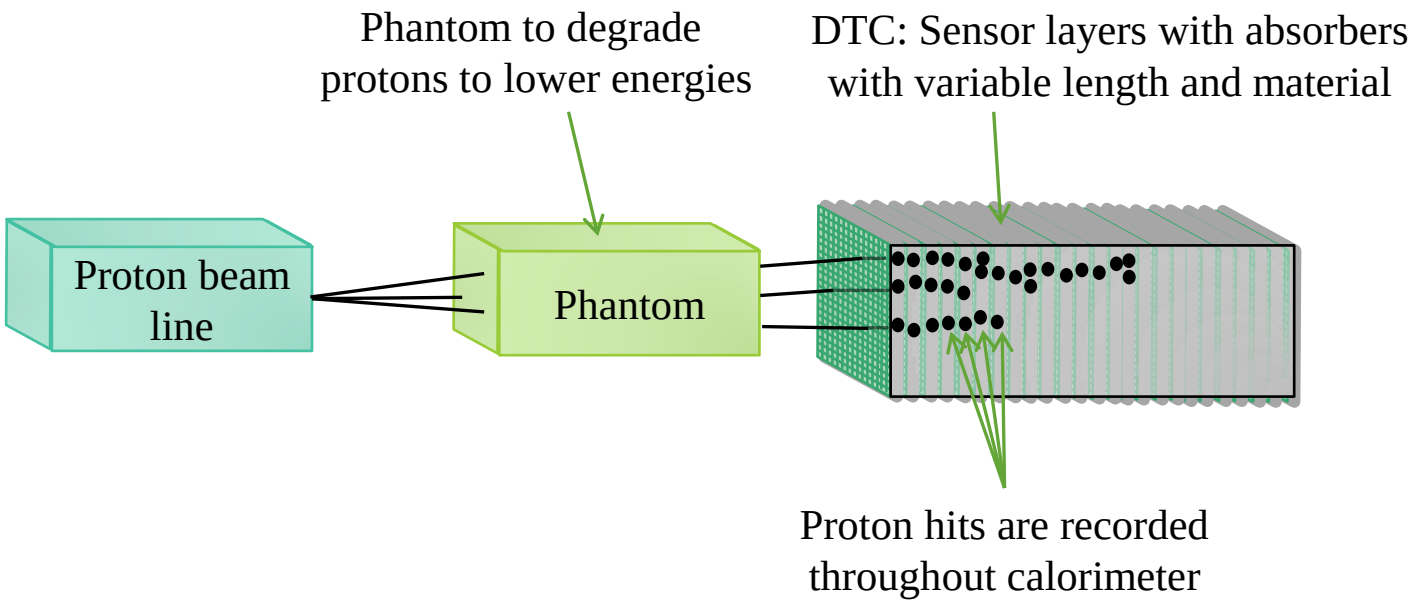
Preliminary DTC Optimization Results

2017-09-03

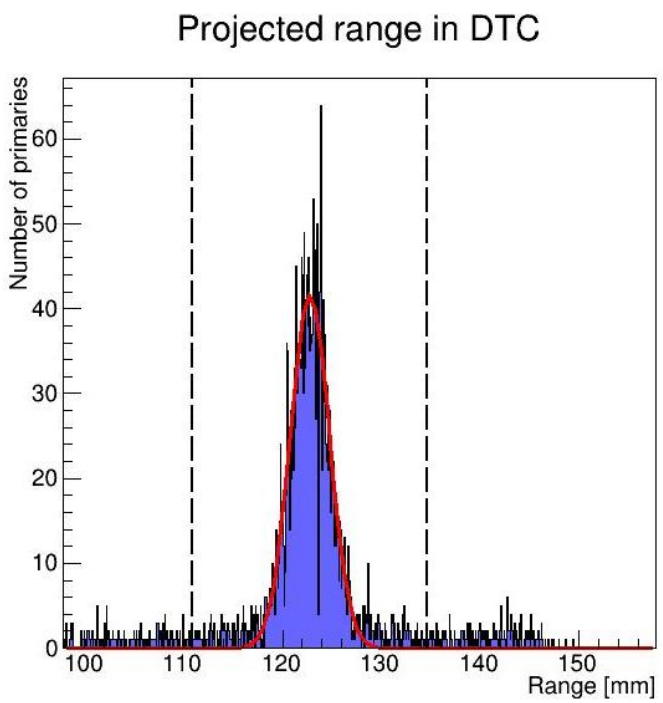
Method

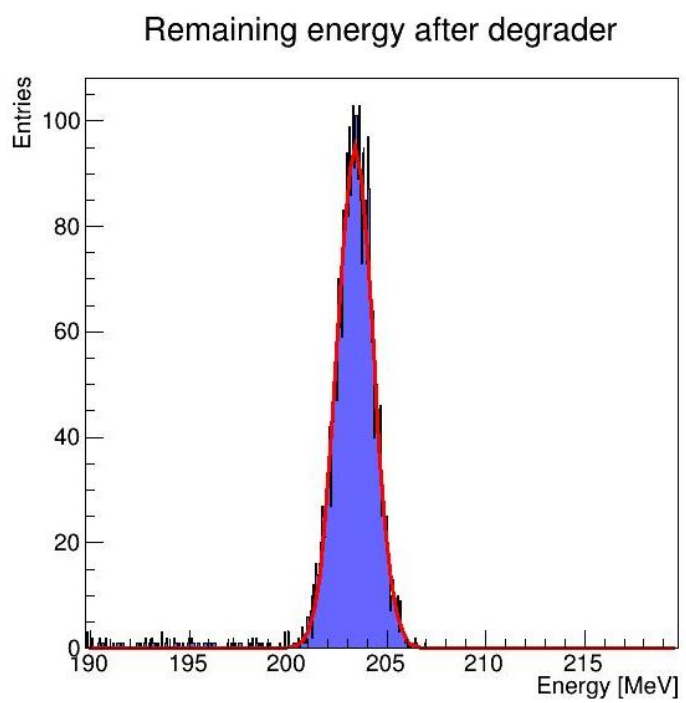

Phantom to degrade protons to lower energies
DTC: Sensor layers with absorbers with variable length and material
Proton beam line
Phantom
Proton hits are recorded throughout calorimeter

