The Status of the CMS Forward Pixel Detector

PING TAN

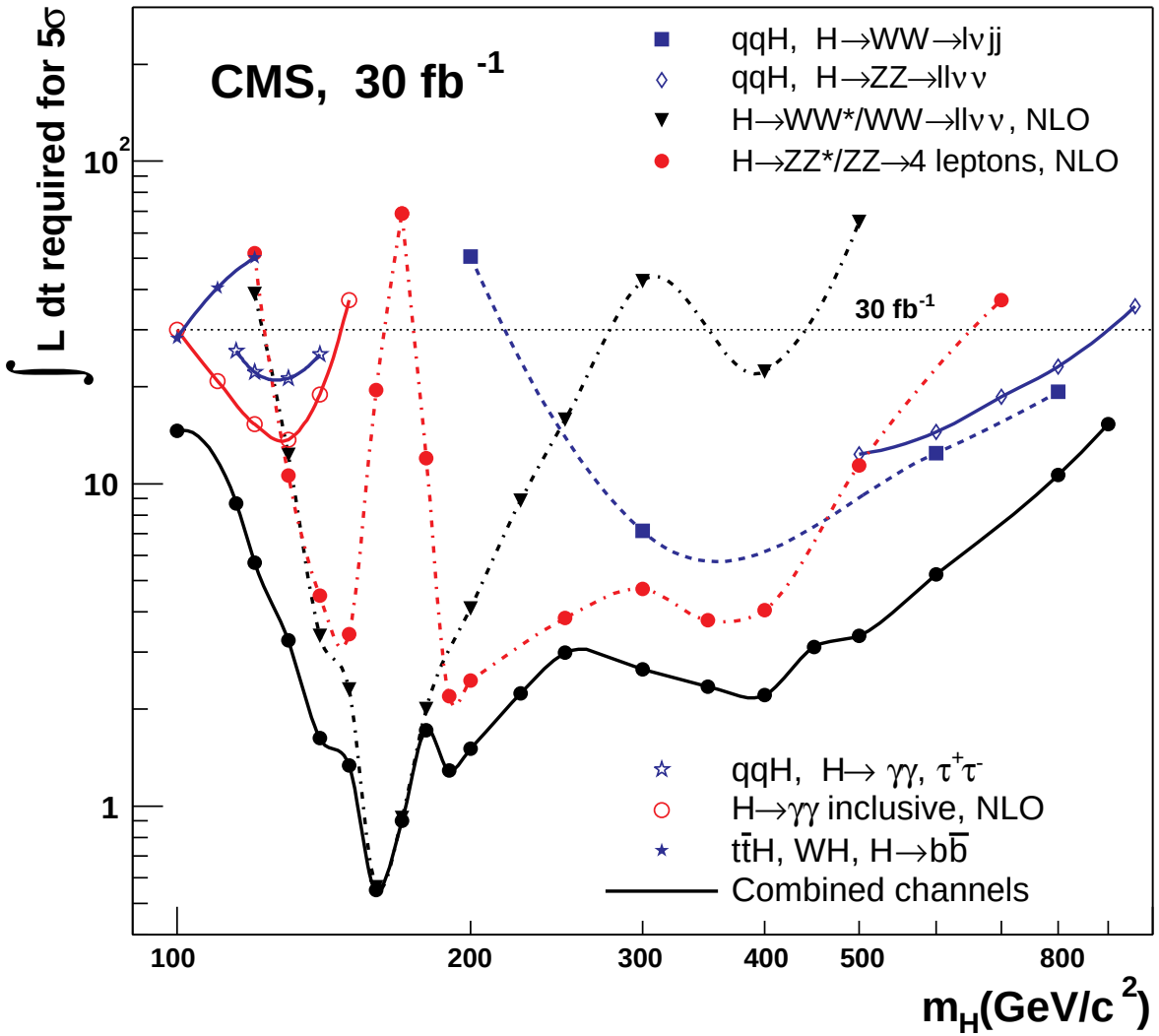
FNAL

On behalf of the CMS Forward Pixel Collaboration

Oct 25th, 2005

PANIC 05, Santa Fe, New Mexico

Physics Reach of the LHC Era



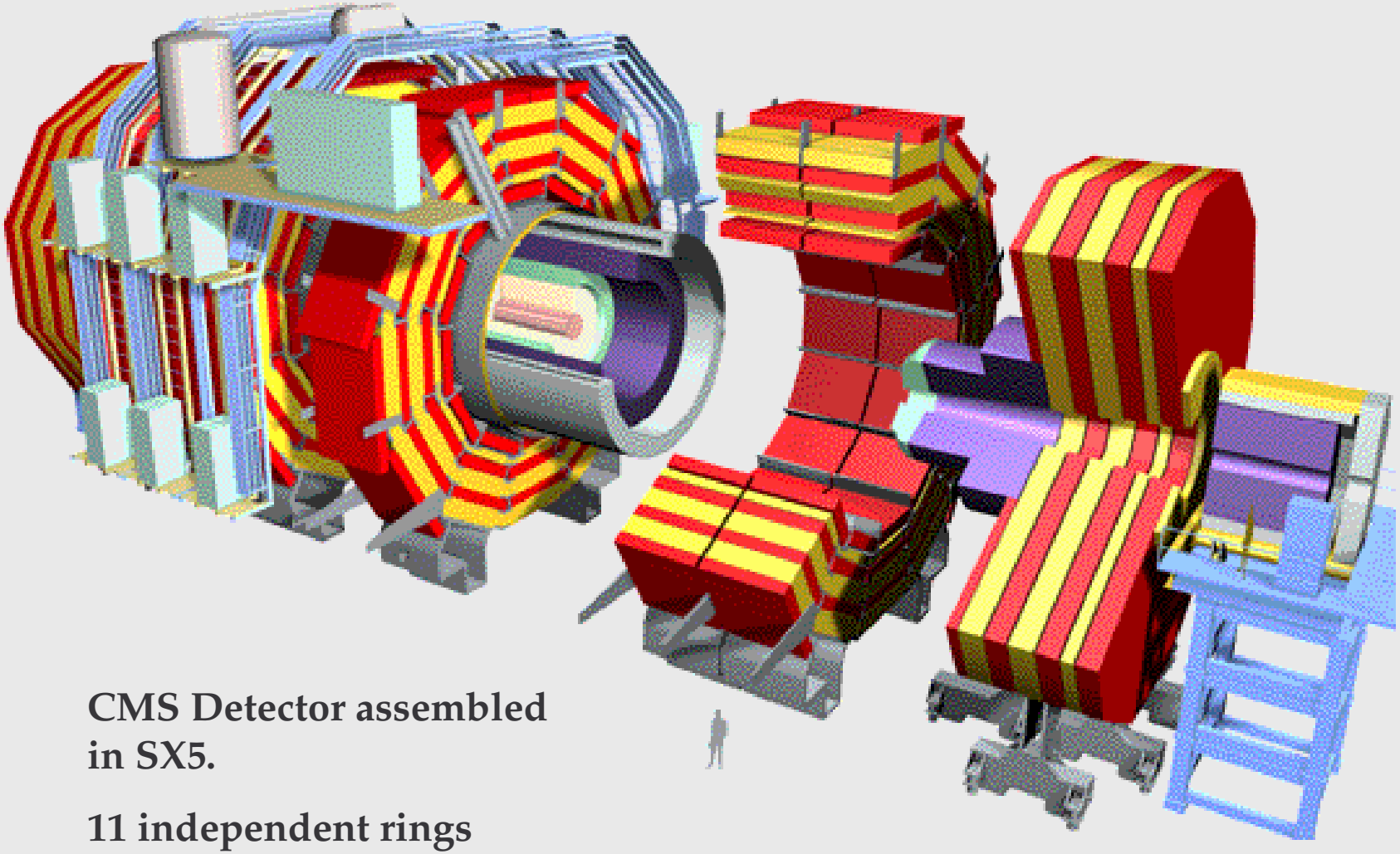
- High Pt physics at Large Hadron Collider (LHC).

