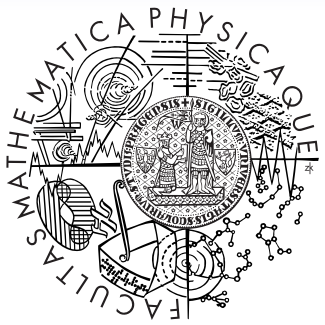


# VXD Alignment: Phase II

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# Outline

VXD Alignment of Phase II

Results of alignment procedure

Alignment validation using collision and cosmic data

Summary

# Status of VXD alignment

- First calculated VXD alignment is done and published in ”Calibration_Offline_Development”.
- It can be used for reprocessing.
- We are using it for validation on collision and cosmic data.
- We are working on (semi-)automatic alignment and validation procedure.
- We are calculate VXD alignment separately to check alignment parameters.
- The both alignment are discussed.

# VXD Alignment procedure

## Cosmic rays

- (Experiment 2) Runs 904, 905, 906, 919, 920, 938, 1107 and 1110 are used for alignment and validation.
- We collected more than 70 0000 cosmic tracks.
- Tracking information of cosmic rays looks very good.
- Applied PXD and SVD masking procedure during reconstruction.

## Beam collision datasets

- (Experiment 3) Runs 577, 578, 579, 580, 674, 677, 686, 782, 783, 785 and 786 are used for alignment and validation.
- We collected more than 70 0000 cosmic tracks.
- Applied PXD and SVD masking procedure during reconstruction.

# VXD alignment procedure

- We are fixing CDC. It is dependent of CDC alignment
- We are using magnetic fields depends on experimental number.
- We are fixing all half-shells and ladders (in alignment hierarchy).
- The Millepede algorithm calculates 108 (18 sensors $\times$ 6) parameters

## Alignment studies using cosmic rays

- The Millepede algorithm is using 50 krecords.
- Alignment validation are used too.

## Alignment studies using collision data

- The Millepede algorithm is using 30 krecords.
- RecoTracks composed via CDCHits and (PXDHits or SVDHits).
- VXDHits more or equal to 3.
- Alignment validation are used too.

VXD Alignment of Phase II

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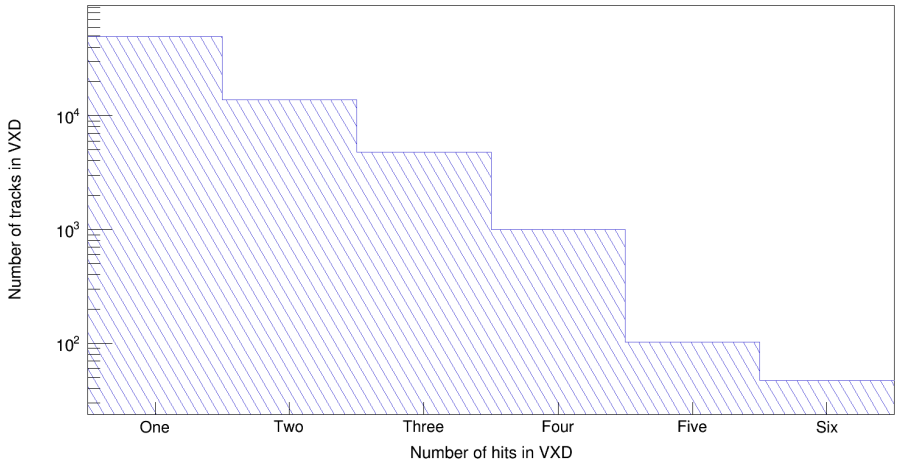
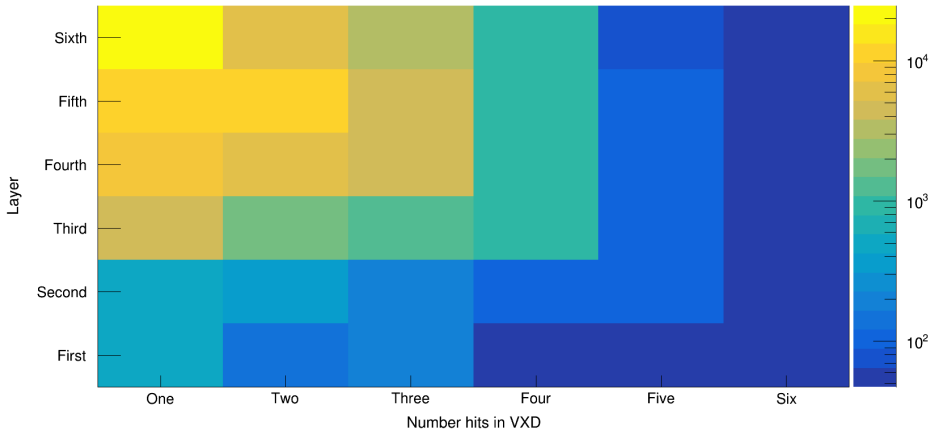
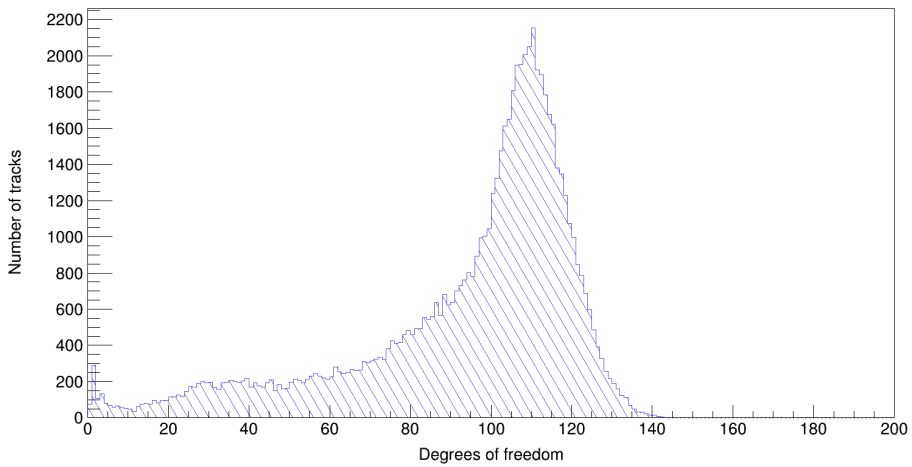
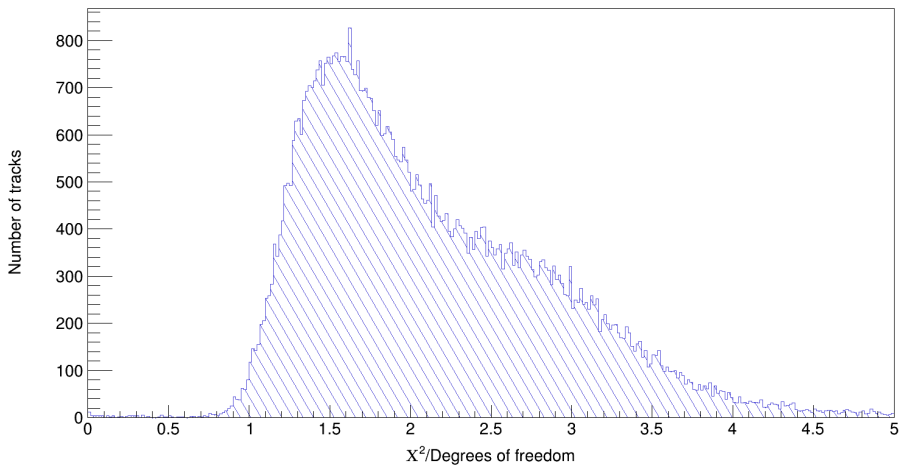
# Occupancy and tracking quality of cosmic rays



