SVD description update in SpdRoot and vertex fitting

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Motivation

- Aim – good understanding of our capabilities for physics with D-mesons.
- In simulation the radiation length of a MAPS layer is underestimated by a factor of 5, for DSSD – by a factor 1.5-2. Radiation length of layer is NOT determined by the thickness of a silicon chip: in case of maps the chip contributes only 15-20 % to the total radiation length of a layer. Additional contributions in case of DSSD.
- DSSD description in SpdRoot is **not consistent** with TDR.
- Hit in DSSD endcaps have not been implemented before.

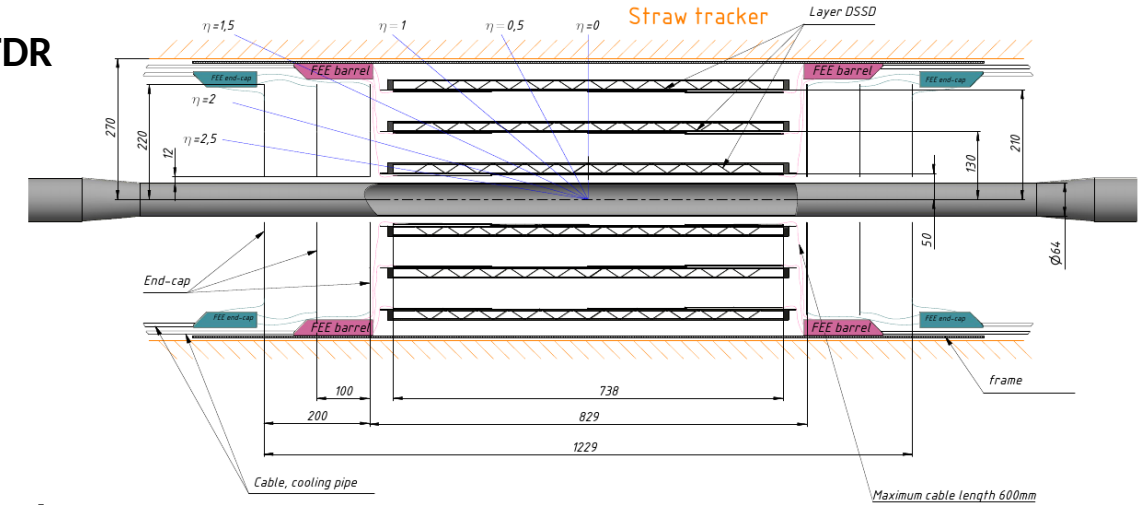
Thickness of detector components in terms of fraction of radiation length X/X_0 -

Material	Thickness (μm)	X_0 (cm)	X/X_0 (%)
Polyimide cooling pipe wall	25 μm	28.41	0.003
Carbon fleece	40 μm	106.8	0.004
Water	1mm	35.76	0.032
Carbon fiber plate K13D2U	70 μm	26.08	0.027
Graphite foil	30μm	26.56	0.011
Thermal greese (glue)	100μm	44.37	0.023
Si-sensor	50μm	9.36	0.064
Total (without FPC)			**0.164**
Total			**~0.3**

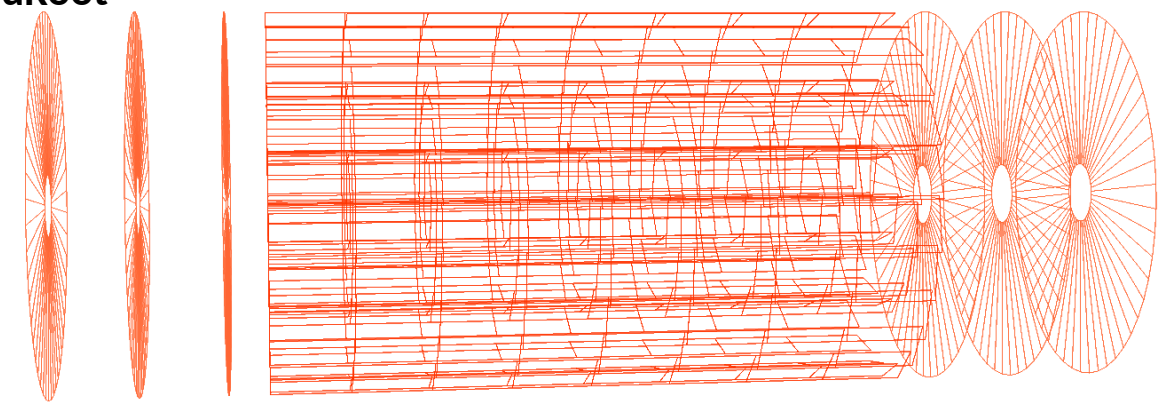
From G. Feofilov at SPD TB (22.09.22)

