Dependence of momentum resolution on straw tracker spatial resolution

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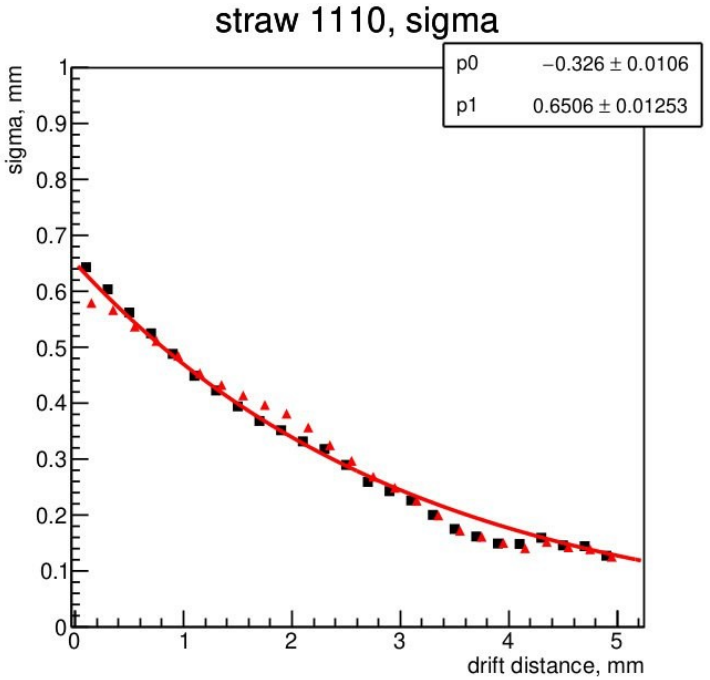
Spatial resolution of straw tracker σ_R

- Until recently (and still in the `master` branch), in SpdRoot σ_R was constant, with default value **150** μm.
- In this report I consider other options for σ_R:
  - $\sigma_R = f(R)$ — based on Artem Chukanov's talk at the last SPD Collaboration Meeting;
  - σ_R = const = 200, 250, 300, 350 μm.

σ_R as a function of R



$$\sigma_R(R) = 0.6506 \exp(-0.326\, R)$$

(here all values in mm)

Plot and parameterization
by Artem Chukanov.

Implementation of $\sigma_R(R)$ in SpdRoot

σ_R as a function *f(R)* of drift radius *R* has been implemented in SpdRoot: necessary changes have been applied to class `SpdTsMCHitProducer`.

Committed to the `development` branch on June 07, 2024.

Type of *f(R)* and its parameters may be changed in reco script by user via methods:

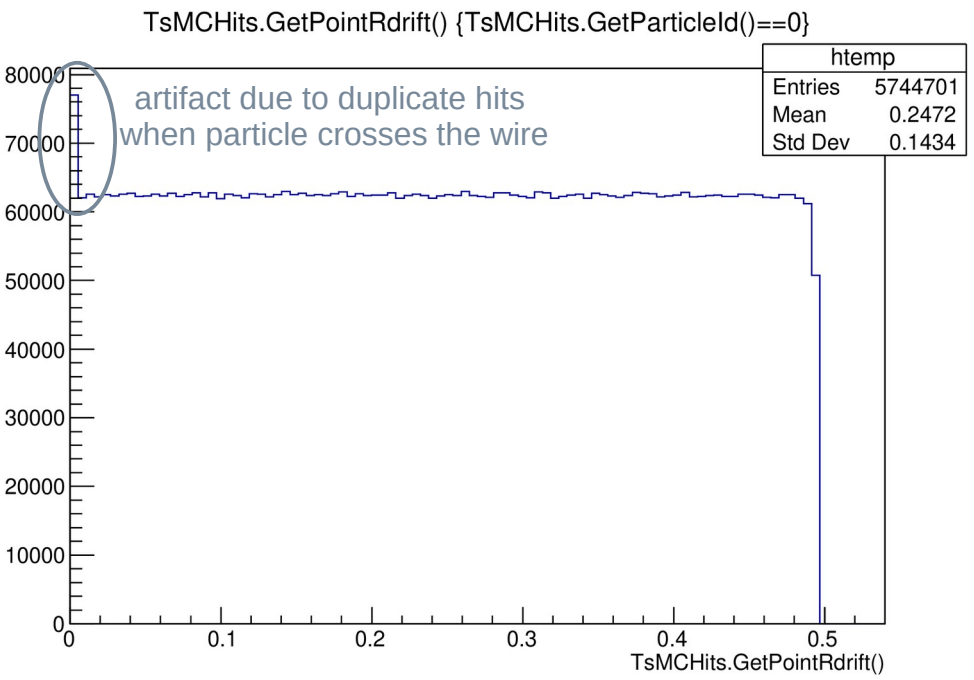
```
SpdTsMCHitProducer::SetHitResolutionRFunctionParameters(Int_t funcType,
const std::vector<Double_t>& par)
```

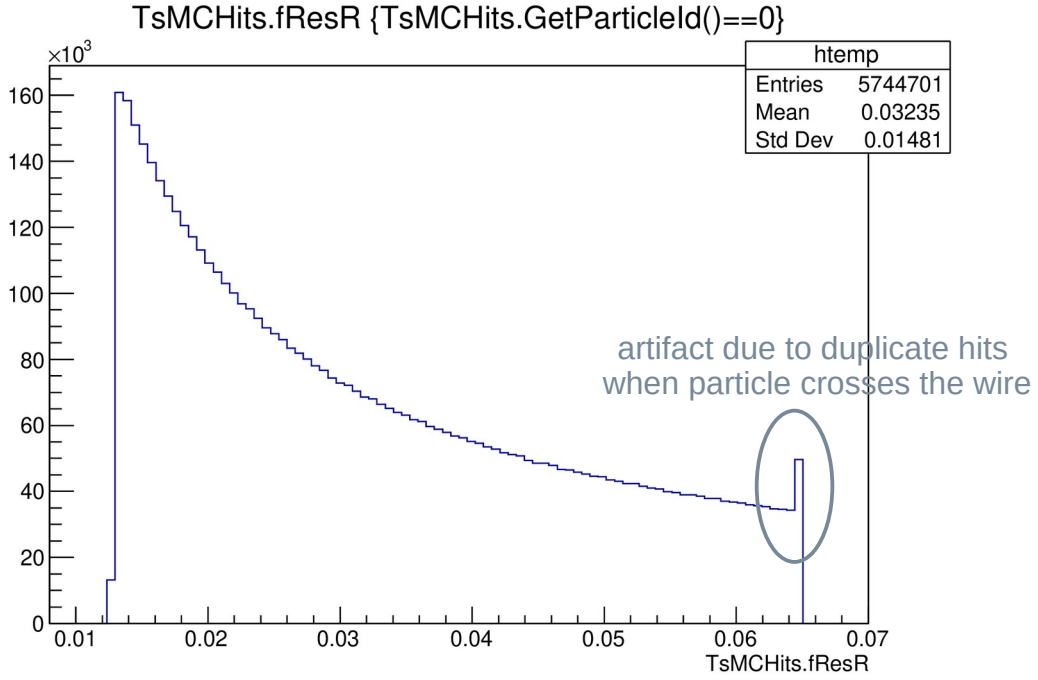
or

```
SpdTsMCHitProducer::SetHitResolutionRFunction(Int_t funcType)
```

