Status update of PFA at Iowa

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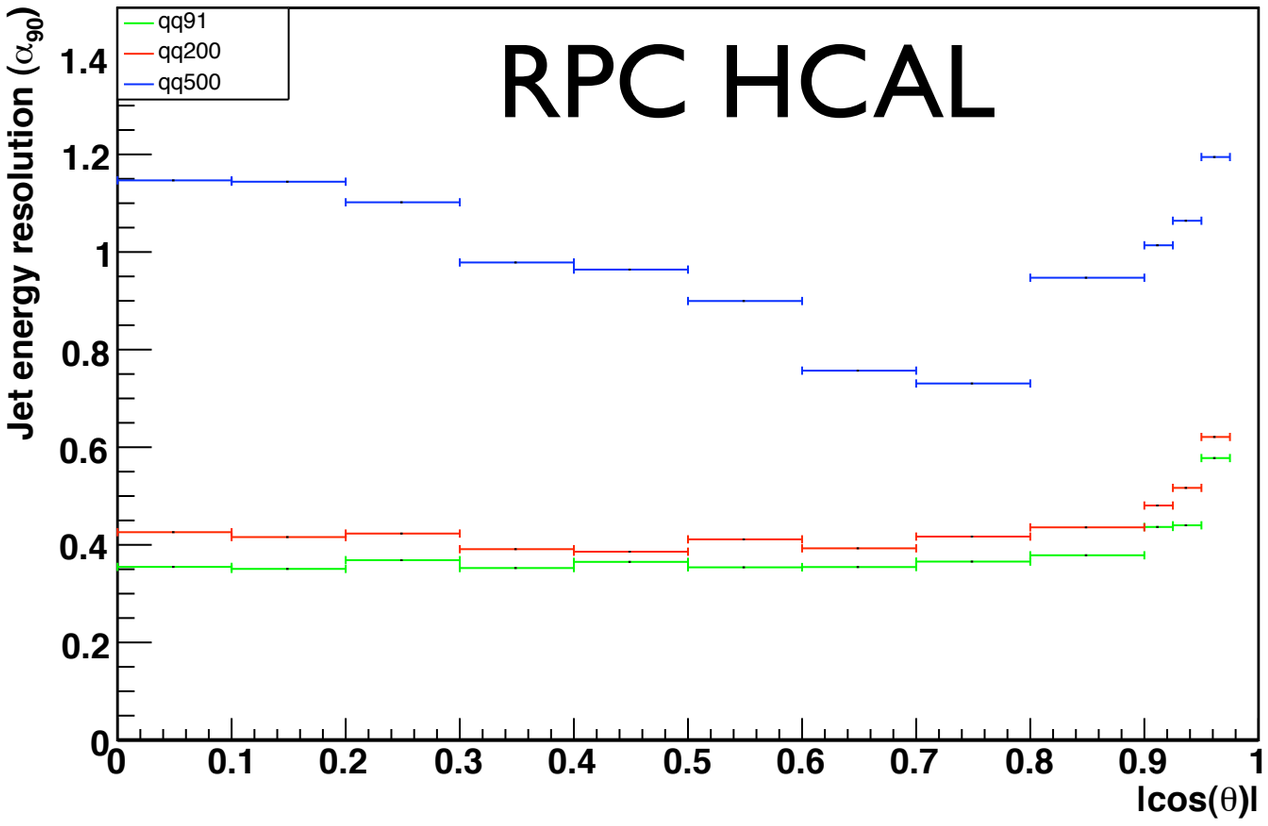
The story so far

Last time, we showed that:

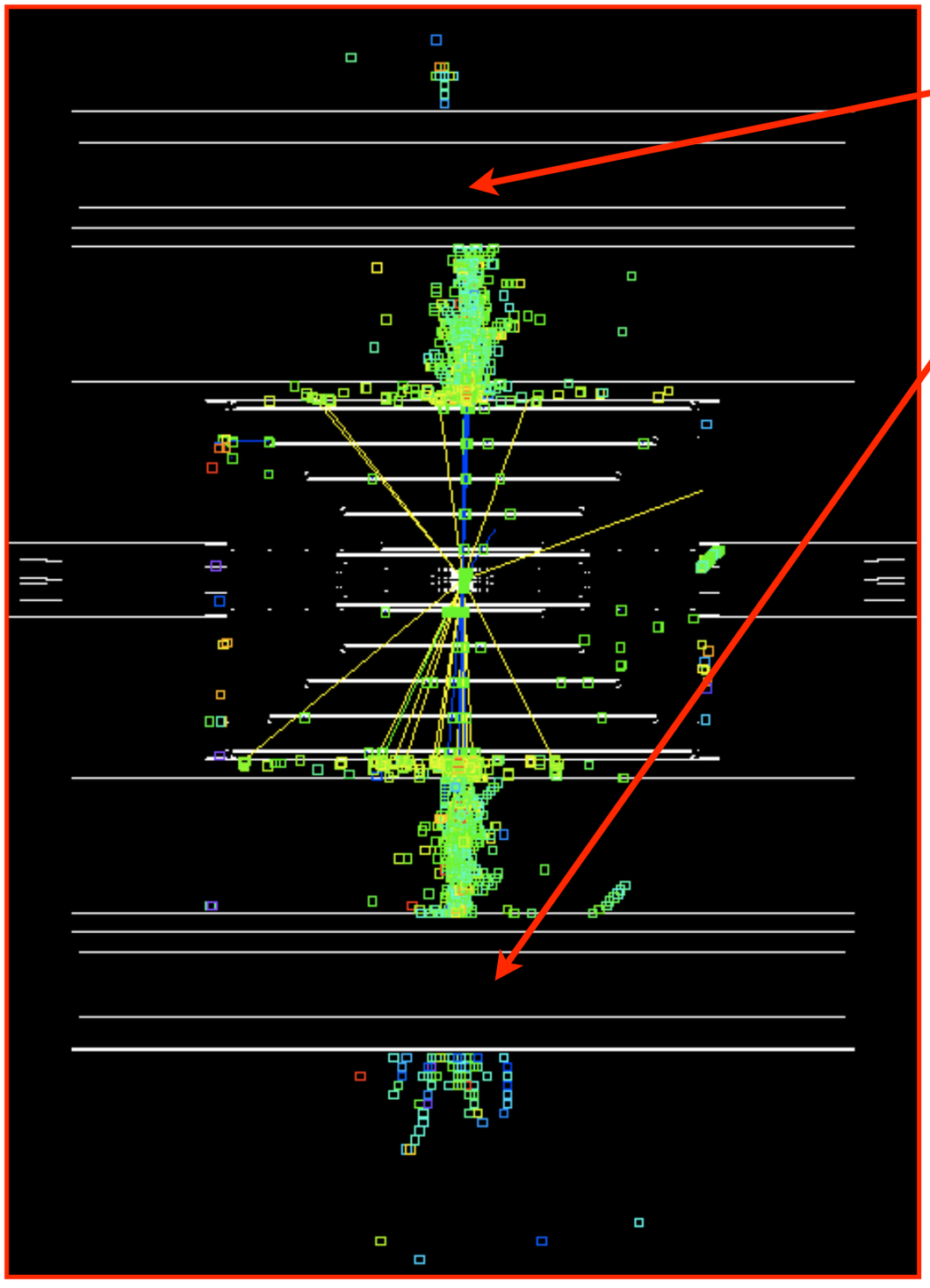
- Resolution has strong angular dependence
  - worse in barrel and in forward region
- Resolution is a lot worse in events with significant leakage into MUCAL
- For qq500, particle multiplicity in MUCAL is low
  - mean 1.0 particle per event with >4 hits in muon system for qq500 (sid01_scint)



