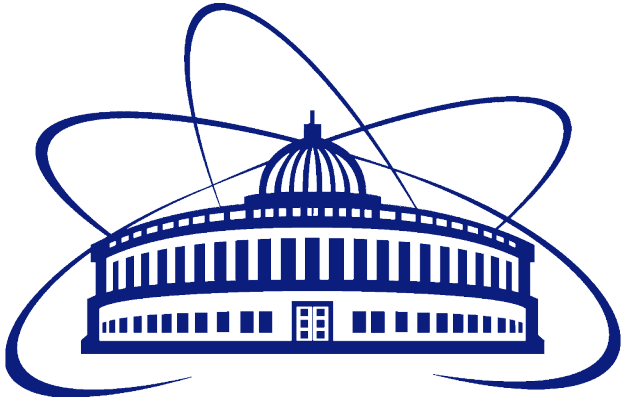
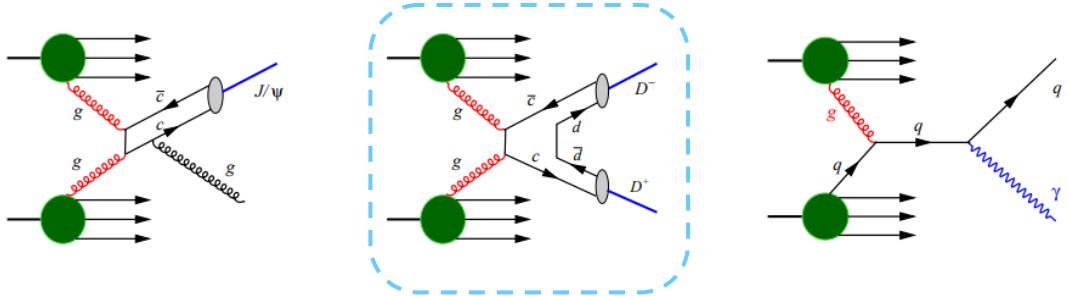
Its (SVD) description in SpdRoot source code

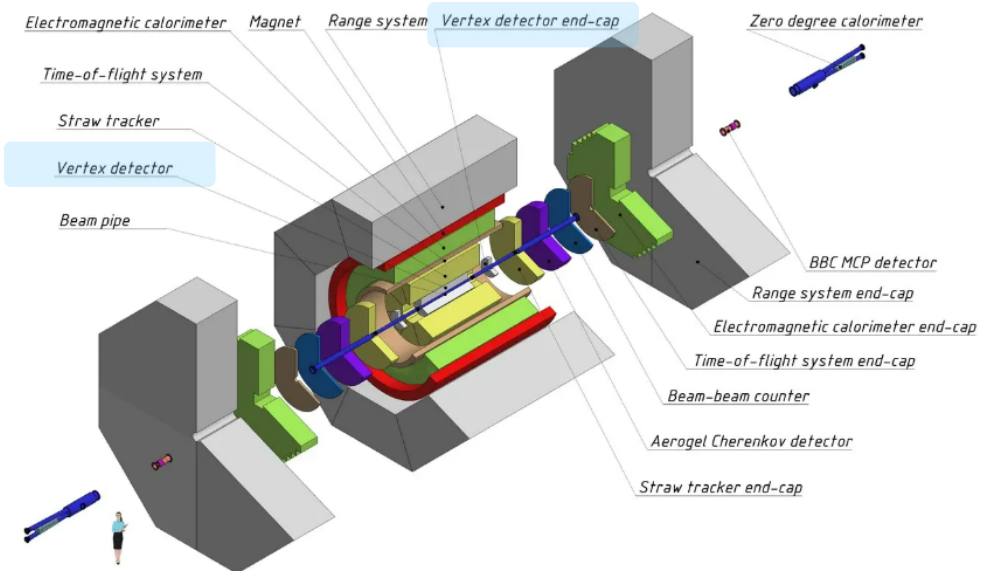
Vasyukov Artem
email: avasyukov@jinr.ru



Silicon Vertex detector

- **Silicon vertex detector** (SVD) is responsible for precise determination of the primary interaction point and measurement of the secondary vertices from the decays of short-lived particles.





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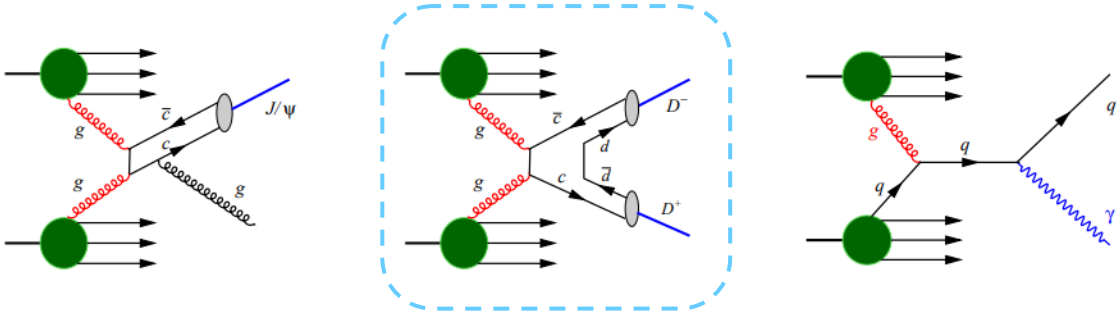
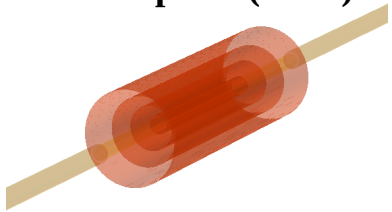


- SVD is planned to be installed in the second stage of SPD operation. On 1st stage Micromegas-beased Central tracker will be installed.
- It is assumed that it will be based on one of two technologies: MAPS (main) and DSSD (backup).