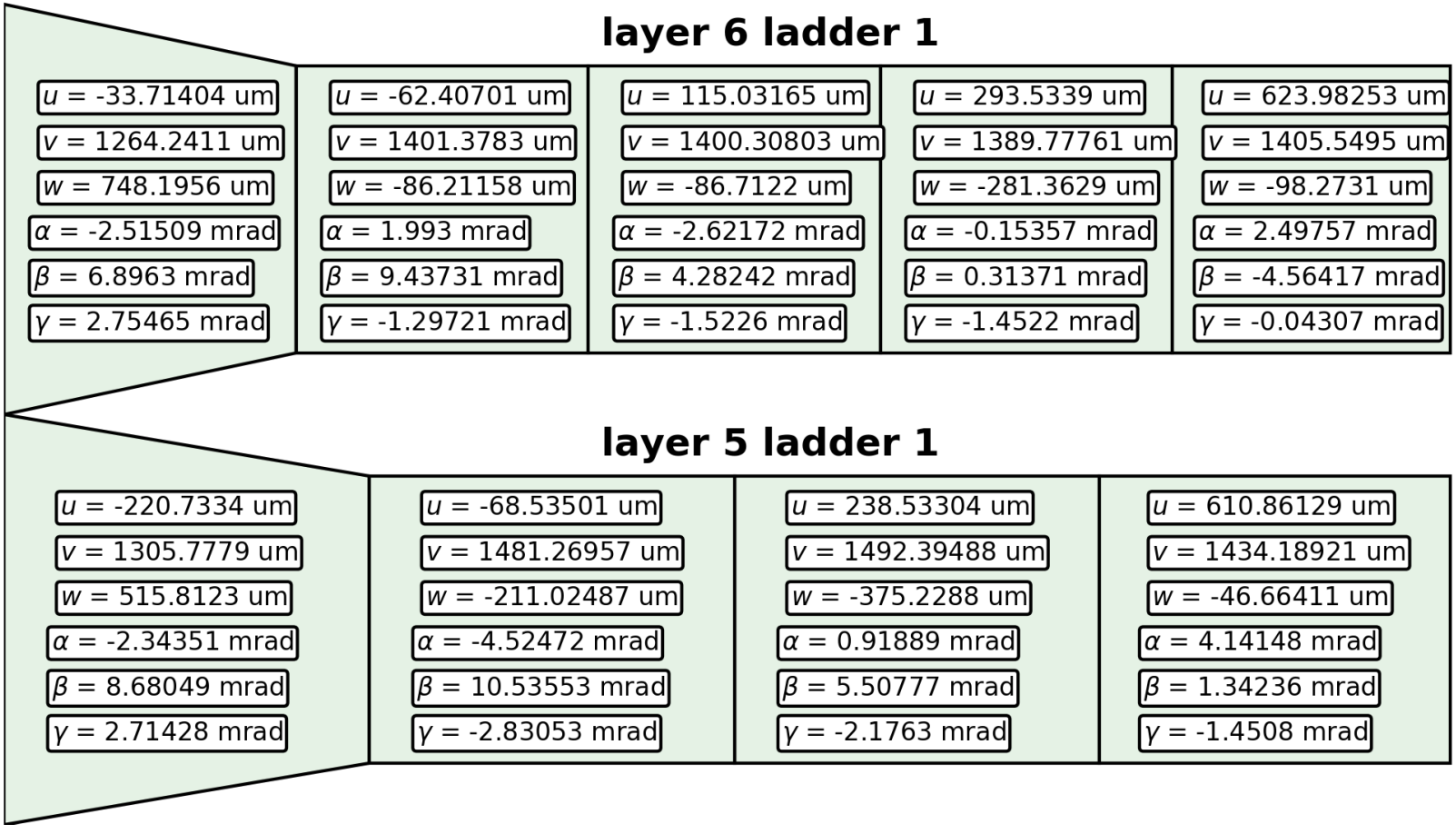

Number of VXD hits in tracks (left) and occupancy of VXD layers (right).




Number degrees of freedom (NDF) on track (left) and $\chi^2/NDF$ of tracks (right).

