



# Face and Iris Evaluation Activities at NIST

Dr. P. Jonathon Phillips - NIST

3 May 2006
CardTechSecurTech 2006

# FRGC, FRVT 2006 & ICE Sponsors

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# FRGC and ICE Team


- **Program Manager for FRGC and ICE**
  - **P. Jonathon Phillips — *NIST***
- **Evaluation Team**
  - **Todd Scruggs — *SAIC***
  - **Matt Sharpe — *SAIC***
  - **William Worek — *SIAC***
  - **Kevin Bowyer — *University of Notre Dame***
  - **Patrick Flynn — *University of Notre Dame***
  - **Ross Beveridge — *Colorado State University***
  - **Alice O'Toole — *University of Texas at Dallas***
- **FRGC and ICE Liaison**
  - **Cathy Schott — *Schafer Corp***

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# Outline

- Face Recognition Grand Challenge (FRGC)

  http://face.nist.gov/frgc

- Status of the Face Recognition Vendor Test (FRVT) 2006

  http://face.nist.gov/frvt2006

- Comparison of Human and Computer Performance

  http://face.nist.gov/frgc

- Iris Challenge Evaluation (ICE) 2005 and 2006

  http://iris.nist.gov/ice


# Face Recognition Grand Challenge Overview

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# FRGC and FRVT 2006


- What is the difference between FRGC and FRVT 2006?
  - FRGC (May 2004 – March 2006)
    - Still and 3D face recognition algorithm development project
  - FRVT 2006 (30 January 2006)


    - Independent government evaluation of face recognition systems
    - Measure progress since FRVT 2002

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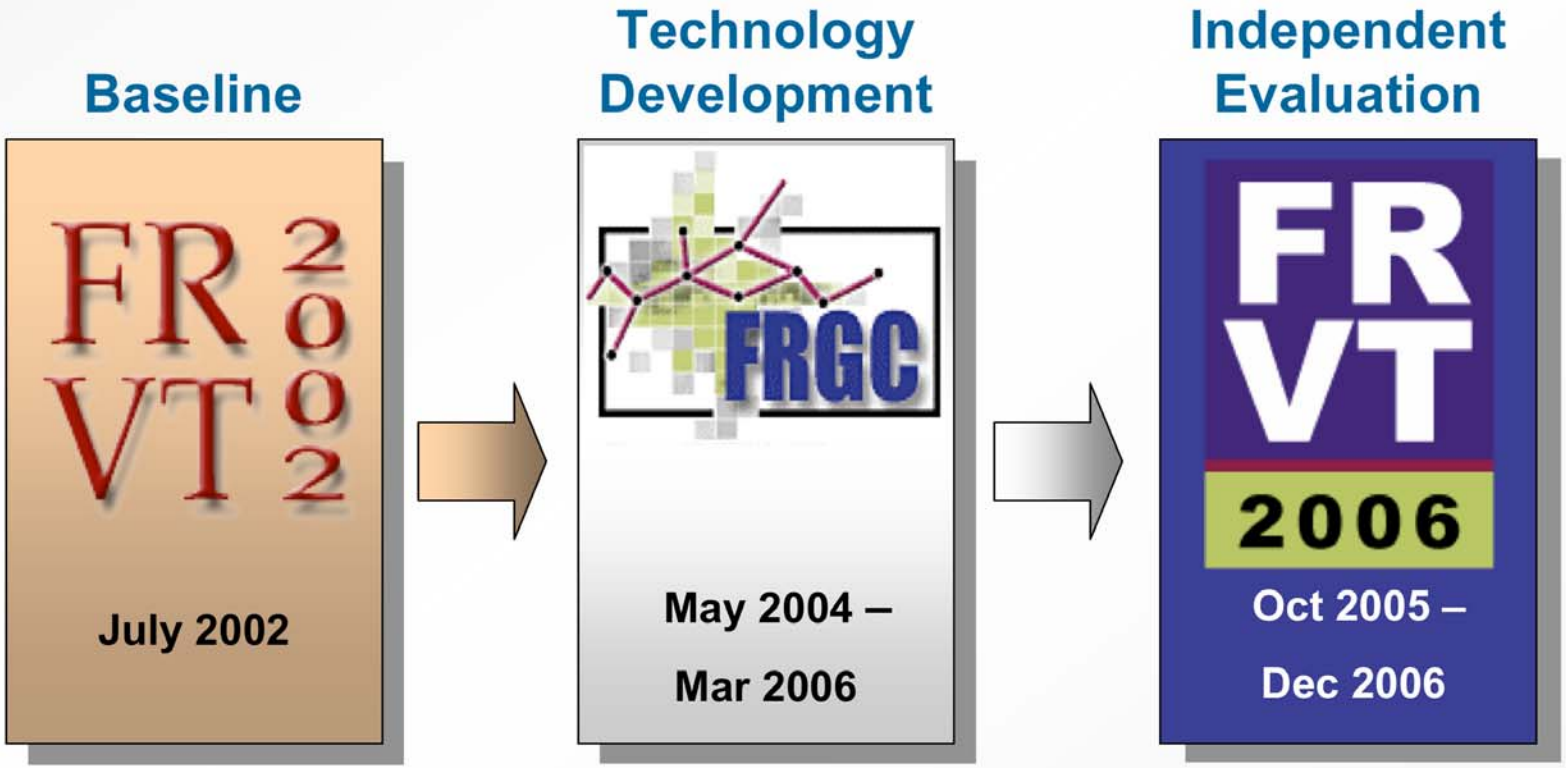
# FRGC Background

- Renewed interest in developing new methods for automatic face recognition
  - Fueled by advances in
    - Computer vision techniques
    - Computer design
    - Sensor design
    - Interest in fielding face recognition systems
- New techniques have potential to significantly reduce error rates

# Background


Baseline
FR 2002
VT 2002
July 2002
Technology Development
FRGC
May 2004 –
Mar 2006
Independent Evaluation
FRVT
2006
Oct 2005 –
Dec 2006

# FRGC Objective

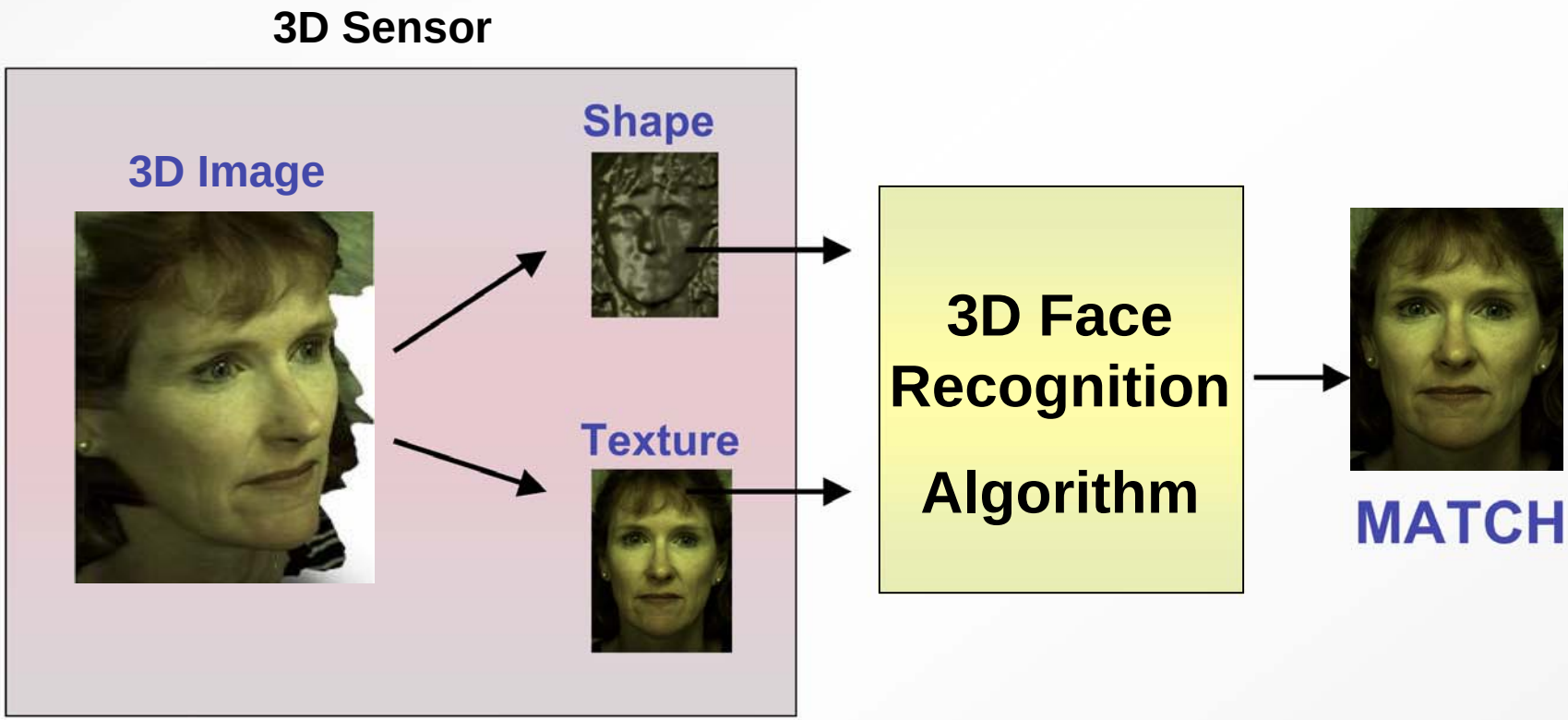

- The primary objective of the FRGC is to:

Develop still and 3D algorithms to improve performance an order of magnitude over FRVT 2002

# Select Point to Measure

- **Verification rate at :**
  - False accept rate = 0.1%
- **July 2002:**
  - 20% error rate (80% verification rate)
- **Goal:**
  - 2% error rate (98% verification rate)

