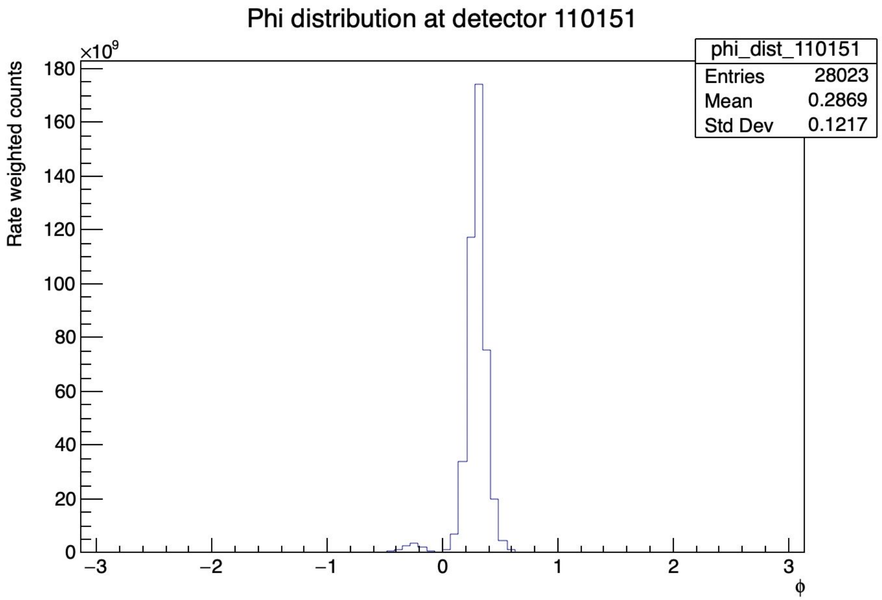
Phi distributions at main detector

James Shirk

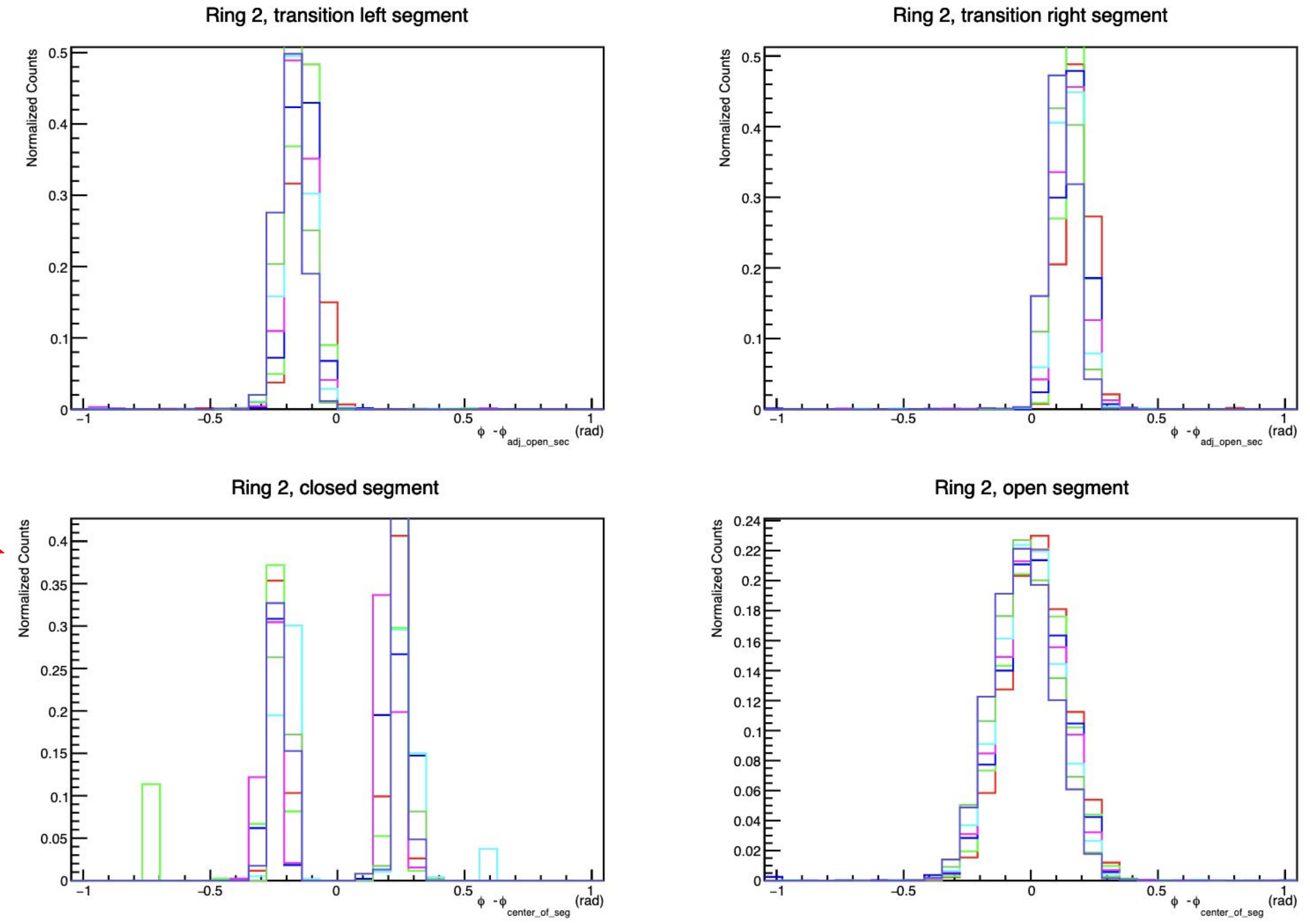
- φ is the azimuthal angle of the generated particles in either the ep elastic or moller generator
- Get the angle between the x and y momentum of the generated particle
- A_T goes primarily with sin(φ)