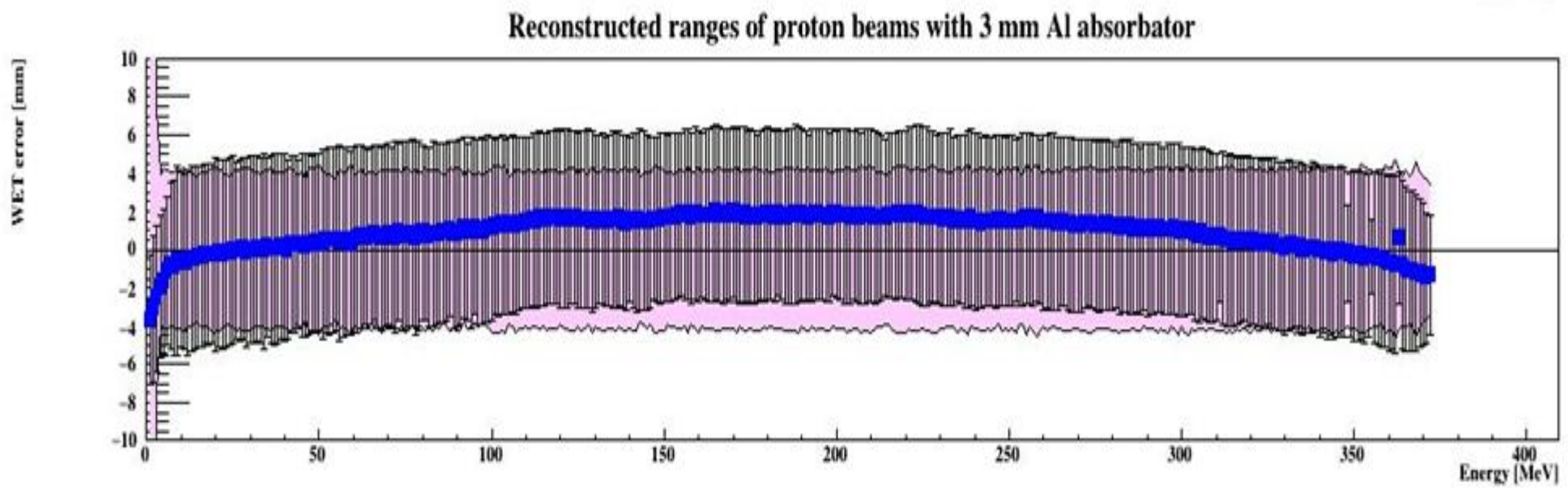
Full MC simulations

The «Gold standard» in this context

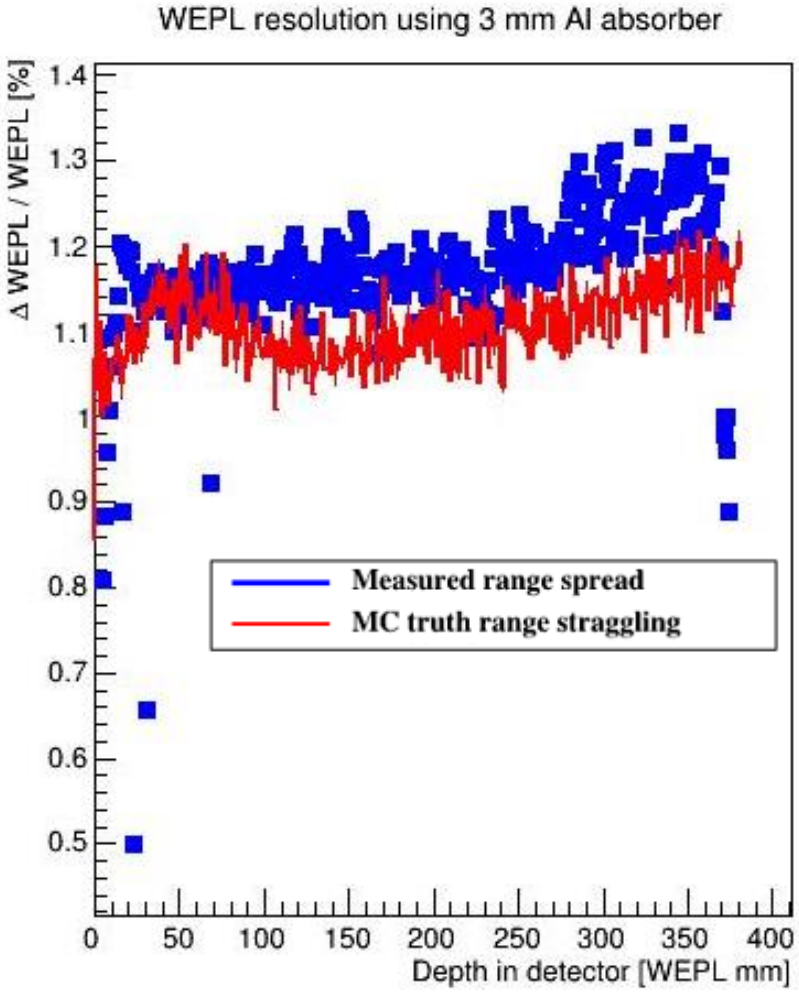
1. Range for each water phantom thickness and geometry configuration
2. Range straggling
3. Energy spread distal to DTC





