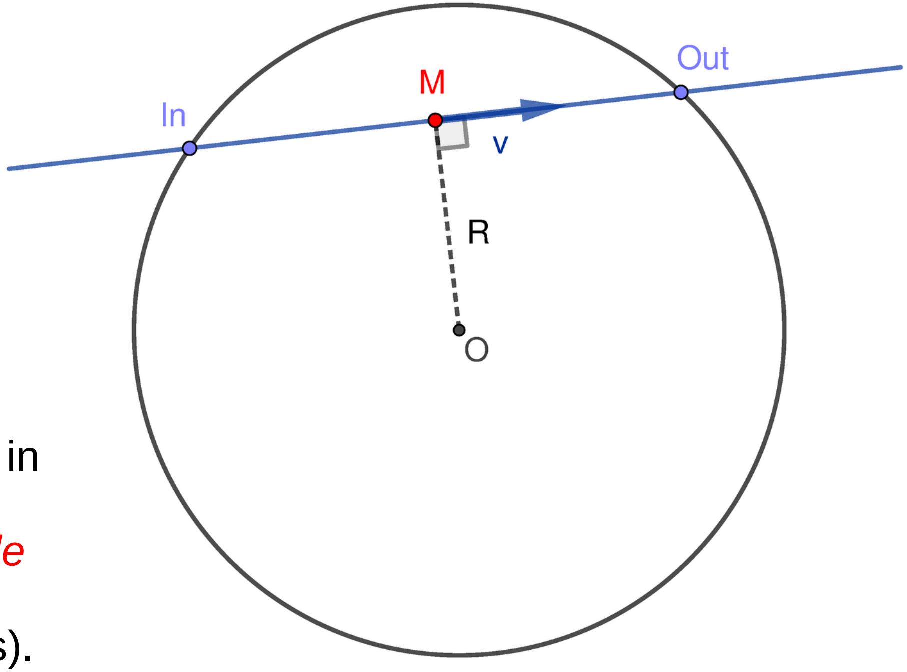
About drift radius calculation in SpdRoot

Ruslan Akhunzyanov

JINR

Spd Weekly Meeting
September 19, 2023

Drift radius calculation in SpdRoot



Currently, drift radius for the hit in the straw tube is calculated as the distance between the *middle* of the track segment inside the tube and the wire (the tube axis).

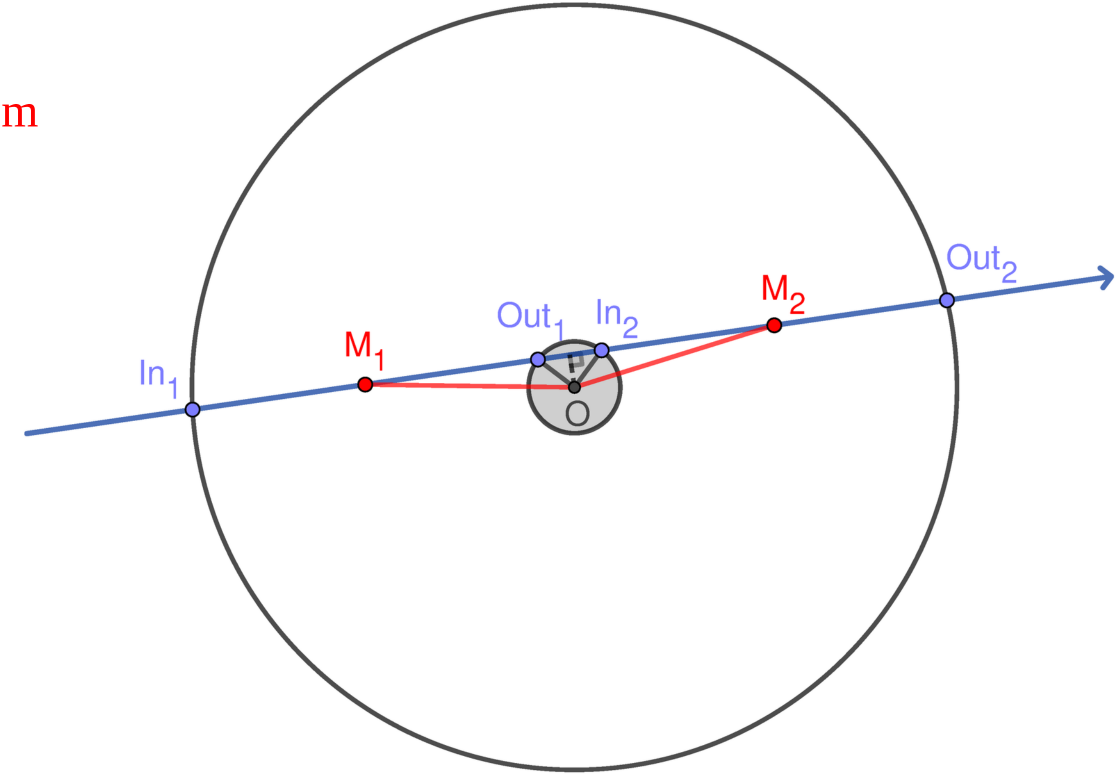
This works OK for the standard case, but not for more tricky cases ...

```
Double_t SpdMCStrawHit1D::GetPointRdrift() const
{
   TVector3 WireDirection = GetWireDirection();
   TVector3 r = (fMCPoint-fWirePoint1).Cross(WireDirection);
   return r.Mag();
}
```