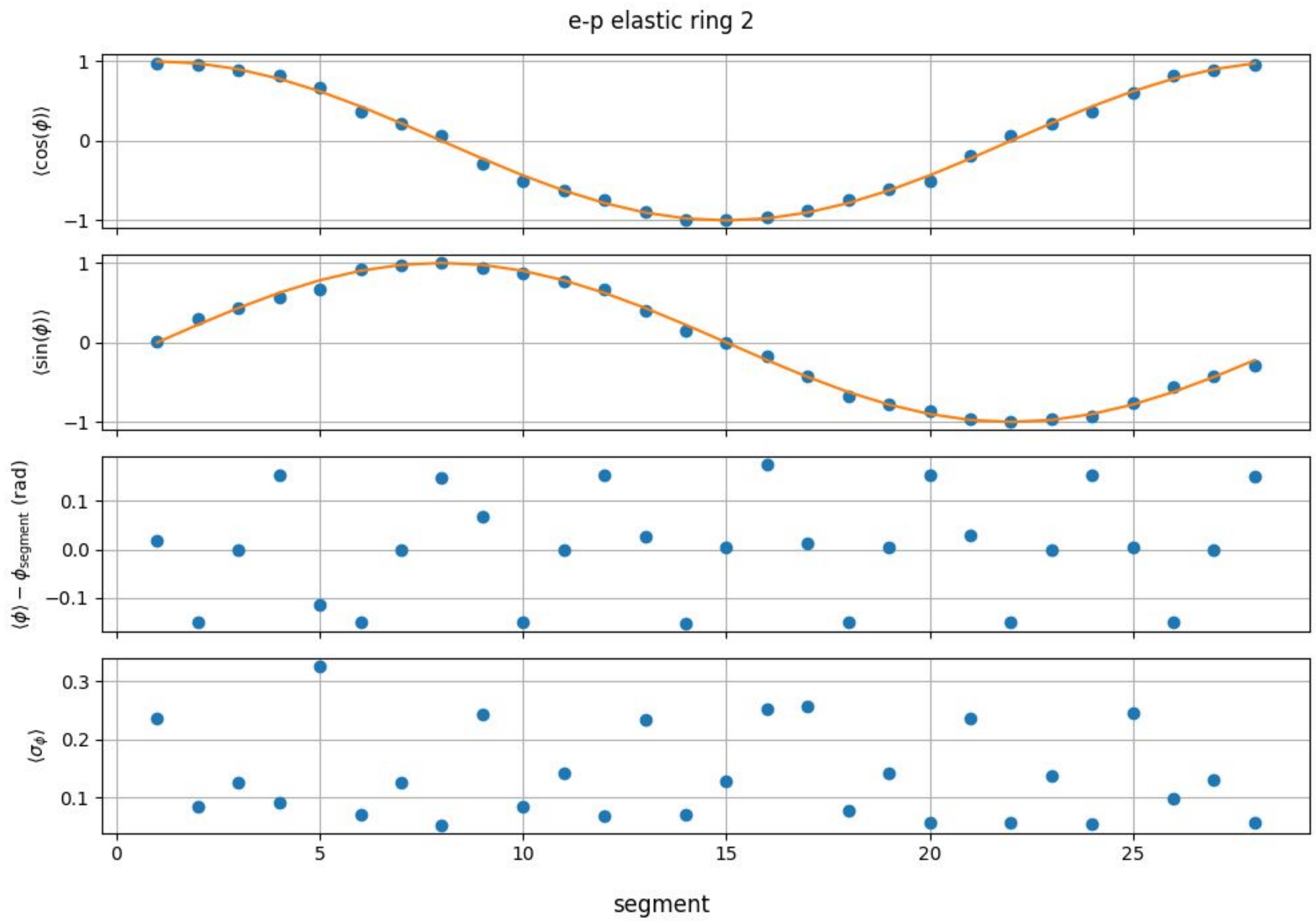
Ring 2 for eP elastic

Y axis is normalized now

See backups for legend

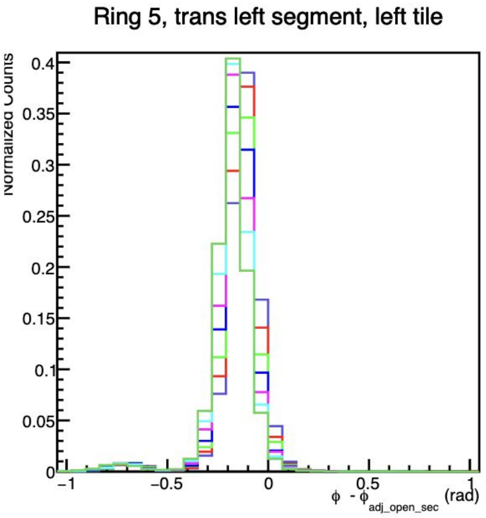


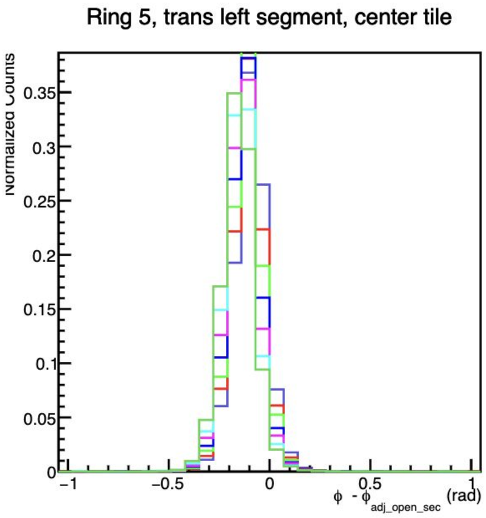
Summary for ring 2

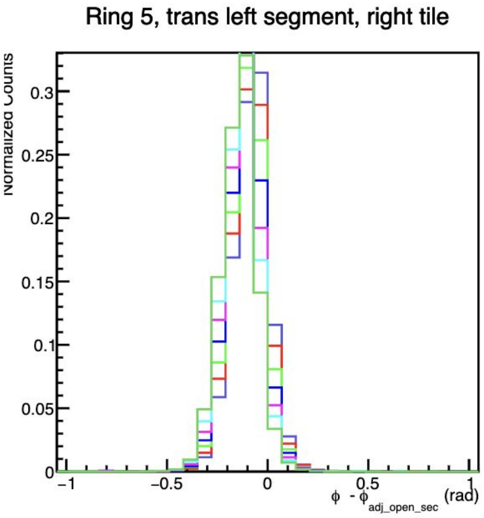


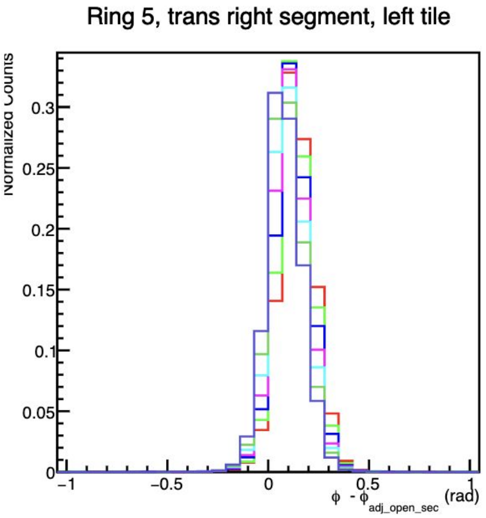
Orange line isn't fit, it's cos(2π/28 * (seg - 1))