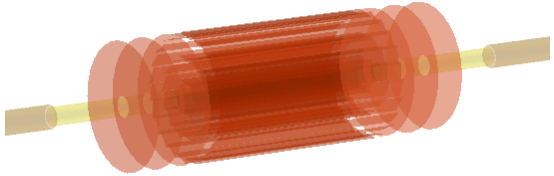
Main requirements:

- Geometry close to 4π;
- Reconstruction efficiency for muons > 99% at p_μ < 13 GeV/c, |η| < 2.5
- Low material budget;
- Coordinate resolution $\sigma_{r,\varphi}$ < 50 μm, σ_z < 100 μm;

MAPS option (main)



DSSD option

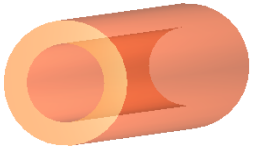


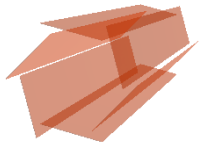
SVD in SpdRoot source code (master) Geometry construction

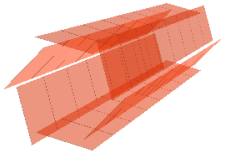
Barrel

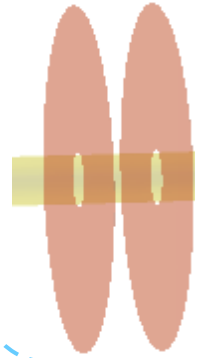
End-Cap

Types of volumes









Geometry level	Level 1	Level 2	Level 3	Level 1
Name	ItsLayer	ItsLadder	ItsChip	ItsEClayer
Material	air	silicon	silicon	silicon
Geometry Shape	TGeoTube	TGeoBox	TGeoBox	TGeoTube
Activity	kFALSE	kFALSE	kTRUE	kTRUE

Implemented only for dssd option

Geometry construction procedure:

<spdroot>/spdgeometry/its

ItsVolPars
Contains classes to simplify working with logical volumes and their nodes

- SpdItsLayer
- SpdItsLadder
- SpdItsChip
- SpdItsEClayer

SpdItsGeoBuilder::ConstructGeometry()

ItsGeoMapperX
- Parameters of logical volumes
- Filling GeoTable with VolPars
- Geometry transformation matrixes

ItsGeoBuilder
- Creating logical volumes
- Creating positioned volumes
- Mother-daughter dependencies

SVD in SpdRoot source code (master) Problems

In the current version of the SpdRoot code there are two points that do not satisfy us in the description of SVD:

1) Currently, the same classes are used to describe both versions of SVD

Fixed

https://indico.jinr.ru/event/4853/#2-status-of-svd-description-in

+ Code flexibility

- Complicates the code
- Changing the description of one of SVD options may affect the other →complication of further development

The selection of a specific version of the internal detector is made using GeoType flags:

```
SpdItsGeoMapperX::Instance()->SetGeometryPars(gtype1, gtype2);
```

layers+ladders parameters
1 - MAPS 2,3 (default) - DSSD

chip parameters
1 - MAPS 2 (default), 3 - DSSD

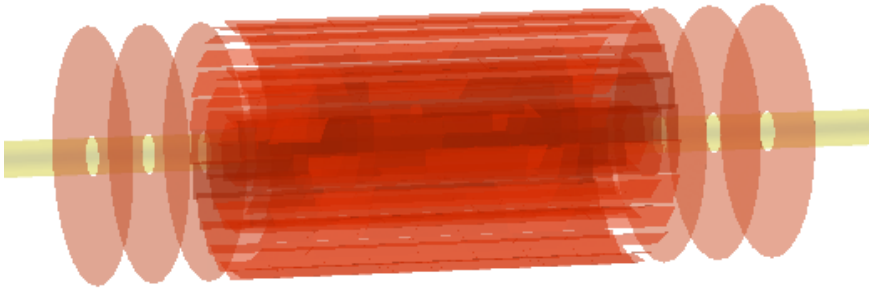
2) The description of End-caps for the MAPS option is not supported.

For MAPS option one should use:

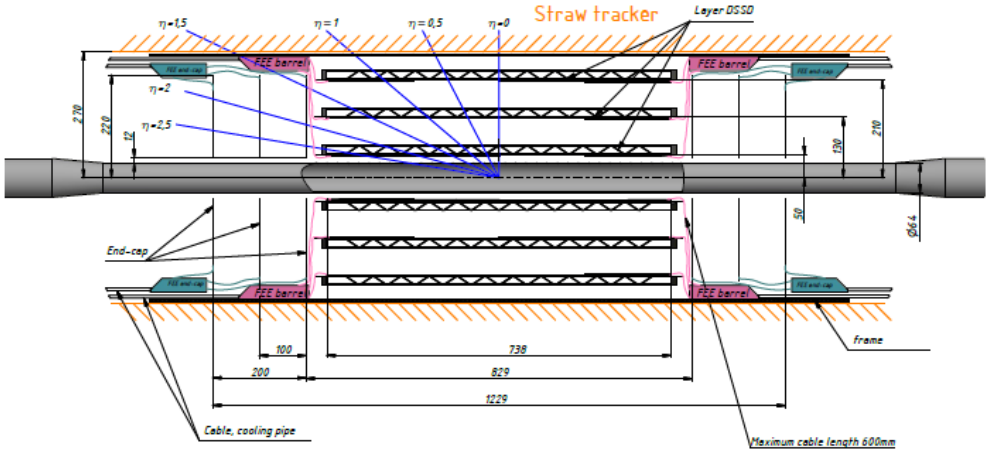
```
SpdItsGeoMapperX::Instance()->EnableEndcaps(0);
```

SVD in SpdRoot source code (master) Dssd

SpdRoot



TDR



- Barrel layer thickness: 500 μm;
- Local rotation angle for ladder: 15 grad;
- End-cap disk parameters:
  - Width: 300 μm;
  - R_{min}: 3.5 cm; (TDR 3.2 cm)
  - R_{max}: 22 cm; (TDR)
- Positions of DSSD end-caps:
  - ± 41.45 cm; (TDR)
  - ± 51.45 cm; (TDR)
  - ± 61.45 cm; (TDR)

