Angle dependent characterisation of MAPS

Ben Brüers

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MAPS

MAPS

Monolithic

MAPS

Monolithic **A**ctive

MAPS

Monolithic **A**ctive **P**ixel

MAPS

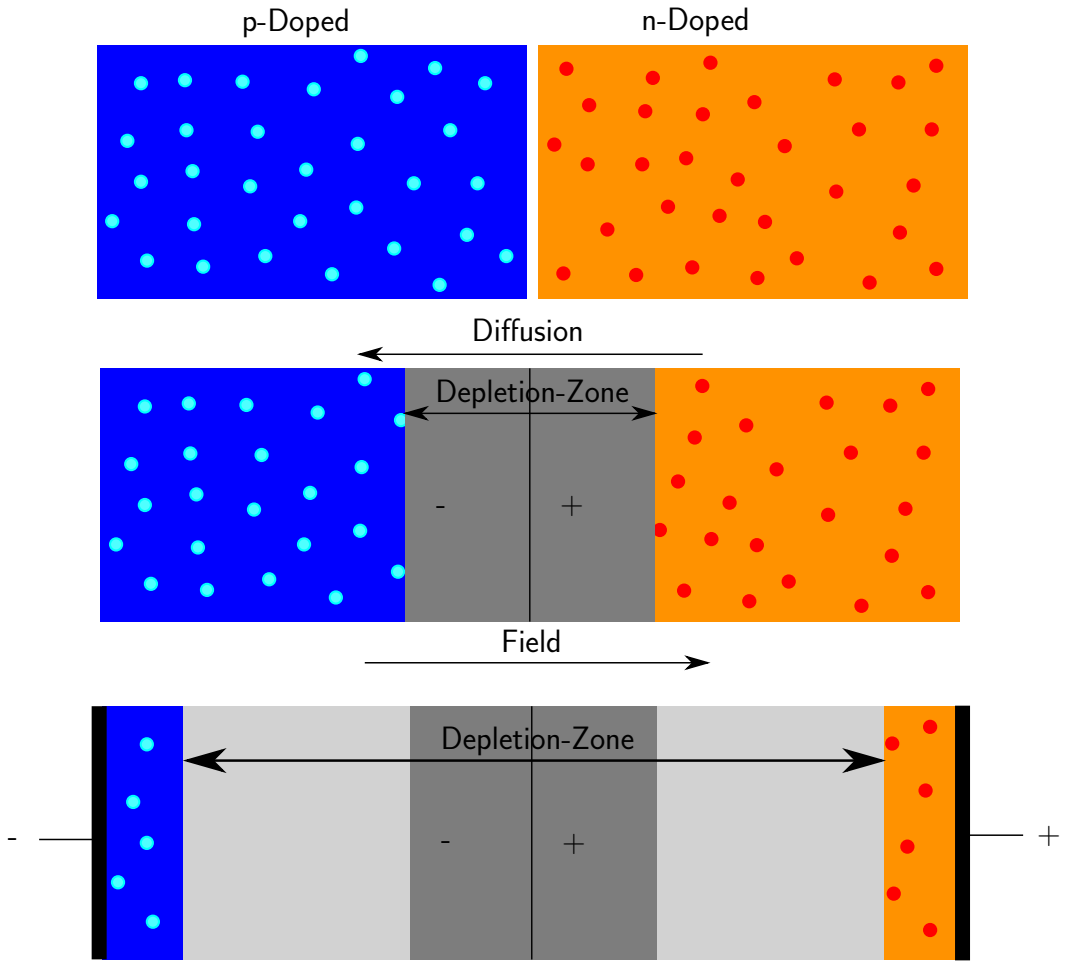
Monolithic **A**ctive **P**ixel **S**ensors

MAPS

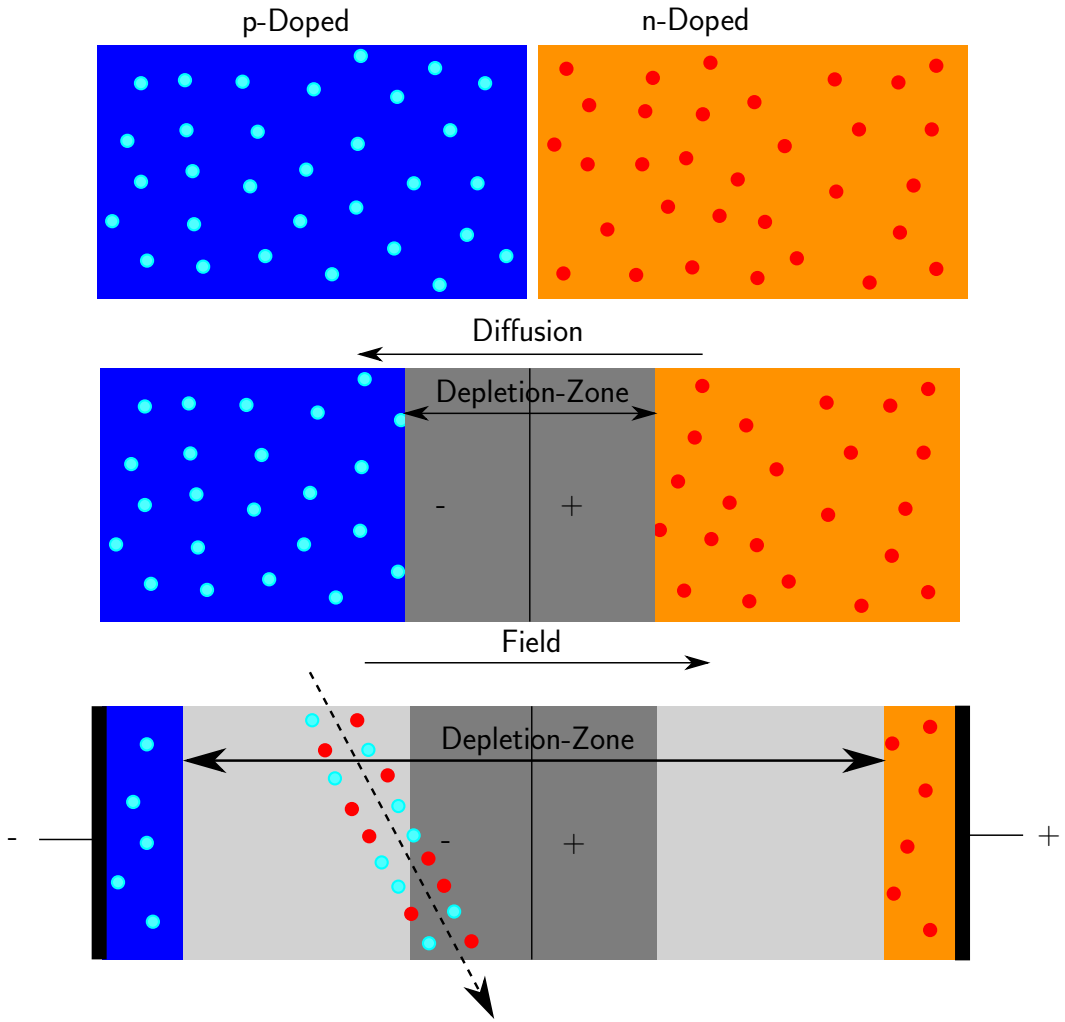
Monolithic **A**ctive **P**ixel **S**ensors