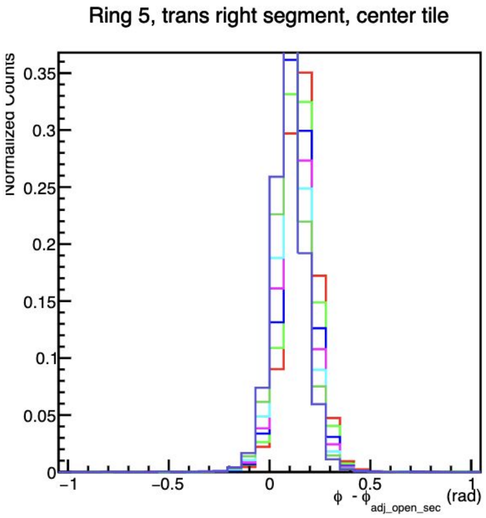
Ring 5 Moller transition tiles

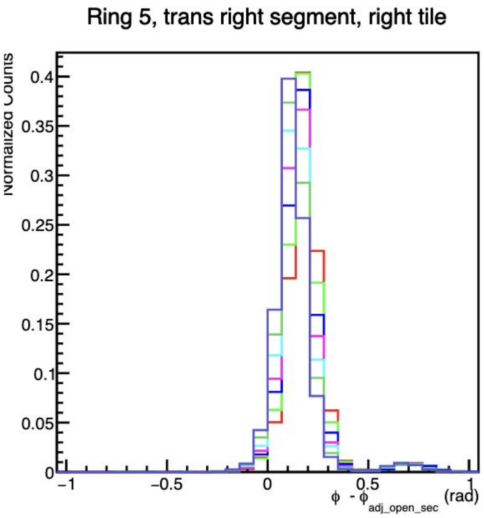