# New SVD alignment



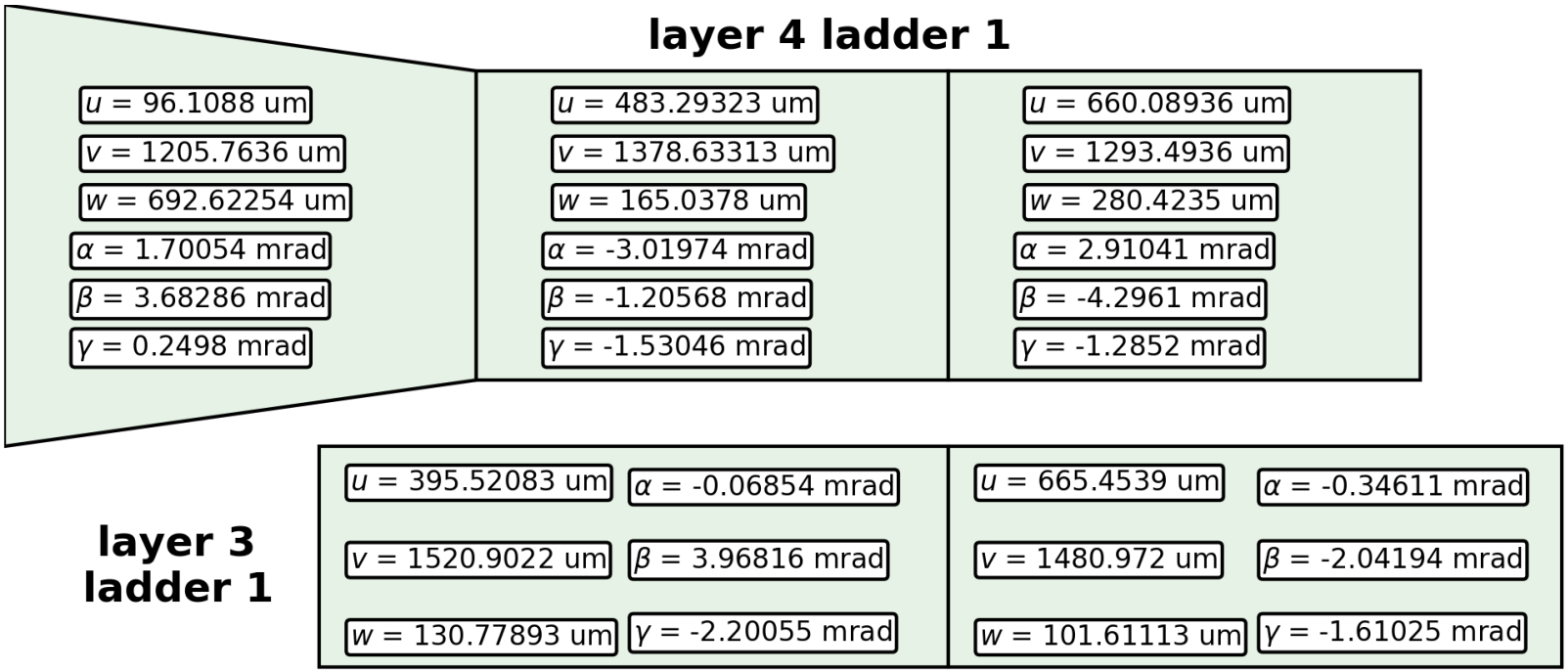

Results of alignment procedure using cosmic rays and collisions.

The largest shift is in $v(z)$ alignment parameters.

Sum of systematic and statistic errors for shifts are $\approx$ 100 um.

Sum of systematic and statistic errors for rotations are $\approx$ 1.0 mrad.

# New SVD alignment



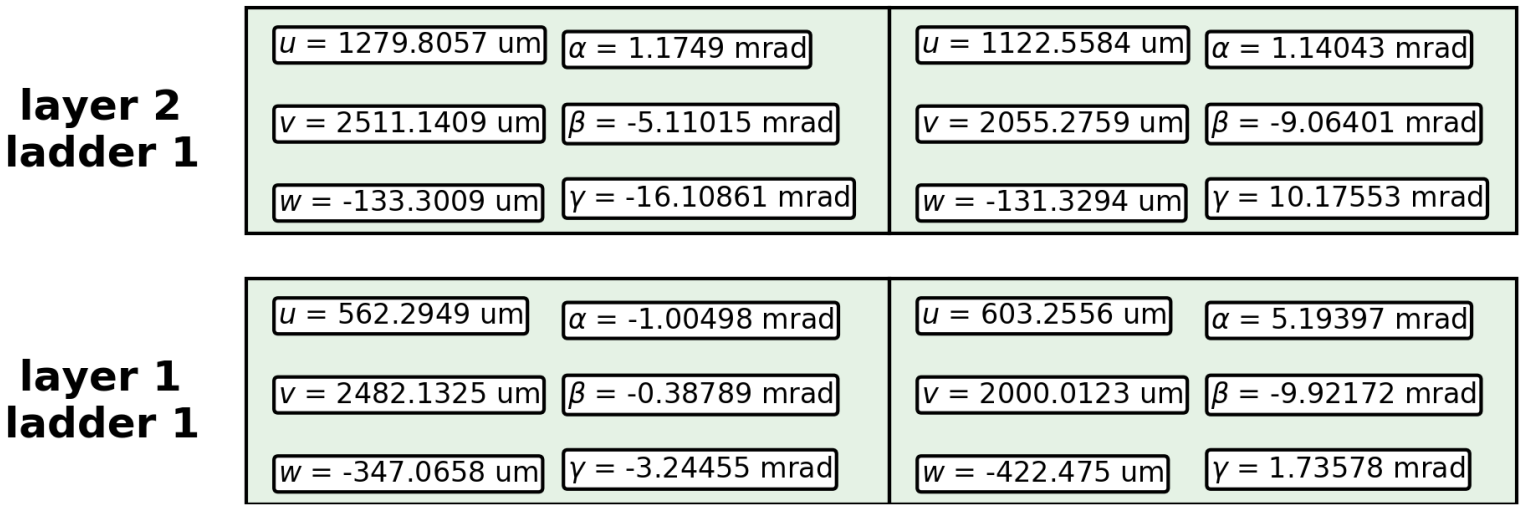

Results of alignment procedure using cosmic rays and collisions.

The largest shift is in $v(z)$ alignment parameters.

Sum of systematic and statistic errors for shifts are $\approx$ 100 um.

Sum of systematic and statistic errors for rotations are $\approx$ 1.0 mrad.

# New PXD alignment




Results of alignment procedure using cosmic rays and collisions.

The largest shift is in $v(z)$ alignment parameters.

Sum of systematic and statistic errors for shifts are $\approx$ 100 um.

Sum of systematic and statistic errors for rotations are $\approx$ 1.0 mrad.

