

Updates to straw tracker end-caps geometry in SpdRoot

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Introduction

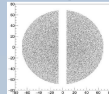
SPD Physics&MC Meeting 26/11/2025: V.Kuzmin „Modelling of the SPD end-cap detector“
— *stand-alone simulation of straw tracker end-cap detector for a lot of variants of geometry*

The EndCap detector geometries

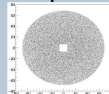


variant	central empty strip	coordinate plane	layer rotation angle	number of layers
0	yes	yes	TDR	16
1	no	yes	TDR	16
2	yes	no	$\pi/2$	16
3	no	no	$\pi/2$	16
4	yes	no	$7\pi/16$	16
5	no	no	$7\pi/16$	16
6	yes	no	$3\pi/8$	16
7	no	no	$3\pi/8$	16
8	yes	no	$\pi/4$	16
9	no	no	$\pi/4$	16
10	yes	no	$\pi/16$	16
11	no	no	$\pi/16$	16
12	yes	no	$\pi/2$	32
13	no	no	$\pi/2$	32
14	yes	no	$7\pi/16$	32
15	no	no	$7\pi/16$	32
16	yes	no	$3\pi/8$	32
17	no	no	$3\pi/8$	32
18	yes	no	$\pi/4$	32
19	no	no	$\pi/4$	32

strip



square



The table lists the geometries of the end-cap detector that we have considered for this study.

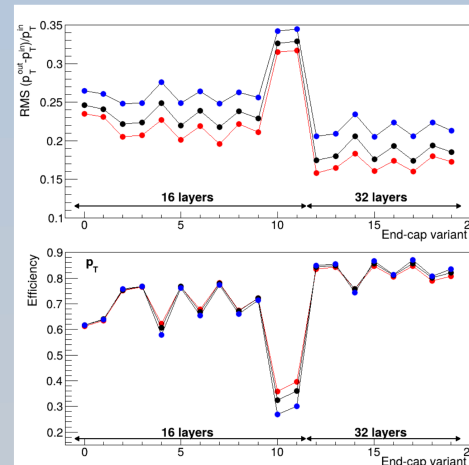
To compensate a relatively small thickness of the tracker, we are considering models of detectors with an increased number of layers that can still fit within the specified dimensions.

Such amount of layout variants requires a simplified modeling option.

Simulation results



Transverse momentum and its selection efficiency



Accuracy: ● 400μm
● 200μm
● 100μm

Cuts:

$$\chi^2 = \frac{\min \sum_{hits} \left(\frac{H_i - T_i}{\sigma_i} \right)^2}{hits} < 10$$

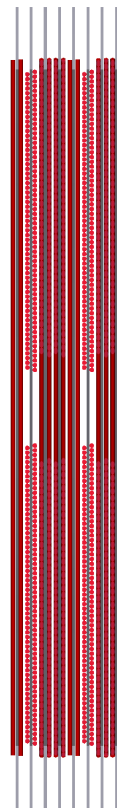
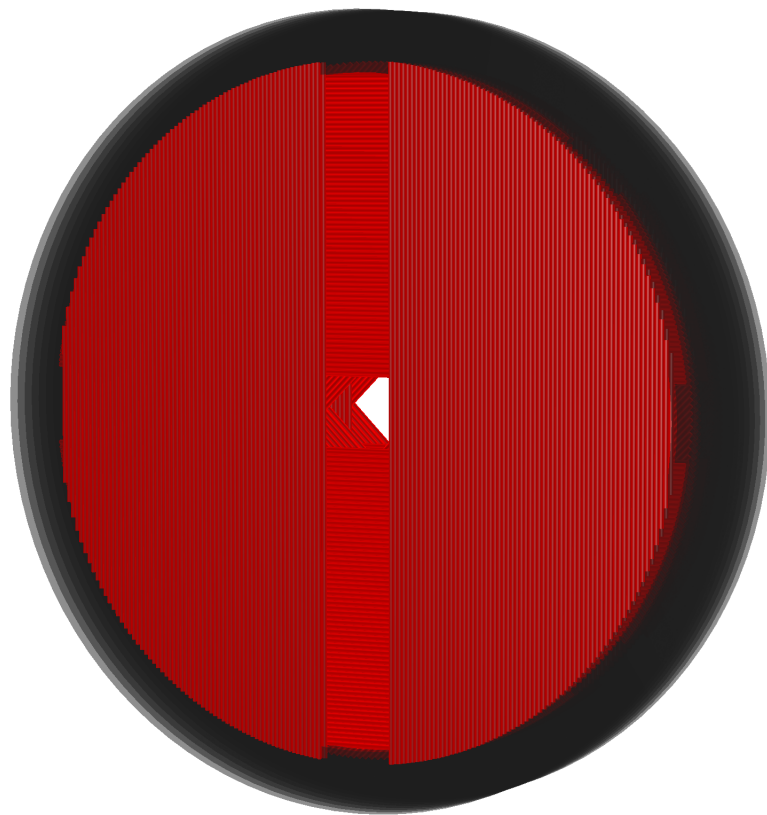
$$\frac{|p_T^{prec} - p_T^{pin}|}{p_T^{pin}} < 0.5$$