`funcType`	*f(R)*	default parameters
`0` (default)	`par[0]*exp(par[1]*R)`	`par[0] =  0.06506` `par[1] = -3.26`
`1`	`par[0]`	`par[0] =  0.0240`

R and σ_R distributions



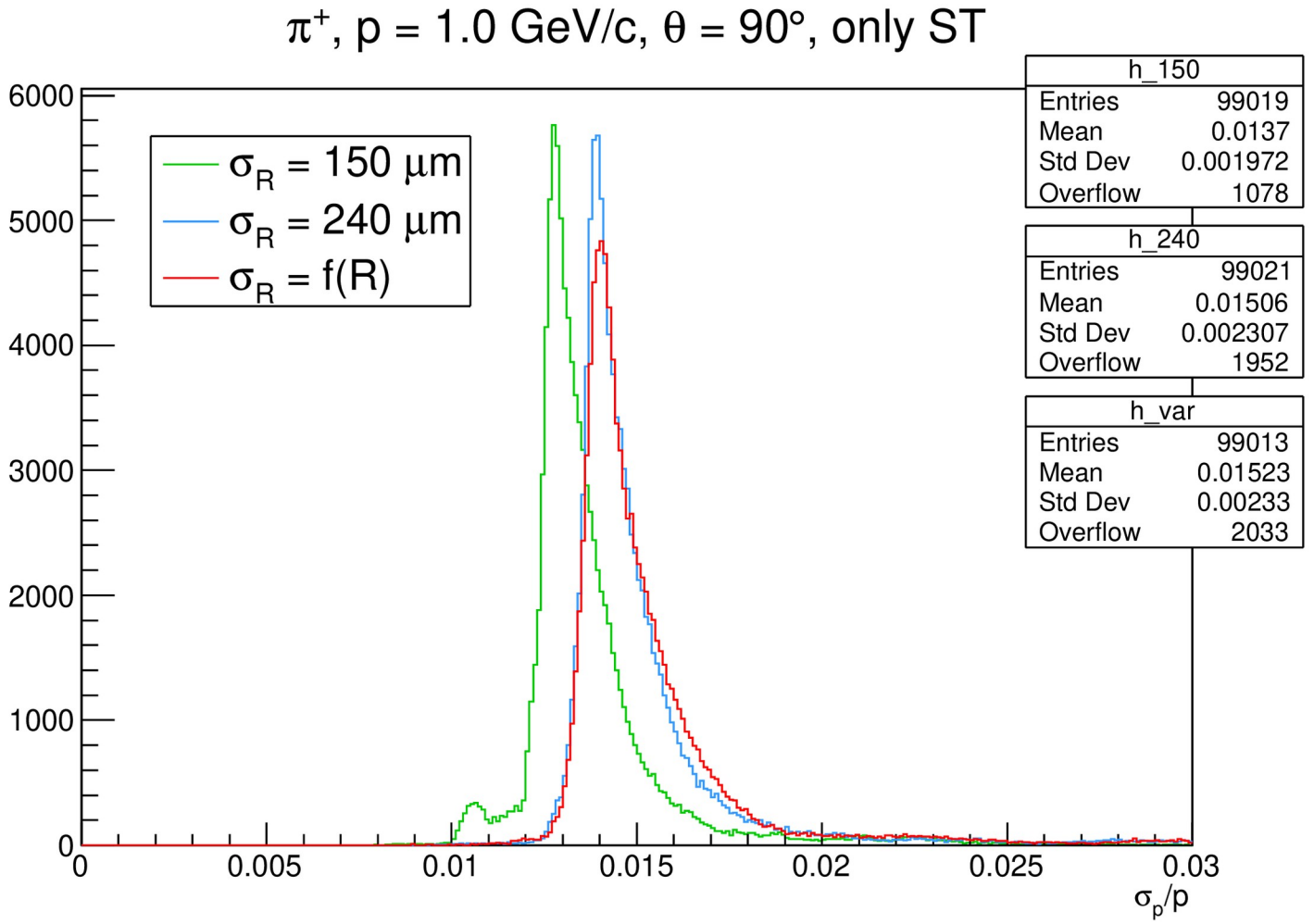


$$\langle \sigma \rangle = 323\,\mu m$$

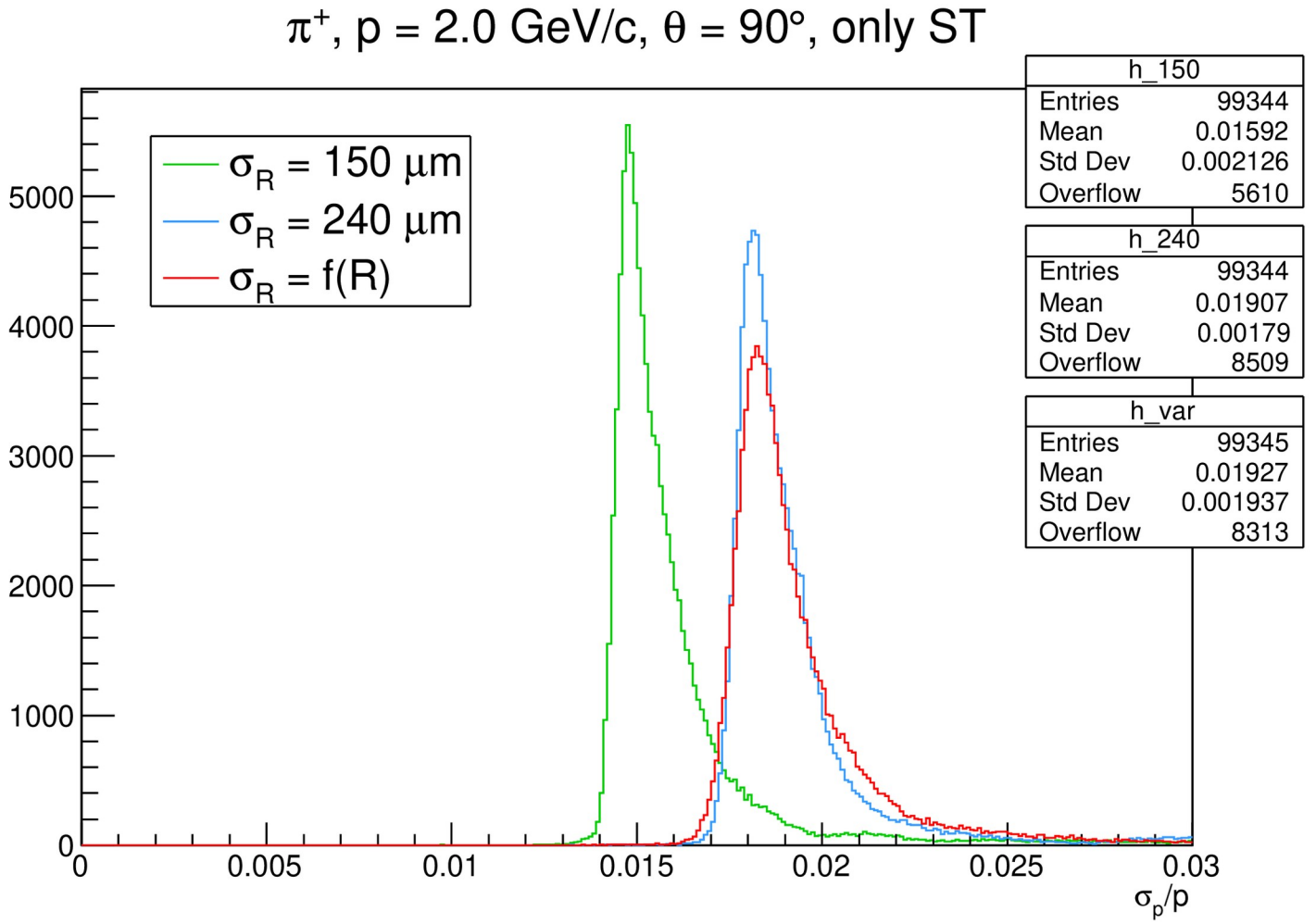
(plots for an artificial sample p = 1 GeV/c, θ = 90°,
φ uniformly distributed, primary vertex fixed)

