

CERN 10 cm x 10 cm Single-Mask GEM Foils Summary

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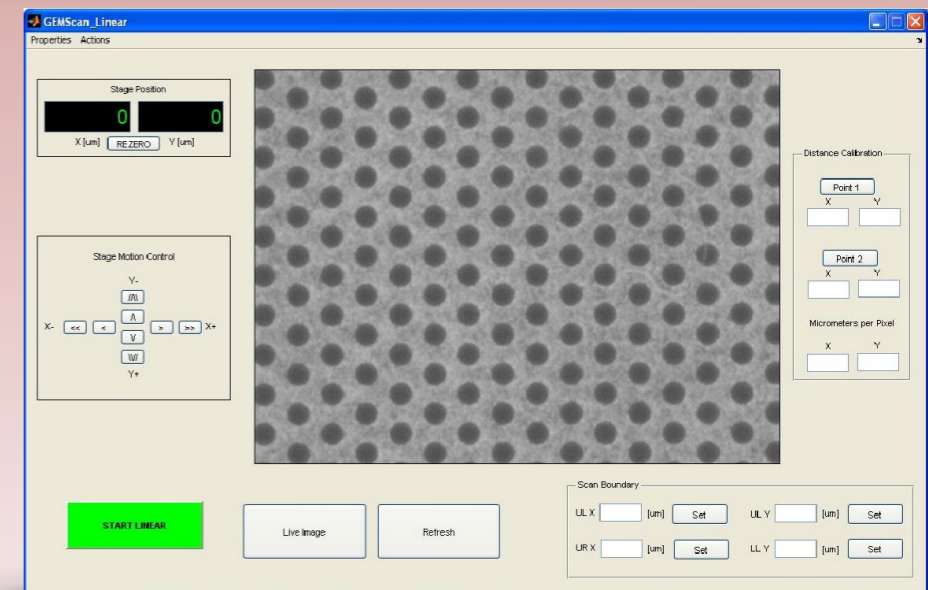
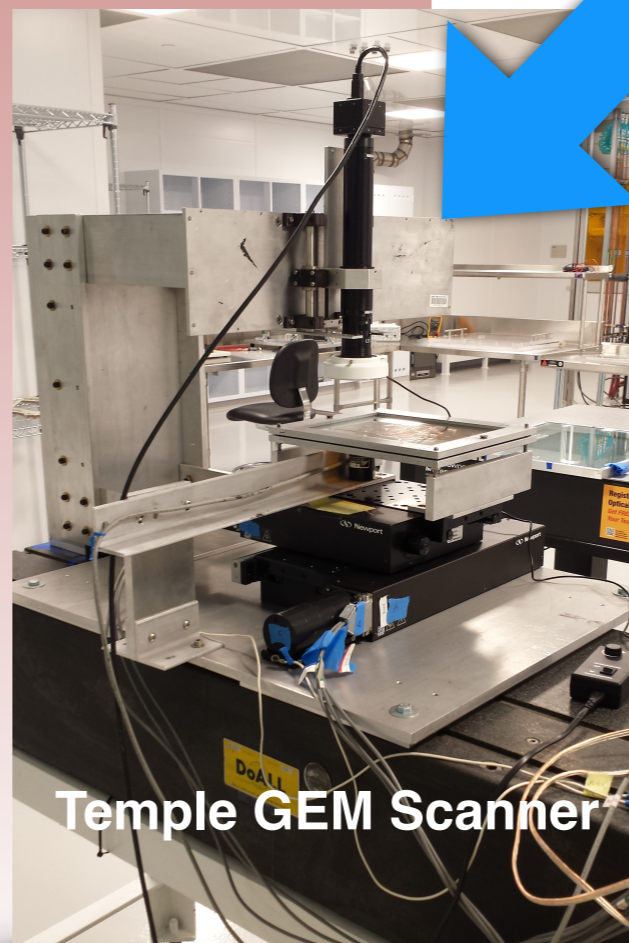
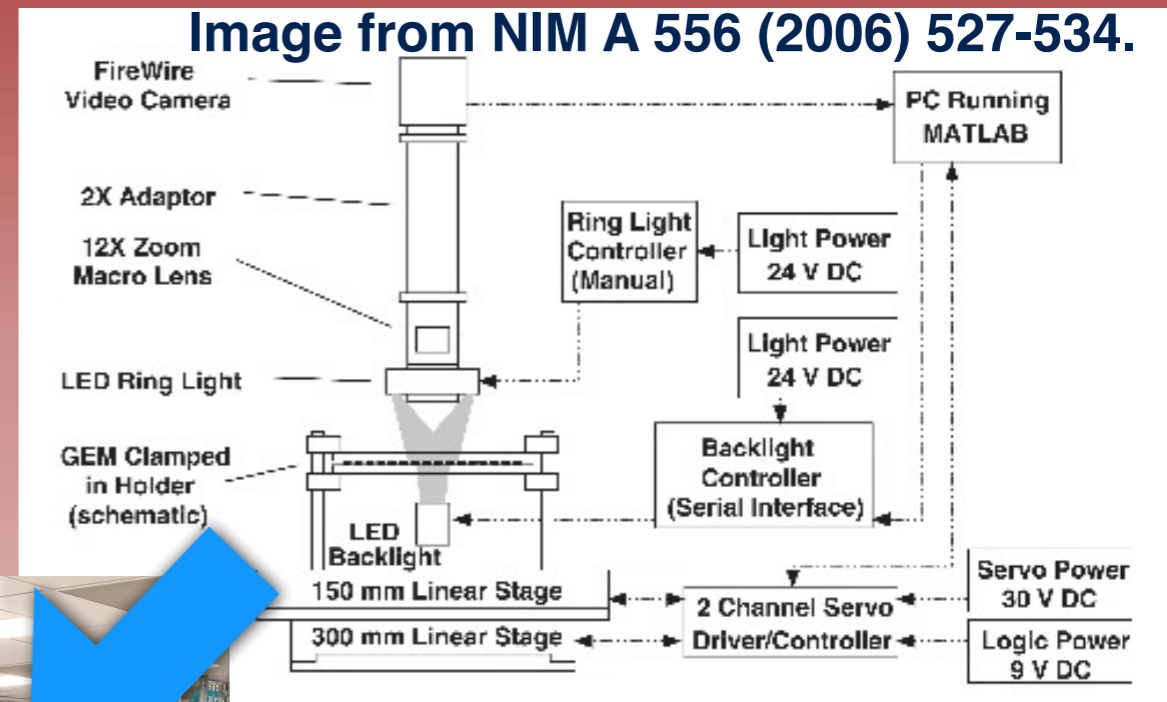
**RD51 Workshop
June 10, 2015**

Overview

- Scanned all **3 CERN** 10 cm x 10 cm **single-mask** GEM foils
- Scanned **inner** and **outer** hole diameters
- Scanned the “**back**” side of **all** foils
- **Front** and **back** sides chosen arbitrarily