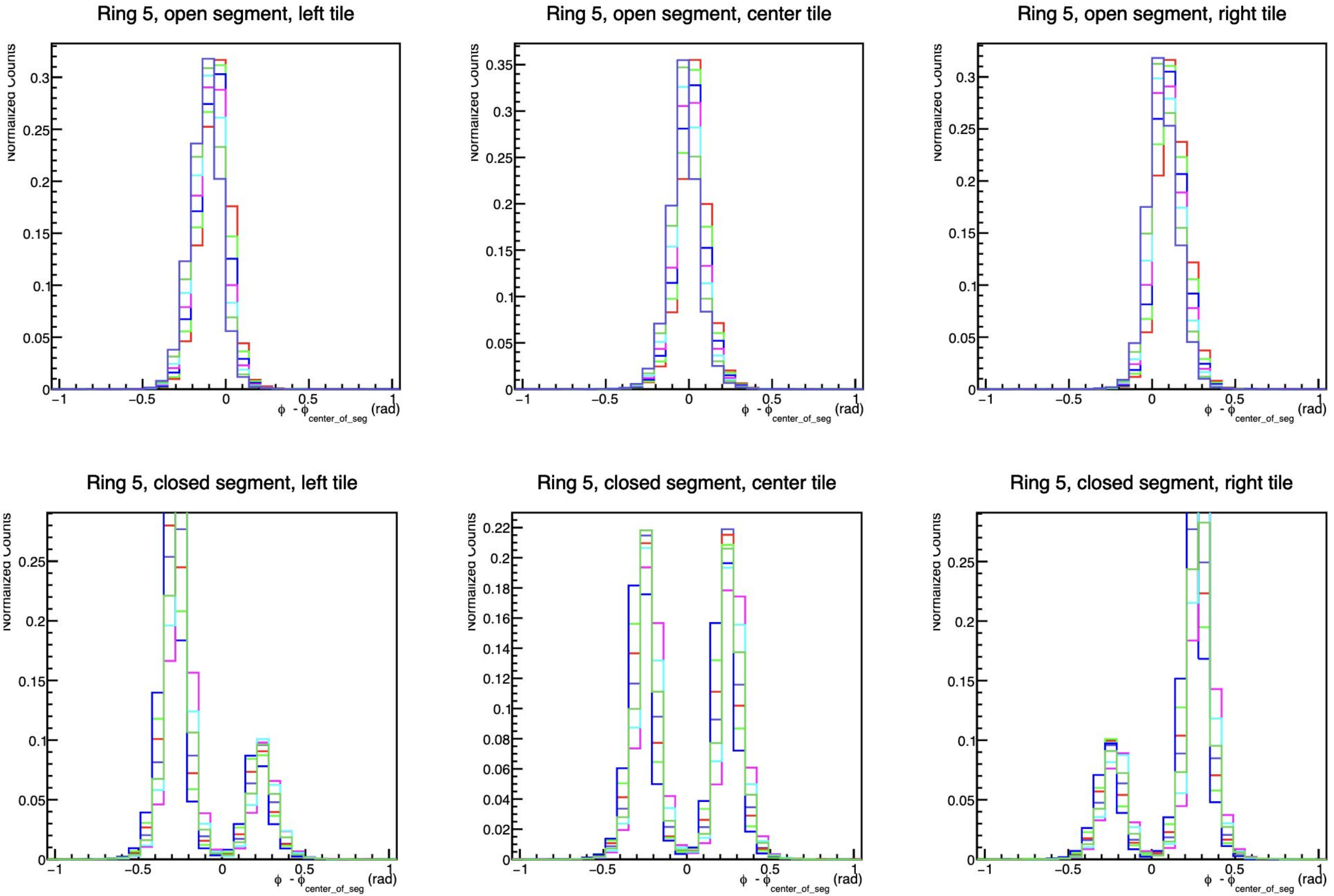




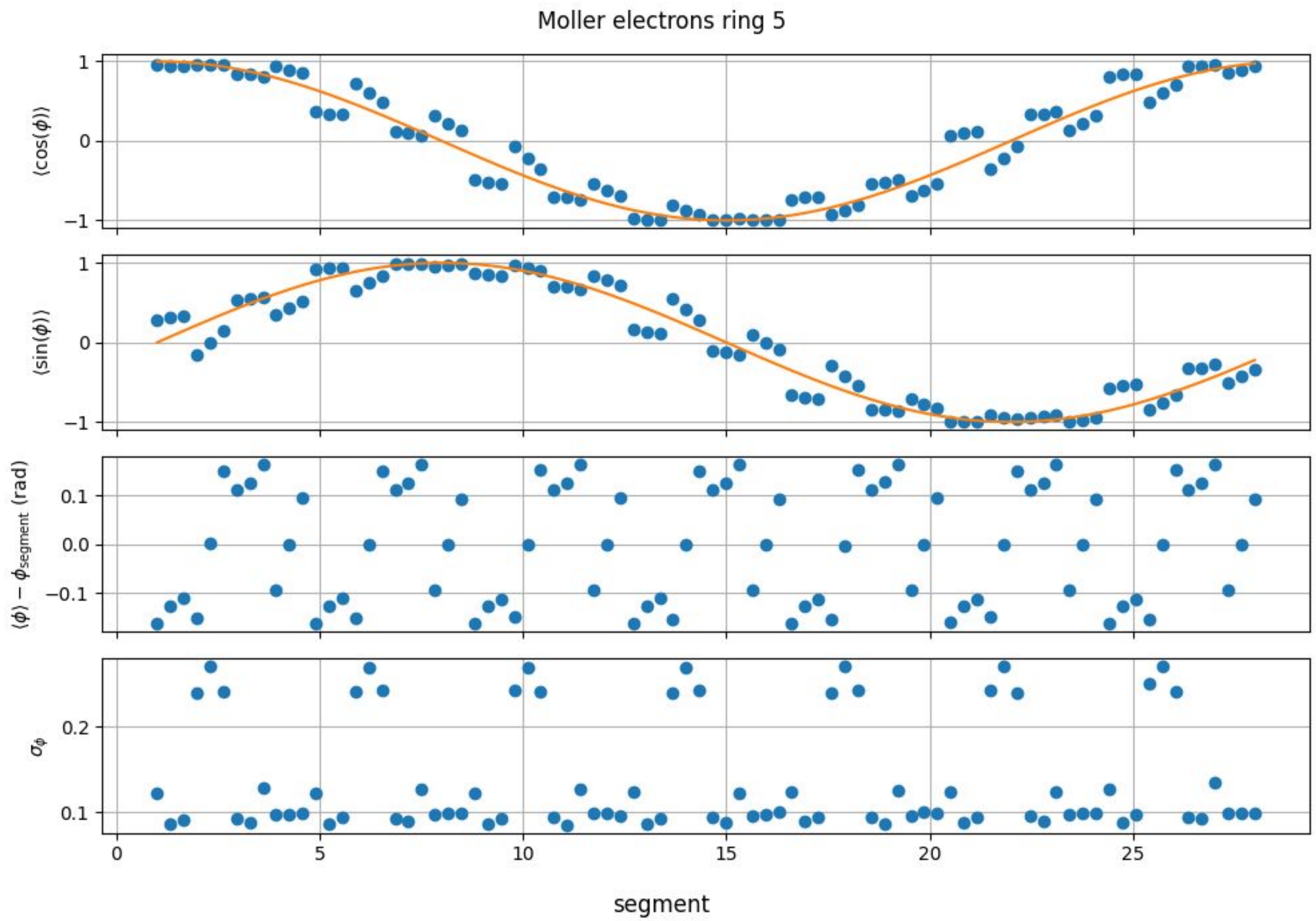




Ring 5
Moller
open/
closed
tiles

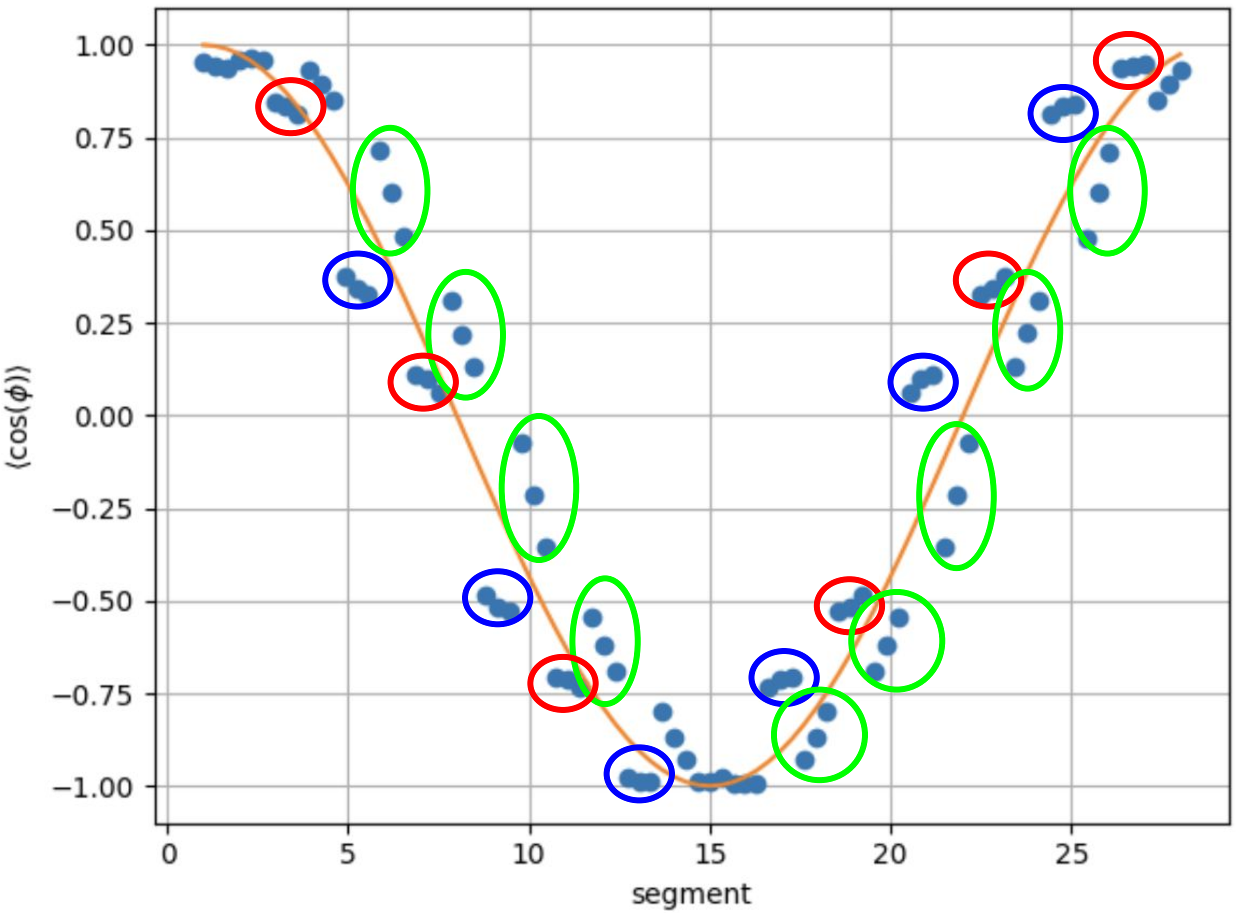