DSSD vertex detector

TDR



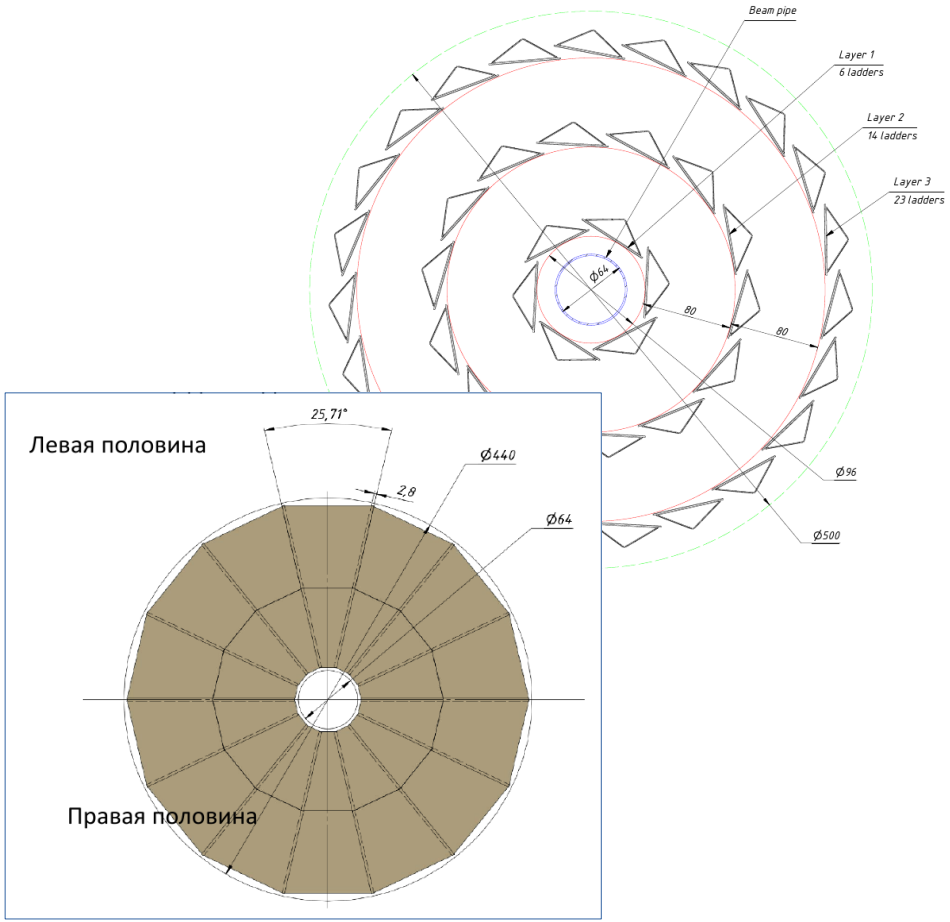
SpdRoot



Simulation:

- Barrel layer thickness increased to 500 µm Si (300 µm + 0.15%*X_{Si}+...)
- DSSD endcaps modeled as discs:
  - width: 300 µm
  - inner R: 35 mm
  - outer R: 220 mm
- Positions of DSSD endcaps (TDR)
  - ± 41.45 cm
  - ± 51.45 cm
  - ± 61.45 cm