After separation 1 possible geotype:

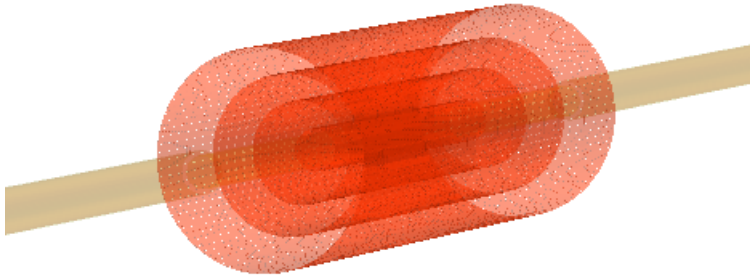
SpdDssdGeoMapper::Instance()→SetGeometryPars(1);

Instead of

SpdItsGeoMapperX::Instance()->SetGeometryPars(3,2);

SVD in SpdRoot source code (master) Maps

SpdRoot



- Barrel layer thickness: 330 μm (0.35%X_0);
- Radii of layers: 40 mm, 96 mm, 152 mm, 210 mm
- The lengths of layers are 762 mm, 889 mm, 1016 mm, 1270 mm (**for no reason**);

After separation 1 possible geotype:

SpdMapsGeoMapper::Instance()→SetGeometryPars(1);

Instead of

SpdItsGeoMapperX::Instance()->SetGeometryPars(1,1);

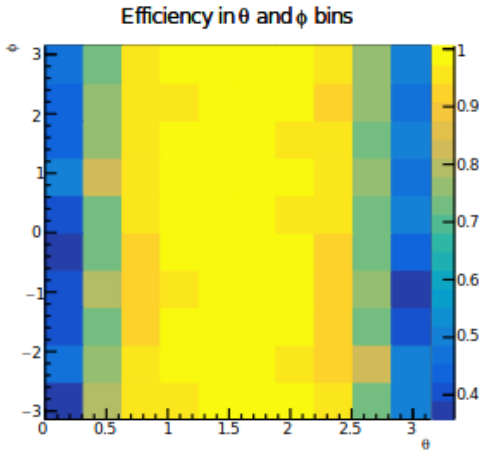
SVD performance test DSSD (no End-Caps)

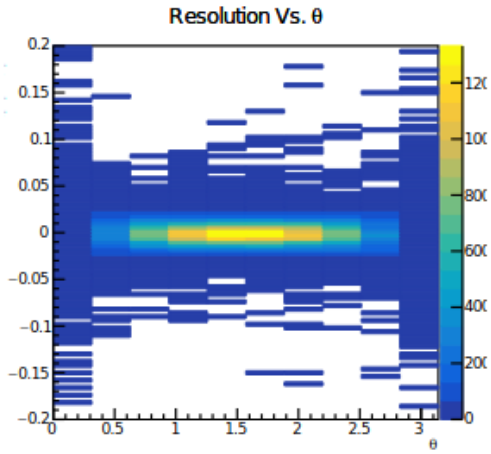
Isotopic production of 1.5 GeV muons at (0, 0, 0) point

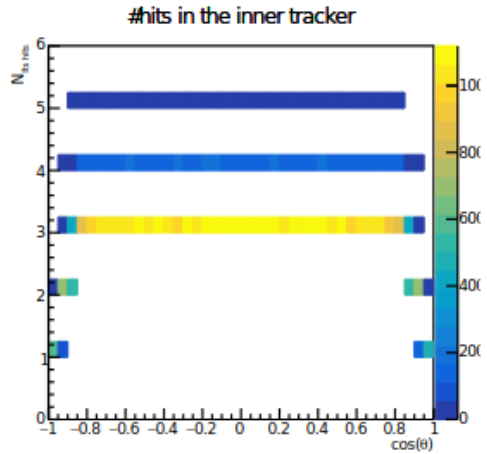
Detector subsystems:

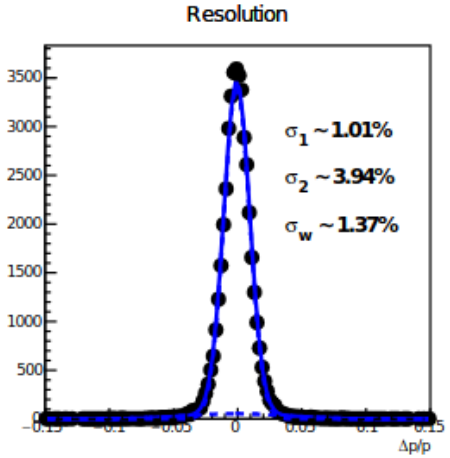
- Dssd SVD
- Straw tracker (barrel + EC)