# 3D Images

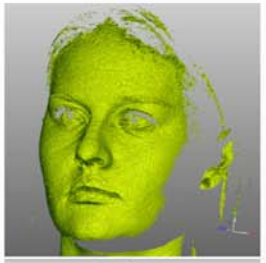

3D Sensor
3D Image
Shape
Texture
3D Face Recognition Algorithm
MATCH

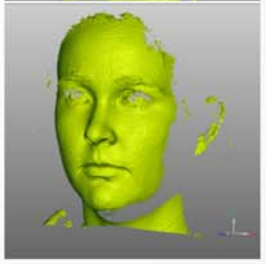
# FRGC Modes Examined

Single Still

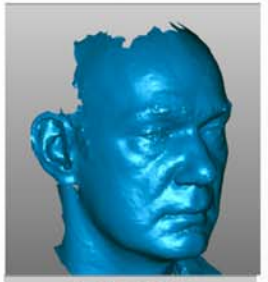
Outdoor/
Uncontrolled

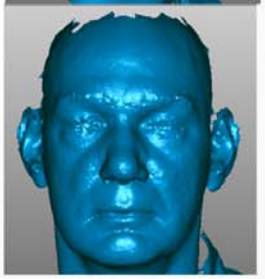
Multiple Stills





3D Single
view





3D Full Face

# FRGC Experiments

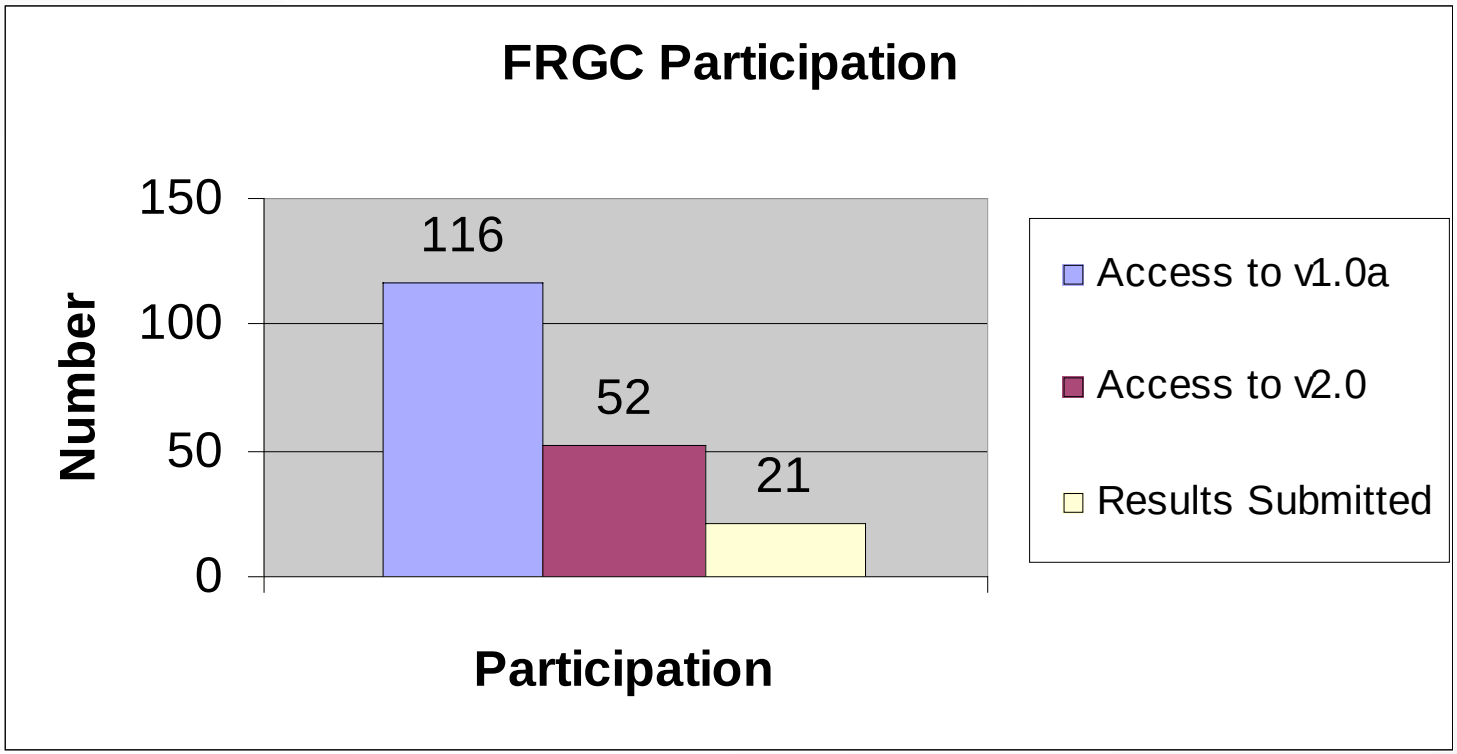
Exp 1: Controlled indoor still versus indoor still

Exp 2: Multiple still versus multiple still

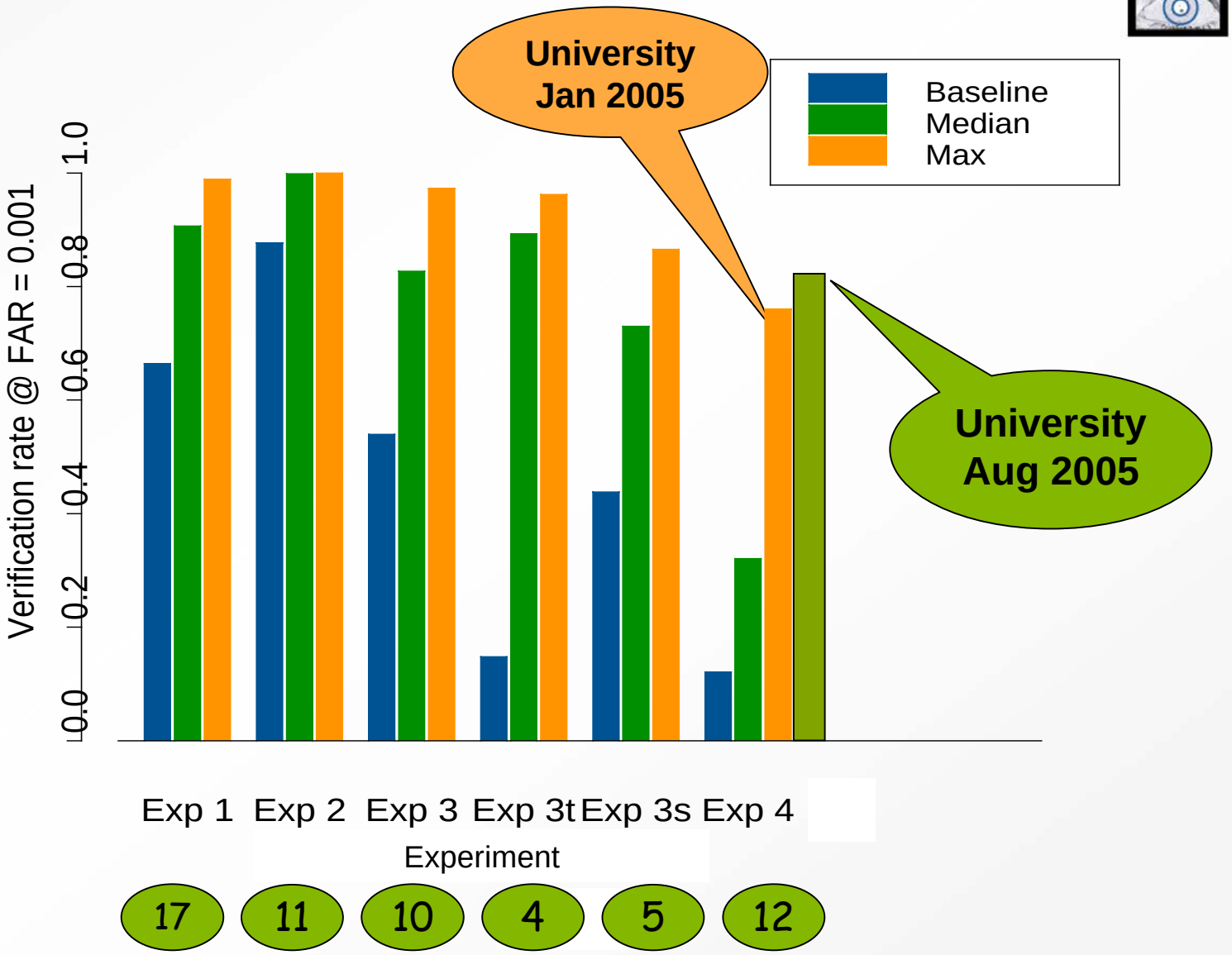
Exp 3: 3d versus 3D
3t - Texture only
3s - Shape only