$$\left(\langle \sigma^{-2} \rangle\right)^{-\frac{1}{2}} = 237\,\mu m$$

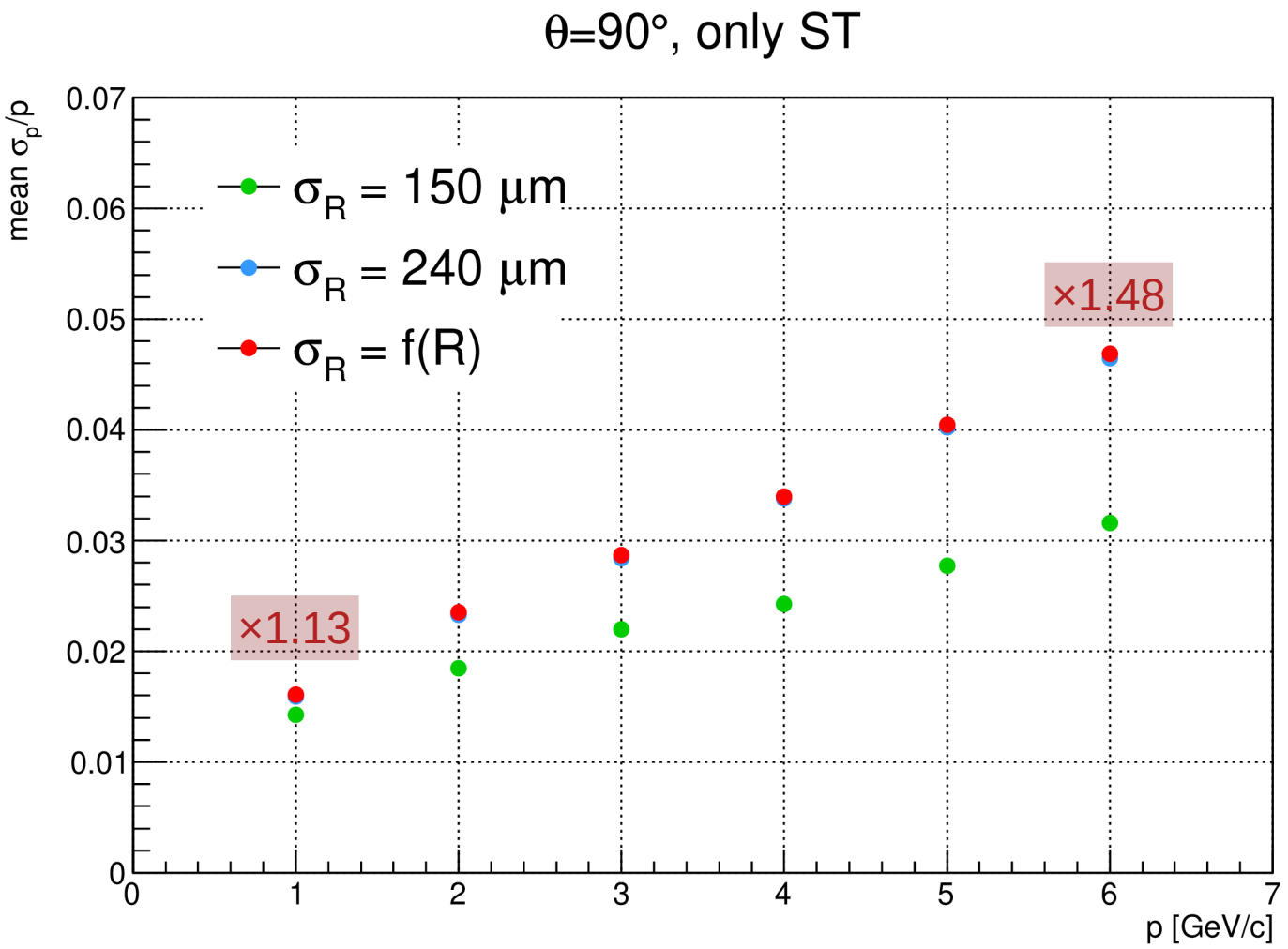
Momentum resolution σ_p/p at 1 GeV/c



Momentum resolution σ_p/p at 2 GeV/c



Mean momentum resolution σ_p/p

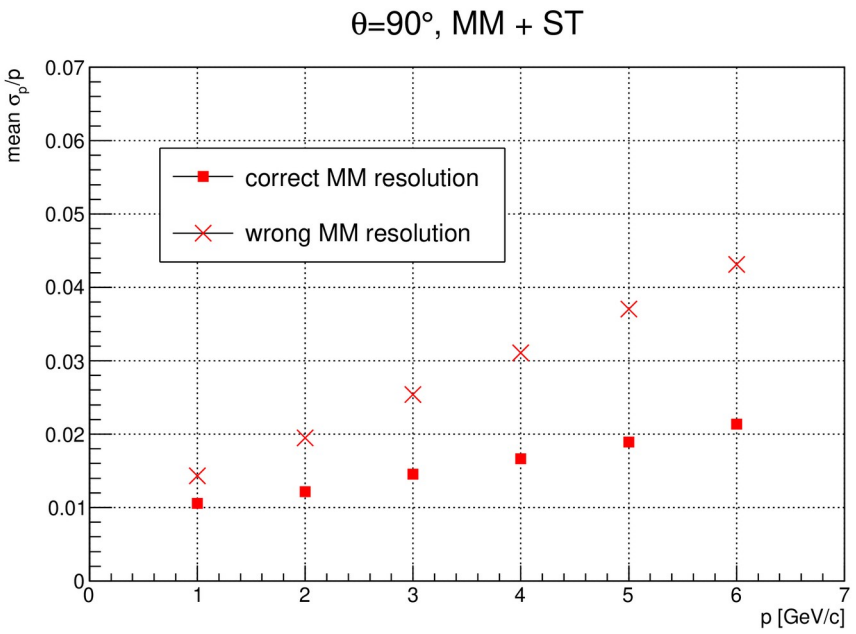


Straw Tracker:
31×2 layers
σ_R on plot

$$ratio \rightarrow \frac{240}{150} = 1.6$$