DSSD vertex detector

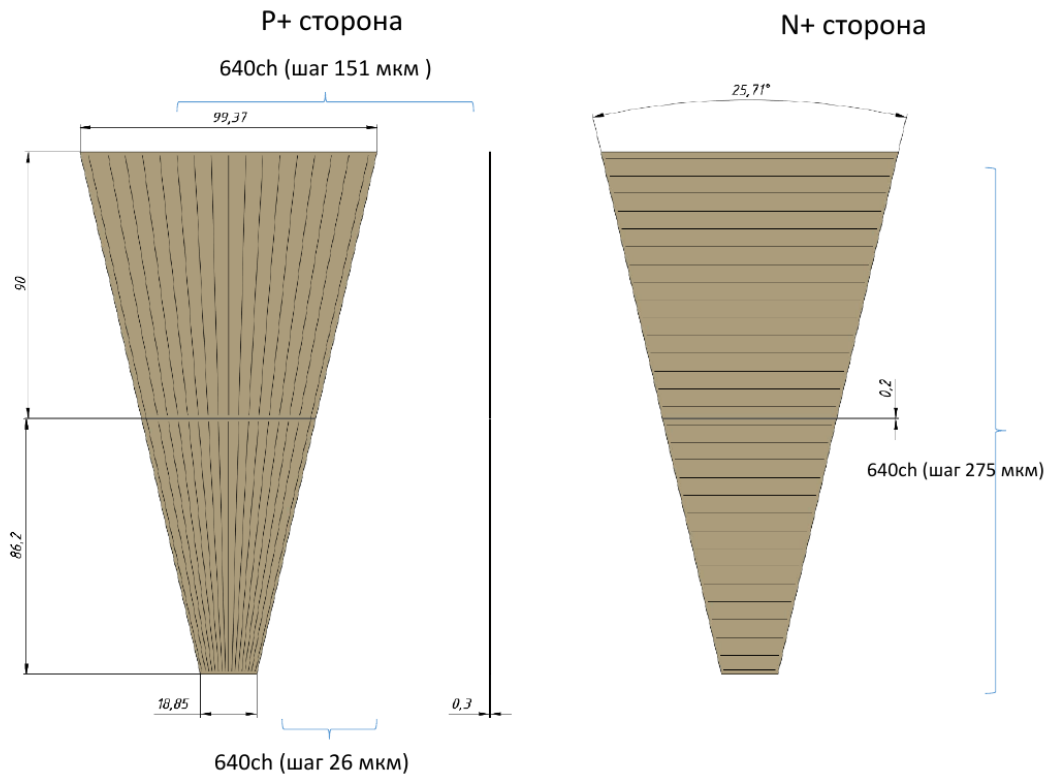


Two barrel configurations configurations

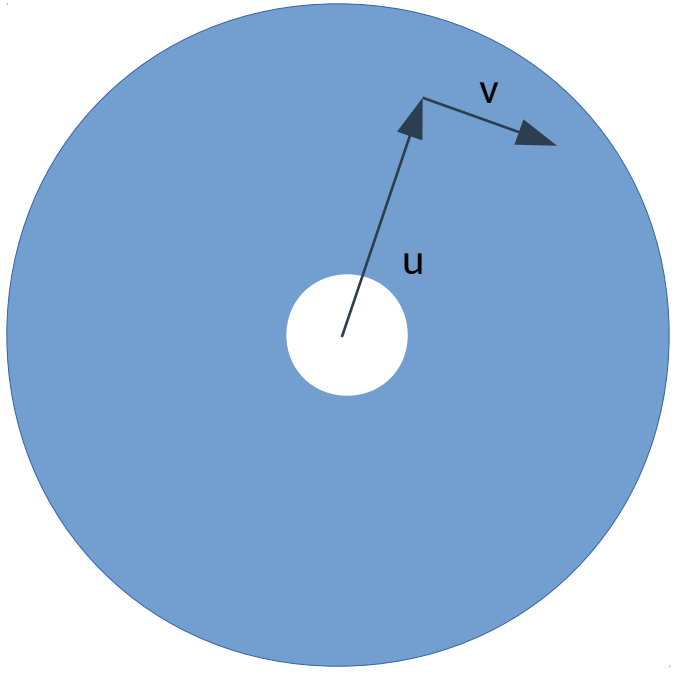
- *mapper→SetGeometryPars(3,2);* – layer radii and number of ladders consistent with the TDR draft
- *mapper→SetGeometryPars(2,2);* – inner layer at 40 mm (can be further reduced), number of ladders is automatically calculated (can be less than in one in TDR)
- angle is set to 15 degrees (not checked with technical drawing!)

To enable endcaps: *SpdItsGeoMapperX::Instance()->EnableEndcaps(1);*

DSSD endcaps hit simulation



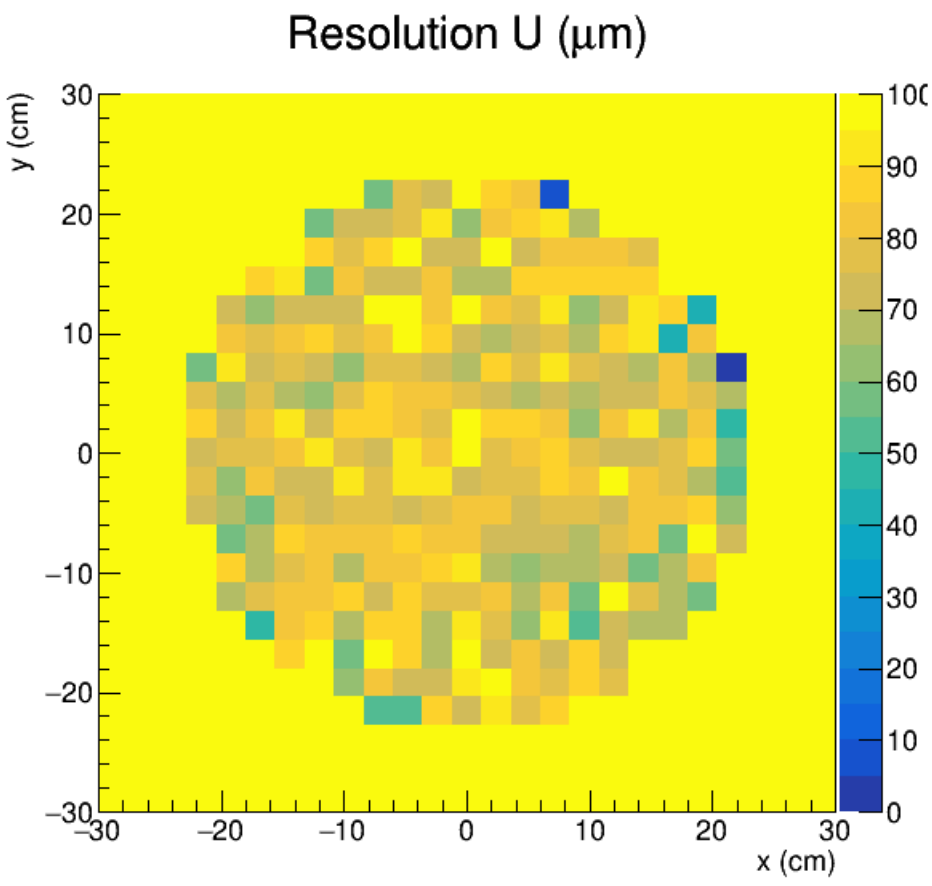
From N. Zamyatin at SPD TB (21.04.22)