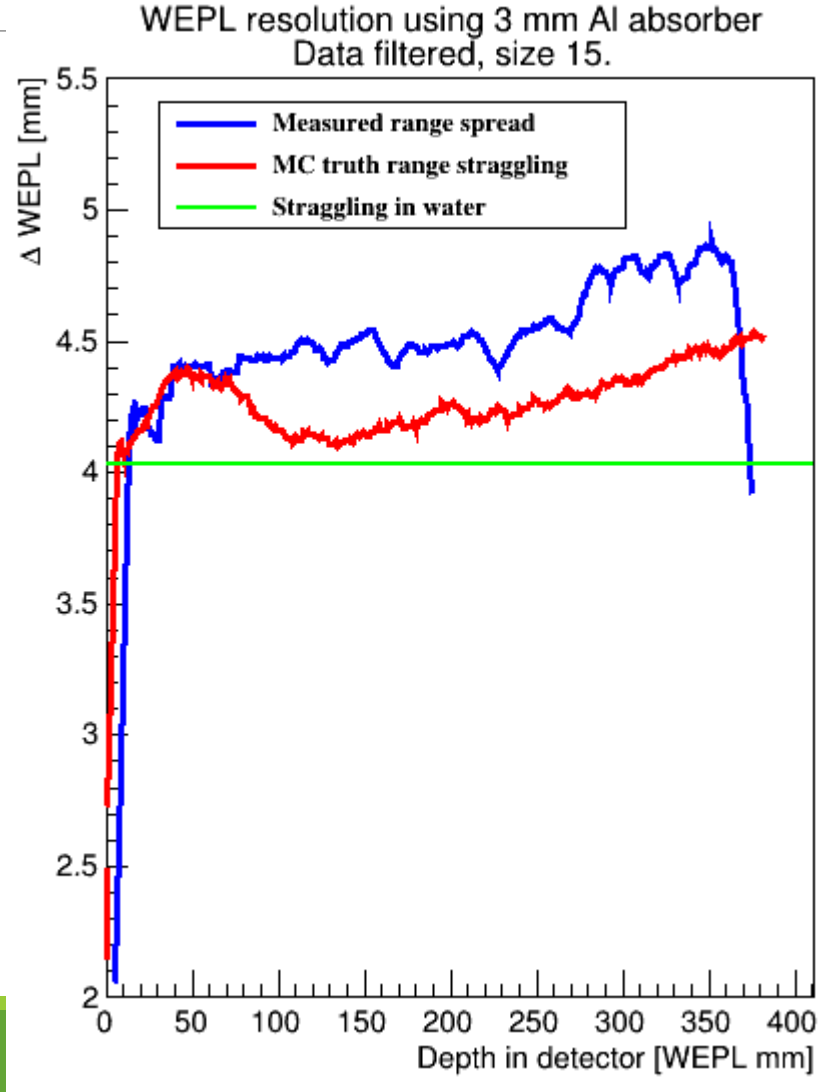

Reconstructed ranges of proton beams with 3 mm Al absorbator
WET error [mm]
10
8
6
4
2
0
-2
-4
-6
-8
-10
0
50
100
150
200
250
300
350
400
Energy [MeV]

Resolution determination



TOO NOISY!!

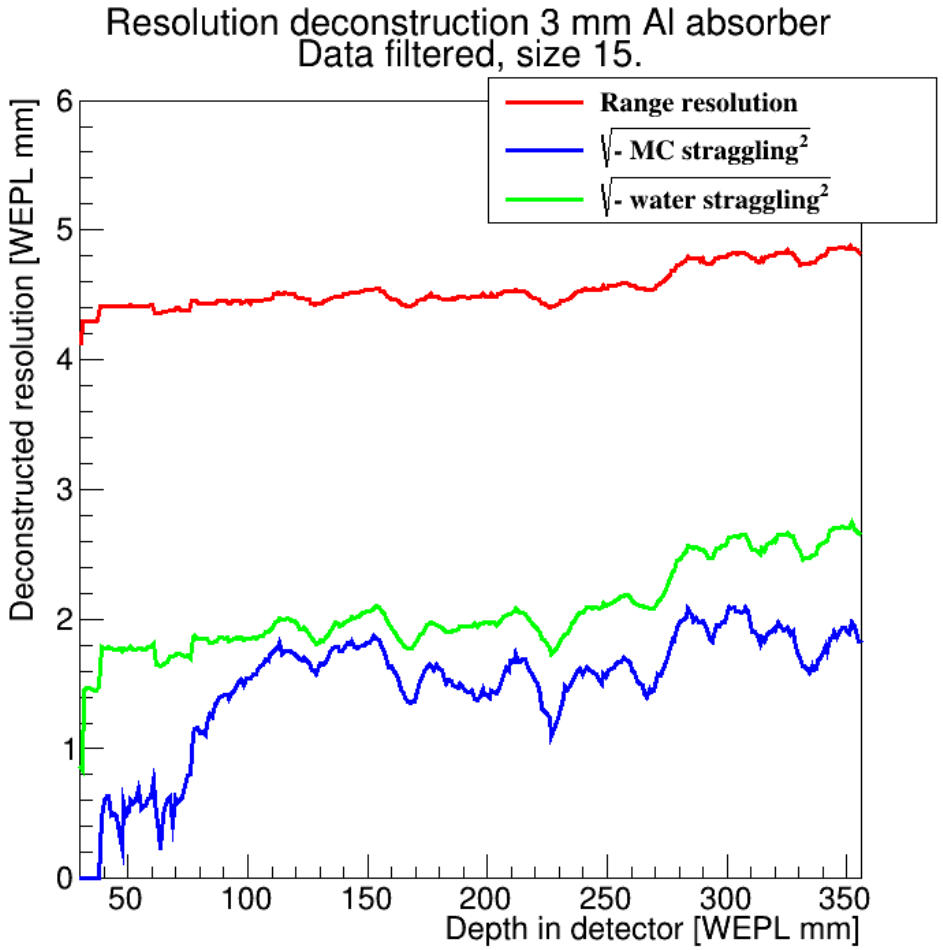
```
for (Int_t i=0; i<arraySize; i++) {
   value = 0;
   n = 0;

   for (Int_t j=i-filterSize/2; j<=i+filterSize/2; j++) {
      if (j<0 || j>=arraySize) {
         continue;
      }
      value += array[j];
      n++;
   }

   value /= n;
   tempArray[i] = value;
}
```