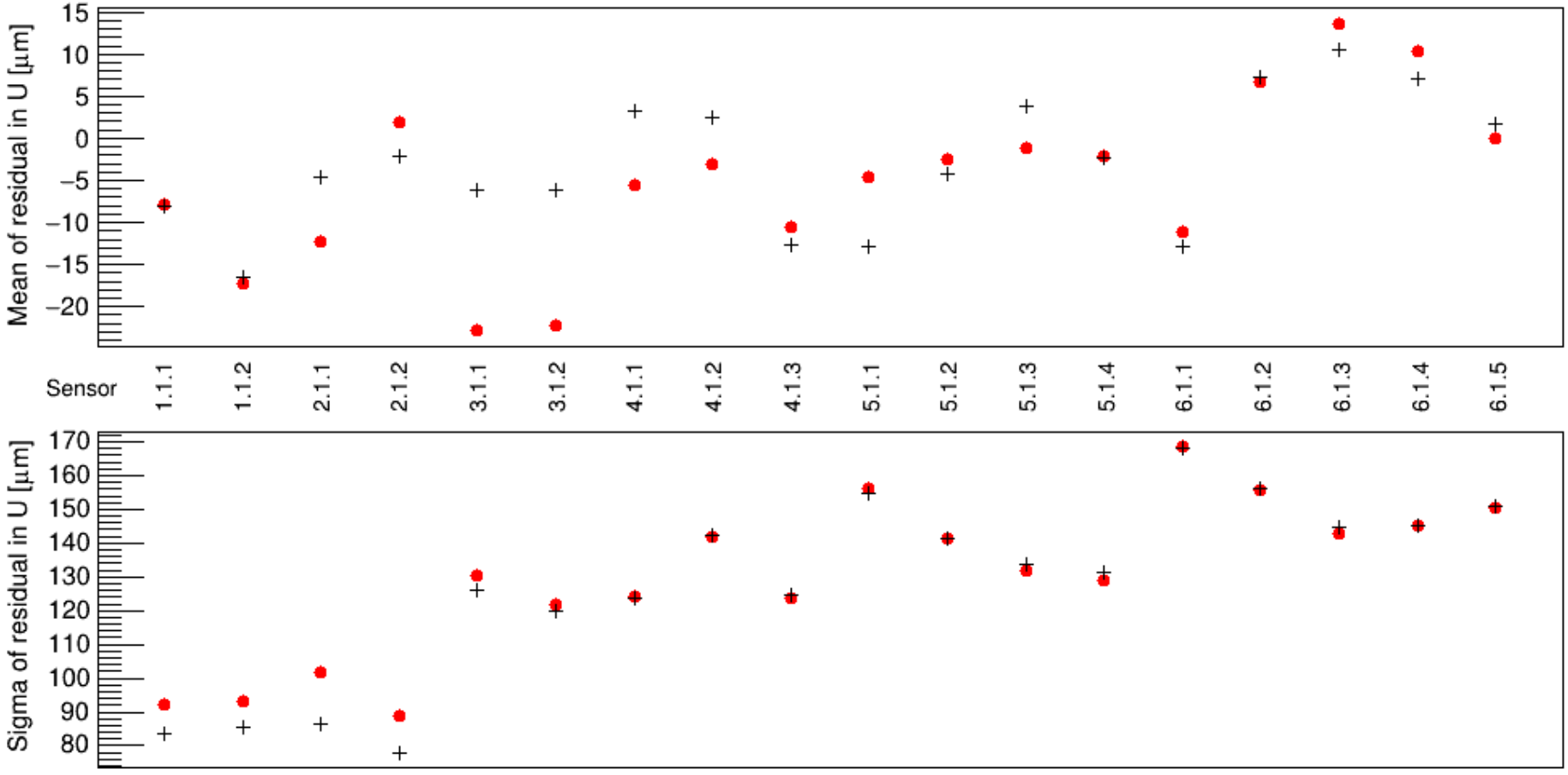
VXD Alignment of Phase II

Results of alignment procedure

Alignment validation using collision and cosmic data

Summary

# VXD alignment validation using cosmic rays

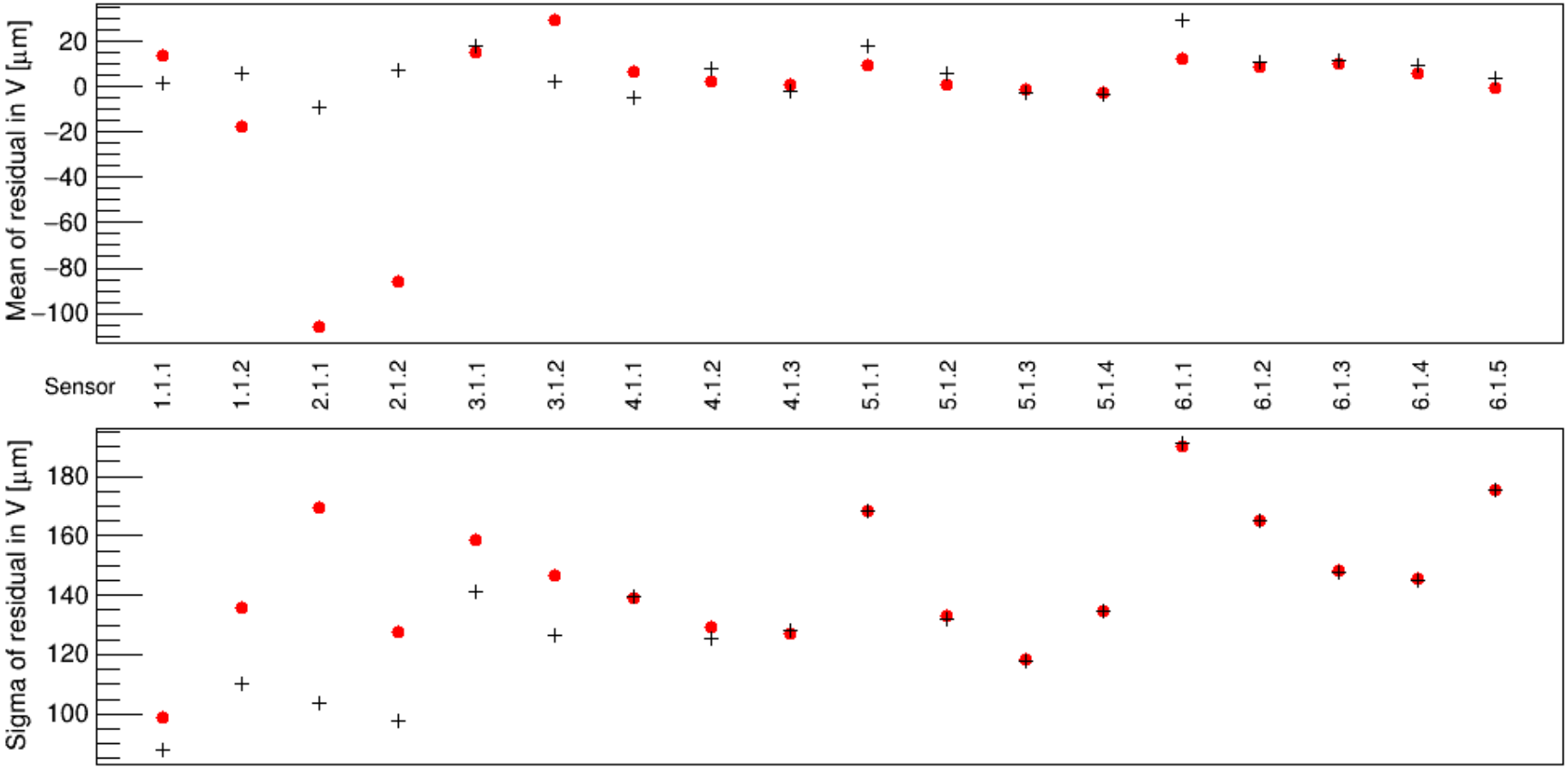



Unbiased residuals for all VXD sensors in phase 2 in U side.