Particle passes through wire

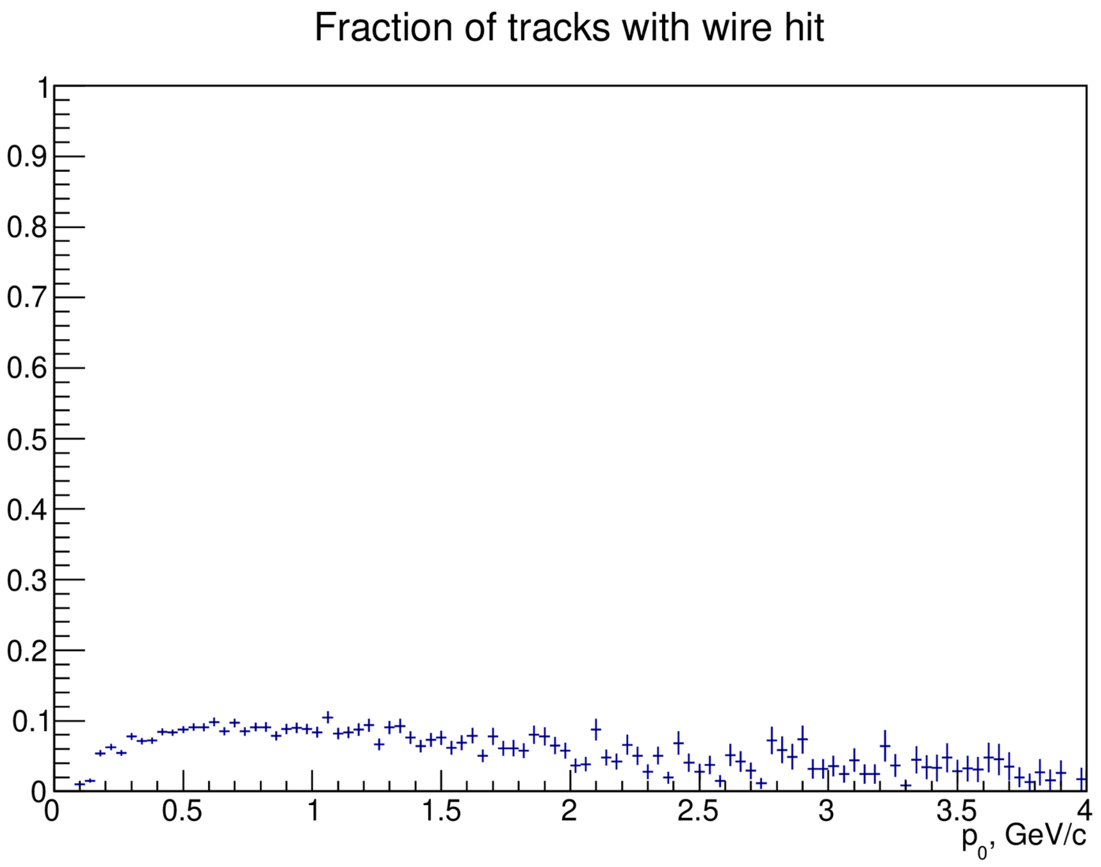
$$\text{calculated } R \approx \frac{r_{tube}}{2} = 0.25\,\text{cm}$$

$$\text{real } R \approx r_{wire} = 15\,\mu\text{m}$$



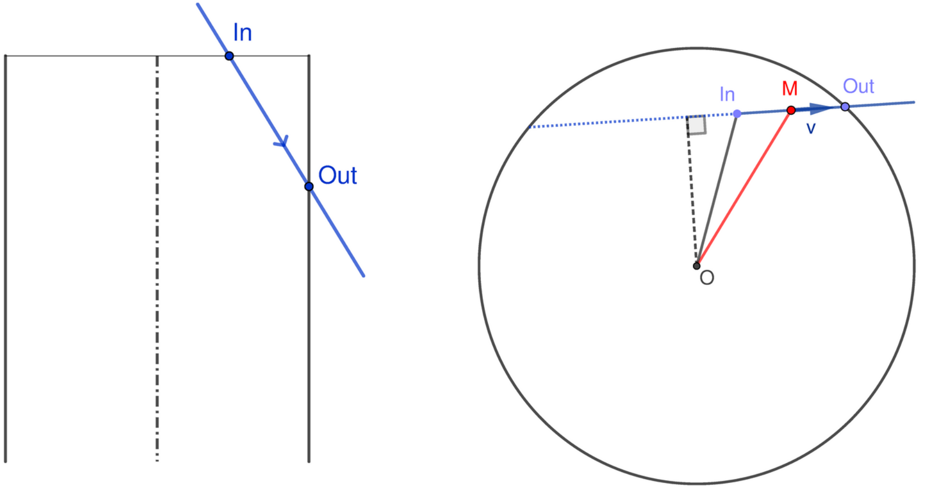
(the wire is shown much exaggerated)

Particle passes through wire

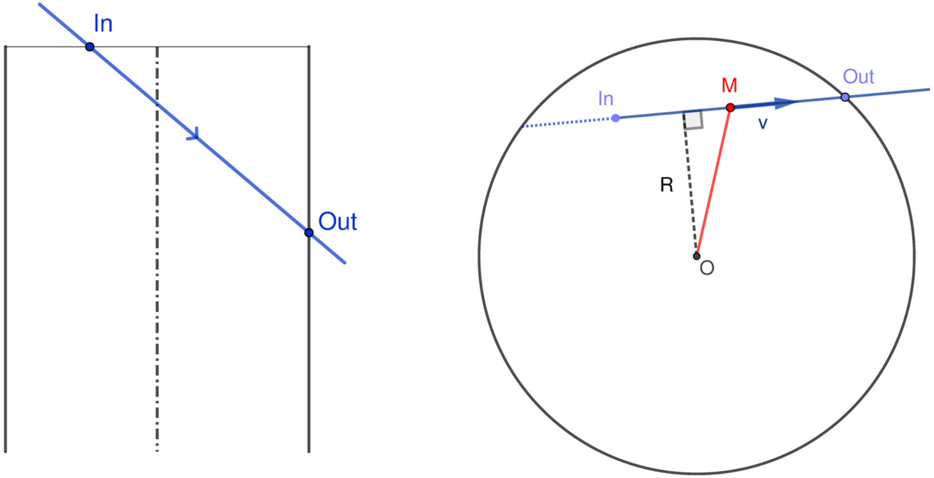


(minimum bias sample, 10k events)