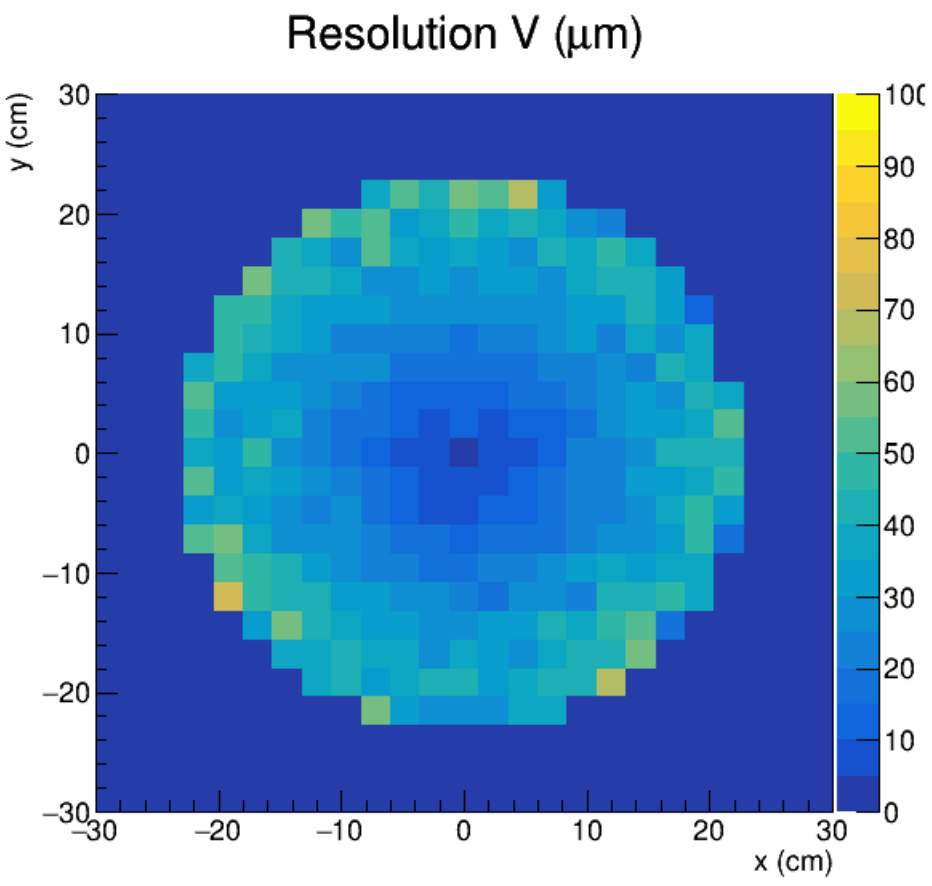


Resolution is modeled with Gaussian smearing in a simplified way:

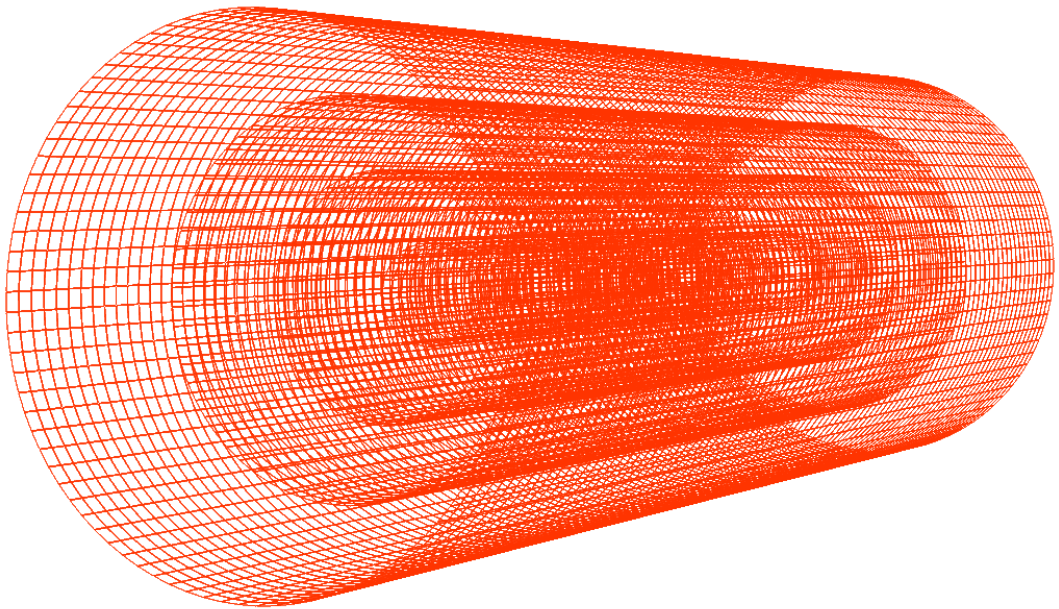
```
Double_t ures = 275 * mkm_/TMath::Sqrt(12.);
Double_t pitch_v = u * TMath::Tan(25.71/2*TMath::DegToRad()) / 320;
Double_t vres = pitch_v / TMath::Sqrt(12.);
```

DSSD endcaps hit simulation tests





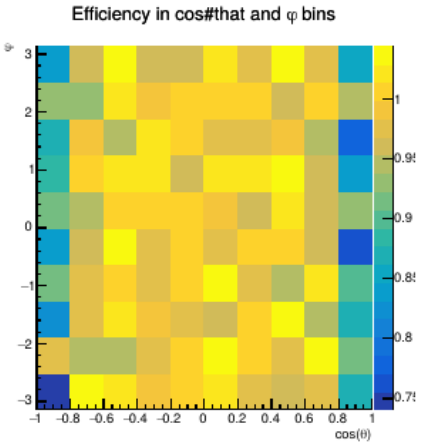
MAPS detector description update

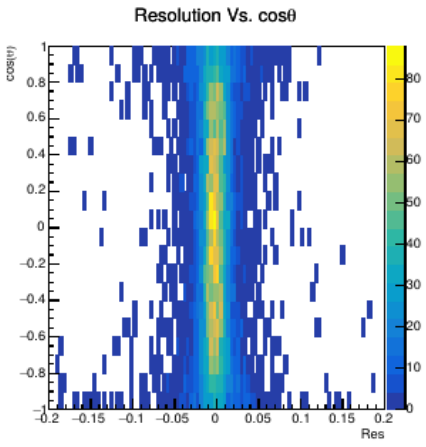


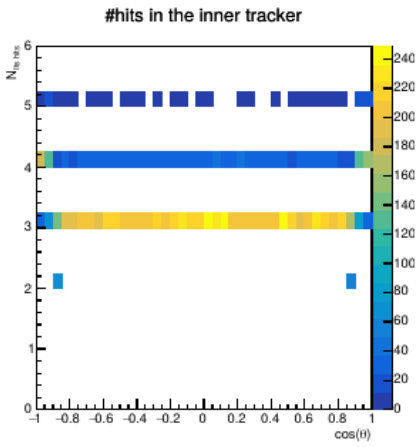
Simulation:

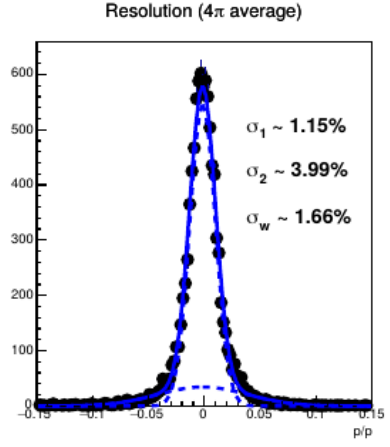
- layer thickness increased from 50 μm to 330 μm Si (0.35% X_0)
- The radii of layers are 40mm, 96mm, 152mm, and 210mm.
- The lengths of layers are 762mm, 889mm, 1016mm, 1270mm (**for NO REASON**)
- enable with *mapper→SetGeometryPars(1,1);*
- Endcaps are not supported yet!
- See *spdgeometry/its/SpdItsGeoMapperX.cxx*

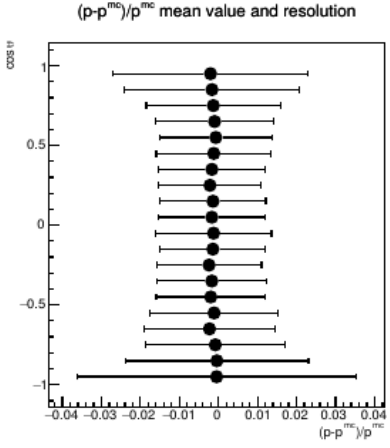
Momentum resolution (DSSD), muons, p=1.5 GeV

