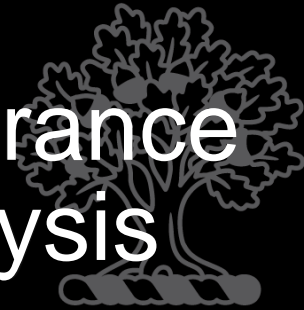


The Science of Quality Assurance Indicators & Technique Analysis



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Radiation Oncology
UNIVERSITY OF TORONTO



What is research?

Definition of Research
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Research Basics
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- 1 Research Basics
- 2 What is Research?
- 3 Steps of the Scientific Method
- 4 What is the Scientific Method?
- 5 Purpose of Research

Browse Full Outline

- 1 Research Basics
- 2 Concepts
- 3 Definitions
- 3.1 Definition of Research
- 3.2 Definition of the Scientific Method

In the broadest sense of the word, the definition of research includes any gathering of data, information and facts for the advancement of knowledge.

Reading a factual book of any sort is a kind of *research*. Surfing the internet or watching the news is also a type of *research*.

Science does not use this word in the same way, preferring to restrict it to certain narrowly defined areas. The word 'review' is more often used to describe the learning process which is one of the underlying tenets of the rigid structures defining scientific research.

SPSS Statistical

Google definition of research

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re·search
/rē sərCH,rə sərCH/ ⓘ

noun

- 1 the systematic investigation into and study of materials and sources in order to establish facts and reach new conclusions
"we are fighting meningitis by raising money for medical research"
synonyms: investigation, experimentation, testing, analysis, fact-finding, fieldwork, examination, scrutiny More

verb

- 1 investigate systematically.
"she has spent the last five years researching her people's history"
synonyms: investigate, study, inquire into, look into, probe, explore, analyze, examine, scrutinize, review More

Translations, word origin, and more definitions

Definition of Research - How is Research Defined?

Oxford Dictionaries Language matters

English

research Dictionary Synonyms Grammar Explore

HOME > BRITISH & WORLD ENGLISH > RESEARCH

research

See definition in Oxford Advanced Learner's Dictionary

★ Top 1000 frequently used words

Line breaks: re|search

Pronunciation: /rɪ'sɜːtʃ/ ⓘ /rɪ'səːtʃ/ ⓘ

Definition of *research* in English: the noun

MASS NOUN (also researches)

- 1 The systematic investigation into and study of materials and sources in order to establish facts and reach new conclusions: 'the group carries out research in geochemistry' 'medical research' 'he prefaced his study with a useful research'

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research SEARCH Get our fr

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Dictionary

research

SAVE POPULARITY

noun | re-search | 'rɪ-'sɜrch, 'rē-,

careful study that is done to find and report new knowledge about something

the activity of getting information about a subject

Word of the Day: futile completely i

Get the Word: Your ema

Words at

Quality Improvement vs. Research

The screenshot shows a web browser window with the following content:

- Page Title:** What is Quality Improvement?
- Header:** QI PATIENT SAFETY - QUALITY IMPROVEMENT | What is Quality Improvement?
- Navigation:** INDEX, PREVIOUS, NEXT
- Department:** Department of Community and Family Medicine, DUKE UNIVERSITY MEDICAL CENTER
- Section: Research**

The distinction between QI and research is an important one. There is a spectrum, and it can be blurry sometimes, but there are some key points (with legal implications!).
- Section: QI:**
 1. Intent is to improve current practice. For internal use only.
 2. By definition, the data is confidential.
 3. Action is within existing standards of care.
 4. Institutional Review Board (IRB) approval is not necessary.
- Section: Research:**
 1. Intended to create generalized knowledge.
 2. Desire to publish or present.
 3. Testing new methods.
 4. **Needs IRB approval!**
(Click here to go to the Duke IRB website for more information)
- Left Sidebar (Table of Contents):**
 - Overview
 - Introduction
 - Measurement: Process and Outcome Indicators
 - Methods of Quality Improvement
 - Things Quality Improvement is NOT
 - Performance Improvement
 - Research
 - Summative Experience
 - Summary

Quality Improvement vs. Research

Quality Improvements

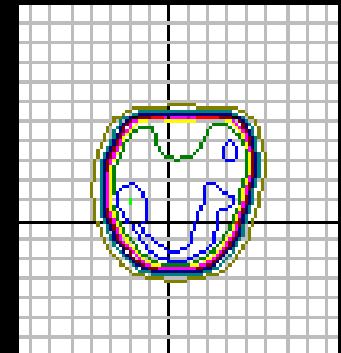
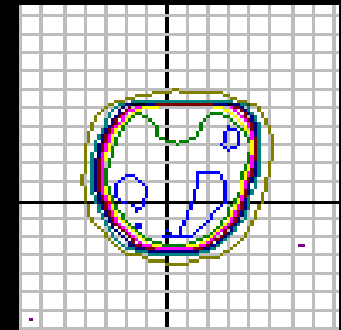
- Intent is to ***improve current practice***. For internal use only.
- Action is ***within existing standards of care***.
 - The knowledge is the same, but we can apply it in a better manner.

Research

- Intended to create ***generalized knowledge***.
- Desire to publish or present.
 - Data must be relevant *outside the institution*.
- Testing new methods.
 - *Perhaps new standards of care?*

What is Patient Specific QA?

- Fundamentally, this is a beam diagnosis test.
- The purpose is to identify radiation beams that are “different” than the planned radiation beam.
- Most methods used to evaluate the result are physics & clinically based:
 - Dose & distance to agreement
 - Plan objectives, DVH, etc
- Are the usual metrics *generalizable*?