GEM Optical Analysis

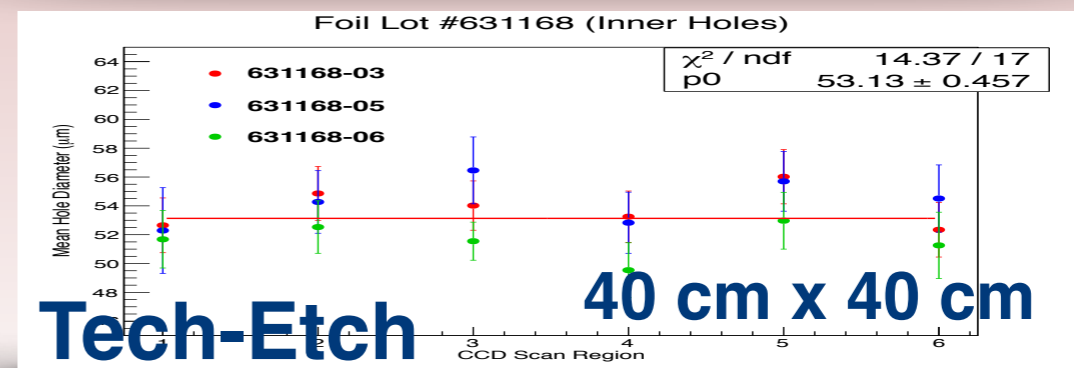
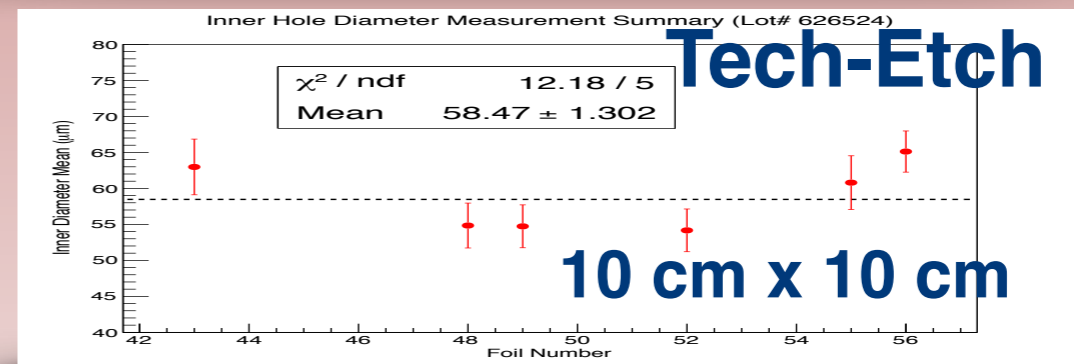
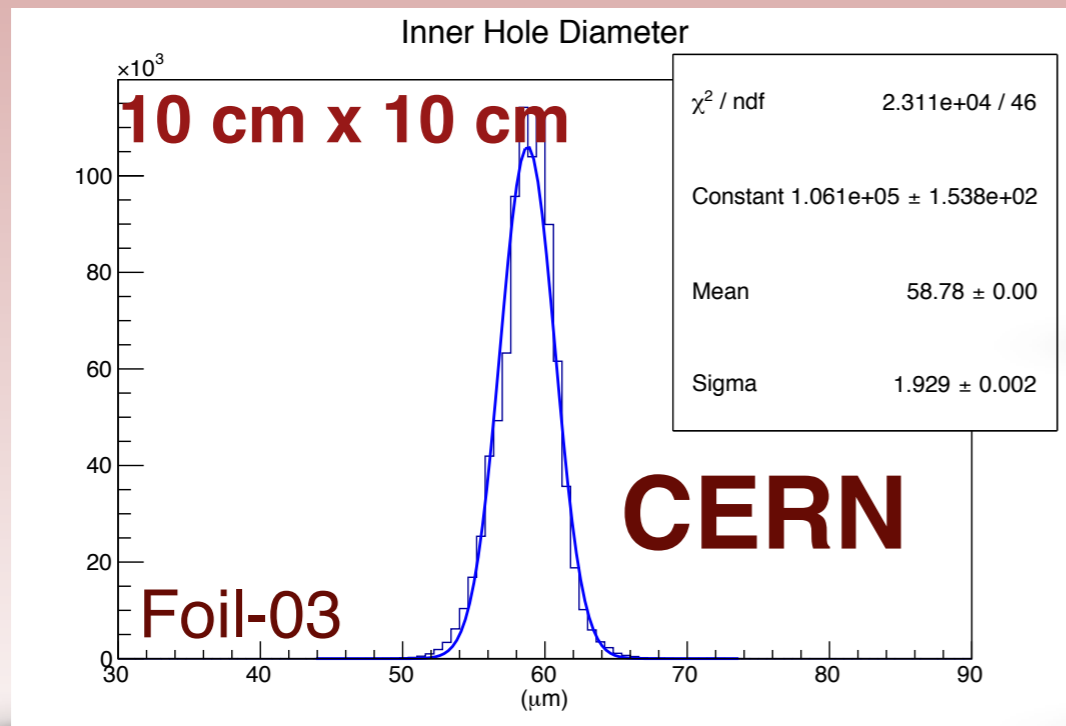
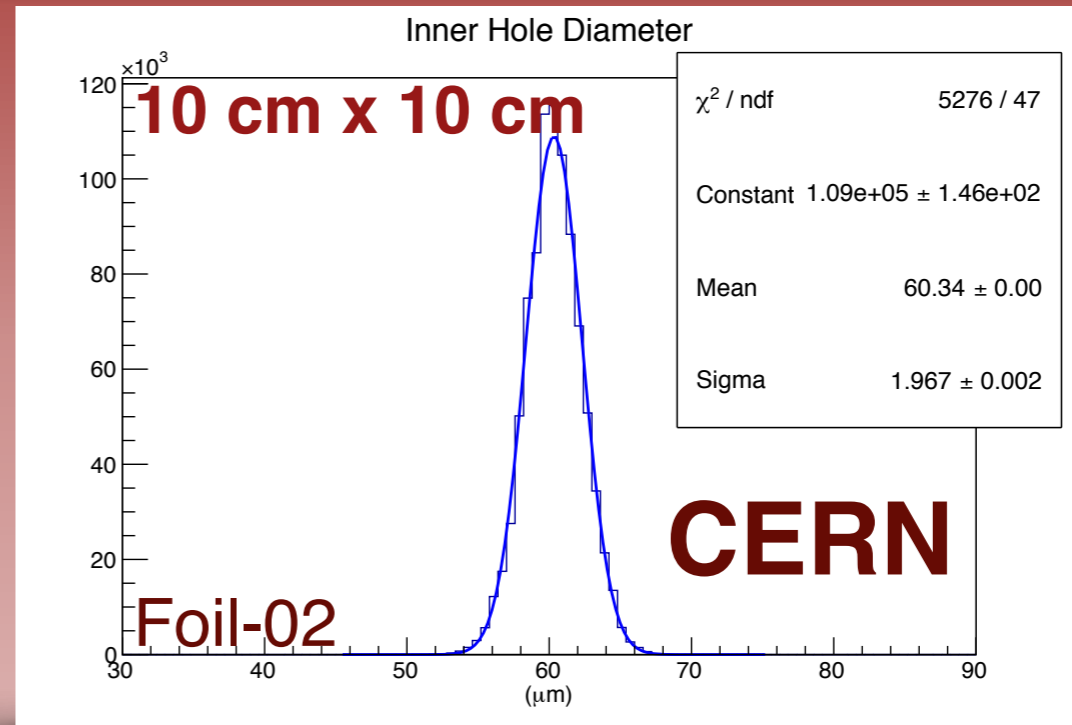
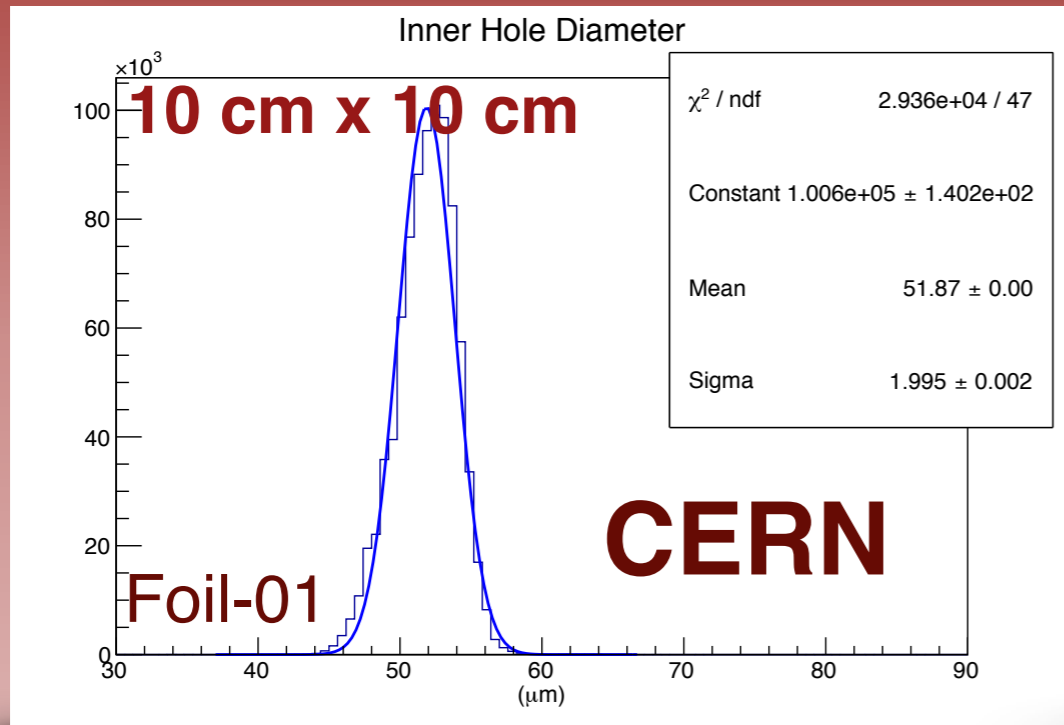
- **Automated** 2D scanner
- X/Y stage traverse **30 cm/ 15 cm**
- High res **CCD camera** with 12x magnification
- **Lighting selection** allows for sensitivity to **inner** or **outer holes**
- Image analysis is handled in **MATLAB**



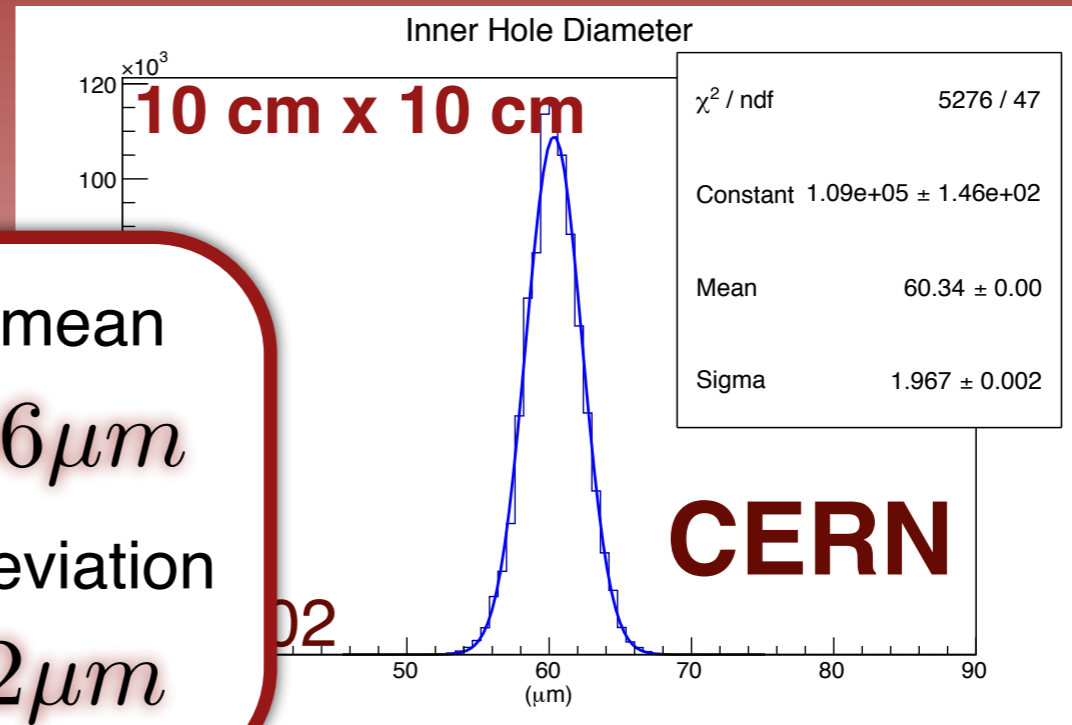
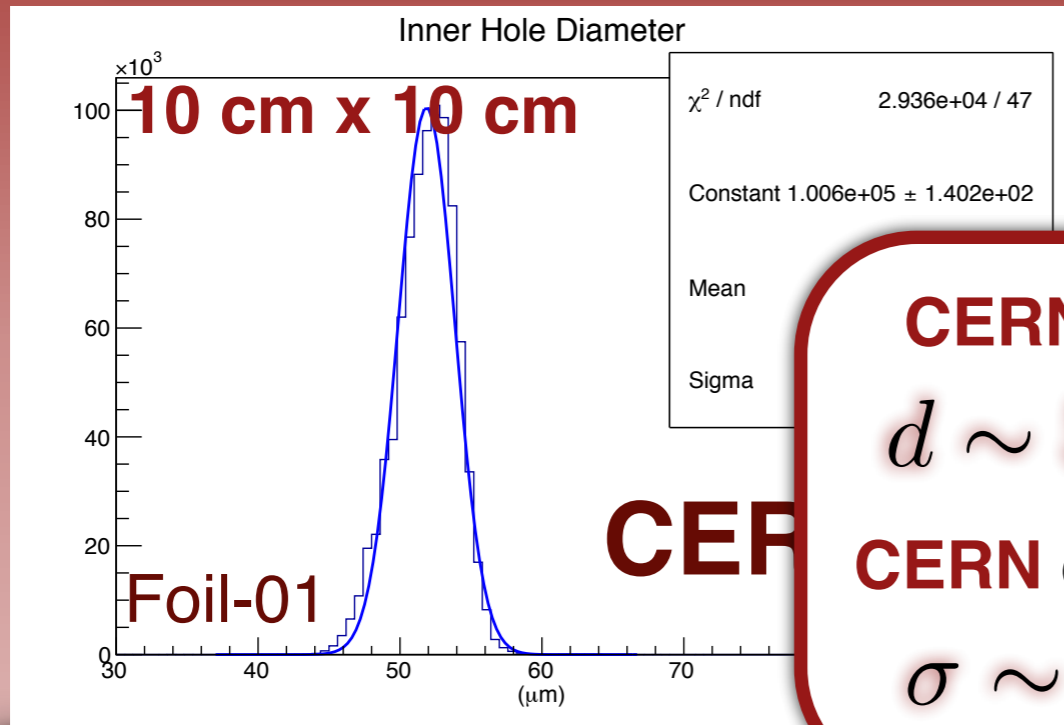
Inner Hole Diameter