Summary for ring 5

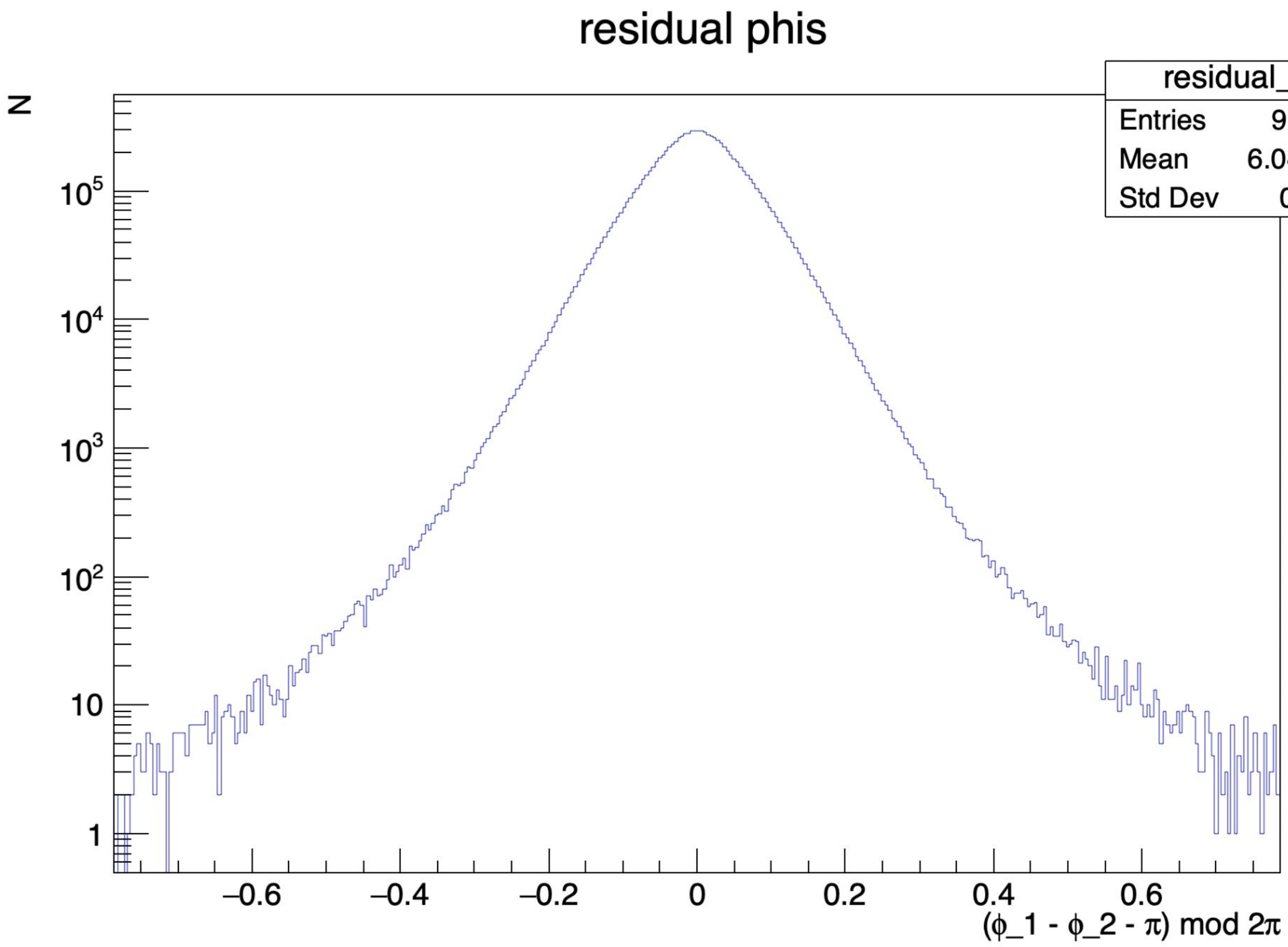


Orange line isn't fit, it's cos(2π/28 * (seg - 1))