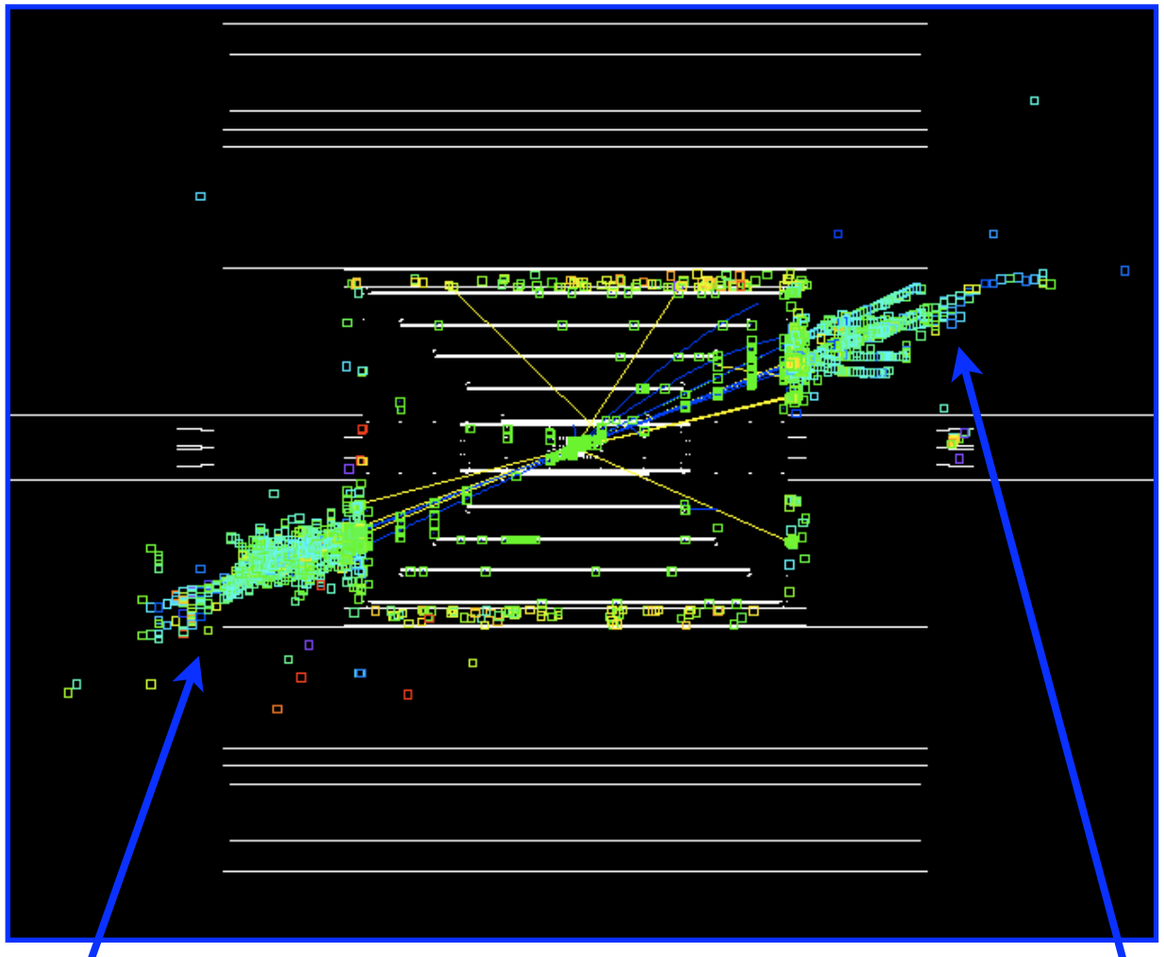
qq500	<20 muon system hits	≥20 muon system hits
sid01 RPC HCAL	+1.55 ± 17.36	-9.46 ± 23.97
sid01_scint Scintillator HCAL	-1.76 ± 15.26	-13.09 ± 22.46

Using the MUCAL

Here are a couple of qq500 events that leak into the MUCAL:



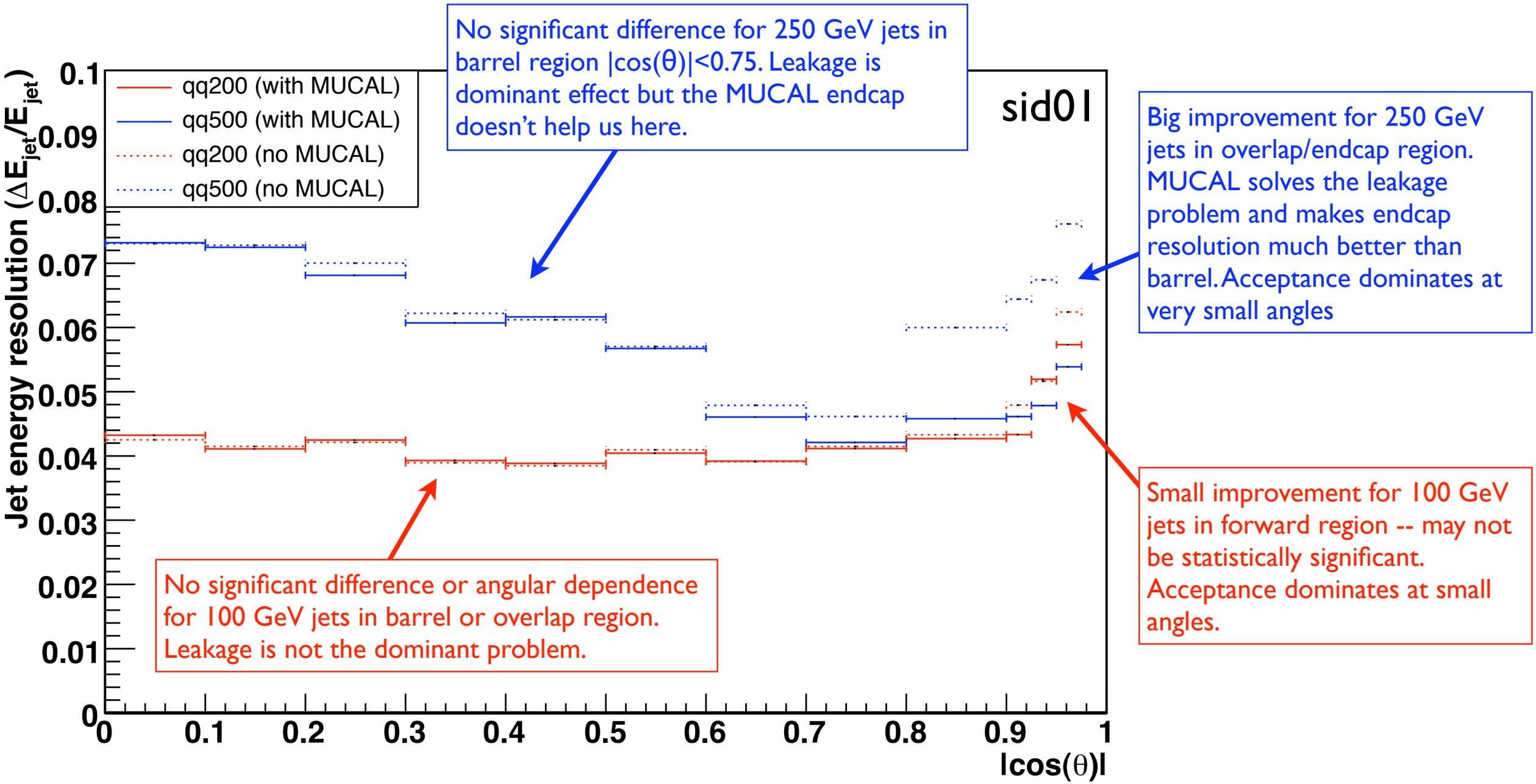
Gap of ~ 1m between barrel HCAL and MUCAL (and lots of material) => we can match to the right jet but identifying which particle is much harder.