Semiconductor Detectors

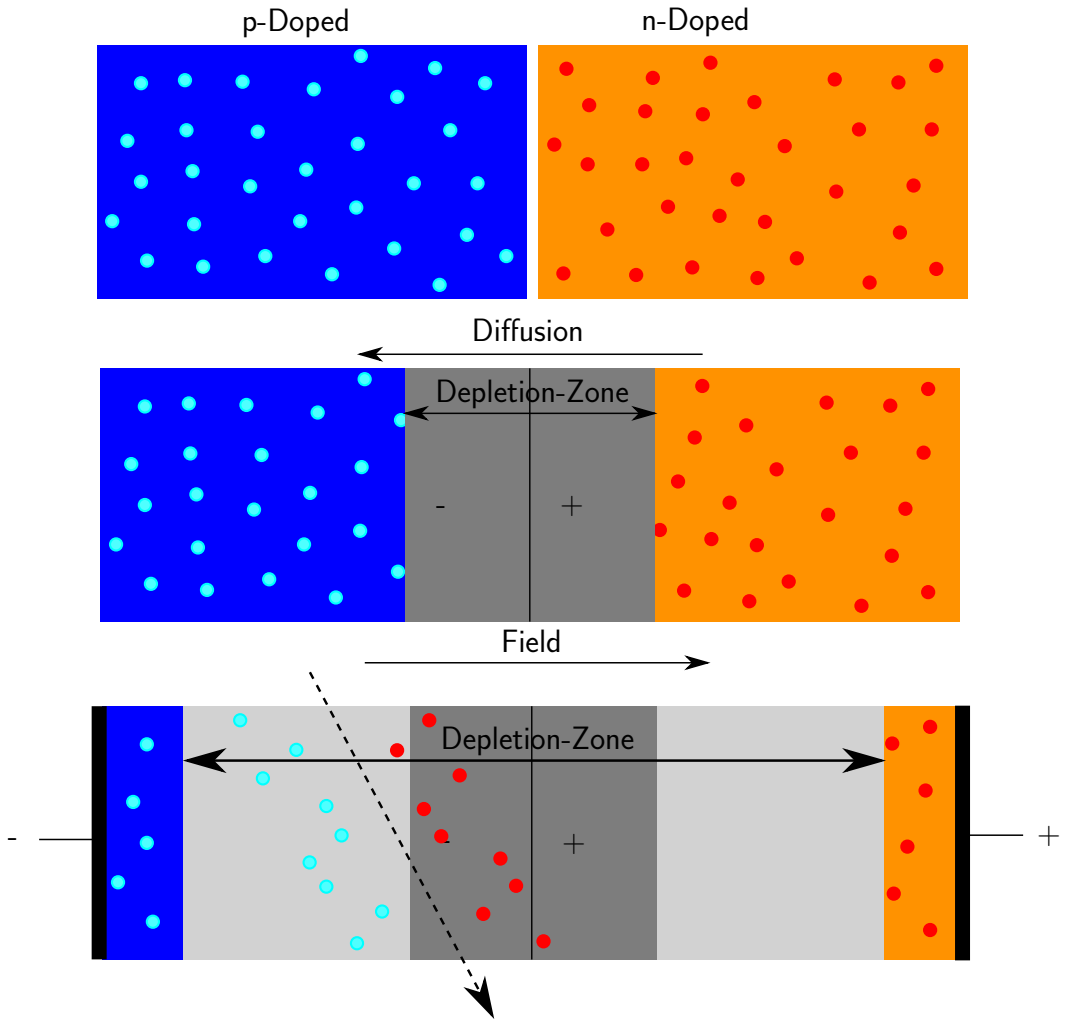
Semiconductor Detectors



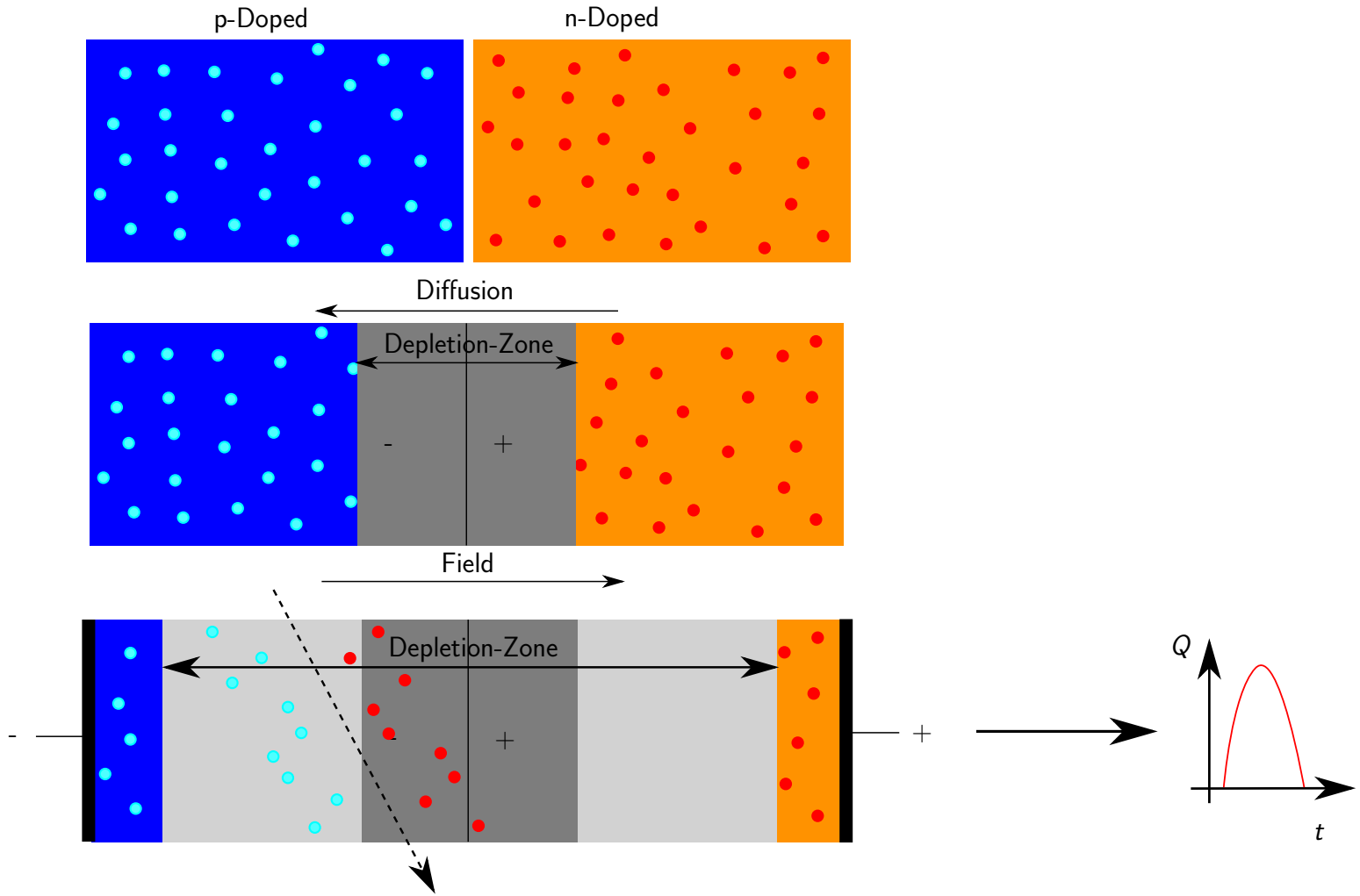
Semiconductor Detectors



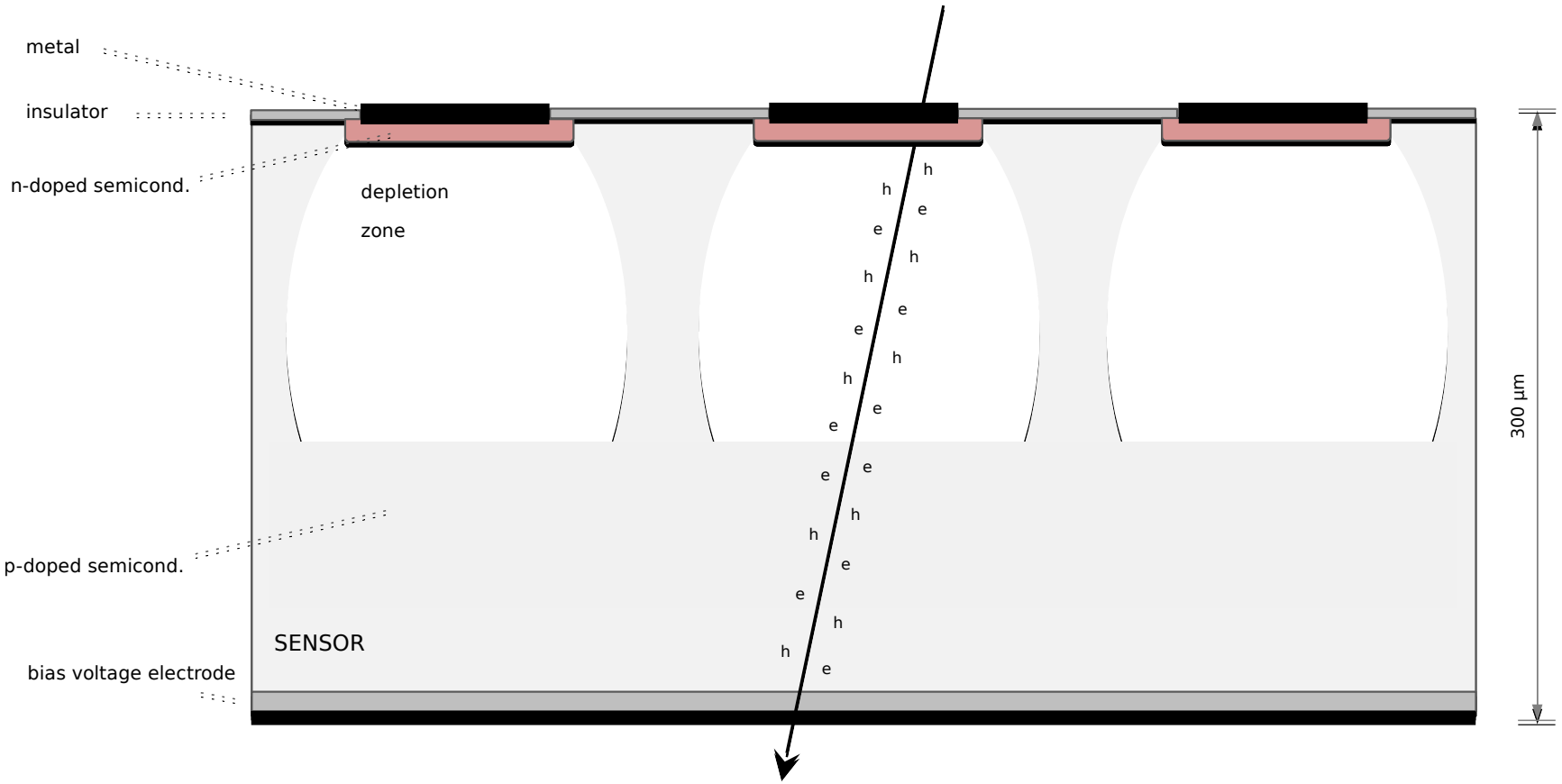
Semiconductor Detectors



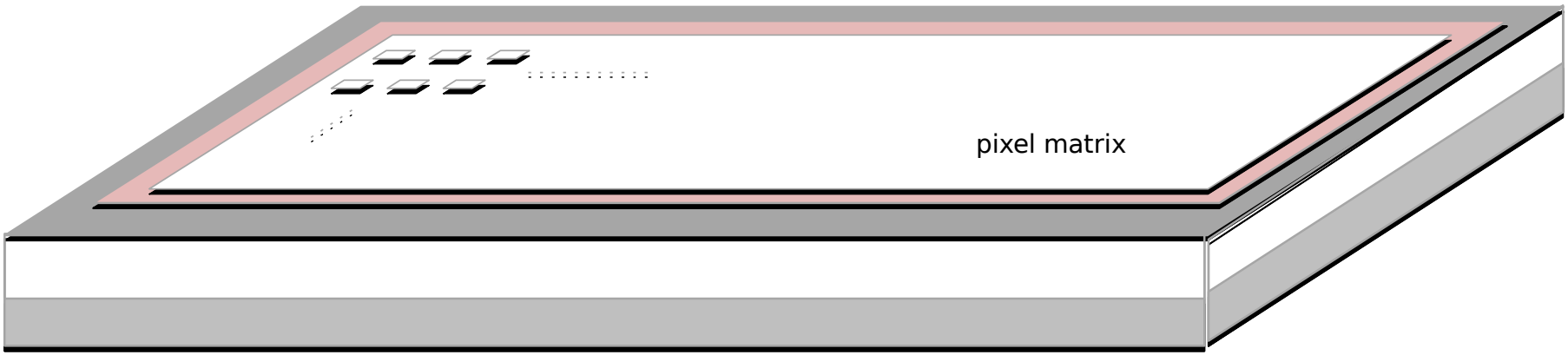
Semiconductor Detectors



Pixel sensors



Pixel sensors



MAPS

