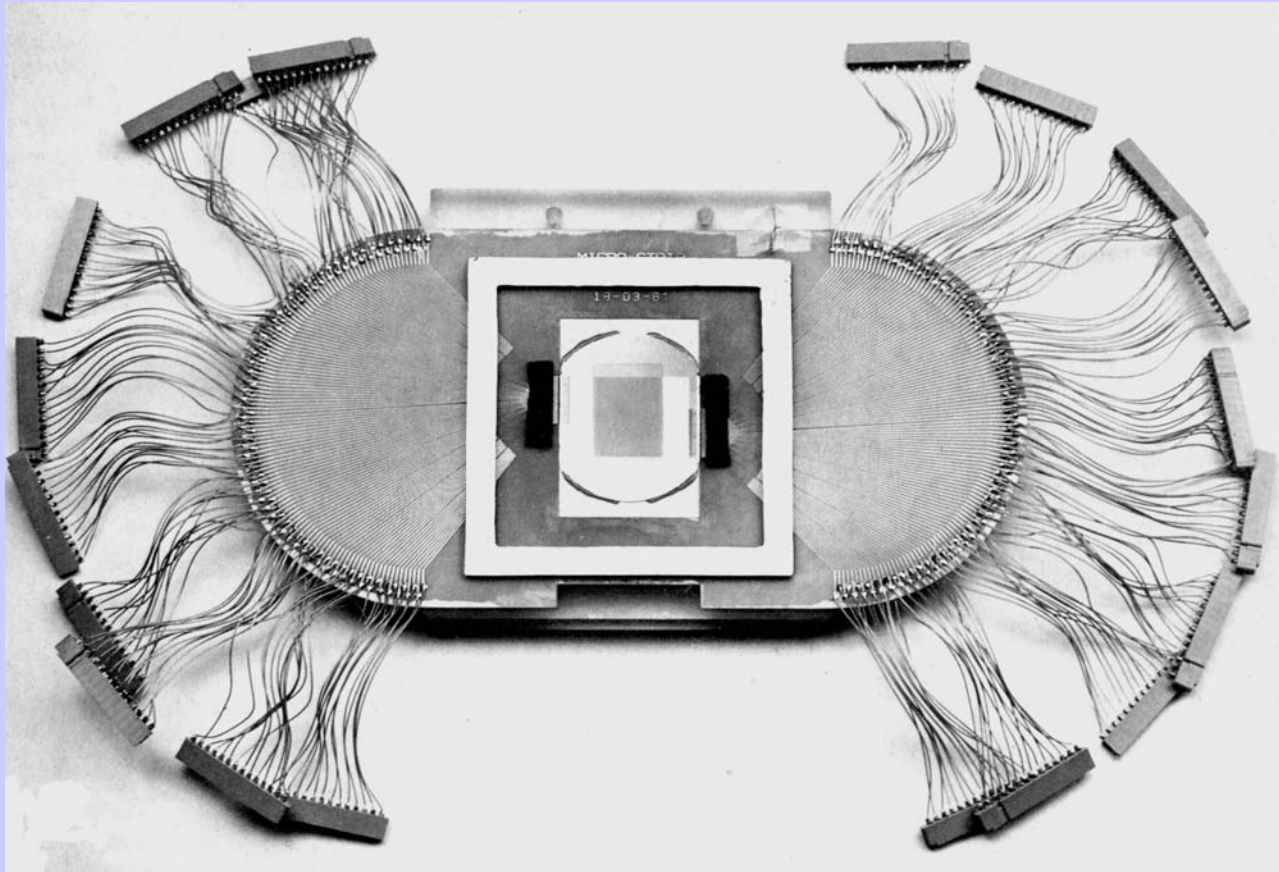


Detektory półprzewodnikowe

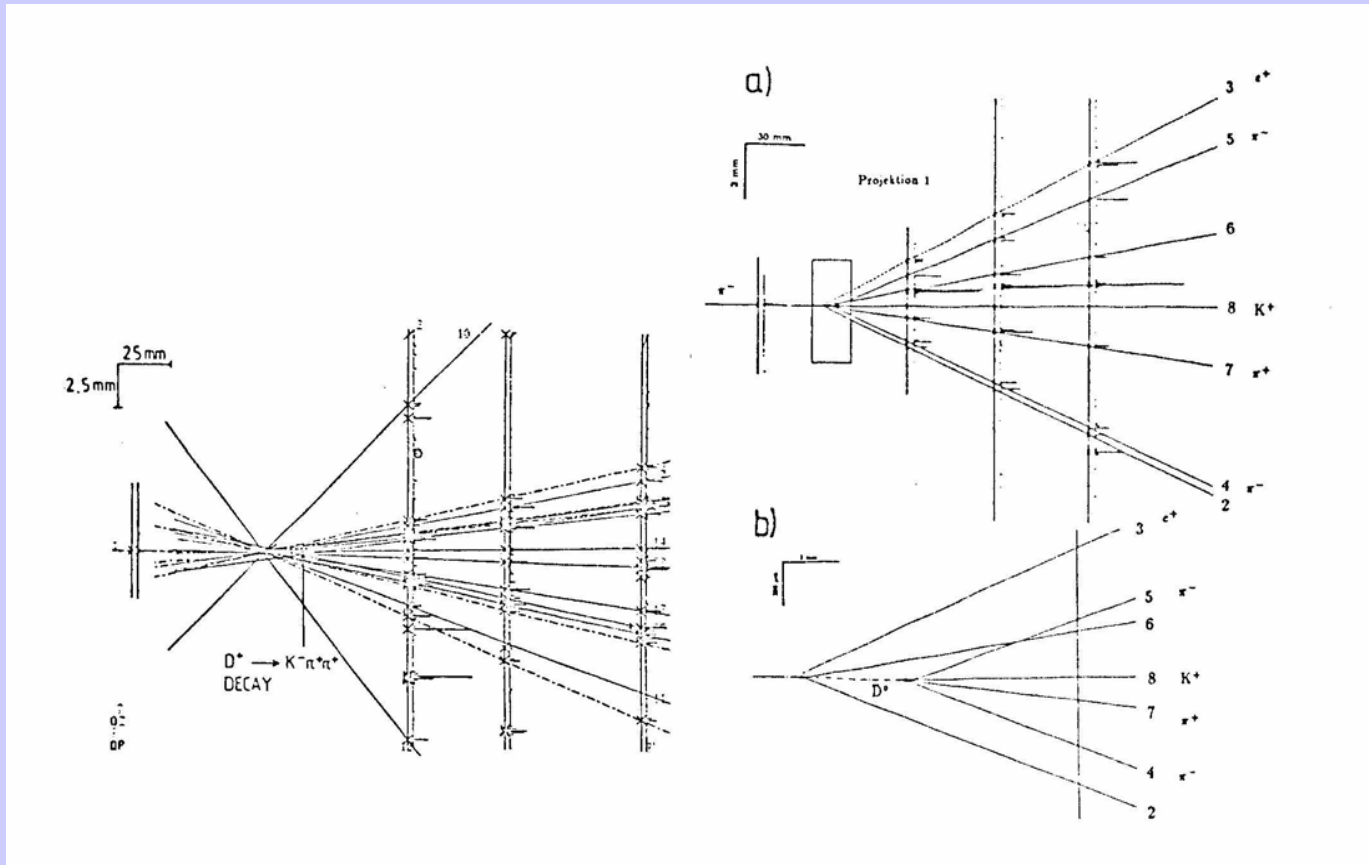
- Eksperyment NA11/NA32 – detektory paskowe



Maksymalna własna dokładność detektorów $\sigma_x \approx (5 - 10) \mu\text{m}$

Detektory półprzewodnikowe

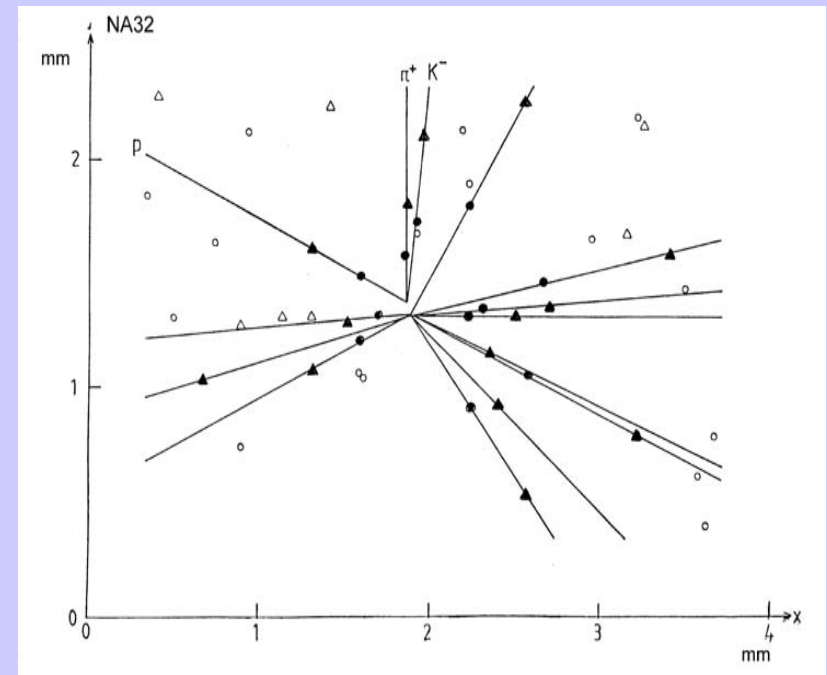
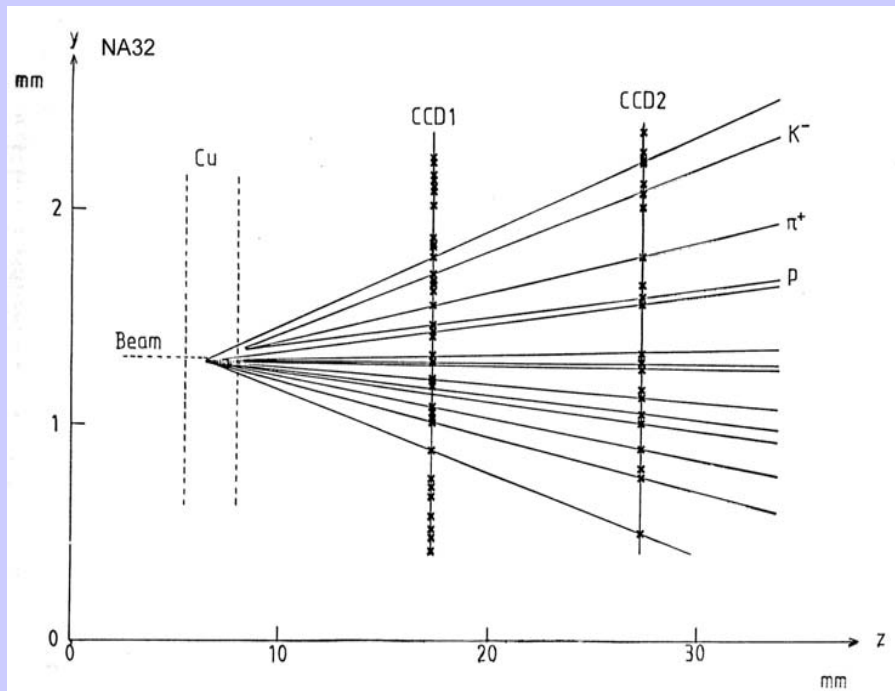
- Eksperyment NA11/NA32 – detektory paskowe



- Maksymalna własna dokładność detektorów $\sigma_x \approx (5 - 10) \mu\text{m}$

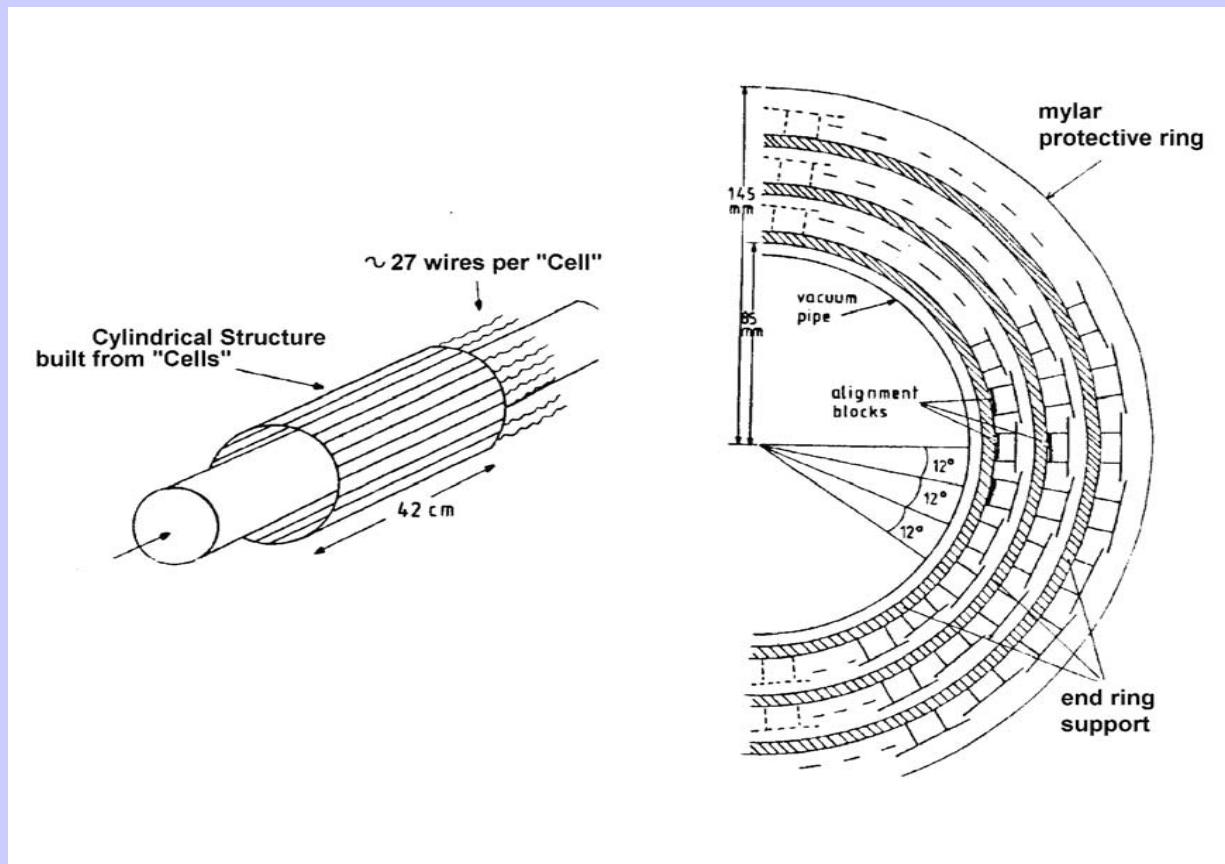
Detektory półprzewodnikowe

- Eksperyment NA11/NA32 – detektory mozaikowe CCD



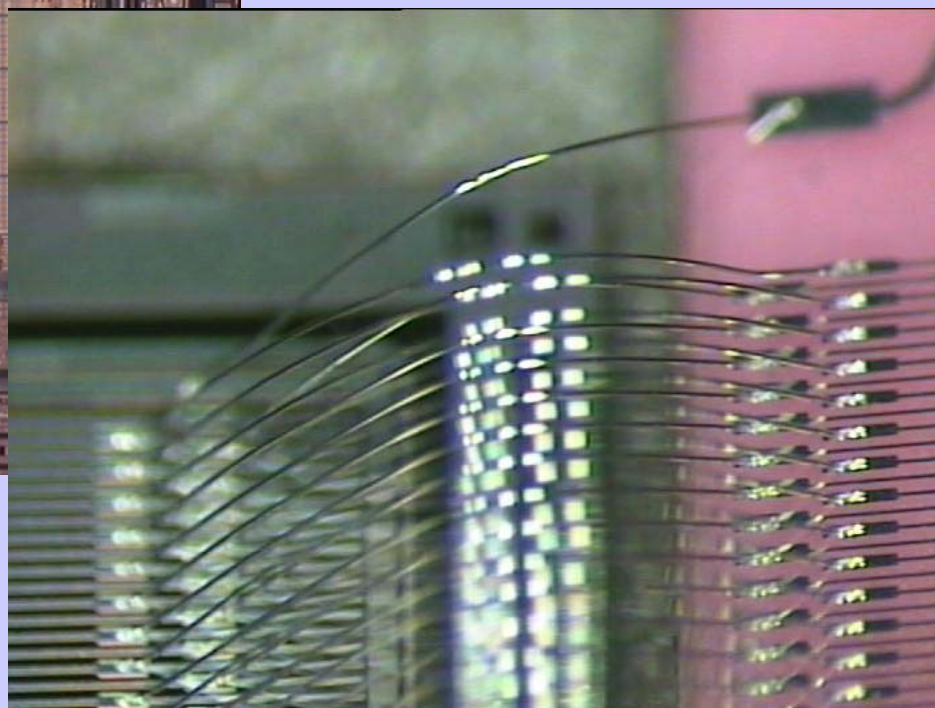
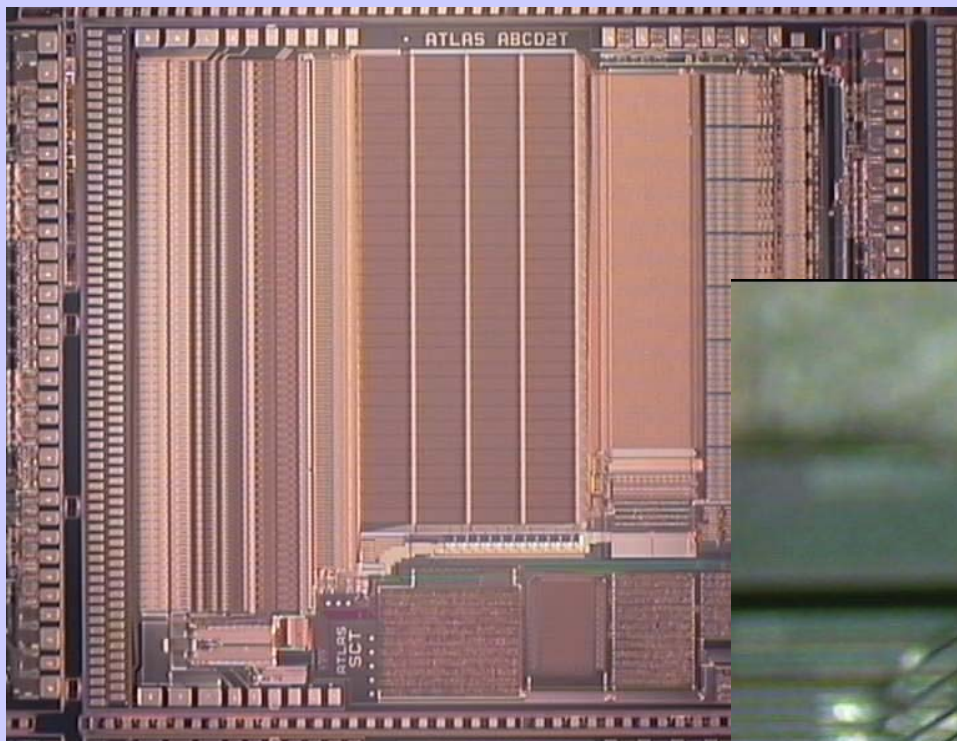
Detektory wierzchołka

- Detektor wierzchołka eksperymentu DELPHI – koncepcja
 - wymaga zintegrowanej elektroniki VLSI ASIC