Inner Hole Diameter Comparisons

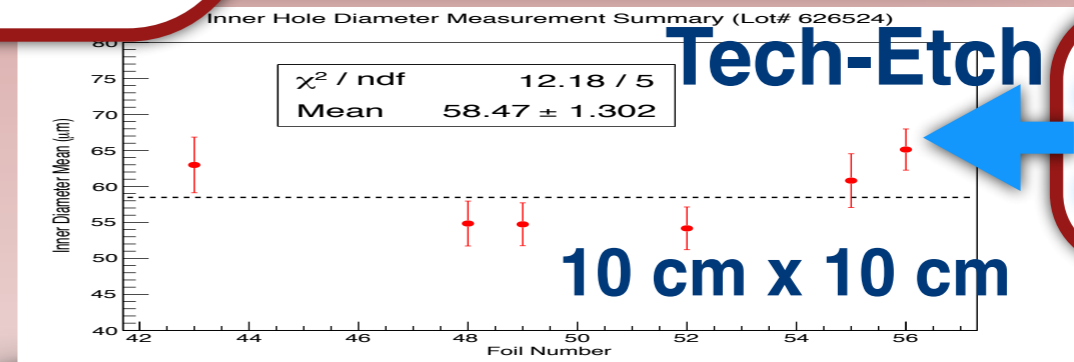
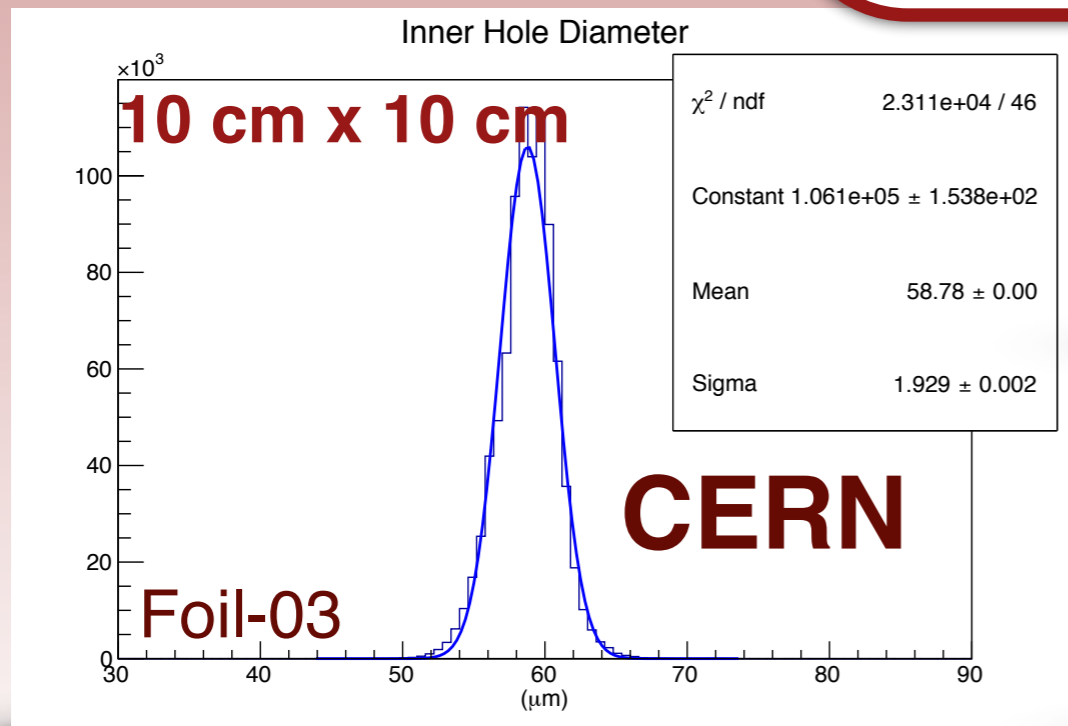
Inner Hole Diameter Front-Side