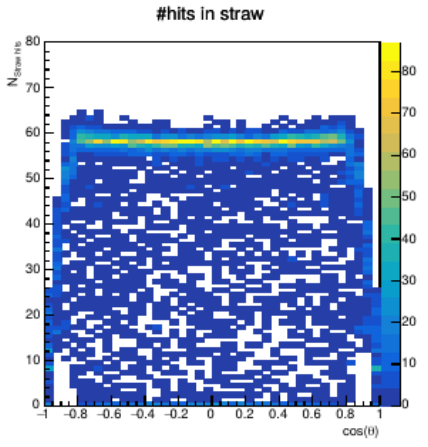




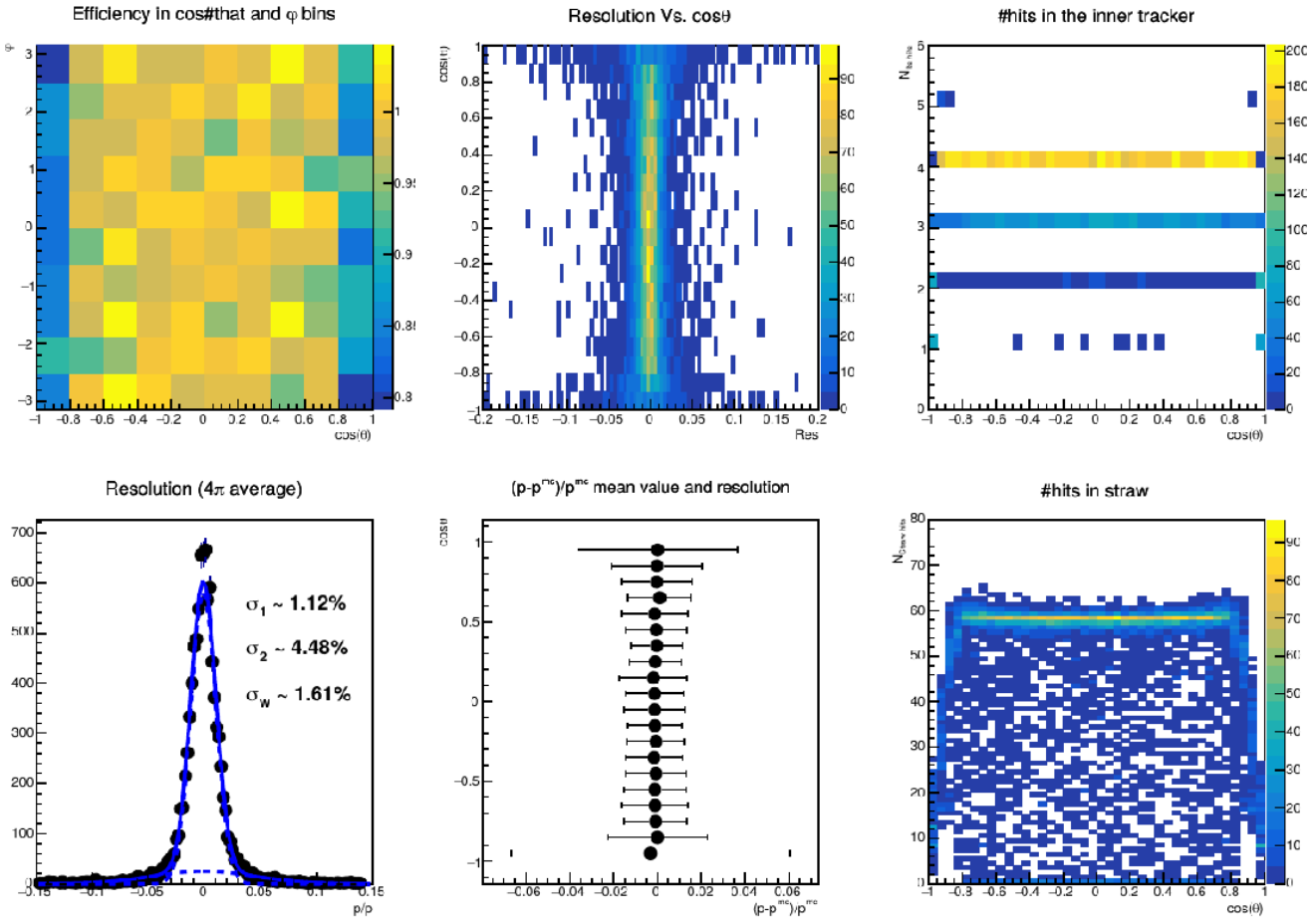




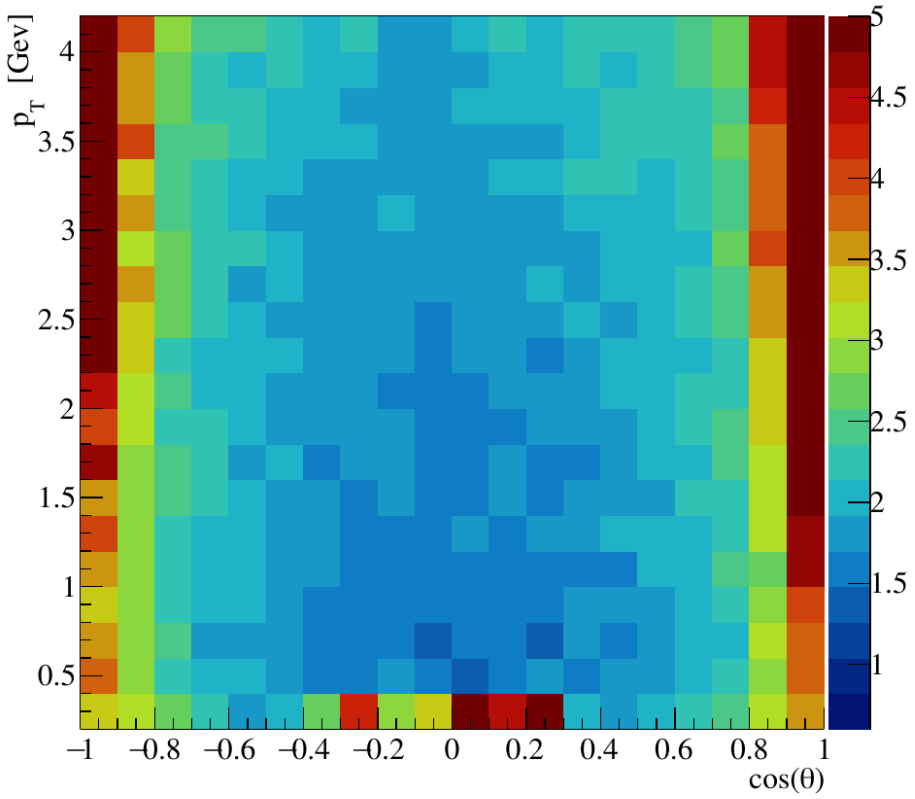




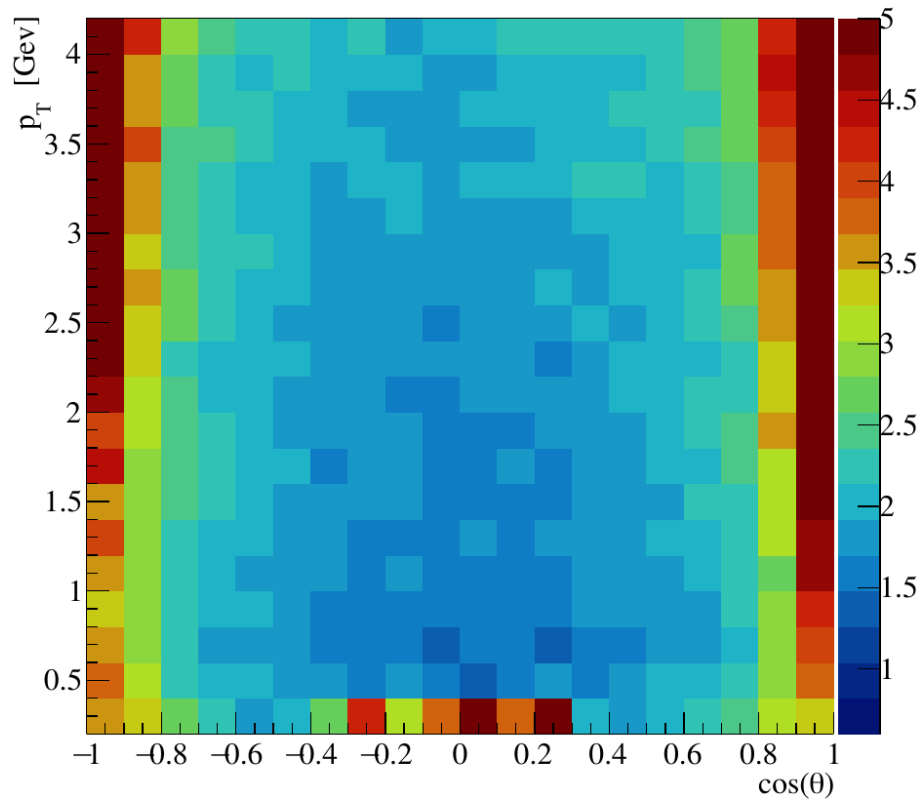
Momentum resolution (MAPS), muons, p=1.5 GeV