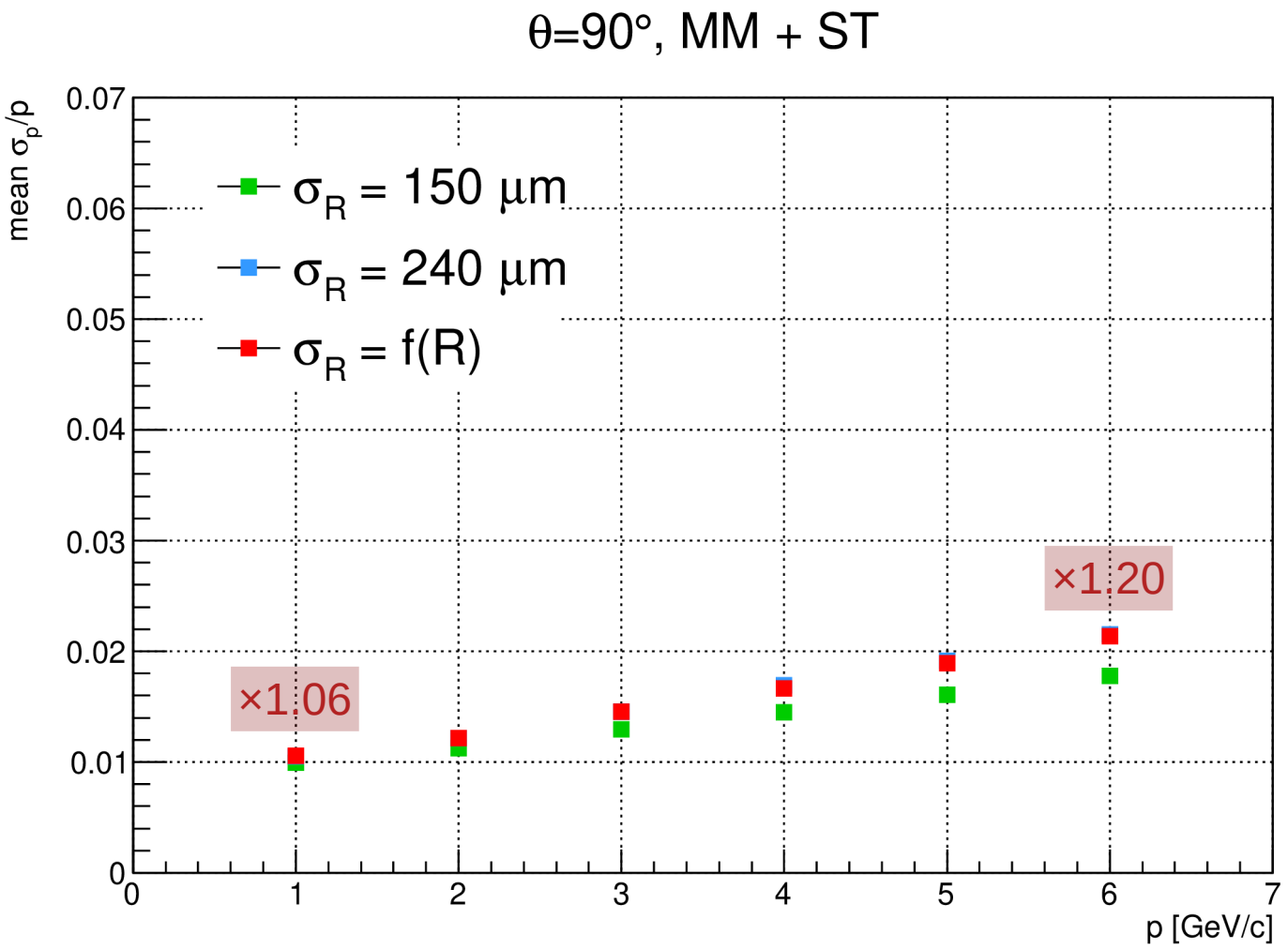
Yet another bug in SpdRoot: Micromegas resolution

- There was a bug inside `SpdMvdMCHitProducer::SetHitResolution(layerId, resU, resV)` method: the `resU` was also used in place of `resV`, (probably, due a typo), while `resV` was ignored.
- So instead of assumed default σ_u = 800 μm, σ_v = 90 μm we got $\sigma_u = \sigma_v$ = 800 μm.