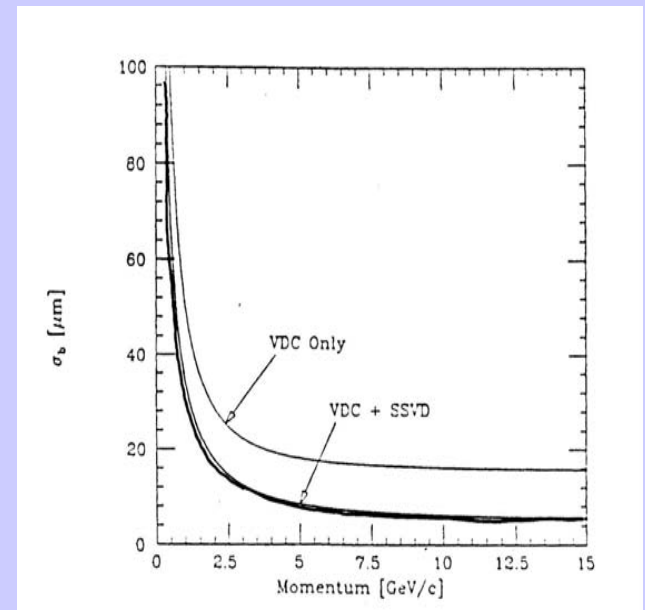
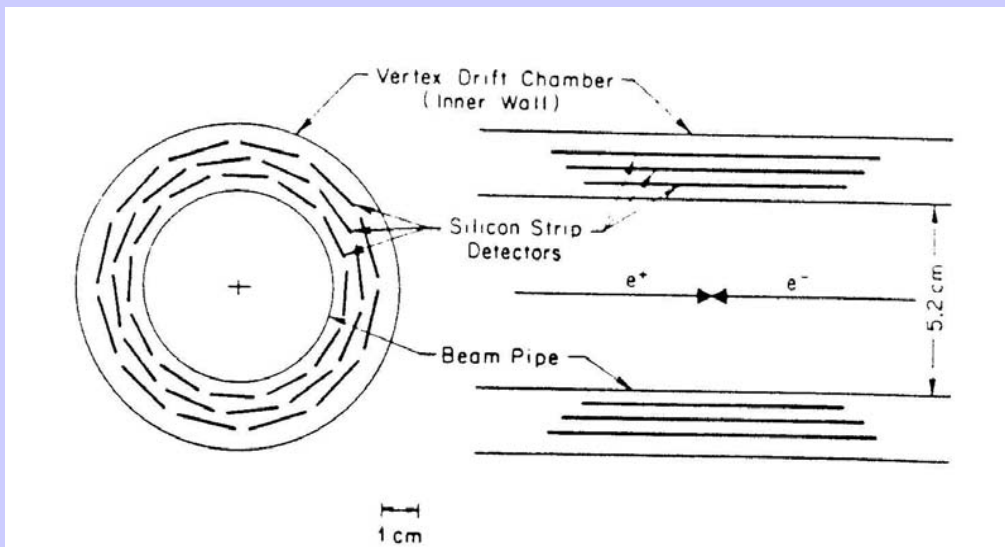
Detektory wierzchołka

- Elektronika odczytu typu VLSI ASIC



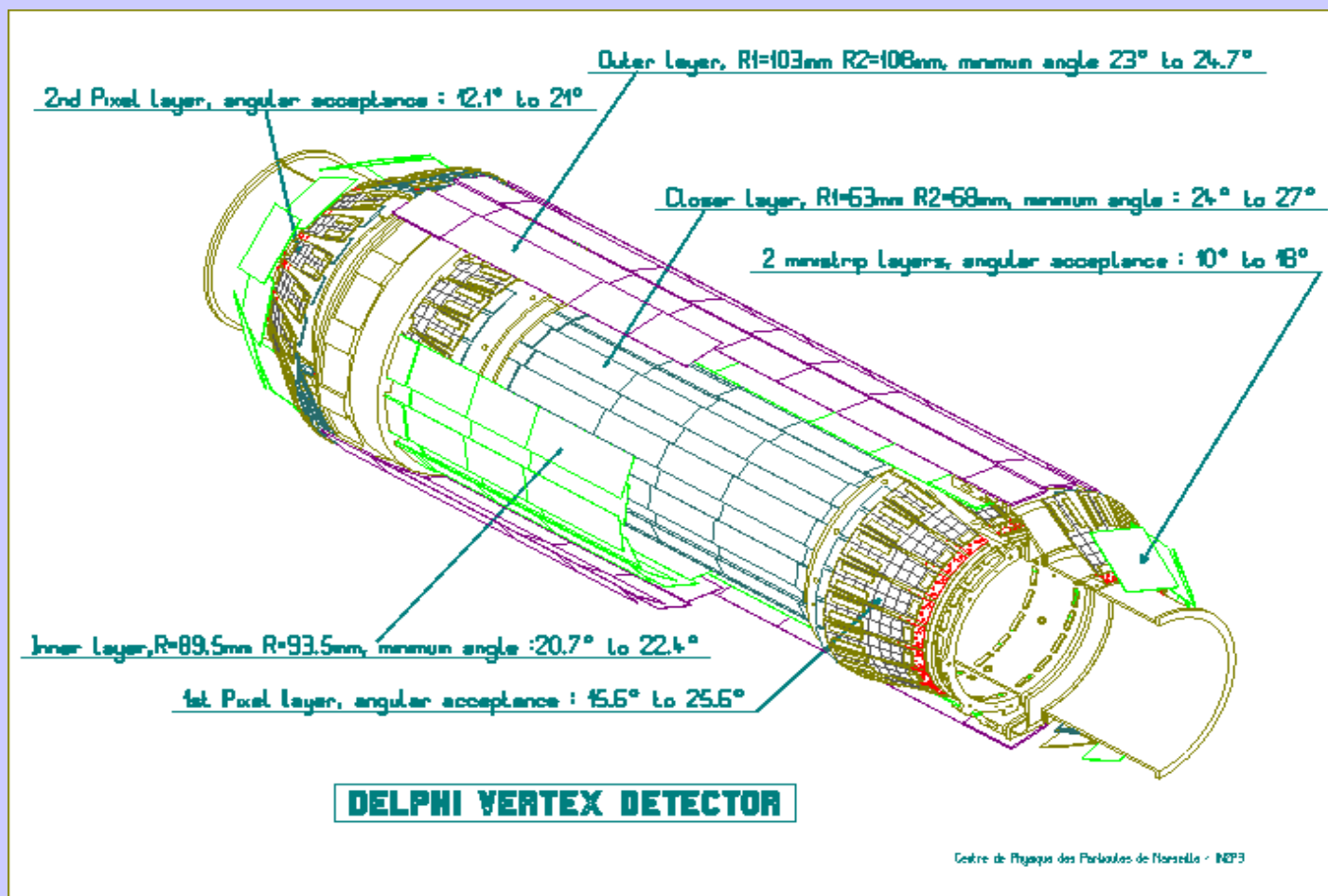
Detektory wierzchołka

- Detektor wierzchołka eksperymentu MARKII w SLAC
 - pierwszy detektor Si na akceleratorze e⁺e⁻ (SLC)



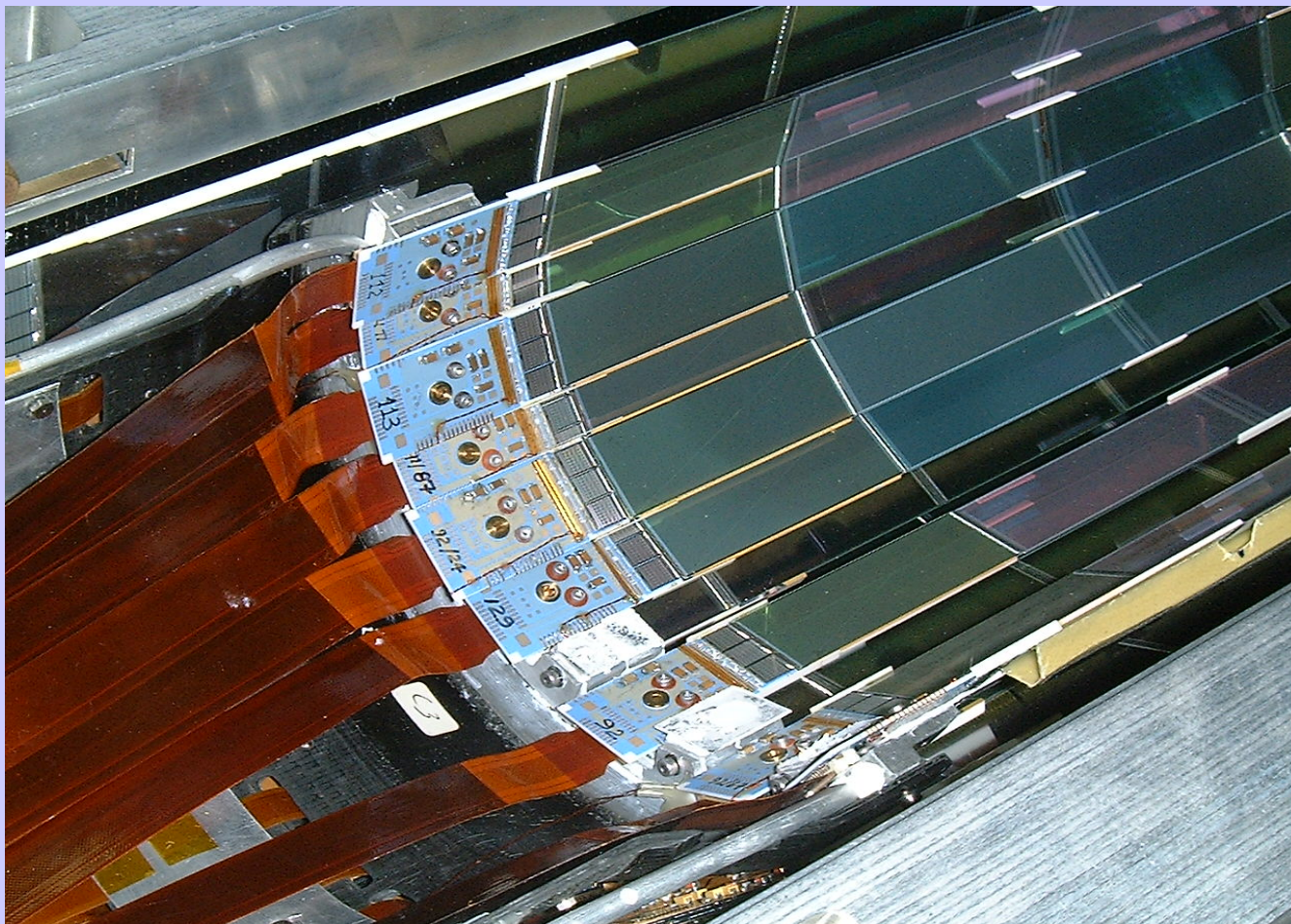
Detektory wierzchołka

- DELPHI Vertex Detector



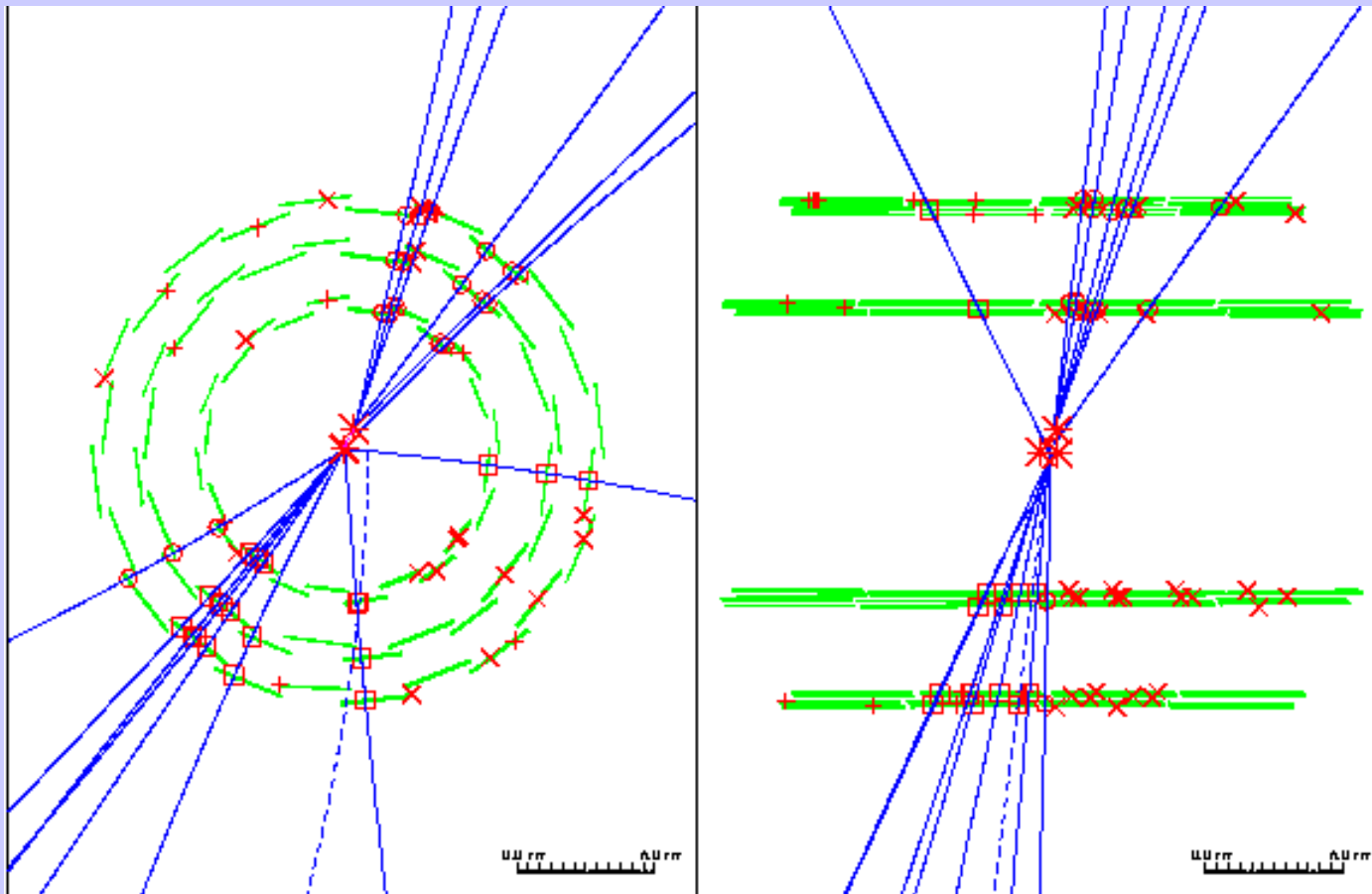
Detektory wierzchołka

- DELPHI Vertex Detector



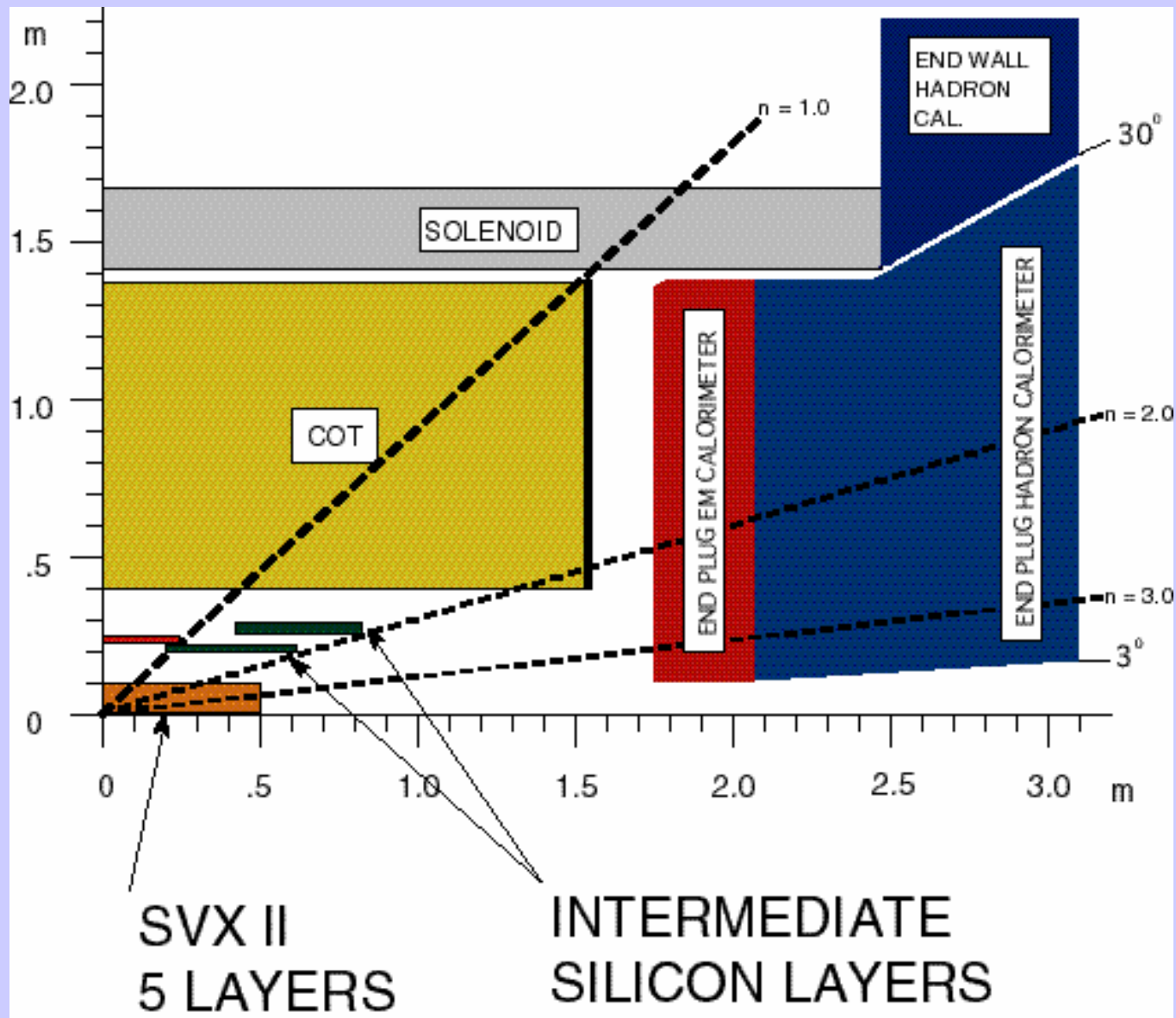
Detektory wierzchołka

- DELPHI Vertex Detector



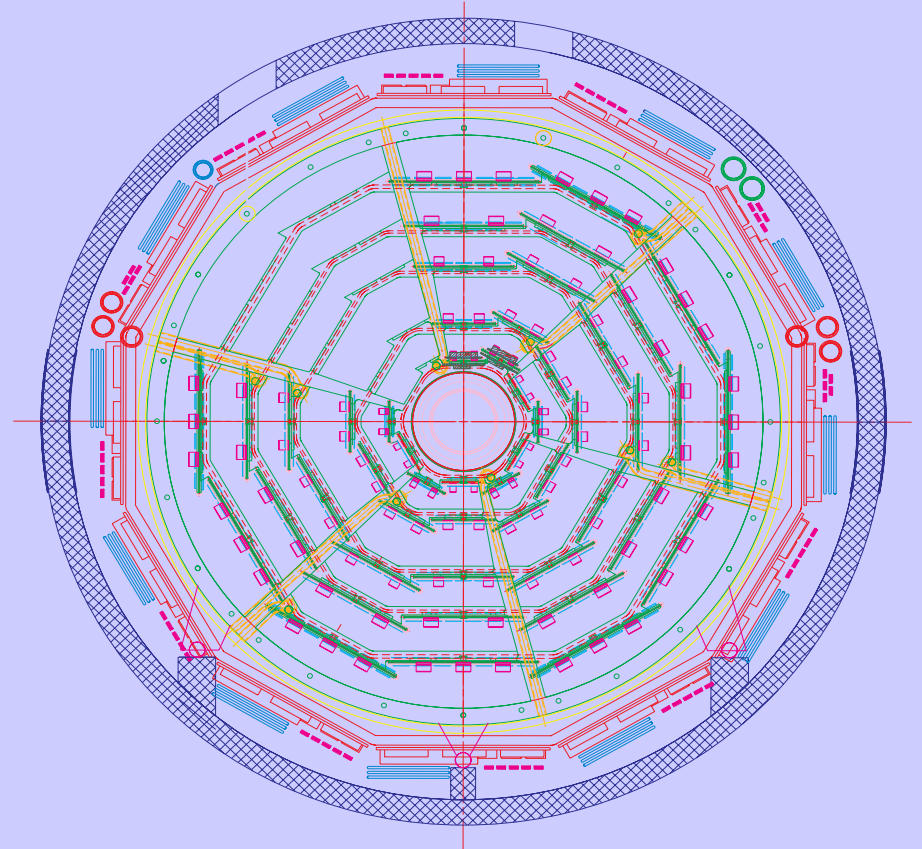
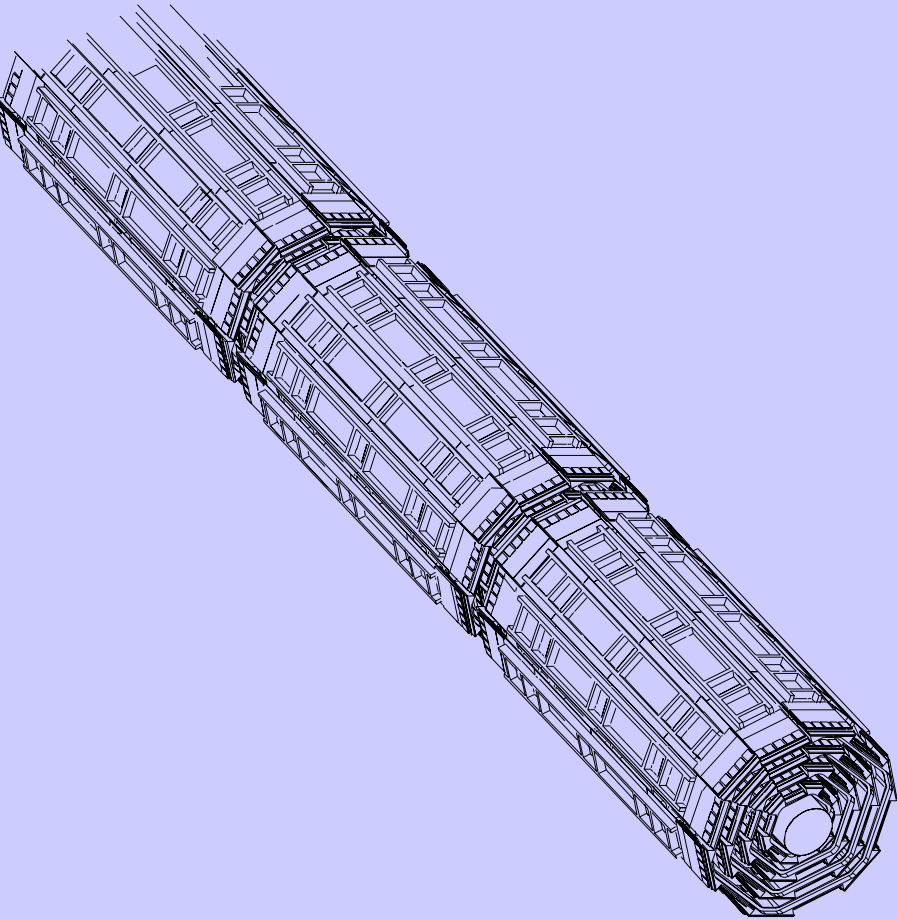
Detektory wierzchołka