Momentum resolution



DSSD

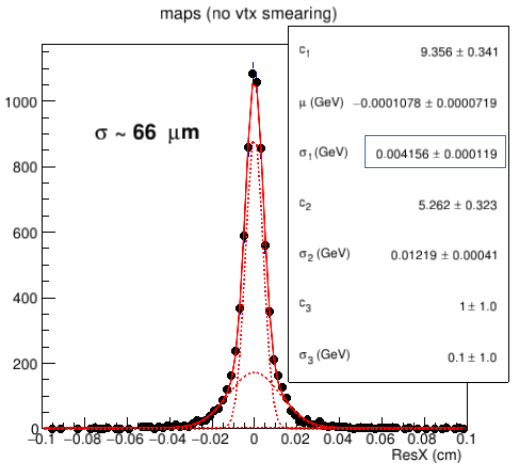


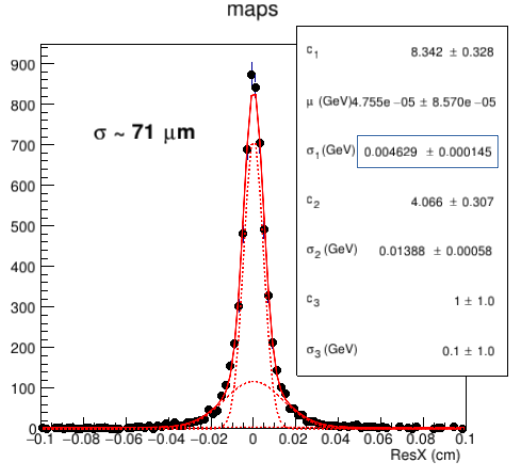
MAPS

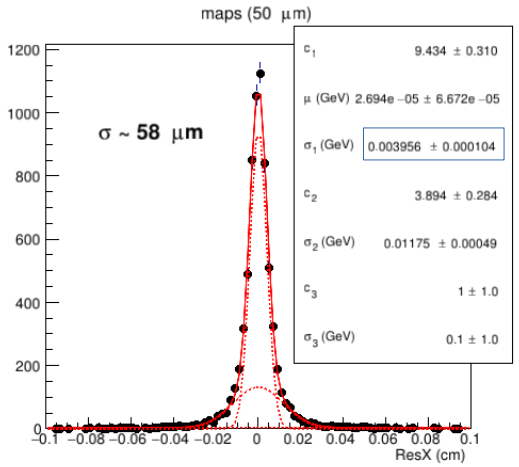
Vertex resolution tests

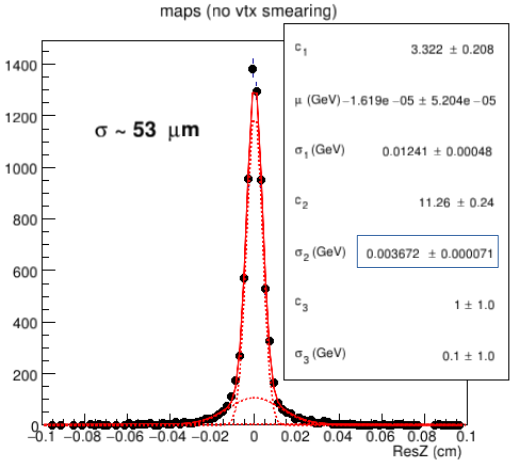
- Two phase-space distributed muons, p = 1.5 GeV
- The algorithm from extracted *SpdMCVerticesFitter.cxx*, initial vertex position estimated using *SpdRCVerticesFitter.cxx::FindPrimVertexCand(…)*
- No tuning of parameters.
- Fit with “three-gaussian” function, weighted average of two contributions with the smallest width is shown in the following.

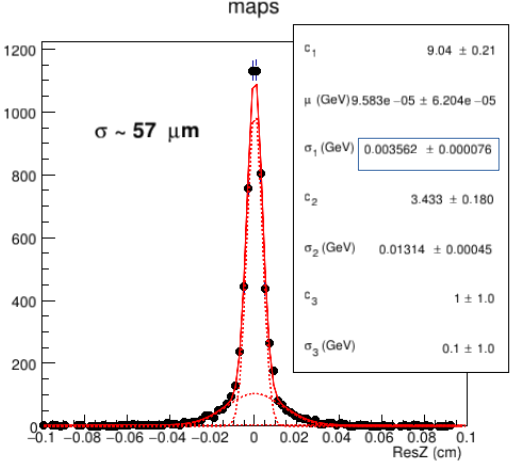
Vertex resolution (MAPS)