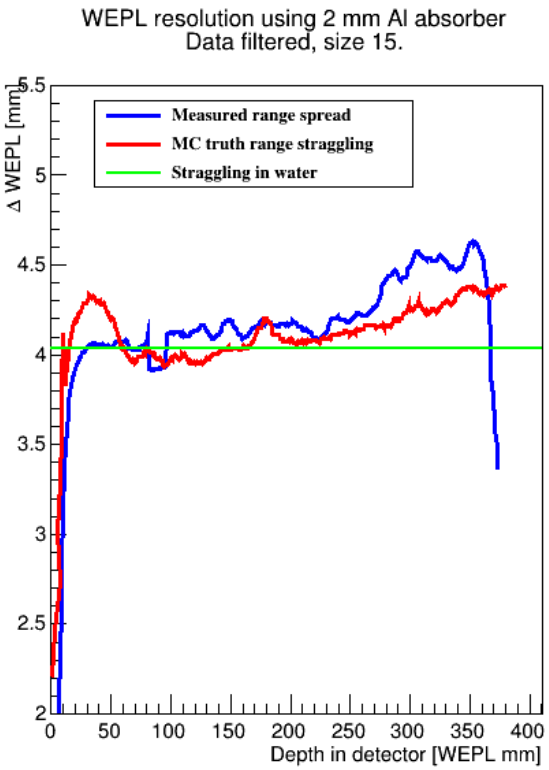
Resolution determination

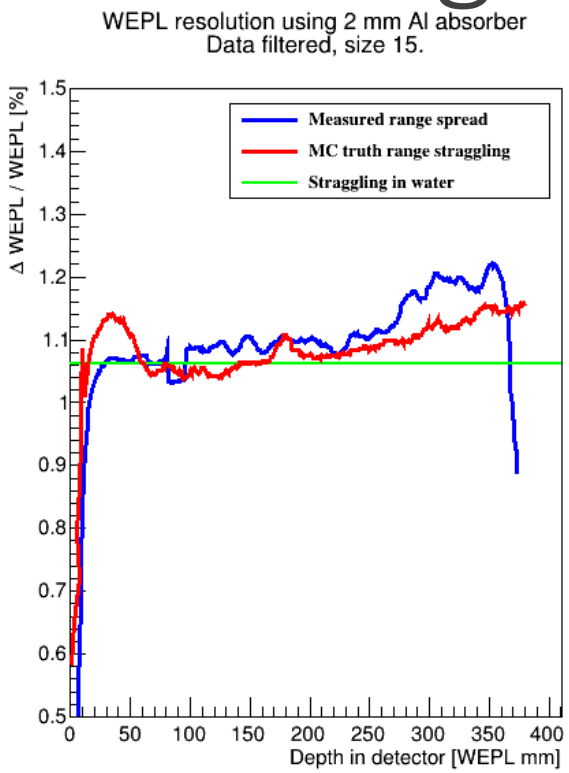
So… Lets do some calculations

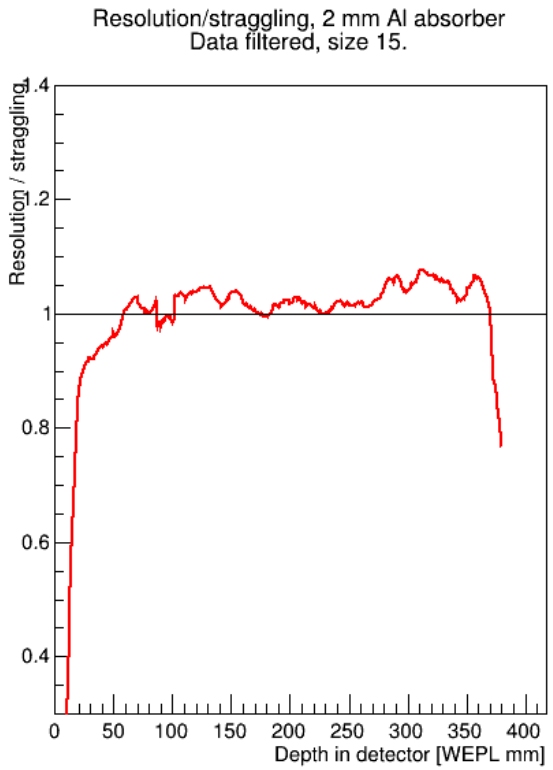
1. Resolution can be added quadratically
2. We can remove the different (known) components by removing also in quadrature
3. Let’s stay in the stable region of the detector (30 – 360 mm)