- Fix commited to the development branch on June 17, 2024.
- Previous simulations involving Micromegas may be too pessimistic...

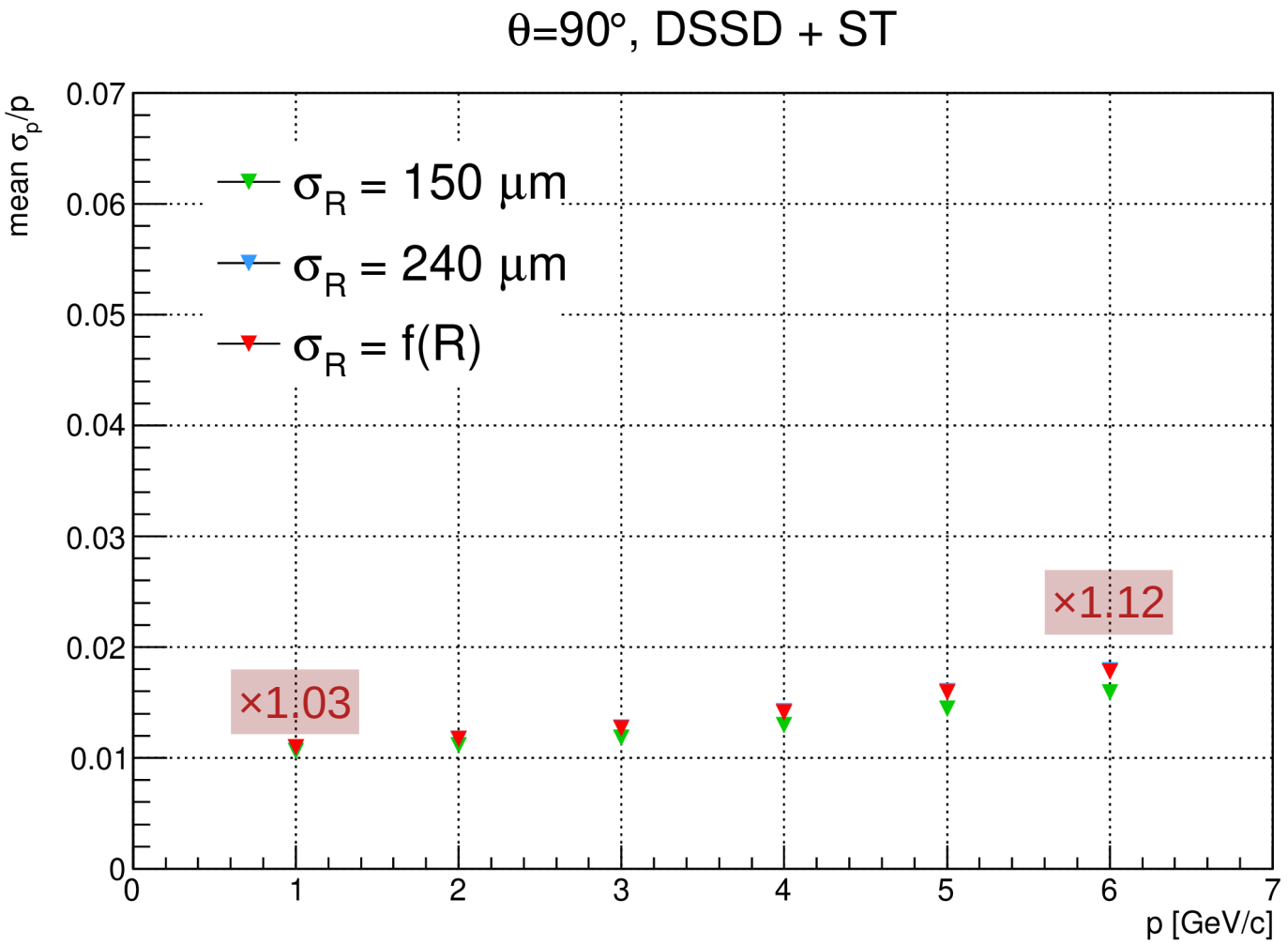
Mean momentum resolution σ_p/p



Straw Tracker:
31×2 layers
σ_R on plot

Micromegas:
1 superlayer
σ_u = 800 μm
σ_v = 90 μm

Mean momentum resolution σ_p/p