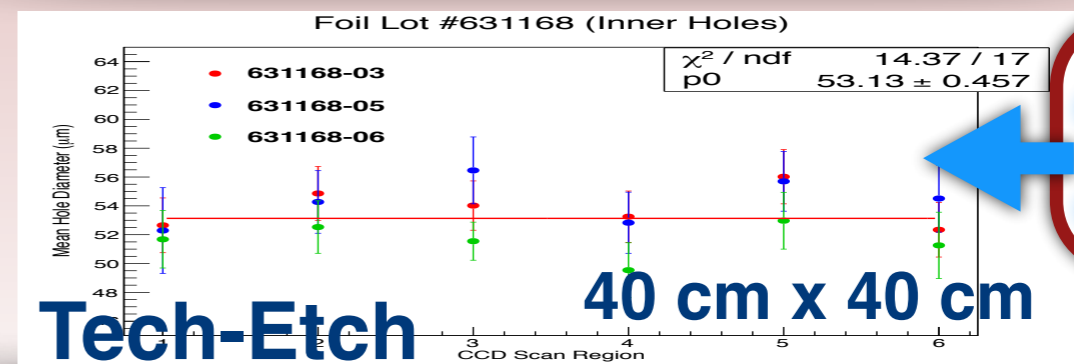
Inner Hole Diameter Front-Side



CERN mean
 $d \sim 56 \mu\text{m}$
CERN deviation
 $\sigma \sim 2 \mu\text{m}$

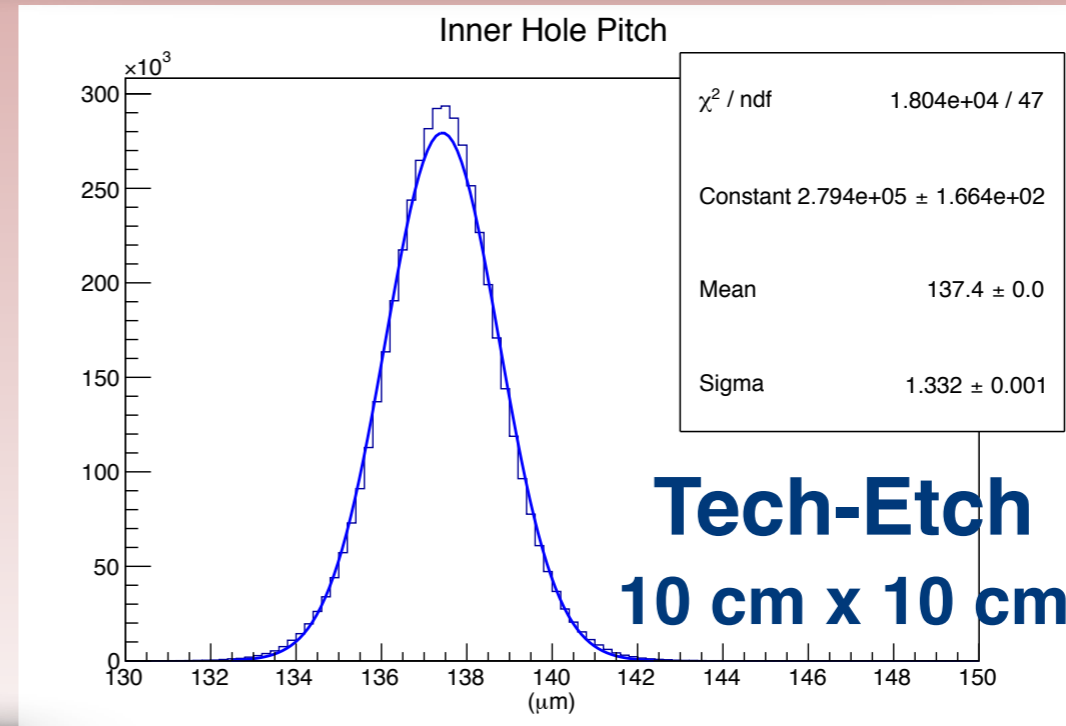
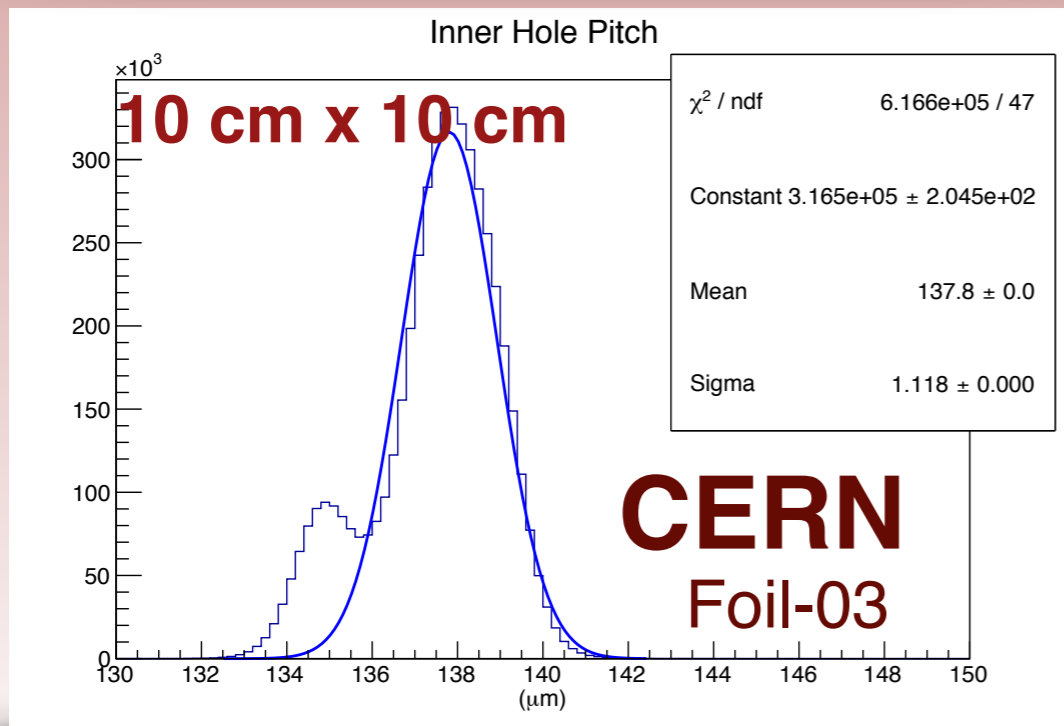
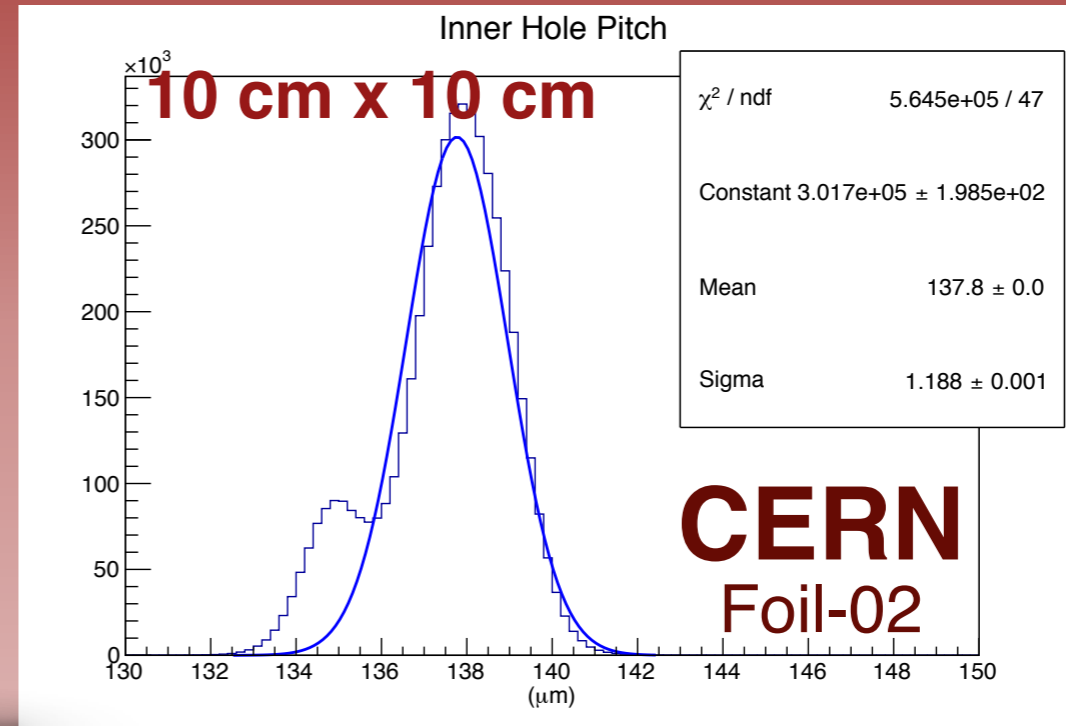
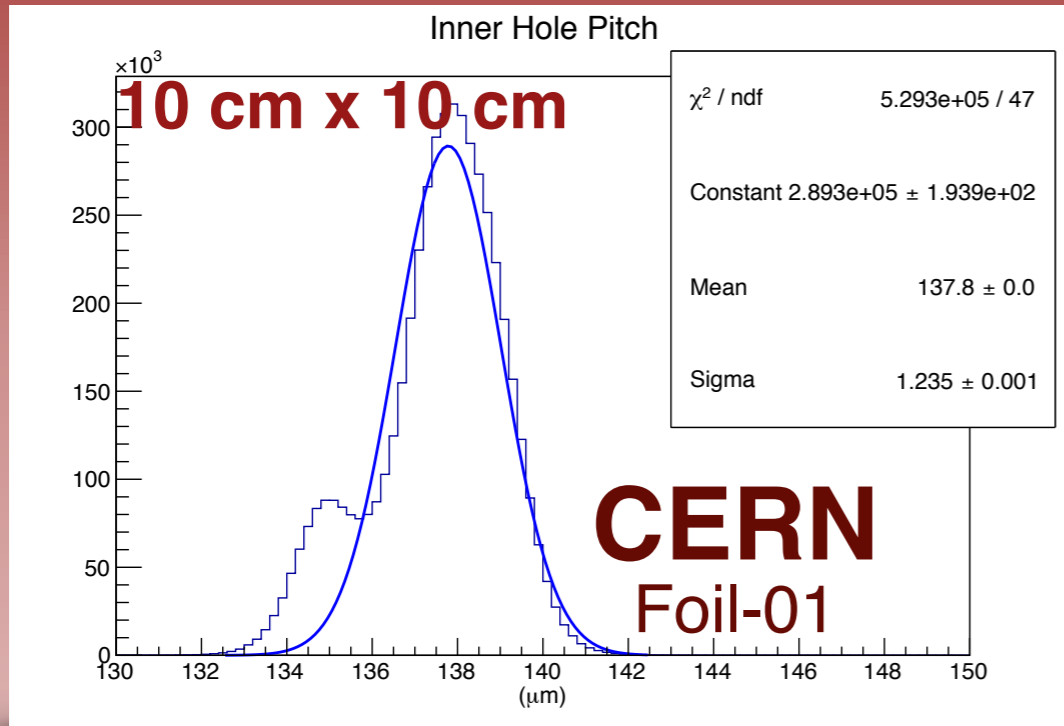


Tech-Etch
 $d \sim 58 \mu\text{m}$
 $\sigma \sim 3 \mu\text{m}$

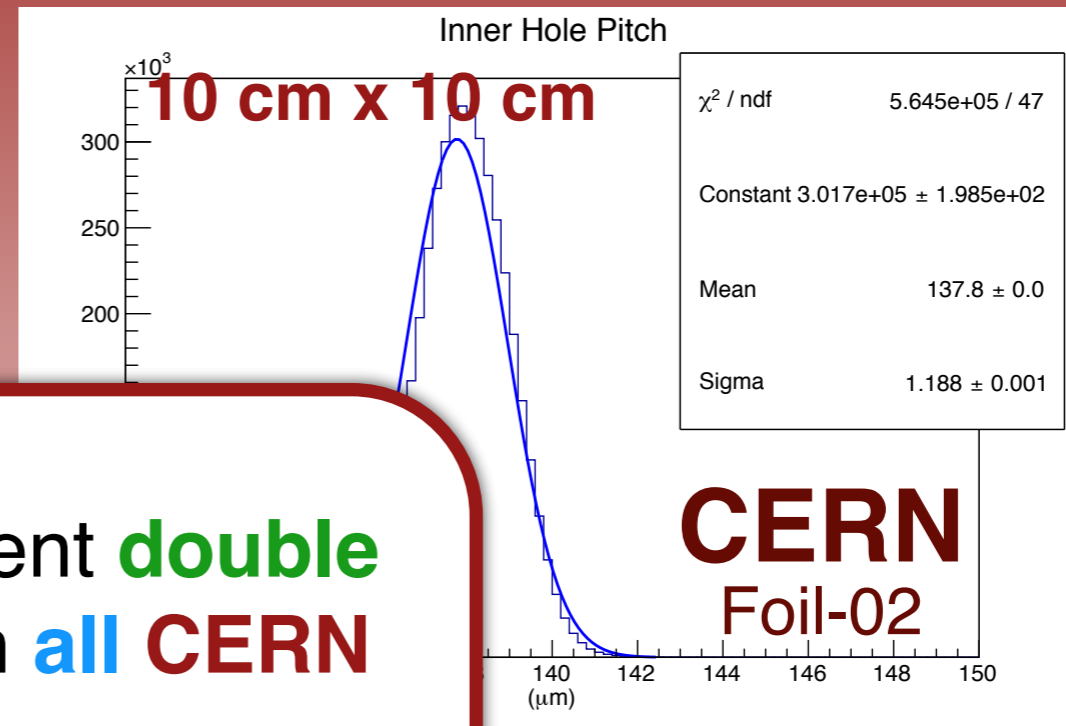
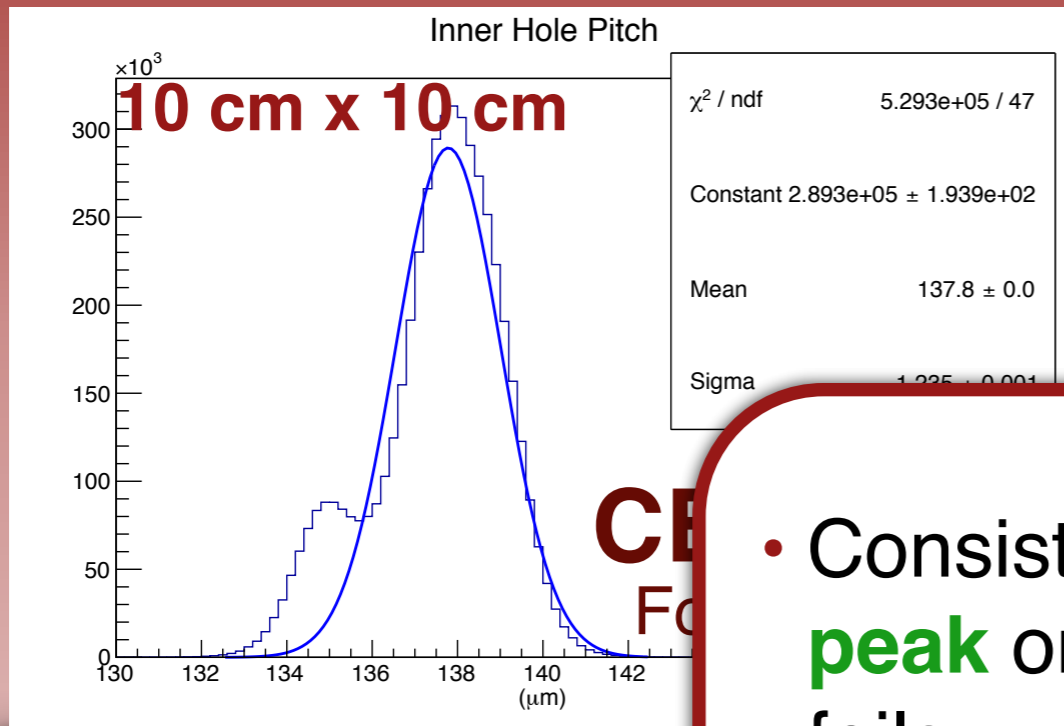


