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Solid-State Lighting Measurement Assurance Program Summary with Analysis of Metadata

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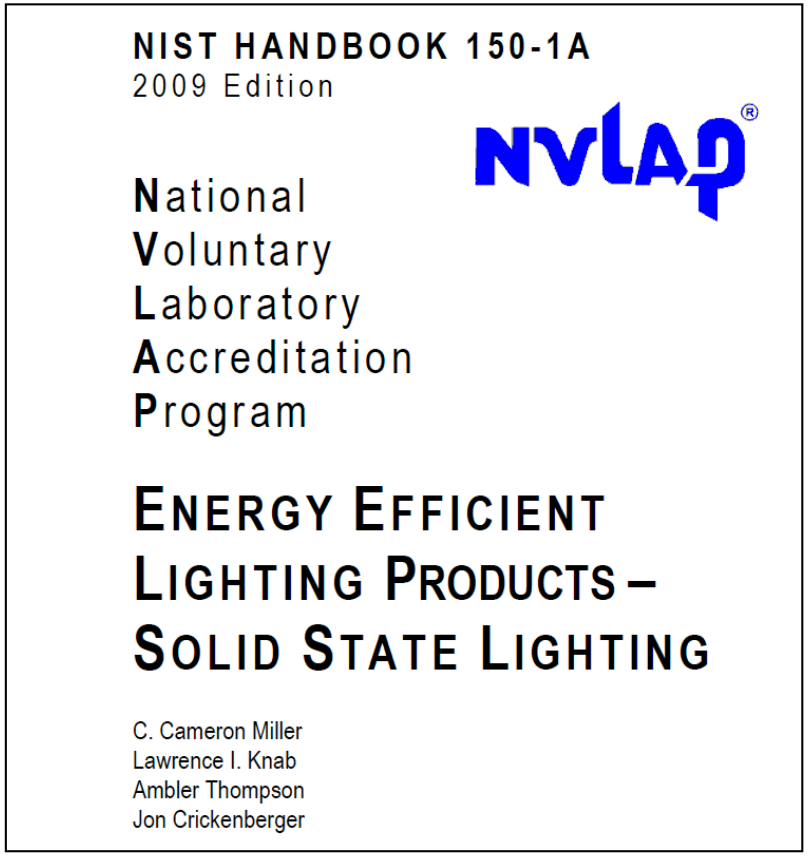
SSL Measurement Assurance Program

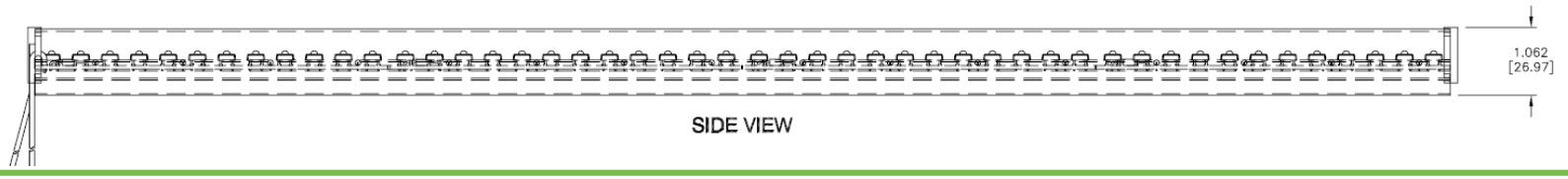
- IES LM-79: Laboratory Accreditation
  - SSL program was required for Energy Star and Lighting Facts labeling program
  - Assessor Training – February 7, 2008
  - DOE sponsored Laboratory Training
    - February 16-17, 2010
    - 34 laboratory representatives
  - Establish a proficiency testing program
  - At request of the EPA, PT program was opened to customers of other accrediting bodies



Combined 150-1 and 150-1A in 2010 Edition

SSL MAP - Artifacts

- Six items
  - Incandescent lamp (120 V AC)
  - Under cabinet SSL luminaire
    - (12 V DC, DC current controlled)
  - Four different white SSL lamps (120 V AC)