Exp 4: Uncontrolled still versus indoor still

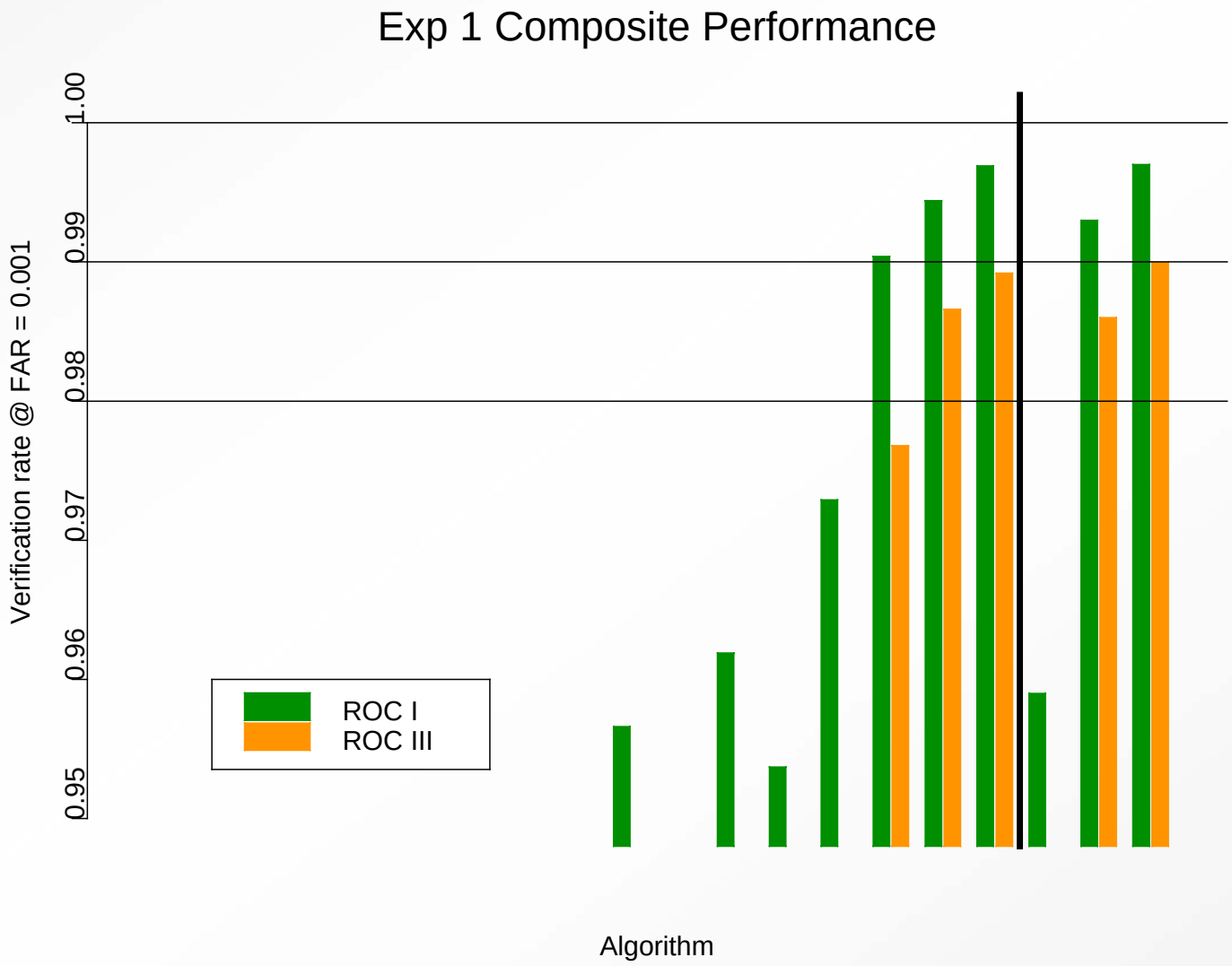
# FRGC Participation



# FRGC Progress



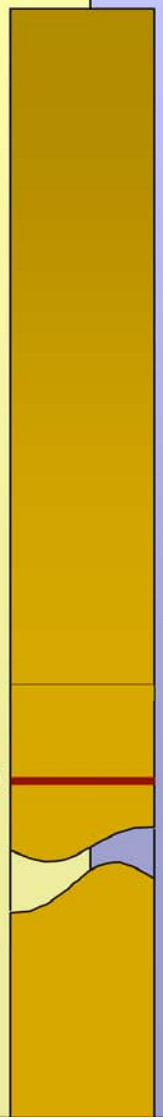
# FRGCv2 Exp. 1


Exp 1 Composite Performance
Verification rate @ FAR = 0.001
1.00
0.99
0.98
0.97
0.96
0.95
ROC I
ROC III
Algorithm

# Performance Goals and Progress

## Independent Evaluations (Gold Standard)

FR 2002
VT 2002



**Starting Point 80%**

Measured in FRVT 2002

**FAR = 0.1%**

# Performance Goals and Progress

## Independent Evaluations (Gold Standard)

FRVT 2006

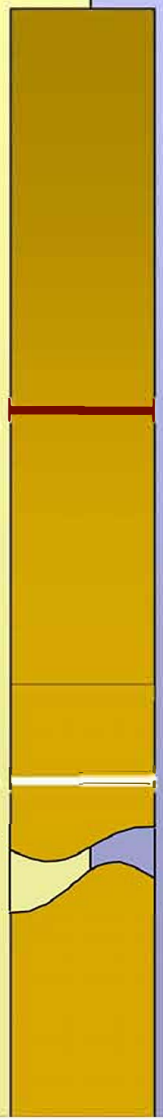
Goal 98%

To be measured by FRVT 2006

Starting Point 80%

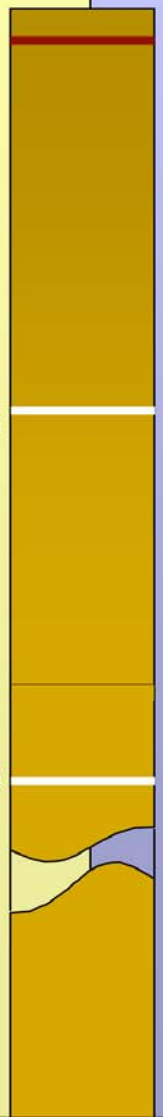
FRVT 2002 Measured in FRVT 2002

FAR = 0.1%



# Performance Goals and Progress

## Independent Evaluations (Gold Standard)



**Goal** 98%

FRVT 2006

To be measured by FRVT 2006

**Starting Point** 80%

FRVT 2002

Measured in FRVT 2002

**FAR = 0.1%**

## Face Recognition Grand Challenge (Qualified Results)

**99.99%** Multi-Still (Mar 06)

**99%** High Resolution Still (Mar 06)

**98%** Three-Dimensional (Mar 06)

FRGC

* First set of results after 4 months in a 12 month period

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FRGC

* First set of results after 4 months in a 12 month period

# Summary

- Face Recognition Grand Challenge
  - Order of magnitude increase in performance
  - Systematically investigate still and 3D
  - Formulate series of challenge problems
  - Face Recognition Grand Challenge Completion March 2006

# FRVT 2006



- Latest in a series of large scale independent evaluations for face recognition systems
  - Previous evaluations in the series were the FERET, FRVT2000, and FRVT 2002
- Primary goal is to
  - Measure progress of prototype systems/algorithms and commercial face recognition systems since FRVT 2002
  - Conduct comparison across modalities
  - Compare performance with FRGC goals

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# FRVT 2006 Status Update

- The Face Recognition Vendor Test (FRVT) 2006
  - Began on 30 January 2006
  - Currently underway
    - Testing executables at this time
  - 22 Participants
    - 10 countries
    - 30% of Participants are from Academia

FACE RECOGNITION VENDOR TEST 2006


# Human-Computer Comparison

O'Toole, Phillips, Jiang, Penard, Ayyad, Abdi 2005

# Problem

- Are face recognition algorithms *ready* for applications?
  - enormous improvements over last decade
  - accuracy of algorithms tested intensively
- *How accurate do they have to be to be useful?*
  - meet or exceed human performance

# Human-Machine Comparisons

- Same image pairs from Exp. 4
- Seven state-of-the-art algorithms
  - 4 from industry
  - 3 from academic institutions
- Comparisons
  - 120 difficult face pairs
  - 120 easy face pairs