Tech-Etch
 $d \sim 53 \mu\text{m}$
 $\sigma \sim 2 \mu\text{m}$

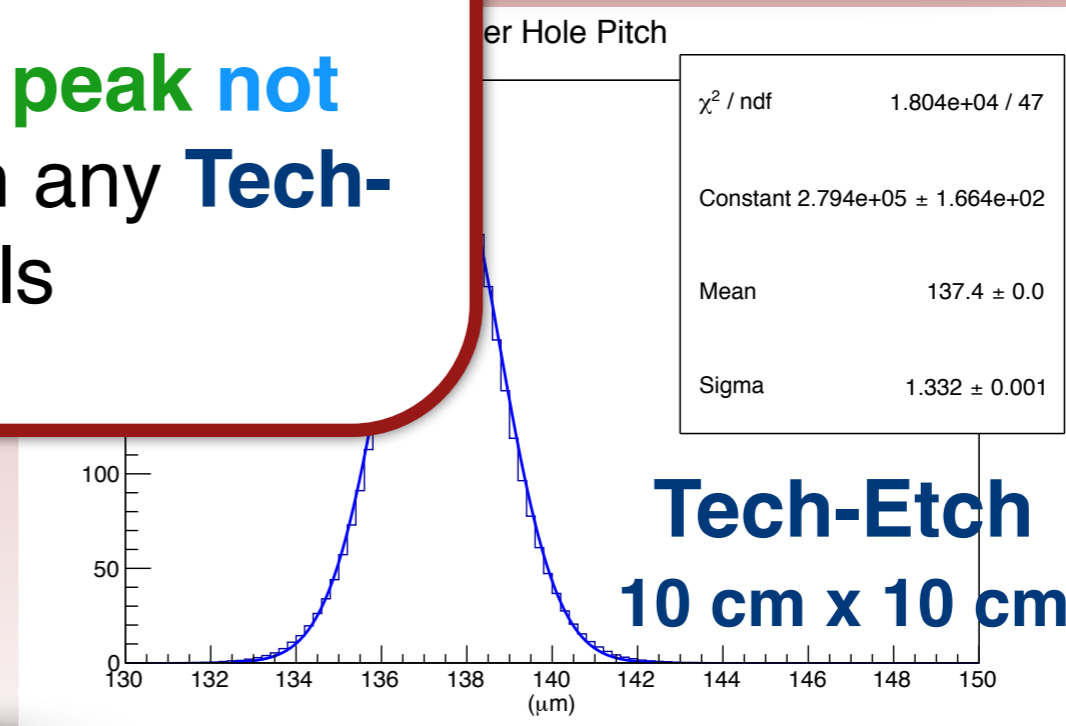
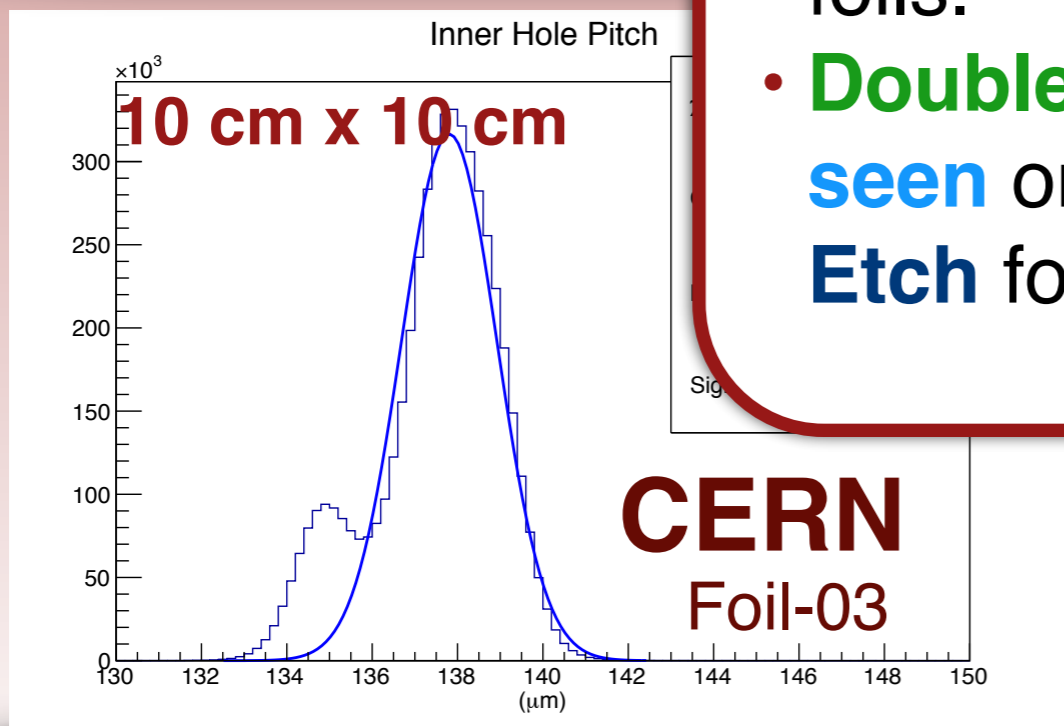
Inner Hole Pitch Front-Side



Inner Hole Pitch Front-Side



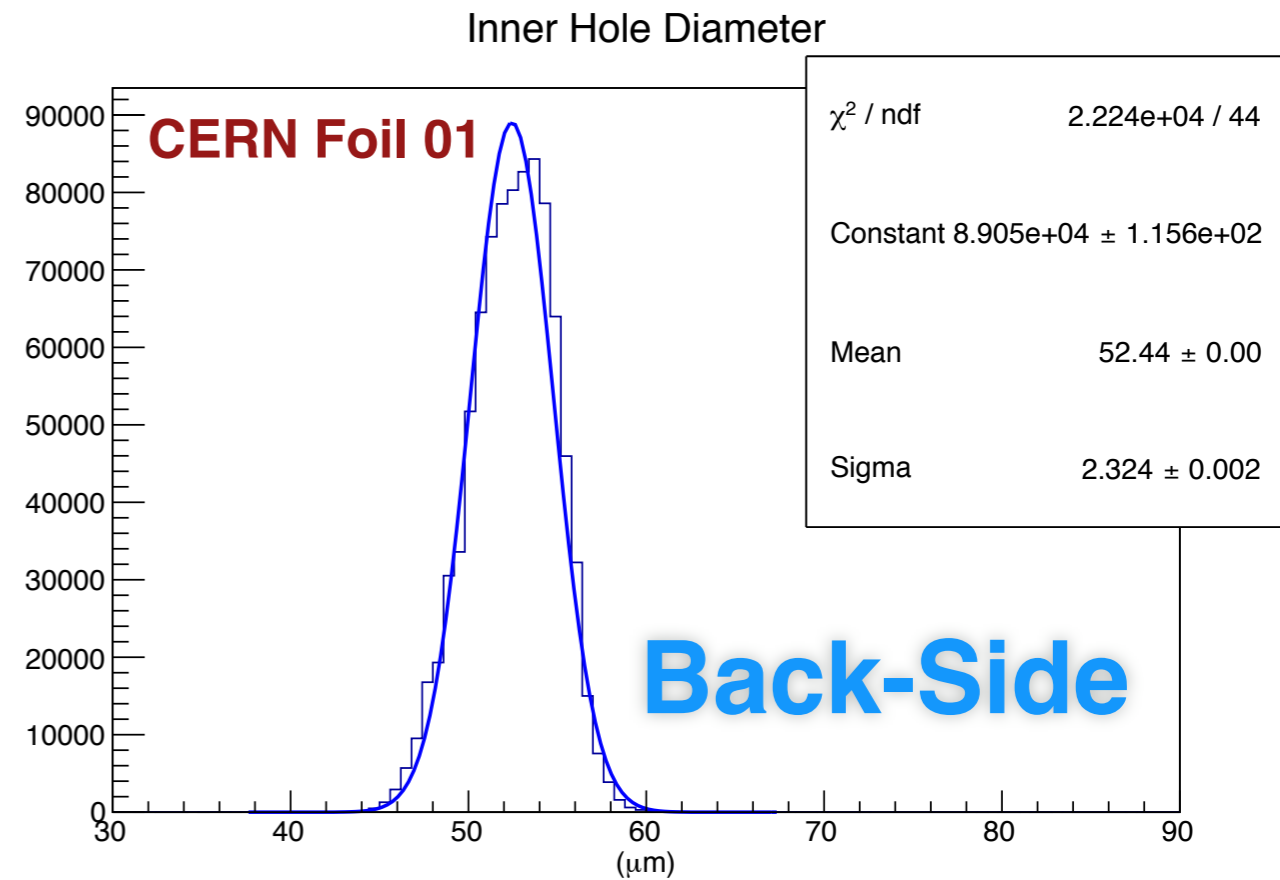
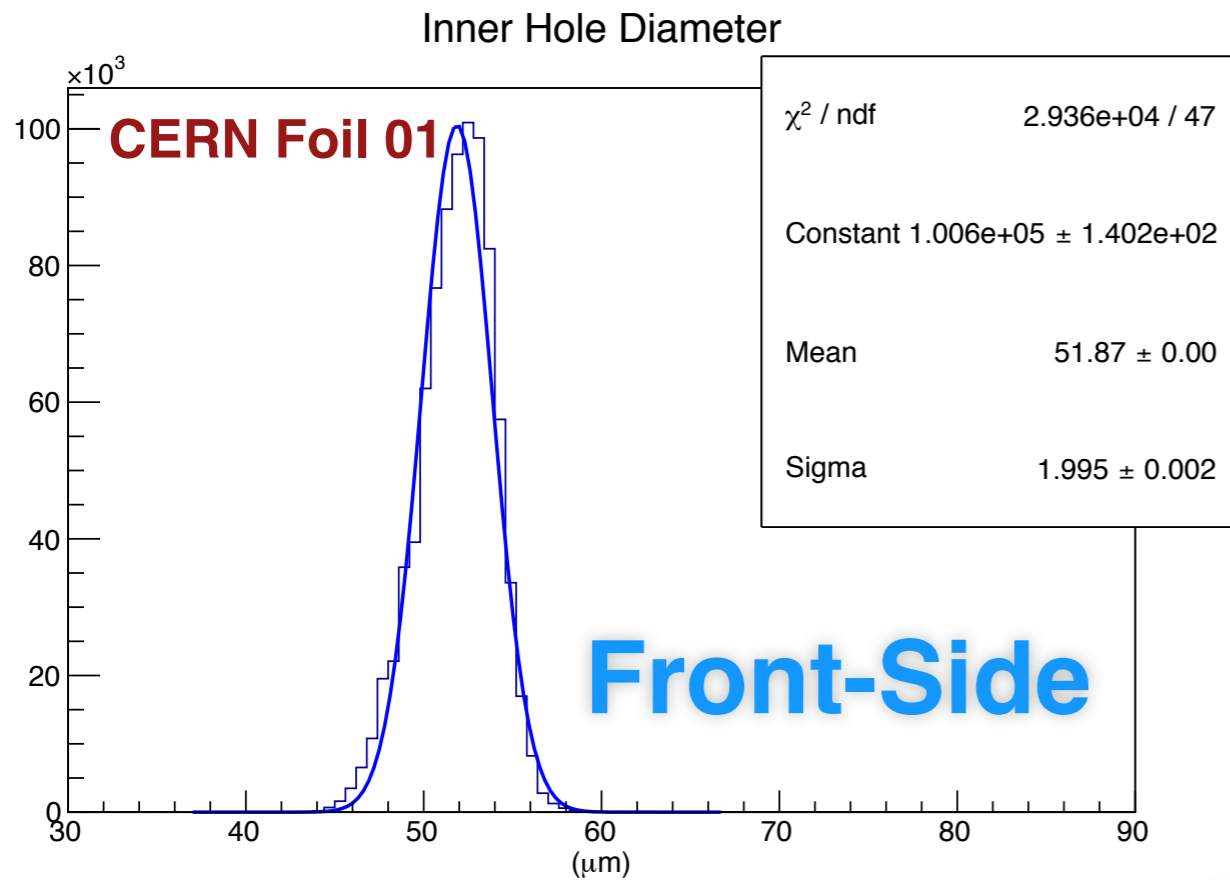
- Consistent **double peak** on **all CERN** foils.
- **Double peak not seen** on any **Tech-Etch** foils