Monolithic **A**ctive **P**ixel **S**ensors

Hybrid VS Monolithic

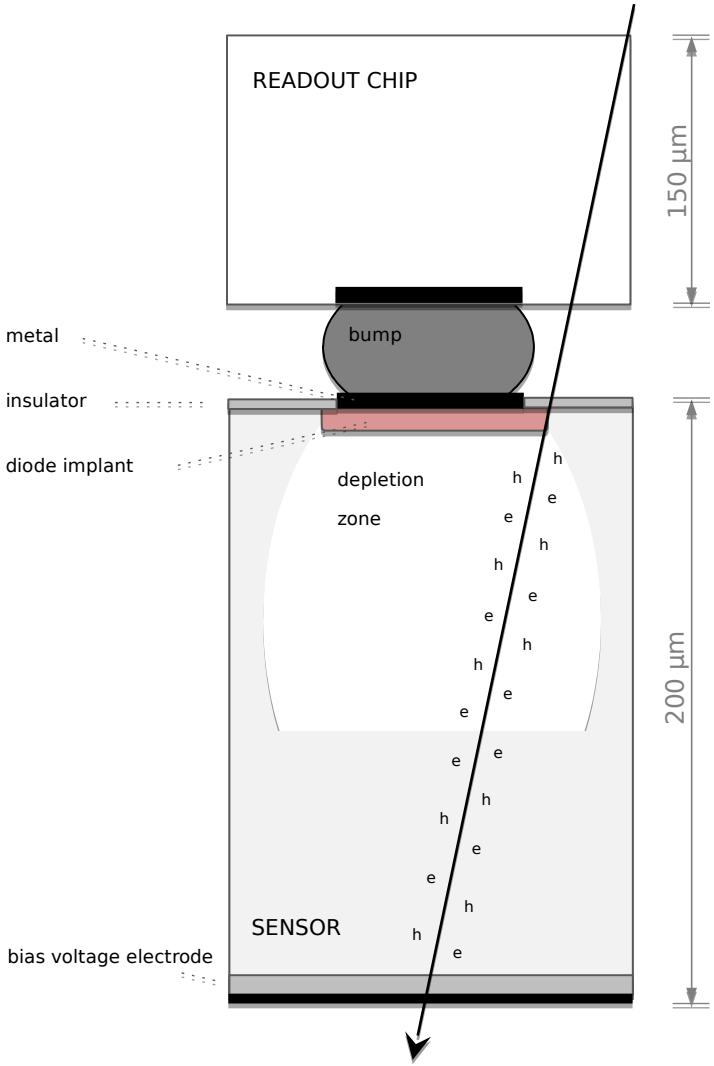
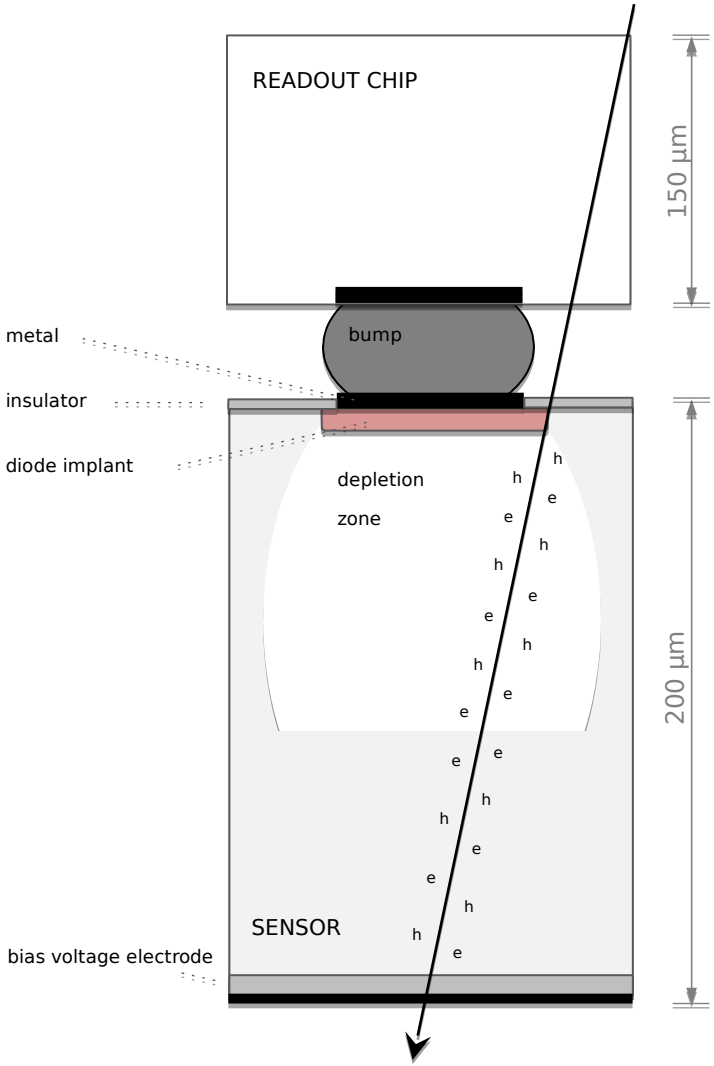


Figure : [1]

Hybrid VS Monolithic



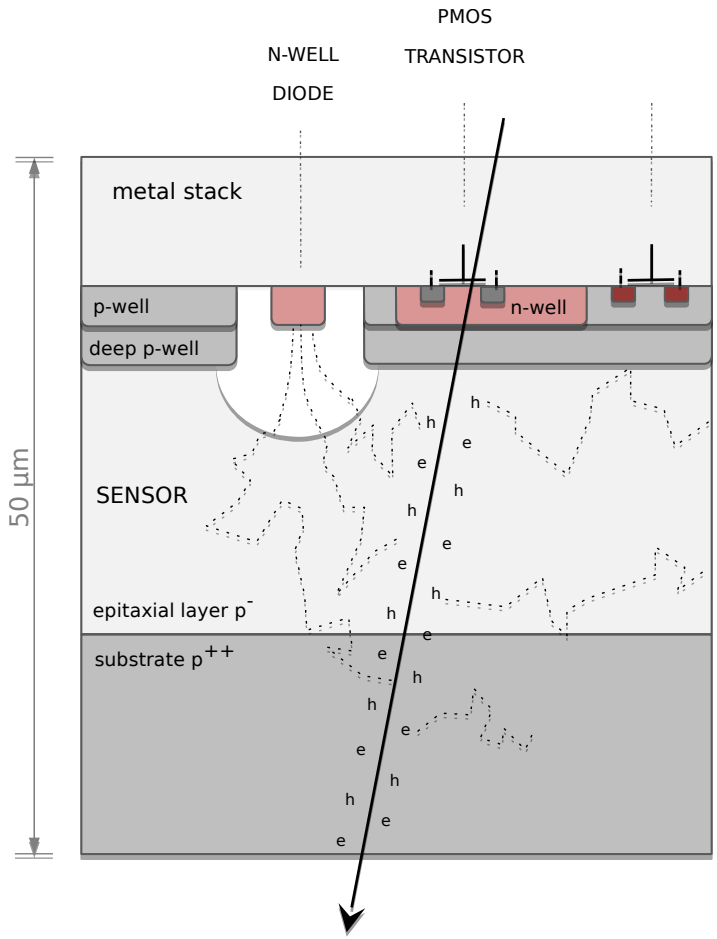


Figure : [1]

The ALICE Inner Tracking System (ITS)

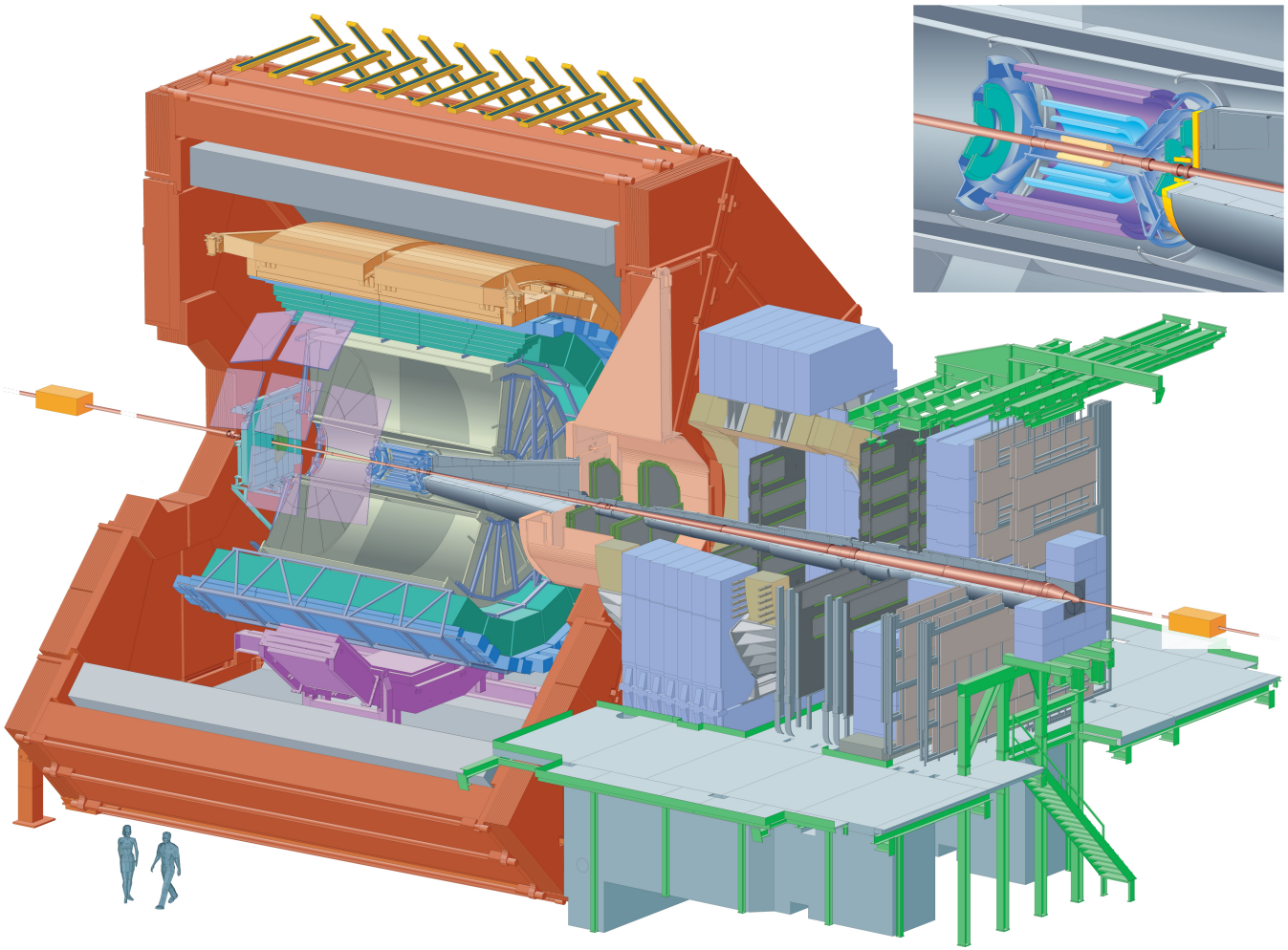


Figure : [2]