Results calculated using **GT** are marked as **red dots**.

Results calculated using **new alignment** are marked as **black crosses**.

# VXD alignment validation using cosmic rays

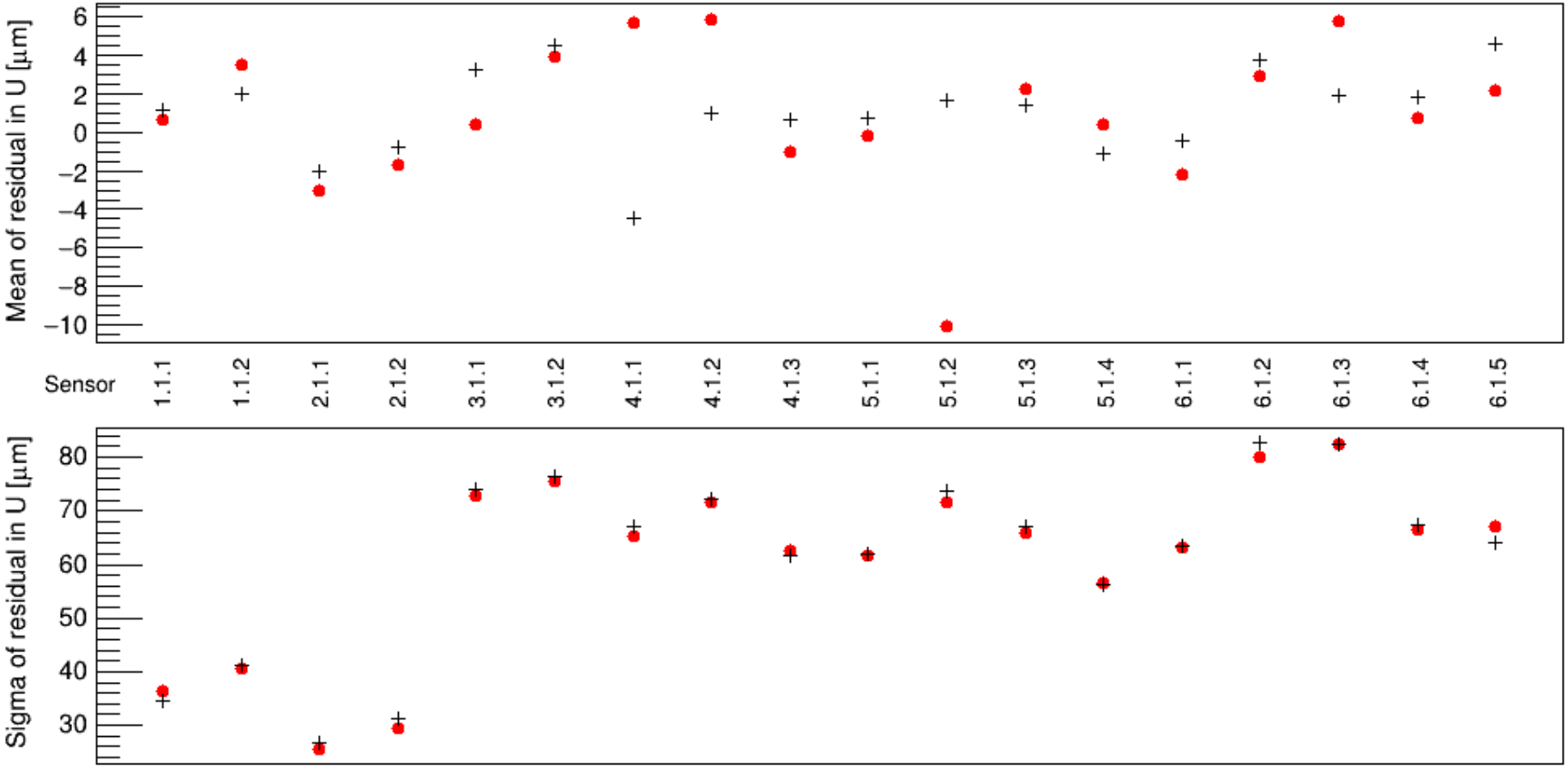



Unbiased residuals for all VXD sensors in phase 2 in V side.

Results calculated using **GT** are marked as **red dots**.

Results calculated using **new alignment** are marked as **black crosses**.

# VXD alignment validation using collision data




Unbiased residuals for all VXD sensors in phase 2 in U side.