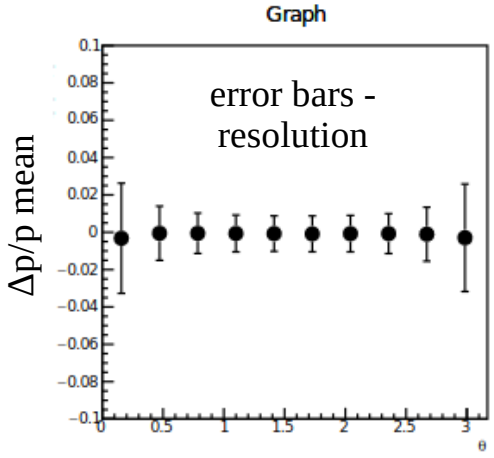
Magnetic field is on

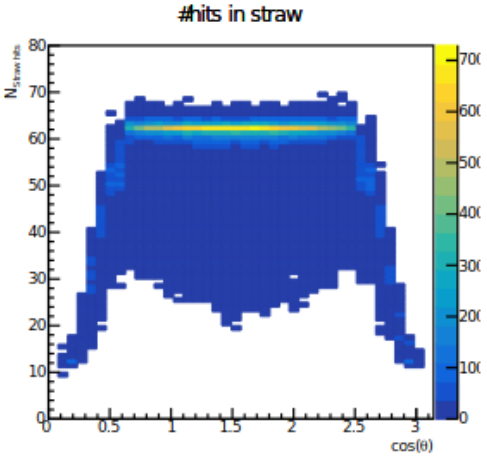












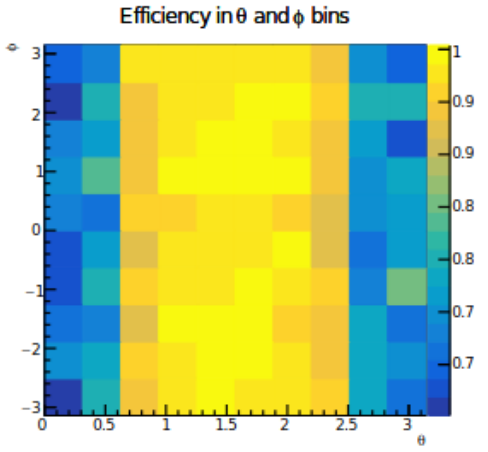
SVD performance test DSSD (with End-Caps)

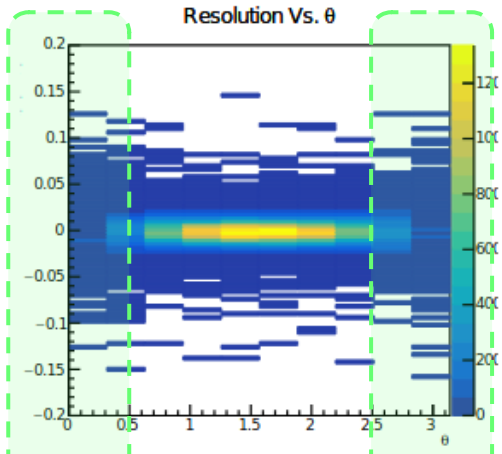
Isotopic production of 1.5 GeV muons at (0, 0, 0) point

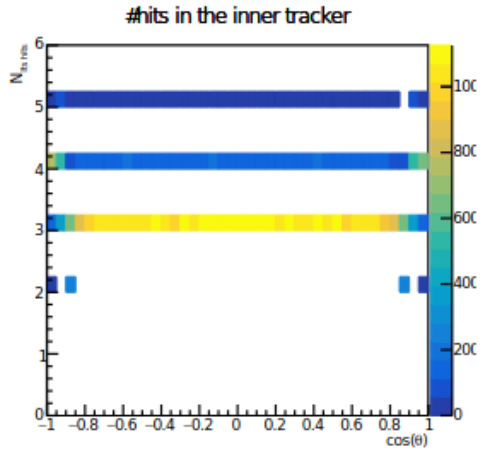
Detector subsystems:

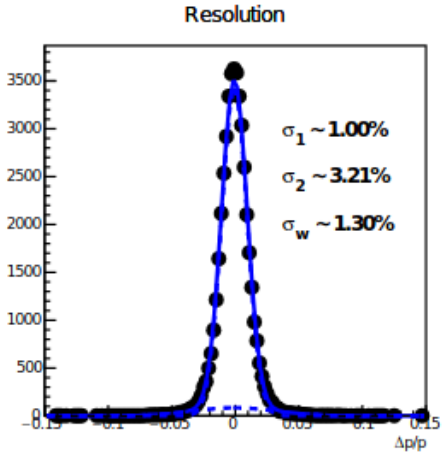
- Dssd SVD
- Straw tracker (barrel + EC)

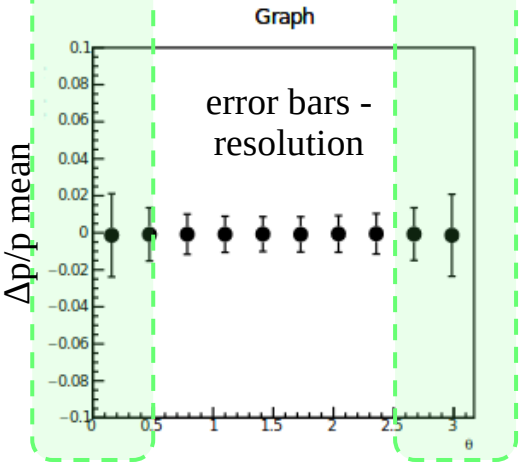
Magnetic field is on

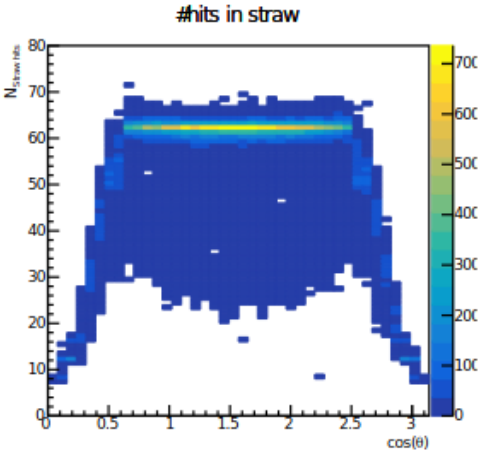












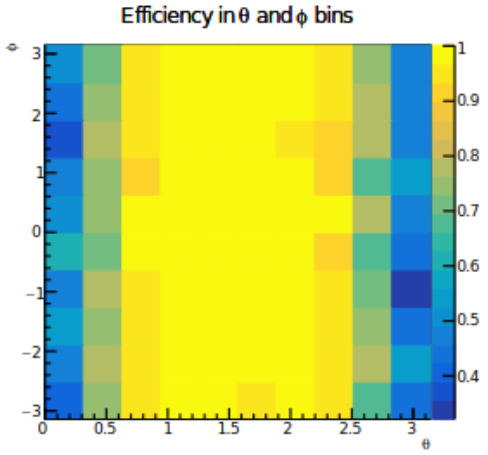
SVD performance test MAPS (no End-Caps)