The ALICE ITS upgrade

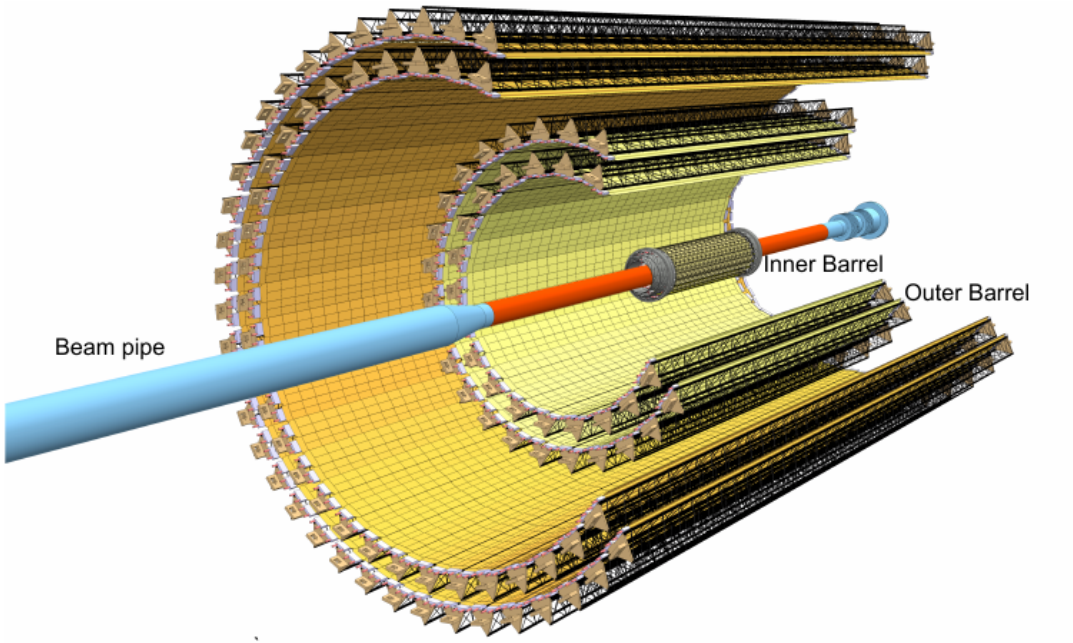


Figure : [3]

The ALICE ITS upgrade

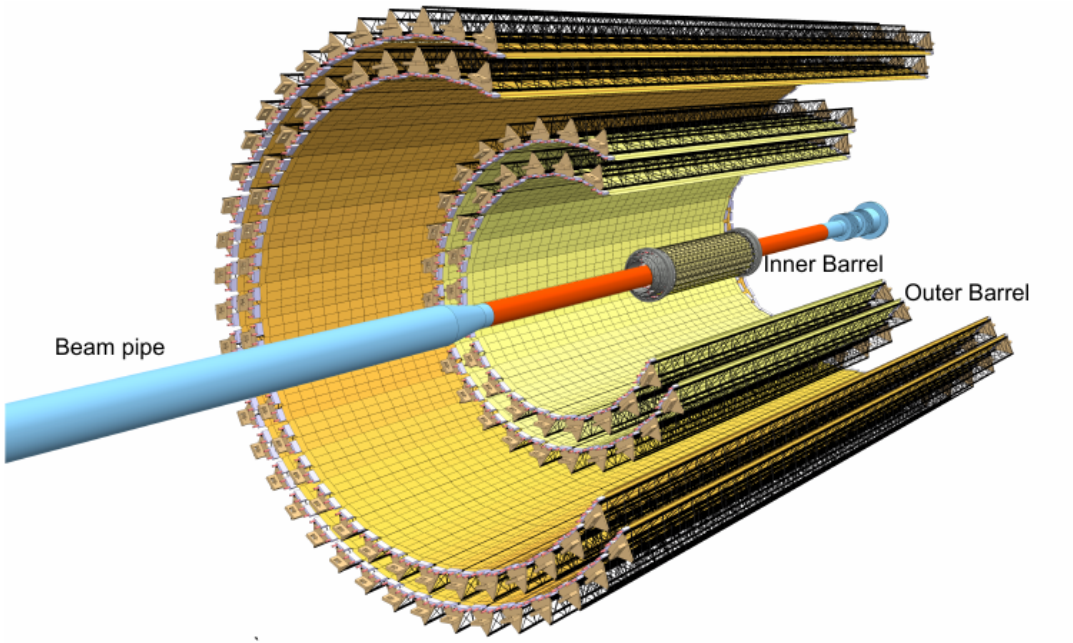
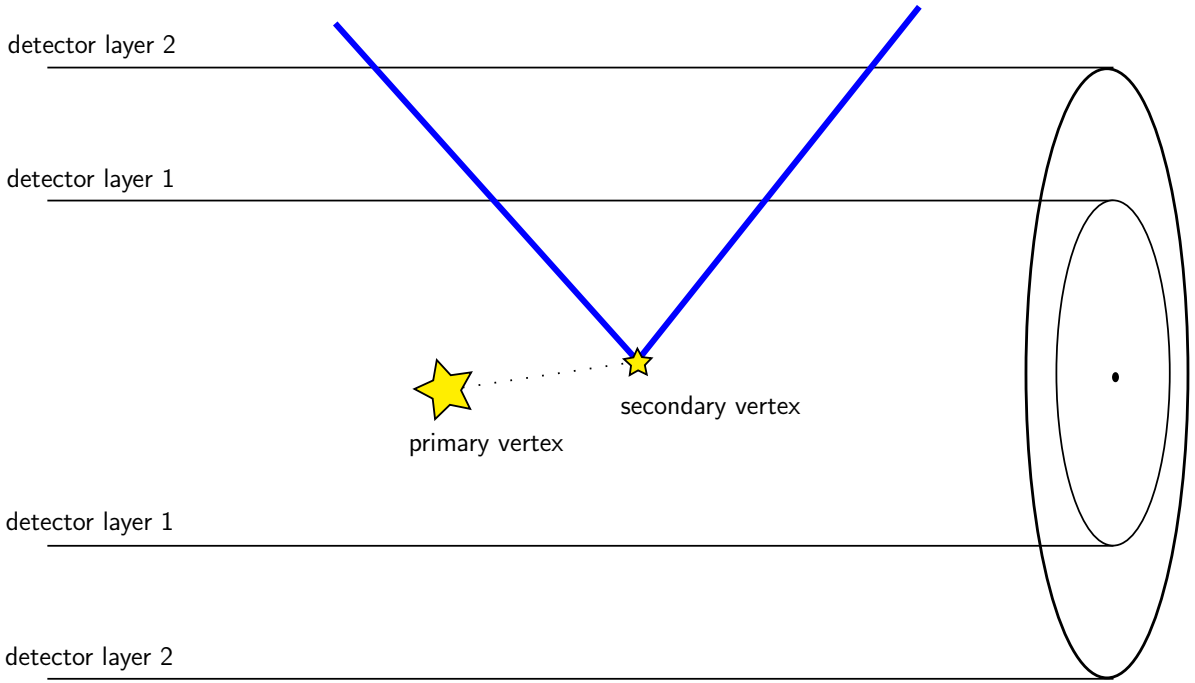


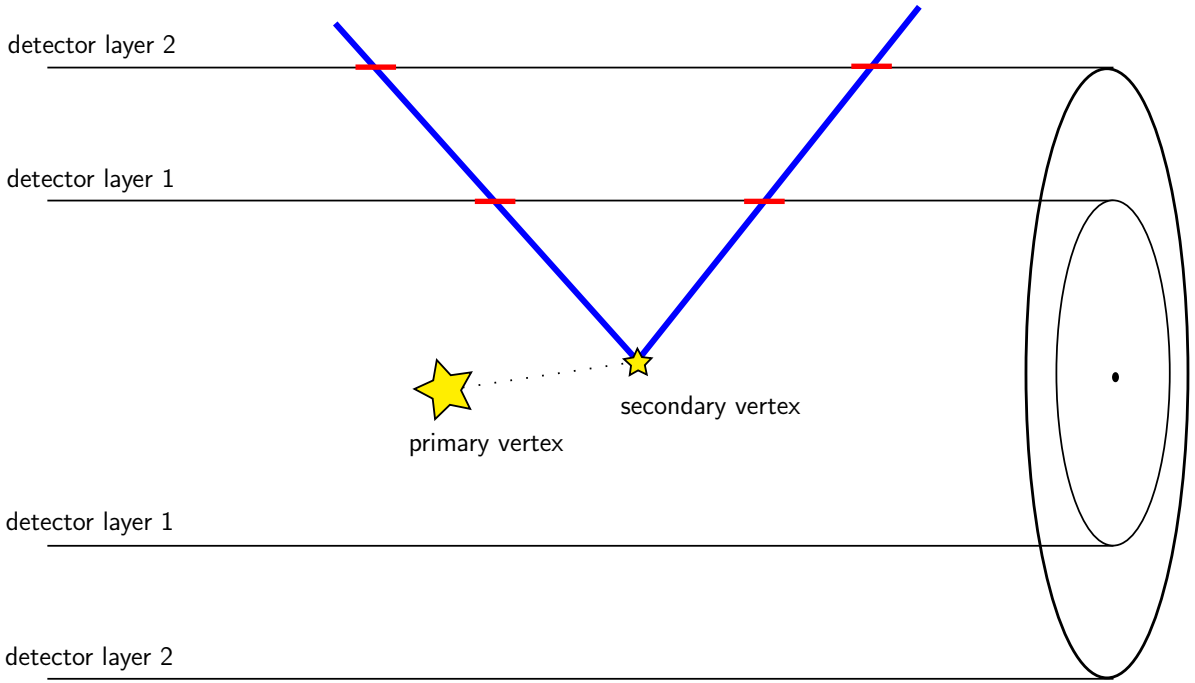
Figure : [3]