Silicon Vertex detector (SVX) w eksperymencie CDF



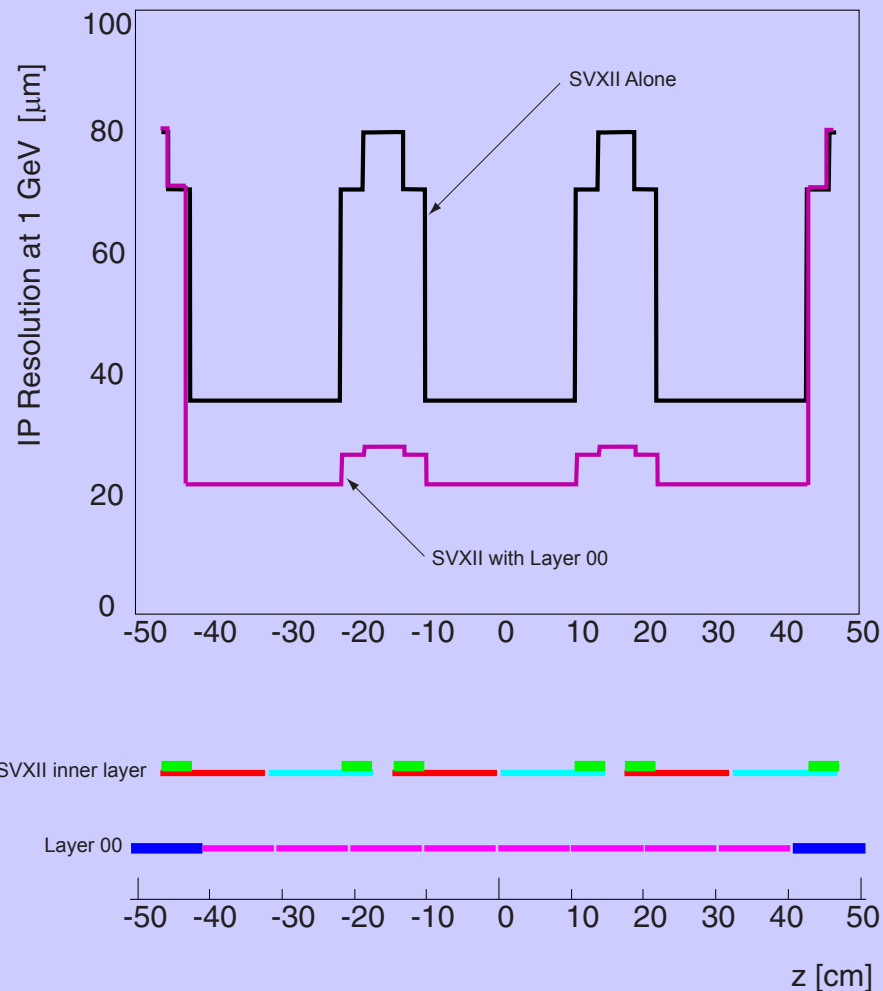
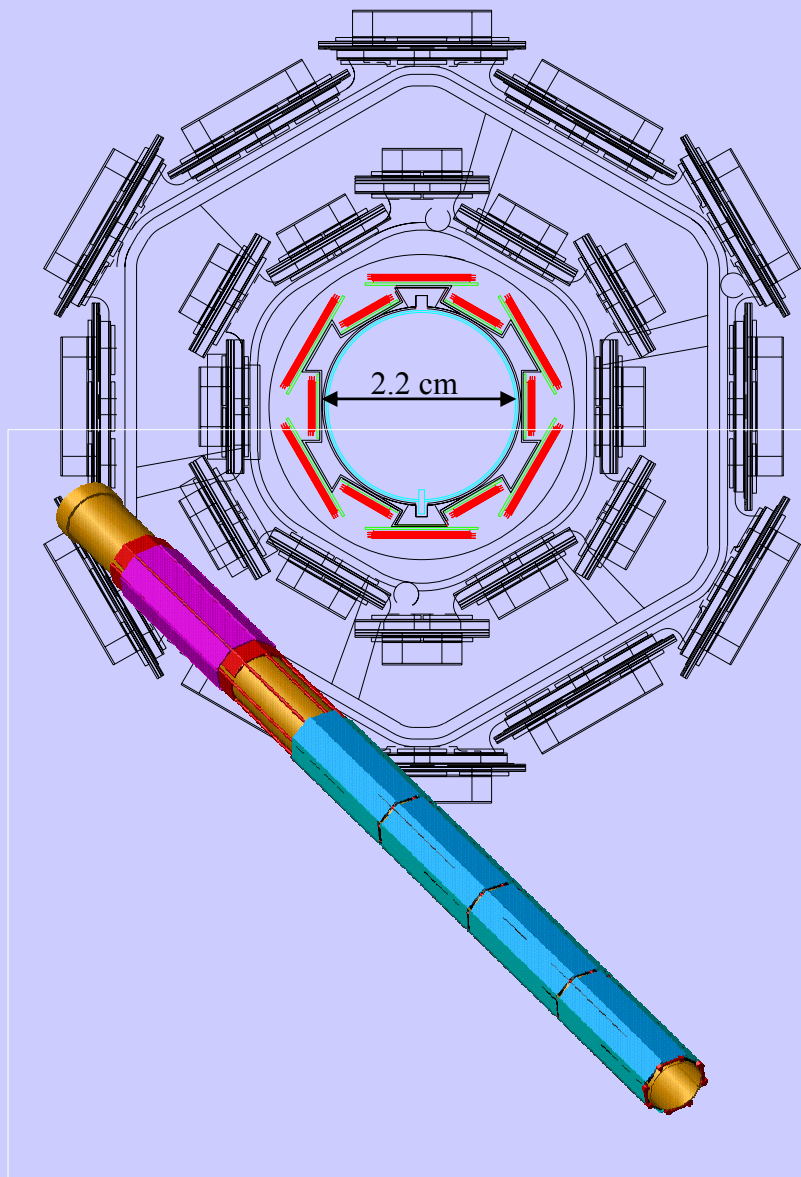
Detektory wierzchołka

Silicon Vertex detector (SVX) w eksperymencie CDF



Detektory wierzchołka

Silicon VerteX detector (SVX) w eksperymencie CDF – warstwa „00”

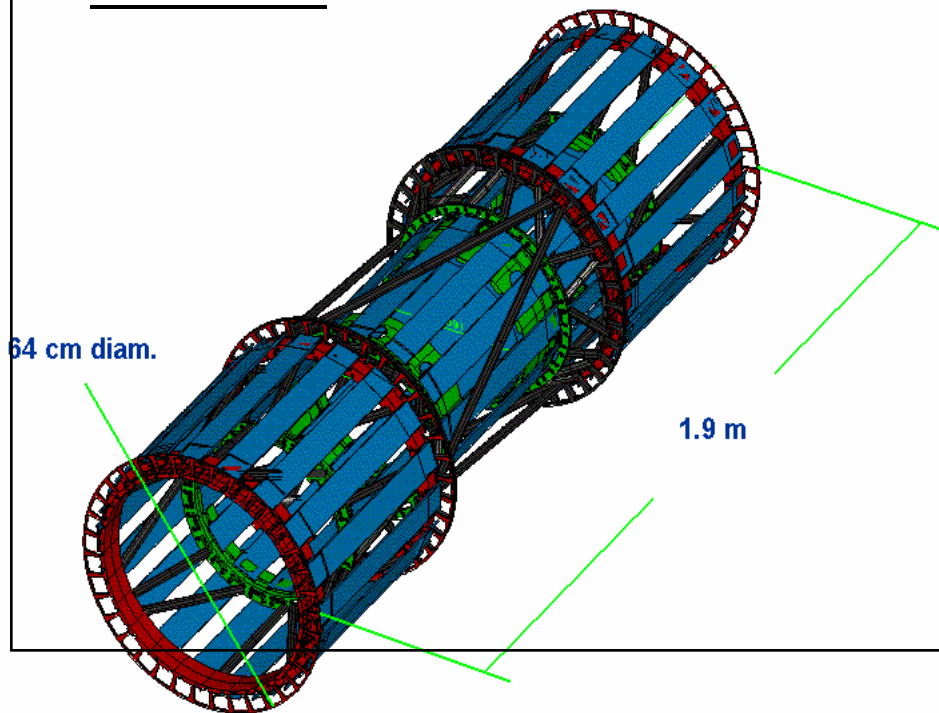


Dodanie detektorów b. blisko punktu zderzenia znacznie poprawiło dokładność pomiaru punktu oddziaływania

Detektory wierzchołka

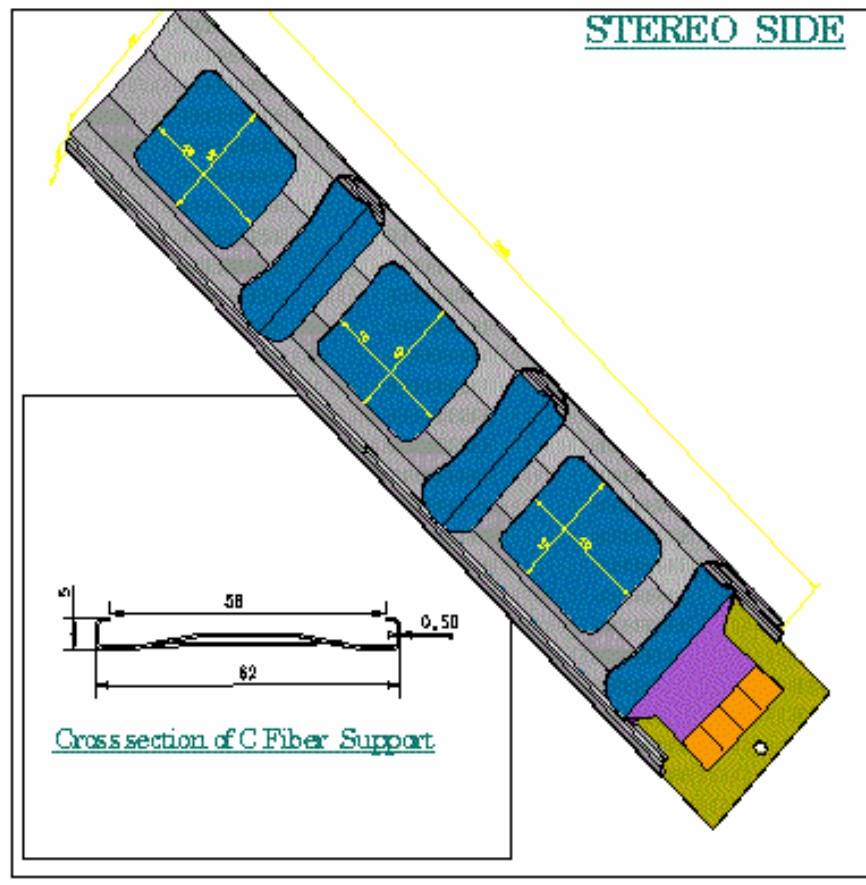
Silicon Vertex detector (SVX) CDF – warstwa pośrednia