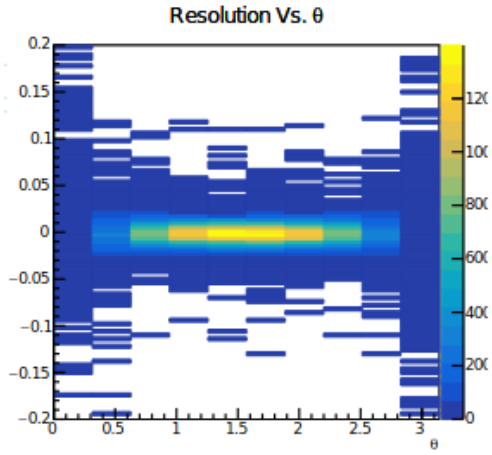
Isotopic production of 1.5 GeV muons at (0, 0, 0) point

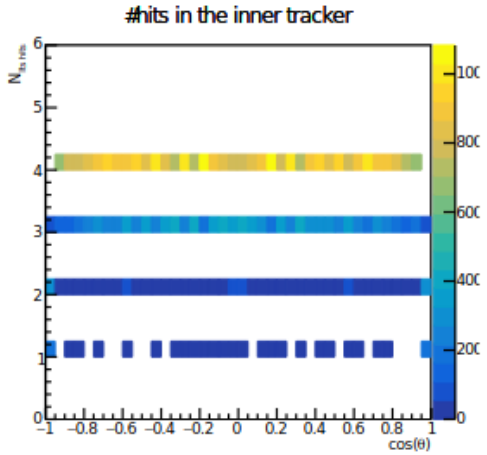
Detector subsystems:

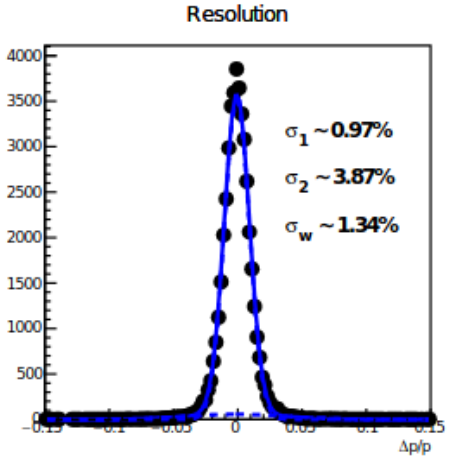
- Dssd SVD
- Straw tracker (barrel + EC)

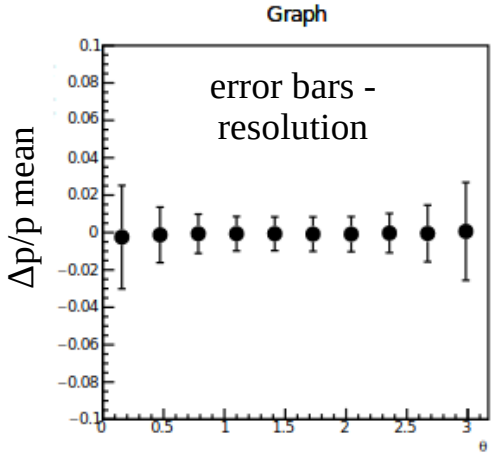
Magnetic field is on

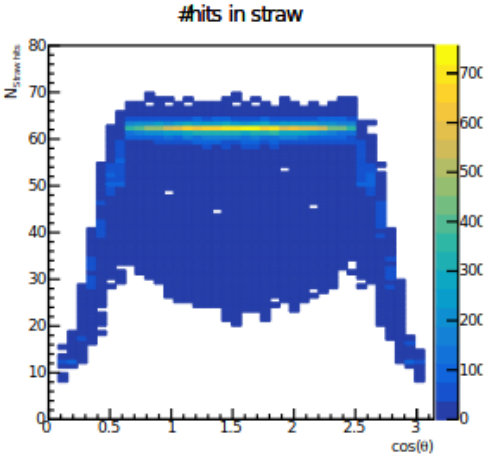






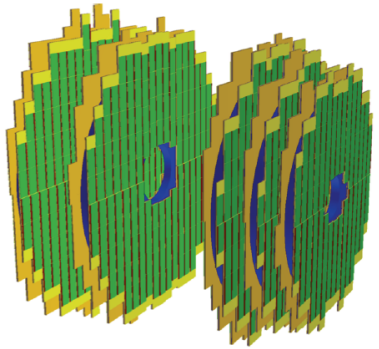




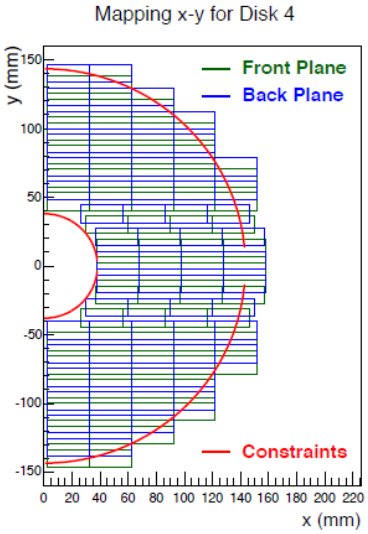


End-cap for MAPS proposal

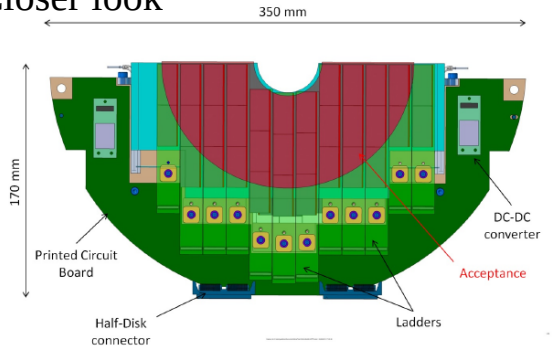
Role model: Muon Forward Tracker (ALICE experiment)
TDR: https://cds.cern.ch/record/1981898
Detector web page: https://alice-collaboration.web.cern.ch/menu_proj_items/MFT