CMS, (the Compact Muon Solenoid Detector)

ATLAS,

- Discover the Higgs boson.
- Search Super-symmetric particles.

CMS in the Collision Hall

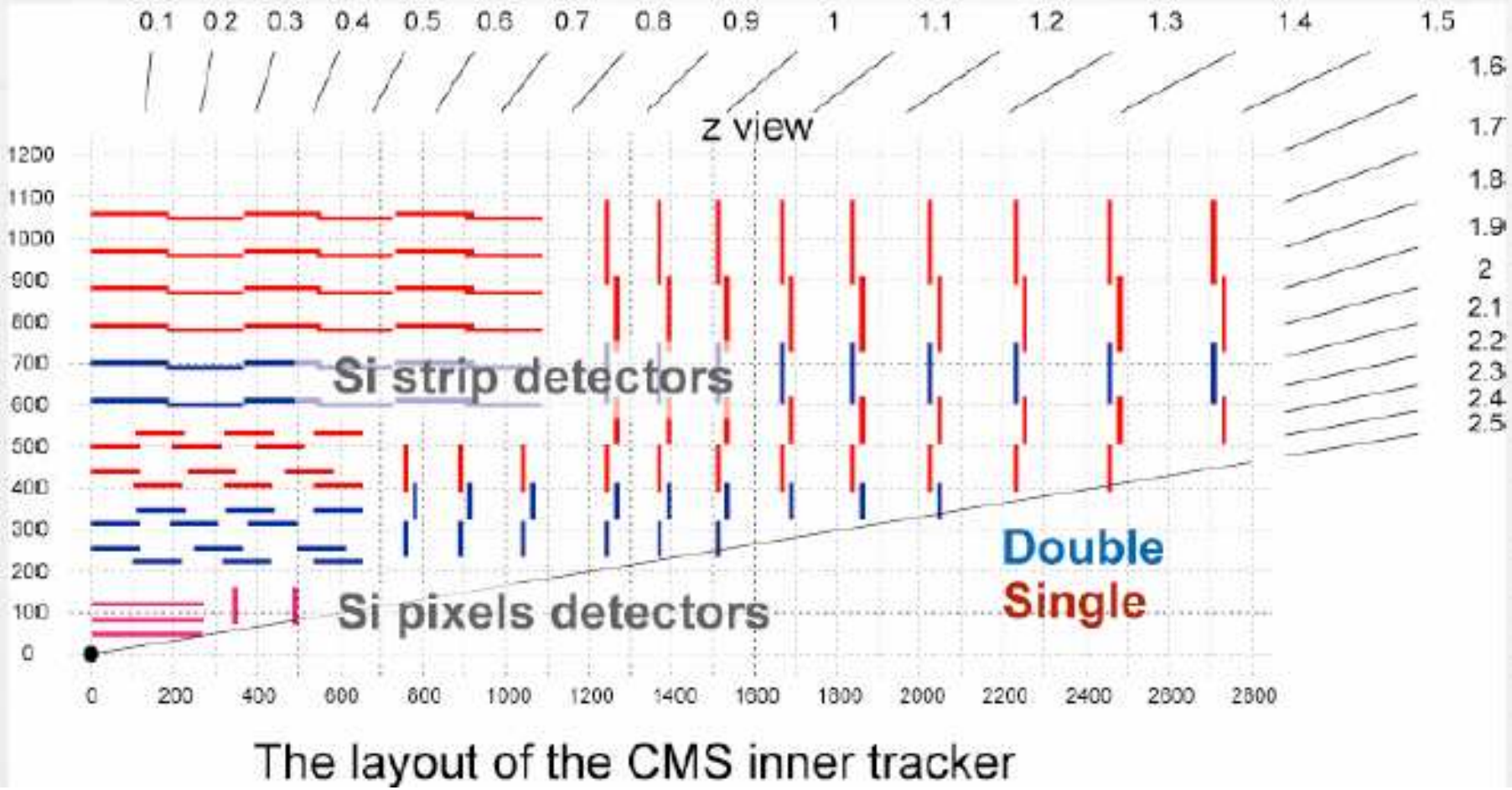


CMS Detector assembled in SX5.