Dosimetry vs. Imaging

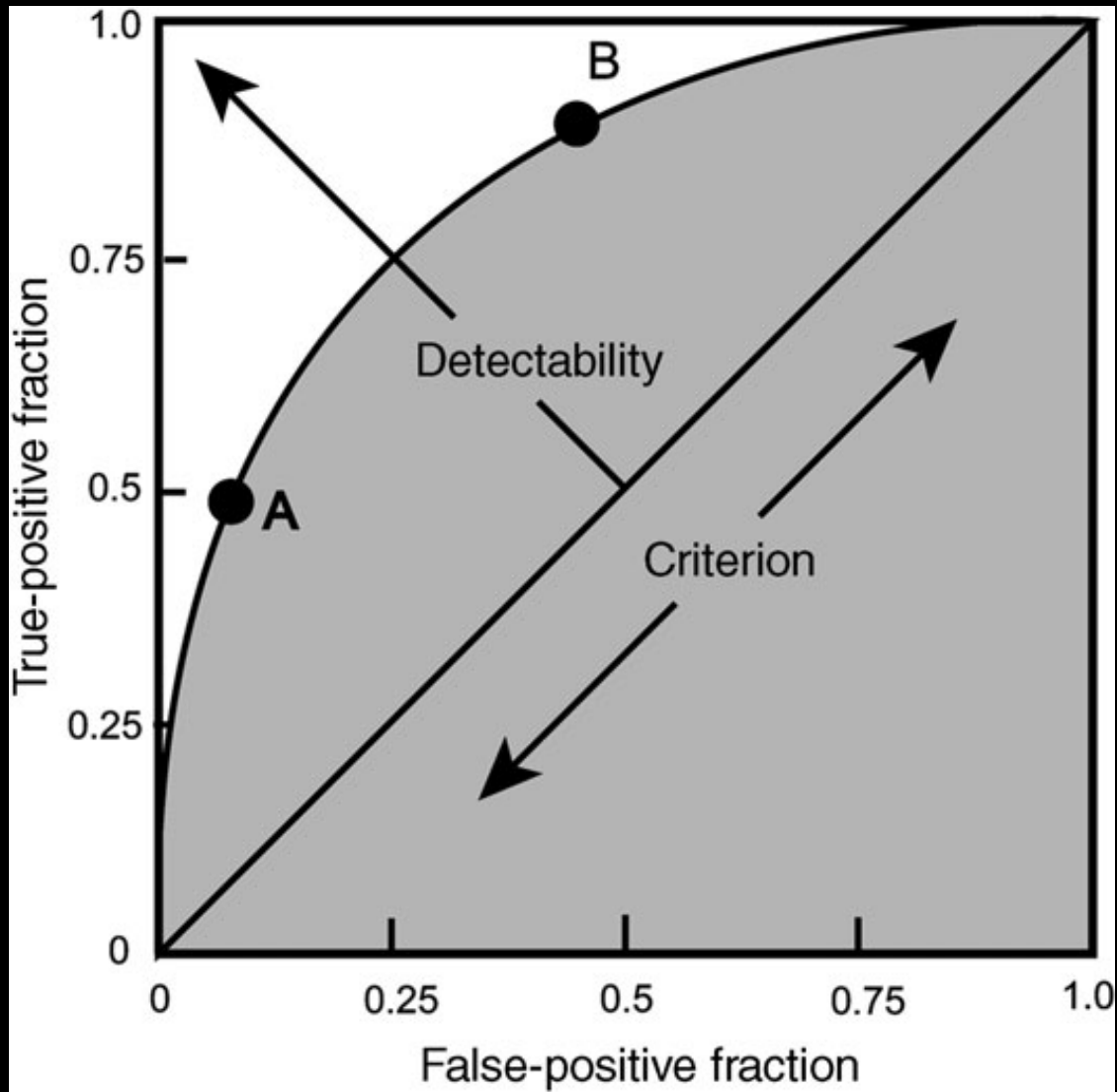
- **Patient specific QA has been viewed as a dosimetry problem.**
- **From dose point of view:**
 - **How different is the measured dose from the planned dose?**
 - **Detectors, spatial resolution, etc.**
- **From image analysis point of view:**
 - **Is the measured beam fluence abnormal?**

From a statistics point of view

- **Statistical tools exist to measure how different two (1-dimensional) distributions are.**
- **Extended to 2-dimensions, this problem becomes very difficult to solve explicitly.**
- **Measures of dose difference at a point and distance to agreement:**
 - indicate conformance,
 - difficult to generalize

Decision Theory

- **The ROC Decision model**
 - Receiver Operator Curve (ROC) is a plot of performance of a binary classifier system.
- **Graphical tool allows quantification of best cut-off point.**
- **Also offers insight into where gains in sensitivity and specificity can be obtained.**



Generalizing IMRT QA results

- **Evidence that IMRT/VMAT QA results don't translate well center to center.**
- **Letourneau, McNiven & Jaffray (IJROBP 2013)**
 - **Multi-institutional evaluation of IMRT/VMAT QA.**
 - **Results depend on the performance of many variables.**
 - **Variables interact with each other in ways that can be non-intuitive.**
- **Different centers may report IMRT/VMAT QA results that are similar, but the performance of their systems may be different.**
 - **Leaf calibrations, beam models, etc.**

ROC analysis in patient specific quality assurance

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Miller MacPherson

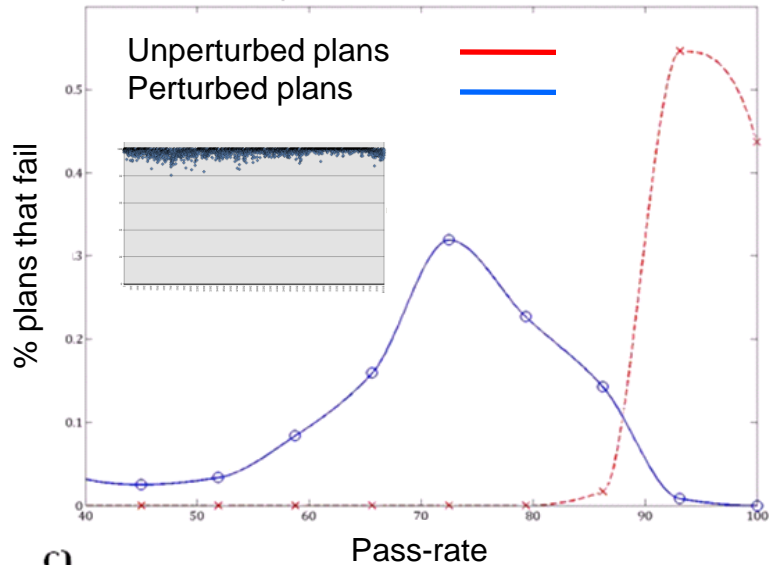
Department of Medical Physics, Trillium Health Partners, Mississauga, Ontario L5M 2N1, Canada; Radiation Medicine Program, Princess Margaret Cancer Centre, Toronto, Ontario M5G 2M9, Canada; and Department of Radiation Oncology, University of Toronto, Toronto, Ontario M5S 3S2, Canada

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- **34 patients (single phase prostate cases)**
- **Half delivered normally.**
- **Other half delivered with known MLC errors**
 - 1 mm, 2 mm, 3 mm
- **Assume that the unperturbed delivery was “true” fluence pattern.**
- **Depending on passing criterion, measure rates of TP, TN, FP, FN.**