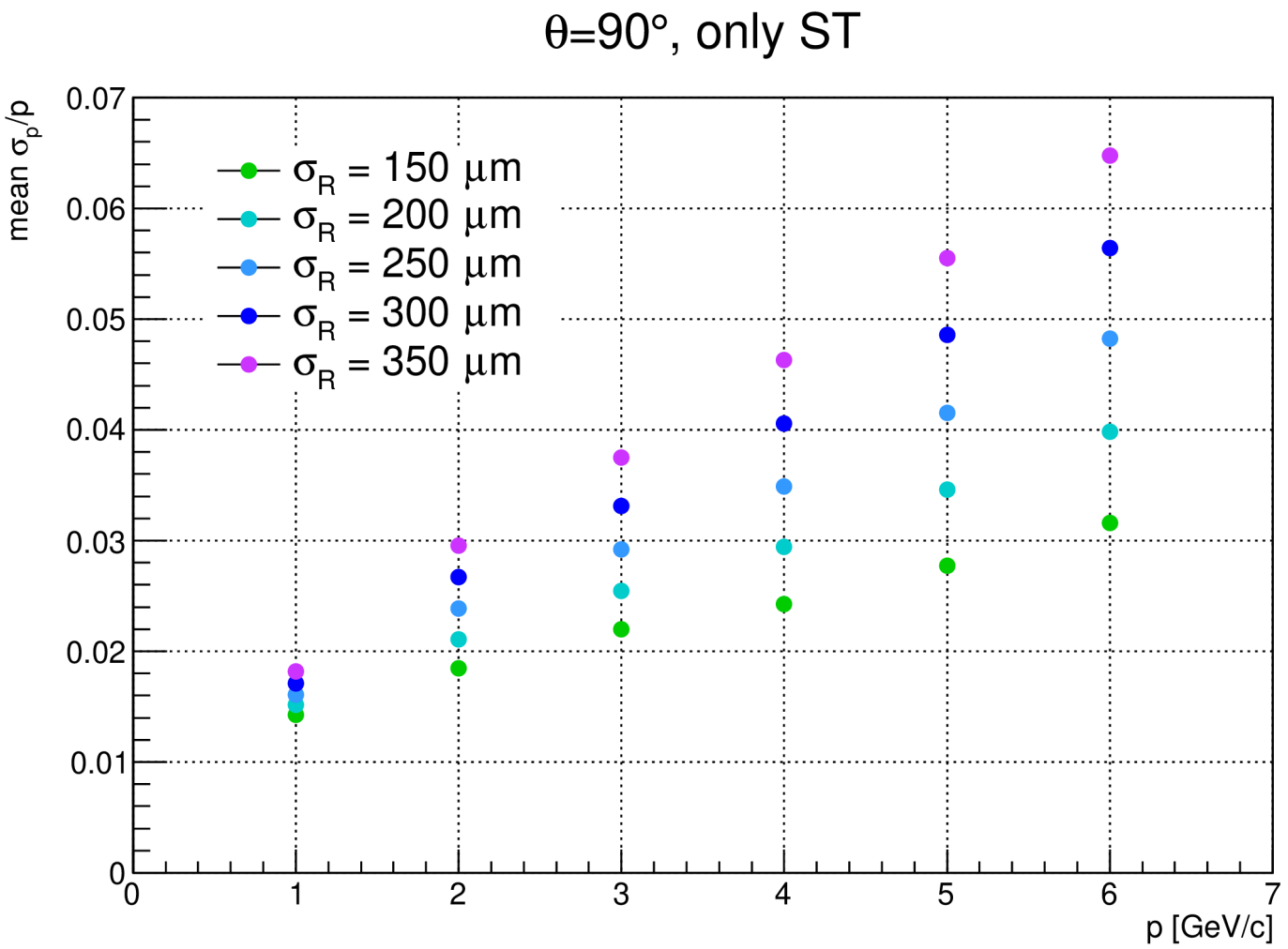


Straw Tracker:
31×2 layers
σ_R on plot

DSSD:
3 layers
σ_u = 81.3 μm
σ_v = 27.4 μm

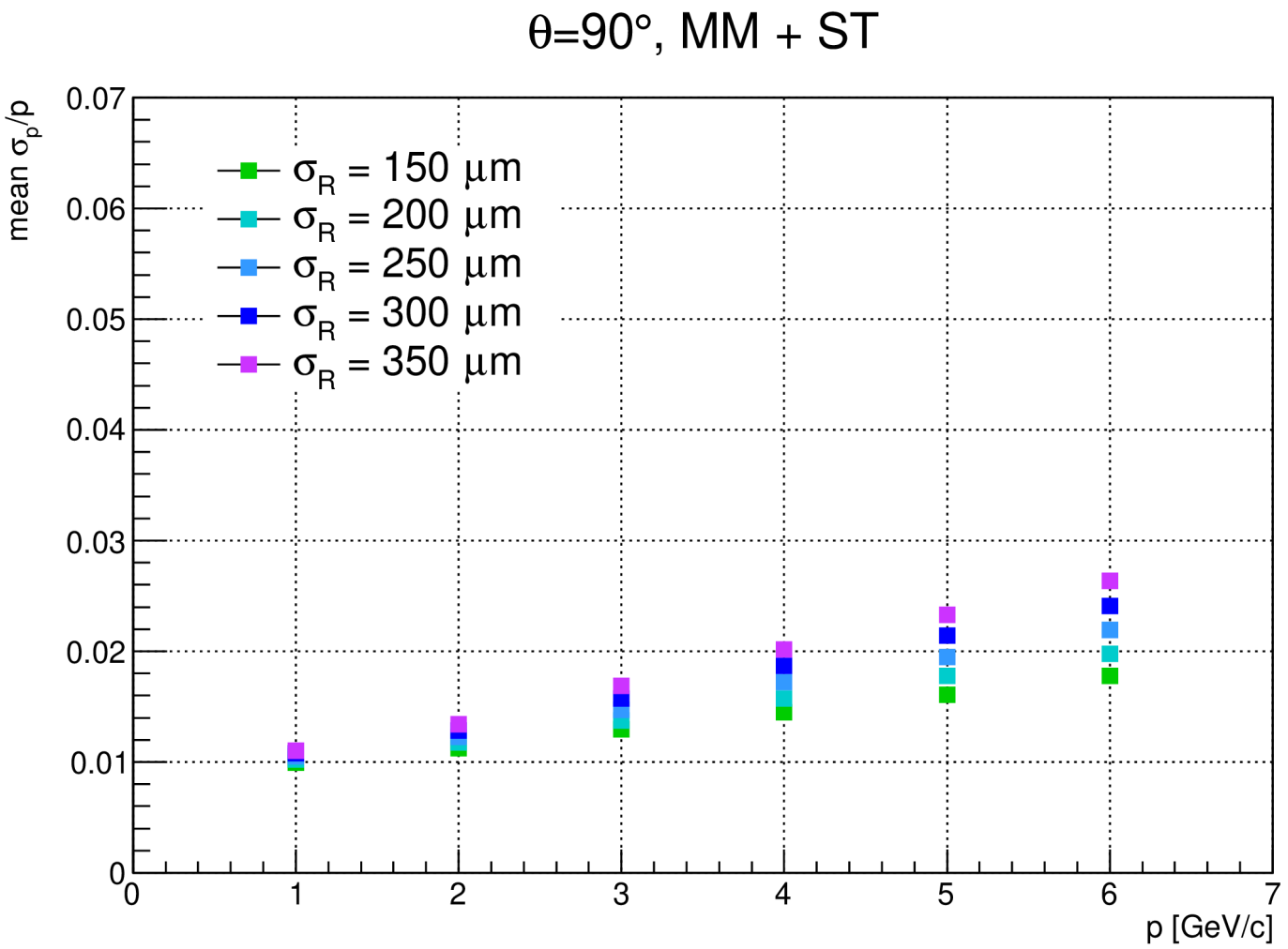
Plots for different values of σ_R

Mean momentum resolution σ_p/p



Straw Tracker:
31×2 layers
σ_R on plot

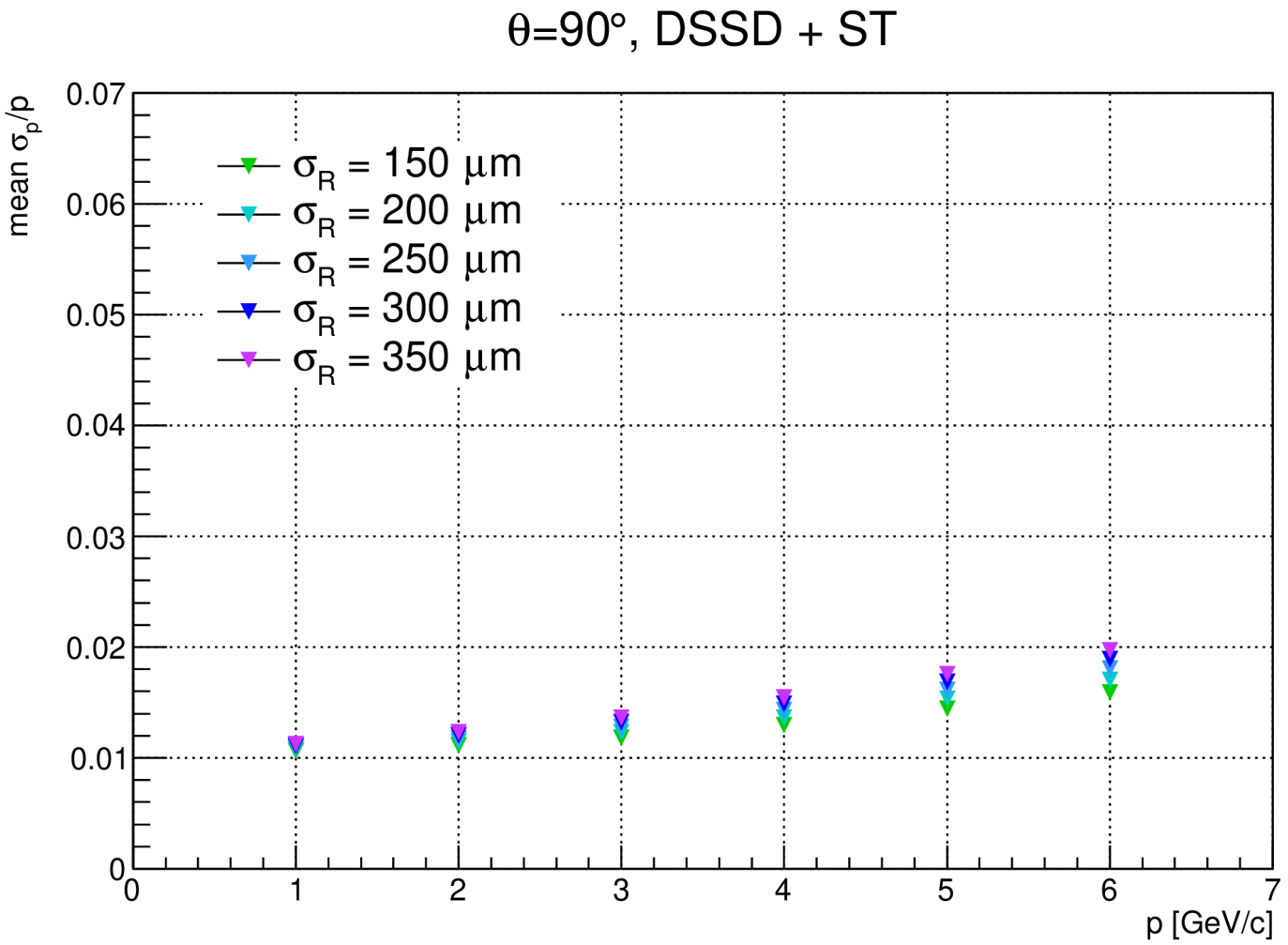
Mean momentum resolution σ_p/p