Front vs Back Sides

Front vs Back Side Comparisons

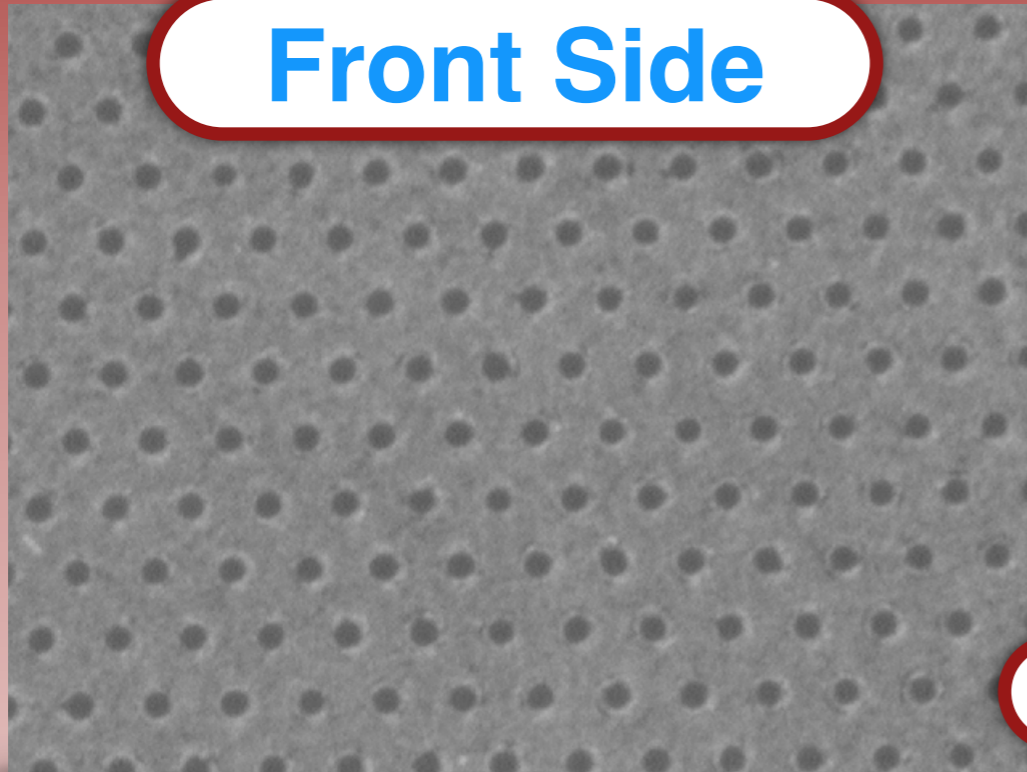
Inner Hole Diameter Front vs Back Sides



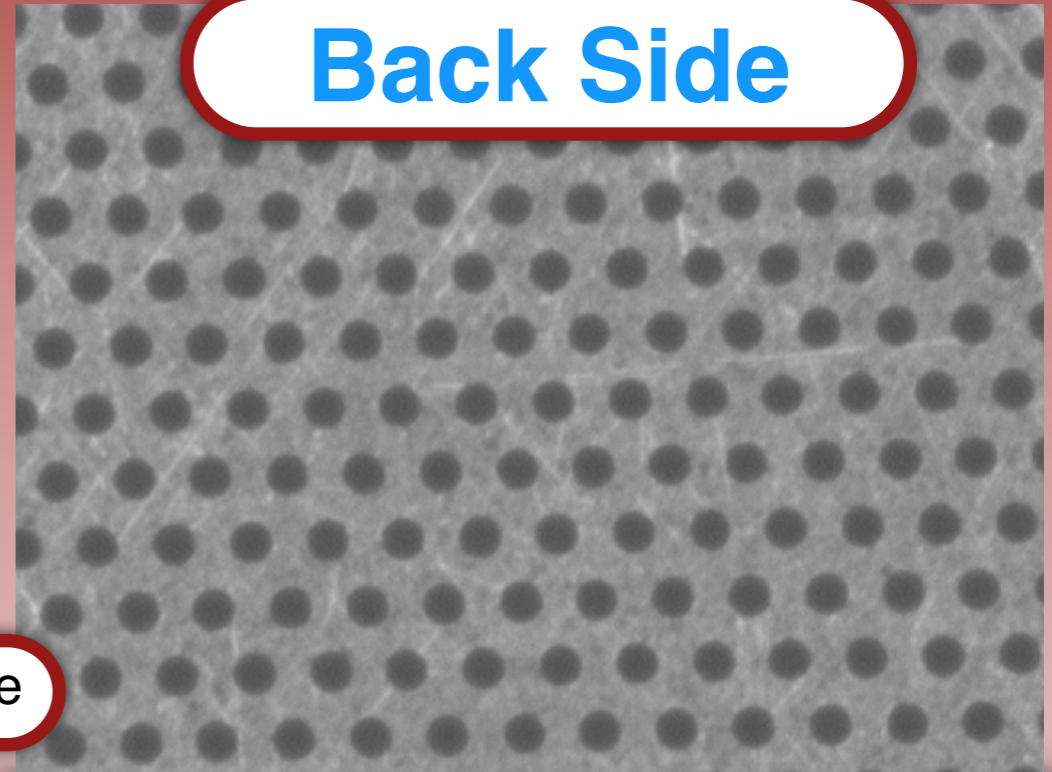
- **Similar** inner hole diameter between **front** and **back** sides of the **CERN** foils ($\sim 1 \mu\text{m}$).
- **Tech-Etch** foils showed **similar** behavior