- one goal: improve pointing resolution

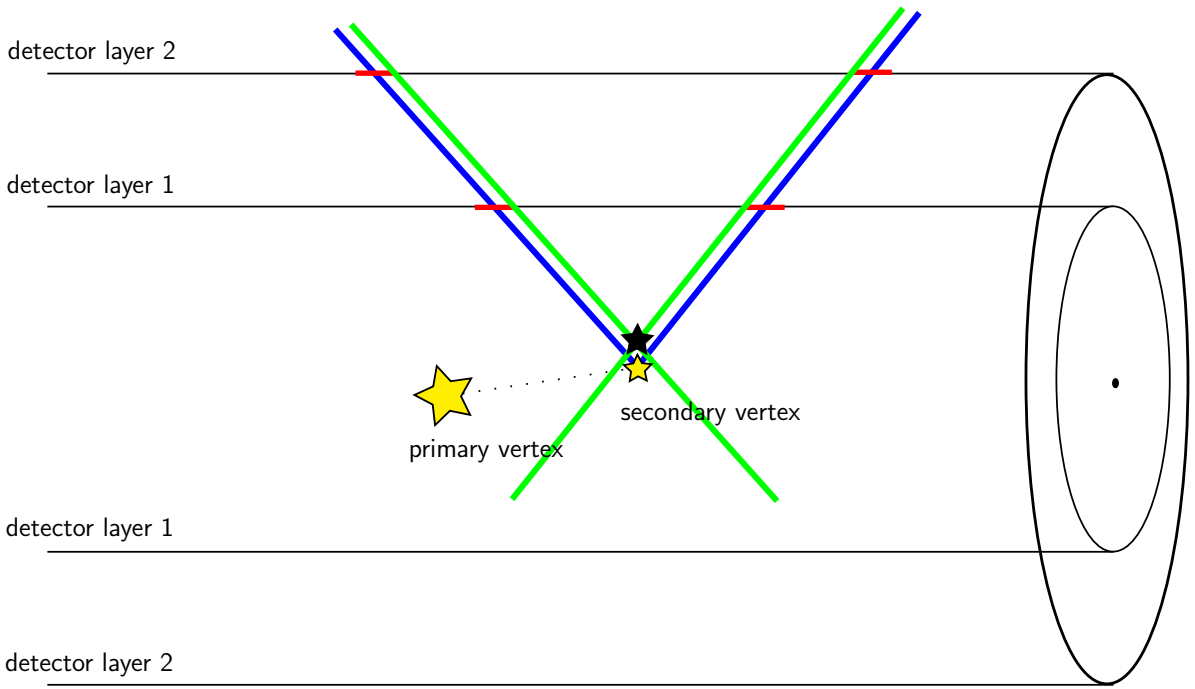
Pointing resolution



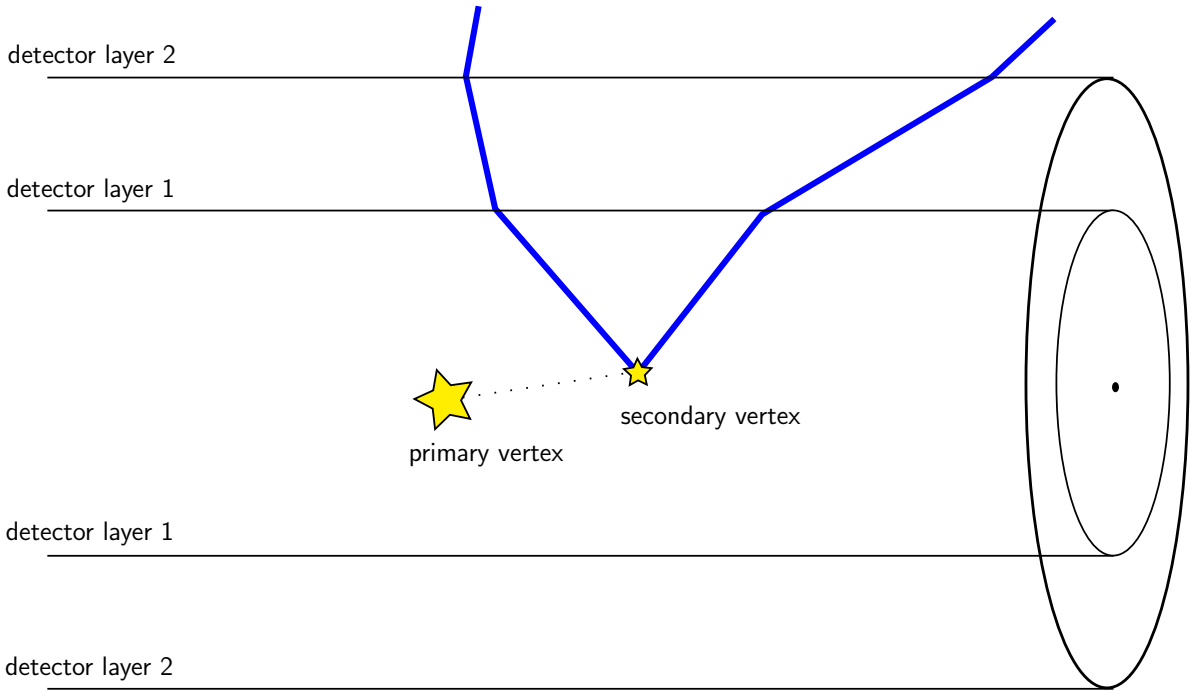
Pointing resolution



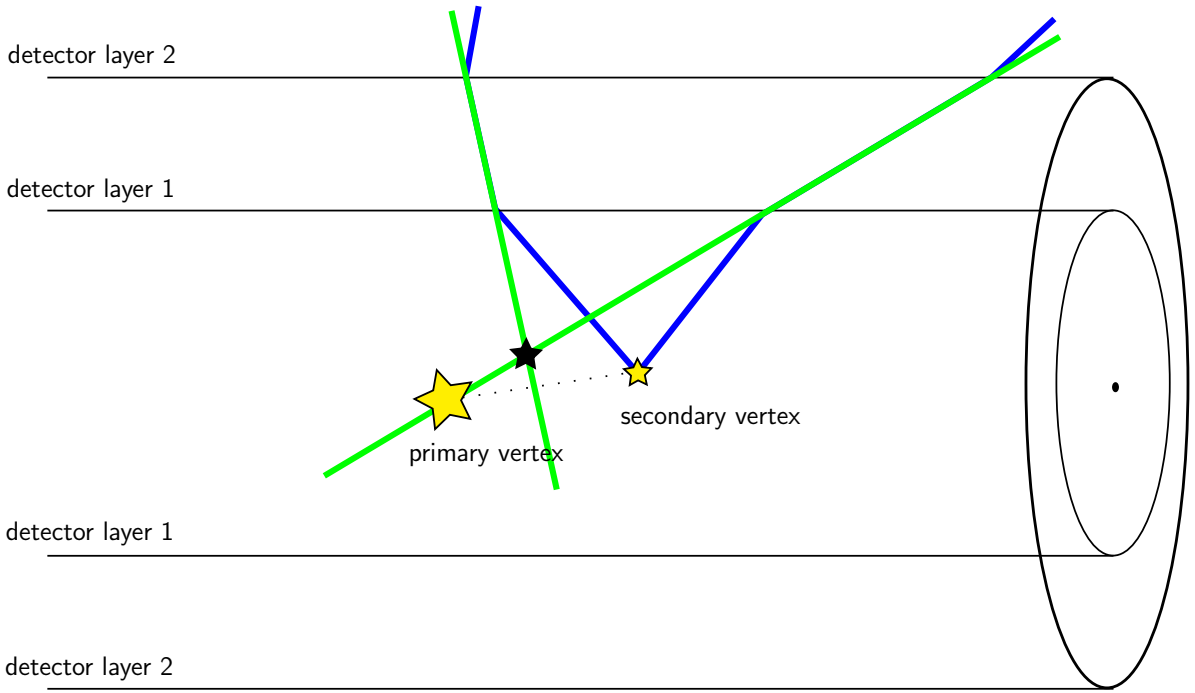
Pointing resolution



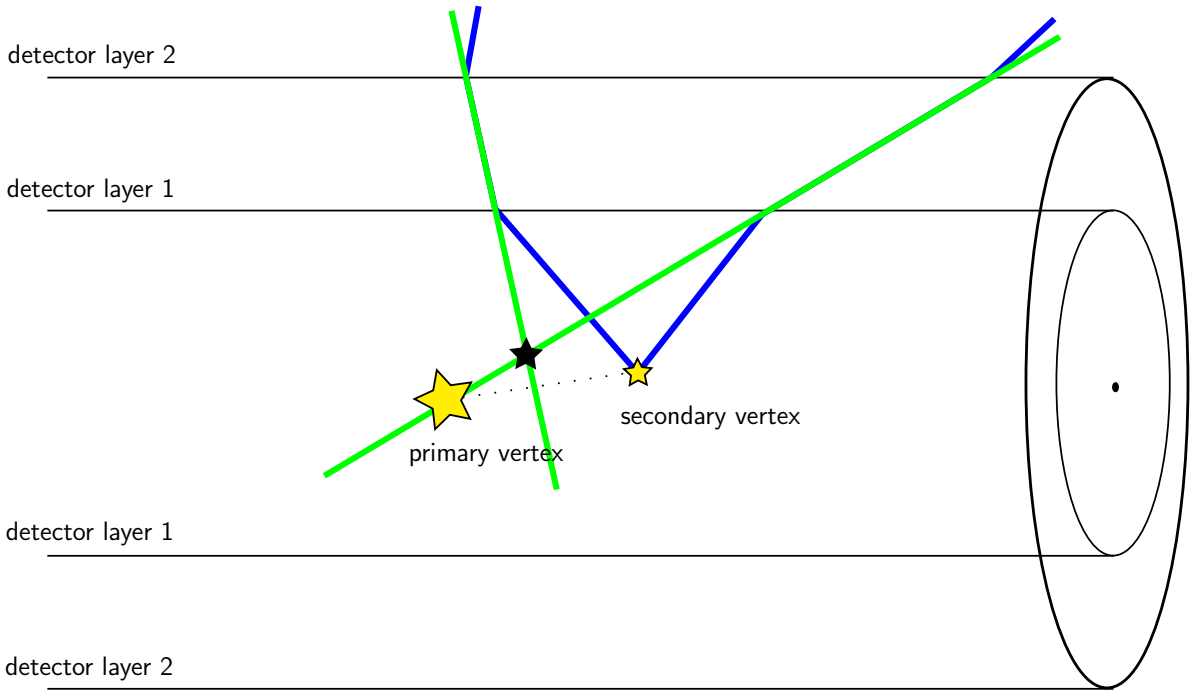
Pointing resolution



Pointing resolution



Pointing resolution



- improvement by
  - increase of position resolution
  - decrease of multiple scattering