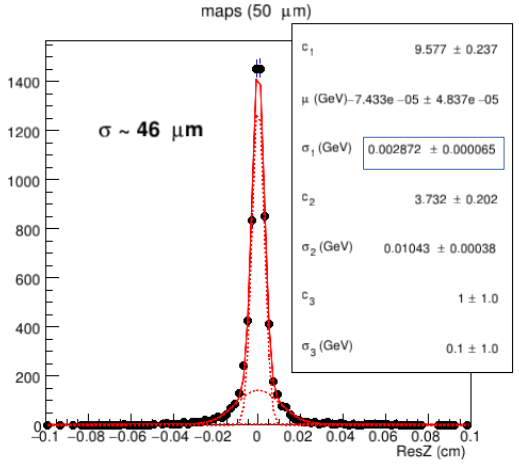




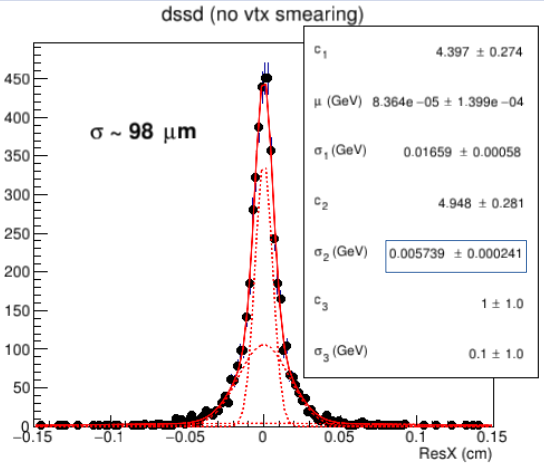


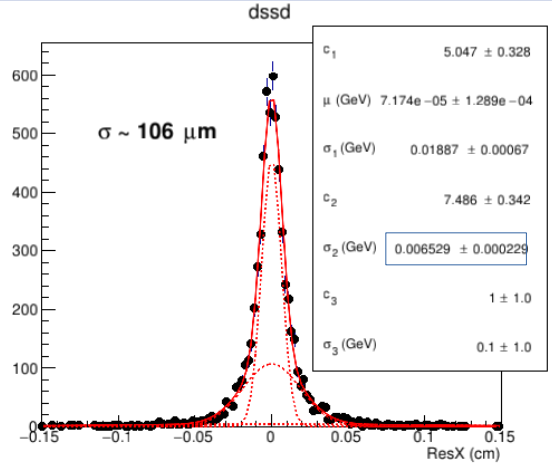


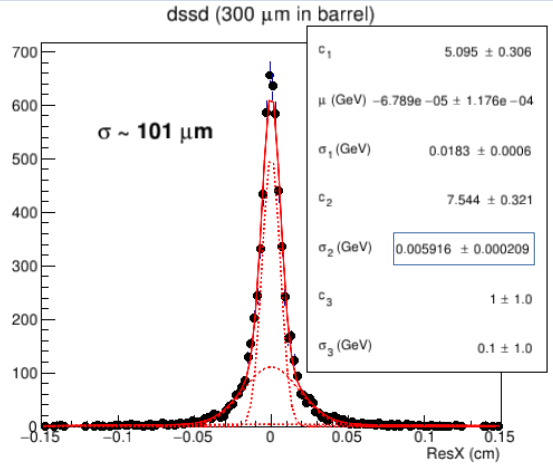


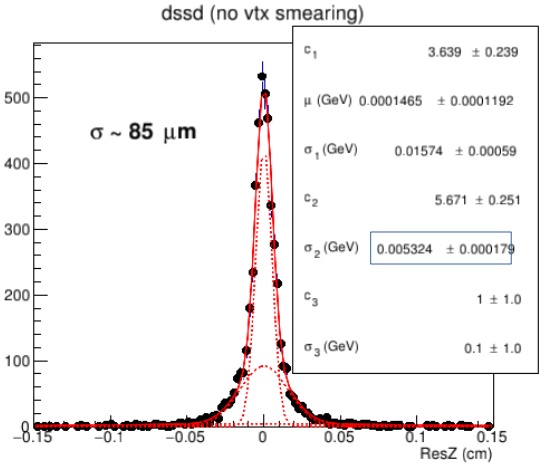


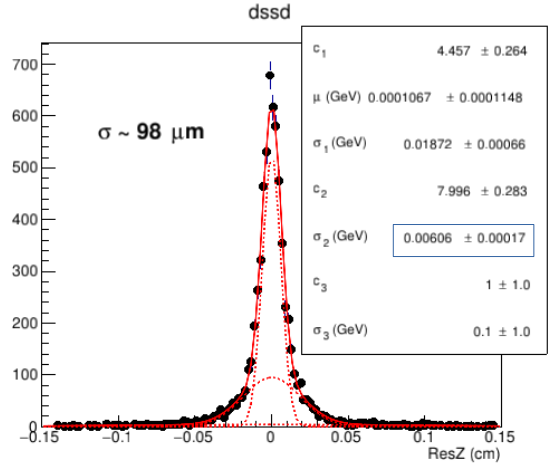
Vertex resolution (DSSD)

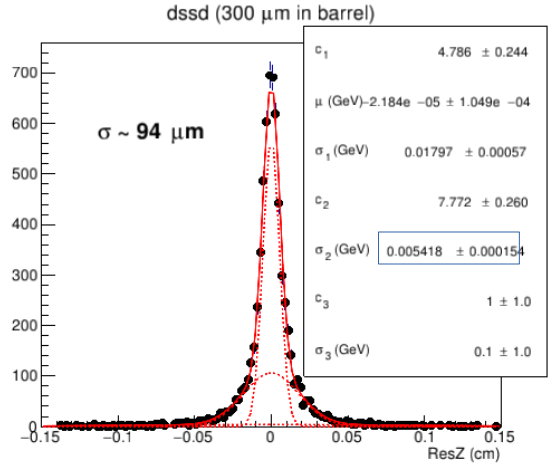












Summary

- More realistic geometry has been implemented. SpdRoot muster brunch has been updated (but not the SimuQsl… to be done soon)
- Initialize geometry with:
  - *mapper→SetGeometryPars(1,1)* for MAPS
  - *mapper→SetGeometryPars(2,2)* for DSSD (inner layer r = 40 mm)
  - *mapper→SetGeometryPars(3,2)* for DSSD (inner layer r = 50 mm, TDR)
- Performance of algorithms should be studied (also talk by V. Andreev on details of algorithms can be expected soon). Parameters of algorithms should be optimized (volunteers?). It might slightly improve the vertex resolution.
- Ongoing work by V. Andreev to separate vertex fitting algorithms from SpdRoot “tasks”.
- Future tasks (volunteers?):
  - What is the optimal set-up for MAPS-based SVD (see talks by at SPD TB)
  - How performance depends on the position of the first layer?
  - How performance depends on the pixel size for MAPS?