Minimal gap between endcap HCAL and MUCAL => pattern recognition is straightforward and we can match to the right particle.

Using the MUCAL

We can plug the endcap MUCAL into the PFA easily (treating it like another HCAL). We don't use the barrel MUCAL at all yet.



So this is why our qq500 resolution was so awful -- leakage was killing us!

A few practical points:

- The plot was made with sid01, which has a very nice muon system (48 layers each with 5cm steel).
- Real, affordable MUCAL may not have so many layers -- but if we can, we should keep good segmentation at the front (as per Norman).
- MUCAL barrel does carry some information -- we want to look into this (need to talk to muon people). But it's not the low-hanging fruit.
- Haven't touched sid01_scint -- it has a screwy muon system:

```
<detector id="8" name="MuonEndcap" reflect="true" type="CylindricalEndcapCalorimeter" readout="MuonEndcapHits">
    <dimensions inner_r = "26.0*cm" inner_z = "277.5*cm" outer_r = "645.0*cm" />
    <layer repeat="5">
        <slice material="Iron" thickness="10.0*cm" />
        <slice material="Air" thickness="1.0*cm" />
        <slice material="Aluminum" thickness="0.2*cm" />
        <slice material="Air" thickness="0.4*cm" />
        <slice material="PyrexGlass" thickness="0.2*cm" />
        <slice material="RPCGasDefault" thickness="0.2*cm" sensitive="yes" />
        <slice material="PyrexGlass" thickness="0.2*cm" />
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        <slice material="Air" thickness="0.3*cm" />
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        <slice material="RPCGasDefault" thickness="0.2*cm" sensitive="yes" />
        <slice material="PyrexGlass" thickness="0.2*cm" />
        <slice material="Air" thickness="0.4*cm" />
        <slice material="Aluminum" thickness="0.2*cm" />
    </layer>
    <layer repeat="8">
        <slice material="Iron" thickness="0.2*cm" />
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        <slice material="PyrexGlass" thickness="0.2*cm" />
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        <slice material="Aluminum" thickness="0.2*cm" />
    </layer>
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        <slice material="Iron" thickness="20.0*cm" />
    </layer>
</detector>
```

Odds & Ends

Started looking at BeamCal

- Doesn't make much difference in bulk of detector, somewhat predictably.
- Appears to help at $|\cos(\theta)| > 0.975$, also somewhat predictably.
  ... but still awful performance down there.
- sid01 design is very similar to ECAL (30 layers of Si+W) -- is this realistic?
- For now we're leaving it out of the production PFA, but code toggles are in there to enable it.

Some other improvements -- see Tae Jeong's talk

In process of porting recent changes to stable

- New release in next few days.