11 independent rings

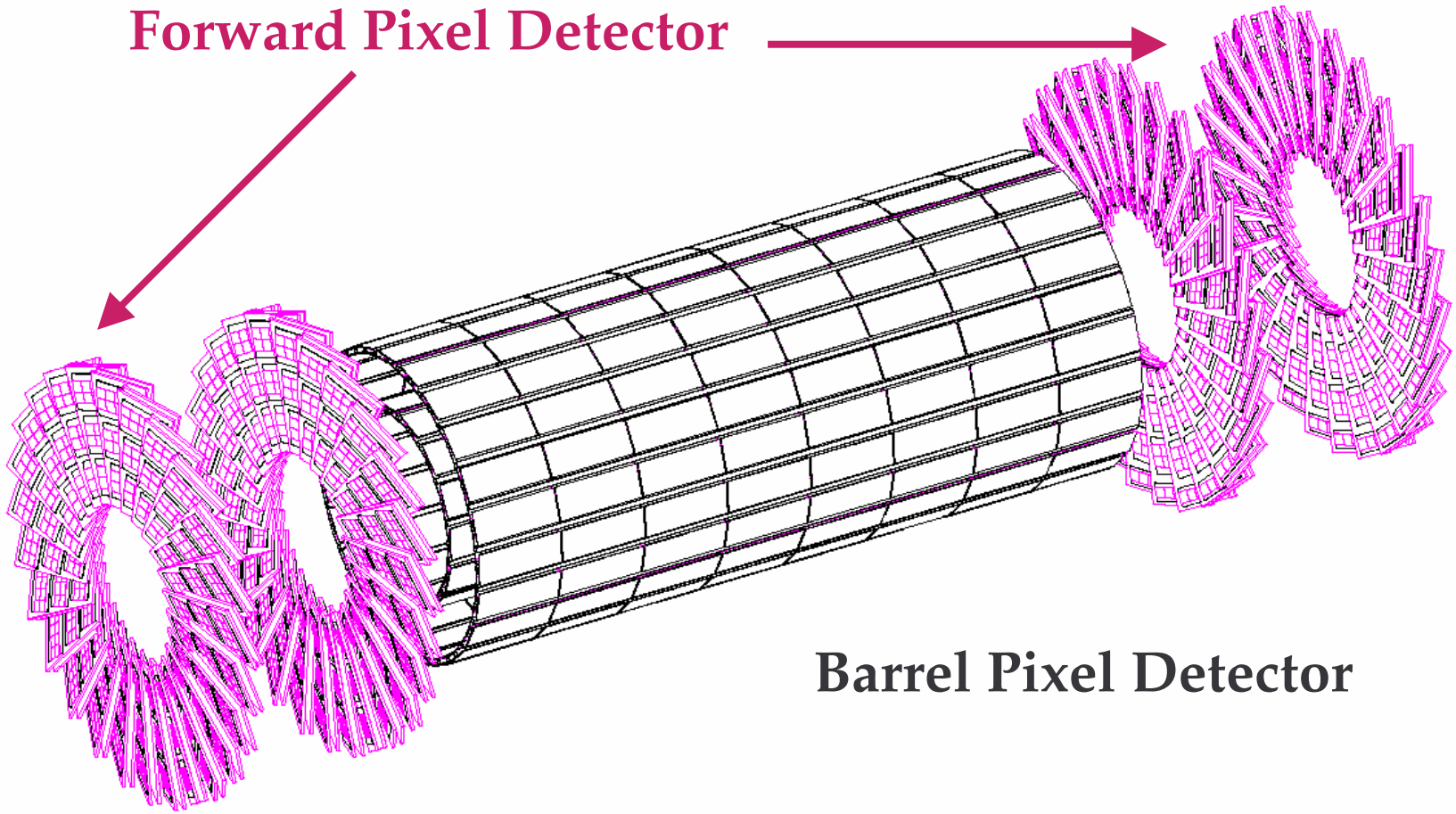
CMS Tracker

- **CMS all silicon tracker.**



The layout of the CMS inner tracker

The CMS Pixel Detector



- $\Rightarrow$ 3 high resolution space points for $\eta < 2.2$
- Expected resolution: r- ϕ, ~ 10 μm; r - z, ~ 17 μm

Forward Pixel Collaboration

U of Colorado: M. Bunce, J. Cumalat, E. Erdos, V. Frusillo, K. Stenson, S. Wagner

Cornell U: J. Alexander, A. Ryd, K. Eckland, J.Thom, P. Wittich

UC Davis: J. Conway, R. Lander, D. Pellett, M. Searle, H. Powell, C. Veelken

FNAL: M. Atac, B. Baldin, J. Butler, G. Cardoso de Cardoso, G. Derylo, I. Fang, B. Freeman, P. Gartung C. Gingu, A. Hahn, S. Kwan, S. Los, M. Matulik, E. Ramberg, C. Selcuk, P. Tan, M. Turqueti, U. Joshi, L. Uplegger, W. Wester, J.C.Yun

U of Iowa: C. Newsom

JHU: B. Barnett, C.Y. Chien, K. Dongwook, M. Swartz, A. Peysner

Kansas S.: T. Bolton, Y. Maravin, D. Onoprienko, R. A. Sidwell, R. Taylor, E. von Toerne

Milano: P. D'Angelo, M.Di Nardo, S. Erba, S. Magni, S. Malvezzi, D. Menasce, L. Moroni, D. Pedrini, M. Rovere, S. Sala

Mississippi: L. Cremaldi, B. Quinn, D. Sanders

U of Nebraska: K. Bloom, D. Claes, A. Dominguez, M. Eads, S. Malik

NU: B. Gobbi, M. Kubantsev, E. Spencer, R.N.Tilden

Purdue U: A. Apresyan, K. Arndt, D. Bortoletto, G. Bolla, A. Garfinkel, D. Graves, M. Jones, P. Merkel, D. Miller, I. Shipsey, S. Son, B. Xin

Purdue U Calumet: N. Parashar

Rutgers U: S. Schnetzer, R. Stone, E. Bartz, J. Doroshenko, A. Macpherson, L. Perera, S. Sherman, Y. Streltsov

Vanderbilt U: W. Johns, P. Sheldon, E. Vaandering

U of Virginia: S. Conetti, B. Cox, R. Hirosky, M. Arenton, A. Ledovskoy, A. Kreymahdi, H. Powell, W. Stephens, D. Phillips, M. Ronquest, D. Smith, S. Zelitch

16 Institutions,
>100 Physicists

Forward Pixel Components

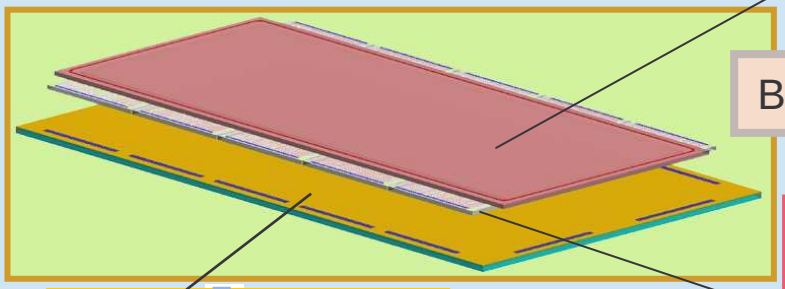
Plaquette (672, 5 types)

Sensors

Bump bonded

ROC (4,500)

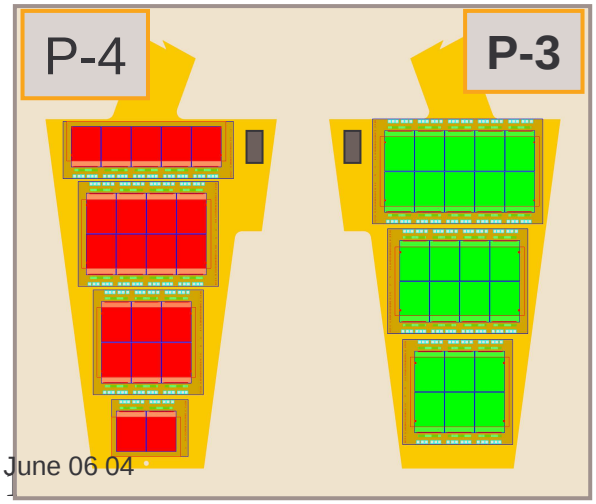
Detector Unit (672)

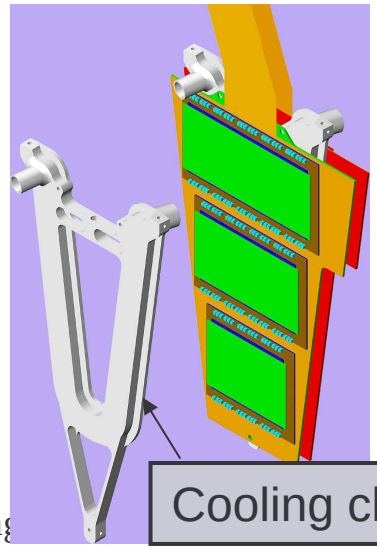


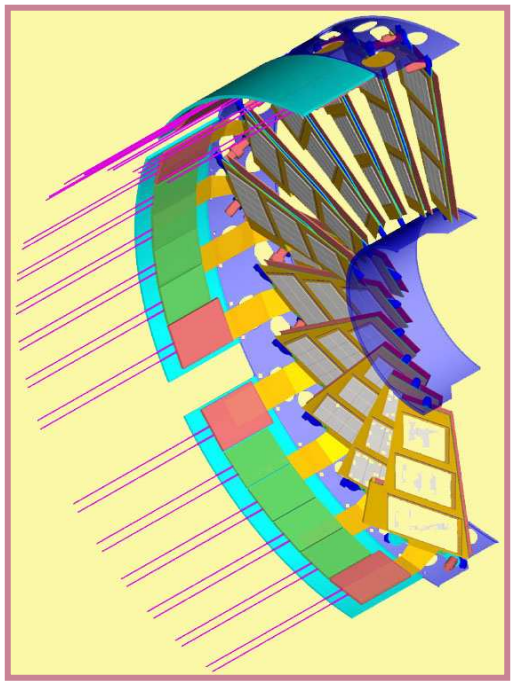
VHDI (672, 7)

Panels, (192,4)

Blade, (96)