Straw Tracker:
31×2 layers
σ_R on plot

Micromegas:
1 superlayer
σ_u = 800 μm
σ_v = 90 μm

Mean momentum resolution σ_p/p



Straw Tracker:
31×2 layers
σ_R on plot

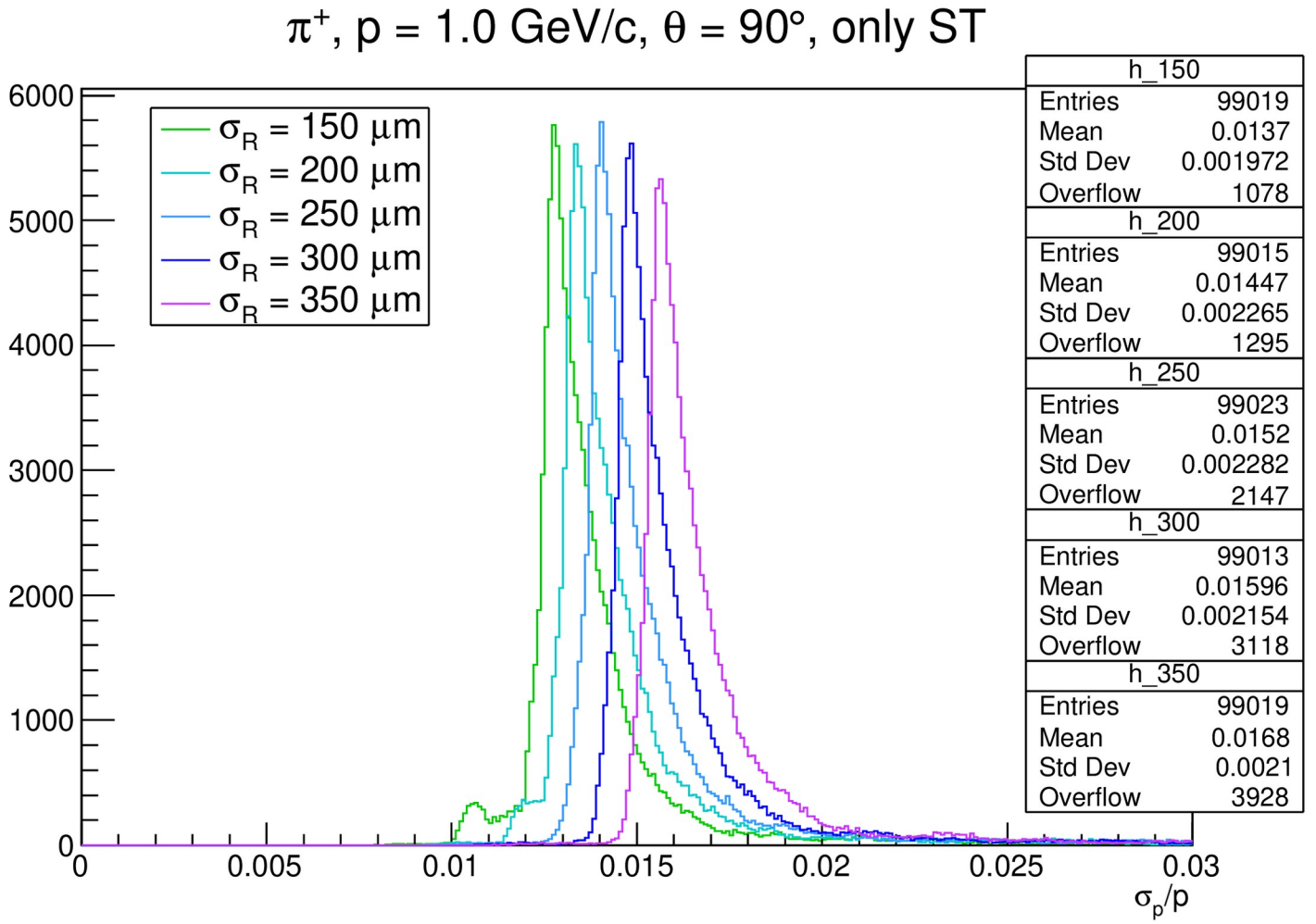
DSSD:
3 layers
σ_u = 81.3 μm
σ_v = 27.4 μm

Conclusions

- Spatial resolution of straw tube σ_R as a function of drift distance R has been implemented in SpdRoot.