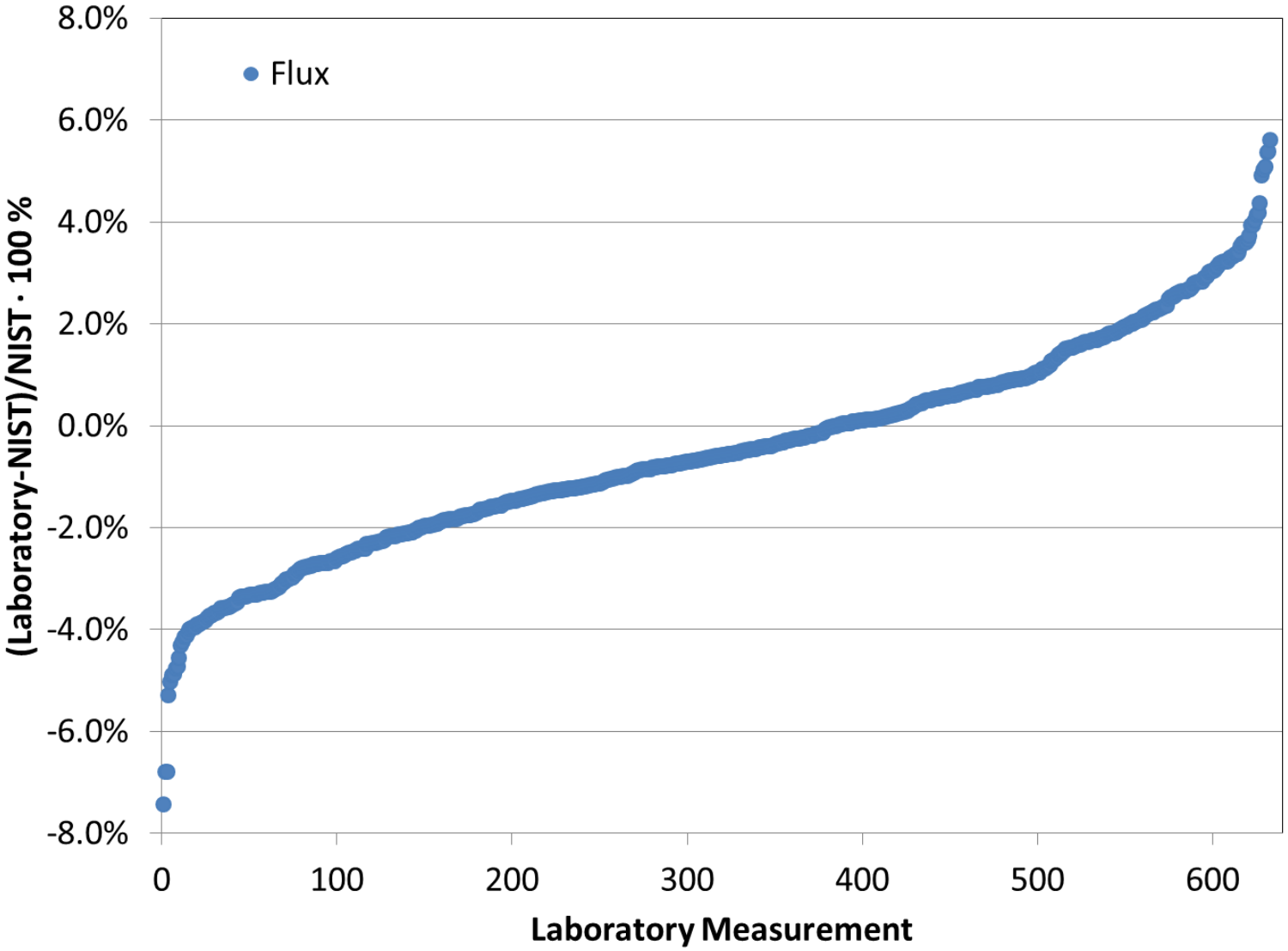
Business Model Mistake

- 117 laboratories have participated

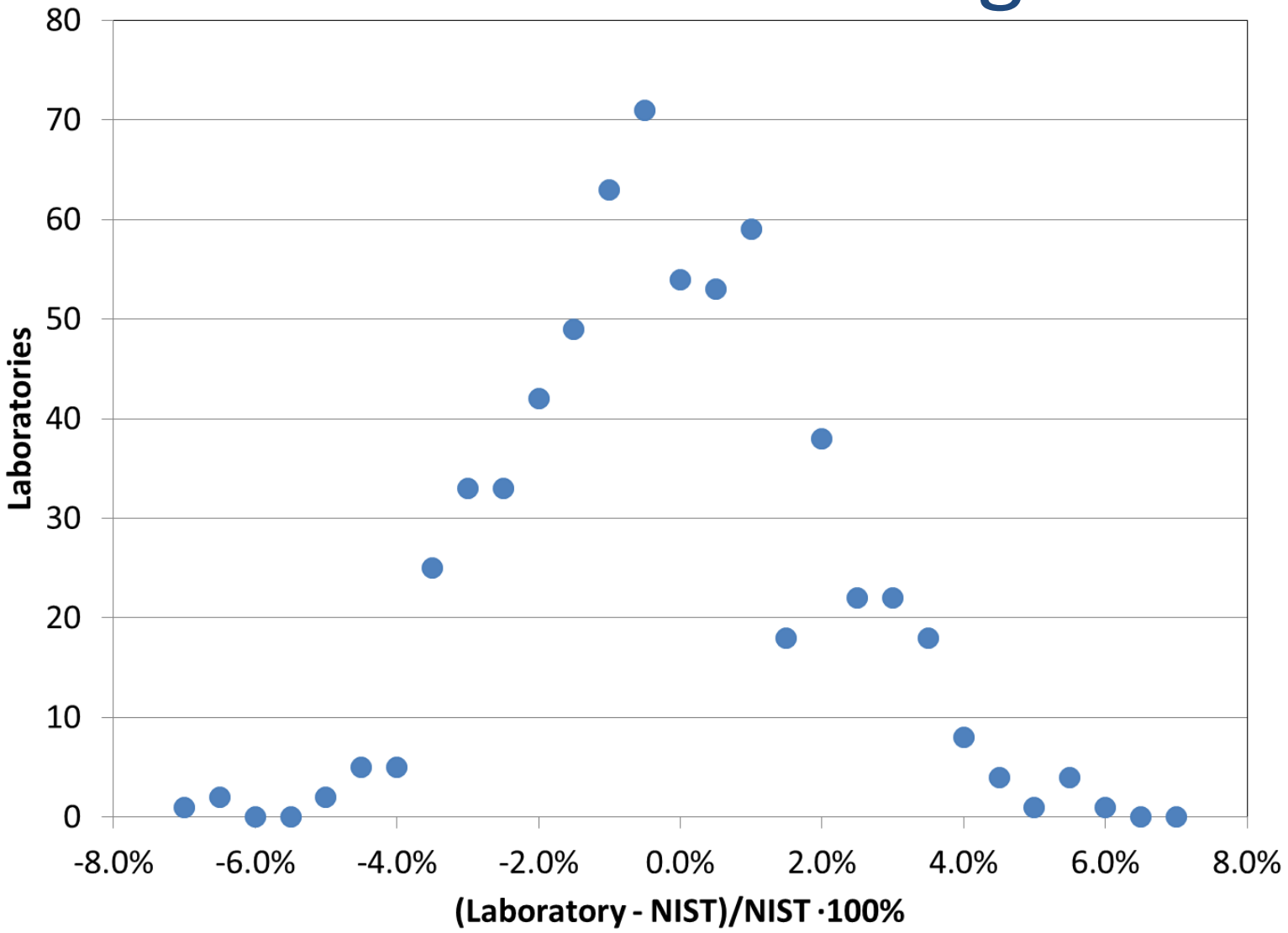
United States (48)	China (45)
Taiwan (9)	Korea (4)
Canada (3)	Netherlands
Brazil	Singapore
India	Malaysia
Hungary	Italy
Germany	

SSL-MAP1 officially closed on January 1st, 2015

Overall Results - Flux



Overall Results - Histogram



Normal Probability Plot

Graphical technique for assessing whether or not a data set is approximately normally distributed. (Chambers, 1983)