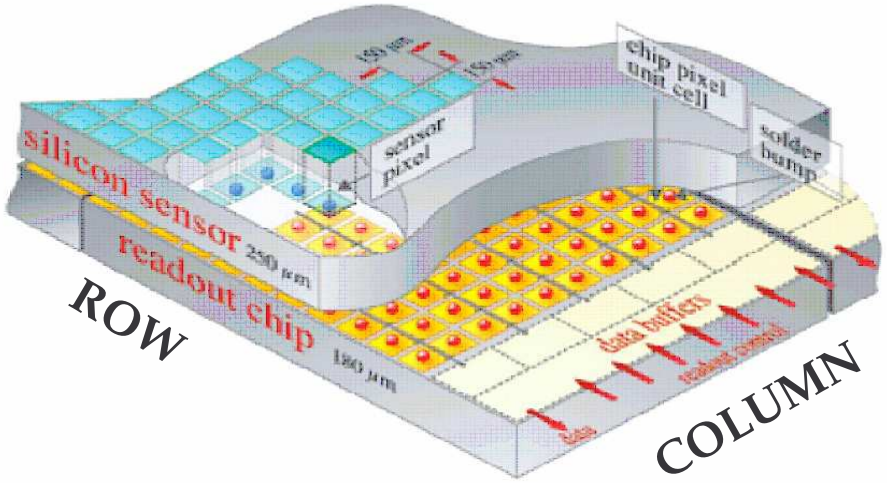
½ -Disk (8, 2 types)

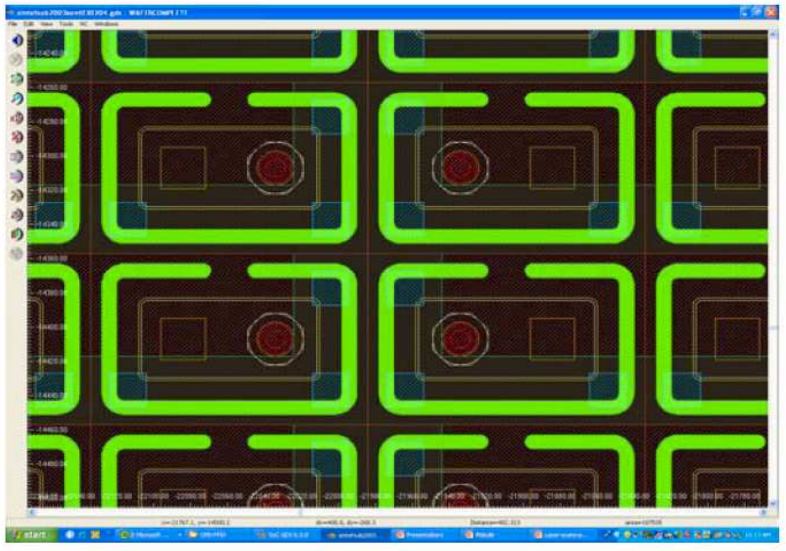
Cooling channels, (96, 4)

D:\cms\aaa-www\6-assbly-blade-r.ppt

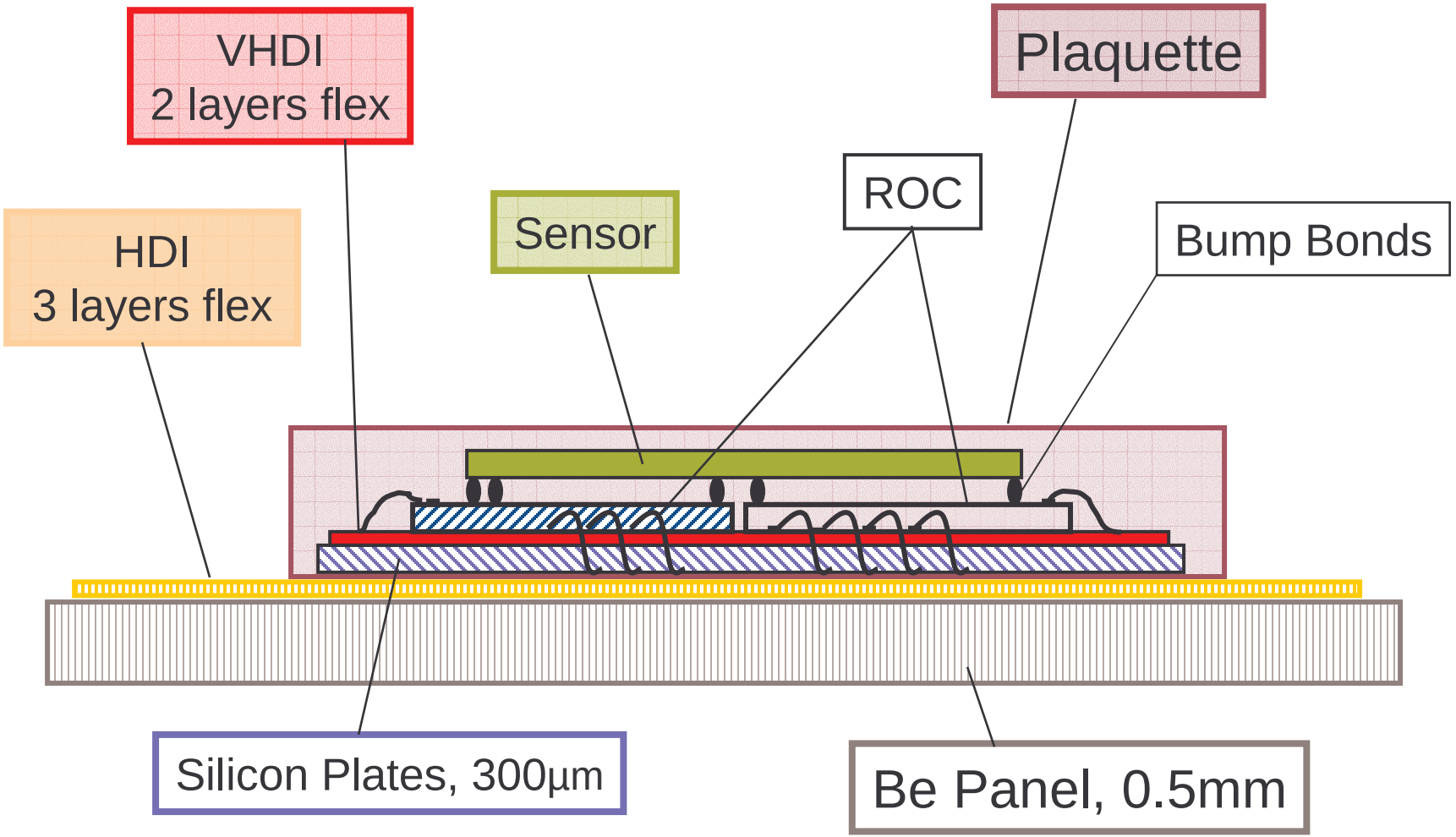
Detector Construction

- Sensors designs are specified by the LHC environment.
  - n-on-n, p-stop, multiple guard rings ensure high break-down voltage.
- Pixel size : 100 x 150 μm
- Pixel Readout Chip has 80 rows by 52 columns
- Sensors are bump-bonded to the readout chips.