Introduction

Goal of the work reported here is to introduce all of the considered geometry options in SpdRoot, in order to be able to make performance estimations of the whole SPD tracking system (Micromegas + ST barrel + ST end-caps).

Default geometry of ST end-cap in SpdRoot

(until recently)



Each end-caps consists of 8 double layers of straws.

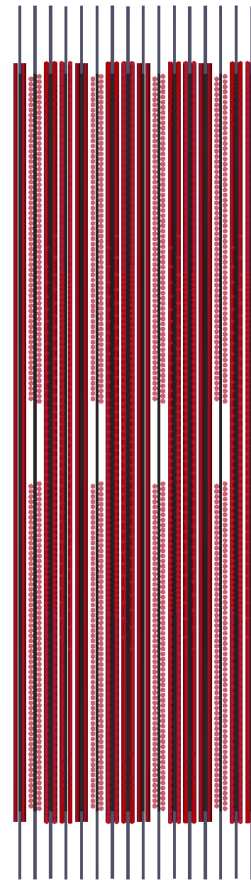
Each layer has a general circular form with a strip hole in the middle.

Angle pattern (TDR):
X - Y - U - V
(0° - 90° - 45° - 135°)

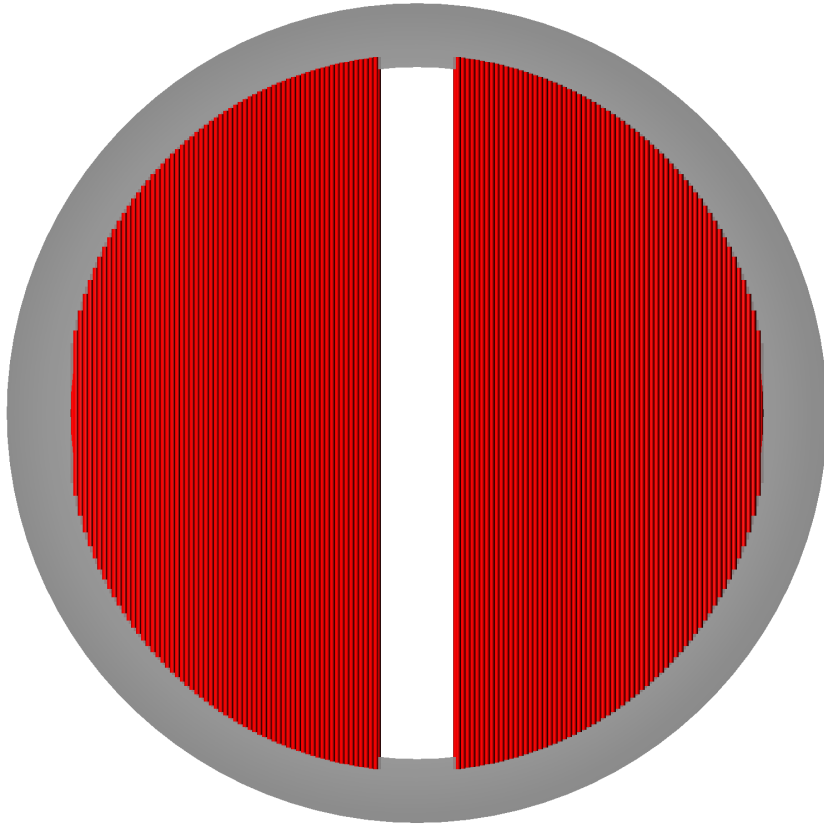
Total length 24 cm.