Outer Hole Diameters Front vs Back Sides

Front Side



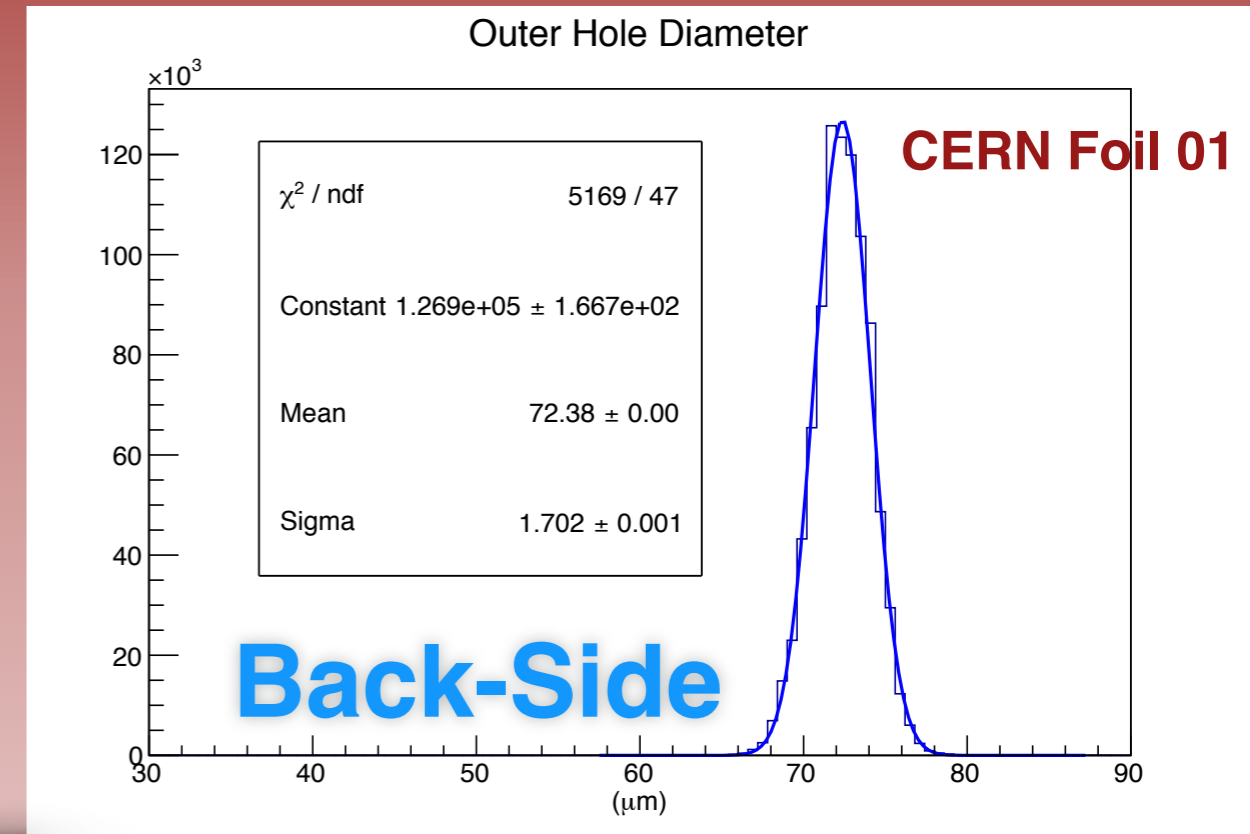
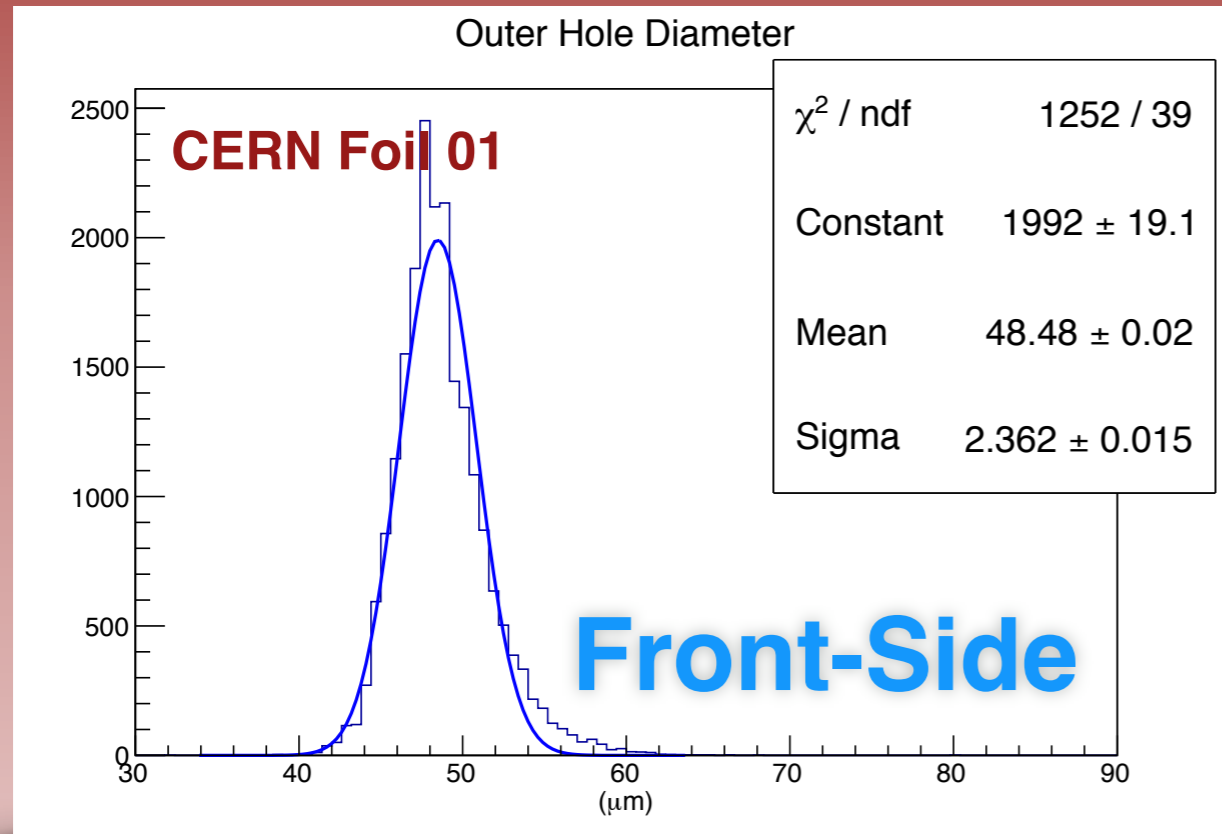
Back Side



Same scale

- There is a clear **asymmetry** in the **outer holes** between the **front** and **back** sides of the **CERN** foils
- **CERN** etches from what I call **back** side to **front** side?
- **Front** side **outer holes** appear **similar** in size to **inner** diameter holes.

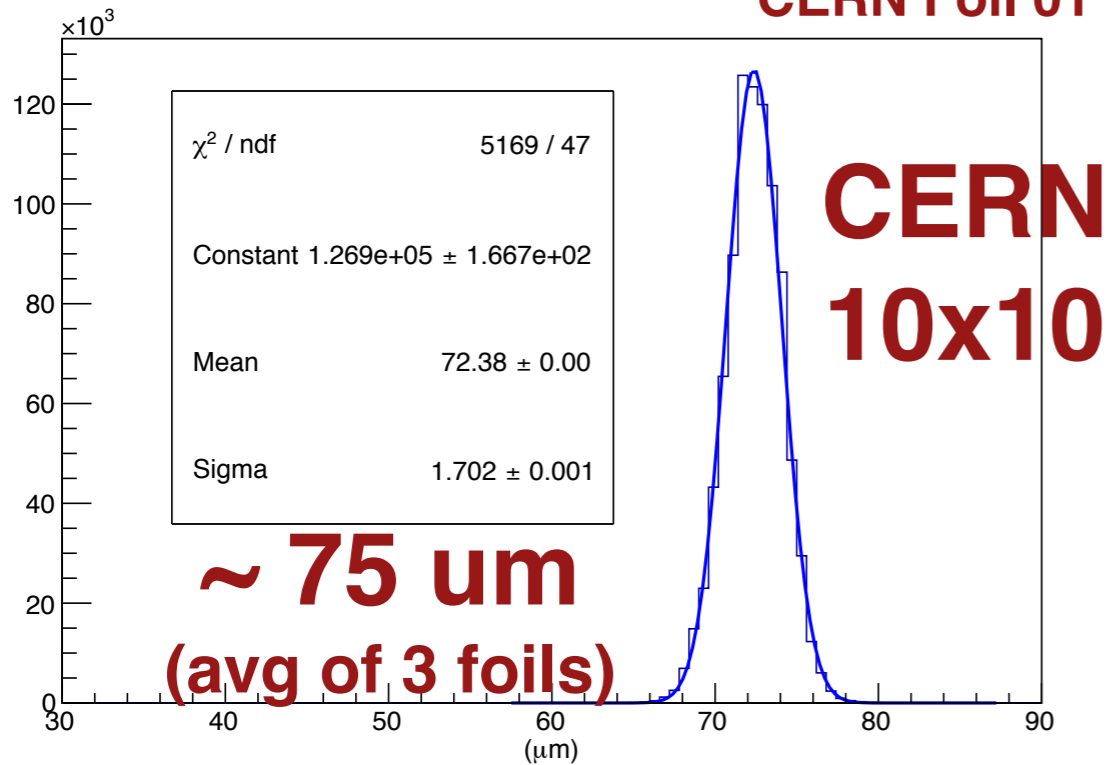
CERN Outer Hole Diameters Front vs Back Sides



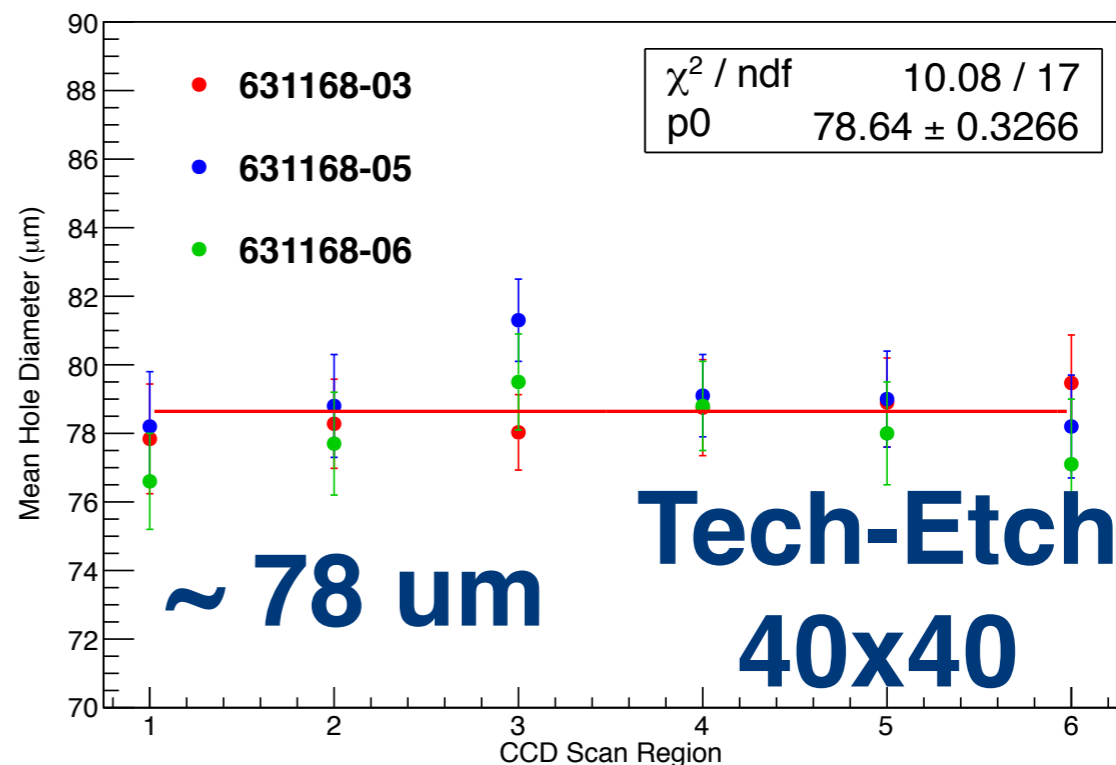
- **CERN 10x10** Asymmetry: **~24 um** (**mean** outer diameter)
- **Tech-Etch 10x10** Asymmetry: **5-15 um** (Tech-Etch measured)
- **Tech-Etch 40x40** Asymmetry: **~1-5 um** (**mean** outer diameter, only a few sections checked)