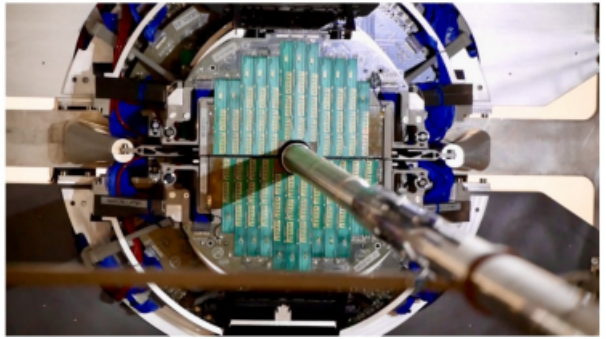


- It is based on Alpide chip architecture;
- Five disks, each one has 2 detection planes;
- The overlap between sensors of the back and front plane ensures the hermeticity of the half-disk
- Material budget: 0.6% X_0 per disk

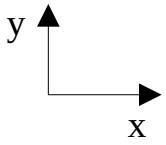


Closer look

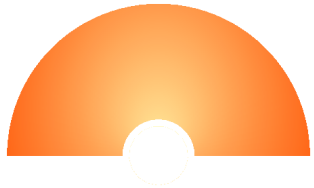


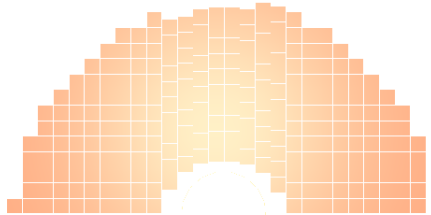


End-cap for MAPS implementation in SpdRoot



Types of volumes

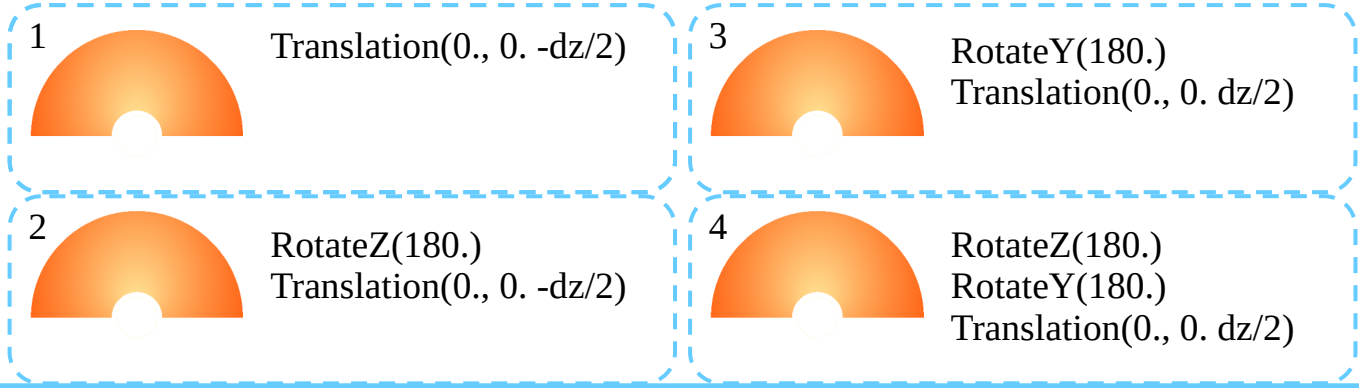




Same objects as for barrel

Geometry level	Level 1	Level 2	Level 3	Level 4
Name	MapsECLayer	MapsECHalfCone	MapsECLadder	MapsECChip
Material	air	air	silicon	silicon
Geometry Shape	TGeoTube	TGeoTubs	TGeoBox	TGeoBox
Activity	kFALSE	kFALSE	kFALSE	kTRUE

MapsECLayer packing:
By default it contains 4 half cones



End-cap for MAPS implementation in SpdRoot

- One EC layer;
- EC Ladder thickness: 290 μm (0.3%X_0)
- EC Layer material budget: 290 + 290 μm of silicon 0.6%X_0 MFT Alice TDR;
- Distance between sensitive planes: 20 mm; (**for no reason**)
- Rmin: 5cm;
- Rmax: 21 cm (as for Barrel);
- Position: ± 69 cm; (**for no reason**)

Future optimization is **needed**

For Maps EC is used the **same** hit production algorithm as for Barrel

N_{chips} per ladder

1	[	1	1]	MapsECChip1 MapsECLadder1
13	[	2	14]	MapsECChip1 MapsECLadder10
11	[	15	25]	MapsECChip1 MapsECLadder11
10	[	26	35]	MapsECChip1 MapsECLadder12
10	[	36	45]	MapsECChip1 MapsECLadder13
10	[	46	55]	MapsECChip1 MapsECLadder14
10	[	56	65]	MapsECChip1 MapsECLadder15
10	[	66	75]	MapsECChip1 MapsECLadder16
11	[	76	86]	MapsECChip1 MapsECLadder17
12	[	87	98]	MapsECChip1 MapsECLadder18
13	[	99	111]	MapsECChip1 MapsECLadder19
5	[	112	116]	MapsECChip1 MapsECLadder2
12	[	117	128]	MapsECChip1 MapsECLadder20
12	[	129	140]	MapsECChip1 MapsECLadder21
11	[	141	151]	MapsECChip1 MapsECLadder22
10	[	152	161]	MapsECChip1 MapsECLadder23
9	[	162	170]	MapsECChip1 MapsECLadder24
8	[	171	178]	MapsECChip1 MapsECLadder25
7	[	179	185]	MapsECChip1 MapsECLadder26
5	[	186	190]	MapsECChip1 MapsECLadder27
7	[	191	197]	MapsECChip1 MapsECLadder3
8	[	198	205]	MapsECChip1 MapsECLadder4
9	[	206	214]	MapsECChip1 MapsECLadder5
10	[	215	224]	MapsECChip1 MapsECLadder6
11	[	225	235]	MapsECChip1 MapsECLadder7
12	[	236	247]	MapsECChip1 MapsECLadder8
12	[	248	259]	MapsECChip1 MapsECLadder9