Vertical axis: Ordered response values
Horizontal axis: Normal order statistic medians

$$N_i = G(U_i)$$

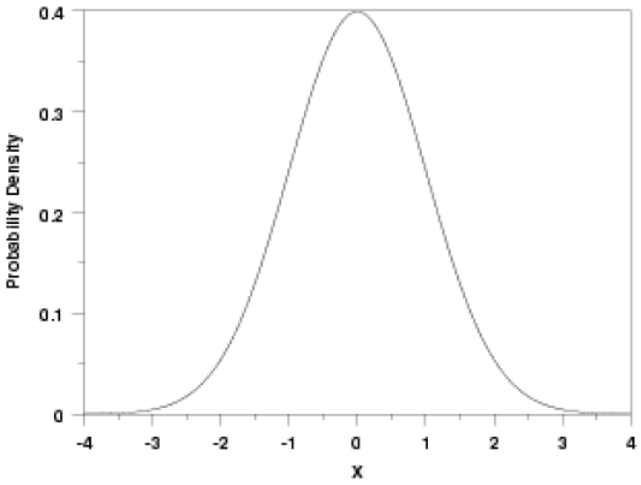
where U_i are the uniform order statistic medians
G is the percent point function of the normal distribution

$$U_i = 1 - U_n \text{ for } i = 1$$
$$U_i = (i - 0.3175)/(n + 0.365) \text{ for } i = 2, 3, \ldots, n\text{-}1$$
$$U_i = 0.5(1/n) \text{ for } i = n$$

http://www.itl.nist.gov/div898/handbook/eda/section3/normprpl.htm

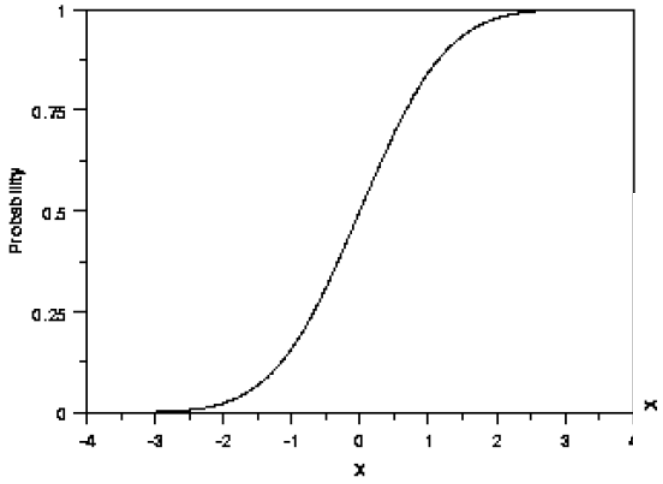
Normal Probability Plot - 2

Percent point function is the inverse of the cumulative distribution function (probability that *x* is less than or equal to some value).