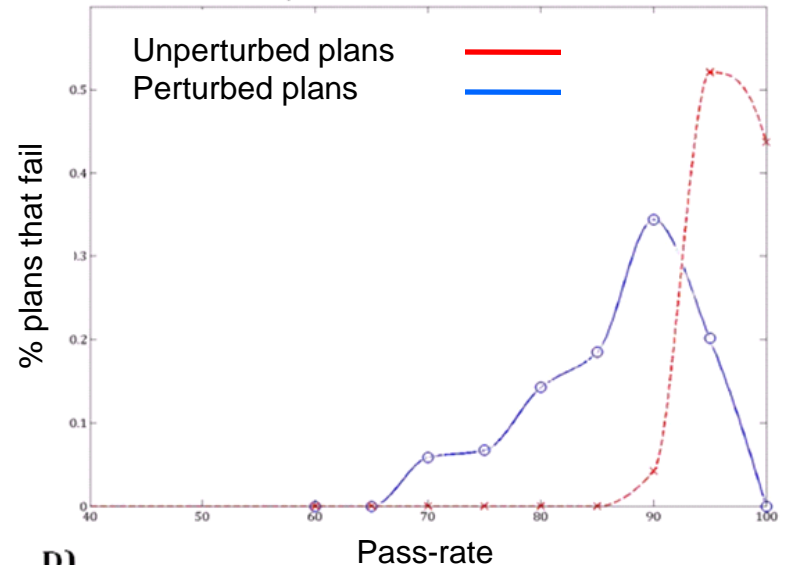
A)

3%/3mm % Pass for $\langle\sigma\rangle=3.13$ mm



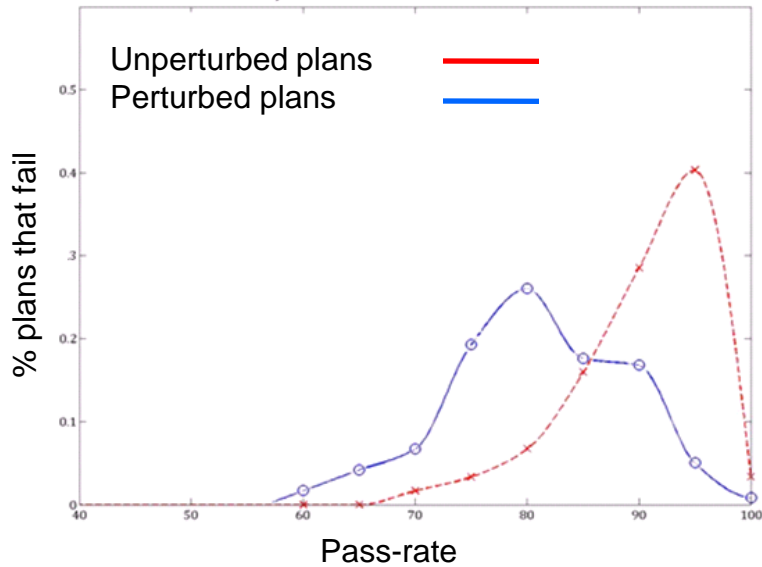
B)

3%/3mm % Pass for $\langle\sigma\rangle=2.12$ mm



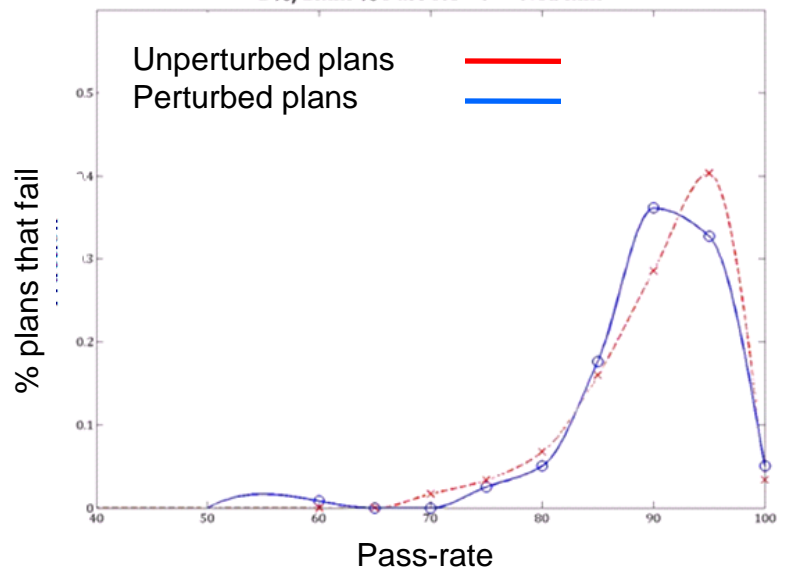
C)