CDF ISL



Sztywna, lekka konstrukcja dla
mocowania detektorów

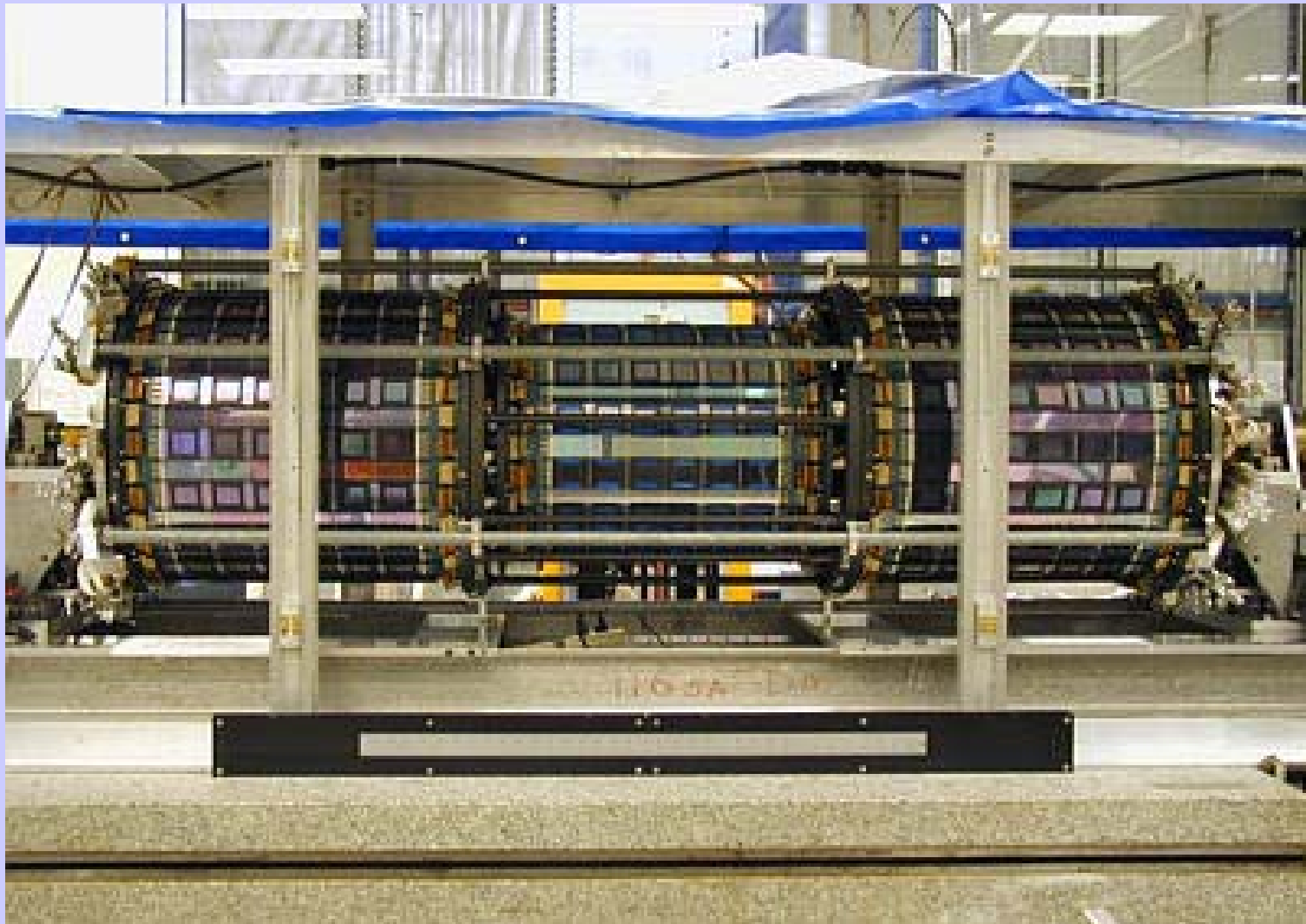
STEREO SIDE



Moduł detektora

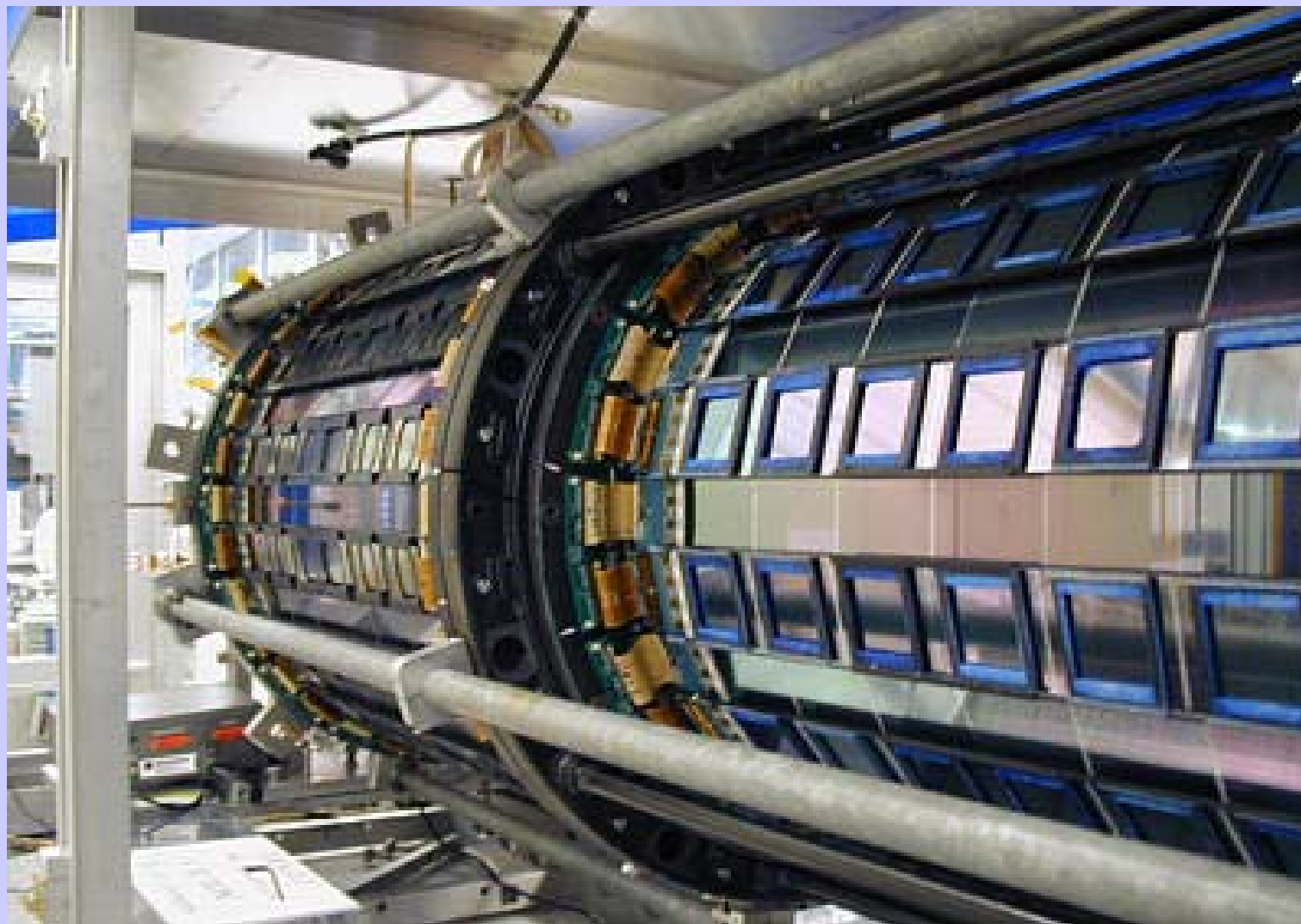
Detektory wierzchołka

Intermediate Silicon Layers (ISL) w eksperymencie CDF



Detektory wierzchołka

Intermediate Silicon Layers (ISL) w eksperymencie CDF



Detektory wierzchołka

Intermediate Silicon Layers (ISL) w eksperymencie CDF

$e + 4 \text{ jet event}$

40758_44414

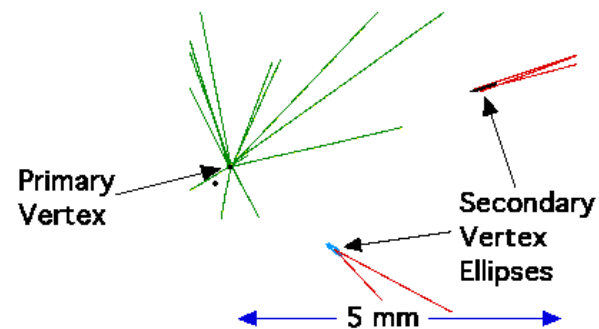
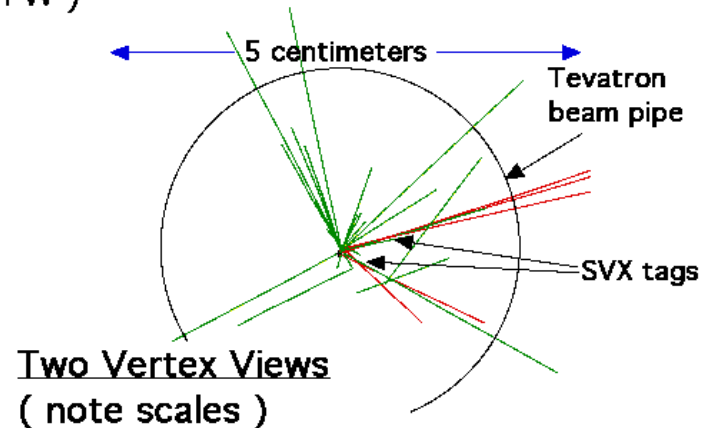
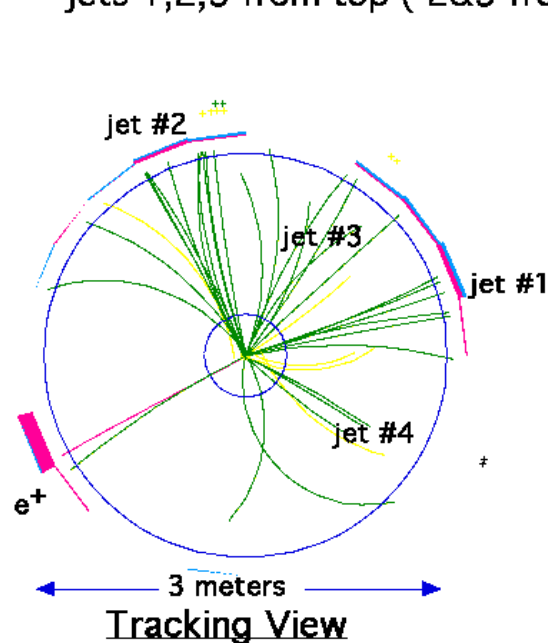
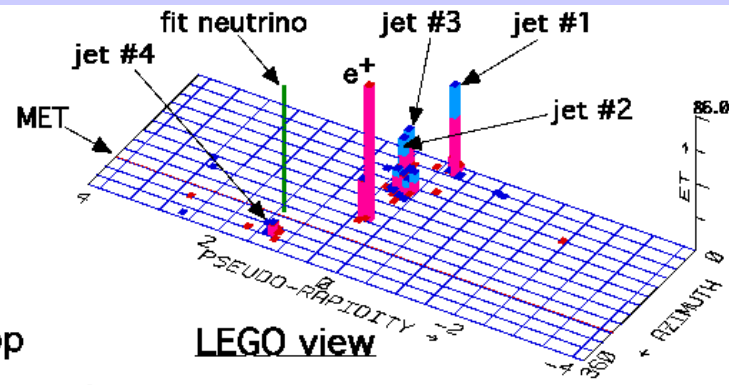
24-September, 1992

TWO jets tagged by SVX

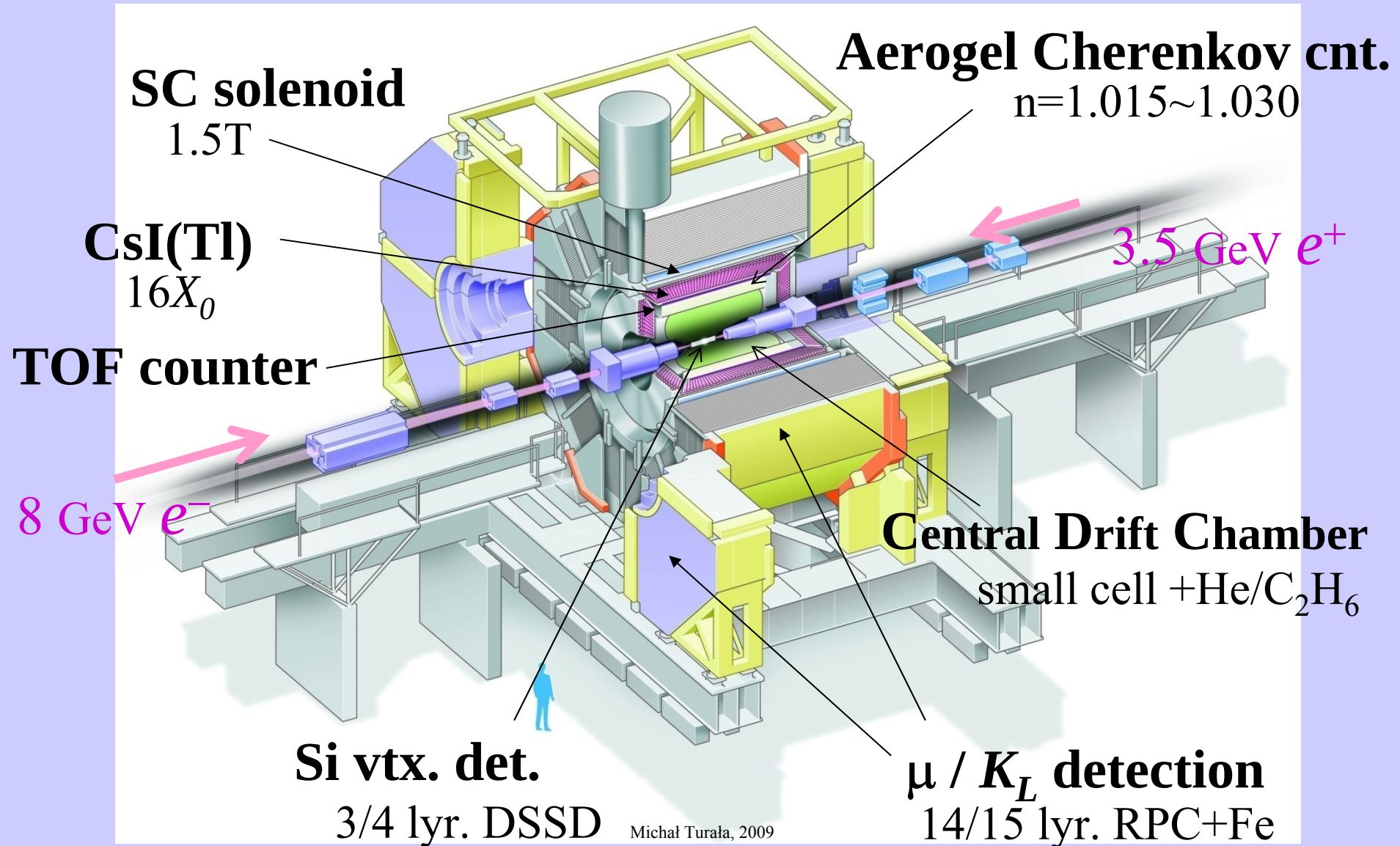
fit top mass is $170 \pm 10 \text{ GeV}$

e^+ , Missing E_T , jet #4 from top

jets 1,2,3 from top (2&3 from W)



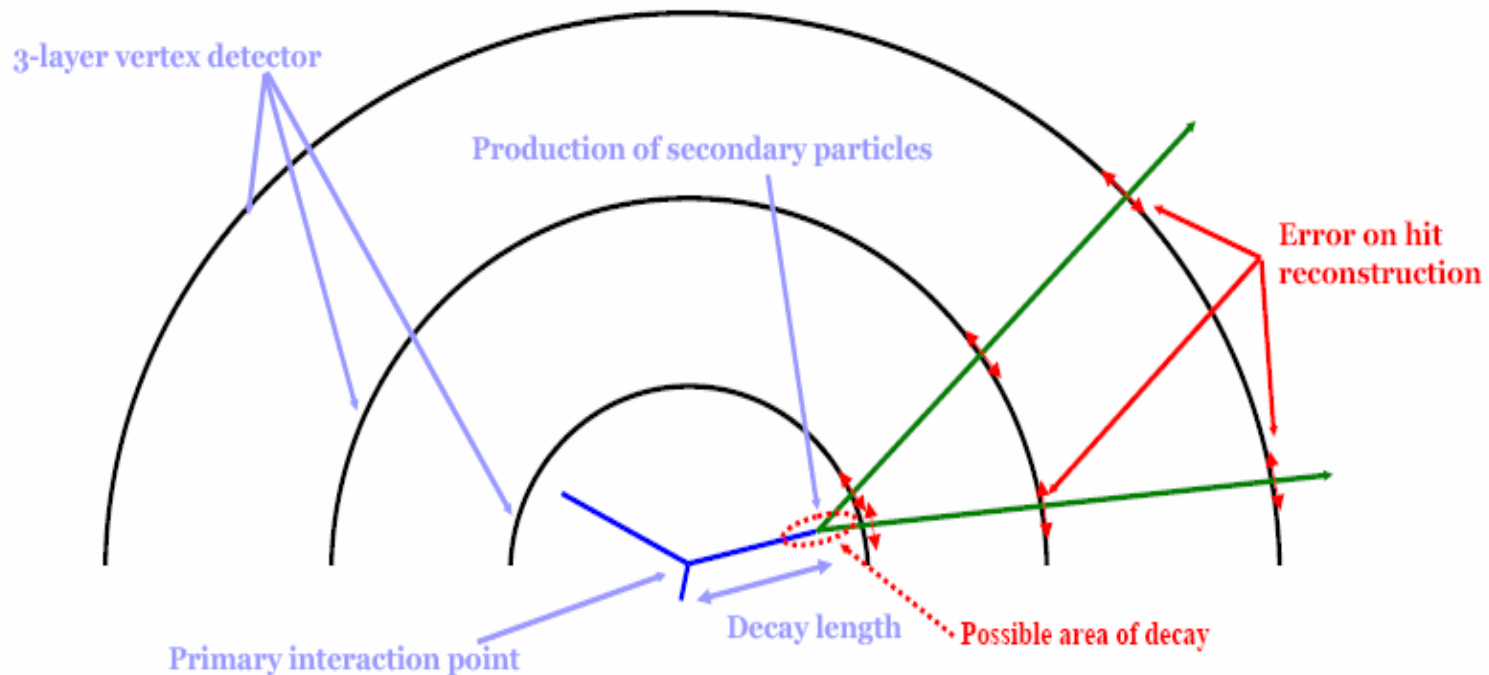
Belle Detector



Detektory wierzchołka

Krzemowy detektor wierzchołków w eksperymencie Belle

Principle of Vertex Detector



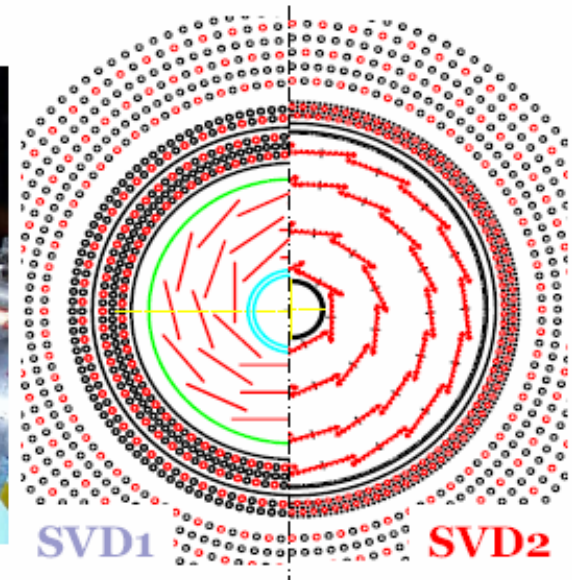
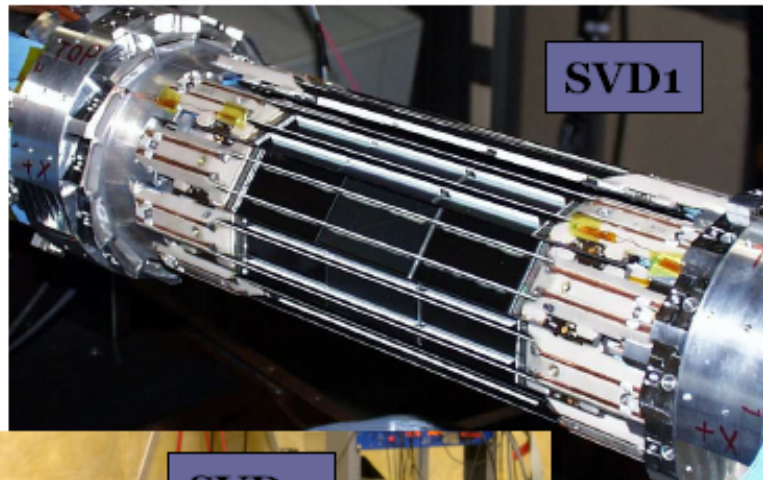
- 1) Decay length gives a hint at **which particle was produced** and when.
- 2) Need **accuracy in our extrapolation from recorded hit** → Need **good hit resolution** in layers of detector: **small size** of detection units, and **not so much material**

Detektory wierzchołka

Krzemowy detektor wierzchołków w eksperymencie Belle

Silicon Vertex Detector 1 & 2

Summer 2003

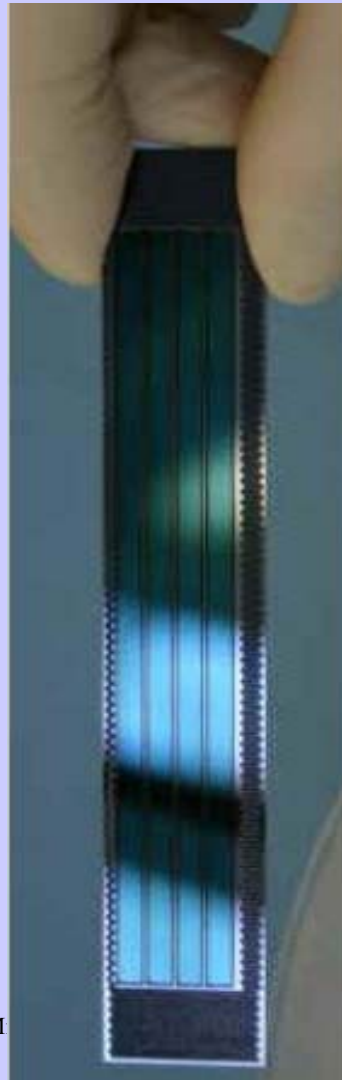
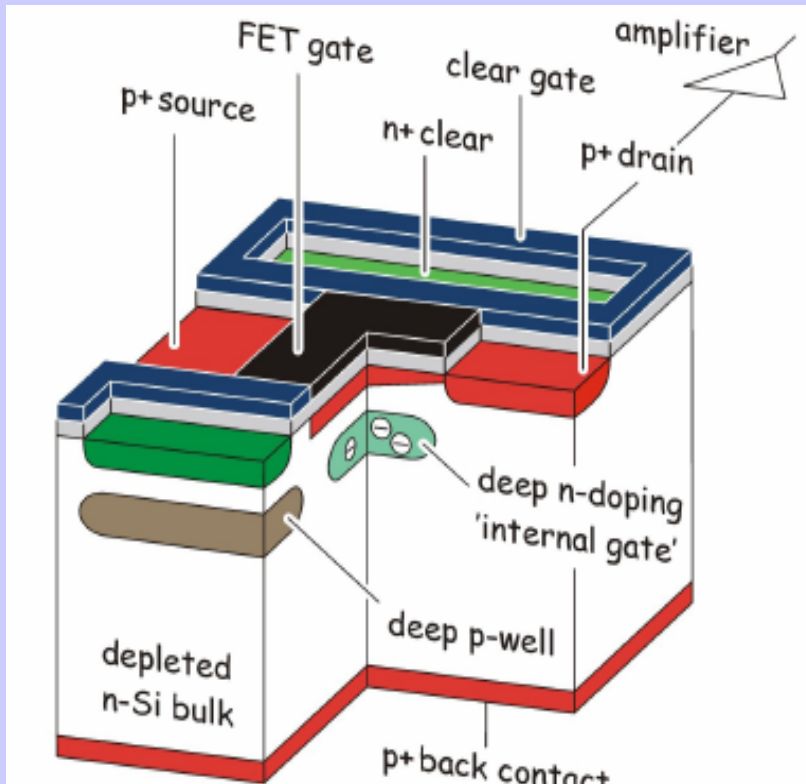


- 3 layers $\rightarrow$ 4 layers
- $23^\circ < \theta < 139^\circ \rightarrow 17^\circ < \theta < 150^\circ$
- 1 MRad $\rightarrow$ >20 MRad
- $R_{bp} = 2.0 \text{ cm} \rightarrow 1.5 \text{ cm}$

 Better I.P. resolution

Detektory wierzchołka

Krzemowy detektor wierzchołków w eksperymencie Belle DEPFET detector (DEPleted Field Effect Transistor)

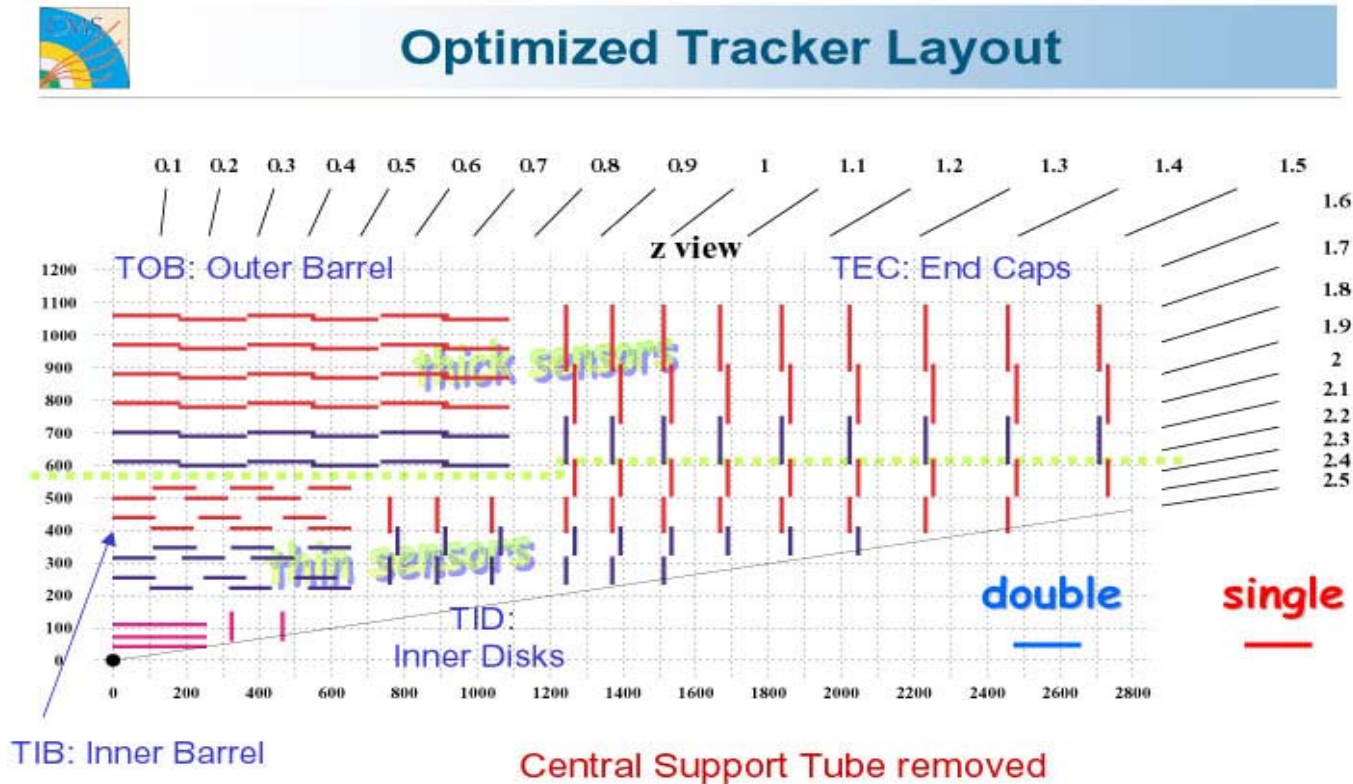


The all-silicon module

- The DEPFET sensor is self-supporting
- It can be thinned
- Auxiliary electronics located on end- of sensor (readout) and balcony (steering)
- One material – uniform (and small) thermal expansion

