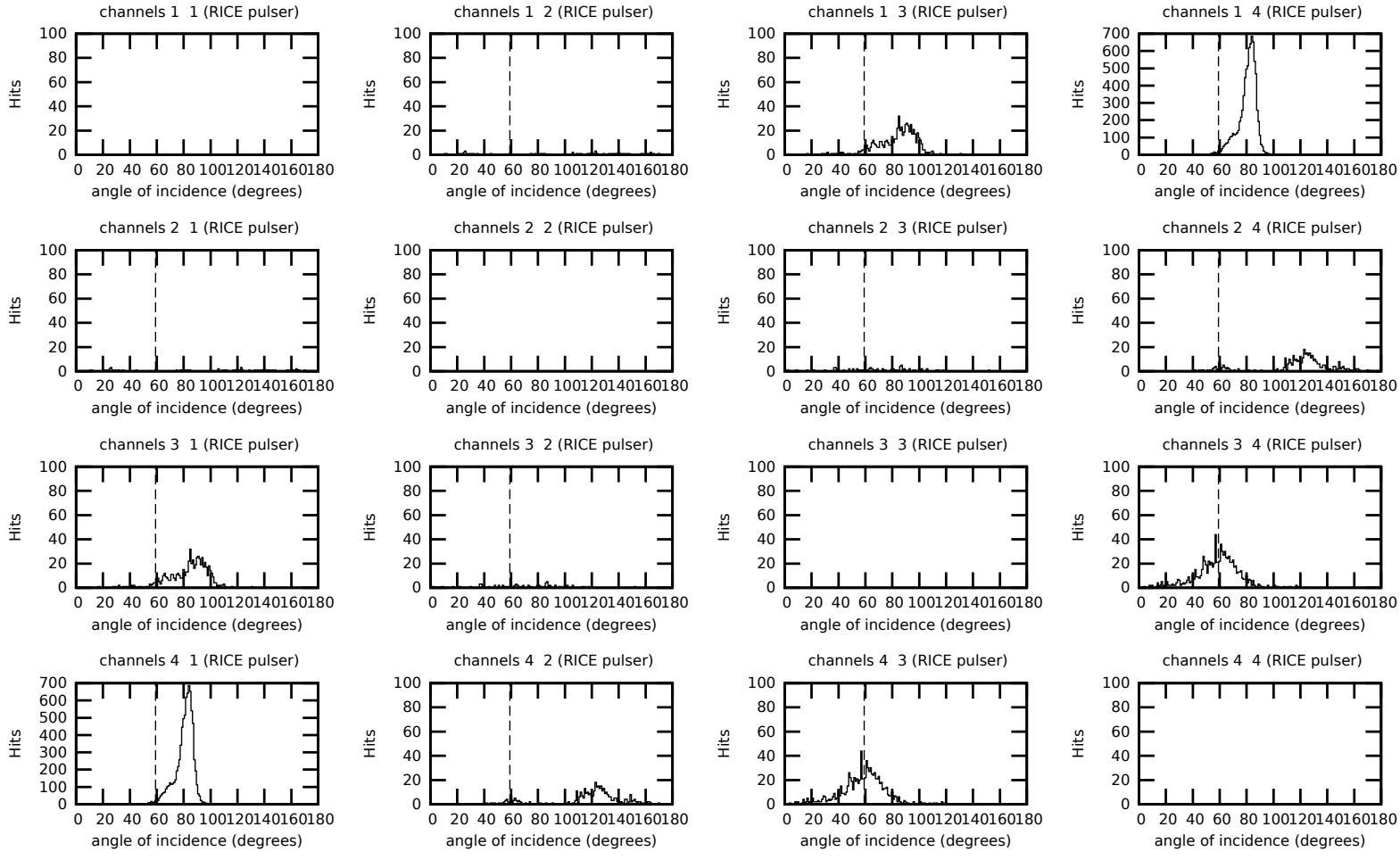

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