Outer Hole Diameters

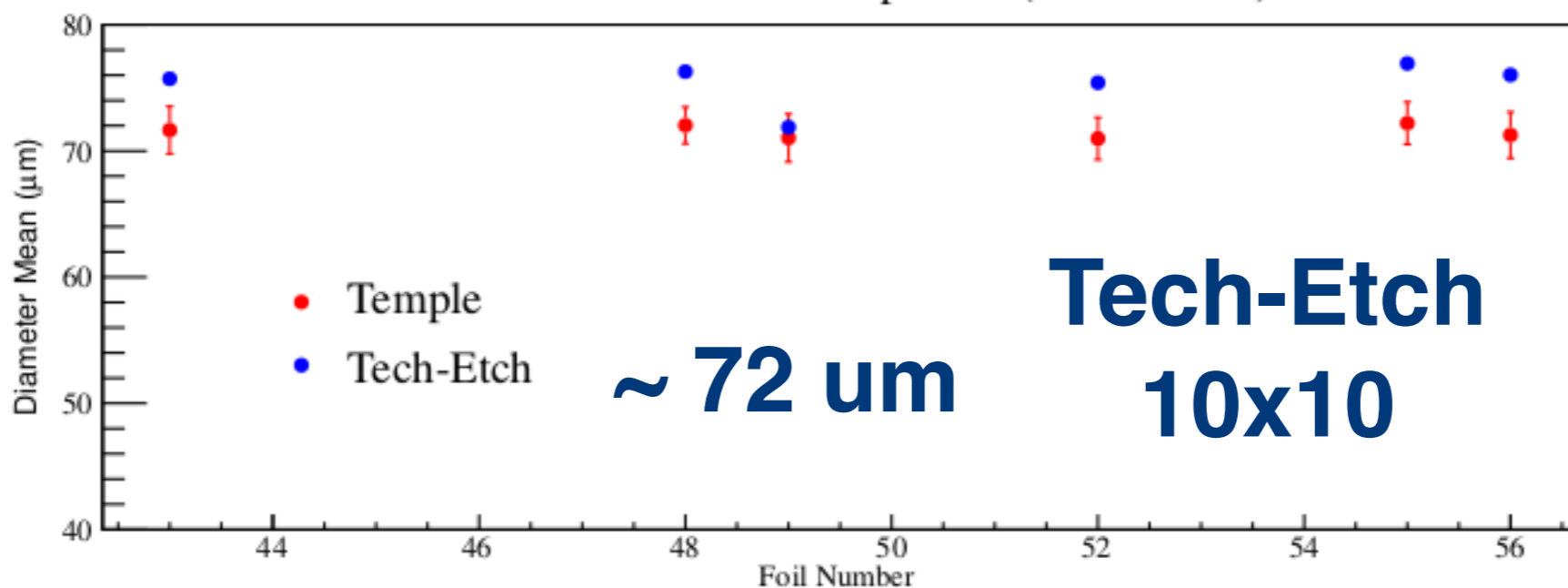
Outer Hole Diameter **CERN Foil 01**



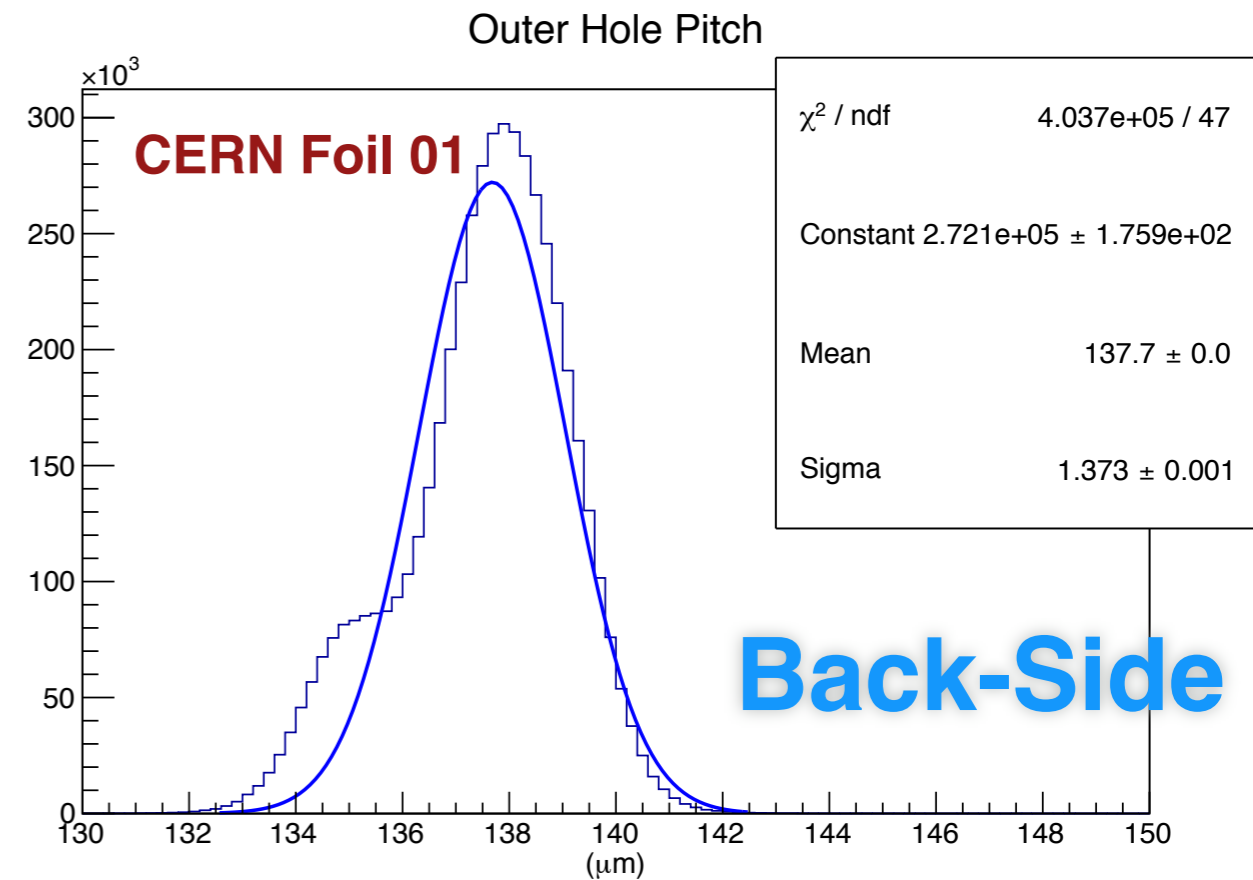
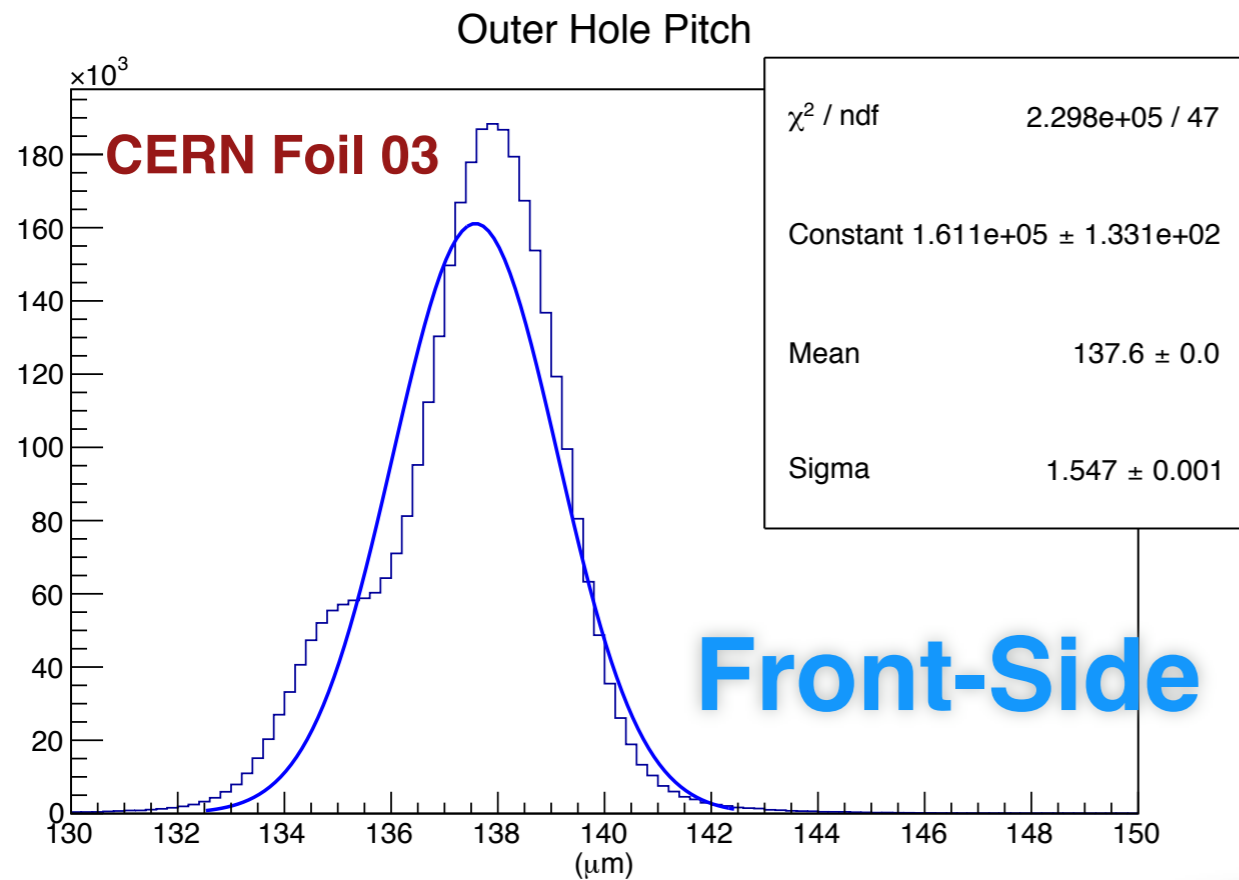
Foil Lot #631168 (Outer Holes)



Outer Hole Diameter Comparison (Lot# 626524)



Outer Hole Pitch Front vs Back Sides



Double peak seen on **outer** hole diameters and **front/back** sides