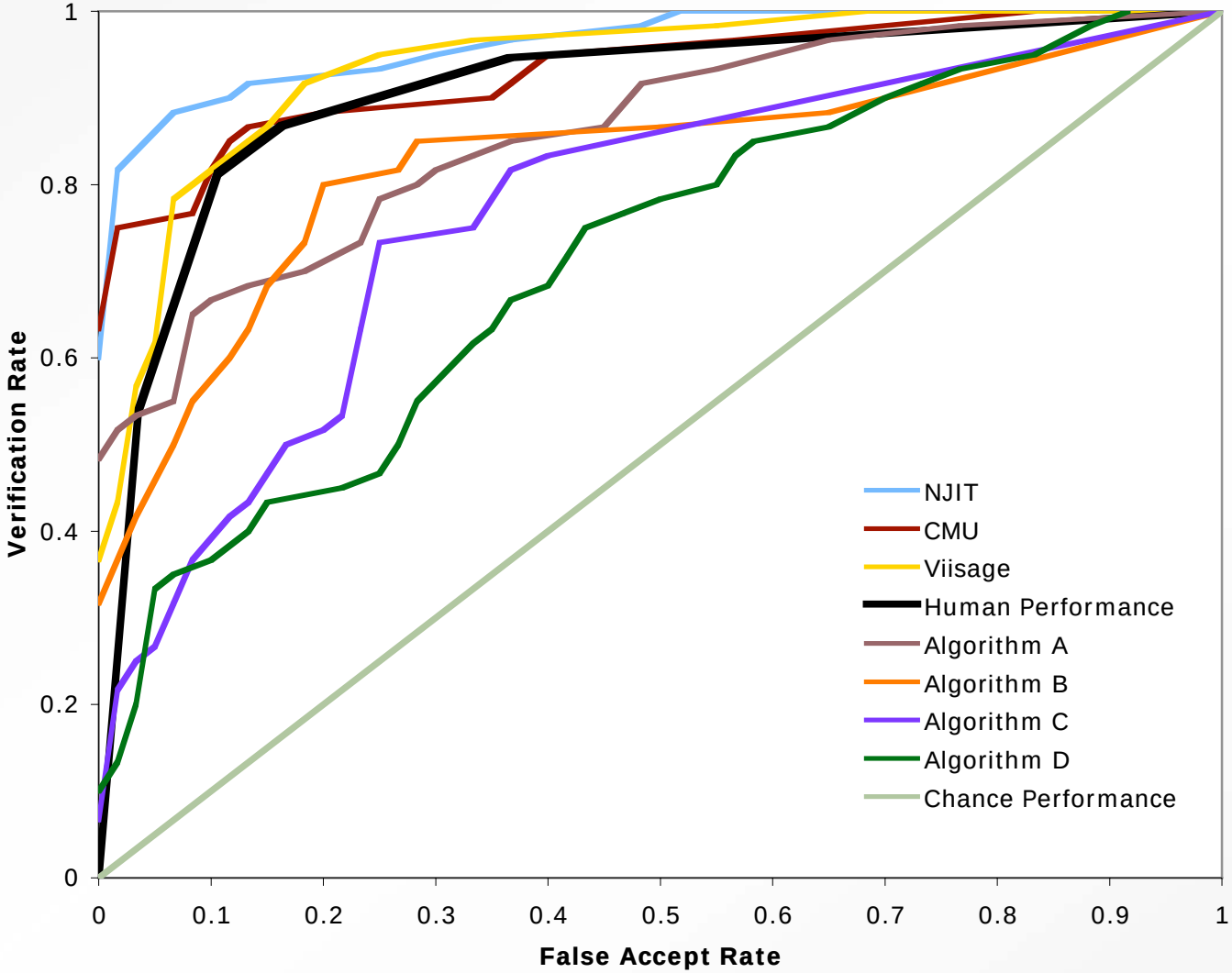
# Sampling

- homogeneous
  - caucasian males/females 20-30 yrs
  - comparisons made on identity not
    - age, race, sex
- Stimuli
  - 240 pairs of faces
    - 120 male pairs
      - 60 easy
      - 60 difficult
    - 120 female pairs
      - 60 easy
      - 60 difficult

# Procedure

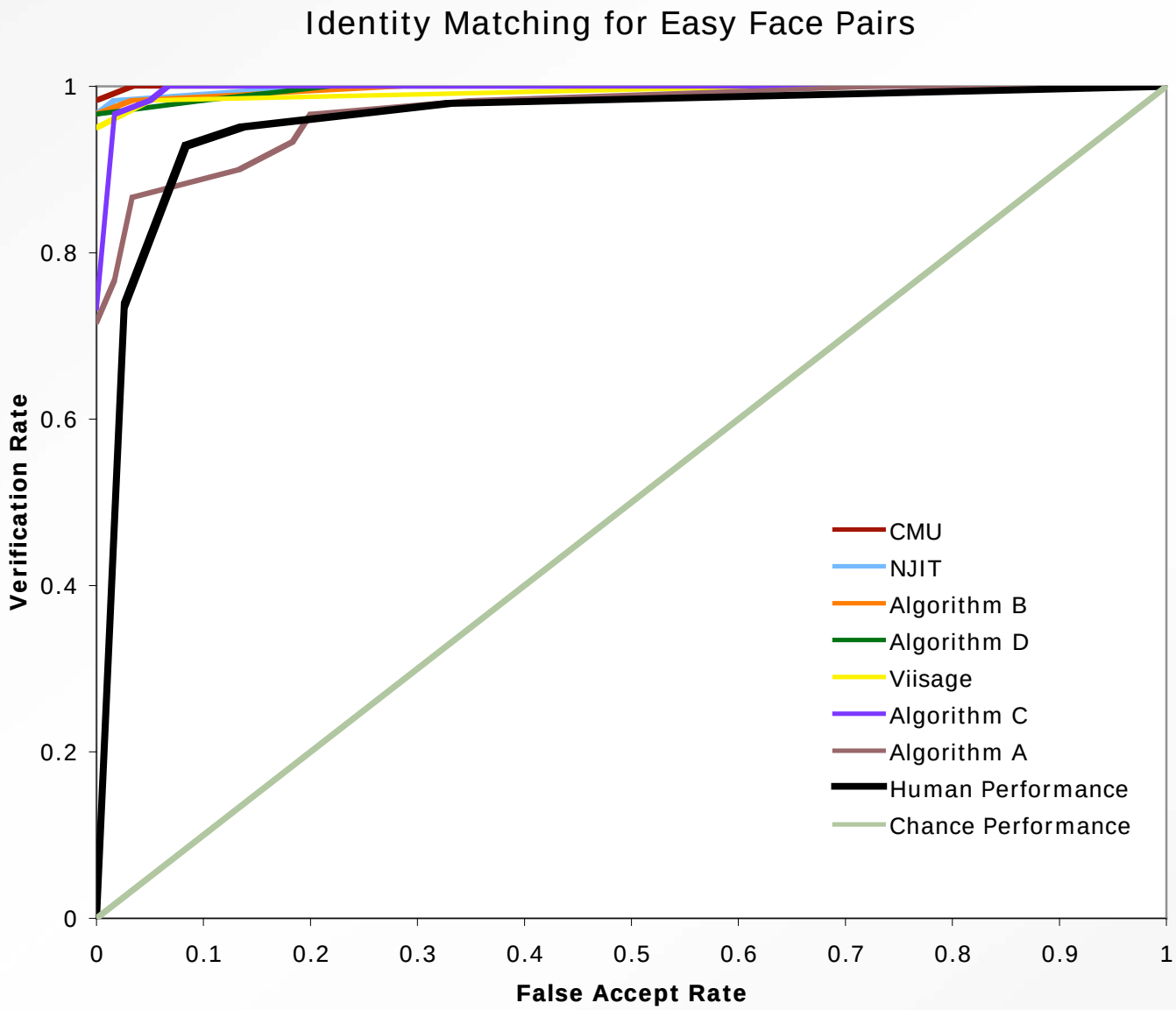

- Human subject raters respond…
  - 1. sure they are the same person
  - 2. think they are the same person
  - 3. not sure
  - 4. think they are not the same person
  - 5. sure they are not the same person

## Identity Matching for Difficult Face Pairs



# Results Summary

- 3 algorithms surpass humans!
  - NJIT (Liu, *IEEE: PAMI, in press*)
  - CMU (Xie et al., 2005)
  - Viisage (Husken et al., 2005)
- 4 less accurate than humans


Identity Matching for Easy Face Pairs
Verification Rate
False Accept Rate
0
0.2
0.4
0.6
0.8
1
0.1
0.3
0.5
0.7
0.9
CMU
NJIT
Algorithm B
Algorithm D
Viisage
Algorithm C
Algorithm A
Human Performance
Chance Performance

# Conclusions

- Algorithms compete favorably with humans on the difficult task of matching faces across changes in illumination
  - some algorithms are *better* than humans on “difficult” face pairs
  - nearly all are *better* than humans on “easy” face pairs


# Iris Challenge Evaluation Overview

# ICE Goals

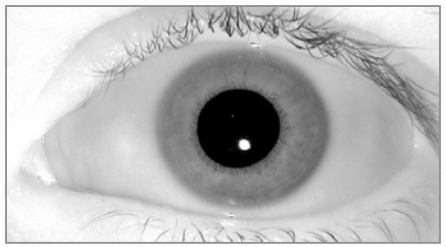
- Broad Goals
  - Facilitate iris recognition technology development
  - Technology assessment of iris recognition
- Modeled after FRGC/FRVT 2005
  - FRGC (Face Recognition Grand Challenge)
  - FRVT 2006 (Face Recognition Vendor Test 2006)