2%/2mm % Pass for $\langle\sigma\rangle=1.28$ mm

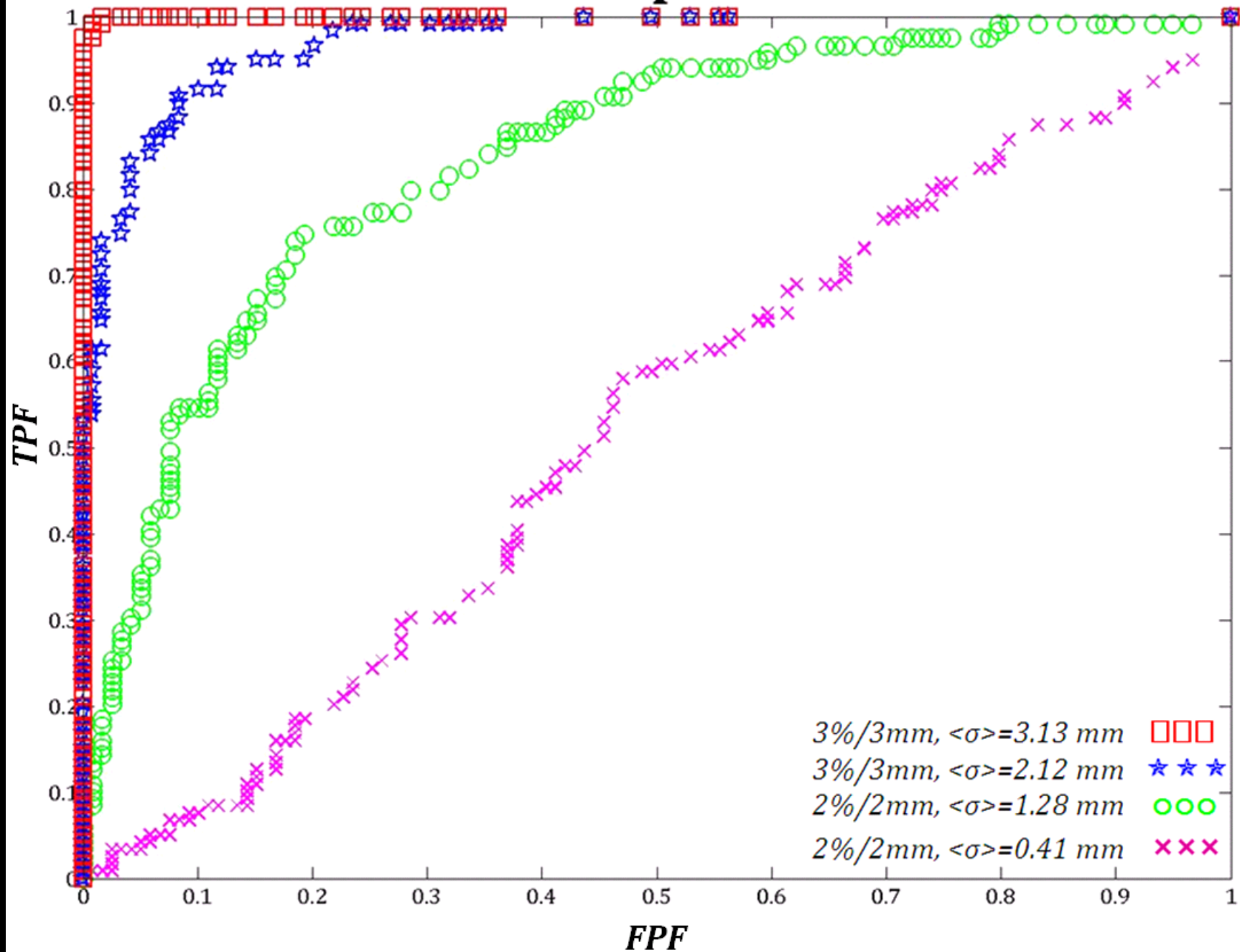


D)

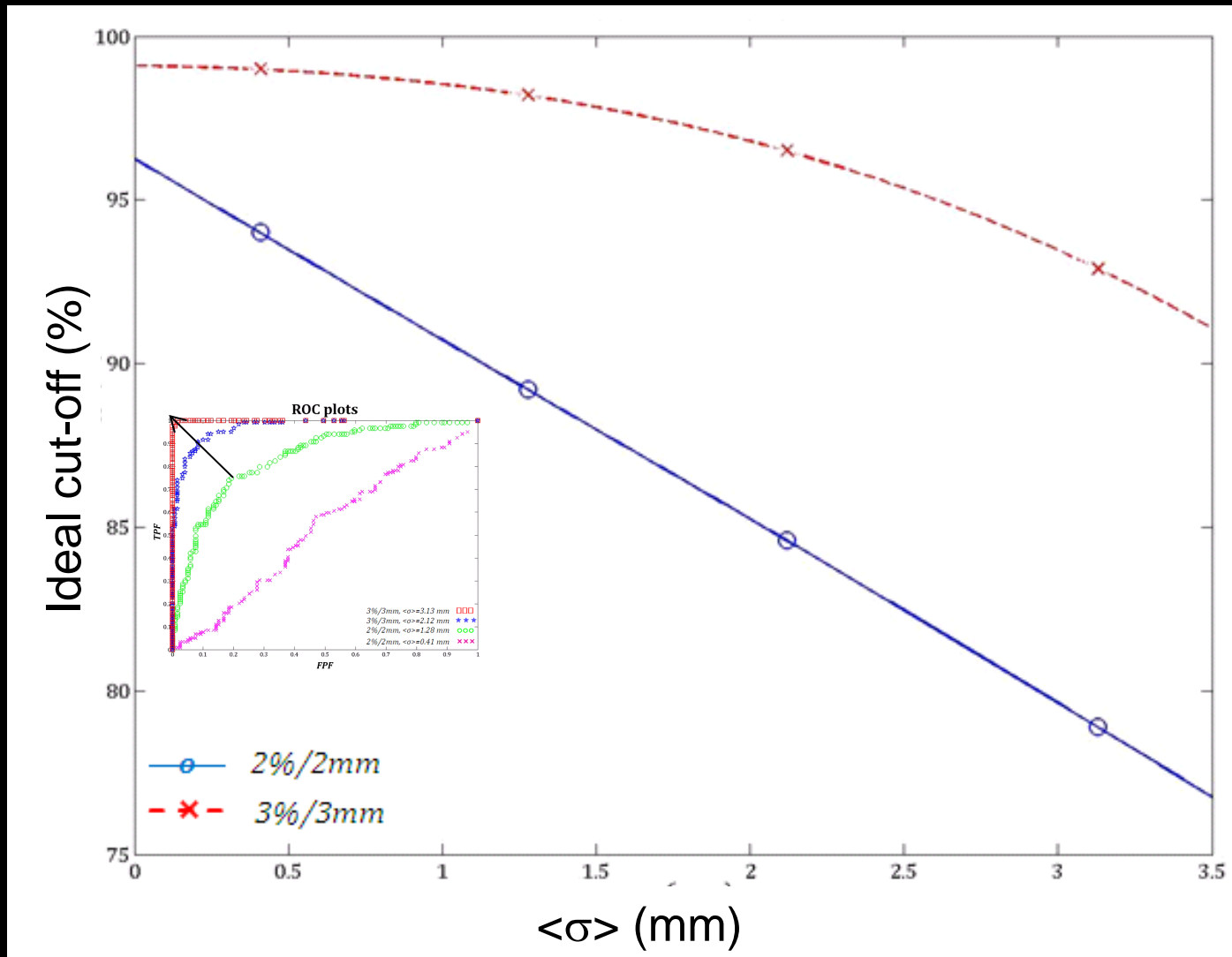
2%/2mm % Pass for $\langle\sigma\rangle=0.41$ mm