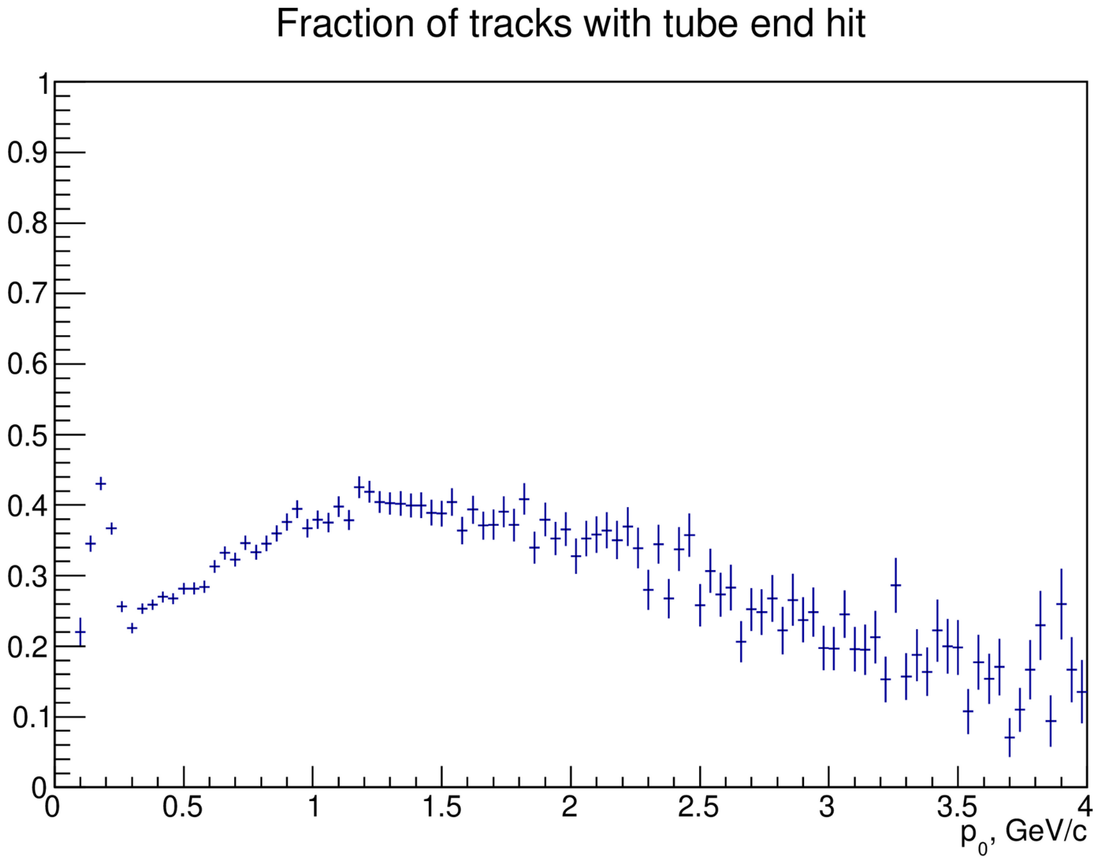
Particles enters (or exits) through the end of the tube



or

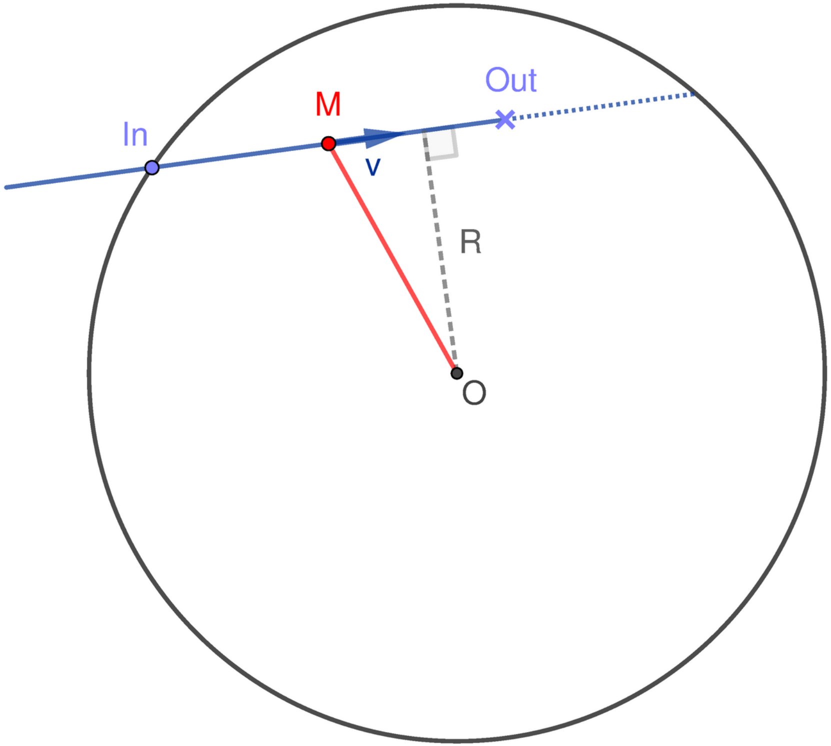


Particles enters (or exits) through the end of the tube

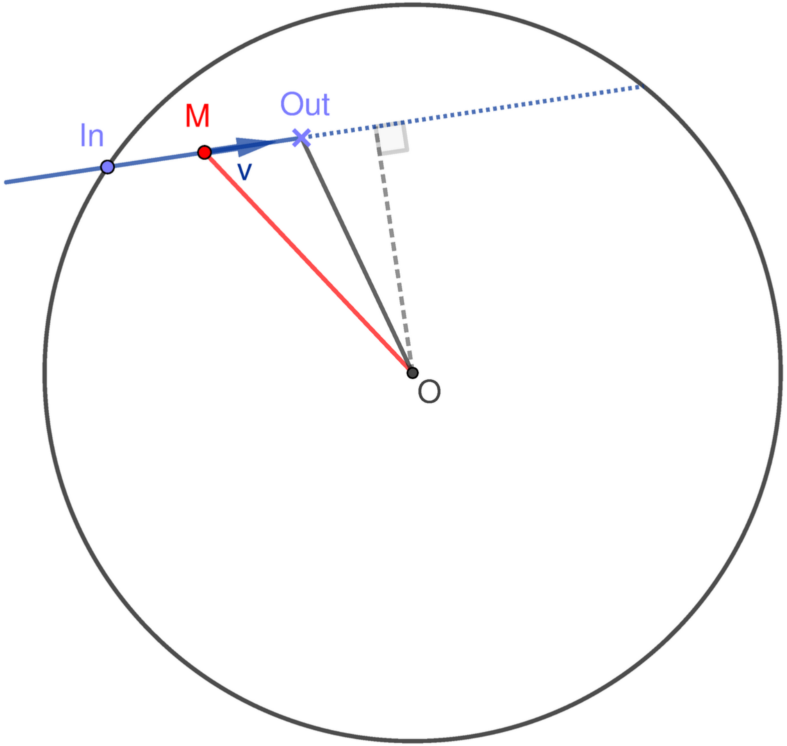


(minimum bias sample, 10k events)