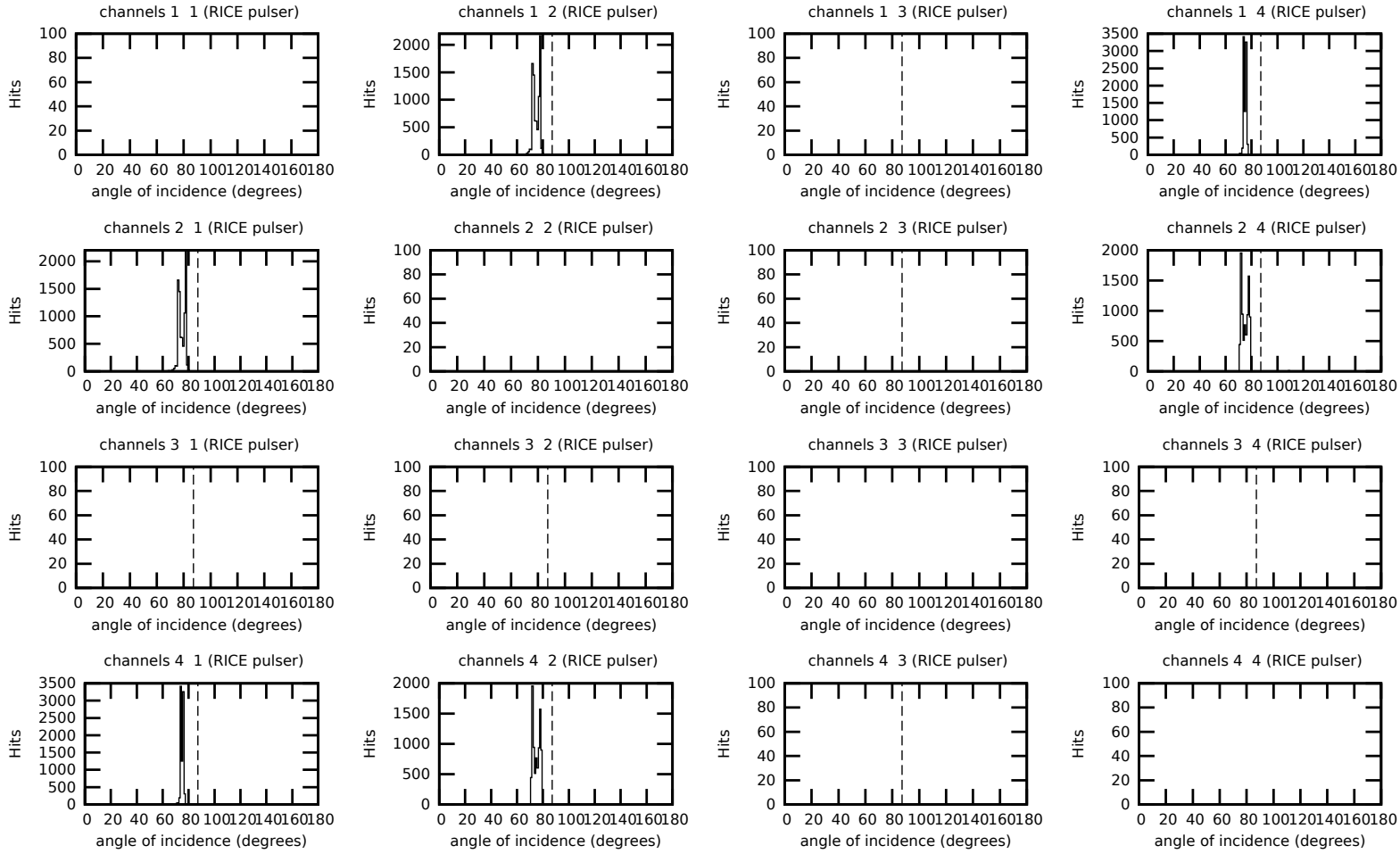

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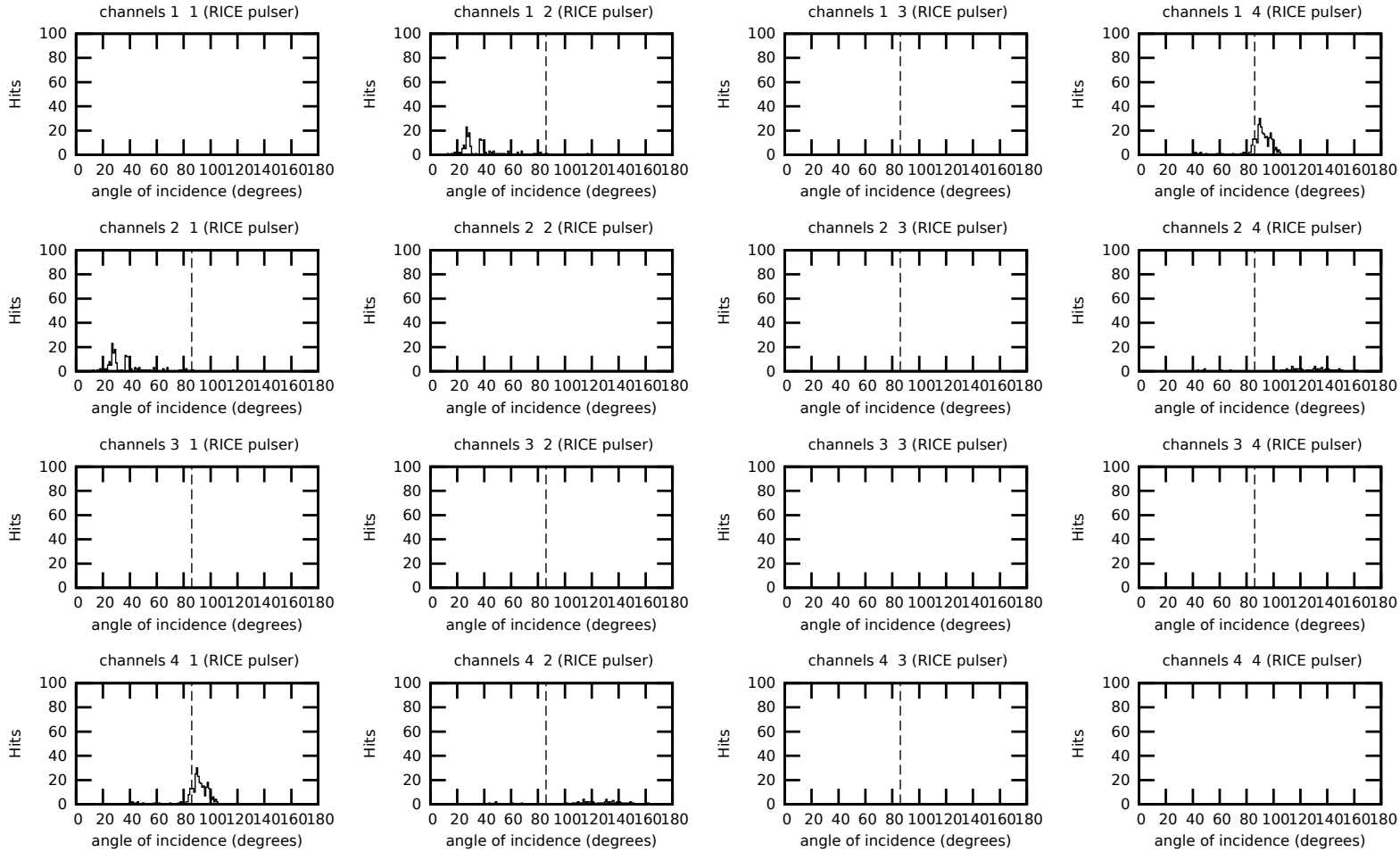