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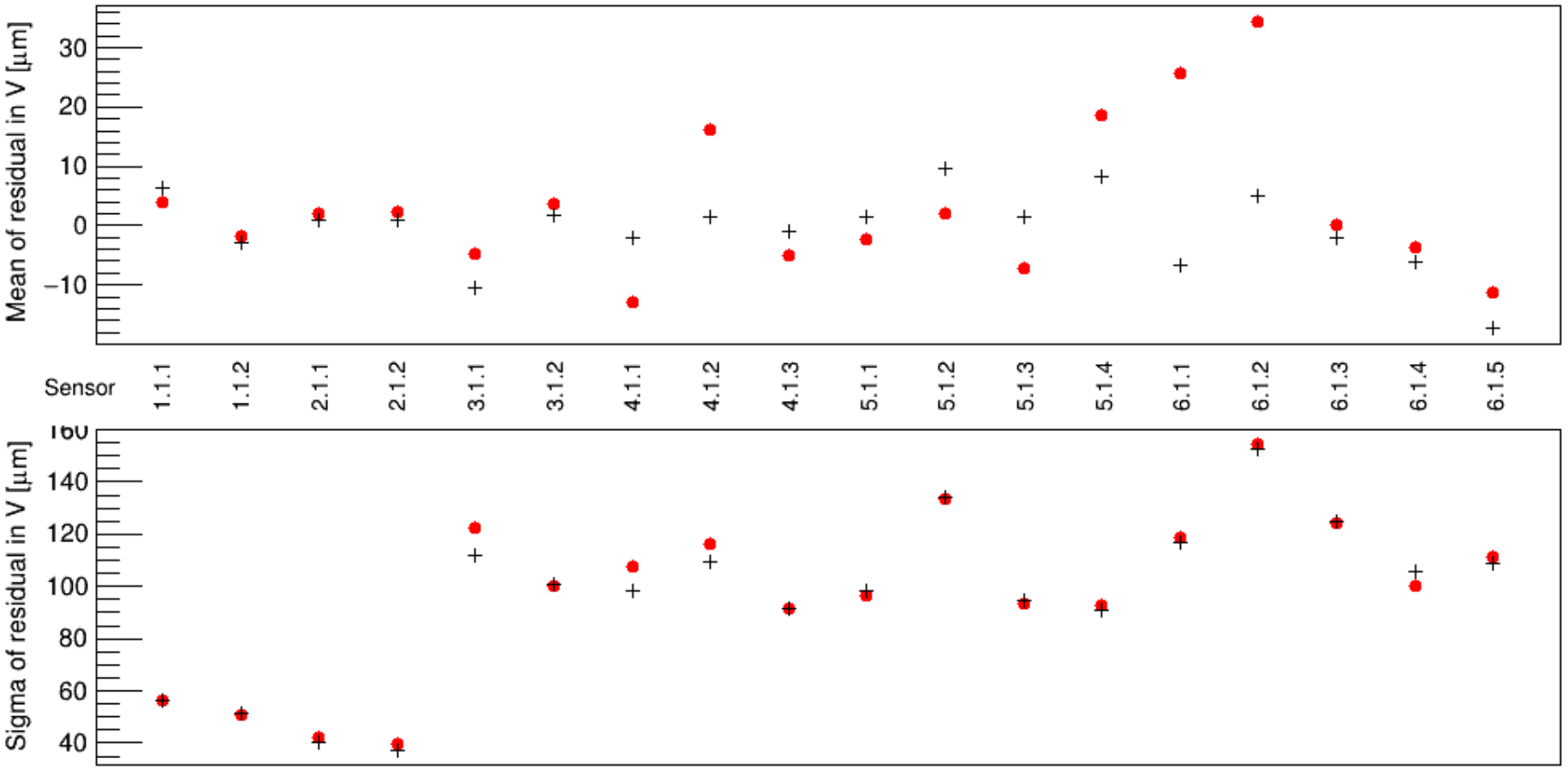
Results calculated using **new alignment** are marked as **black crosses**.

# VXD alignment validation using collision data




Unbiased residuals for all VXD sensors in phase 2 in V side.

Results calculated using **GT** are marked as **red dots**.

Results calculated using **new alignment** are marked as **black crosses**.

# Summary

- We were calculate two independent alignment for checking alignment procedure.
- One of them is published in GT ”Calibration_Offline_Development” (back-up)
- Second is stored locally only

`/home/belle2/jkandra/basf2/beam/alignment/phase2/data/cosmicAndBeam/database.txt`

- Systematic and statistical errors are $\approx$ 100 um and 1.0 mrad.
- Alignment constants are validated using cosmic rays and collisions.
- The alignment and validation procedure are semi-automatic.

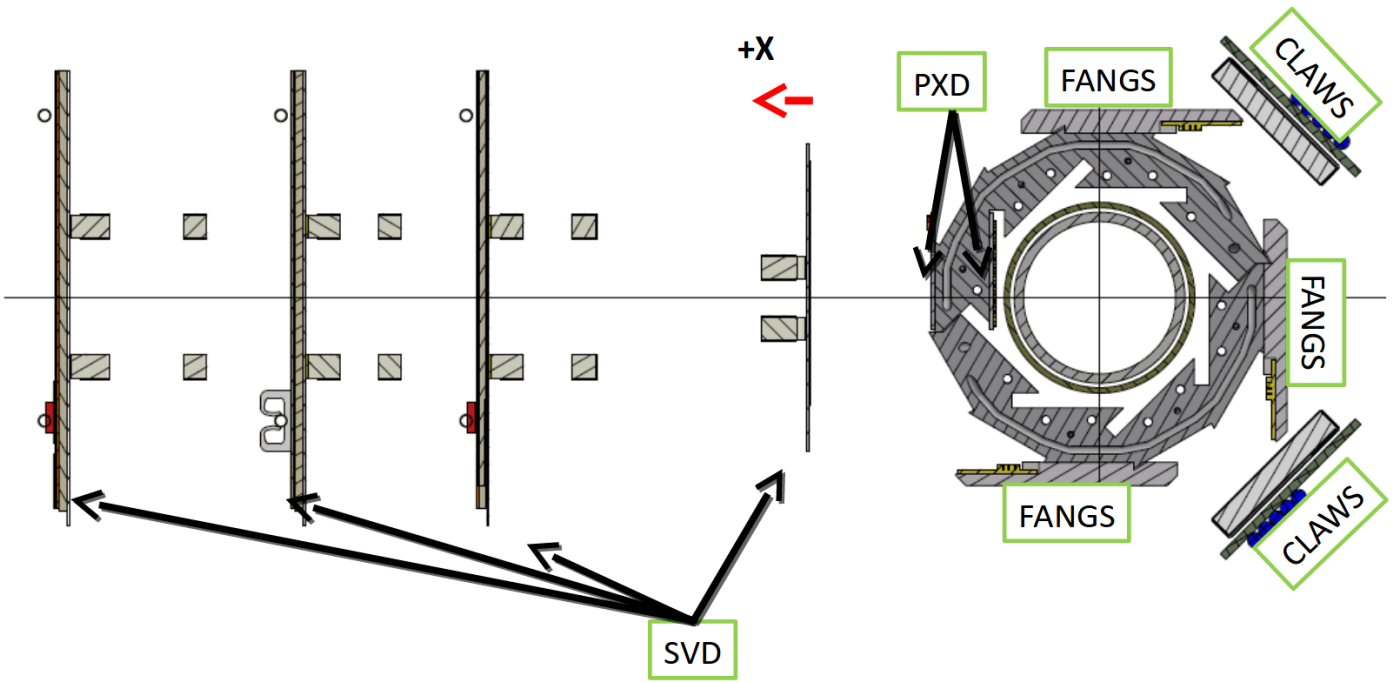
## Plans for next weeks

- Time dependent analysis of validation variables (residuals).
- Developed full automatized procedure to validate and calculate alignment.
- The second alignment parameters will be updated to GT soon.