Particles stops inside the tube

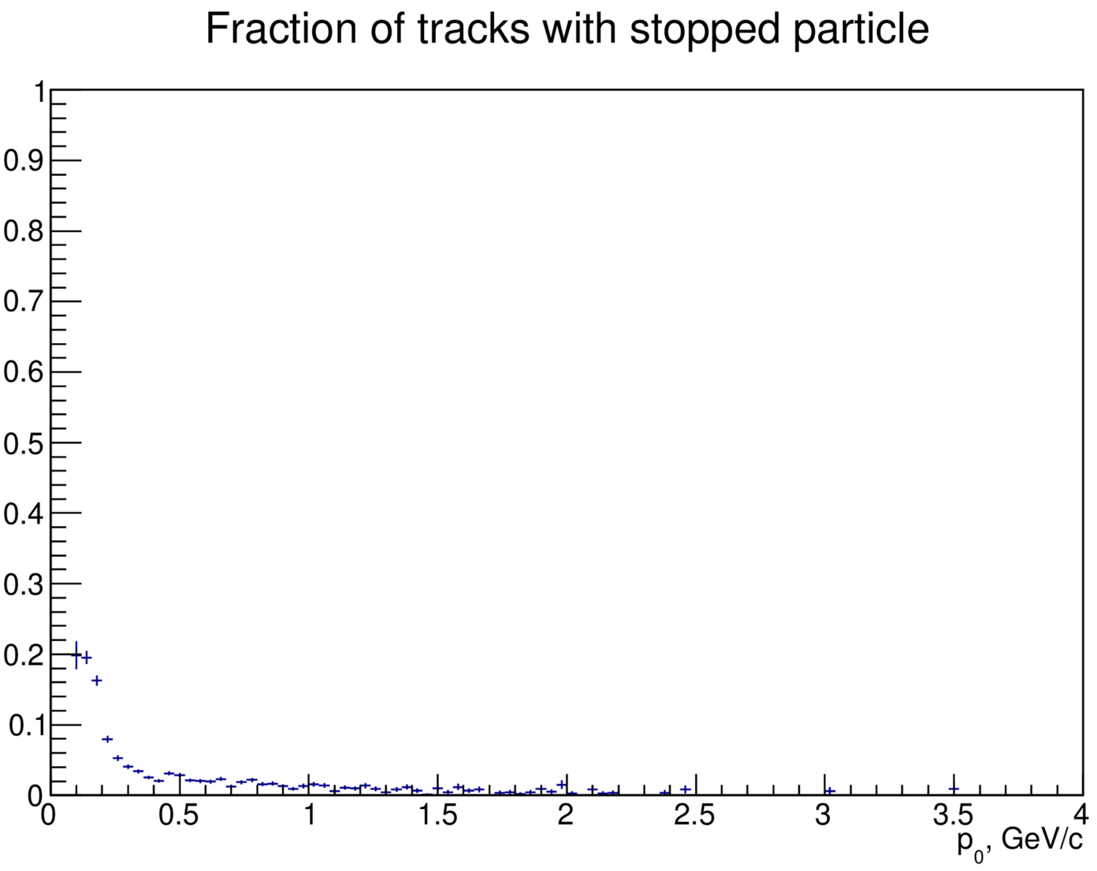


or



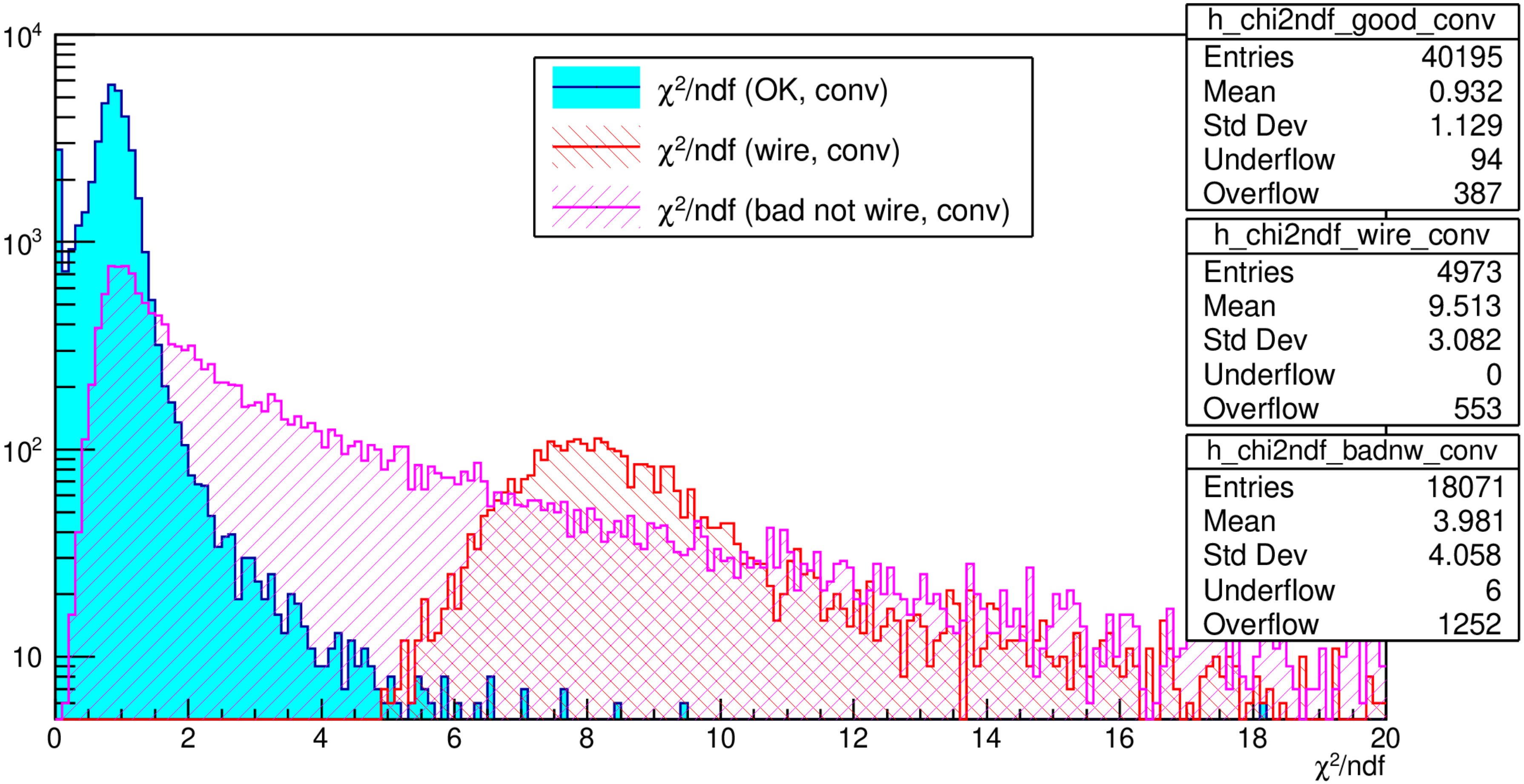
(this happens always in the **last** hit of the track; usually for small momenta (p < 0.3 GeV/c))

Particles stops inside the tube



(minimum bias sample, 10k events)