# Fully Automatic

## Input

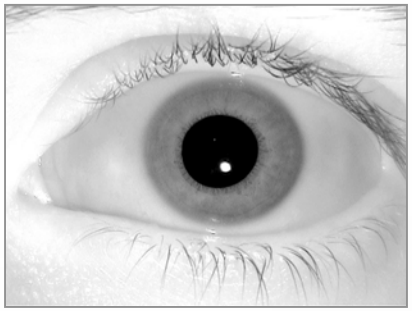
**Target Set**

Image

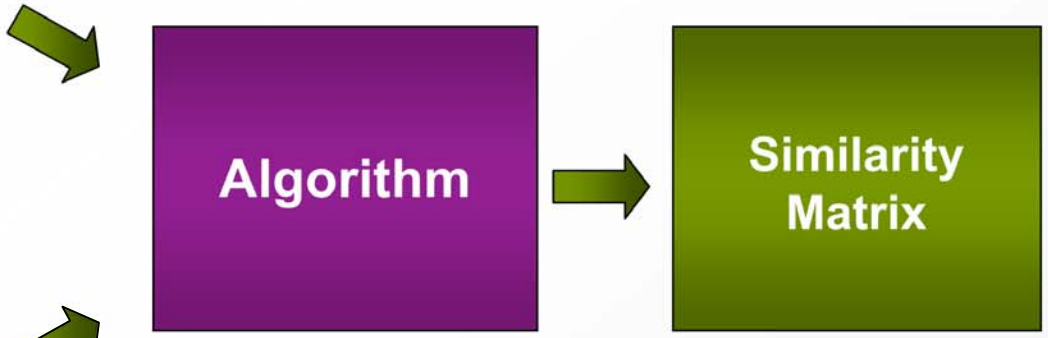


**Query Set**

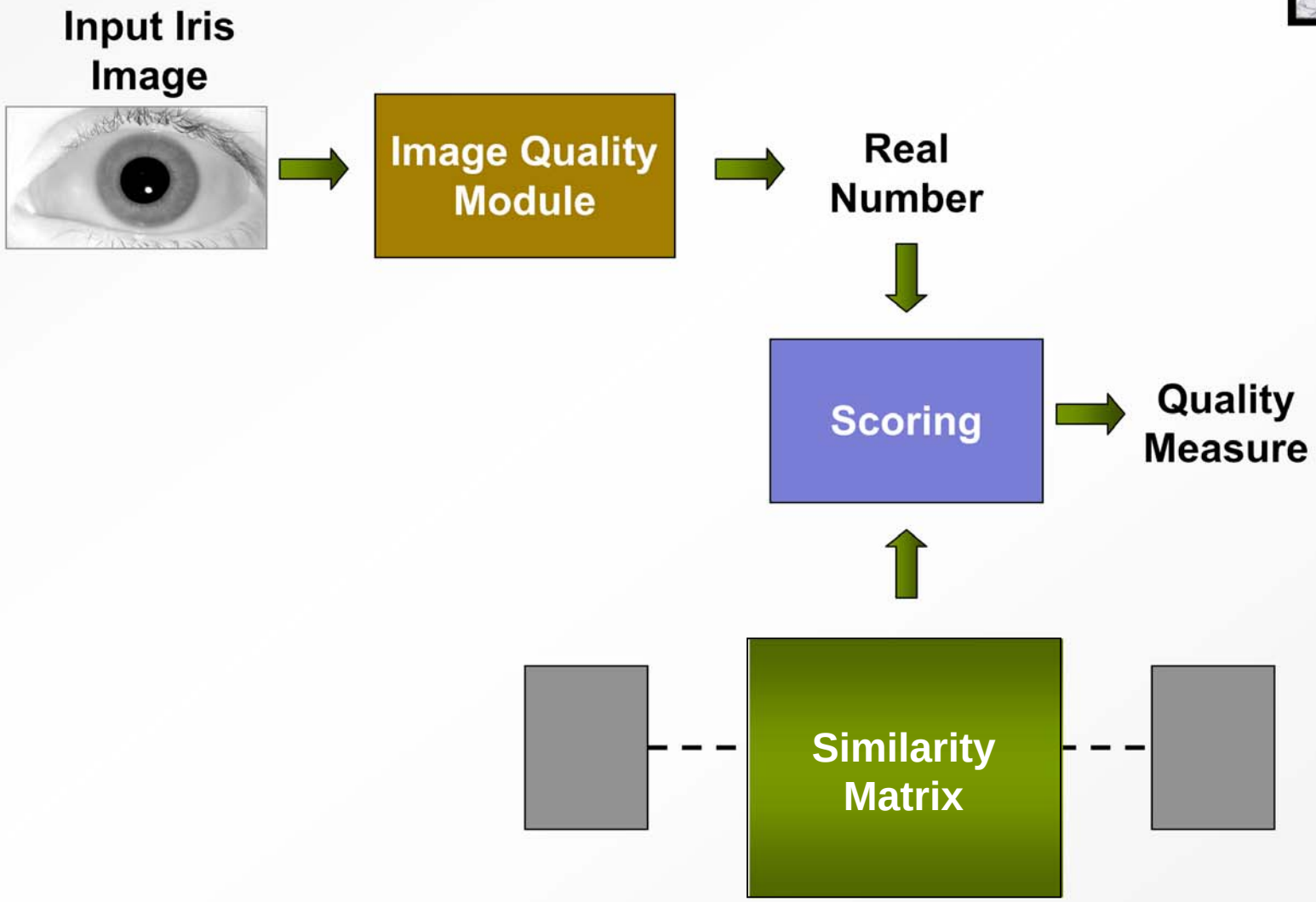
Image



## Output



# Image Quality



# ICE 2005 and 2006

- What is the difference between ICE ~~Phase I~~ 2005 and ICE ~~Phase II~~ 2006?
  - ICE 2005 – Technology Development
    - Iris recognition challenge problems
    - Iris data set
  - ICE 2006 - Evaluation
    - Independent government technology evaluation
    - Sequestered data


# ICE 2005 Challenge Problems

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# Define Experiments

## Exp 1

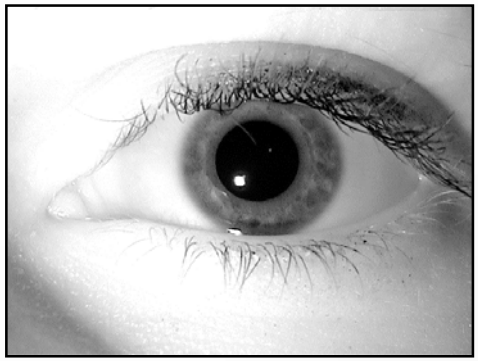
Right Eye

1425 Iris Images

124 Individuals

## Exp 2

Left Eye



1528 Iris Images

120 Individuals

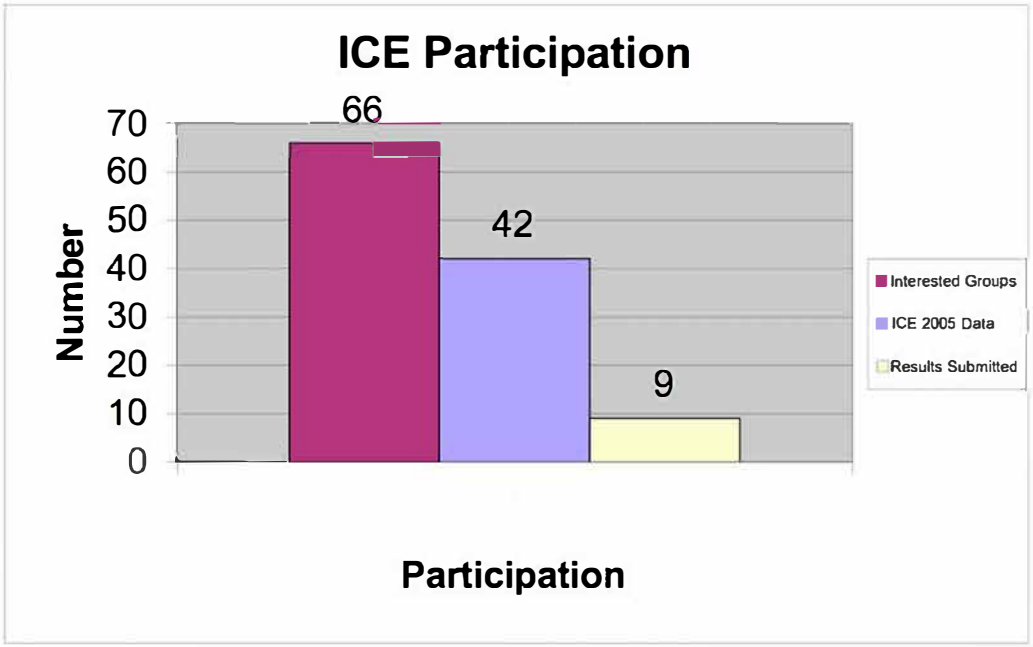
112 Overlapping Individuals

132 Total Individuals

# ICE 2005

- Challenge Problem
  - Open book
- Data Released September 2005
  - Iris images
  - Experiments
  - Ground truth
- Similarity Matrices Submitted March 2006
  - Generated by participants
  - Scored by NIST
- NOT an independent Evaluation
  - NO sequestered data