How to change number of planes in end-cap ?

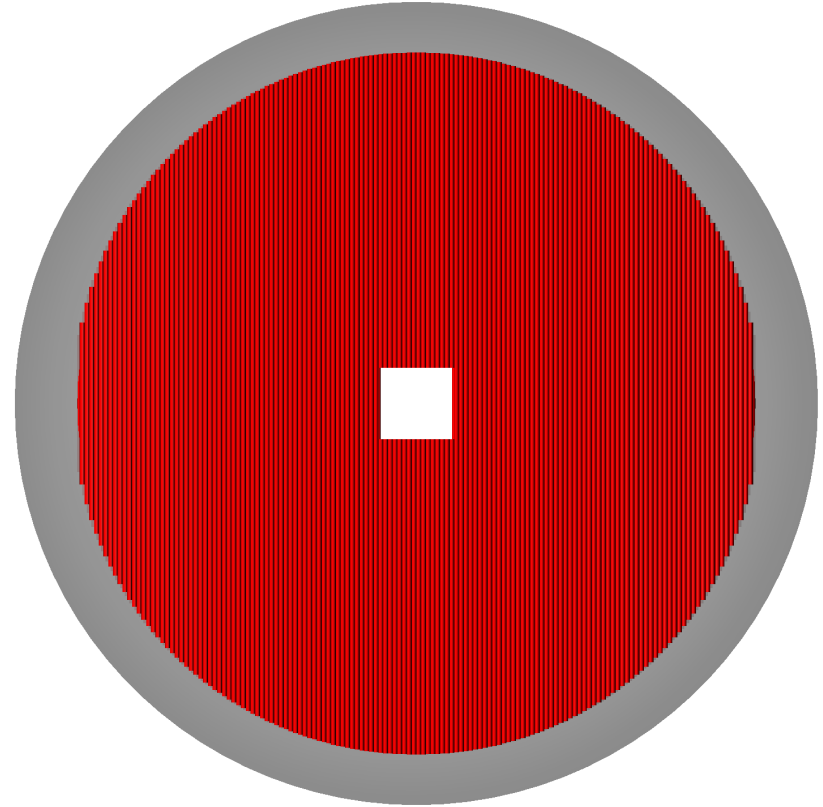
```
void CustomTsEC()  
{  
    SpdTstECGeoMapper* tsec_mapper = SpdTstECGeoMapper::Instance();  
  
    // Change total length  
    SpdParameter* par;  
    par = tsec_mapper->AddParameter("TsTECLength");  
    if (par) *par = 48.; // cm  
  
    // Set default parameters (straw radius, etc.) of modules  
    tsec_mapper->SetParameters(1);  
    tsec_mapper->SetParameters(2);  
  
    // Set number and orientation of planes  
    Int_t n = 16;  
    std::vector<Double_t> angle_pattern = {0, 90, 45, 135};  
    Int_t n_angles = angle_pattern.size();  
  
    Double_t gap = 0.4; // gap between planes  
    Double_t d;  
    for(Int_t i = 0; i < n; i++) {  
        d = (i==0) ? 0 : gap;  
        tsec_mapper->AddForwardModule(1, d, angle_pattern[i%n_angles]);  
    }  
    for(Int_t i = 0; i < n; i++) {  
        d = (i==0) ? 0 : gap;  
        tsec_mapper->AddBackwardModule(2, d, angle_pattern[i%n_angles]);  
    }  
}
```