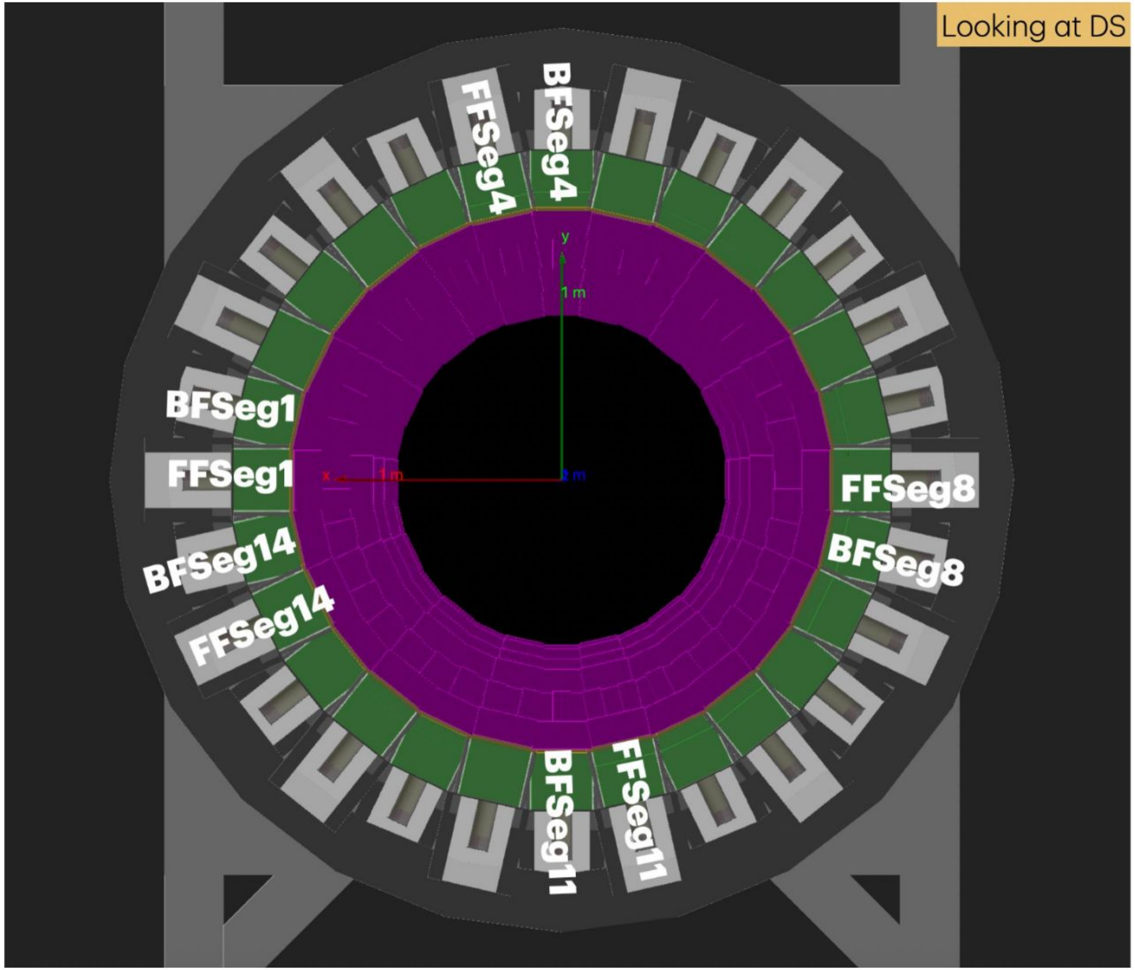
Open
Closed
Transition



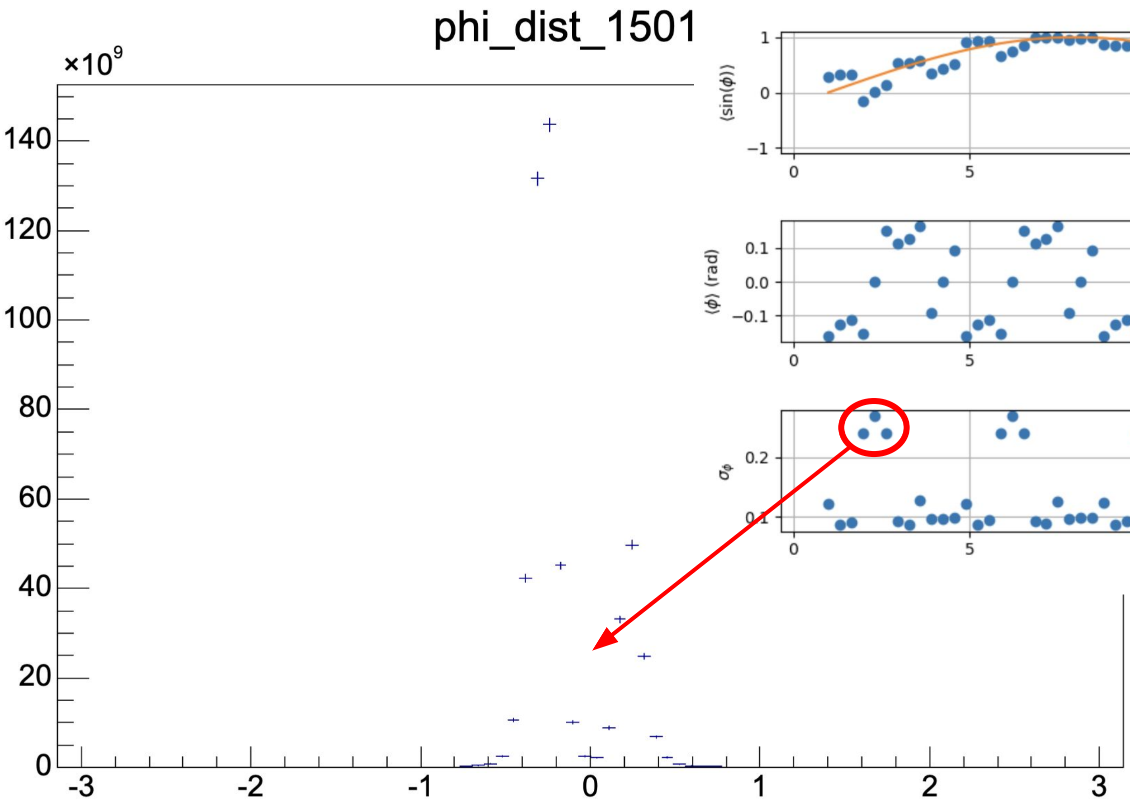
Other slides

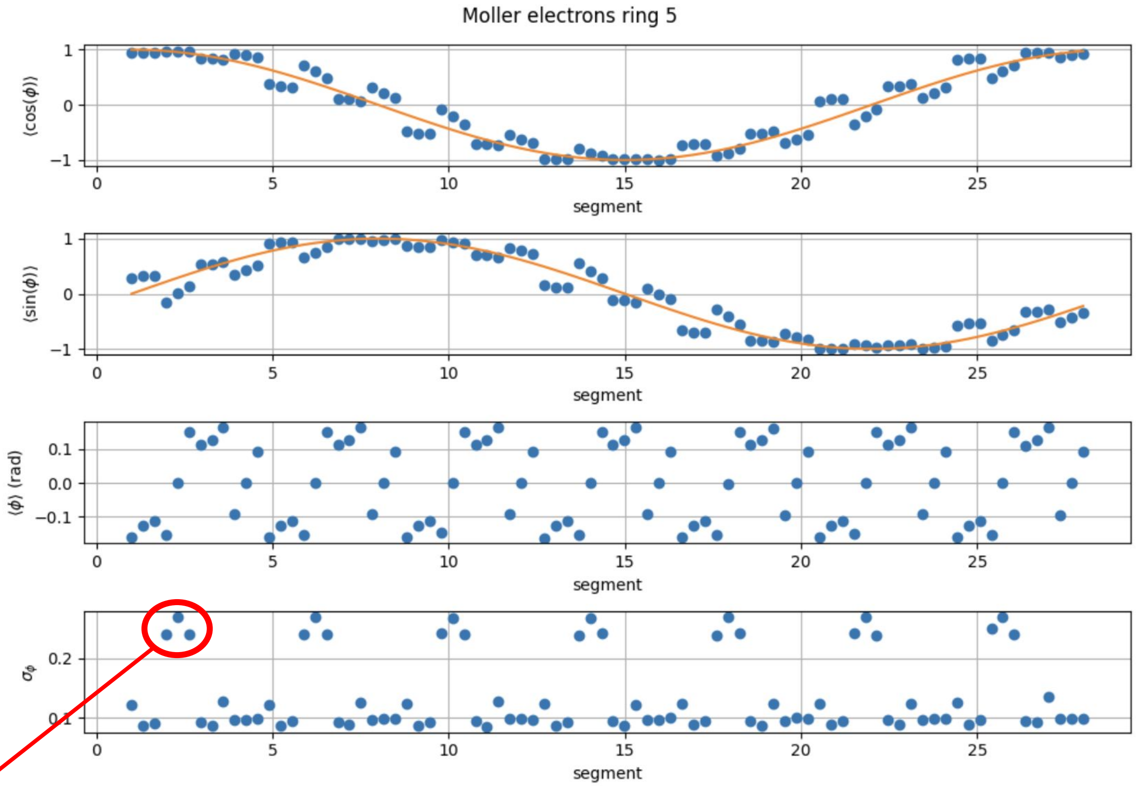


Particles are generated roughly back to back



detector type front flush = 0xFF = decimal 15 x 10000
detector type back flush = 0xBF = decimal 11 x 10000
then segment number x 100
then ring number x 10
and then for ring 5: 1 = left, 2 = center, 3 = right as you look in beam direction.
For example;
151152 is FF, segment 11, ring 5, center
110430 is BF, segment 4, ring 3 (the last 0 means there is no left, right, or center)





Distributions in the closed septants are bimodal
-> higher stddev

Colors

Color (root number)	**Septant**
Red (2)	1
Green (3)	2
Blue (4)	3
Magenta (6)	4
Cyan (7)	5
Muted green (8)	6
Periwinkle (9)	7

Event selection: Moller

```
for(int npart = 0; npart < part->size(); npart++){
    if (part->at(npart).trid == 1) phis[0] = TMath::ATan2(part->at(npart).py, part->at(npart).px);