# Backup

# Geometry of Phase II

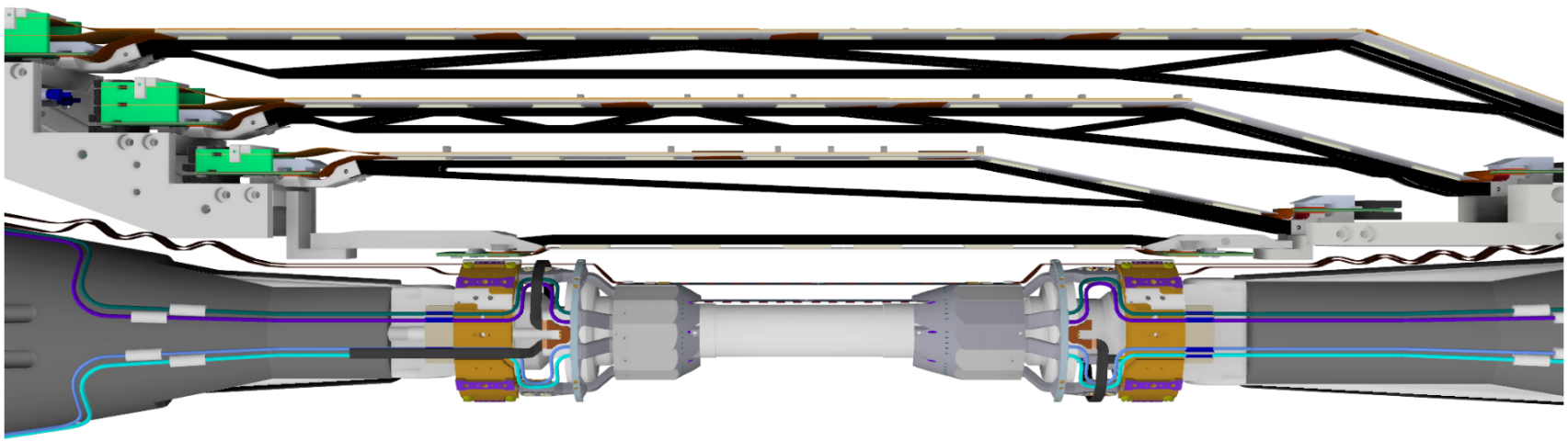
- ECL, CDC, VXD and Beast will be used.
- VXD: One ladder in each layer
- VXD: 4 sensors of PXD and 14 sensors of SVD
- Beast: Dedicated radiation monitors (FANGS, CLAWS, PLUME)
  - $\phi_{FANGS} = \{90°, 180°, 270°\}$
  - $\phi_{CLAWS} = \{135°, 225°\}$
  - $\phi_{PLUME} = \{135°, 225°\}$




VXD and Beast Geometry of VXD.

# Geometry of Phase II

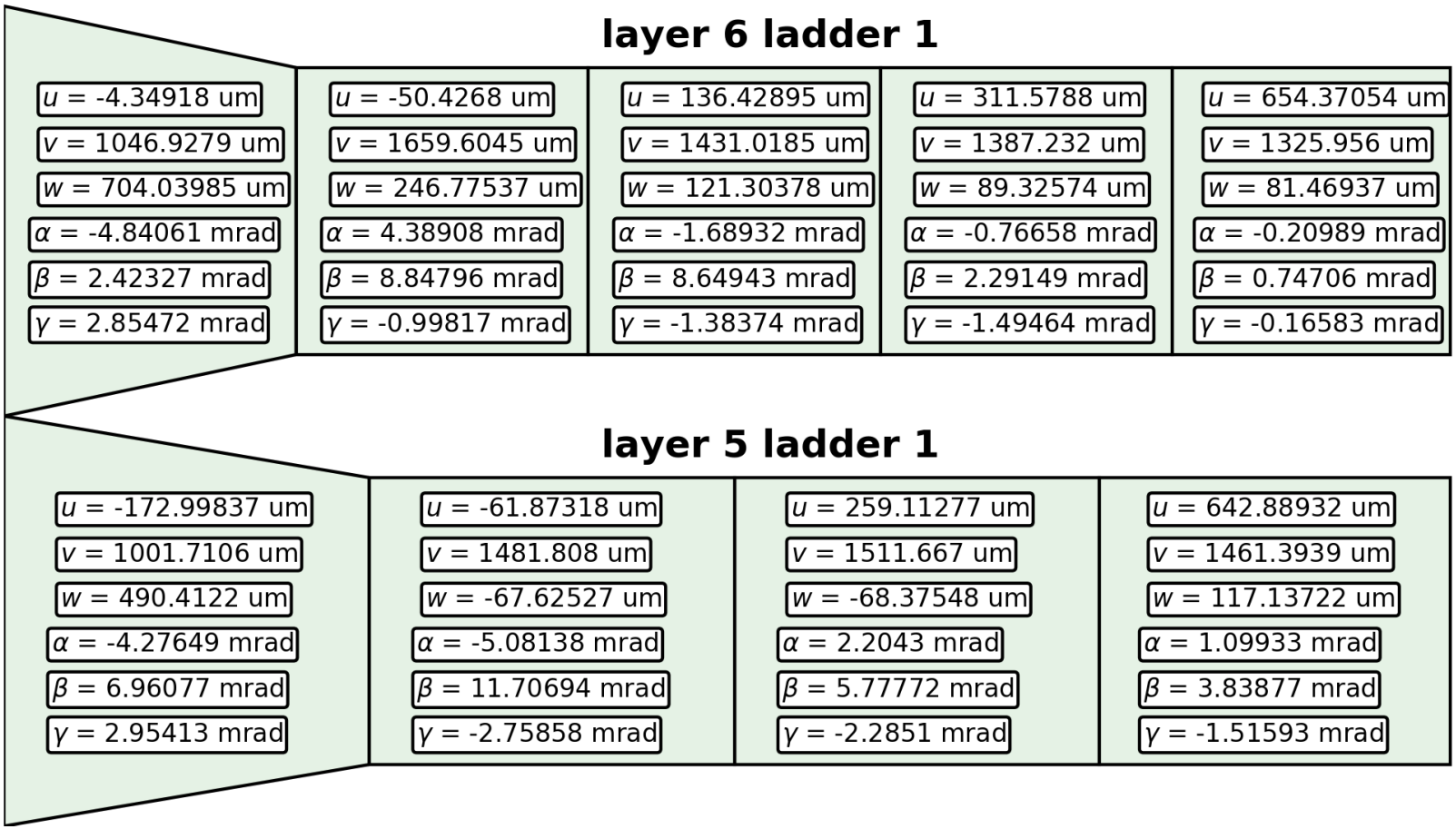
- Similar geometry as in VXD DESY TestBeam 2017
- Difference between Phase II and VXD DESY TestBeam 2017:
  - VXD TB 2017: narrow beam of $e^-$
  - VXD TB 2017: beam is perpendicular to planes of sensors
  - VXD TB 2017: low beam background and no cosmic rays
  - Phase II: particles from collisions
  - Phase II: particles fly out from the IP to all $\theta$ directions
  - Phase II: realistic beam background and cosmic rays




Geometry of Phase II in XZ direction.

Horizontal plane for highest background sensitivity (+X direction).