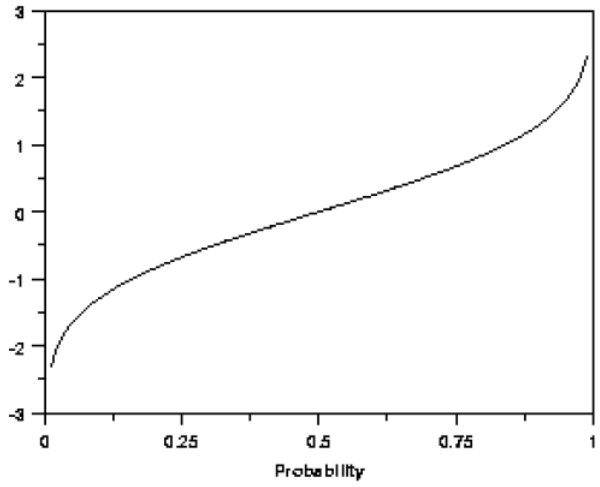


Probability Distribution Function

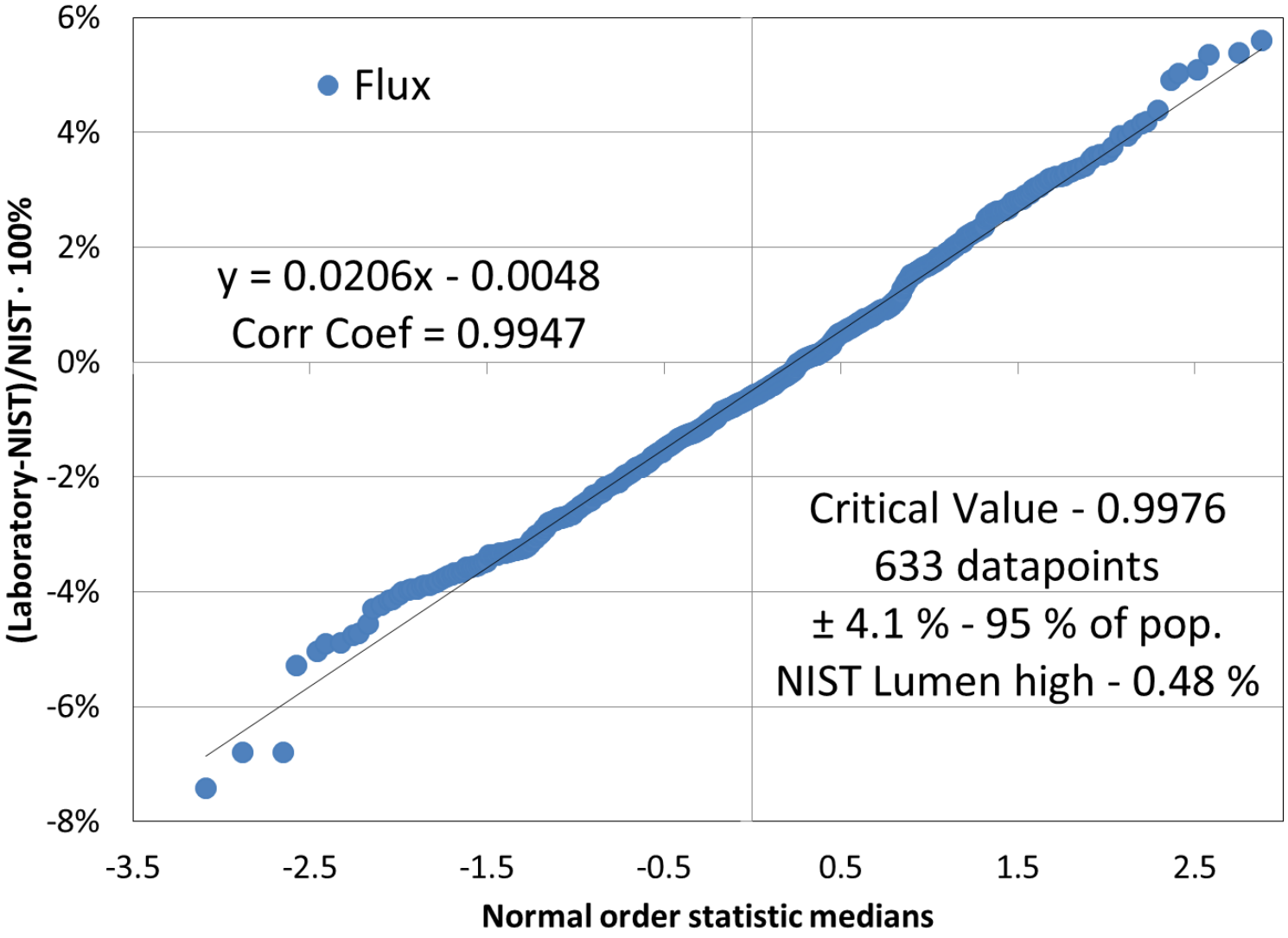
Cumulative Distribution Function



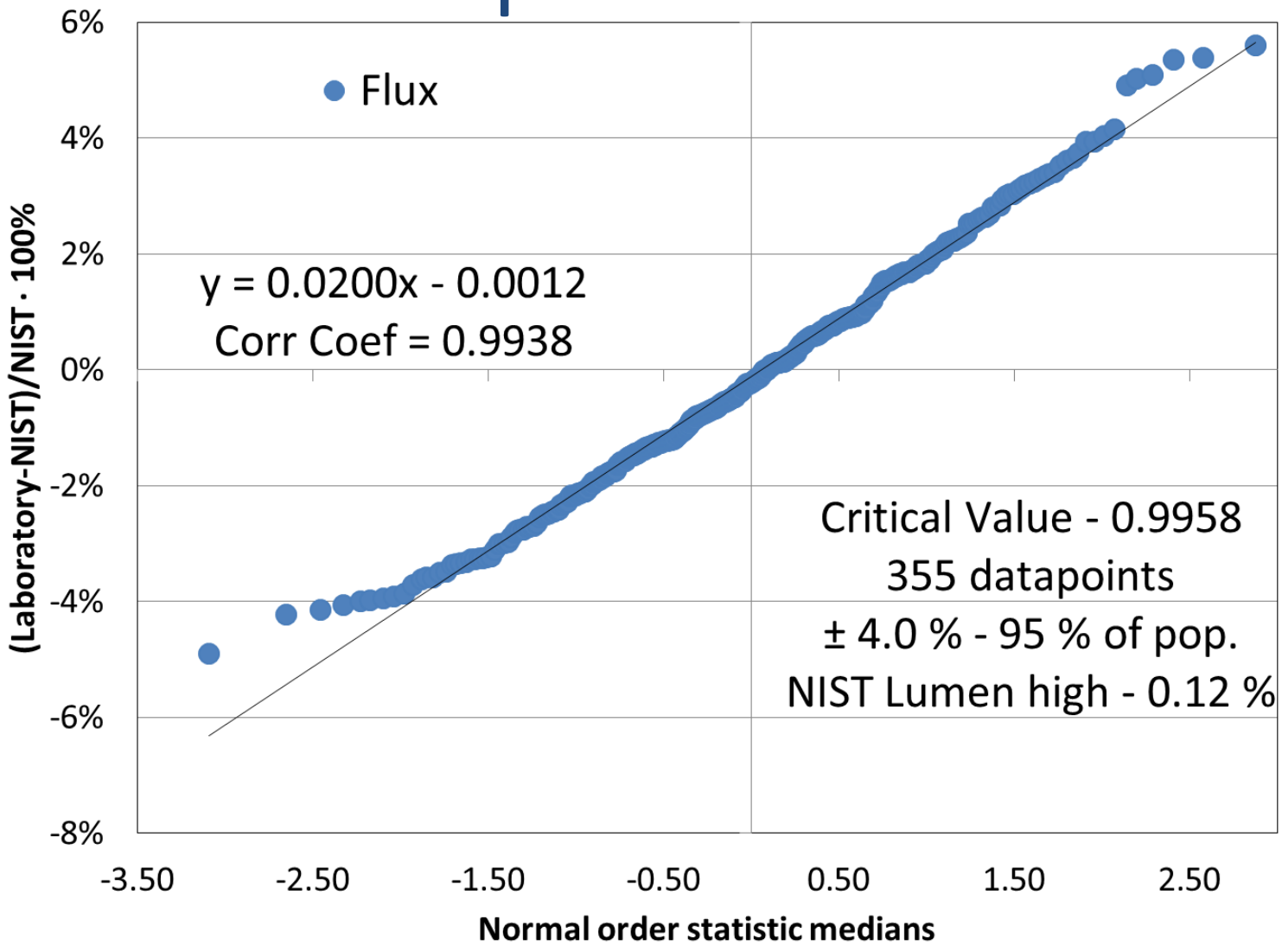
Percent Point Function



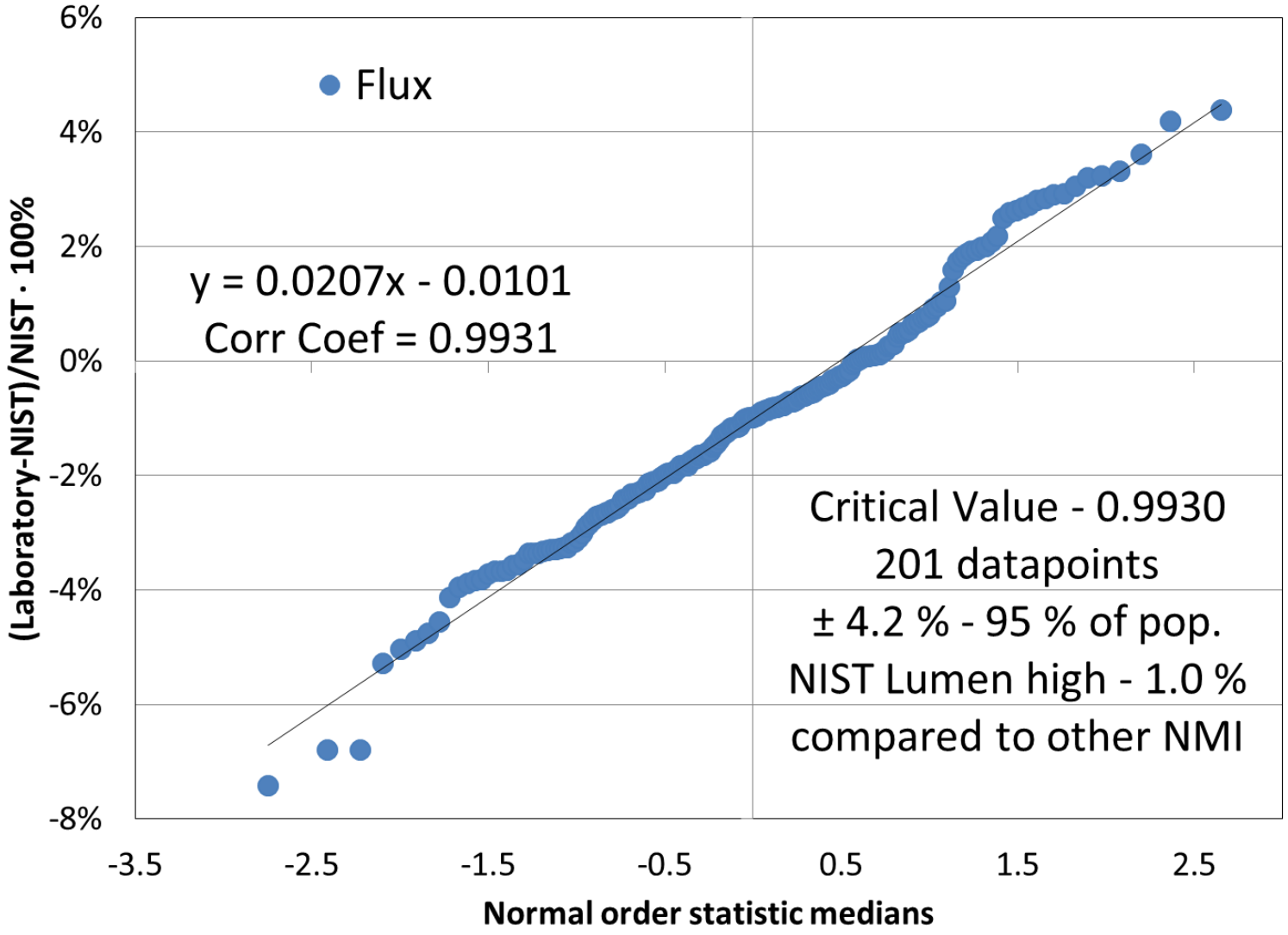
NPPC of All Lamps - Flux



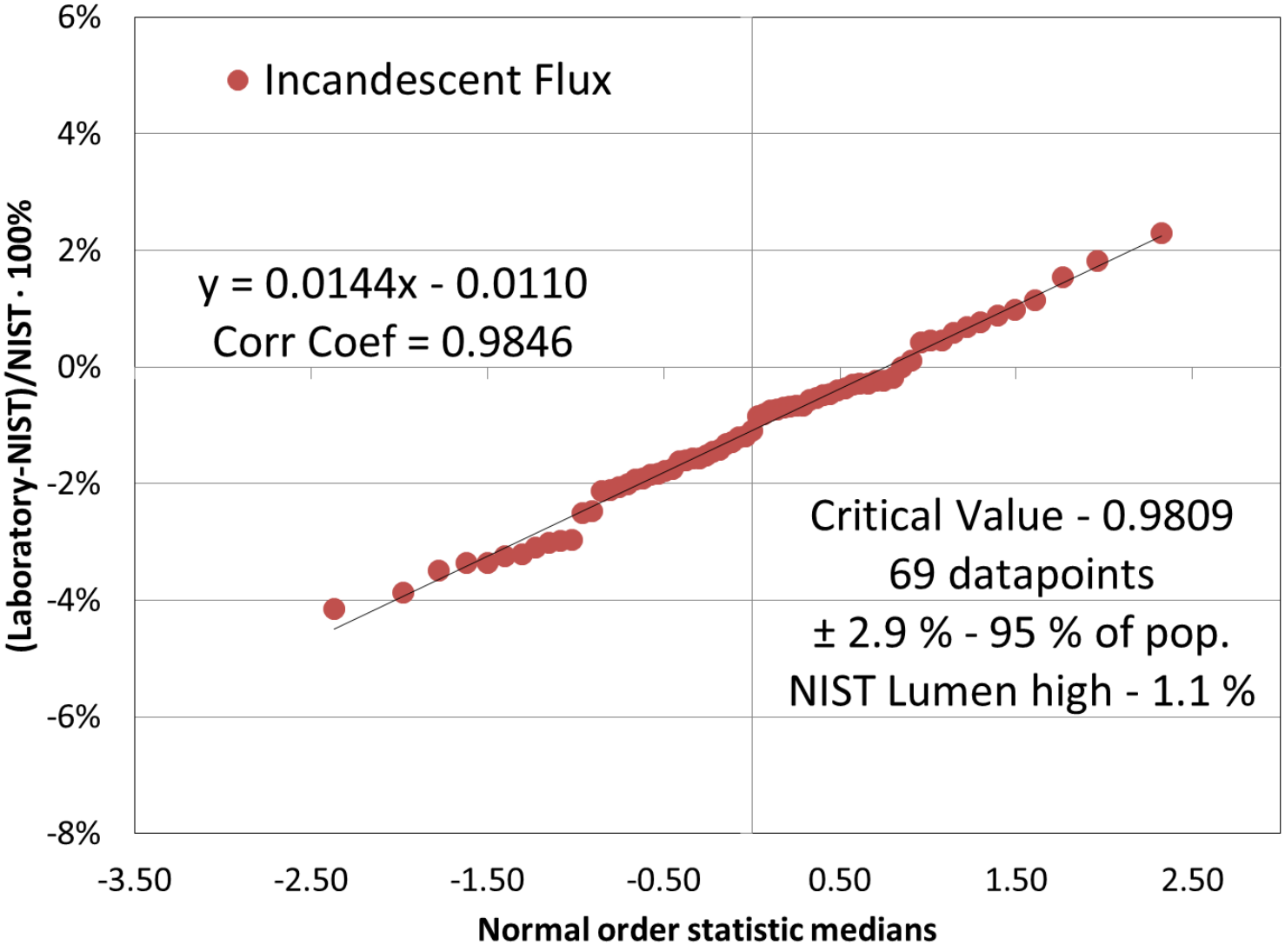
All Lamps – Flux - NIST