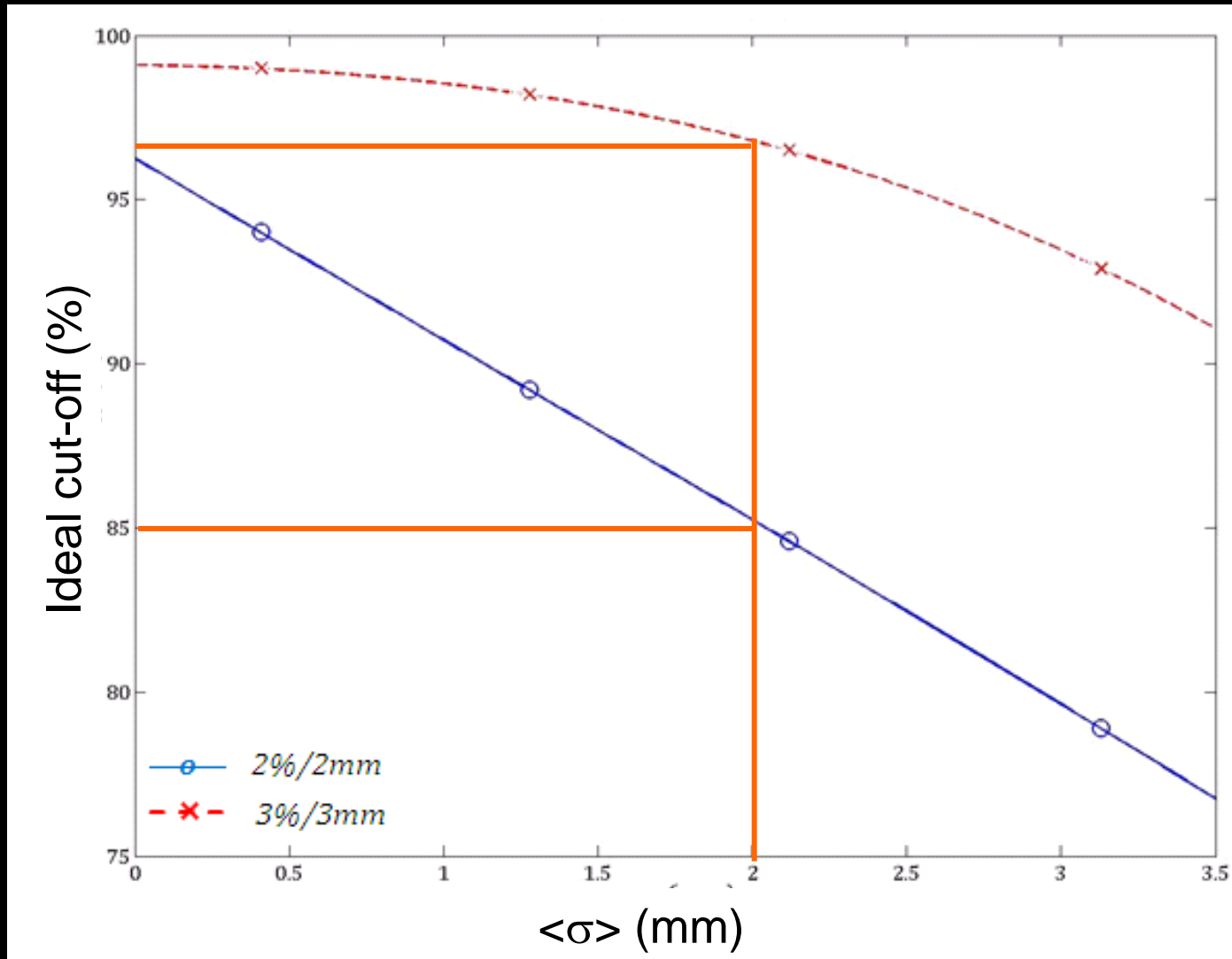
ROC plots



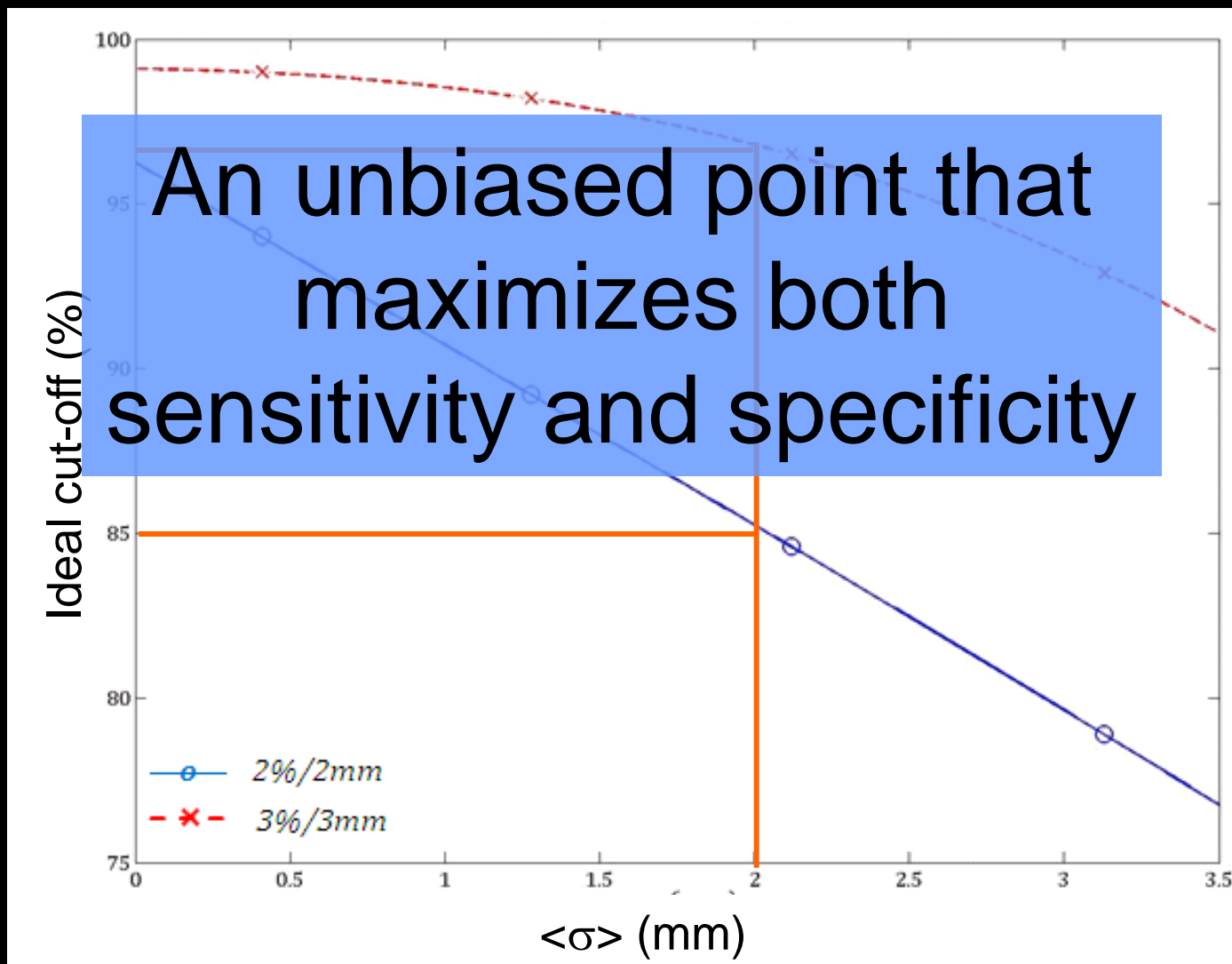
Setting the detector's operating point



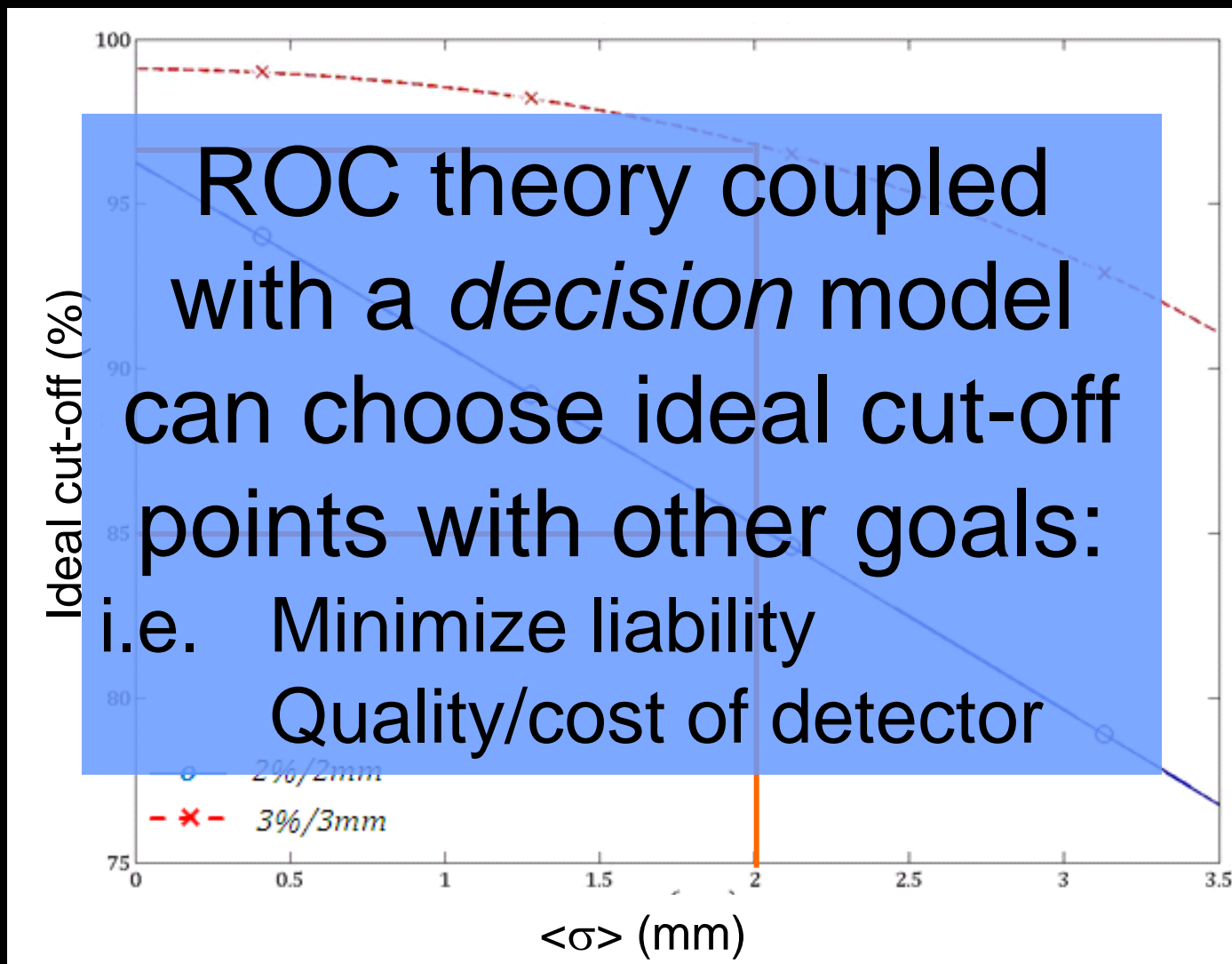
Setting the detector's operating point

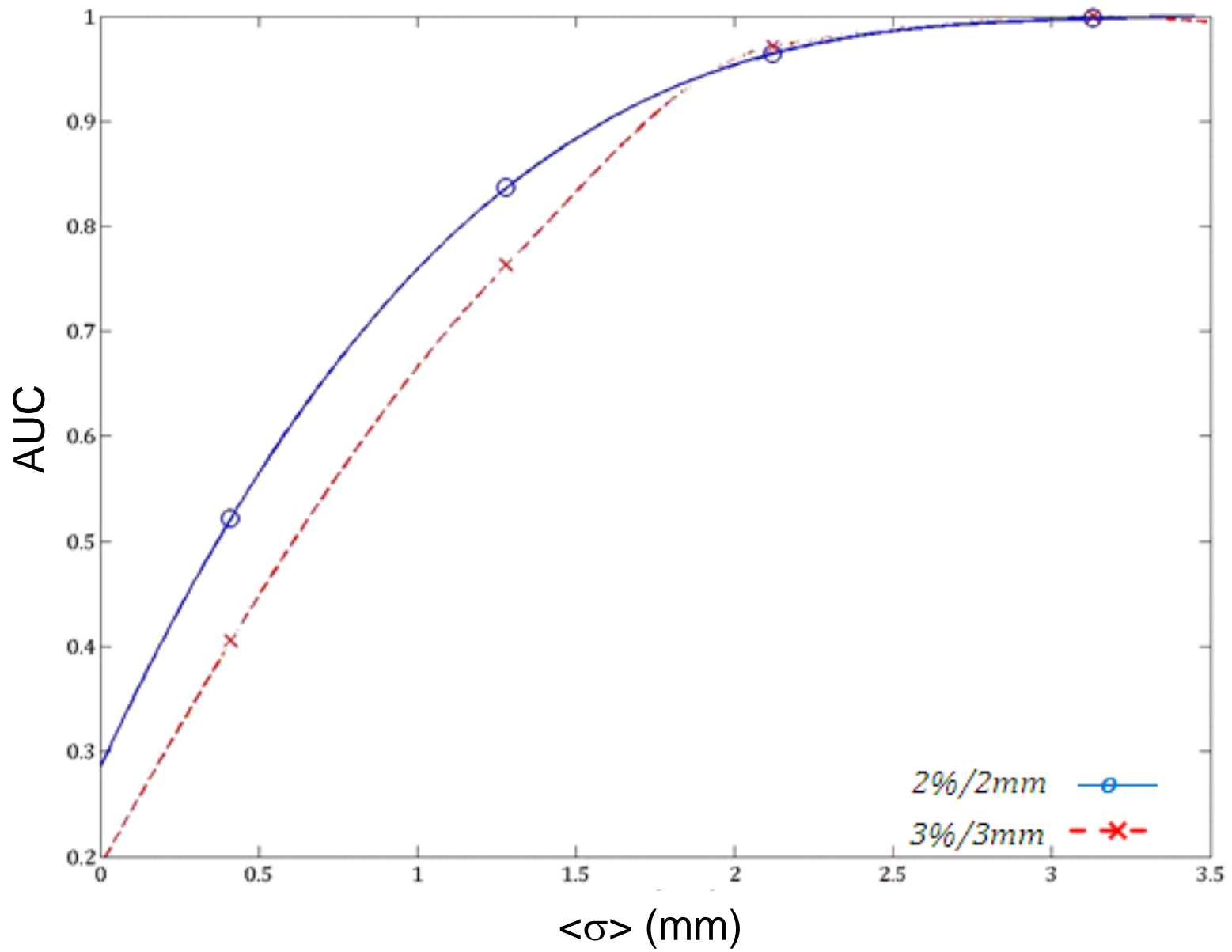


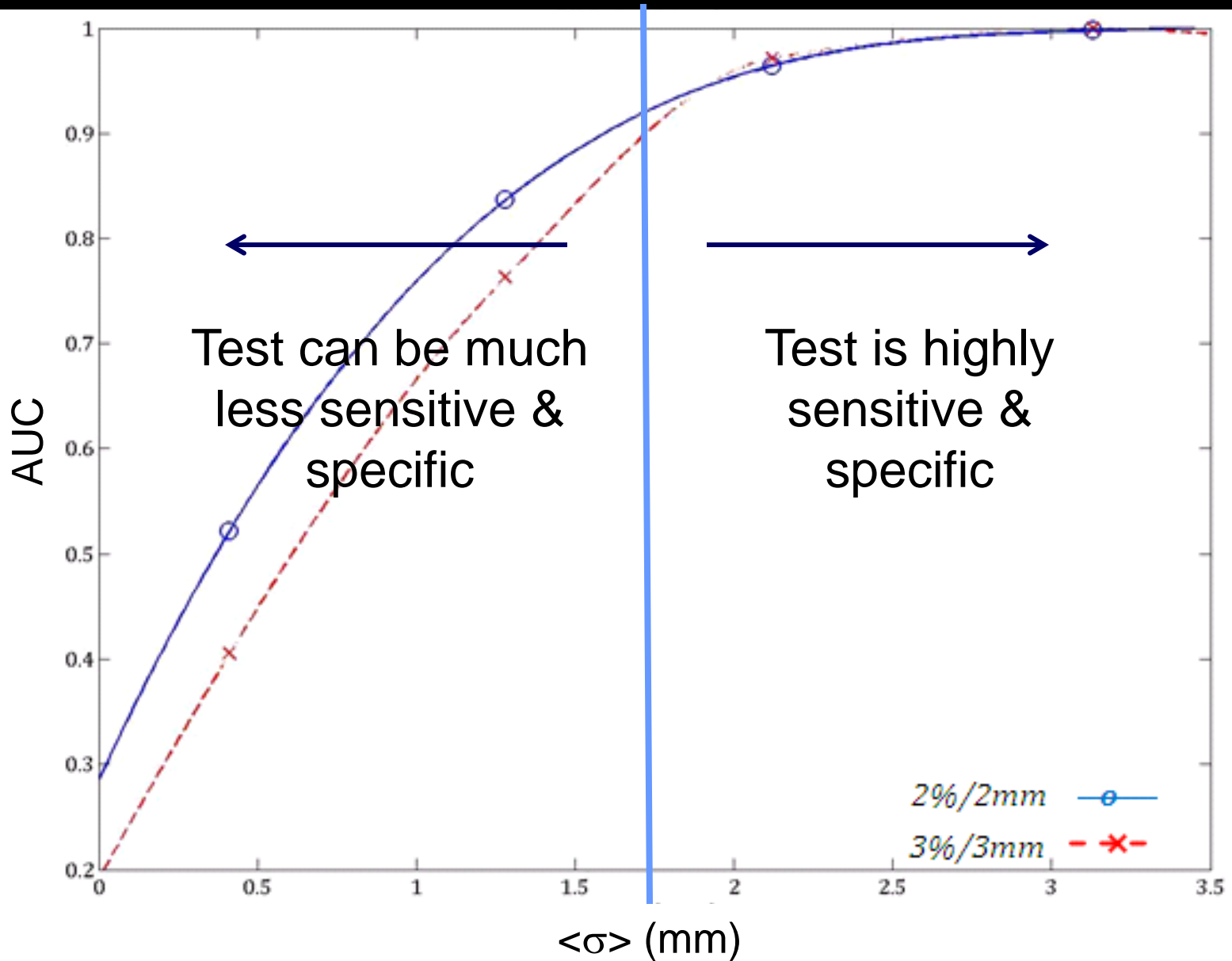