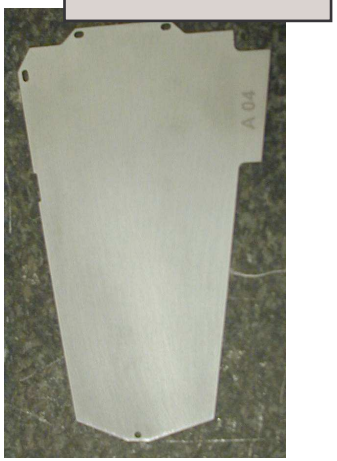


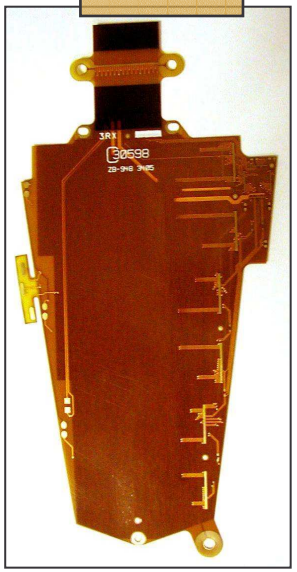


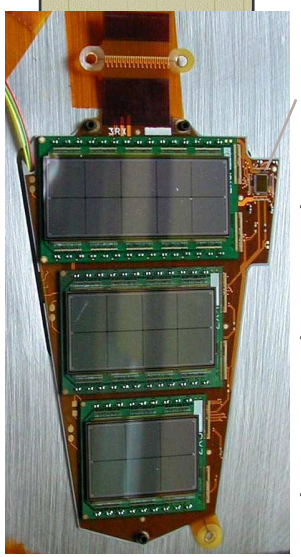
Basic Detector Unit - Plaquette



Milestone – First Panel





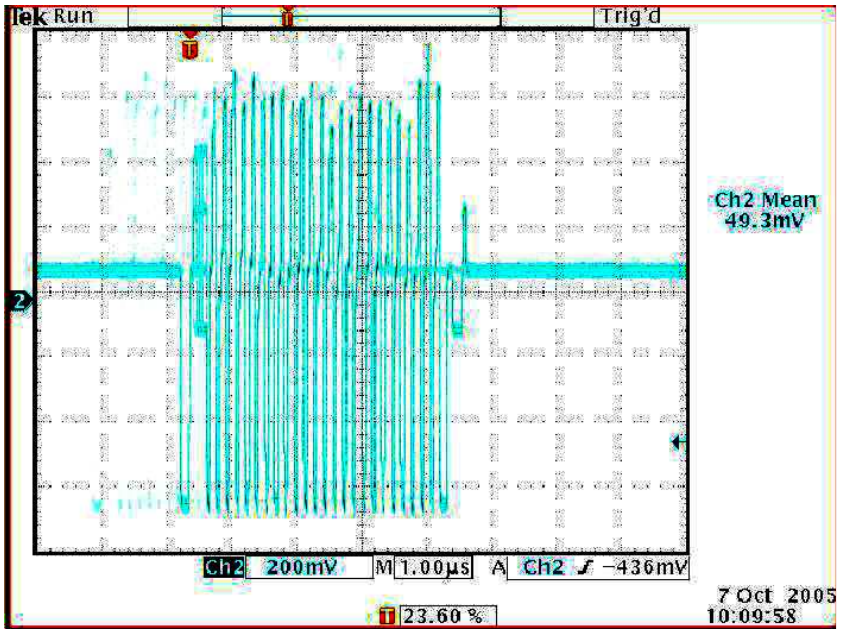


2x5

2x4

2x3

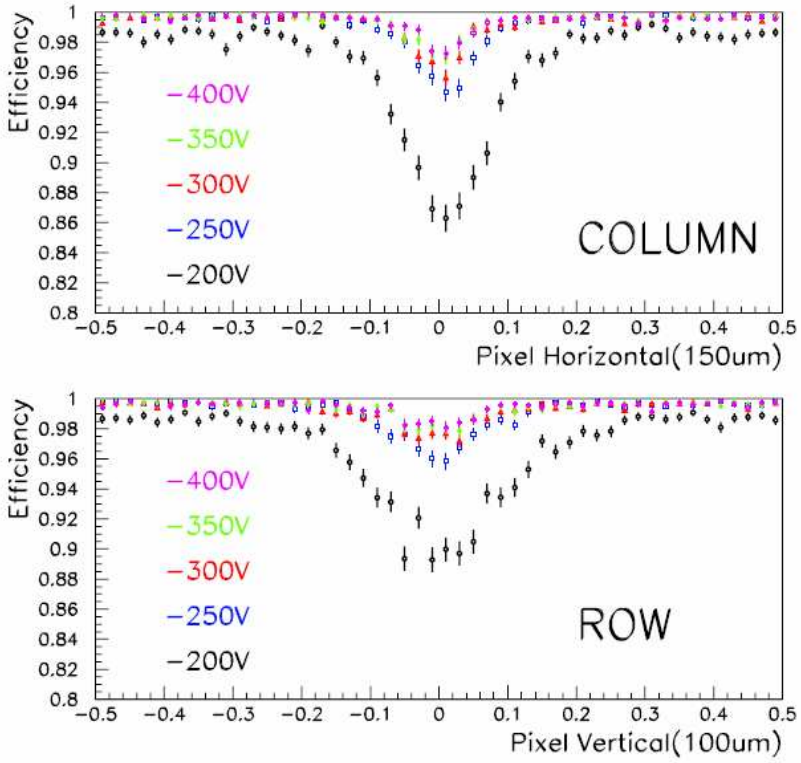
⇐ First panel assembly



⇒ Readout from 24 readout chips

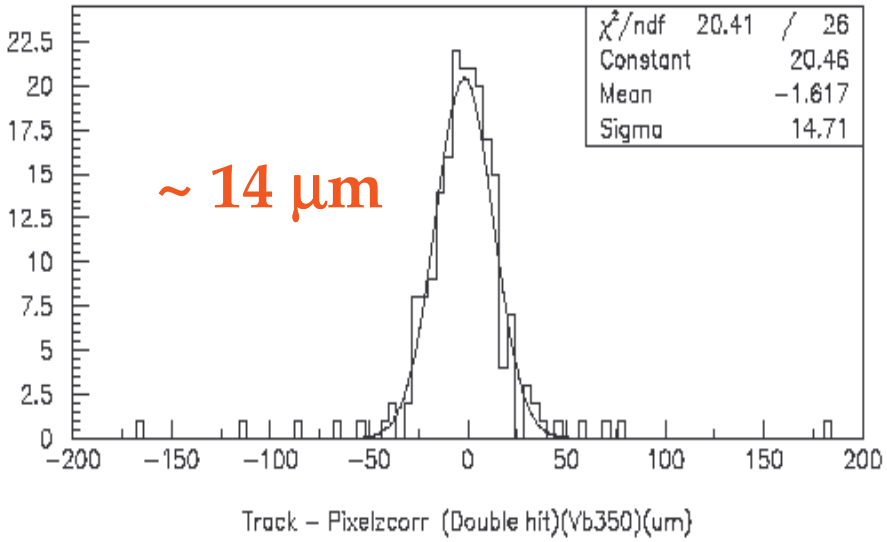
February FNAL Beam Test

- **February beam test at Fermilab with prototype readout chip & preproduction sensors.**
- **Efficiency: 99.3% before irradiation; 98.3% after 6x10^{14}mip/cm^2**