χ^2/ndf for tracks



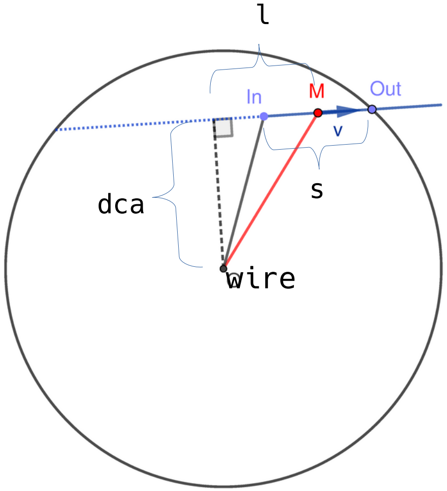
h_chi2ndf_good_conv	
Entries	40195
Mean	0.932
Std Dev	1.129
Underflow	94
Overflow	387

h_chi2ndf_wire_conv	
Entries	4973
Mean	9.513
Std Dev	3.082
Underflow	0
Overflow	553

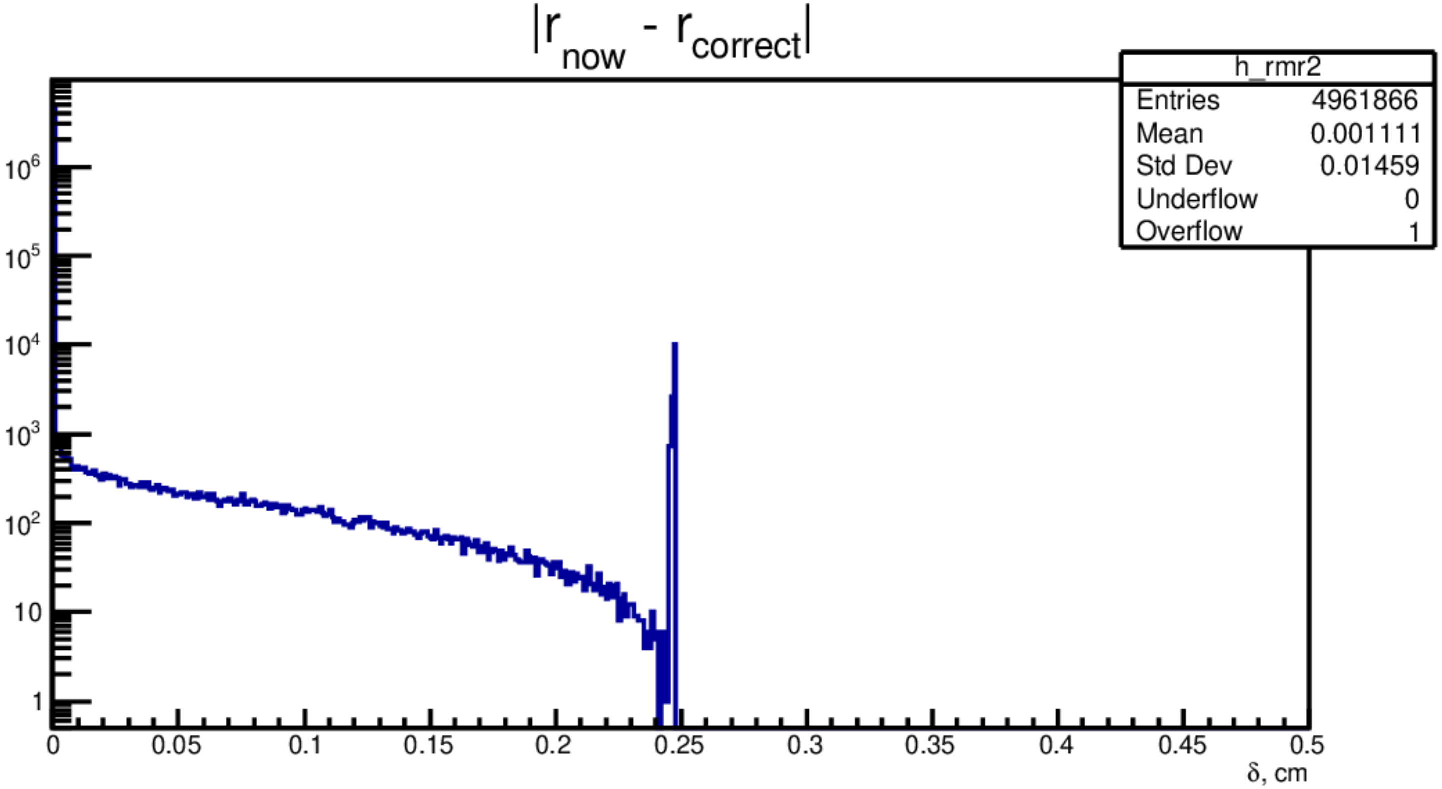
h_chi2ndf_badnw_conv	
Entries	18071
Mean	3.981
Std Dev	4.058
Underflow	6
Overflow	1252

Proposed code for GetPointRdrift( )