Conclusion: MAPS

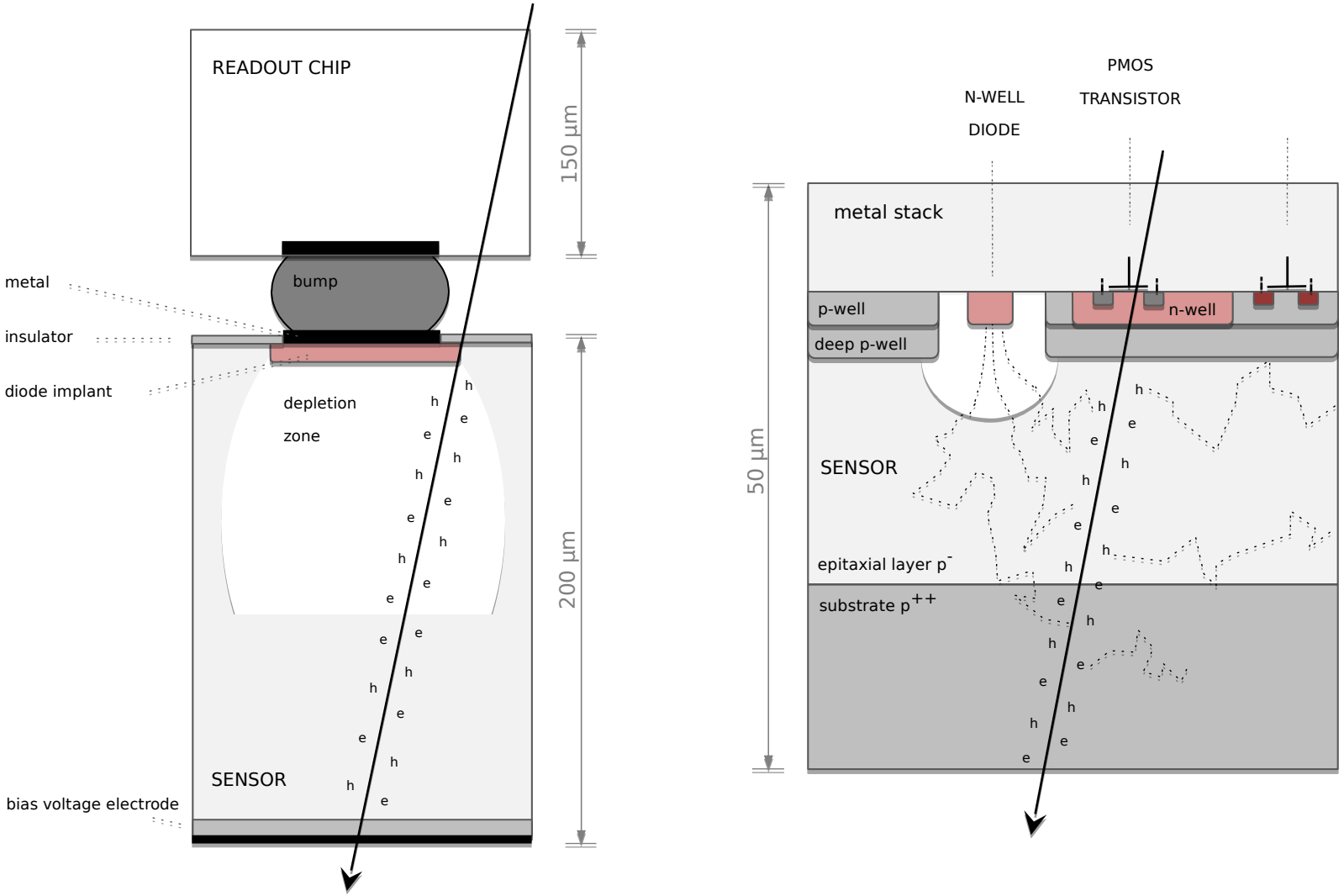


Figure : [1]

The ALPIDE

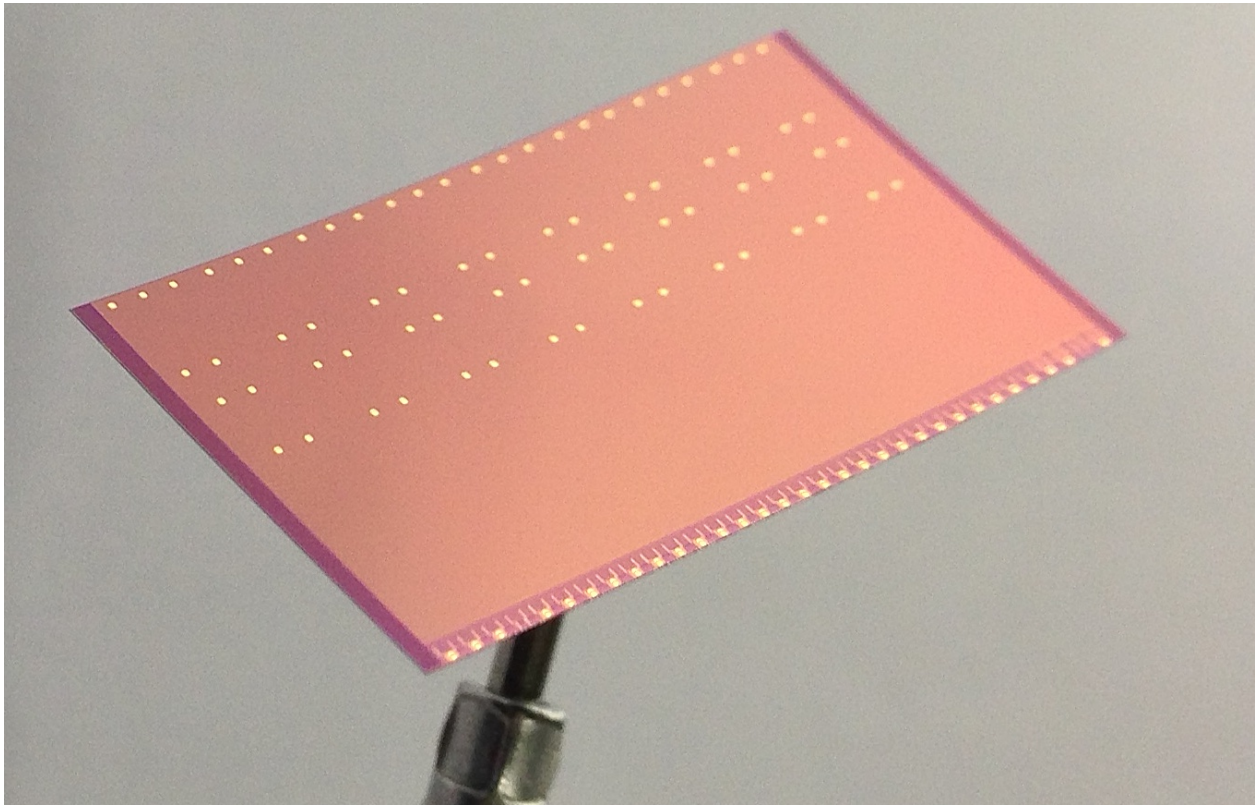
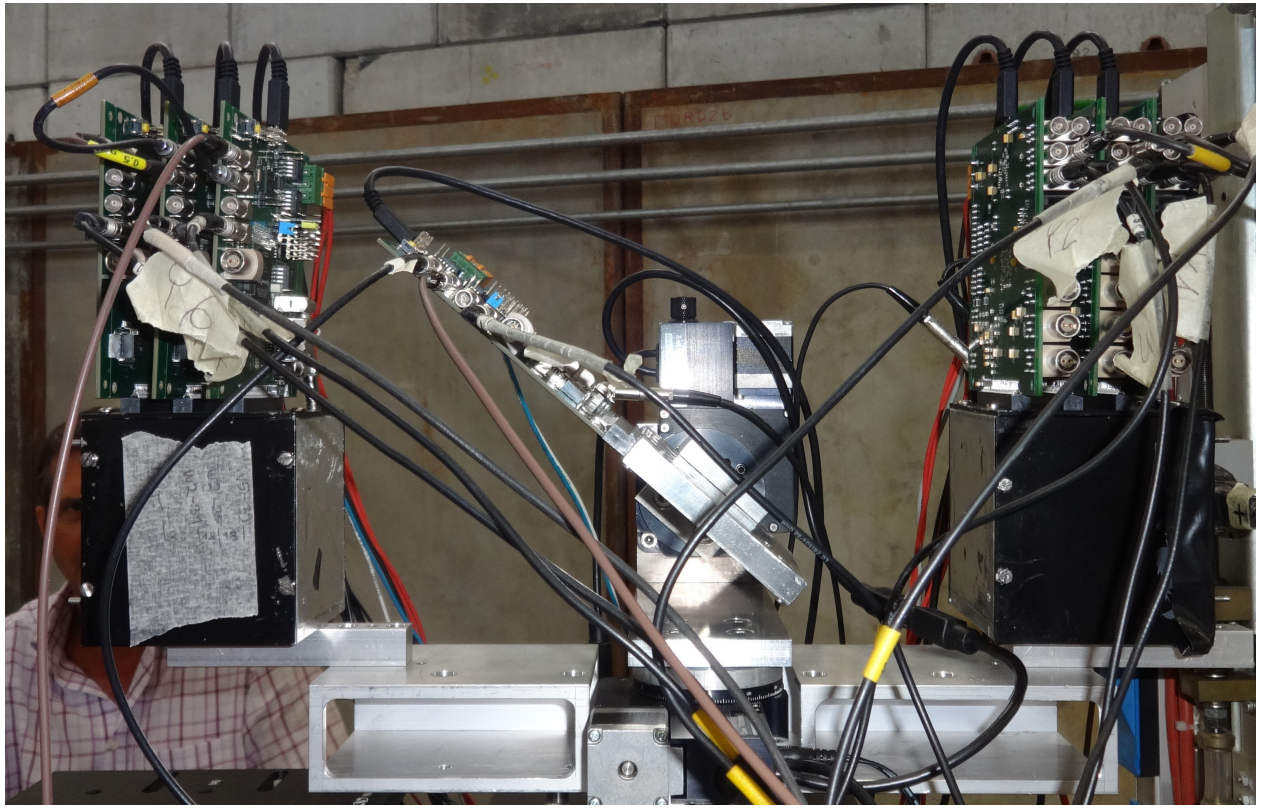
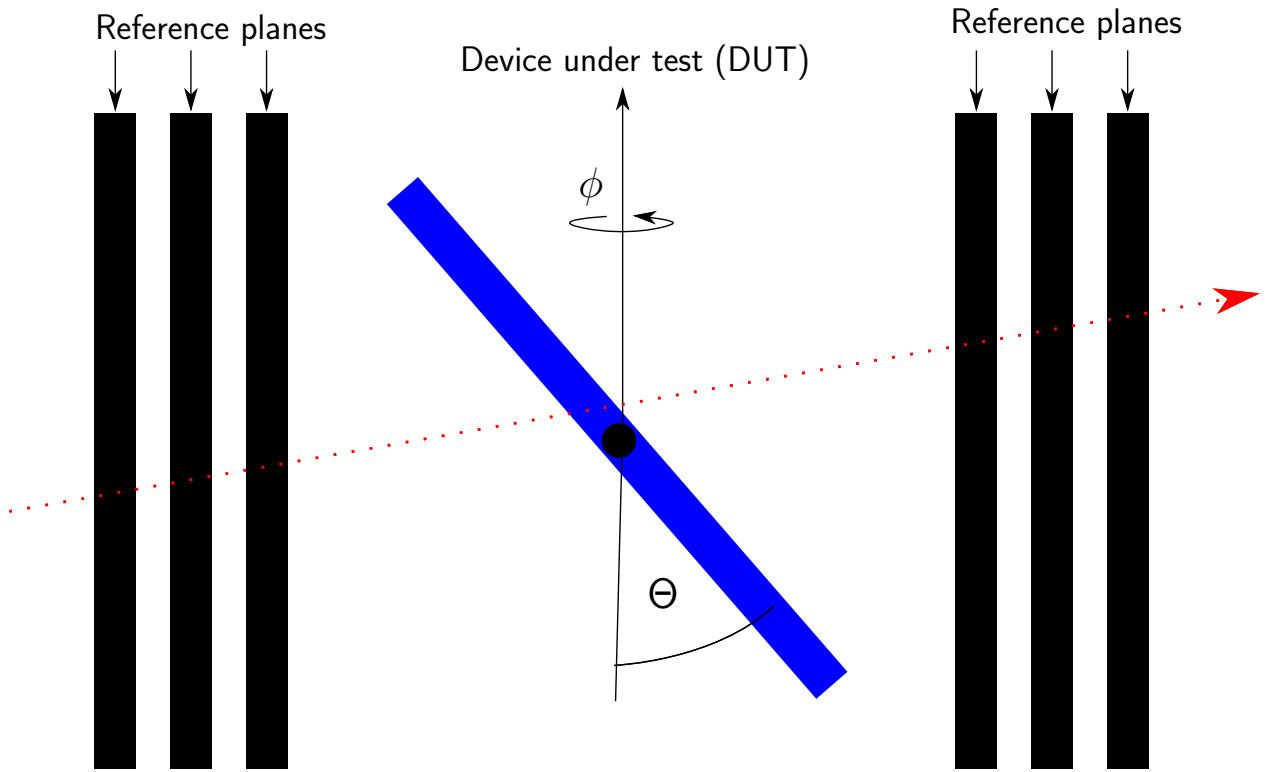