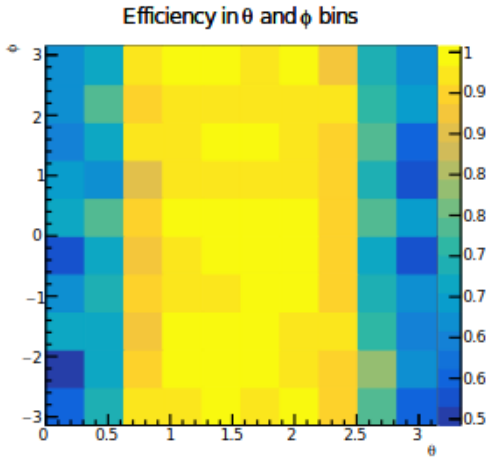
Performance test

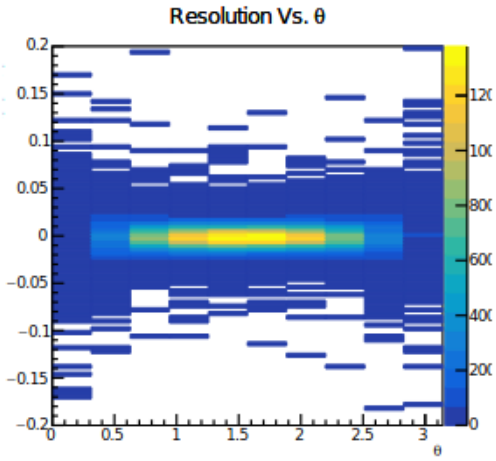
Isotopic production of 1.5 GeV muons at (0, 0, 0) point

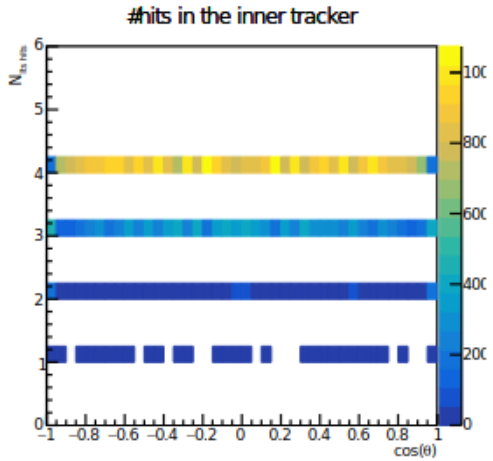
Detector subsystems:

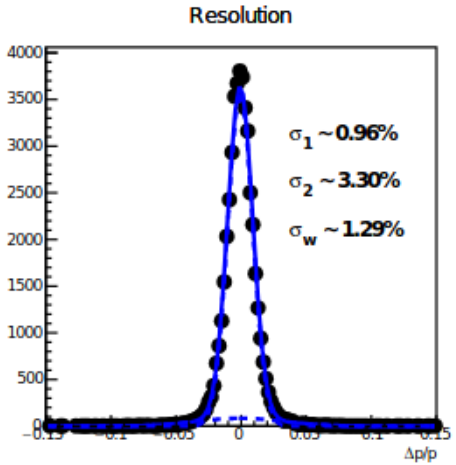
- Dssd SVD
- Straw tracker (barrel + EC)