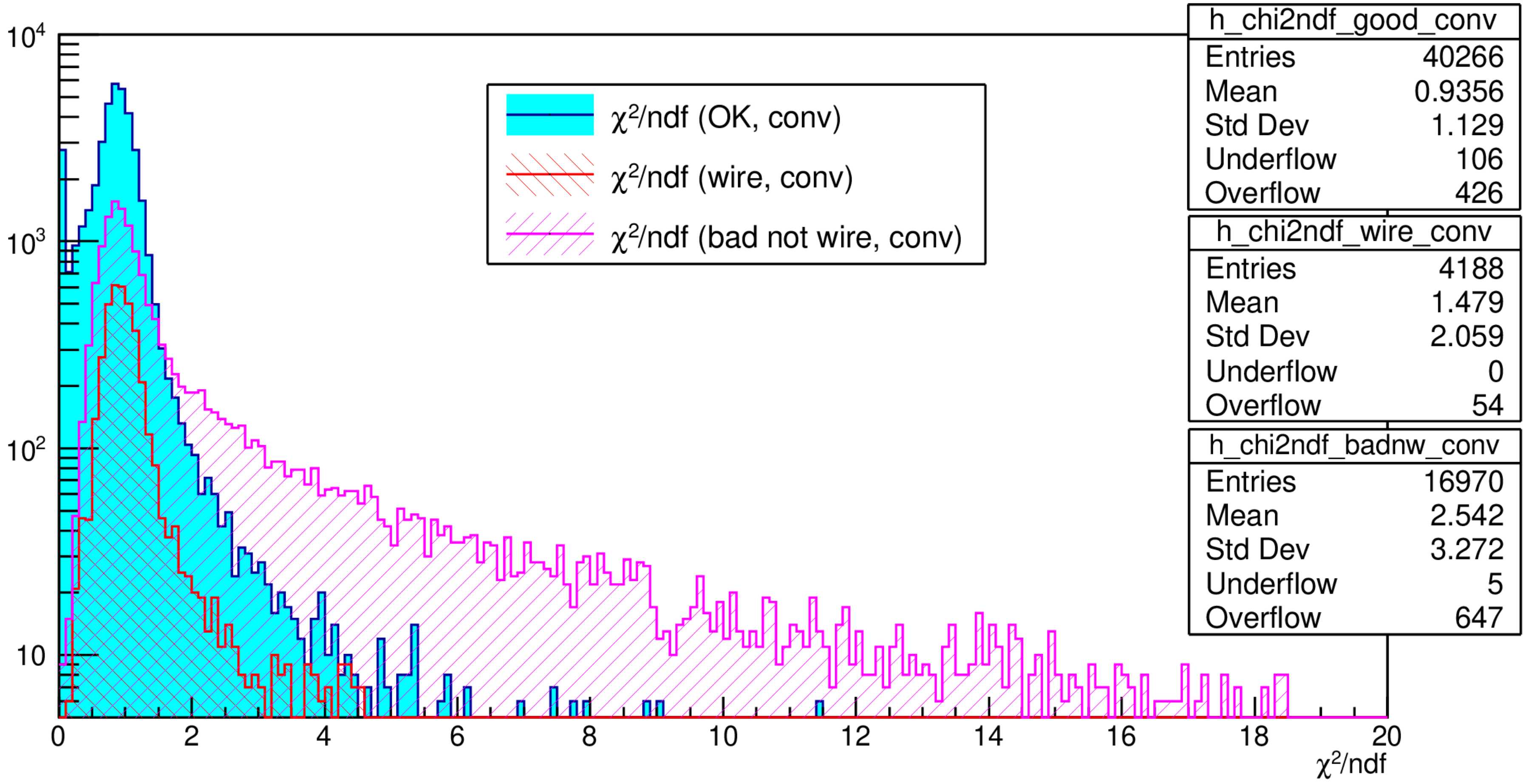
```
Double_t SpdMCStrawHit1D::GetPointRdrift( ) const
{
    TVector3 u = GetWireDirection( );
    TVector3 v = fDirInPoint.Unit( );
    TVector3 deltaPoint = fMCPoint - fWirePoint1;

    // distance along the track line between fMCPoint and the point of the closest approach
to the tube axis
    // in normal case lca == 0
    Double_t l = deltaPoint.Dot(u*u.Dot(v) - v) / (1. - pow(u.Dot(v),2));
    // segment length
    Double_t s = GetSegLen( );

    if (fabs(l) <= s/2.) {
        // if the point of the closest approach lies inside the track segment,
        // return distance of the closest approach between track line and tube axis
        Double_t dca = fabs(deltaPoint.Dot(u.Cross(v).Unit( )));
        return dca;
    }
    else {
        // can happen sometimes when the track enters or exits the tube through its end
        // or when the particle stops inside the tube
        // minimal distance to the tube axis is achieved at one of the track segment's ends
        TVector3 in  = fMCPoint - s/2.*v;
        TVector3 out = fMCPoint + s/2.*v;
        Double_t r_in  = (in  - fWirePoint1).Cross(u).Mag( );
        Double_t r_out = (out - fWirePoint1).Cross(u).Mag( );
        return std::min(r_in, r_out);
    }
}
```