Setting the detector's operating point

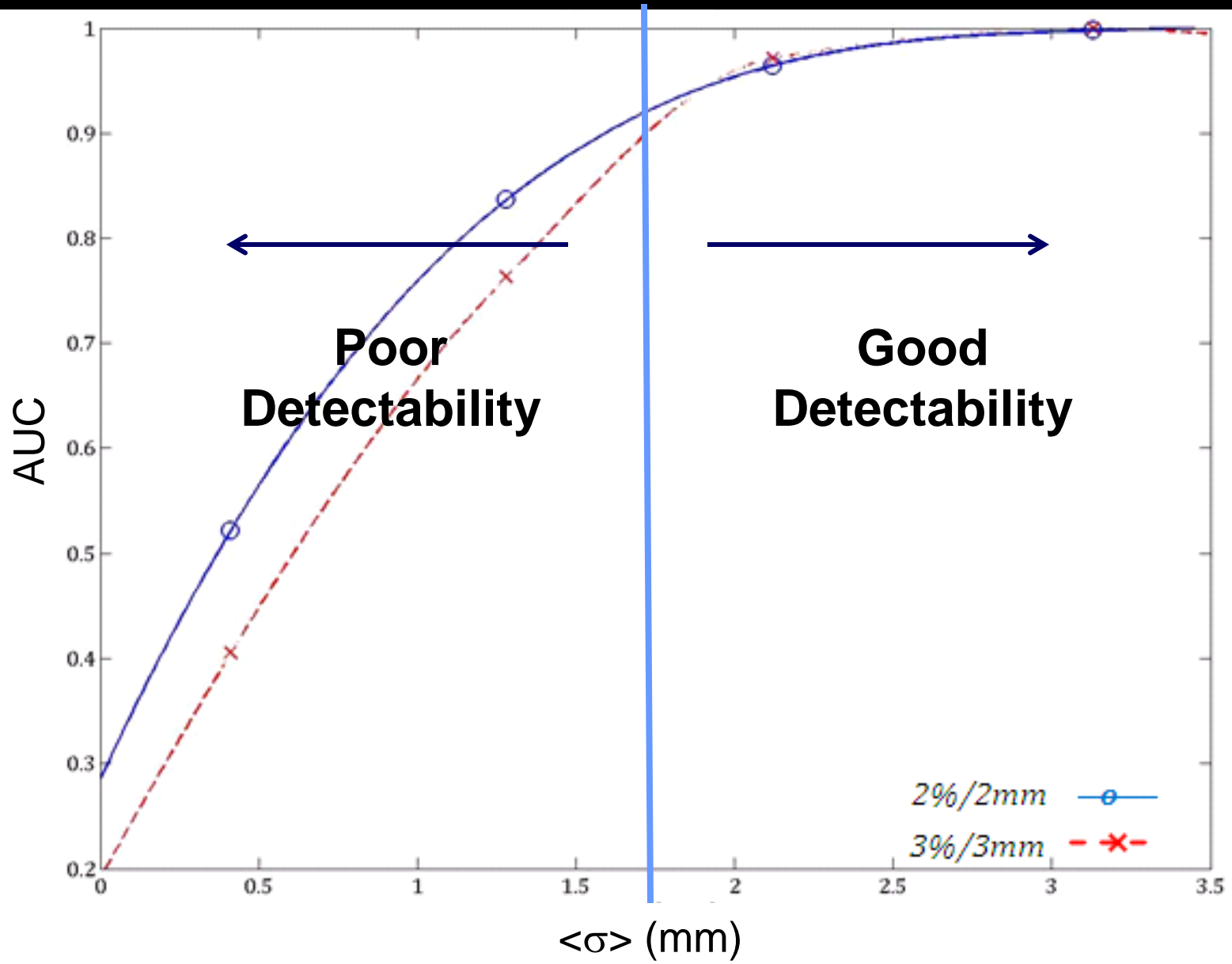


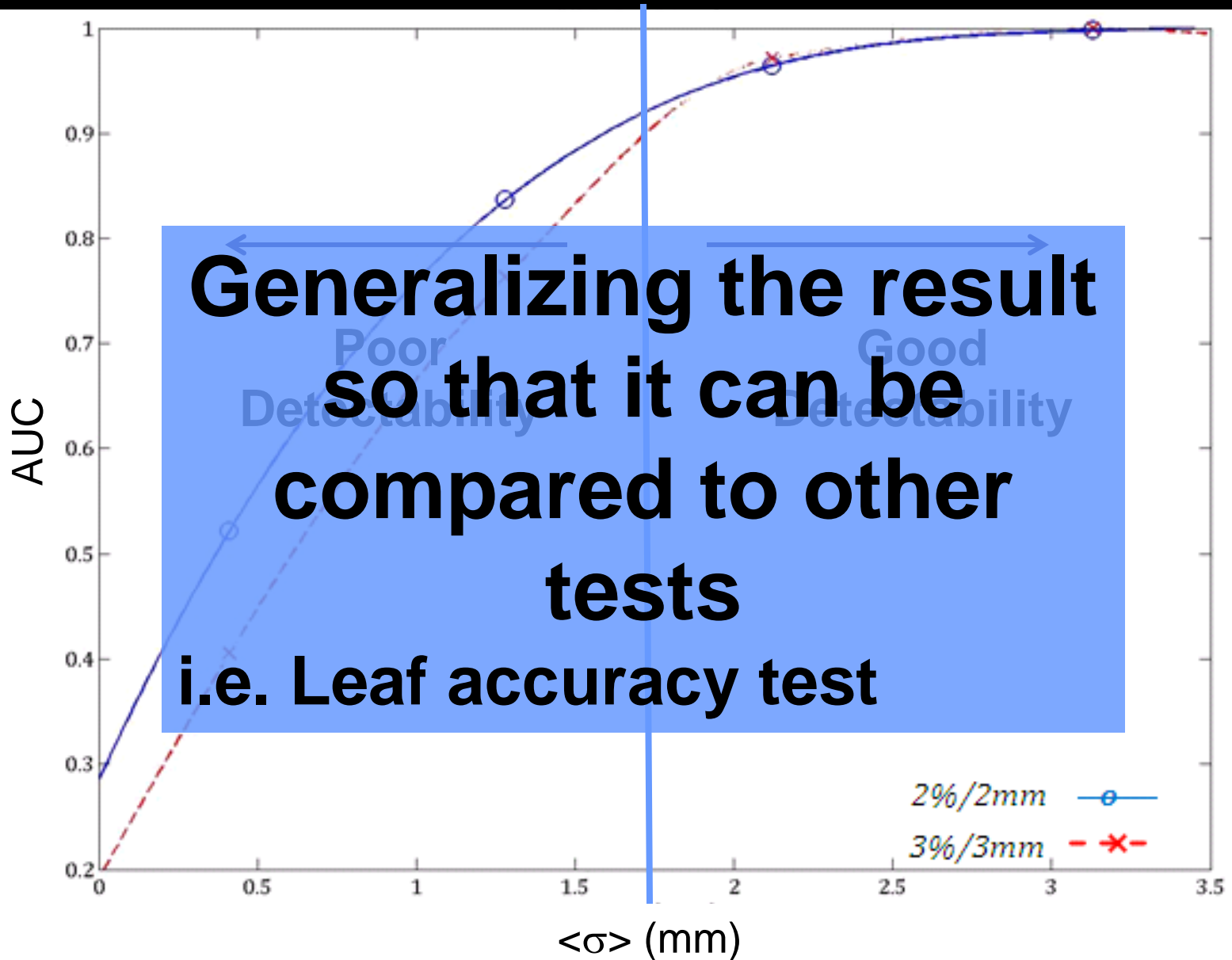
Setting the detector's operating point











The problem with γ

- **“Gamma” is not a physical measurement, nor does it have statistical meaning.**
- **It has local significance, but it is difficult to interpret in a broad, multi-institution sense.**
- **It’s interpretation will always be controversial.**

Summary

- **QA activities are meant to help a specific local problem.**
- **Local problems are often relevant with a ‘narrow’ set of constraining factors.**
- **For the knowledge gained from these activities to be helpful in a broad sense, efforts can be made to choose metrics that have a generalized context.**
- **In the example of patient specific QA, thinking of the problem from a ‘detectability’ point of view led to quantification of some parameter thresholds that may be helpful in more general problem solving.**