    if (part->at(npart).trid == 2) phis[1] = TMath::ATan2(part->at(npart).py, part->at(npart).px);
}
```

Phis[0] always has trid==1 particle

```
for(int nhit = 0; nhit < hit->size(); nhit++){
    // loop over the main detectors by detector id
    if(hit->at(nhit).mtrid == 0 && TMath::Abs(hit->at(nhit).pid) == 11){
        for(int ndet = 0; ndet < n_dets; ndet++){
            if(hit->at(nhit).det == main_det_ids[ndet]){
                if(hit->at(nhit).trid == 1) phi_dist_moller[ndet]->Fill(phis[0], rate);
                if(hit->at(nhit).trid == 2) phi_dist_moller[ndet]->Fill(phis[1], rate);
            }
        }
    }
}
```

Event selection: eP elastic

I require part->size() == 1 so this only ever loops once

```
double phi;
for(int npart = 0; npart < part->size(); npart++){
    phi = TMath::ATan2(part->at(npart).py, part->at(npart).px);
}

for(int nhit = 0; nhit < hit->size(); nhit++){
    // loop over the main detectors by detector id
    if(hit->at(nhit).mtrid == 0 && TMath::Abs(hit->at(nhit).pid) == 11){
        for(int ndet = 0; ndet < n_dets; ndet++){
            if(hit->at(nhit).det == main_det_ids[ndet] && (hit->at(nhit).trid == 1)){
                phi_dist_moller[ndet]->Fill(phi, rate);
            }
        }
    }
}
```

$$m_1 = \frac{1}{N}\sum_{n=1}^{N} e^{i\phi_n}$$

"Sample moment"

$$\langle\phi\rangle = \mathrm{Arg}(m_1)$$

Mean of phi

$$\langle\cos(\phi)\rangle = \mathrm{Real}(m_1)$$

(and <sin(phi)> is the imaginary part)

In general you need to put weights in too, these are the unweighted formulae

$$
\begin{aligned}
m_1 = \frac{1}{N}\sum_{n=1}^{N} e^{i\phi_n} &= \frac{1}{N}\sum_{n=1}^{N} \cos\phi_n + i\sin\phi_n \\
&= \frac{1}{N}\left(\sum_{n=1}^{N}\cos\phi_n + \sum_{n=1}^{N} i\sin\phi_n\right) \\
&= \frac{1}{N}\left(\sum_{n=1}^{N}\cos\phi_n\right) + \frac{1}{N}\left(\sum_{n=1}^{N} i\sin\phi_n\right) \\
&= \langle\cos(\phi)\rangle + i\langle\sin(\phi)\rangle
\end{aligned}
$$