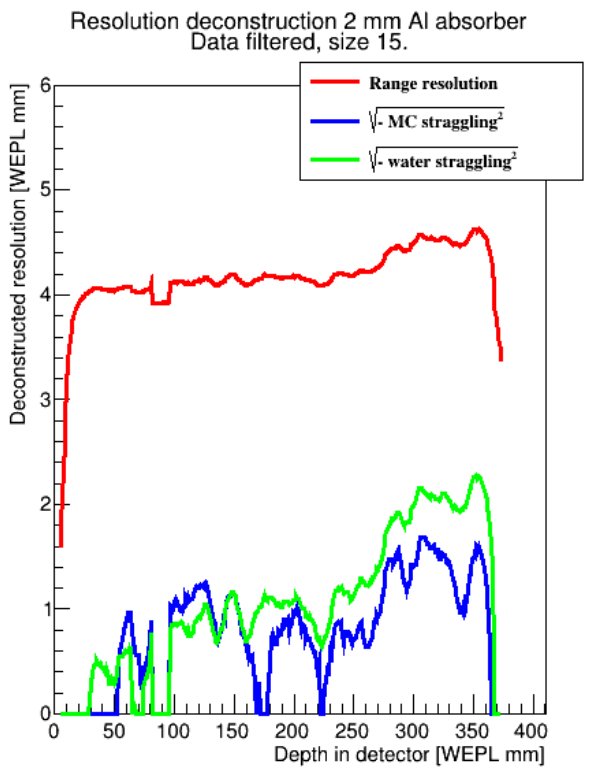


For the different geometries

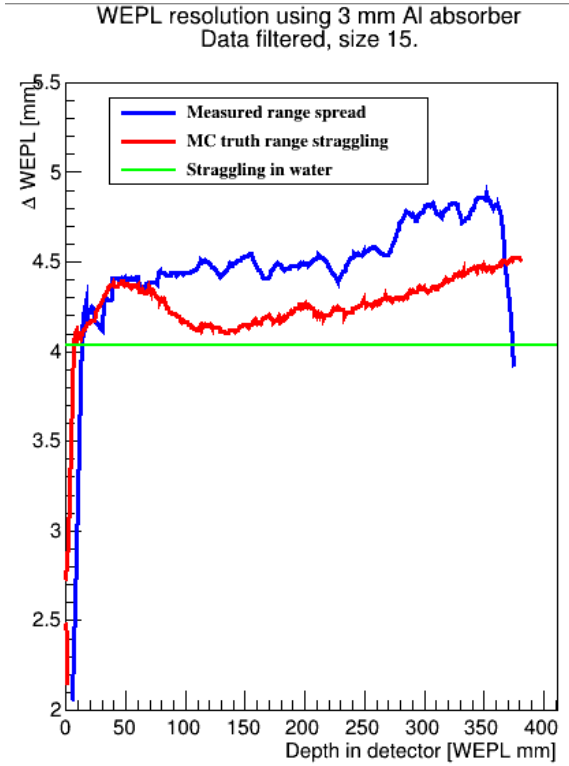


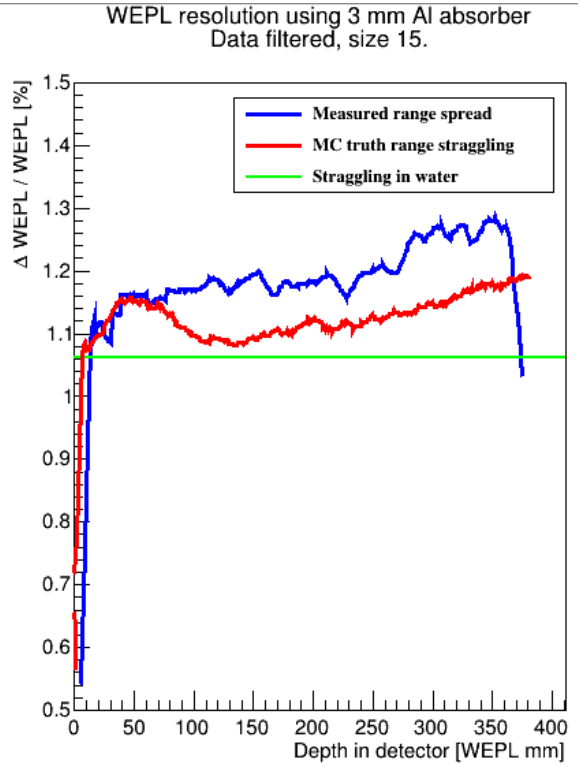


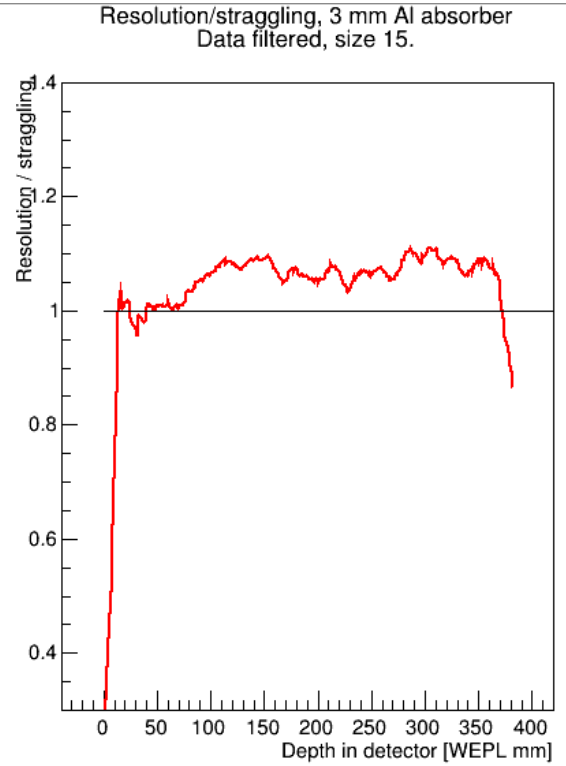