# ICE Participation

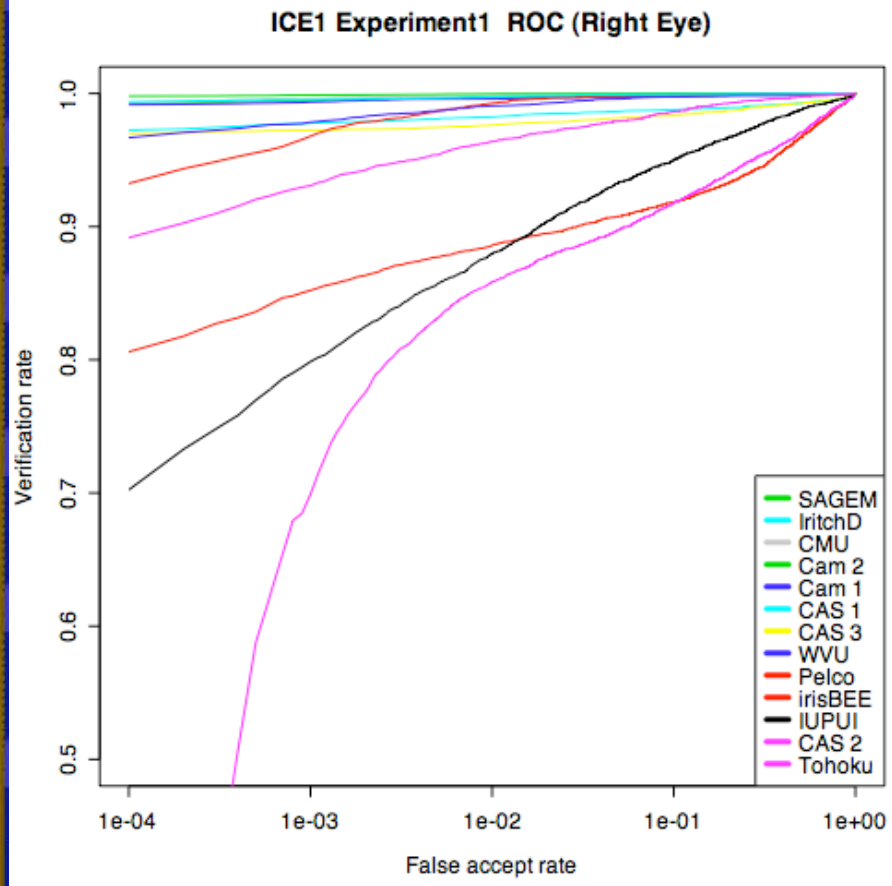


# Result Submissions

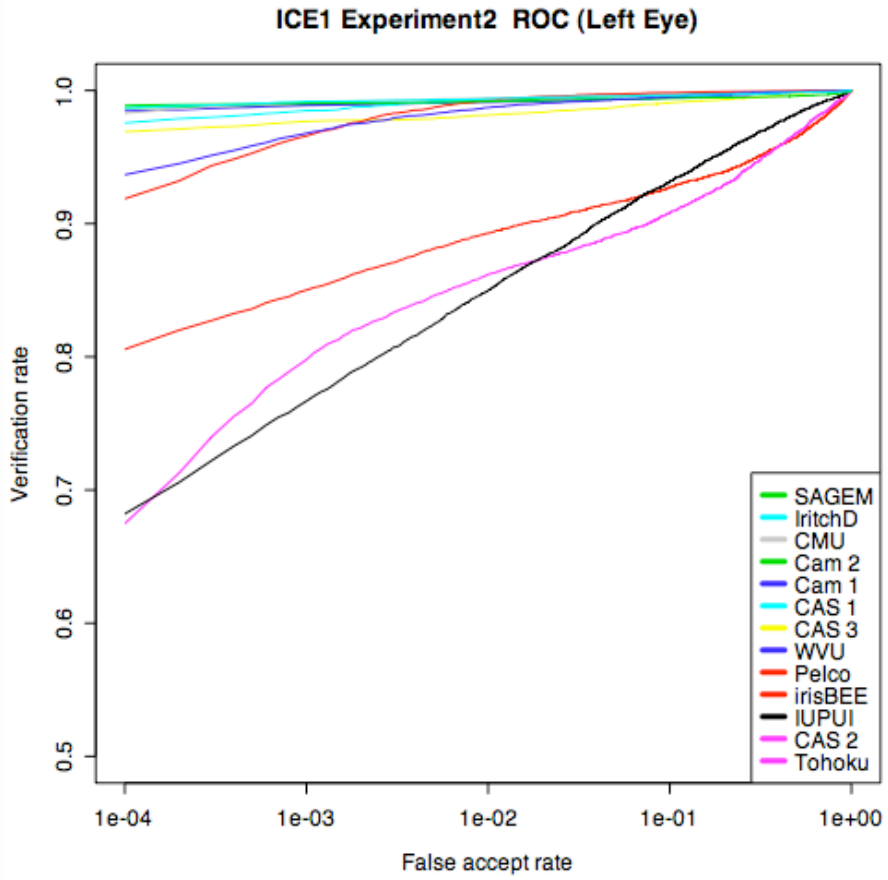
- Results submitted:
  - 9 Groups
  - 15 Algorithms + 1 irisBEE Baseline
  - 6 Countries
- ICE Phase I Participants:
  - Cambridge University *(Cam 1, Cam 2)*
  - Carnegie Mellon University *(CMU)*
  - Chinese Academy of Sciences, Center for Information Science *(CAS 1, CAS 2, CAS 3)*
  - Indiana University, Purdue University, Indianapolis *(IUPUI)*
  - Iritech *(IritchA, IritchB, IrtchC, IritchD)*
  - PELCO *(Pelco)*
  - SAGEM - Iridian *(SAGEM)*
  - West Virginia University *(WVU)*
  - Yamataki Corp / Tohoku University *(Tohoku)*