Hole shape



`tsec_mapper->SetHoleShape("strip")`

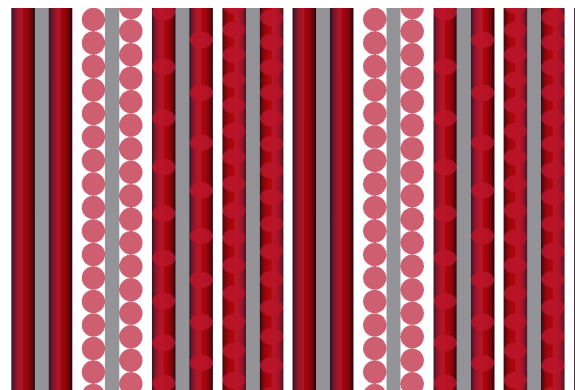


`tsec_mapper->SetHoleShape("square")`

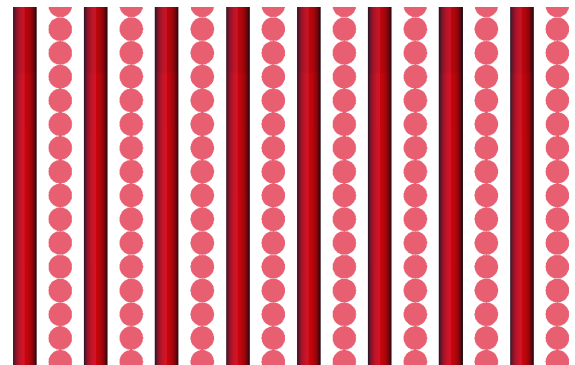
Now default.

Single layers

- Also an option was introduced where each plane is a **single** layer of straws.
- Branch
straw-endcaps-single-layers
- No passive elements are implemented yet for this option.
- Default configuration:
16 layers, angle pattern: $0^{\circ}/90^{\circ}$
- Customizable (see next slide)
- Choice between default configurations with double layers and single layers is done via "TsTECGeoType" parameter:
1 — single layers,
2 — double layers



double layers



single layers

Single layers: customization

```
void CustomTsEC_SingleLayers()
{
    SpdTSTECGeoMapper* tsec_mapper = SpdTSTECGeoMapper::Instance();

    // Change total length
    SpdParameter* par;
    par = tsec_mapper->AddParameter("TsTECLength");
    if (par) *par = 48.;

    // Set default parameters (straw radius, etc.) for module with single layers
    Int_t module_type = 3;
    tsec_mapper->SetParameters(module_type);

    // Set orientation of layers
    Int_t n = 32; // number of layers
    std::vector<Double_t> angle_pattern = {0, 45, 90, 135};
    Int_t n_angles = angle_pattern.size();

    Double_t gap = 0.5; // gap between layers
    Double_t d;
    for(Int_t i = 0; i < n; i++) {
        d = (i==0) ? 0 : gap;
        tsec_mapper->AddForwardModule(module_type, d, angle_pattern[i%n_angles]);
    }
    for(Int_t i = 0; i < n; i++) {
        d = (i==0) ? 0 : gap;
        tsec_mapper->AddBackwardModule(module_type, d, angle_pattern[i%n_angles]);
    }
}
```

Summary

- Geometry of straw tracker end-caps in SpdRoot is highly customizable.
- Two new options were introduced:
 - Hole shape: square / strip
 - Type of layer arrangement: double / single layers
- Next plans: to look at momentum resolution of SPD tracking system for different variants of end-caps geometry