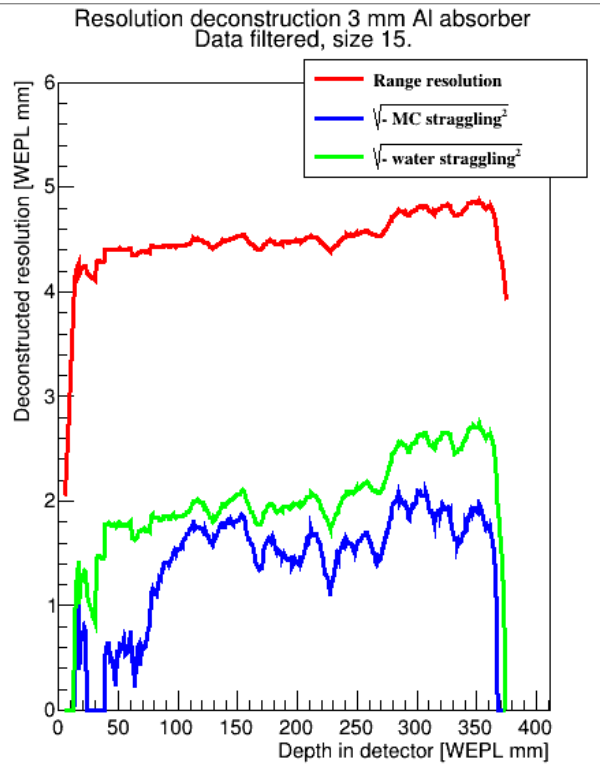


For the different geometries









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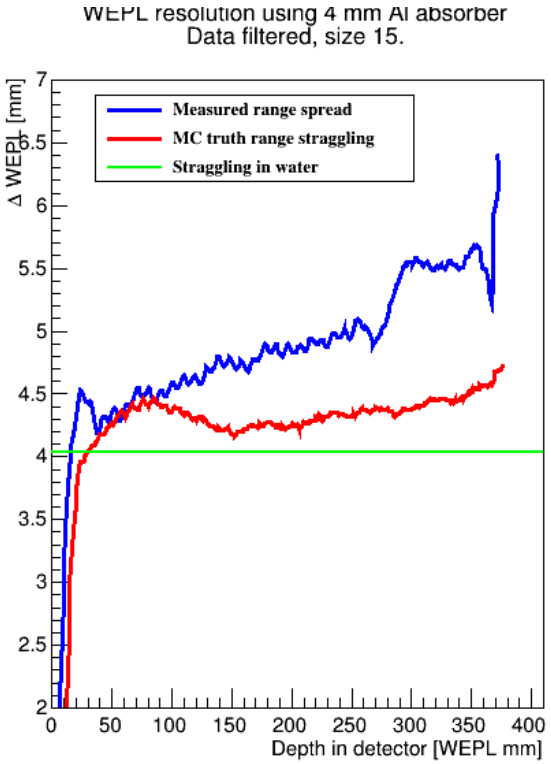