Difference between Rdrift values calculated with current and proposed code



χ^2/ndf for tracks, with corrected R drift calculation

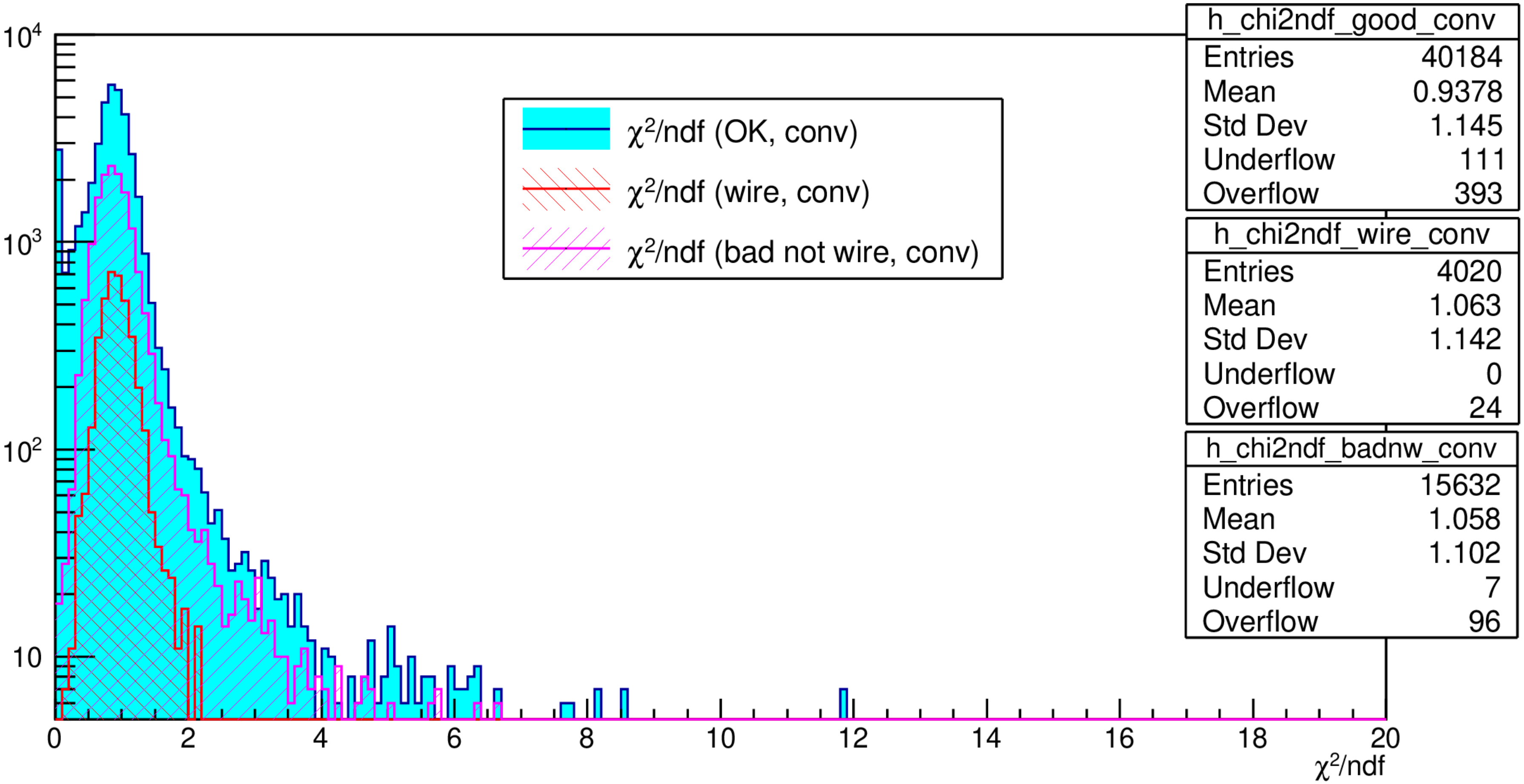


Conclusions

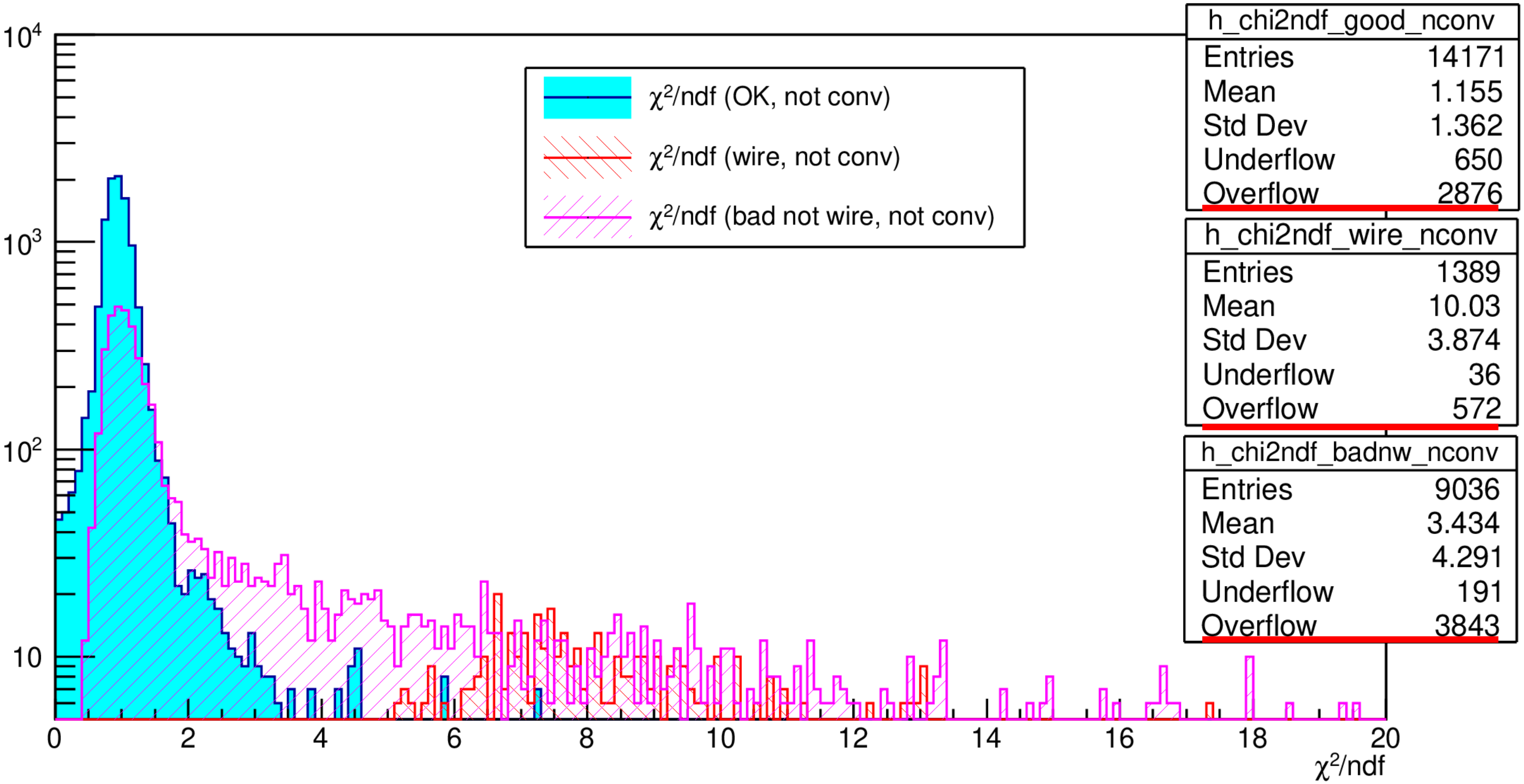
- I propose to change the code of the drift radius calculation in SpdRoot (see above).
- It gives the correct calculation of the drift radius in all cases.
- It eliminates the problem with large χ^2/ndf for tracks with hits in the wire.