Figure : [1]

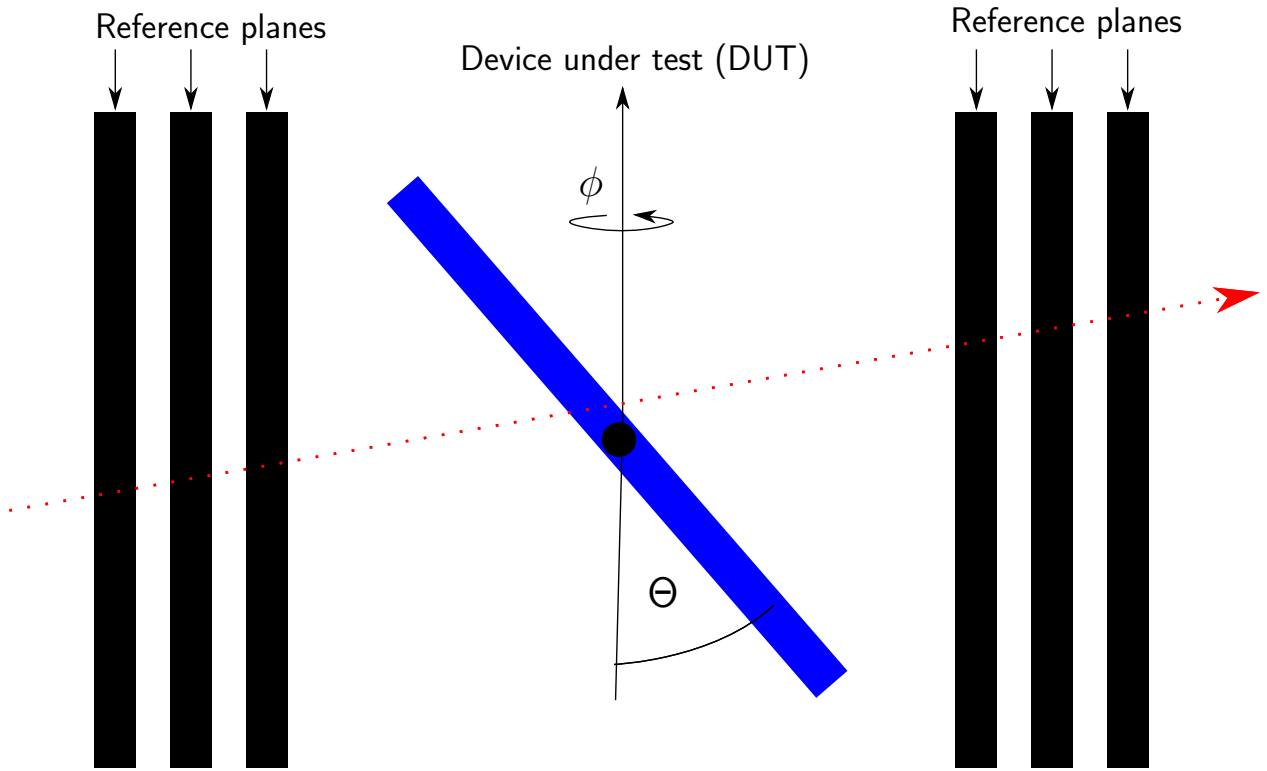
Testbeam Analysis



Testbeam Analysis

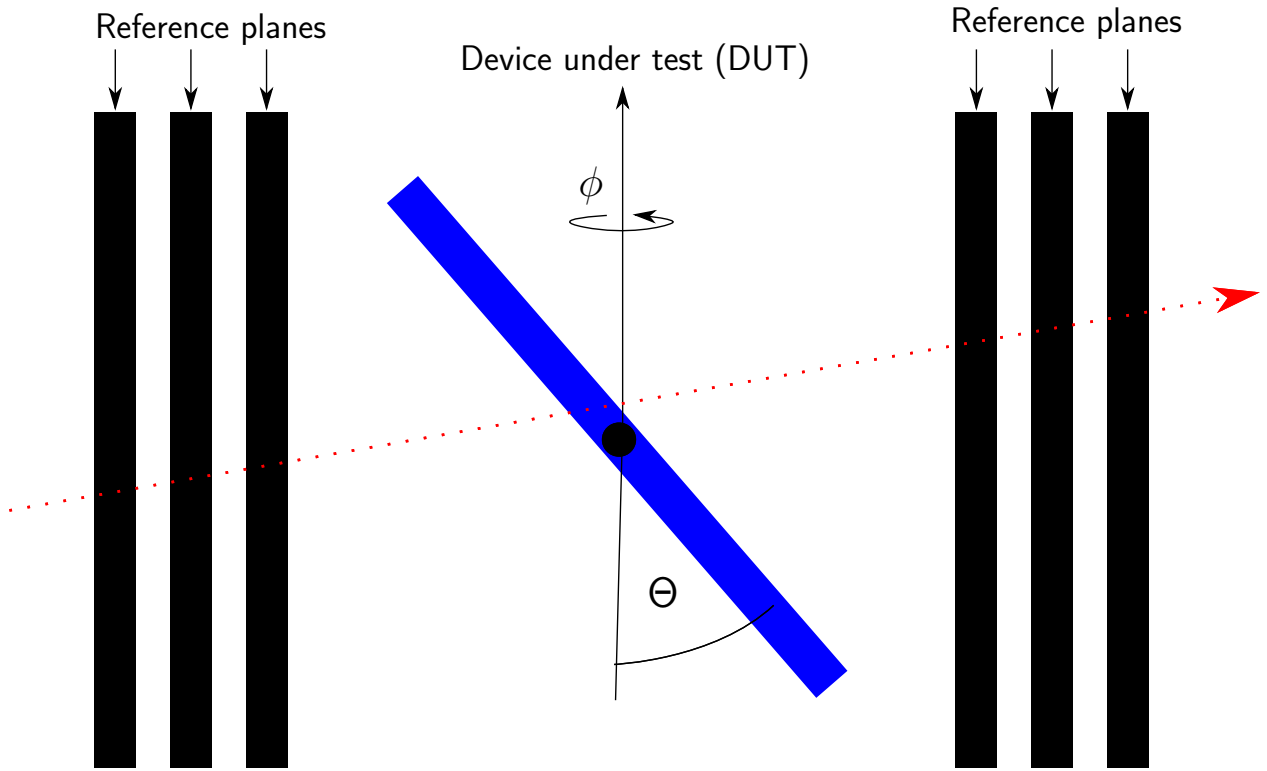


Testbeam Analysis



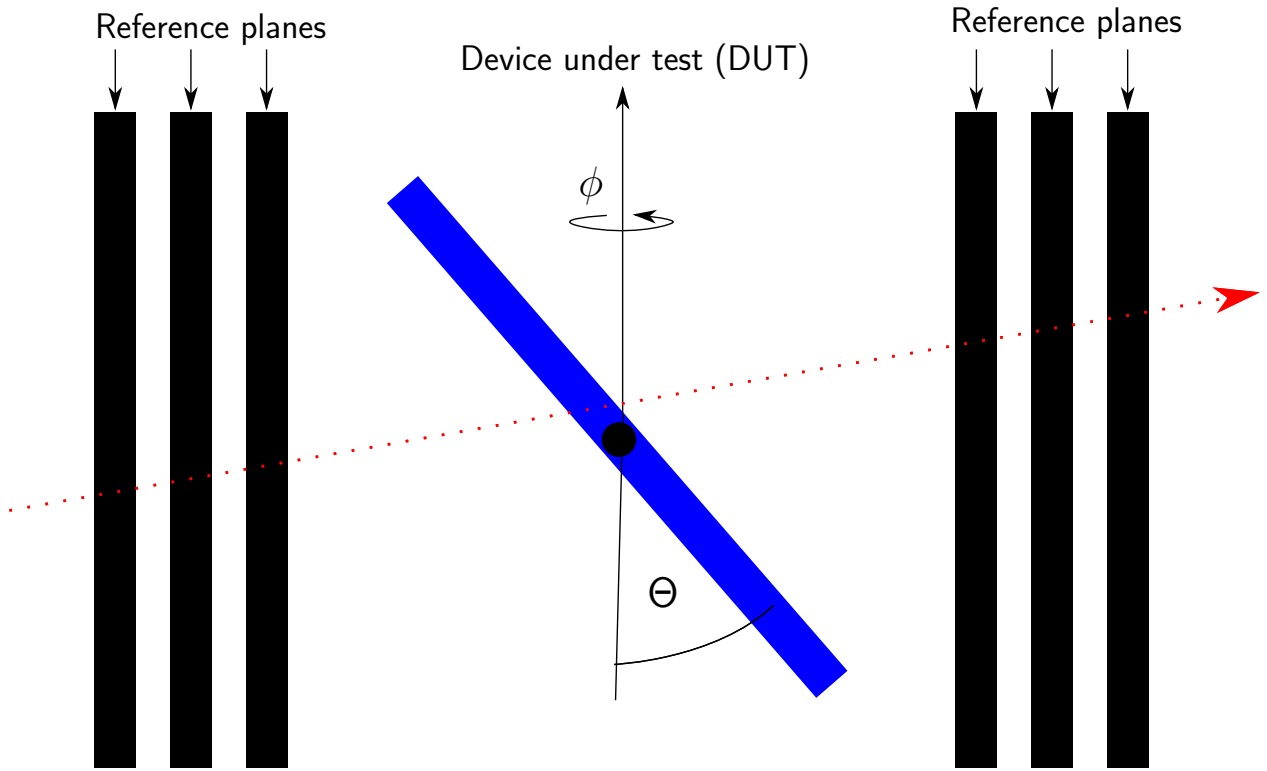
- detection efficiency

Testbeam Analysis



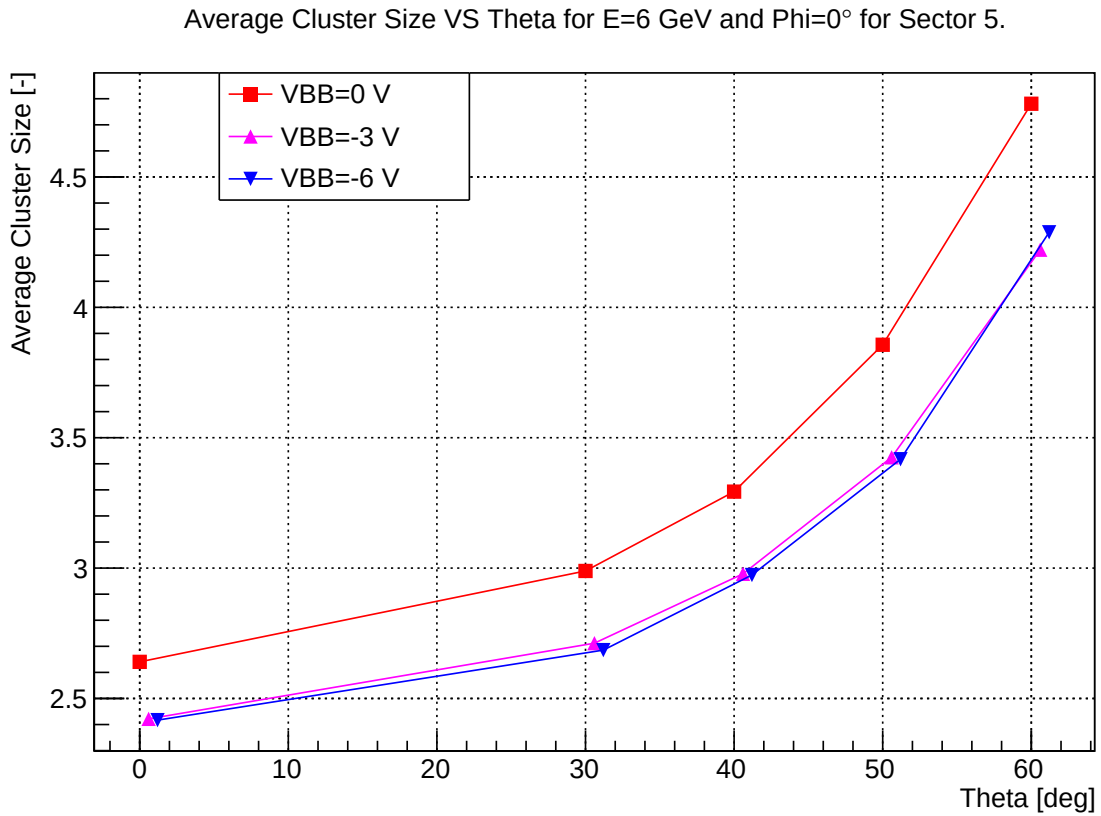
- detection efficiency
- position resolution

Testbeam Analysis



- detection efficiency
- position resolution
- cluster shape

My first results



Conclusion

- detection efficiency

Conclusion

- detection efficiency
- position resolution

Conclusion

- detection efficiency
- position resolution
- cluster shape ✓

Bibliography

[1] Jacobus Willem van Hoorne.
Study and Development of a novel Silicon Pixel Detector for the Upgrade of the ALICE Inner Tracking System.
PhD thesis, TU Vienna, Oct 2015. URL https://cds.cern.ch/record/2119197. Presented 24 Nov 2015.

[2] The ALICE Collaboration et al. The alice experiment at the cern lhc. Journal of Instrumentation, 3(08):S08002, 2008. URL http://stacks.iop.org/1748-0221/3/i=08/a=S08002.

[3] B. Abelev et al. Technical Design Report for the Upgrade of the ALICE Inner Tracking System. Technical Report CERN-LHCC-2013-024. ALICE-TDR-017, Nov 2013. URL https://cds.cern.ch/record/1625842.

Backup Slides

Position-resolution and multiple scattering

- Position-resolution: how accurately can the position be measured
- Multiple scattering:

$$\sigma_\Theta = \frac{19.2\text{MeV}}{c\beta p} z \sqrt{\frac{x}{X_0}} \left(1 + 0.038 \ln \frac{x}{X_0}\right)$$