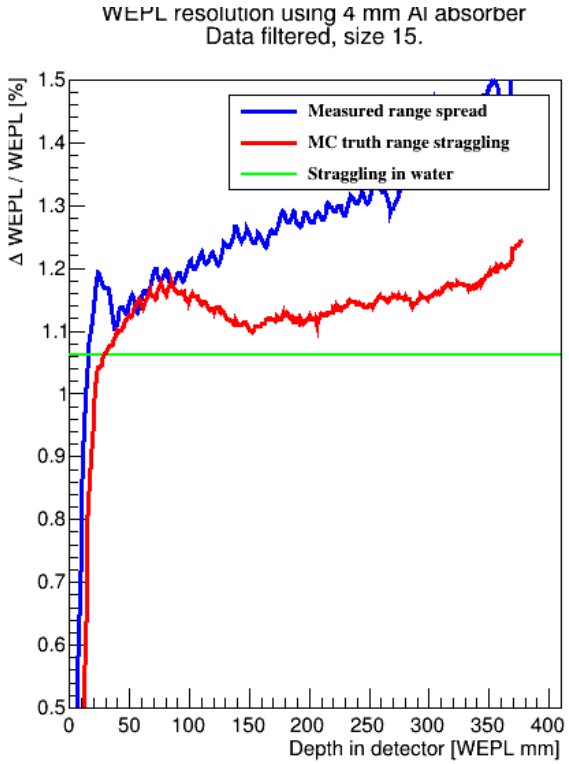

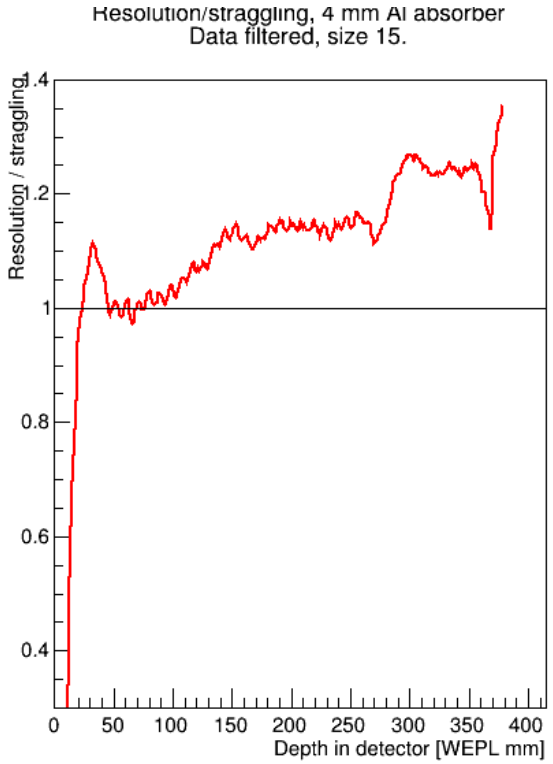

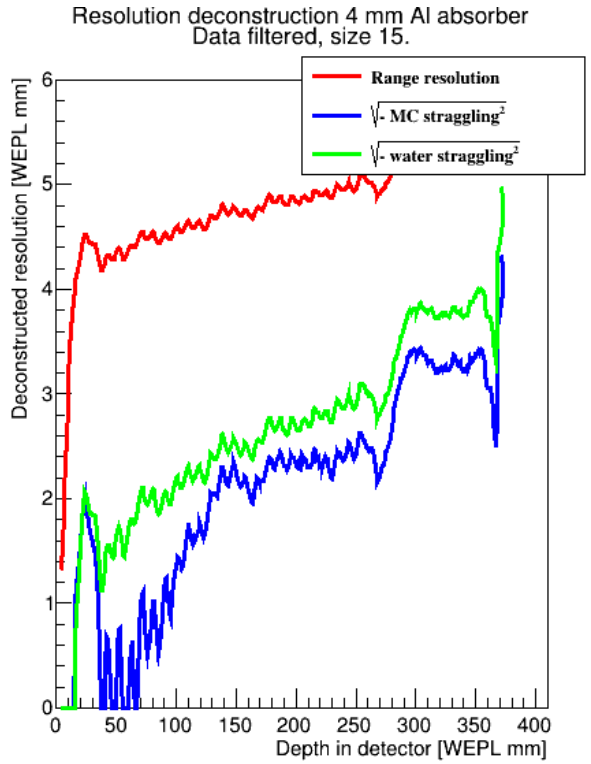

NOTE: This time the DTC had too few layers, so the deepest results are not OK

Resolution determination

So… Lets do some calculations

Setup	**Average Resolution**	**Res. ⊖ MC strag.**	**Res. ⊖ H_2O strag.**
2 mm	4.20 mm (1.11%)	1.03 mm	0.76 mm
3 mm	4.55 mm (1.19%)	1.37 mm	1.98 mm
4 mm	4.89 mm (1.29%)	2.10 mm	2.67 mm
Loma Linda (@ 200 MeV)	4.1 mm (2.19%)?		3.00 mm (1.16%)?
FOCAL @ 188 MeV	9.6 mm (4%) !!		

Remember…

:ope. For the discretization uncertainty to be sub-dominant to range straggling, we would require $\Delta/\sqrt{12} < 3$ mm (Table 4).

The WEPL factor is approx. 2.18

At 2 mm: 4.4 / sqrt(12) = 1.27 ✓

At 3 mm: 6.54/sqrt(12) = 1.89 ✓

At 4 mm: 8.72/sqrt(12) = 2.51 ✓

At 5 mm: 10.9/sqrt(12) = 3.14 ✗

3 * sqrt(12) / 2.18 = 4.76

Poludniowski, G., Allinson, N.M., Evans, P.M., 2015. Proton radiography and tomography with application to proton therapy. The British Journal of Radiology 88, 20150134. doi:10.1259/bjr.20150134