RICE in-ice pulser pulser data per antenna pair in Sophie



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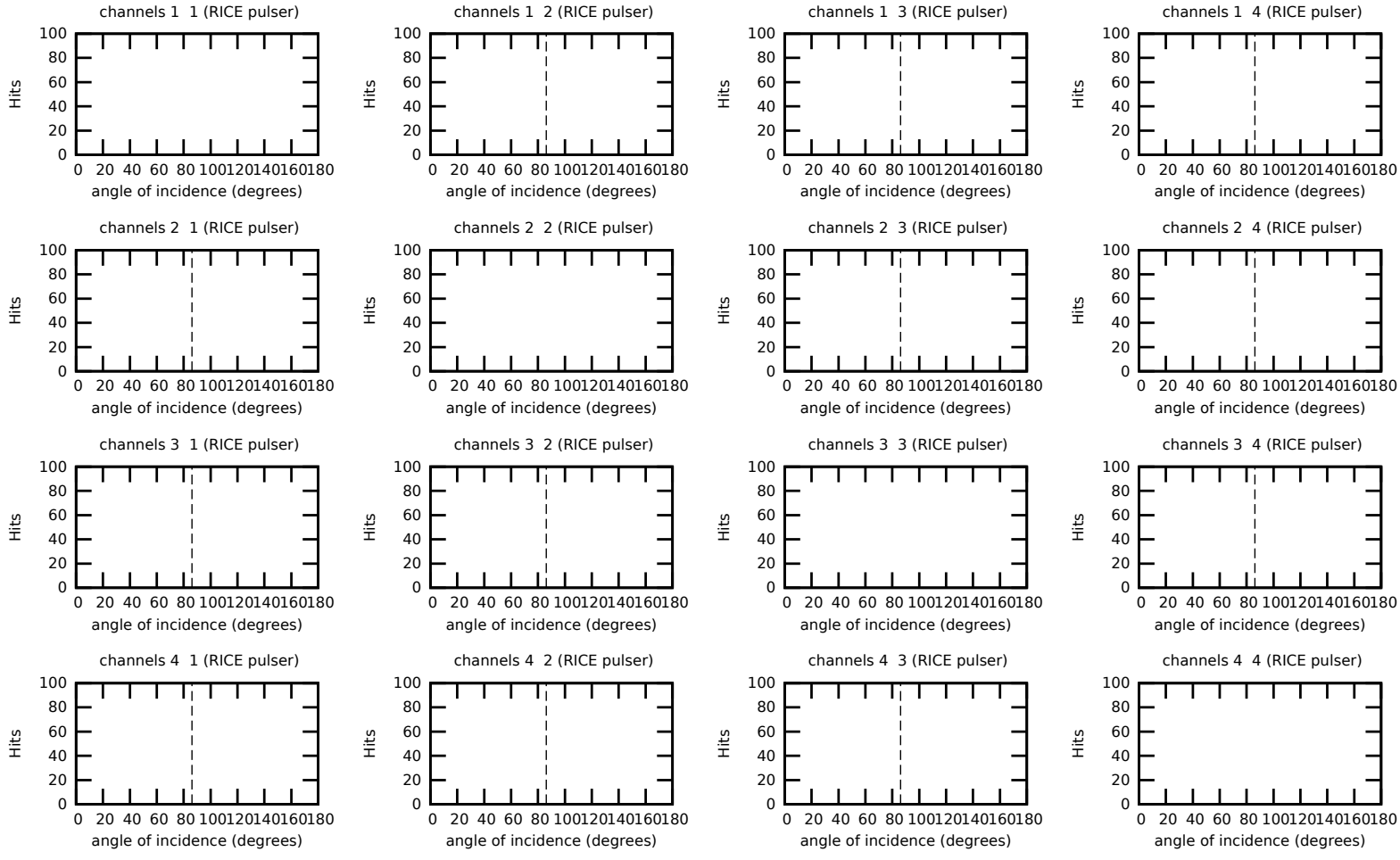

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