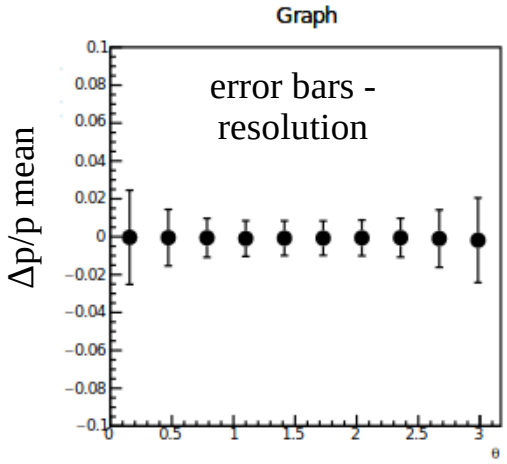
Magnetic field is on

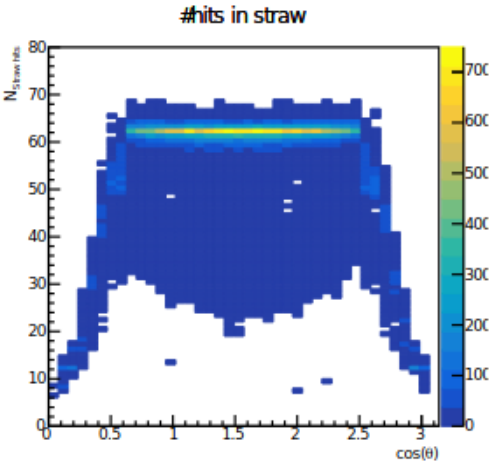




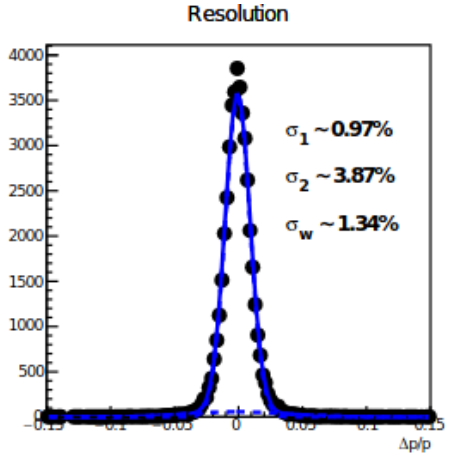
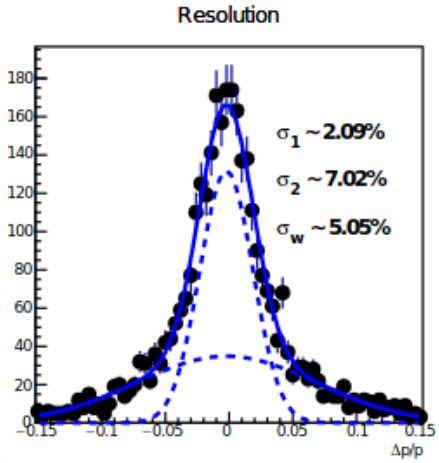
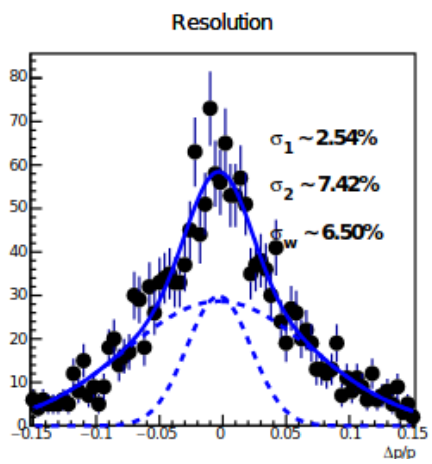
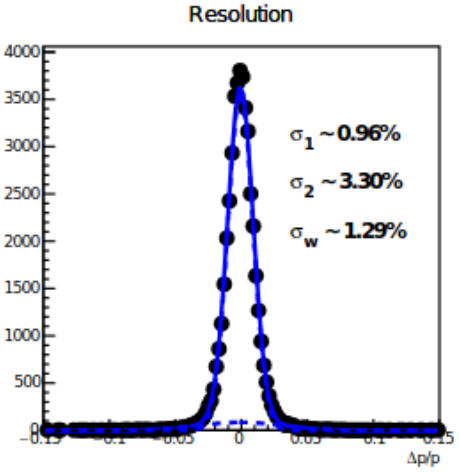
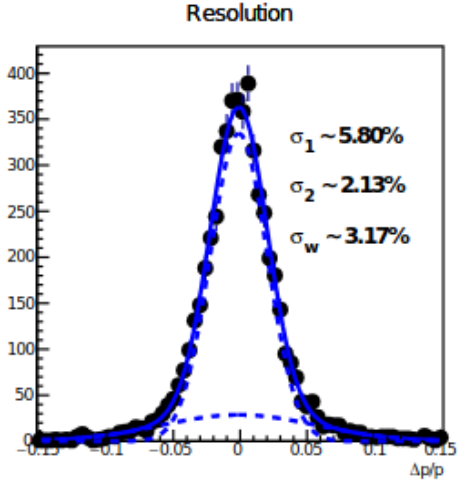
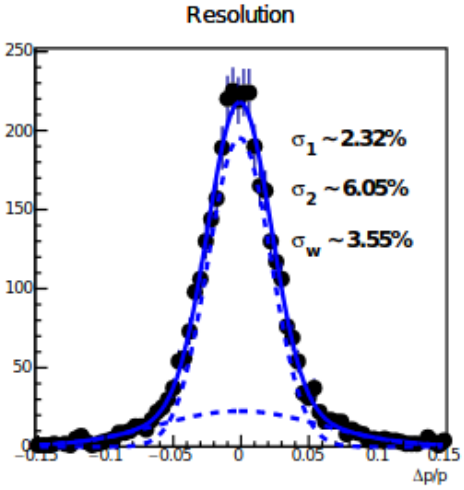








Performance test comparing with no Ens-cap MAPS option

	4π average	|η| > 1.9 average	|η| > 2.1 average
no EC			
With EC			

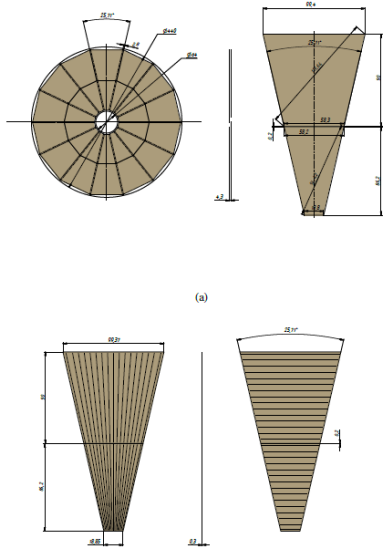
Conclusion and plans

- The descriptions of the MAPS and DSSD detectors have been completely separated in source code;
- End-caps description for MAPS has been developed. Further optimization study is needed;
- Using MAPS EC improves momentum resolution in large pseudorapidity region;
- Confirmation from Physical coordinator is expected to make changes to the development branch;

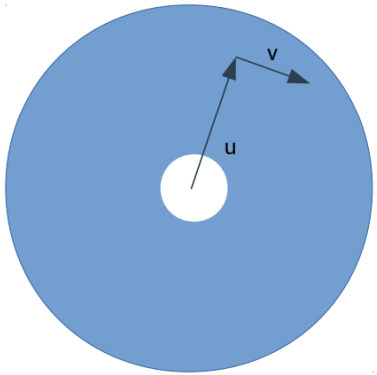
To do:

- Push updates in development branch of SpdRoot main repository.
- Realistic description of DSSD End-caps

TDR



SpdRoot



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.);
```

https://indico.jinr.ru/event/3317/contributions/18119/attachments/13663/22684/Denisenko_SVD.pdf

Thank you for your attention!

Performance test |η| < 2.5