$$X_0 = \left(\frac{4\pi\epsilon_0 c^2}{4\alpha N_A e^2}\right) \cdot \frac{A}{Z^2} \frac{1}{\ln\left(\frac{183}{Z^{1/3}}\right)} \cdot \frac{m^2}{z^2}$$

Energy loss of charged particles by excitation and ionisation

- Physical reason: interaction with atomic electrons
- Described by Bethe-Bloch formula

$$-\frac{\mathrm{d}E}{\mathrm{d}s} = 4\pi N_A r_e^2 m_e c^2 \cdot \rho \frac{Z}{A} \cdot \frac{z^2}{\beta^2} \left(\ln \left(\frac{2 m_e c^2 \gamma^2 \beta^2}{I} \right) - \beta^2 - \frac{\delta}{2} \right)$$

Bremsstrahlung

- Nuclear field slows down particles $\rightarrow$ Emission of photons: Bremsstrahlung

$$-\frac{\mathrm{d}E}{\mathrm{d}x} = \left(4\alpha N_A \frac{e^2}{4\pi\epsilon_0}\frac{1}{c^2}\right) \cdot \frac{Z^2}{A} \ln\left(\frac{183}{Z^{1/3}}\right) \cdot \frac{z^2 E}{m^2} \overset{\text{Elektrons}}{=} \frac{E}{X_0} \Rightarrow E = E_0 e^{-\frac{x}{X_0}}$$

- Energy loss should be little $\Rightarrow X_0$ large
- Bremsstrahlung relevant above „critical“ energy

Pointing Resolution

- tracking devices contribution

$$\sigma_p^x = \sqrt{\left(\frac{r_2}{r_2 - r_1}\sigma_1\right)^2 + \left(\frac{r_1}{r_2 - r_1}\sigma_2\right)^2}$$

- multiple scattering contribution

$$\sigma_p^{ms} = \frac{r_1}{\sin^{3/2}(\phi)} \frac{13.6\text{MeV}}{c\beta p} z\sqrt{\frac{x}{X_0}}$$

- total resolution

$$\sigma_p = \sqrt{(\sigma_p^x)^2 + (\sigma_p^{ms})^2}$$