Detektory torów i wierzchołków

CMS – Compact Muon Spectrometer - Silicon Tracker (ok. 210 m² detektorow paskowych)



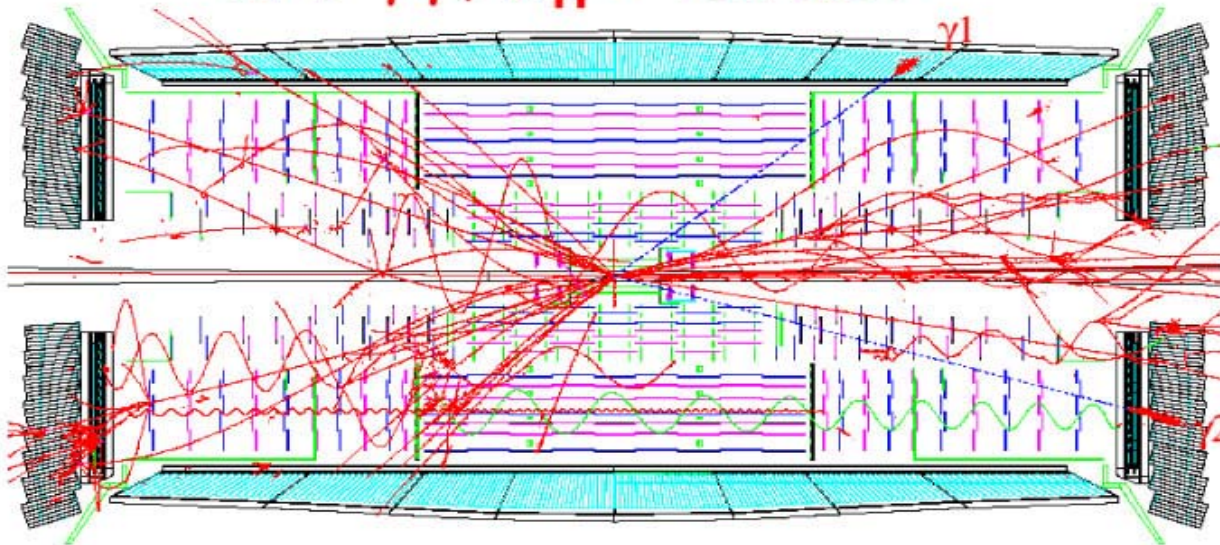
Detektory torów i wierzchołków

- CMS – spodziewana obserwacja przypadku Higgsa



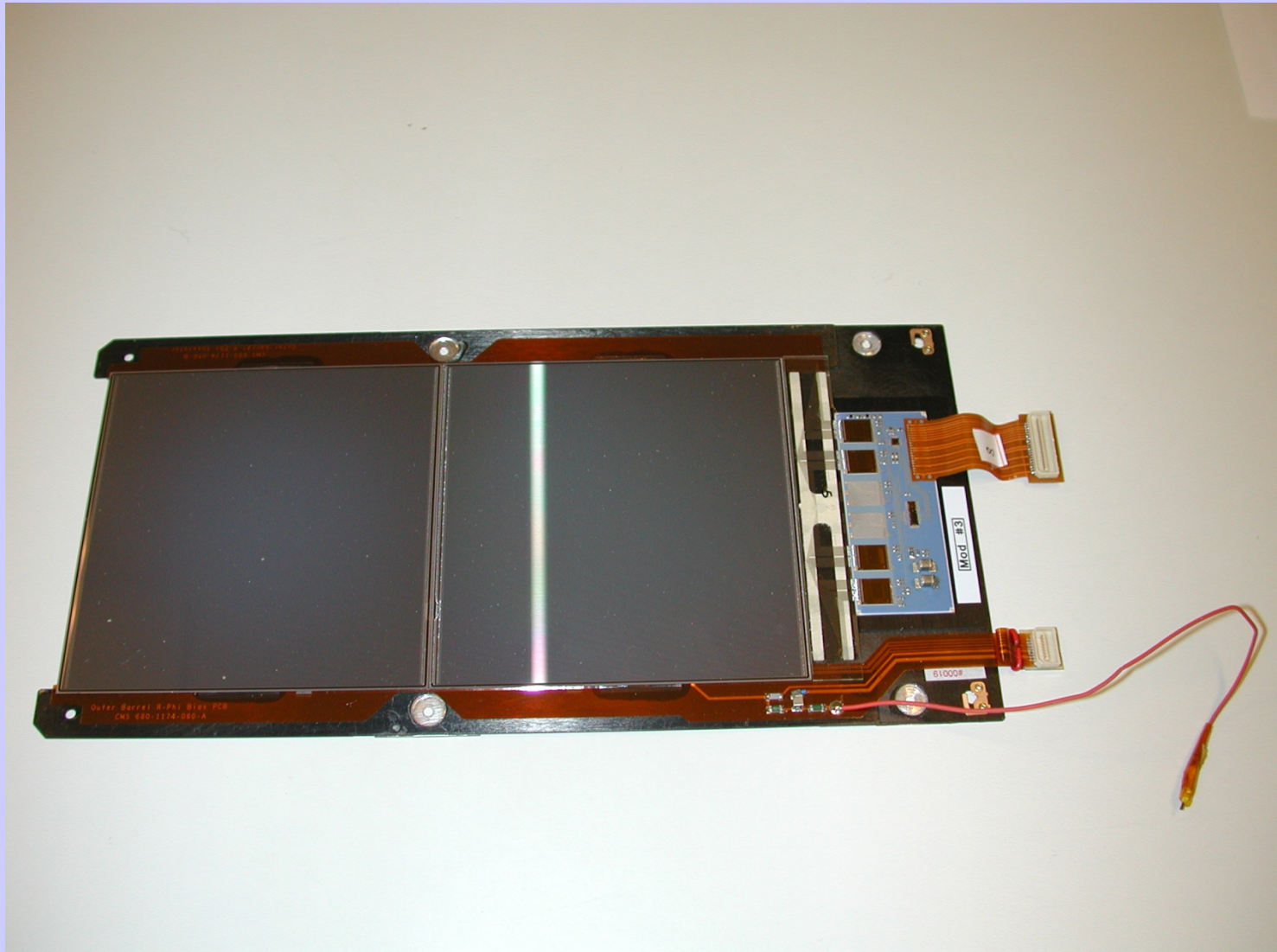
Higgs event into two Photons

$H \rightarrow \gamma\gamma, M_H = 100 \text{ GeV}$



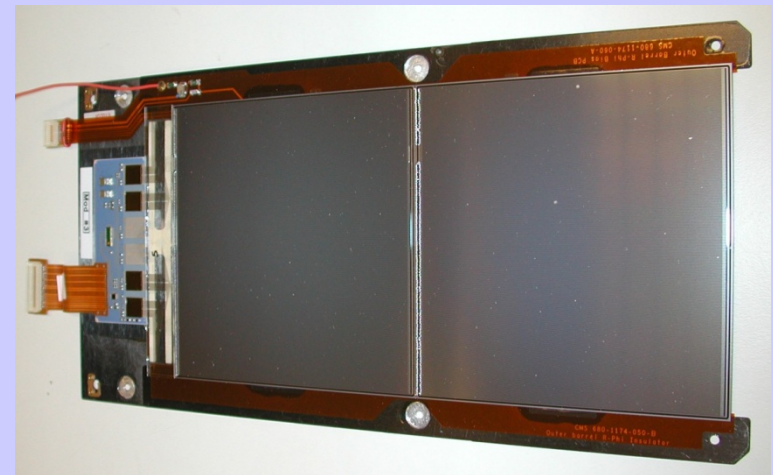
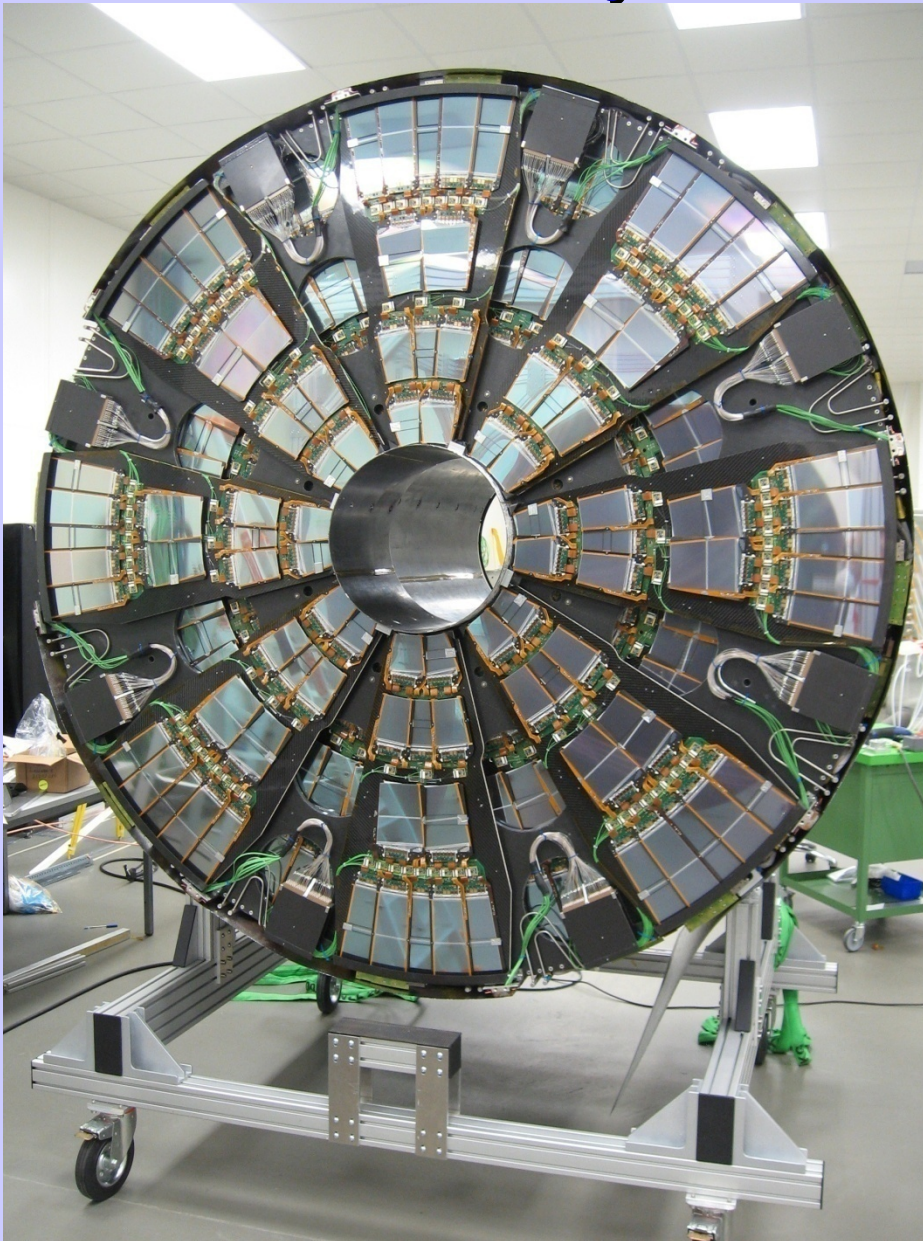
Detektory torów i wierzchołków

CMS – Compact Muon Spectrometer - Silicon Tracker



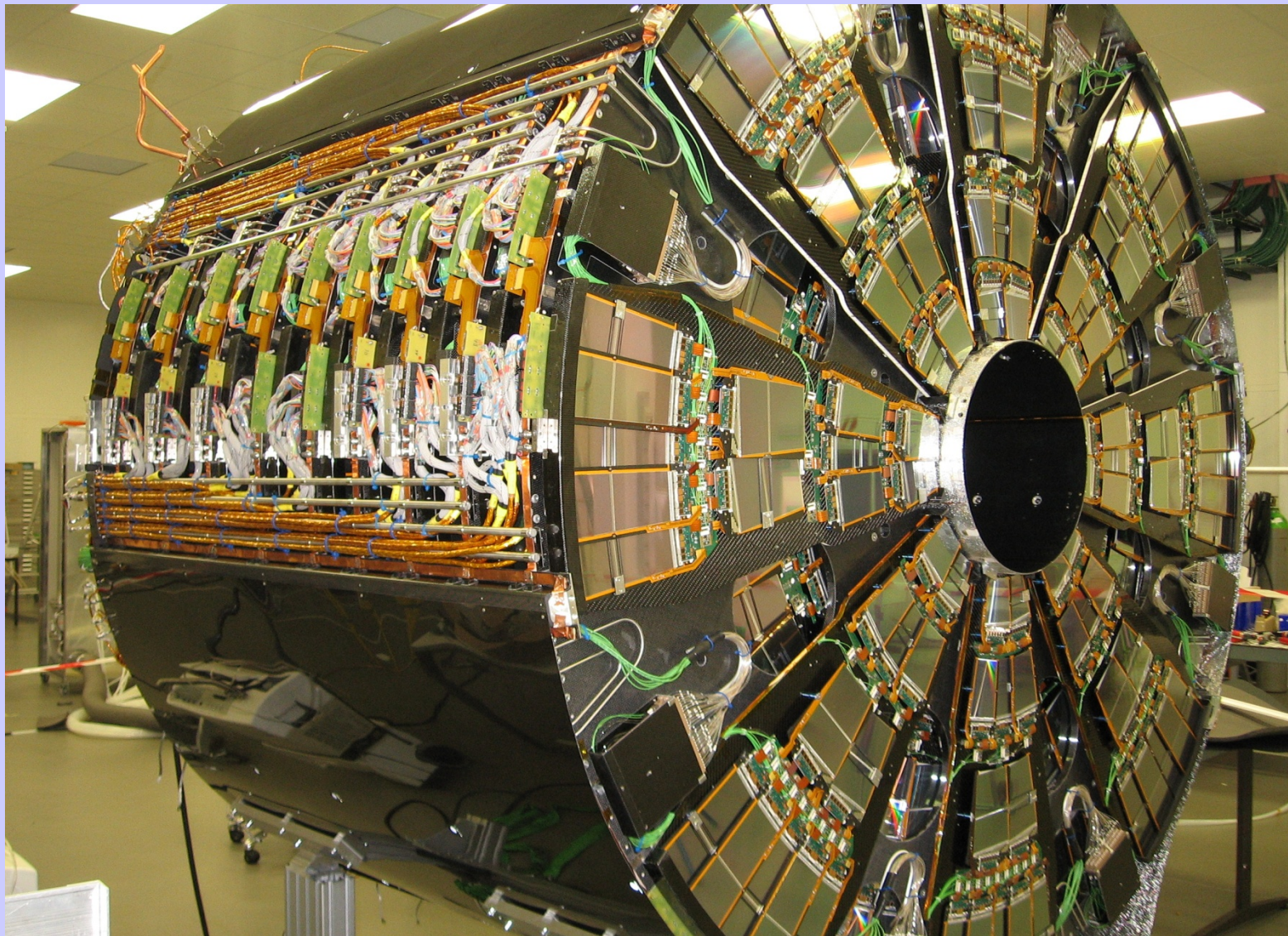
Detektory torów i wierzchołków

**CMS – Compact Muon
Spectrometer -
Silicon Tracker**



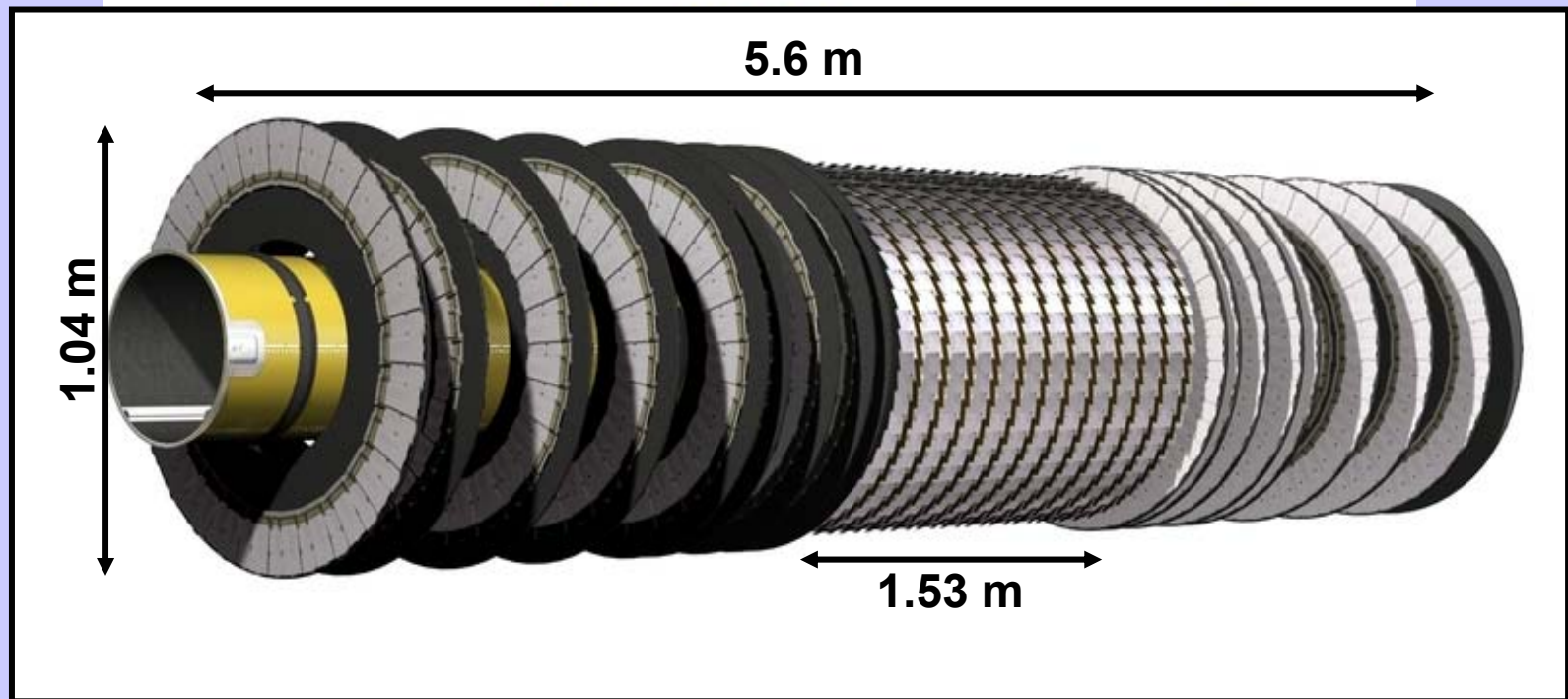
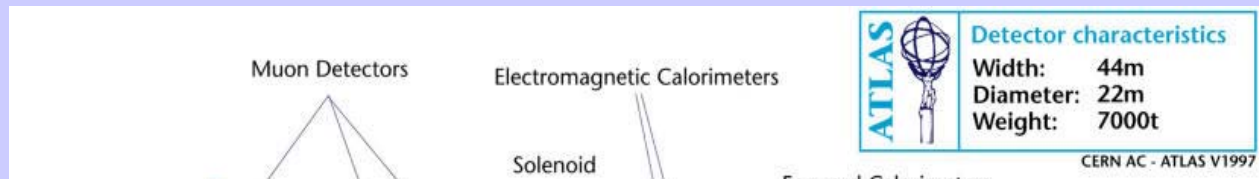
Detektory torów i wierzchołków