# SVD alignment in GT




Results of alignment procedure published in GT.

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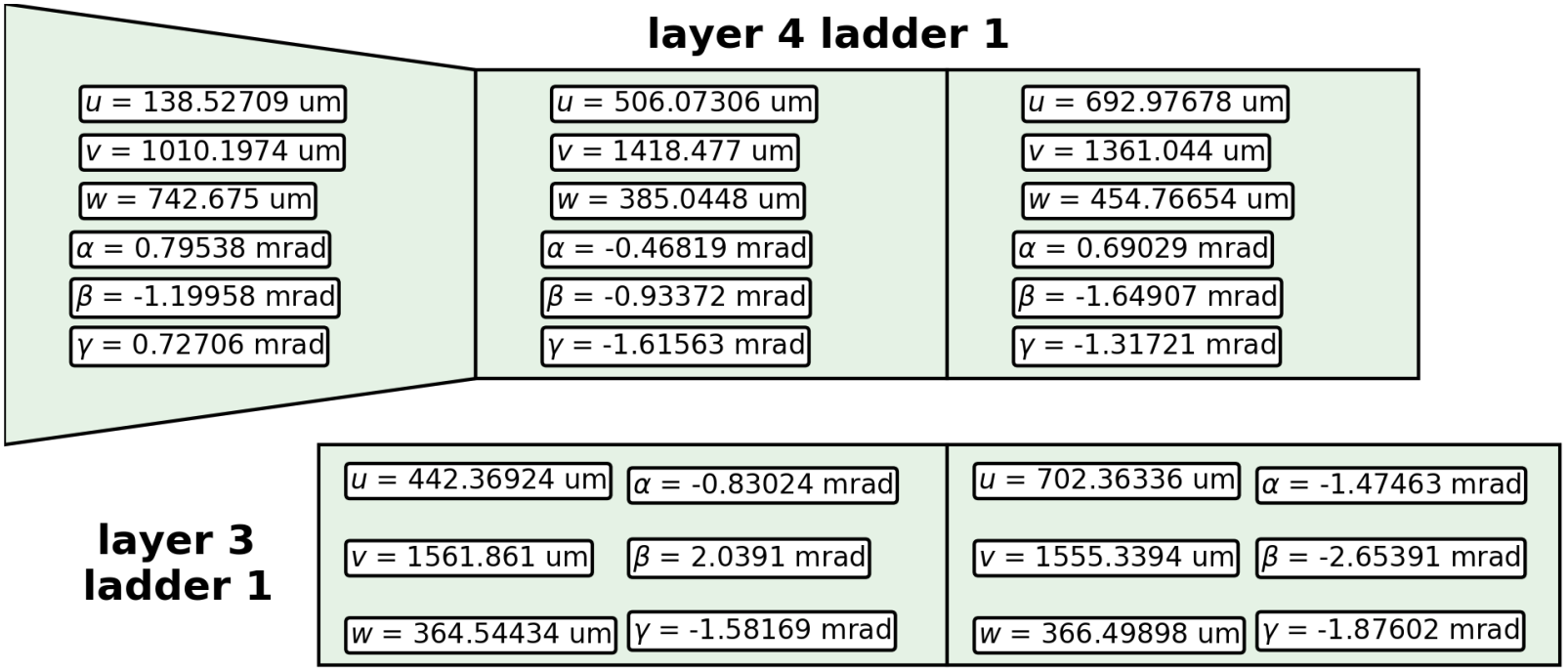
# SVD alignment in GT



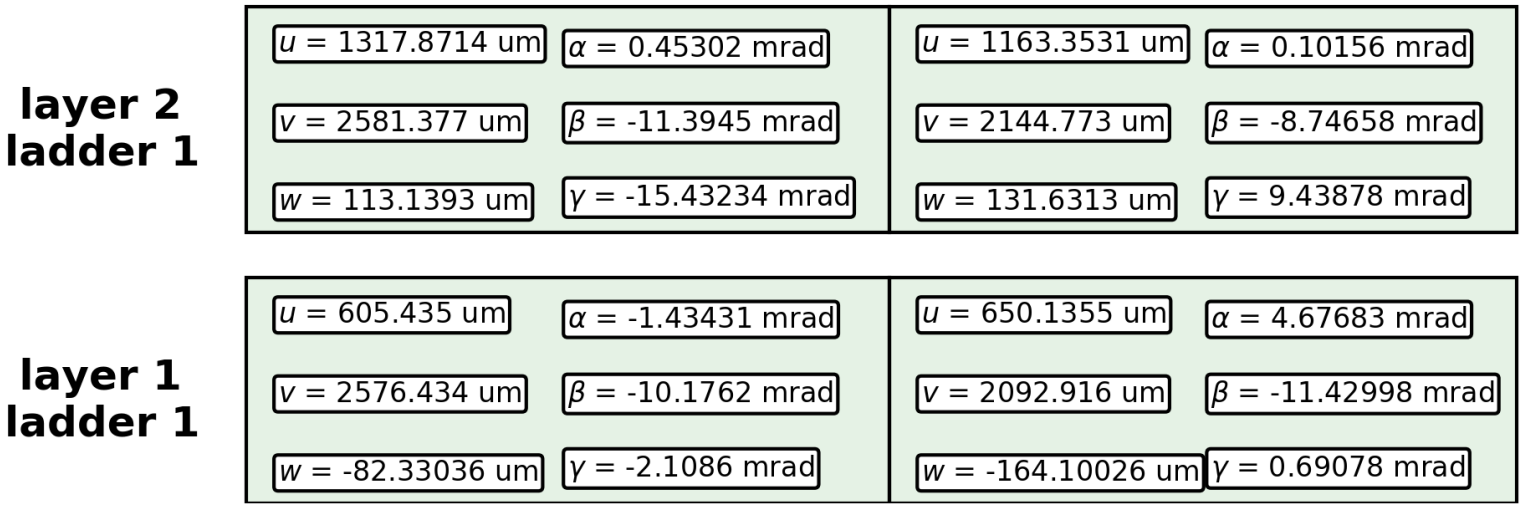

Results of alignment procedure published in GT.

The largest shift is in $v(z)$ alignment parameters.

Sum of systematic and statistic errors for shifts are $\approx$ 100 um.

Sum of systematic and statistic errors for rotations are $\approx$ 1.0 mrad.

# PXD alignment in GT




Results of alignment procedure published in GT.

The largest shift is in $v(z)$ alignment parameters.

Sum of systematic and statistic errors for shifts are $\approx$ 100 um.

Sum of systematic and statistic errors for rotations are $\approx$ 1.0 mrad.