backup slides

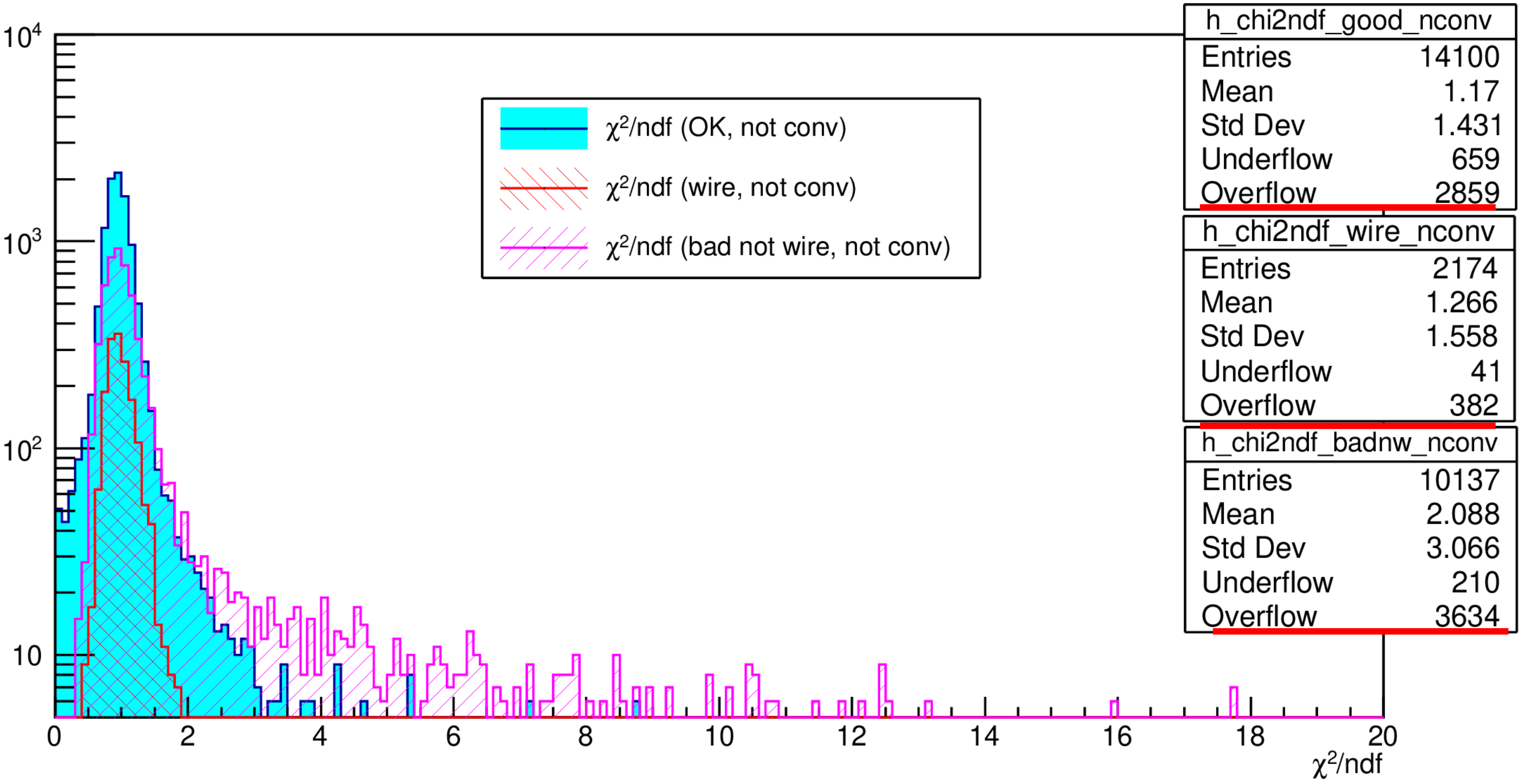
χ^2/ndf for tracks, with R = dca



χ^2/ndf for tracks (fit not converged)



χ^2/ndf for tracks (fit not converged), with corrected R drift calculation

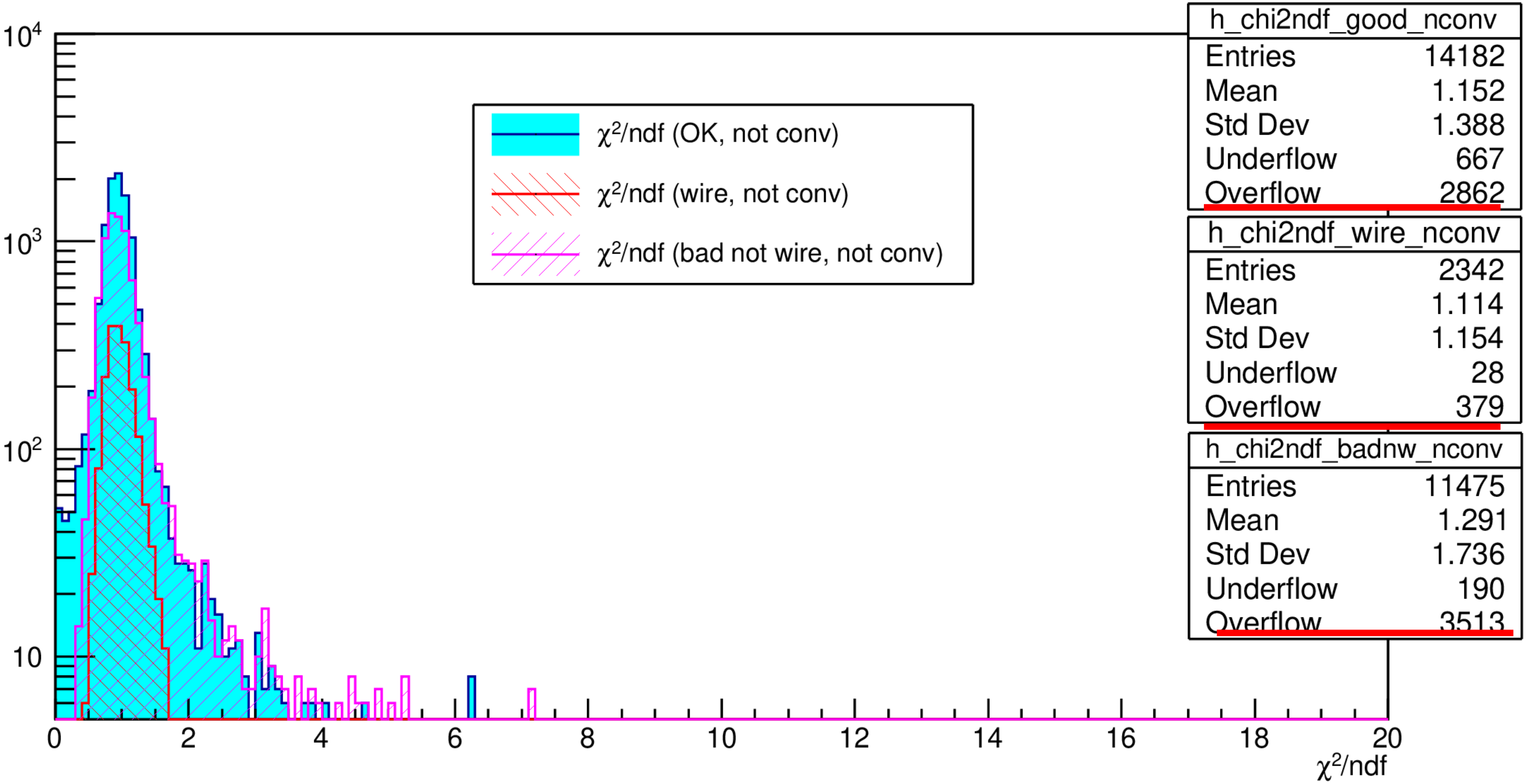


h_chi2ndf_good_nconv	
Entries	14100
Mean	1.17
Std Dev	1.431
Underflow	659
Overflow	2859

h_chi2ndf_wire_nconv	
Entries	2174
Mean	1.266
Std Dev	1.558
Underflow	41
Overflow	382

h_chi2ndf_badnw_nconv	
Entries	10137
Mean	2.088
Std Dev	3.066
Underflow	210
Overflow	3634

χ^2/ndf for tracks (fit not converged), with R = dca


h_chi2ndf_good_nconv
Entries 14182
Mean 1.152
Std Dev 1.388
Underflow 667
Overflow 2862
h_chi2ndf_wire_nconv
Entries 2342
Mean 1.114
Std Dev 1.154
Underflow 28
Overflow 379
h_chi2ndf_badnw_nconv
Entries 11475
Mean 1.291
Std Dev 1.736
Underflow 190
Overflow 3513
χ^2/ndf (OK, not conv)
χ^2/ndf (wire, not conv)
χ^2/ndf (bad not wire, not conv)
10^4
10^3
10^2
χ^2/ndf