CMS – Compact Muon Spectrometer - Silicon Tracker



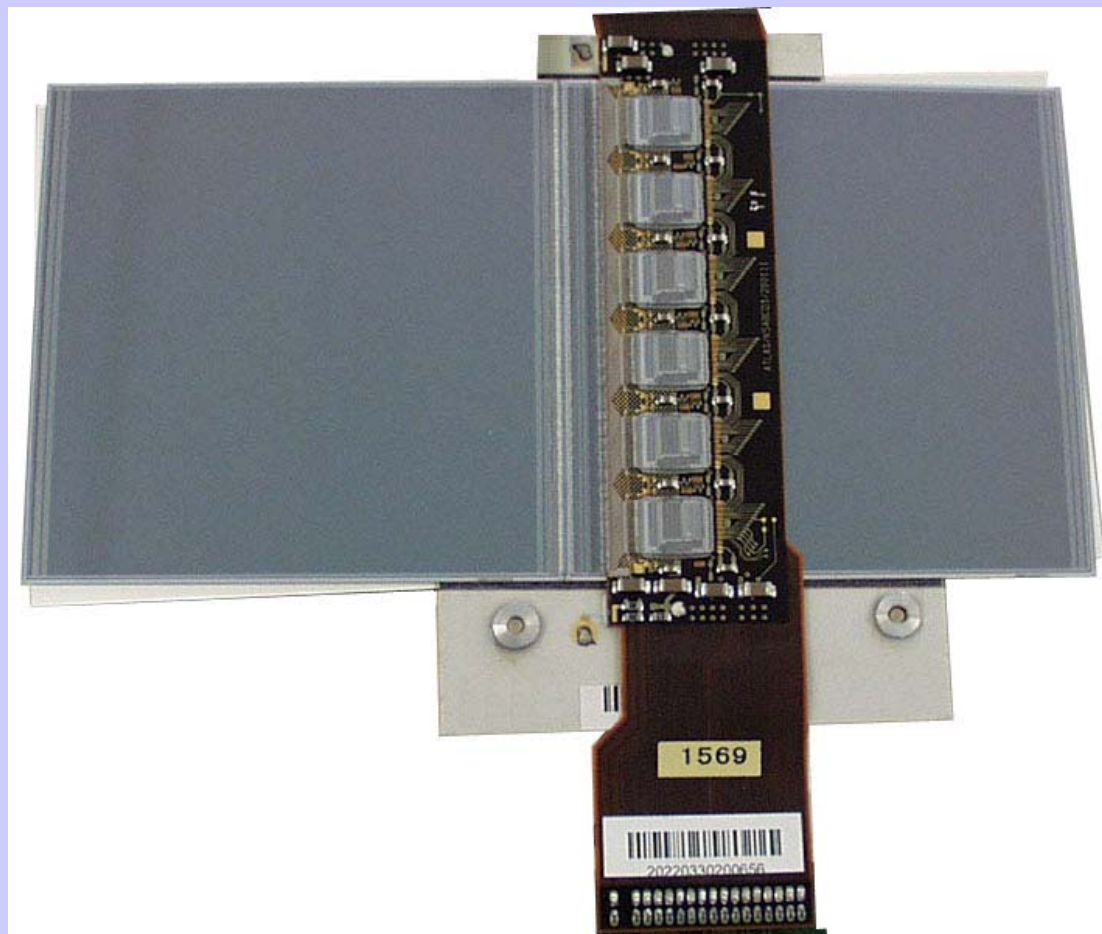
Detektory torów i wierzchołków

- ATLAS Si Tracker (4088 detektorów paskowych, ok. 61 m²)



Detektory torów i wierzchołków

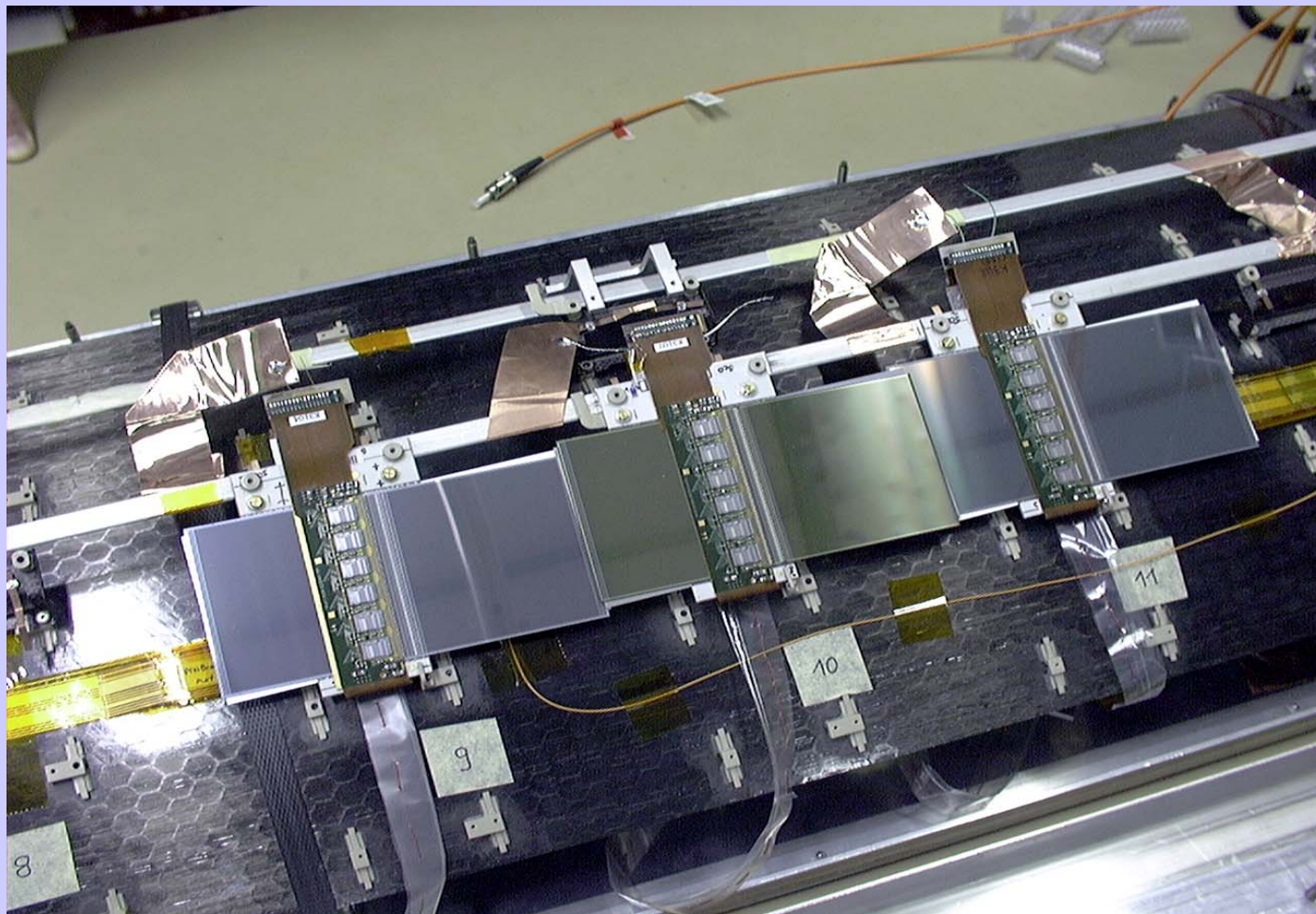
- ATLAS Si Tracker – moduł detektora „barrel”



1 typ modułów, razem 2112 sztuk

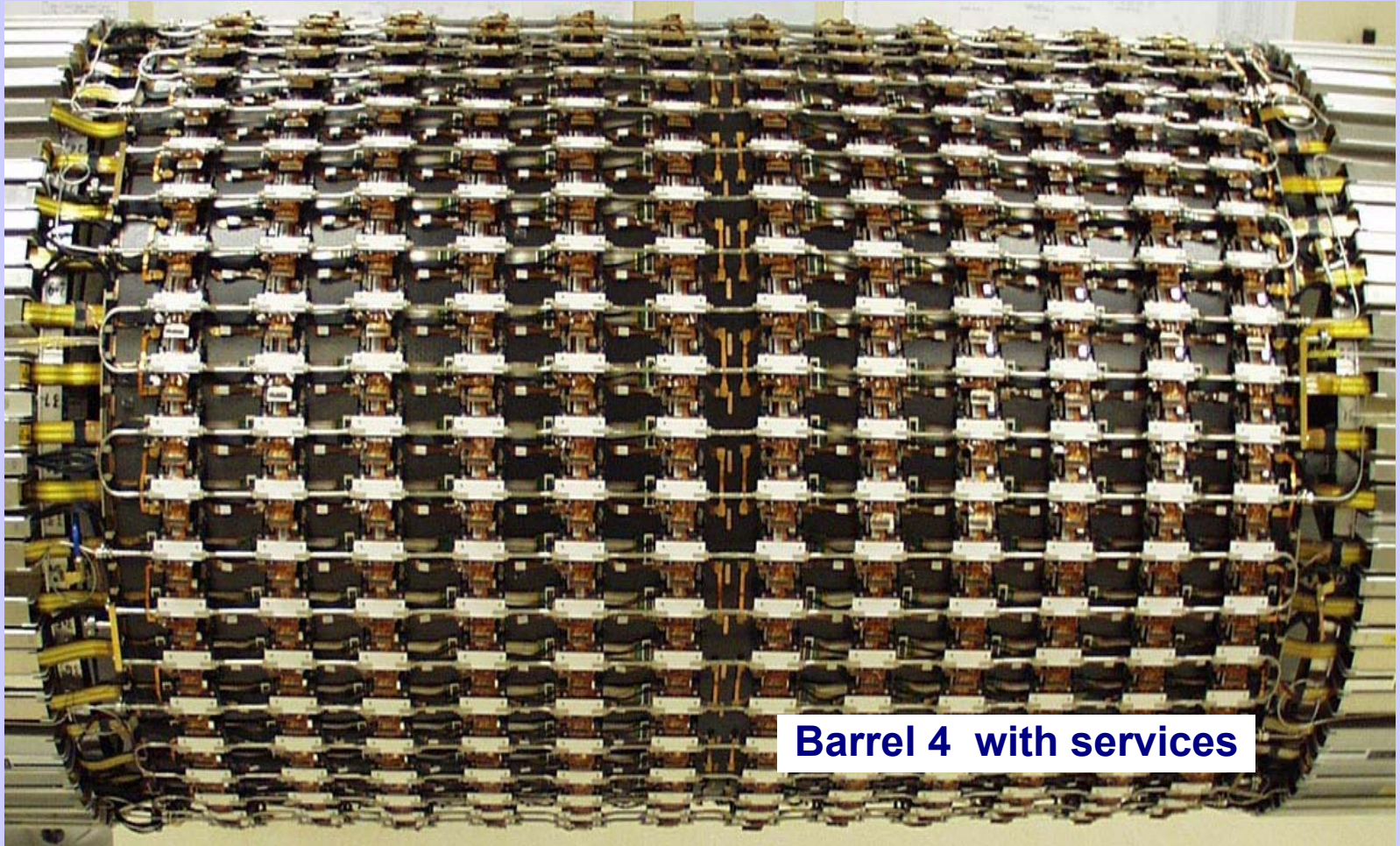
Detektory torów i wierzchołków

- ATLAS Si Tracker – badania systemowe detektorów



Detektory torów i wierzchołków

- ATLAS Si Tracker – zmontowany cylinder Nr. 4

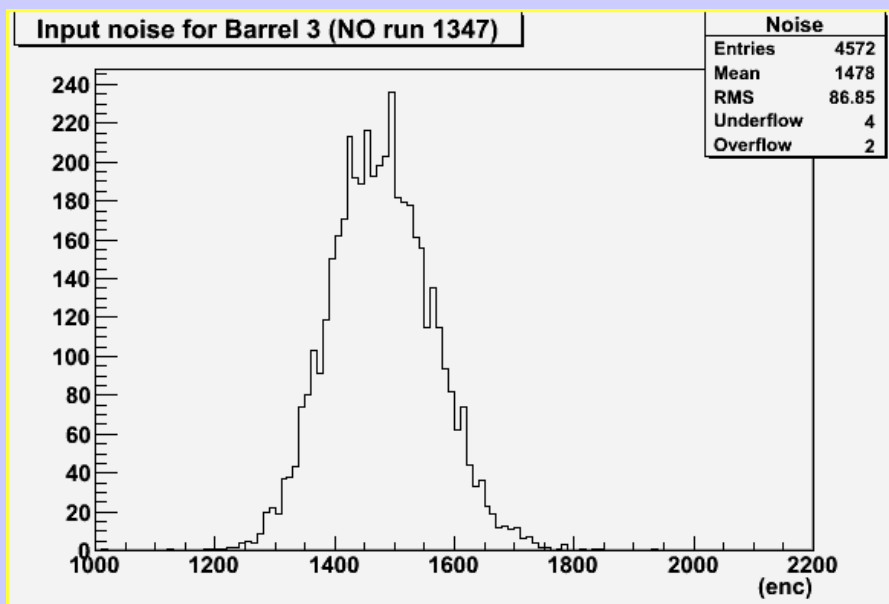


Detektory torów i wierzchołków

- **ATLAS Si Tracker – pomiary zmontowanych detektorów**

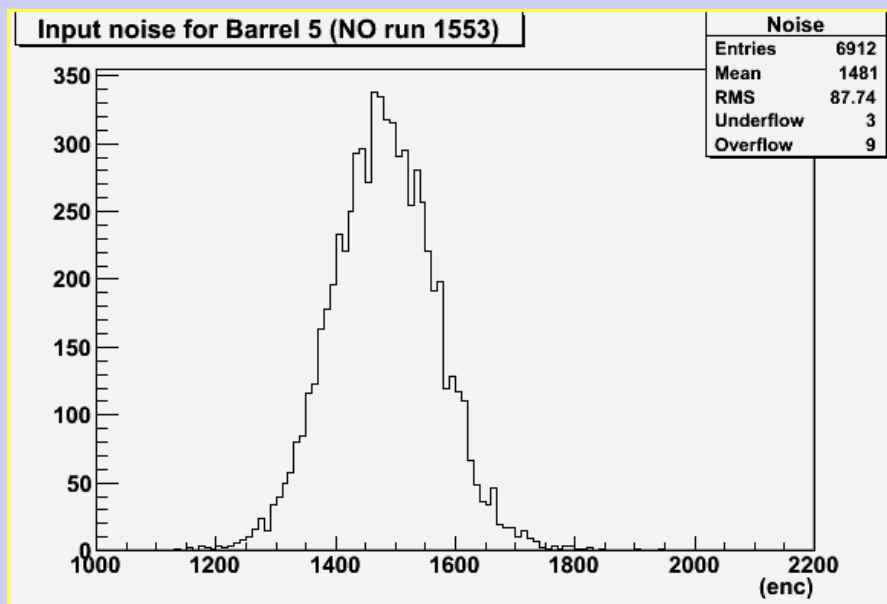
- **B3 reception tests in SR1**

- ‘warm’ run (~13.5 deg.C on cooling pipes)
- 320 nA average detector current
- 1500 e⁻ average ENC
- **99.8%** working channels



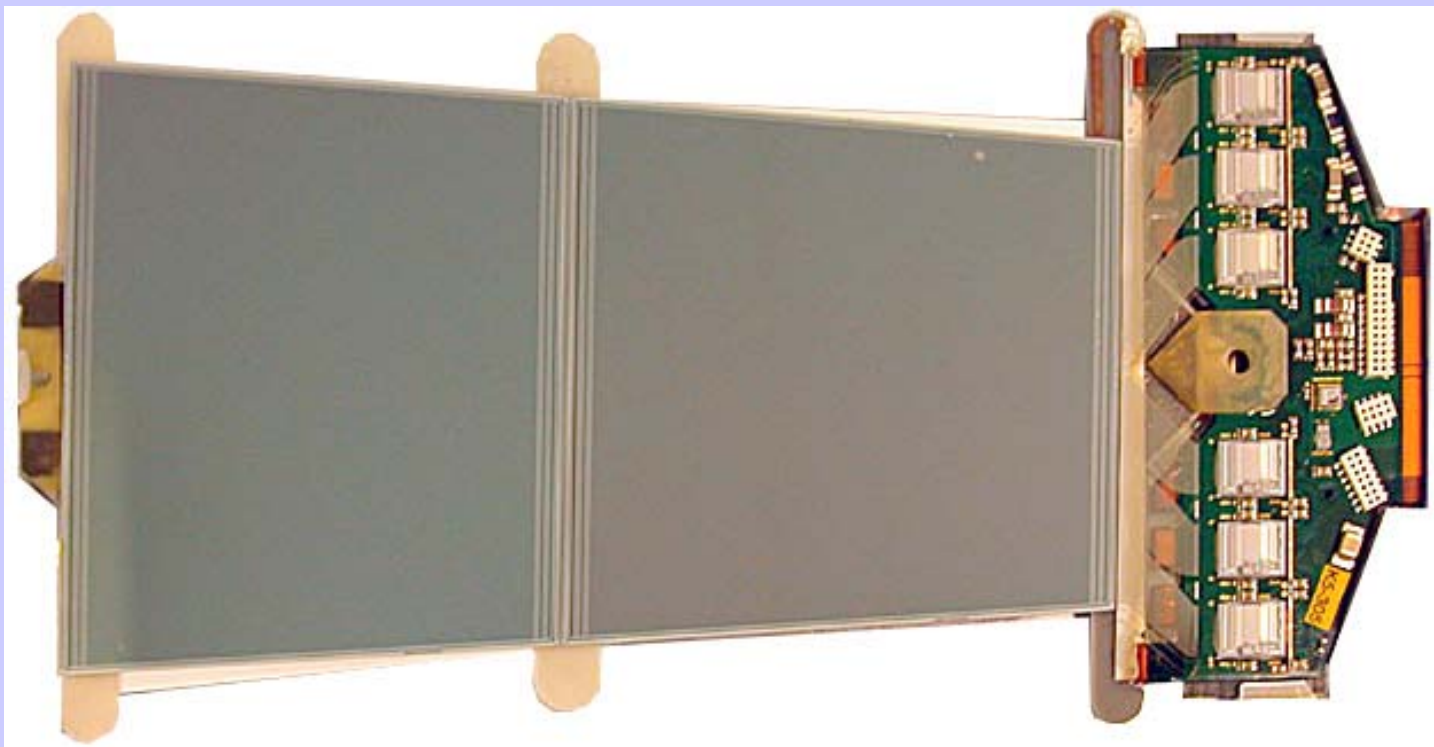
- **B5 reception tests in SR1**

- ‘cold’ run (~6 deg.C on cooling pipes)
- 150 nA average detector current
- 1500 e⁻ average ENC
- **99.85%** working channels



Detektory torów i wierzchołków

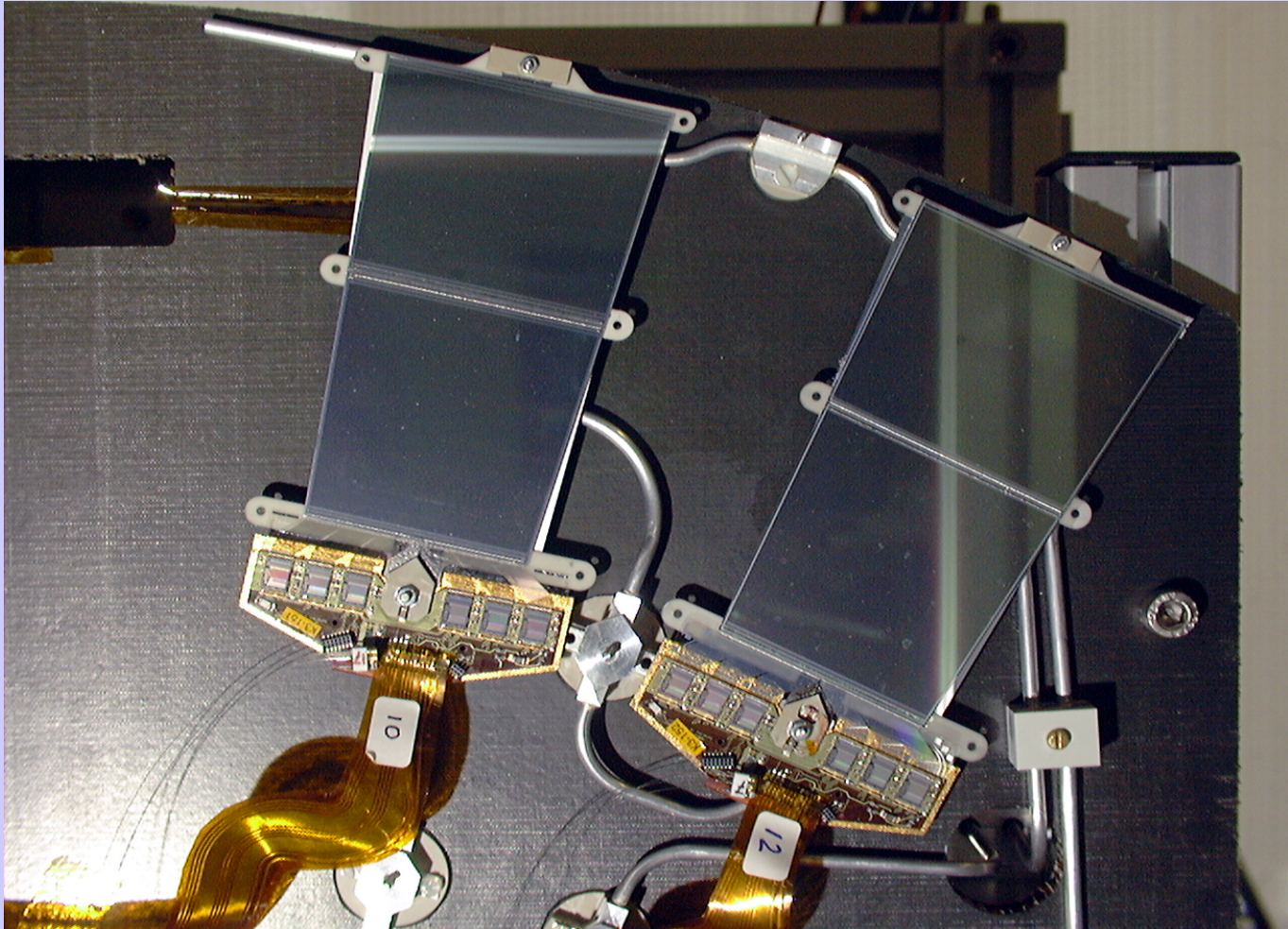
- ATLAS Si Tracker – moduł detektora „end-cap”