# ROC Results - Fully Automatic

## Exp 1



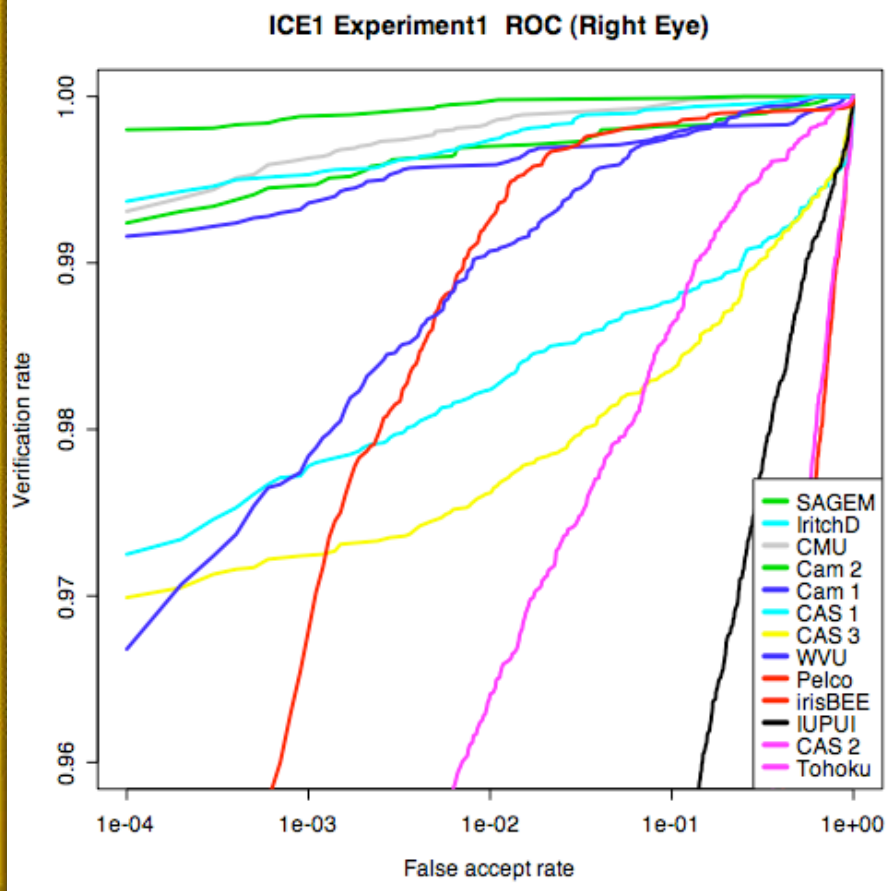

## Exp 2



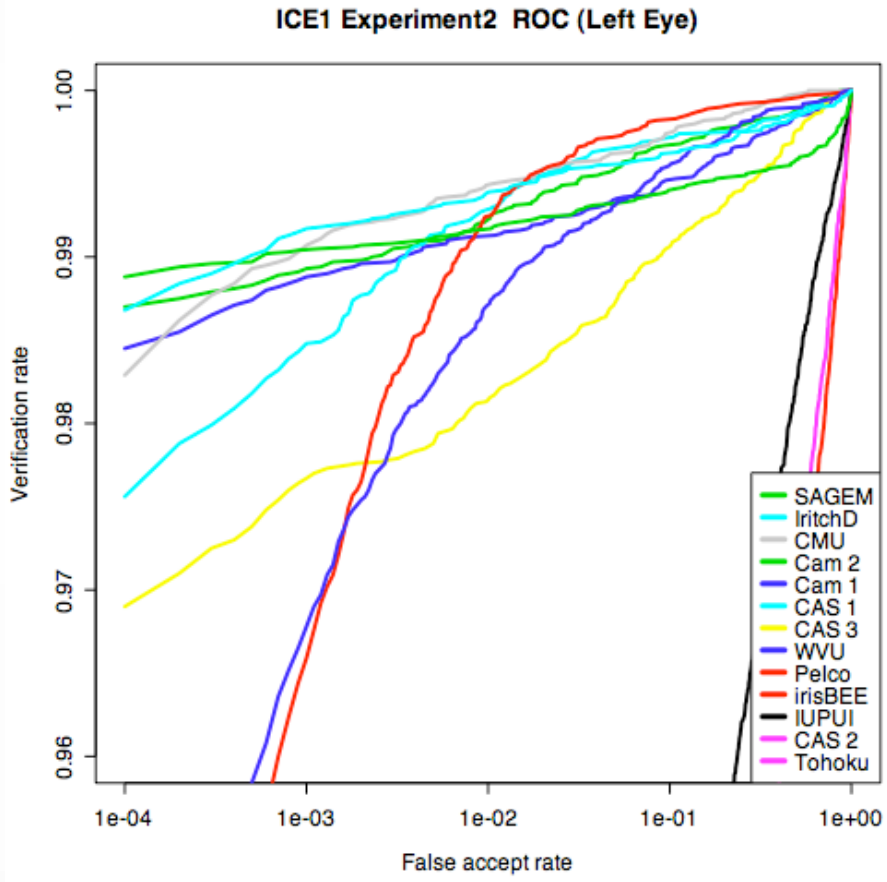

**Results from Open Book Challenge Problem**
**NOT Independent Evaluation**

# ROC Results

## Exp 1

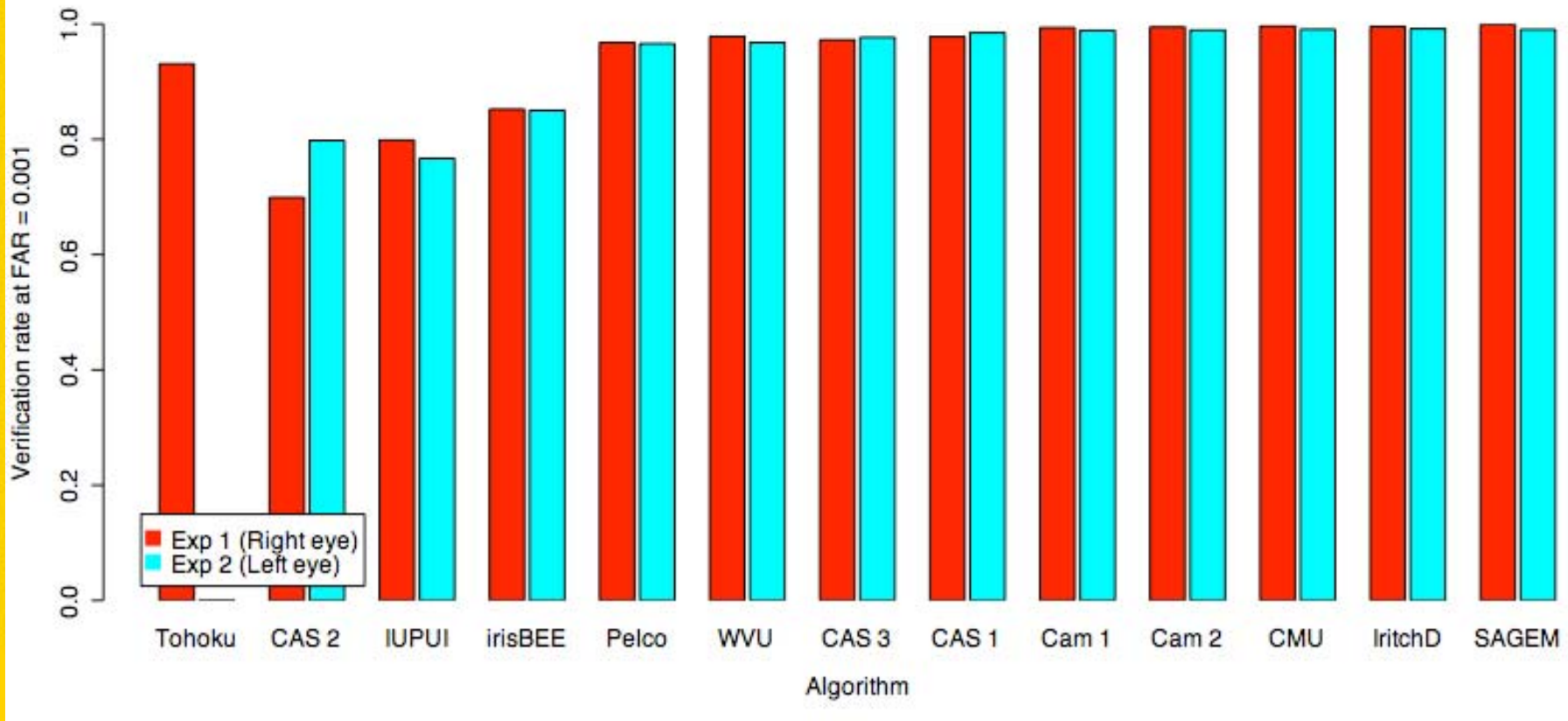



## Exp 2




**Results from Open Book Challenge Problem**
**NOT Independent Evaluation**

# Bar Plot Performance Results Fully Automatic, FAR=0.001

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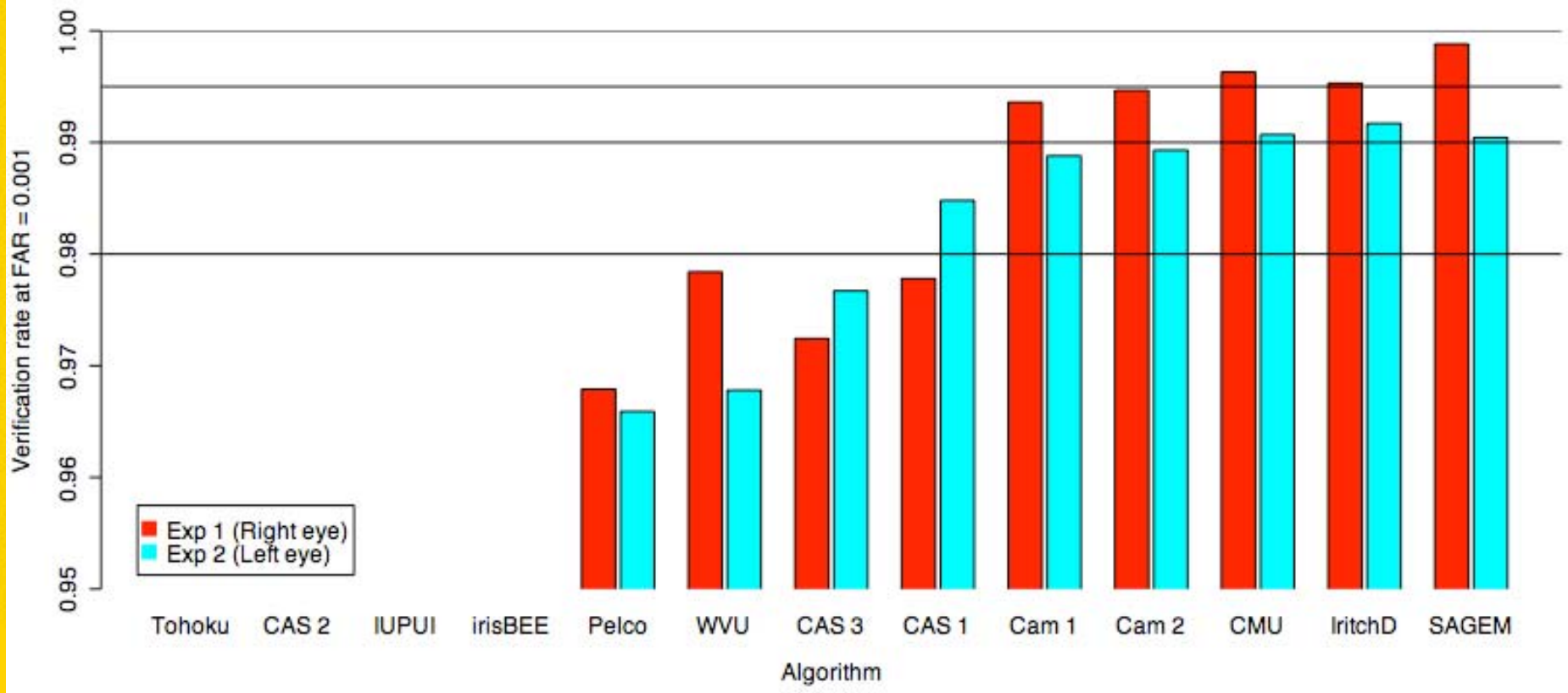
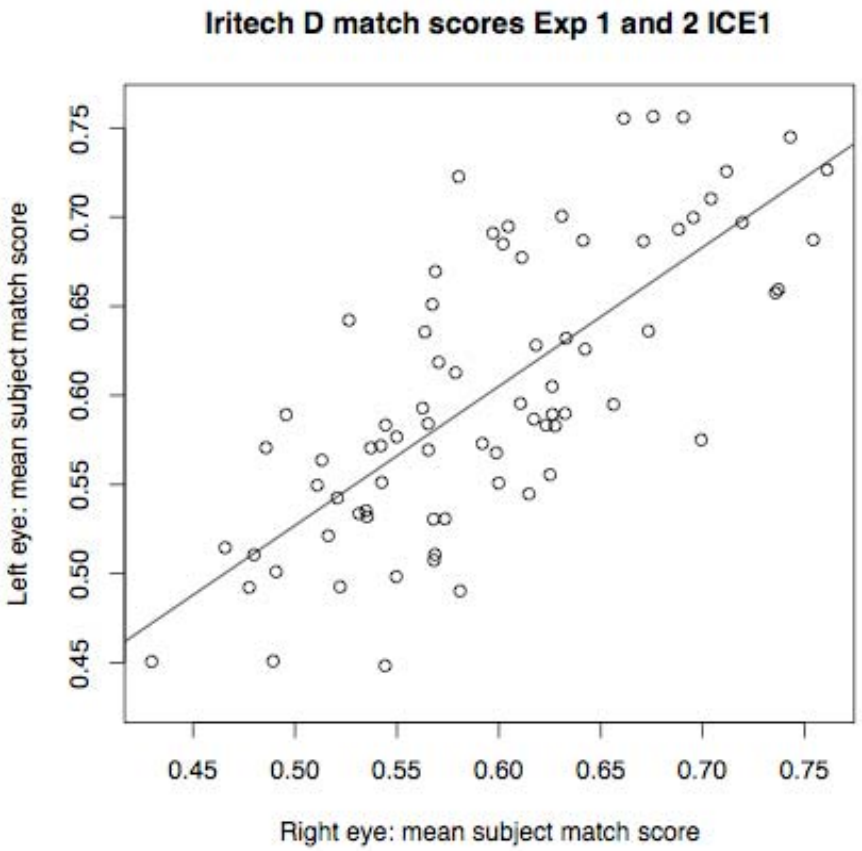