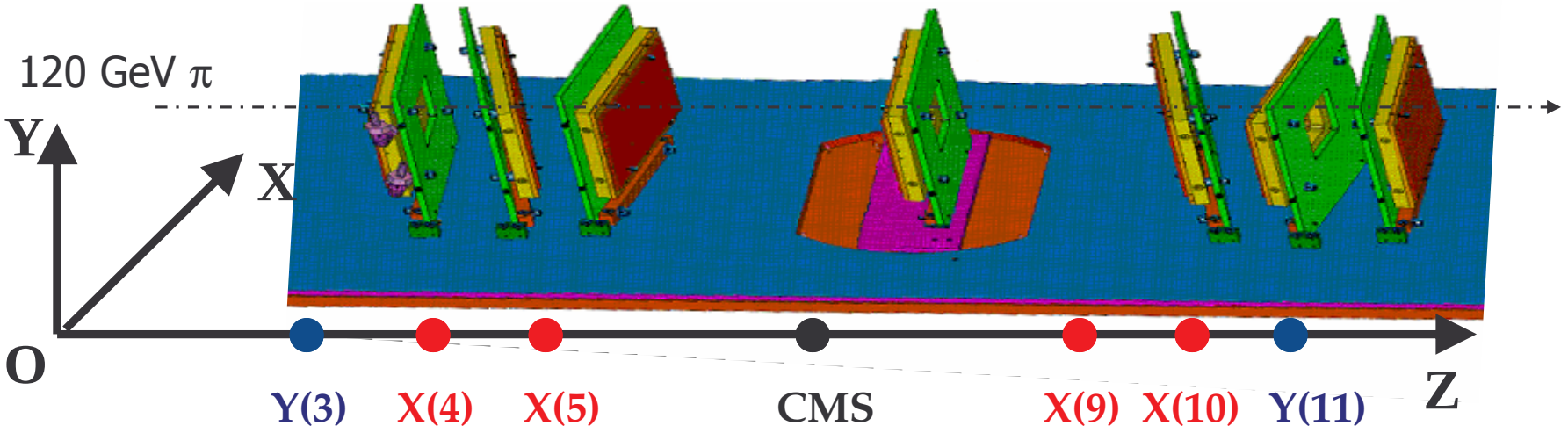


- **Resolution: (20º rotation)**

~14 μm when charges are shared between 2 cells



June & August Beam Test Setup



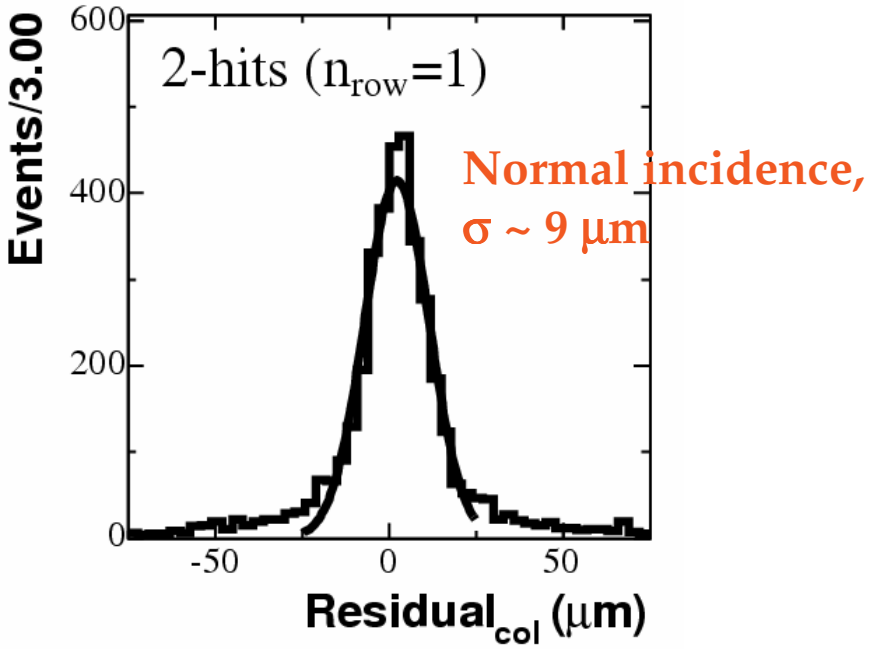
- Telescope of 6 BTeV pixel detectors (50 μm × 400 μm)
  - 2 Y-measurement planes
  - 4 X-measurement planes
- CMS pixel detector in the center
- Track projection error:

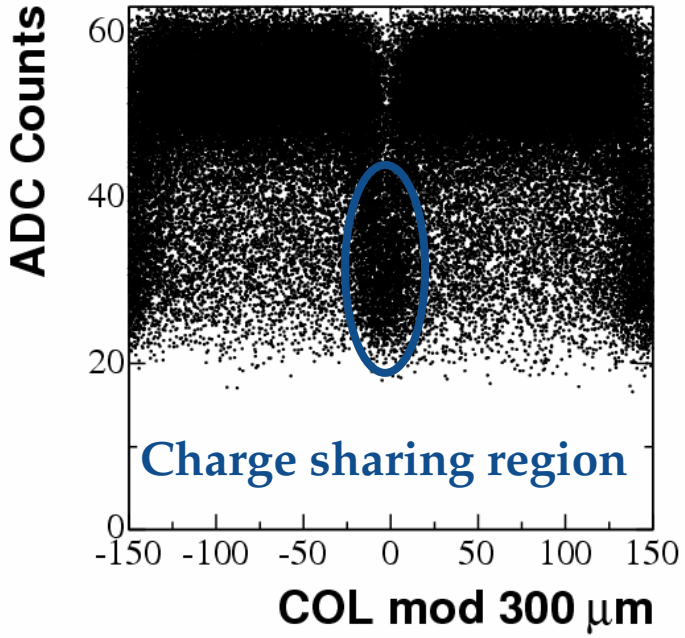
  about 3 μm on X-direction; about 8 μm on Y-direction.

August Beam Test Results & Plan

- June: integration of the CMS pixel with BTeV telescope.
- August (preproduction chip & sensor):

3 detectors non-irradiated plaquette with different temperatures, bias voltages, rotation angles. thresholds. etc.





- These detectors & other front electronics were irradiated.
- Tested in bench OK and ready for beam test again.

Summary

- **A large number of components can be ordered now and tested for the final assembly.**

- **Start final assembly early Summer ’06.**

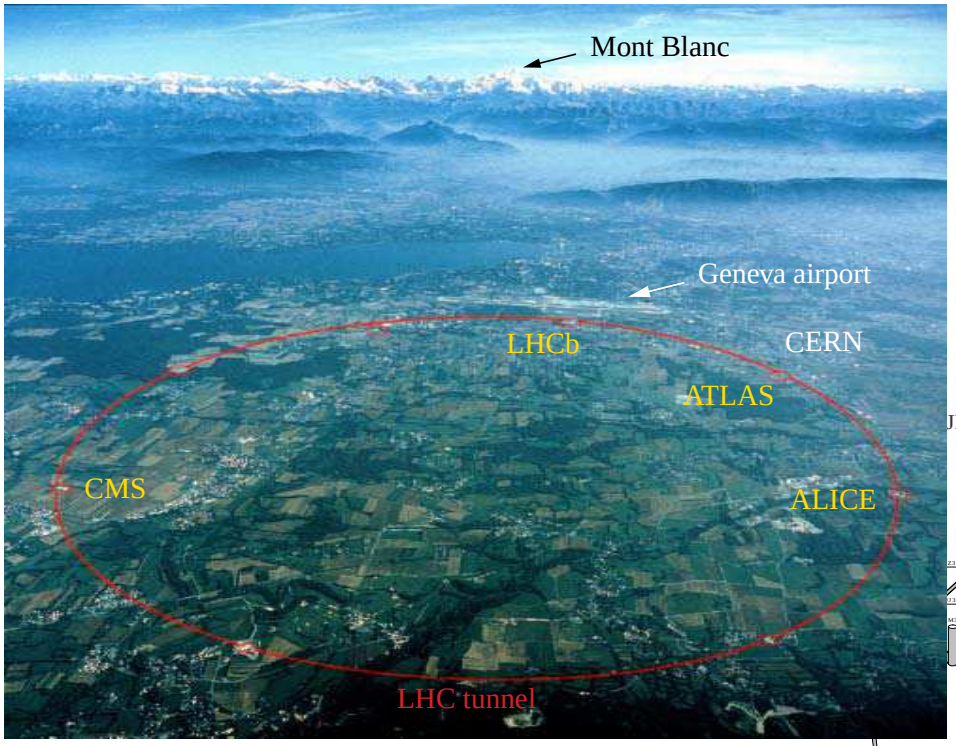
- **Ship to CERN the FPix end Summer ’07.**