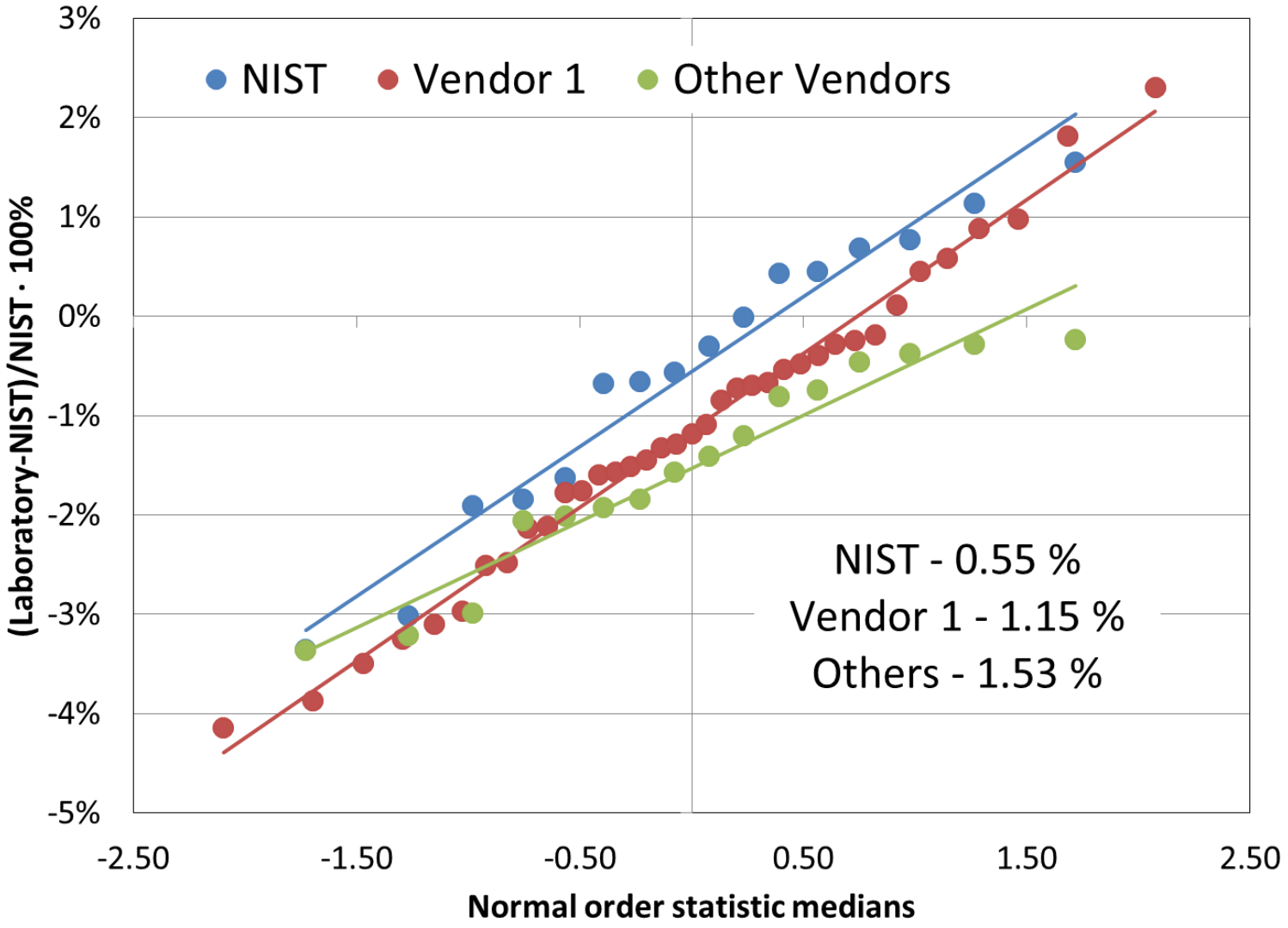
All Lamps – Flux – Other NMI



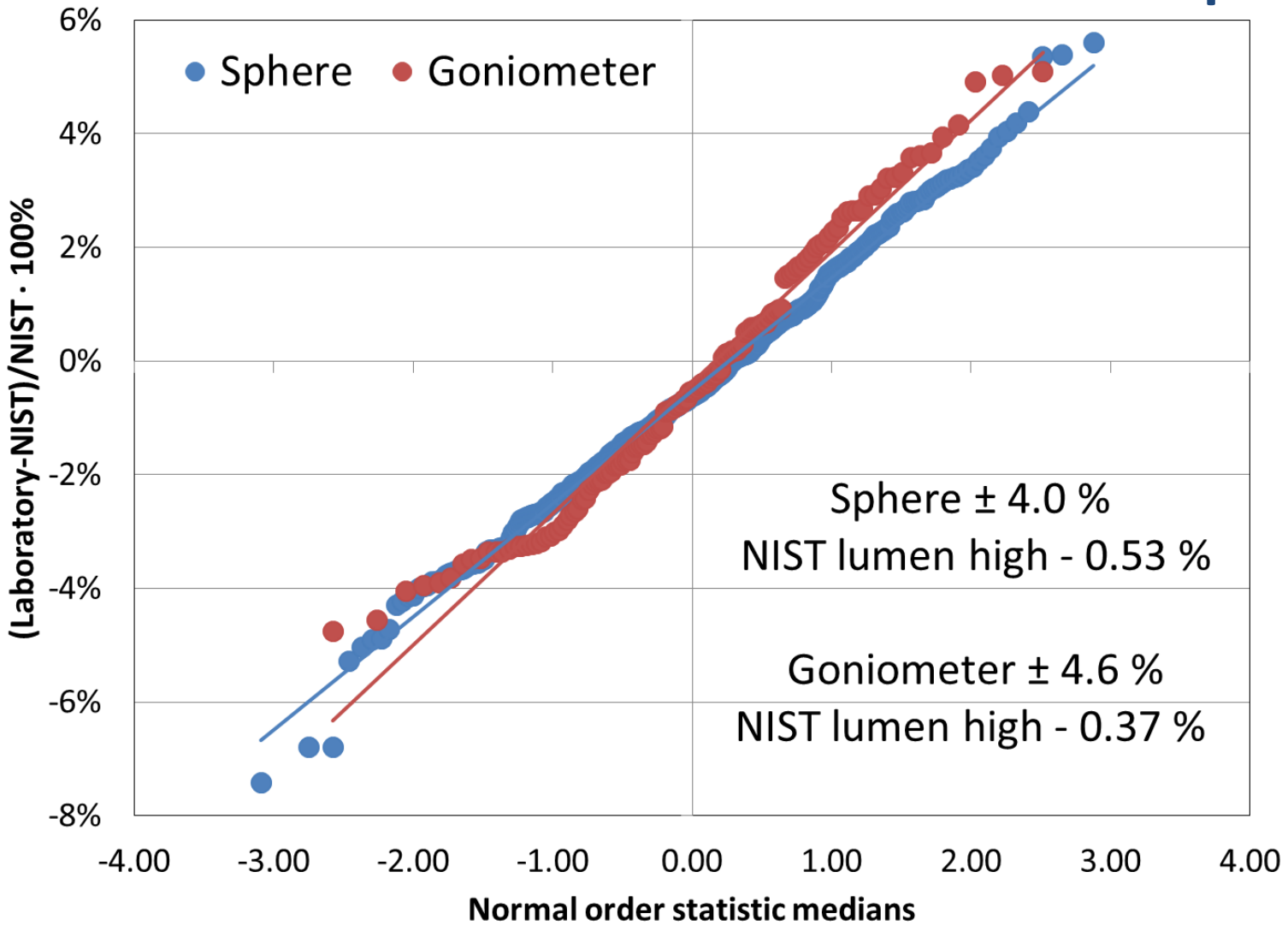
Incandescent – Flux – NIST



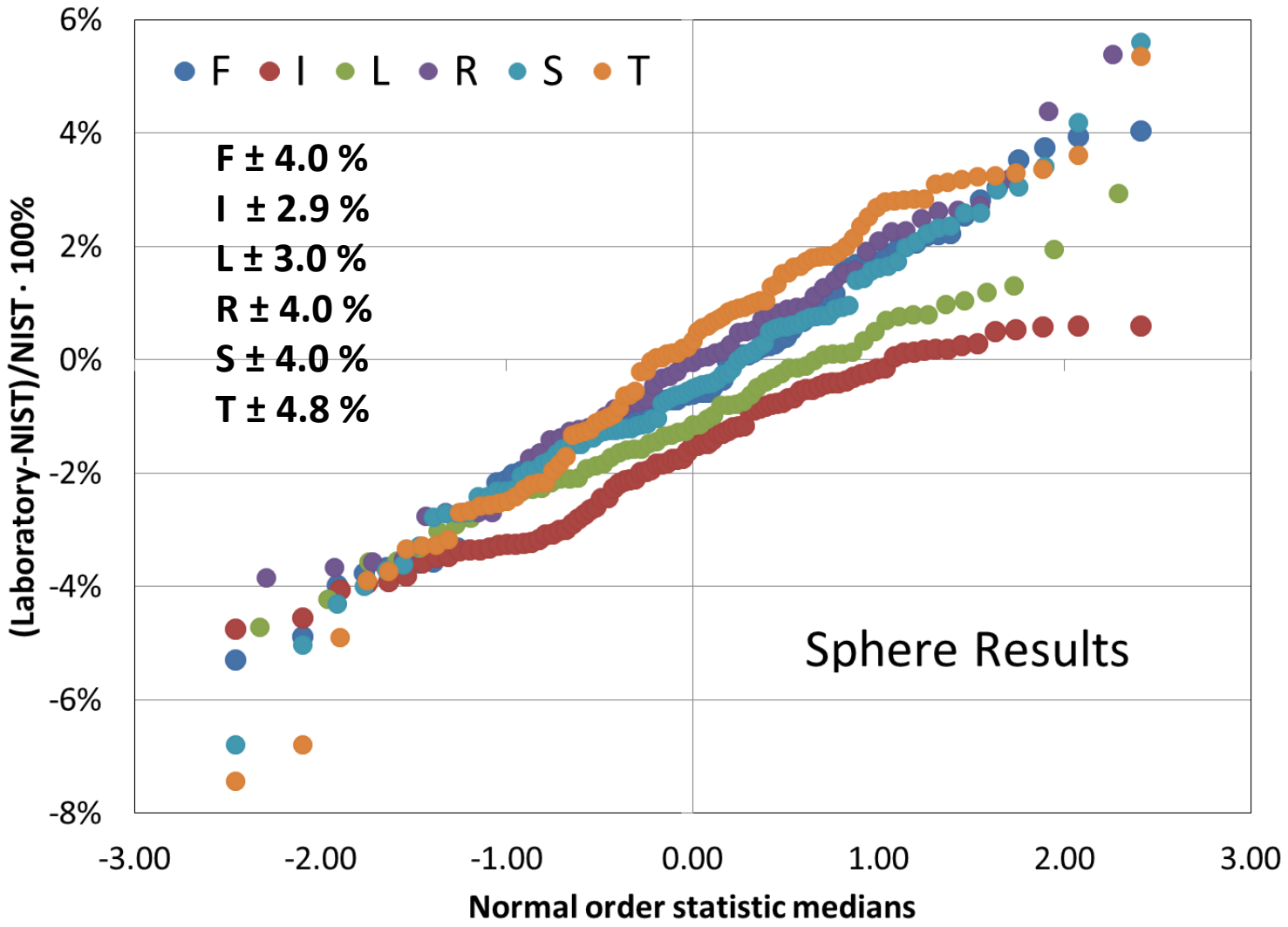
Incandescent – Flux – Vendors



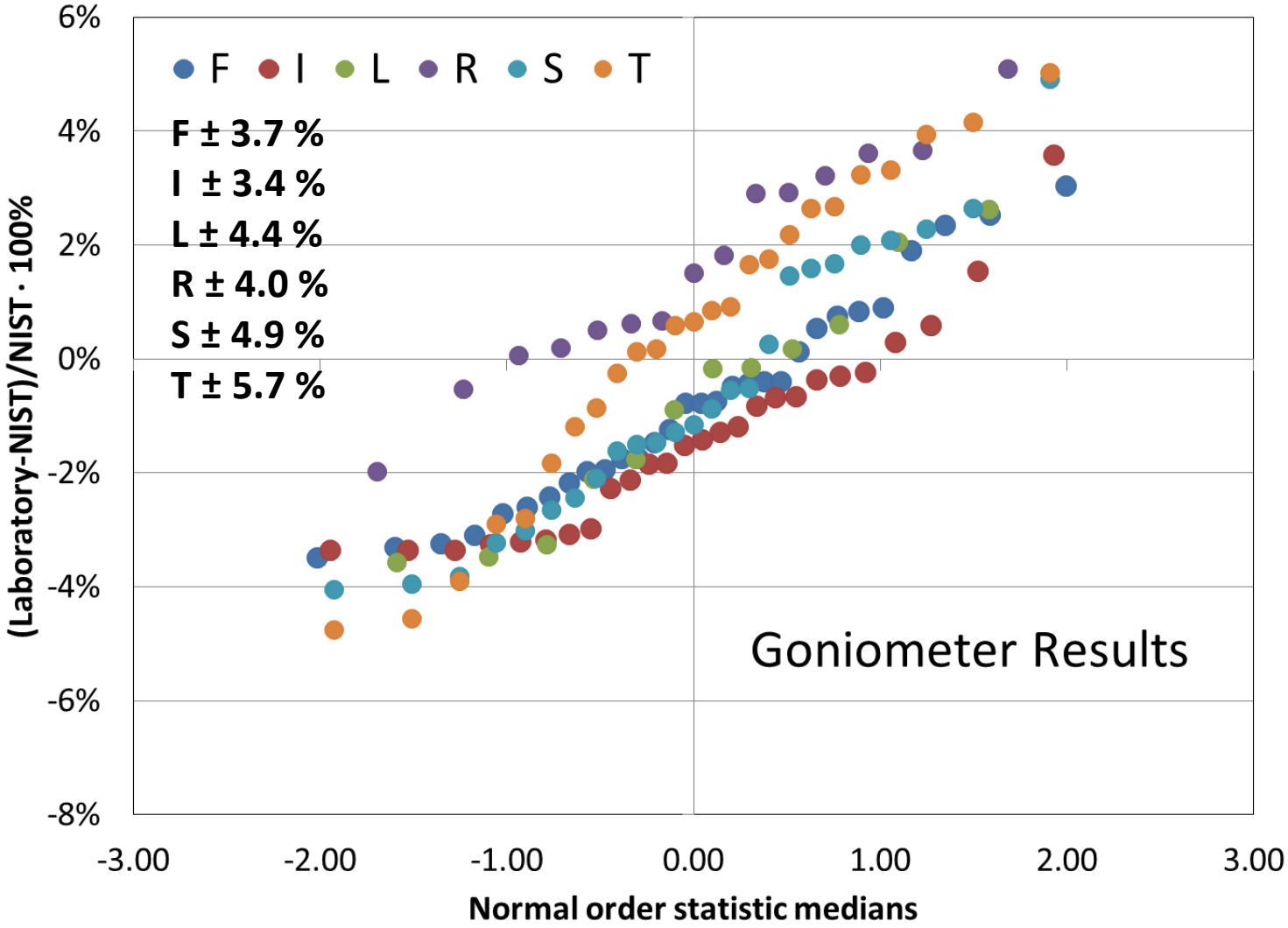
Sphere vs Goniometer – All lamps



Sphere – Lamp Types



Goniometer – Lamp Types



Metadata Collected

Sphere – Manufacturer
Sphere - Size
Goniometer – Manufacturer
Goniometer - Size
Power Supply – Manufacturer
Power Analyzer – Manufacturer
Calibration Lamp – Vendor
Calibration Lamp – Traceability
Calibration Lamp – Flux level
Calibration Lamp – Date
Detector – Type (photometer, spectrometer)
Test Date

Calibration Lamp - Hours

SSL-MAP Summary

- One out of six laboratories - additional measurements
  - All six lamps were out of tolerance – scale bias
  - Single lamp was out of tolerance – particular issue
  - Current measurements are challenging
    - Power analyzer filter settings
    - Power analyzer sampling rate
    - System impedance differences
  - 4-pole socket issues
  - Spectrometer capabilities and calibration concerns
- All the results are within +/- 4 % for luminous flux
- Potential 1.0 % bias with another NMI

SSL MAP 2.0 - Artifacts

- New version (2.0) released Jan 1st 2015
- Mandatory lamps

120 V AC

120 V AC

120 V AC

12 V AC
12 V DC

120 V AC

- Non-mandatory lamps

12 V AC
12 V DC
4.2 A

120 V AC

Option
120 V AC

Thank you

Questions?