4 typy modułów, razem 1976 sztuk

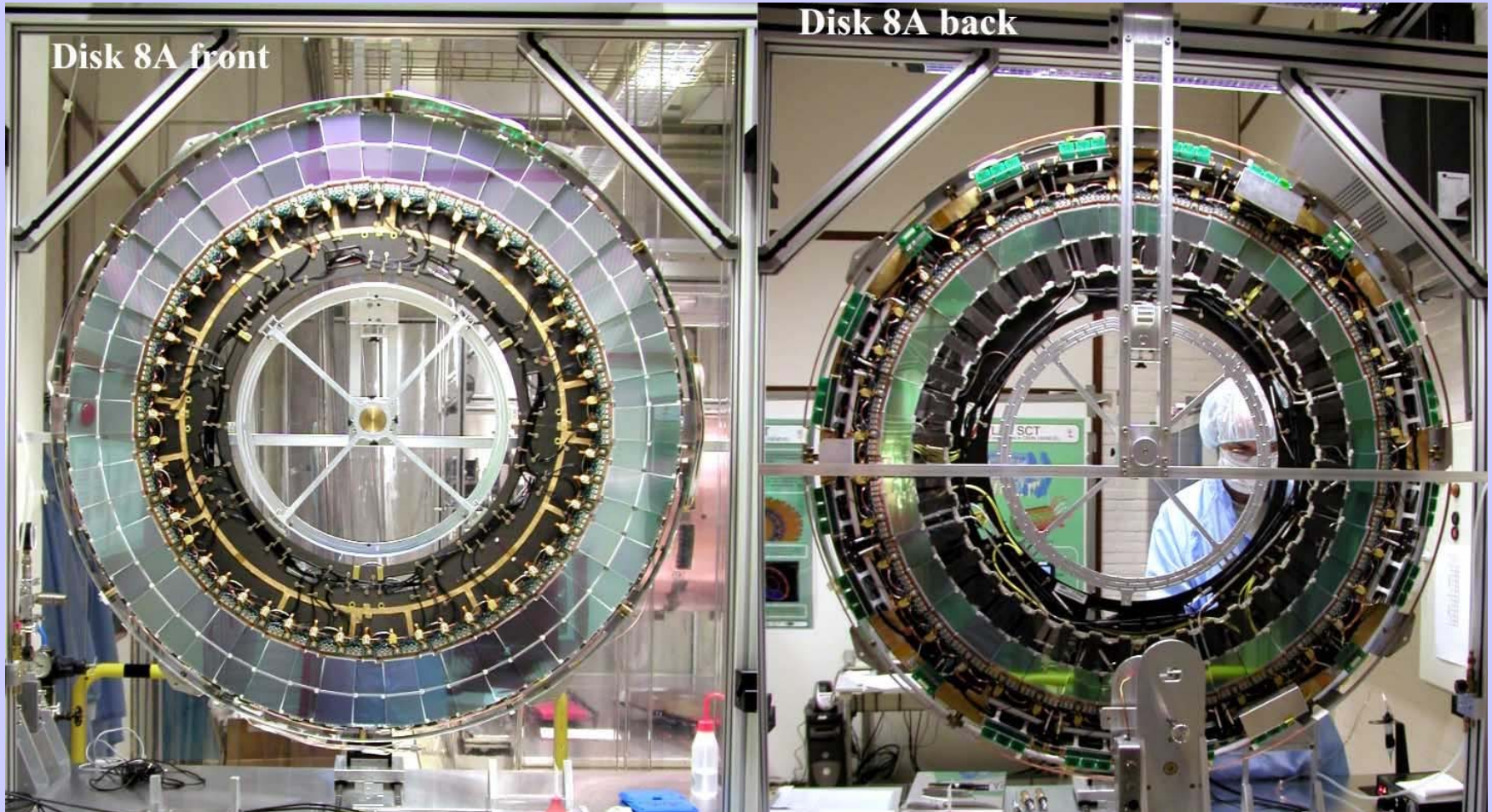
Detektory torów i wierzchołków

- ATLAS Si Tracker – badania systemowe detektorów „end cap”



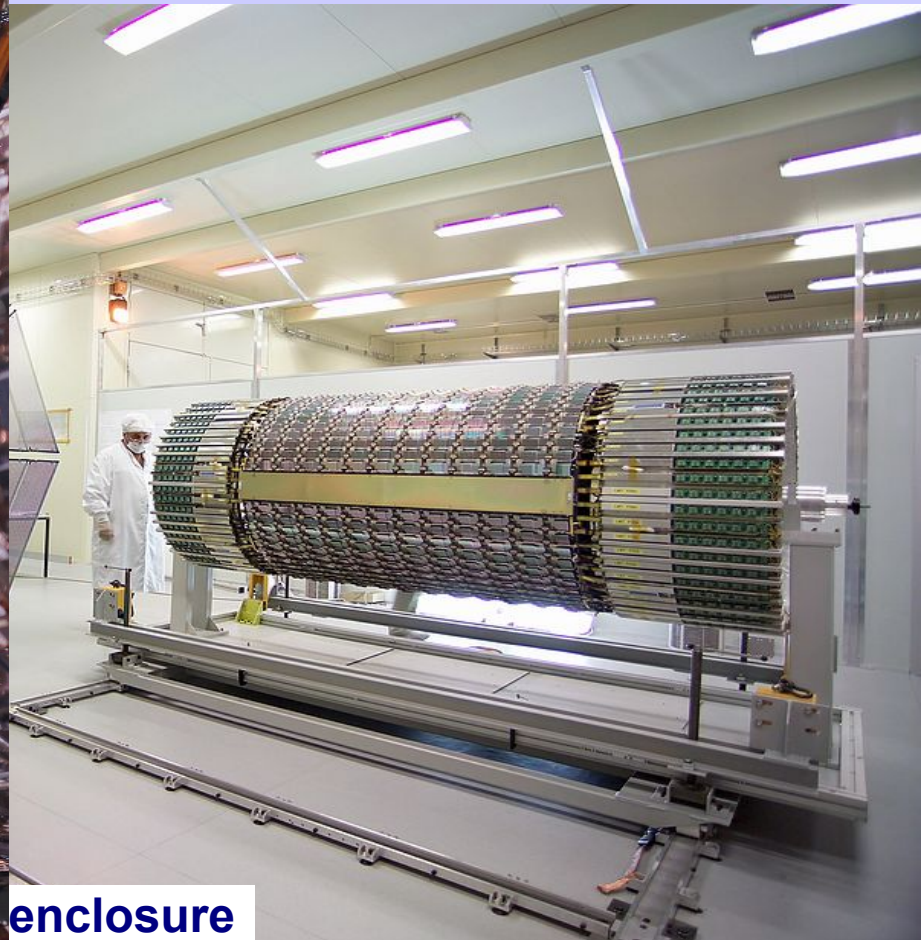
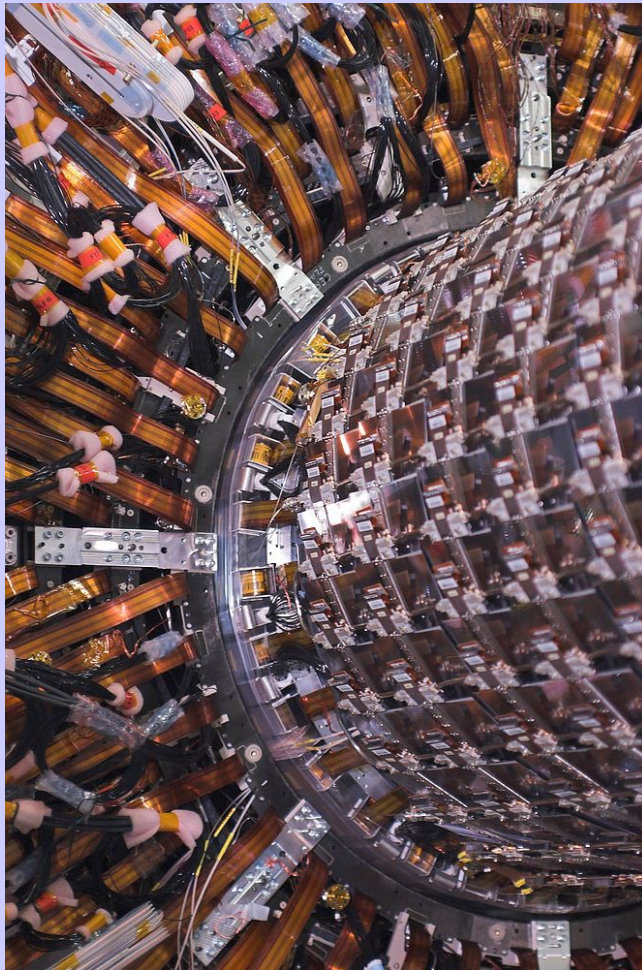
Detektory torów i wierzchołków

- ATLAS Si Tracker – zmontowane dyski detektorów „end cap”



Detektory torów i wierzchołków

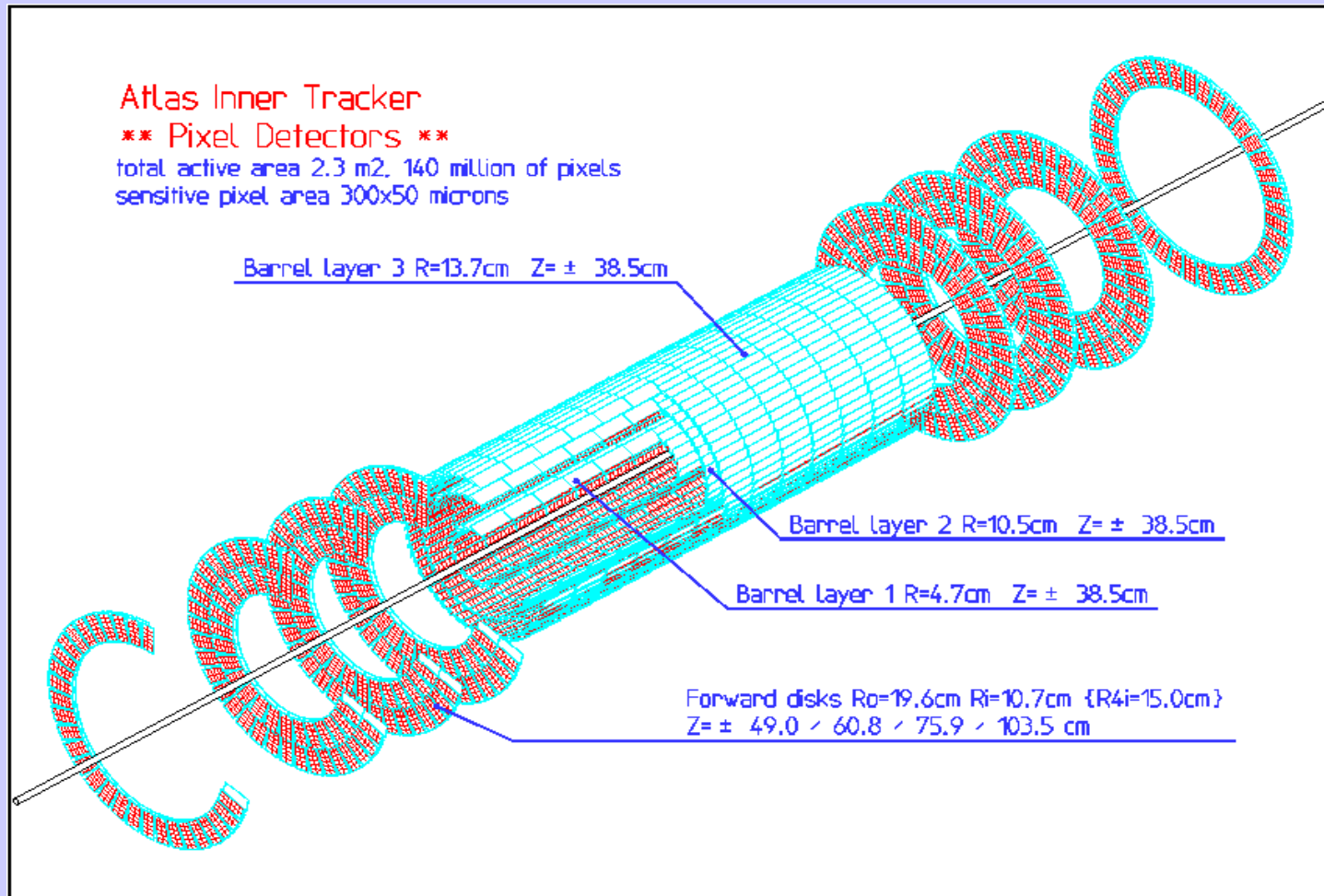
- ATLAS Si Tracker – końcowe składanie detektorów („integracja”)