- **Final check out at CERN Fall ’07 - Winter ‘08.**

- **Installation on CMS detector April ’08.**

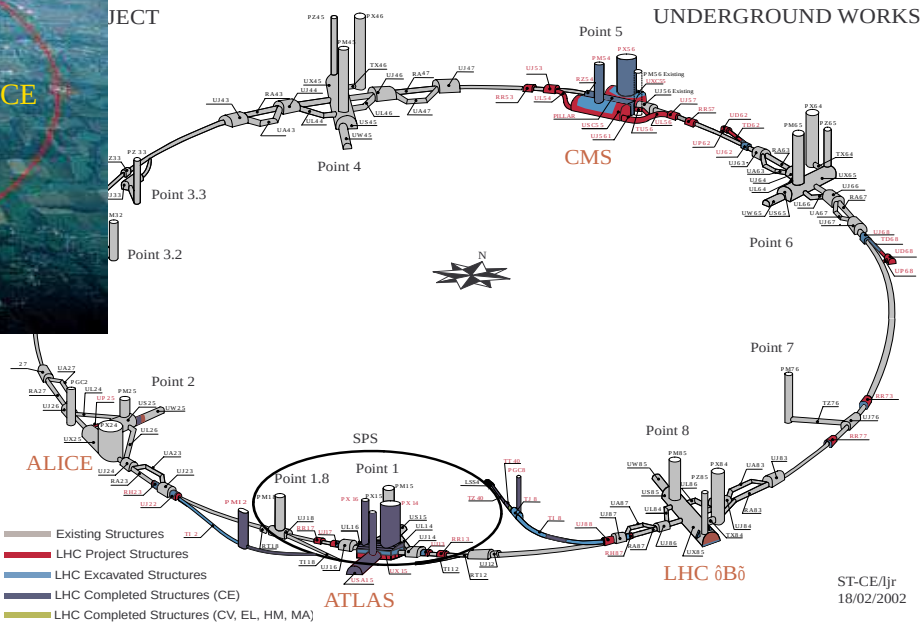
We will be ready for the physics runs starting in 2008!

The LHC Accelerator



- pp, general purpose;

CMS

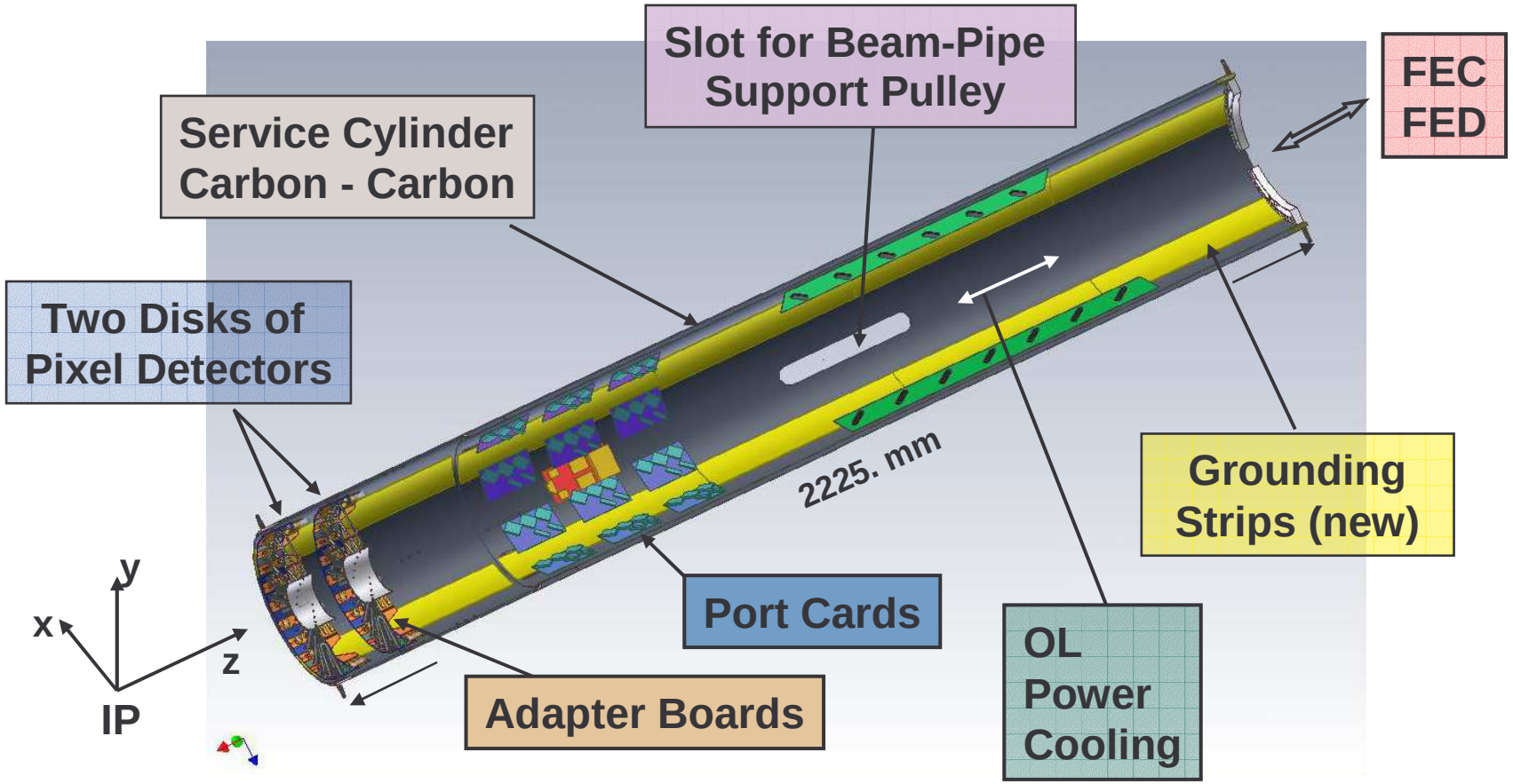


- **pp collision.**
  $\sqrt{s}$ =14 TeV; L=10^{34} cm^{-2} s^{-1}
- **Heavy ions.**