- Effective σ_R of our straw tubes is about **240 μm**.

Additional slides

Momentum resolution σ_p/p at 1 GeV/c



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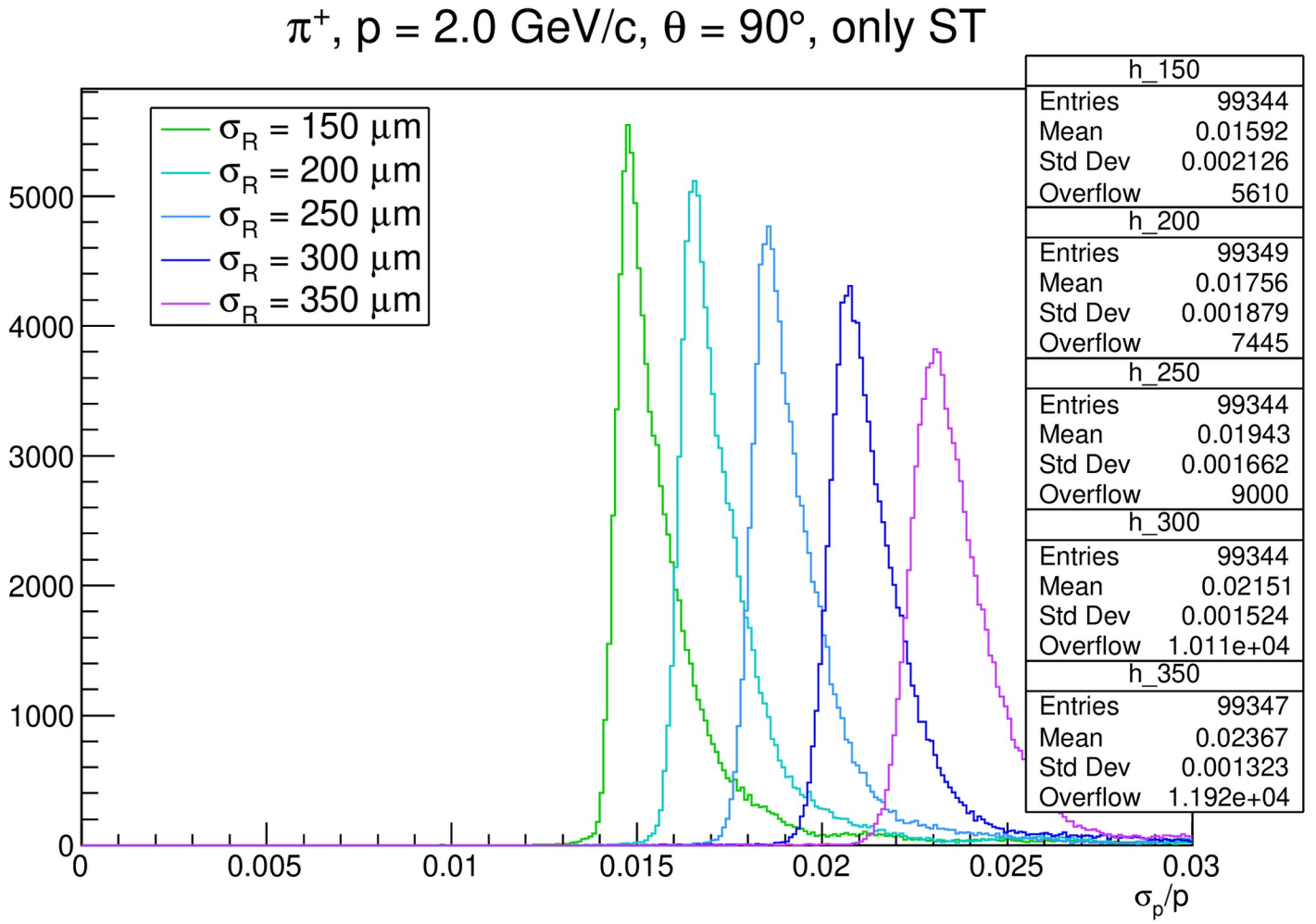
Momentum resolution σ_p/p at 2 GeV/c



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