enclosure

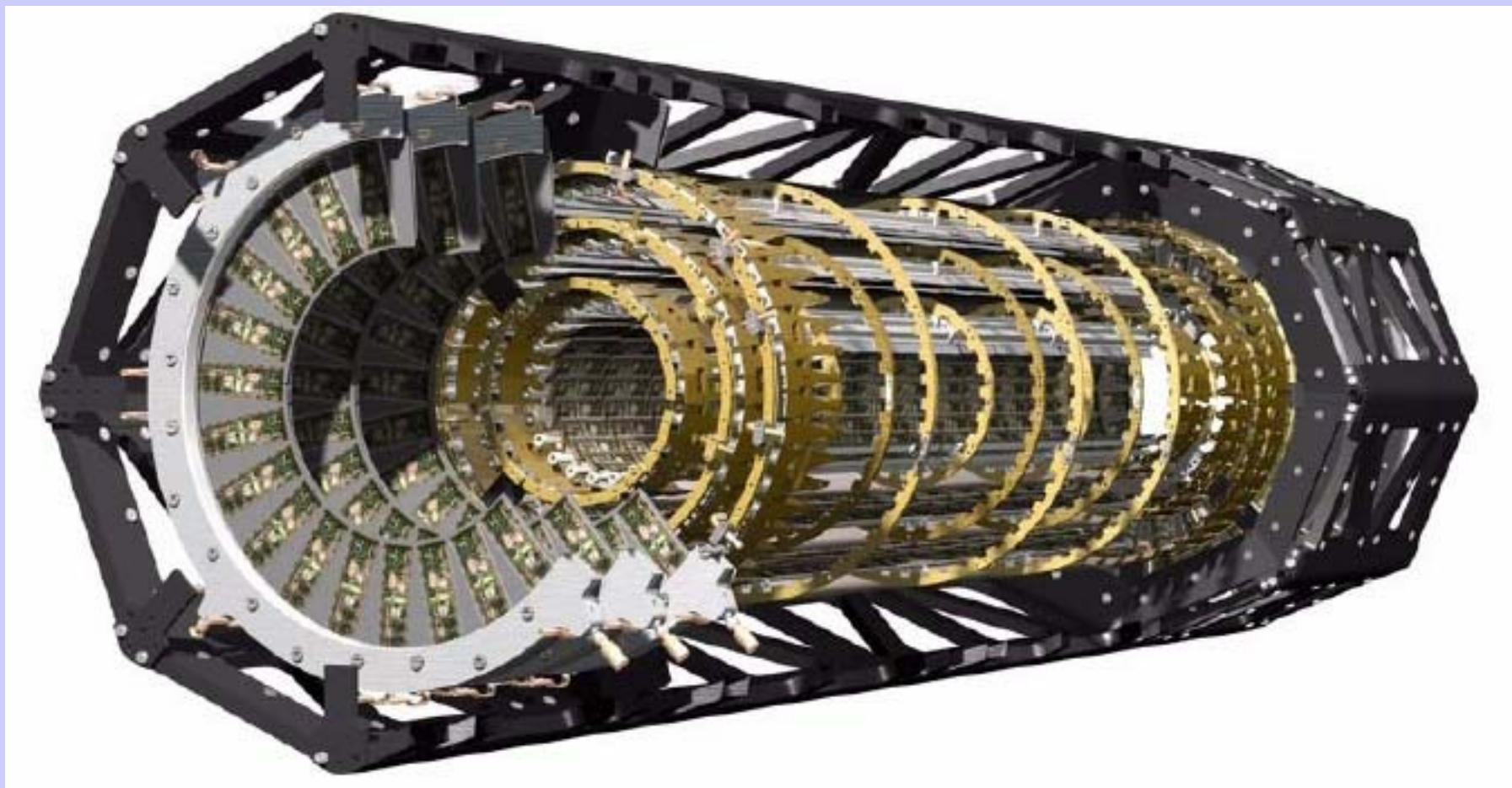
Detektory torów i wierzchołków

- ATLAS Si Pixel Detector – pomiar torów i wierzchołków



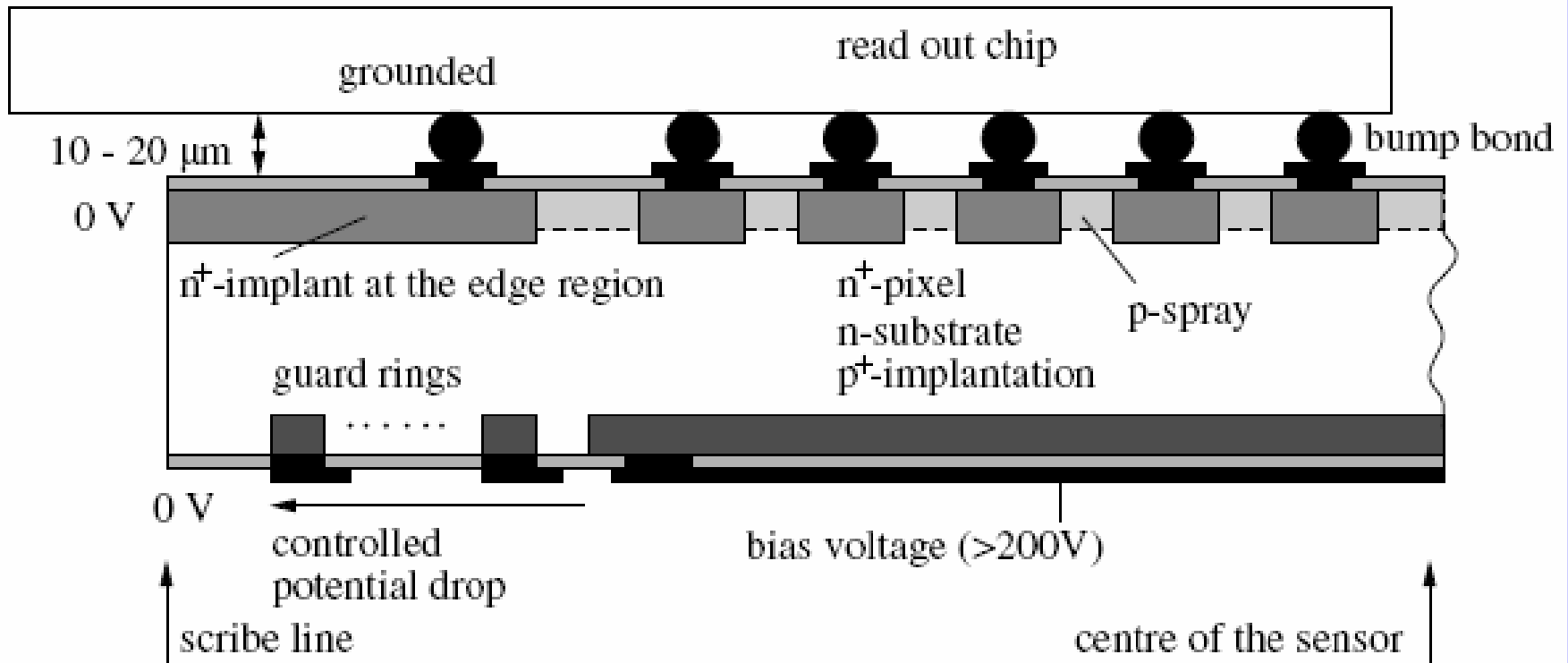
Detektory torów i wierzchołków

- ATLAS Si Pixel Detector – pomiar torów i wierzchołków



Detektory torów i wierzchołków

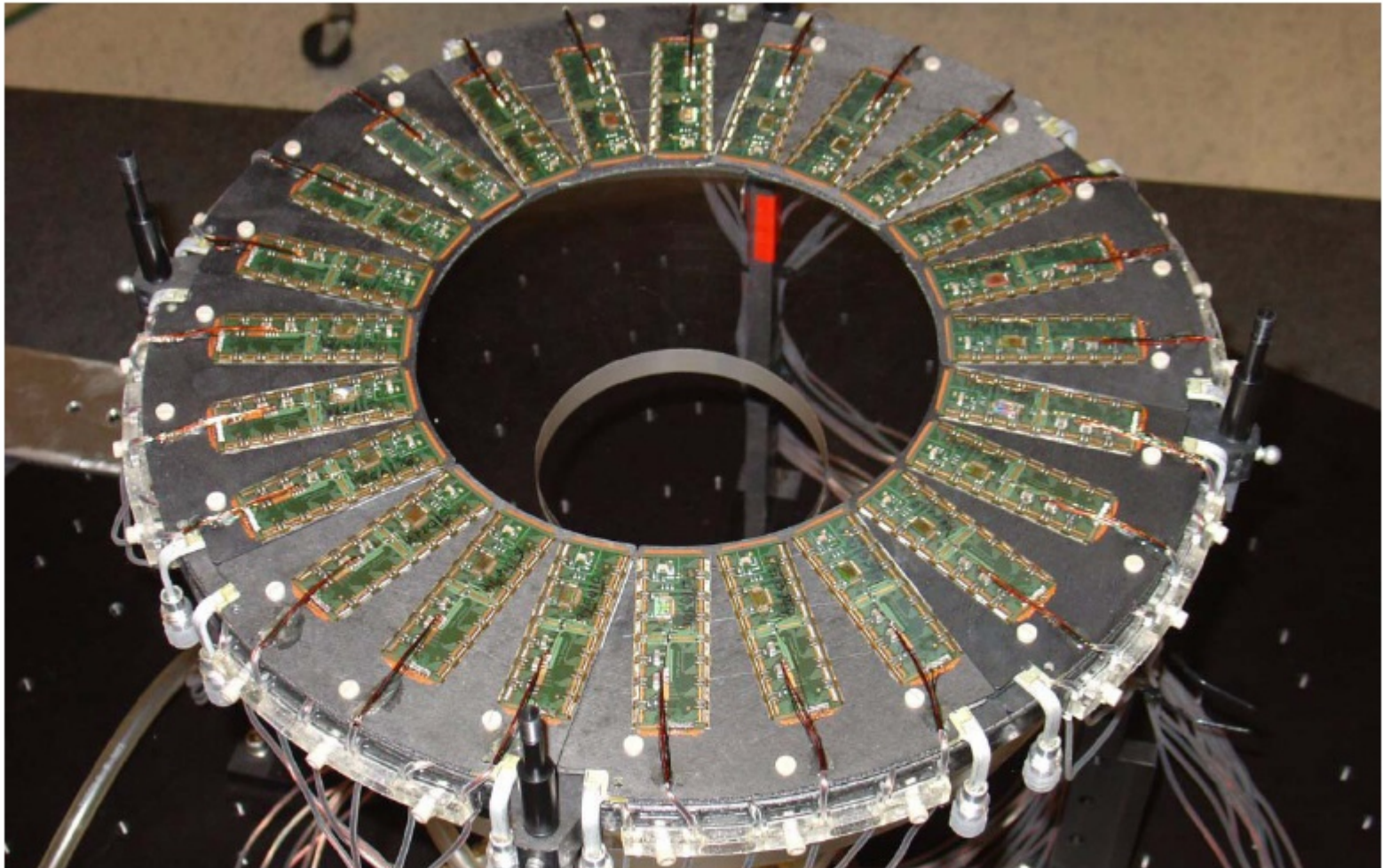
- ATLAS Si Pixel Detector – pomiar torów i wierzchołków



Detektory torów i wierzchołków

ATLAS Si Pixel Detector – pomiar torów i wierzchołków

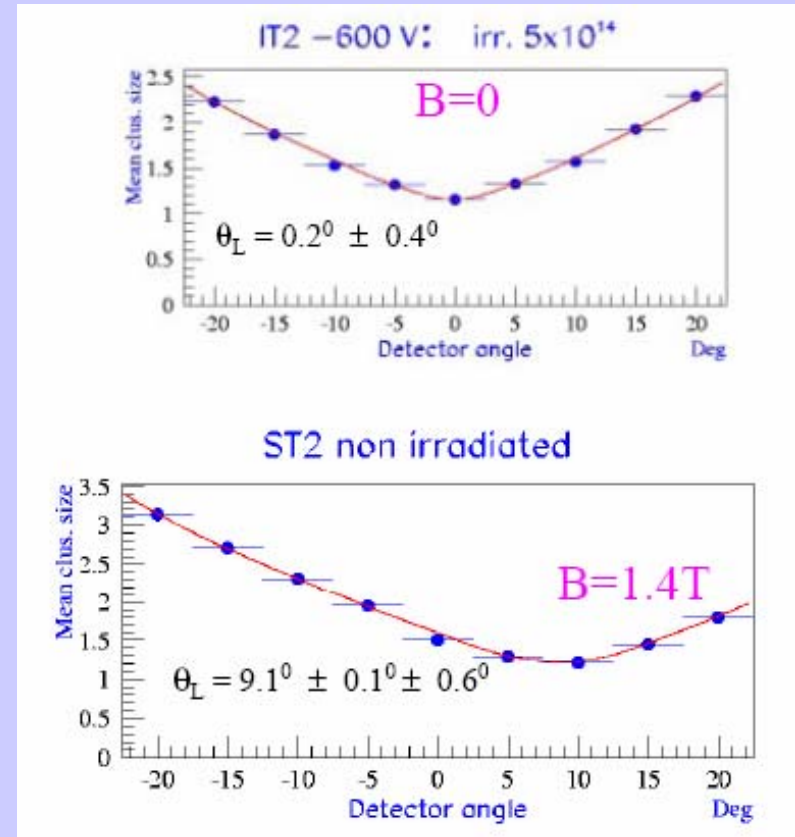
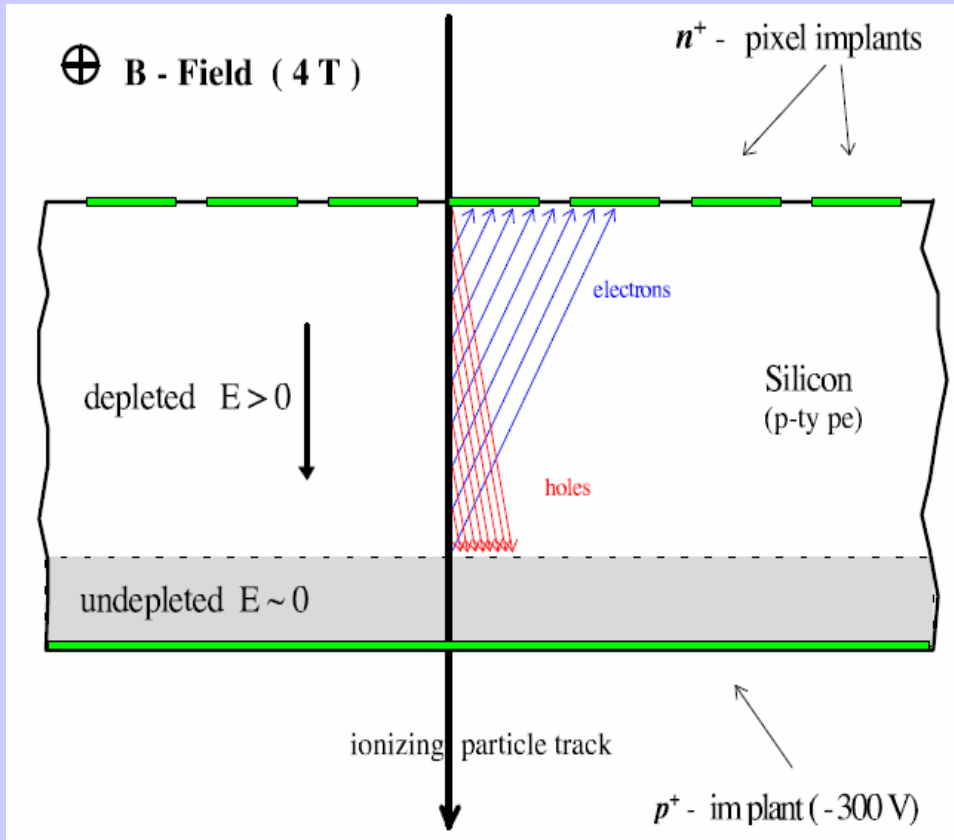
Assembly of First Complete Disk:



- Total of 48 modules (24 top, 24 bottom), 2.2M pixels. Largest assembly so far.

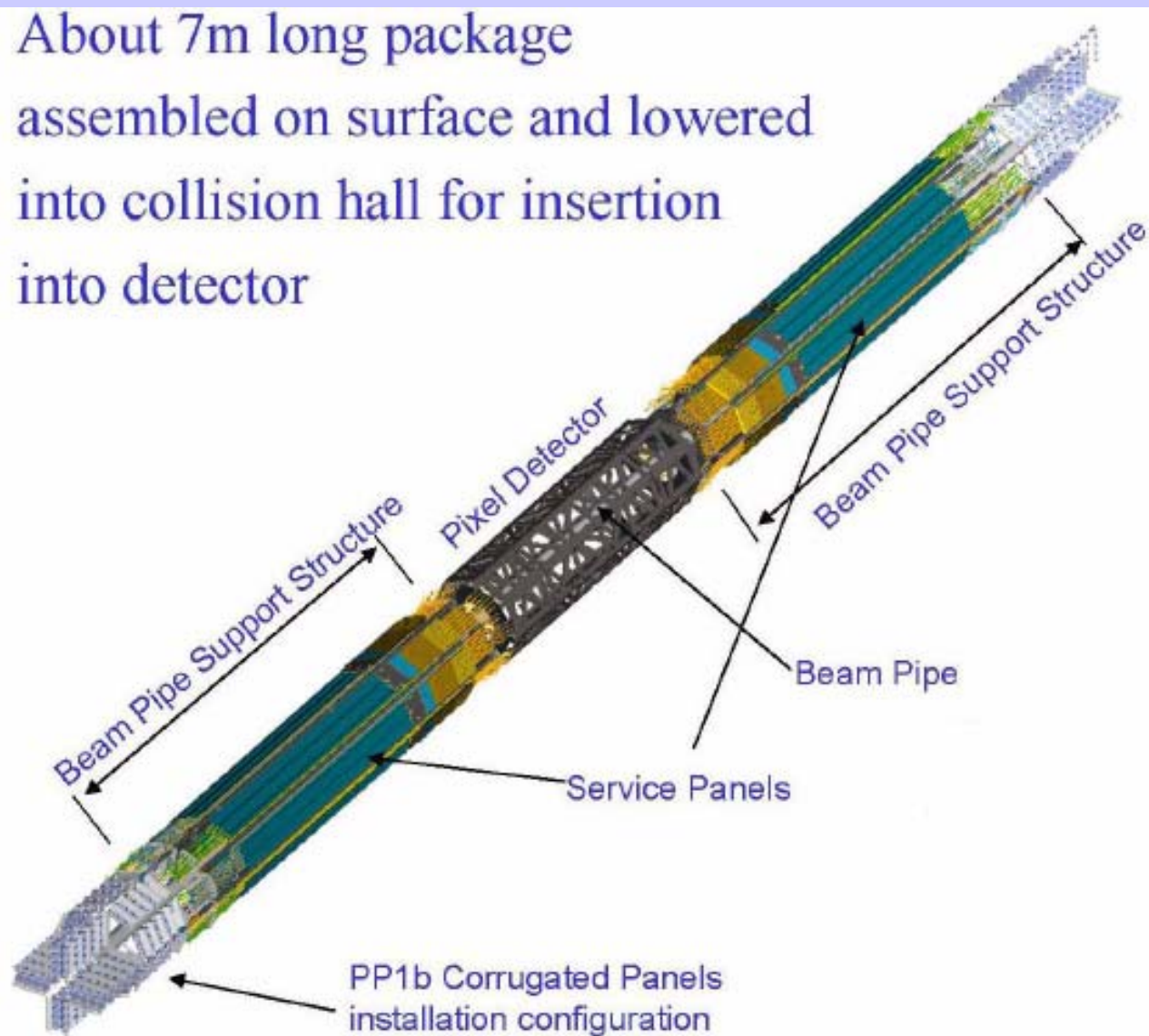
Detektory torów i wierzchołków

ATLAS Si Pixel Detector – pomiar w polu magnetycznym



Detektory torów i wierzchołków

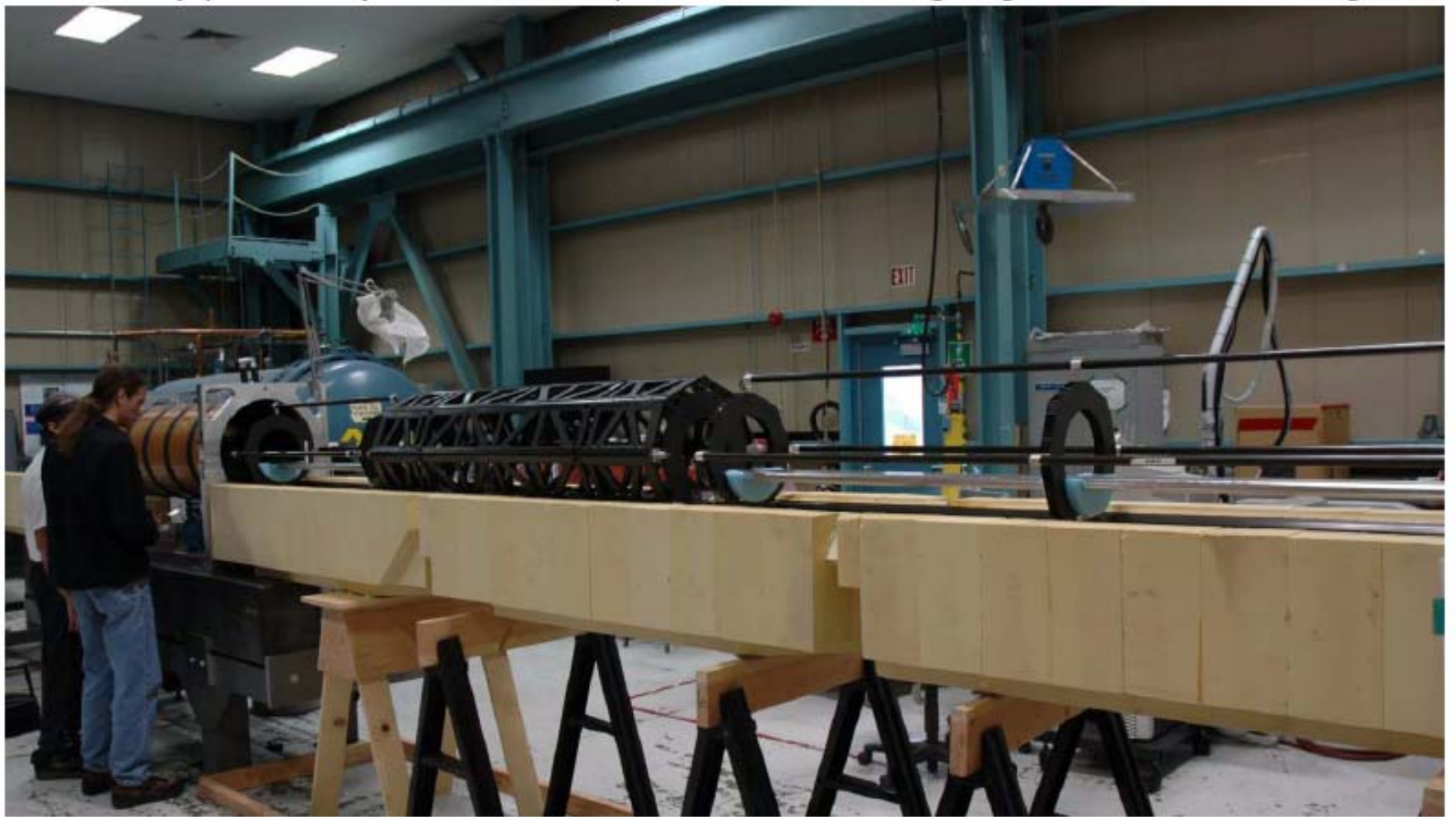
About 7m long package
assembled on surface and lowered
into collision hall for insertion
into detector



**ATLAS Si Pixel
Detector –
instalacja nie
jest łatwą**

Detektory torów i wierzchołków

ATLAS Si Pixel Detector – pomiar torów i wierzchołków



- Mechanics of pixel package are being rolled into central portion of PST.

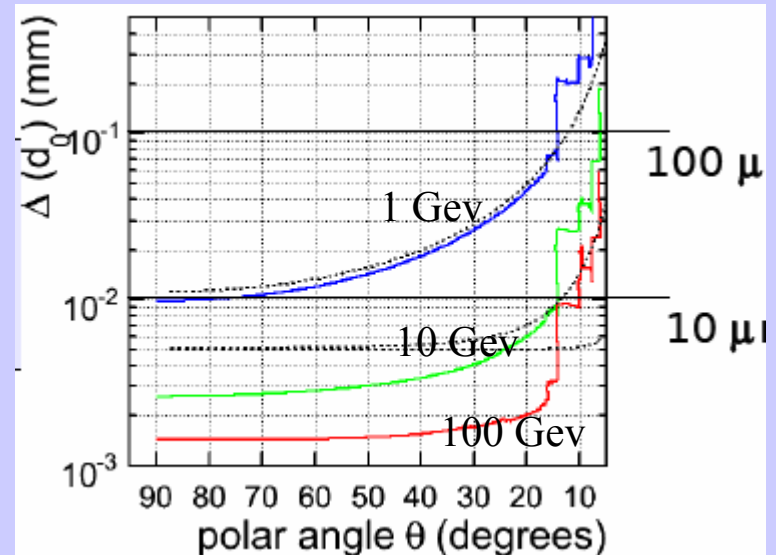
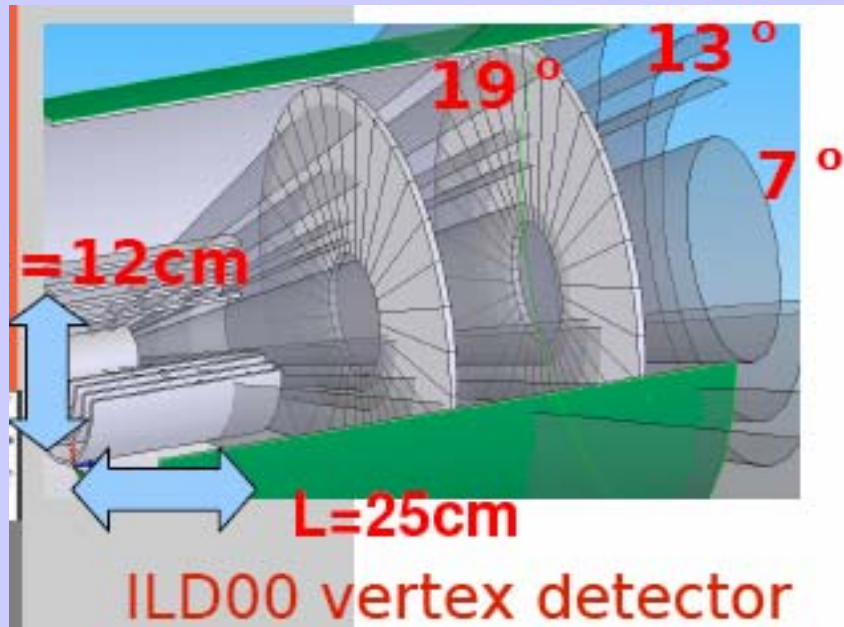
Detektory torów i wierzchołków

Wymagania dla przyszłych detektorów przy ILC – DEPFET, MAPS

Dla rejestracji rozpadów Higgsa na cząstki z ciężkimi kwarkami c i b wymagana jest b. dobra zdolność identyfikacji wierzchołków rozpadu

$$\sigma_{IP} = a \oplus \frac{b}{p \sin^{3/2} \theta}$$

	a (μm)	b (μm GeV)
LEP	25	70
SLD	8	33
LHC	12	70
ILC	5	10



Detektory torów i wierzchołków

Wymagania dla przyszłych detektorów ILC – jak najcieńsze