Forward Pixel Detector

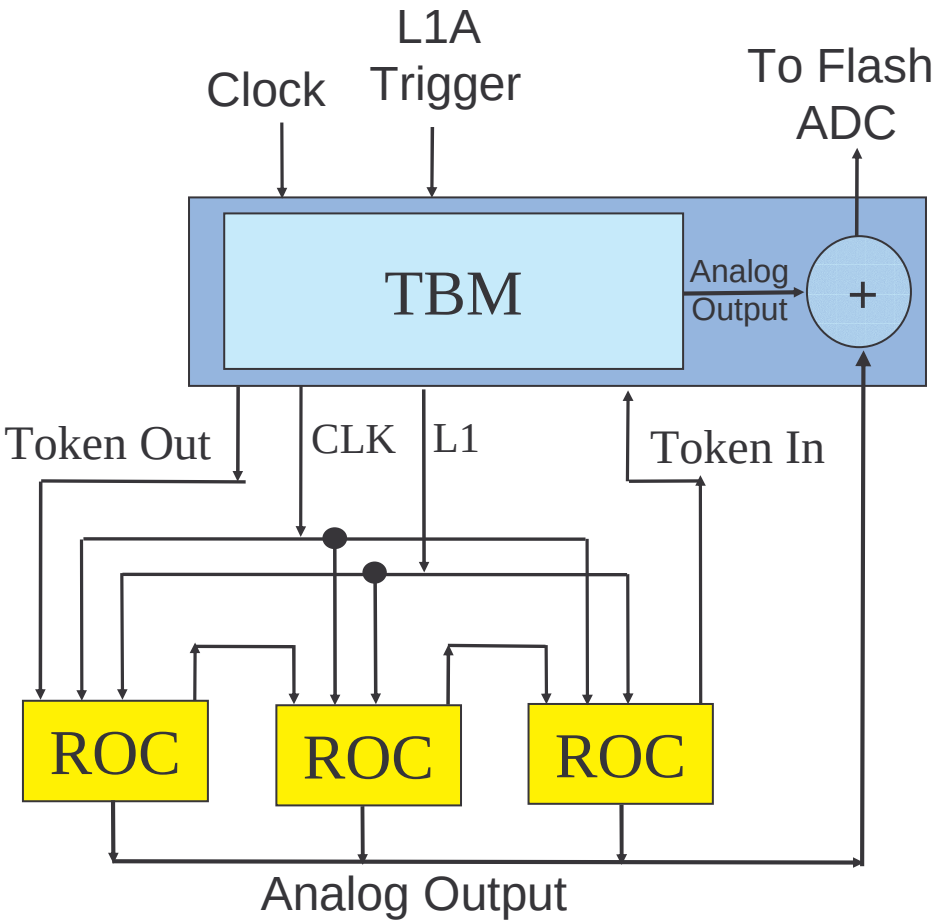
- US and Collaborators are to deliver 4 Units as shown.

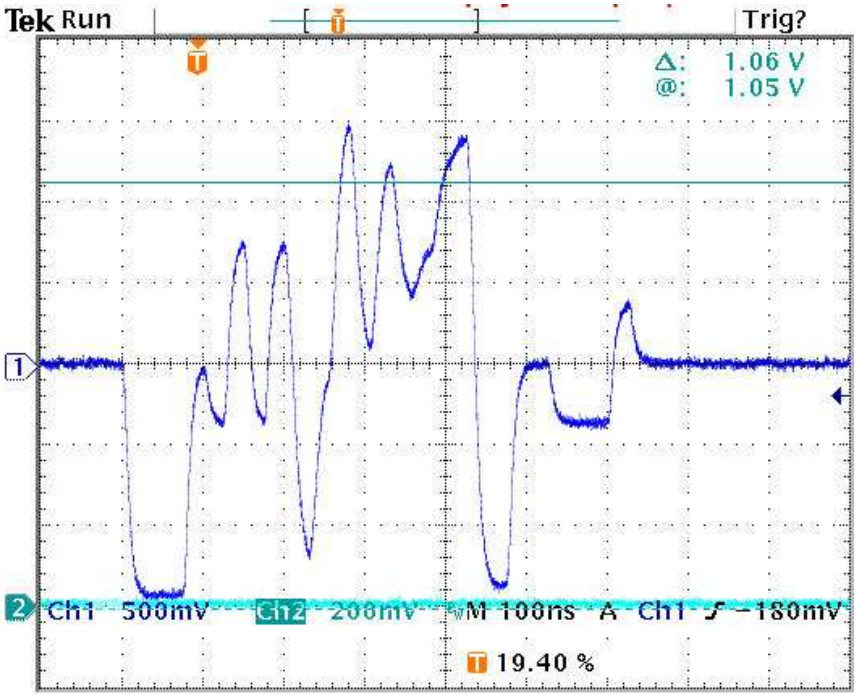
Four Service Cylinders with 2 half Disks



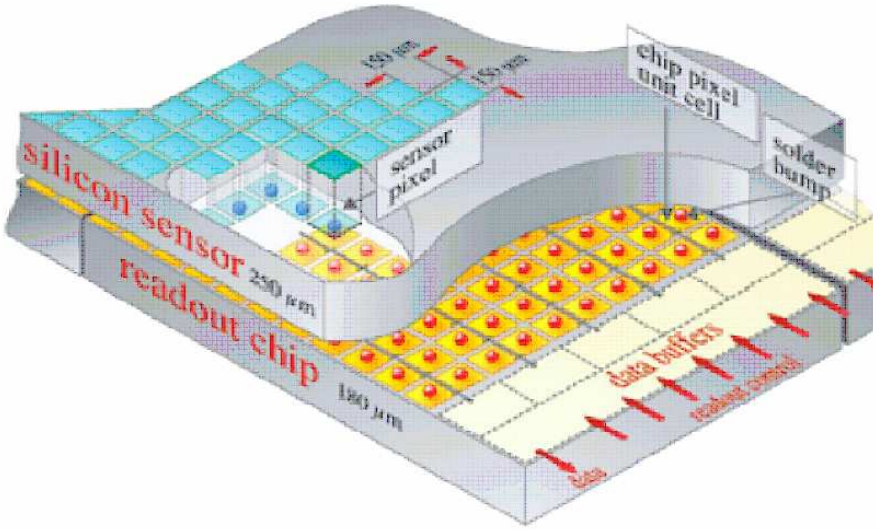
Token Bit Manager (Rutgers)

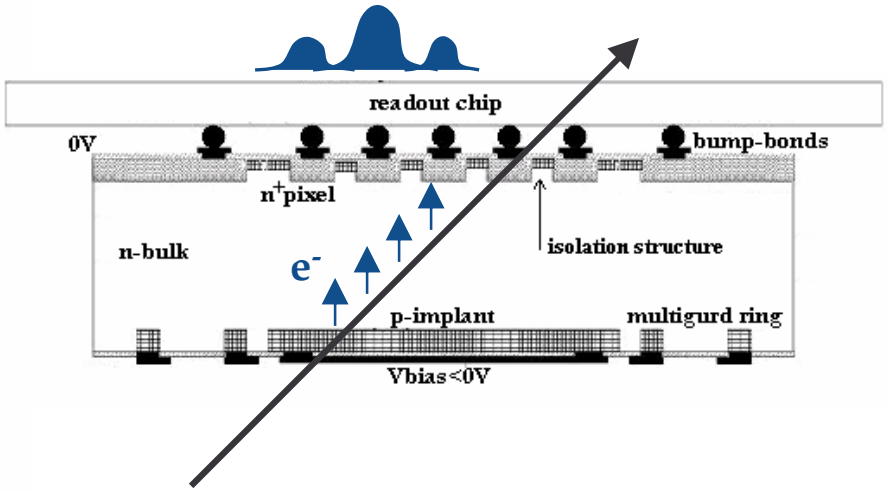
- **Final version of TBM (TBM 05) will be available within couple of months.**





Sensor Construction





- Sensors designs are specified by the LHC environment.
  - n-on-n, p-stop, multiple guard rings ensure high break-down voltage.
- Pitch size is set by the design of the Readout Chip: 100 x 150 μm
- Sensors are bomb-bonded to the readout chips.