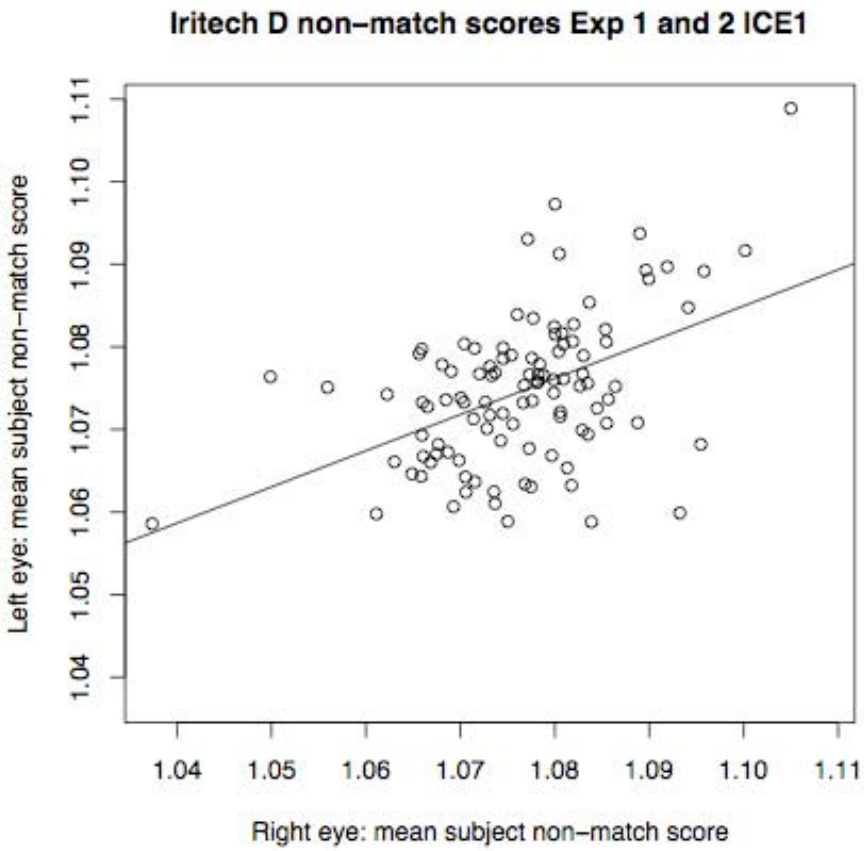

**Results from Open Book Challenge Problem**
**NOT Independent Evaluation**

# Eye Independence

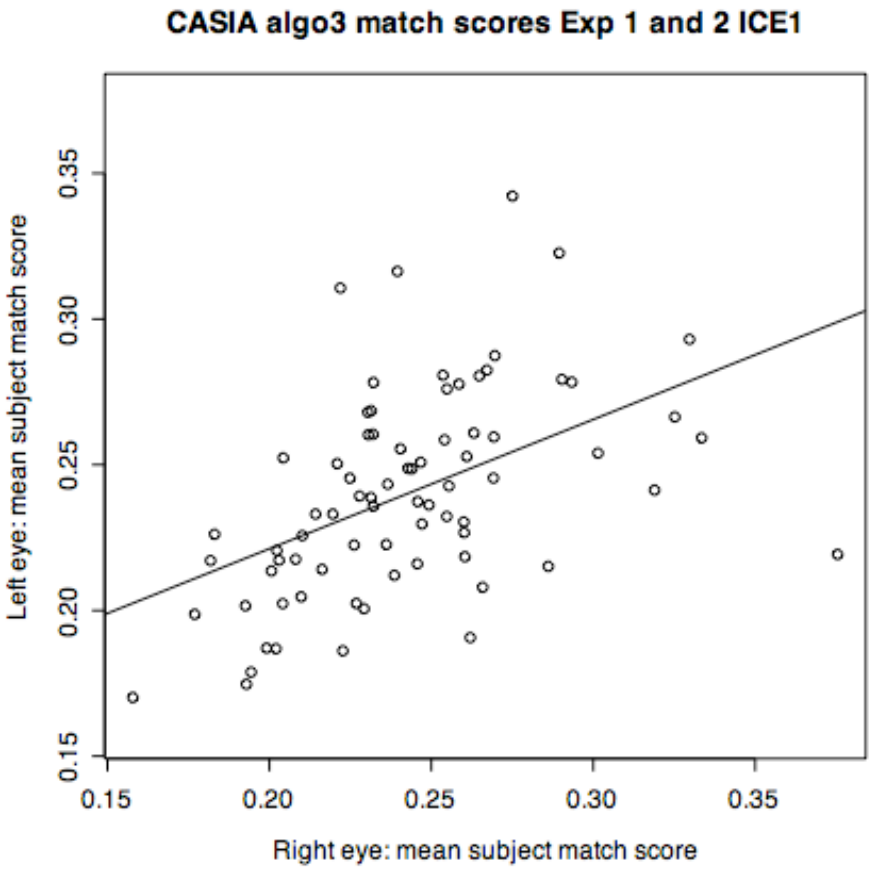
- Purpose:
  - Examine relationship between left & right iris
- Method:
  - For each subject, compute mean match score
    - Right and left iris
  - For each subject, compute mean non-match score
    - Right and left iris
  - Scatter plot of right verses left iris
    - Mean match score
    - Mean non-match score

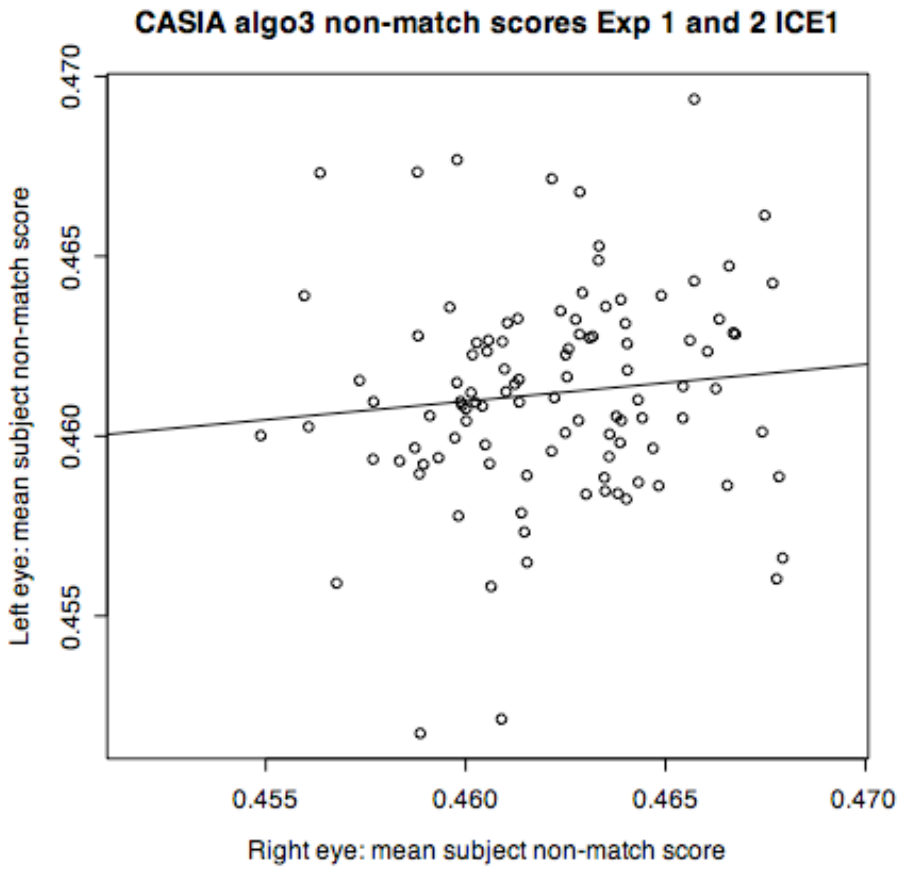
# Eye Independence - Iritech



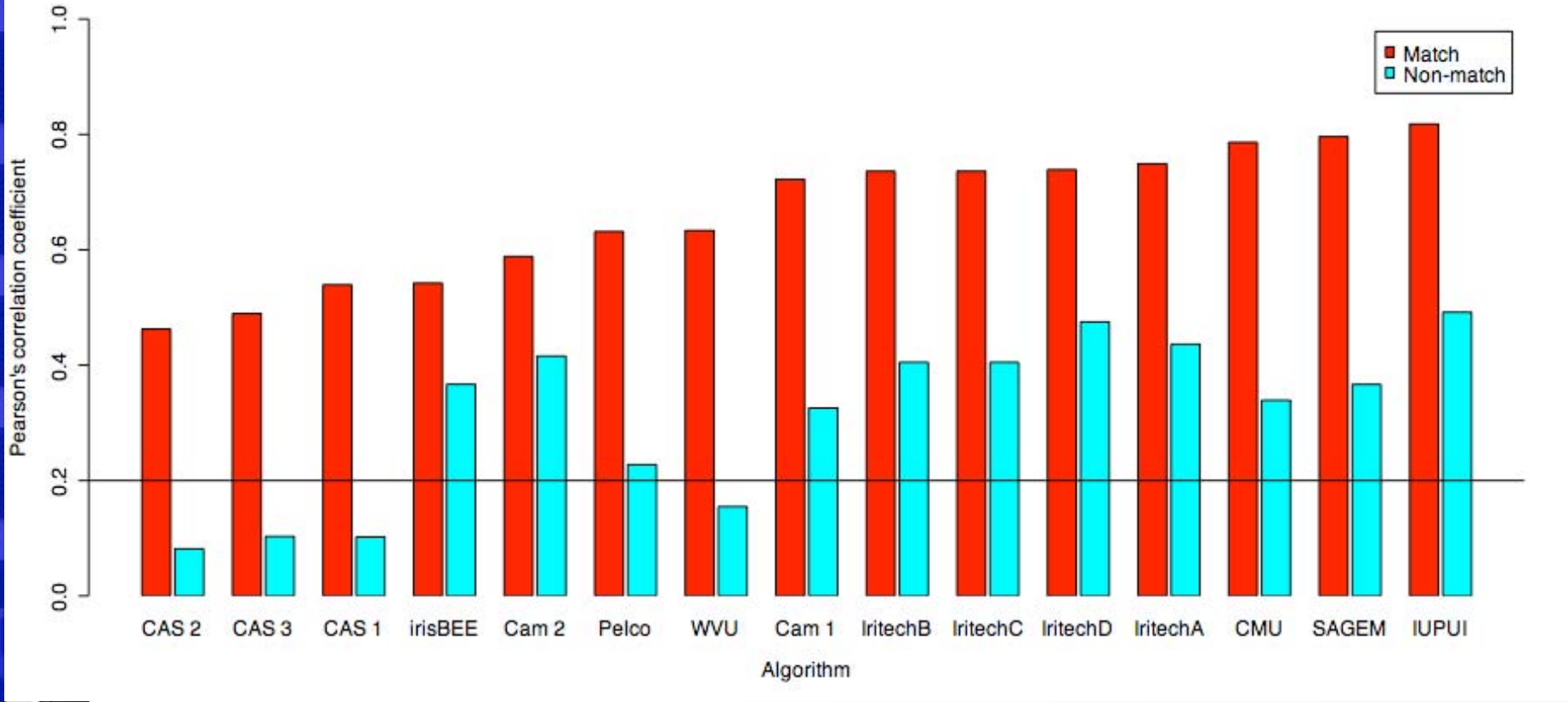



# Eye Independence-CASIA

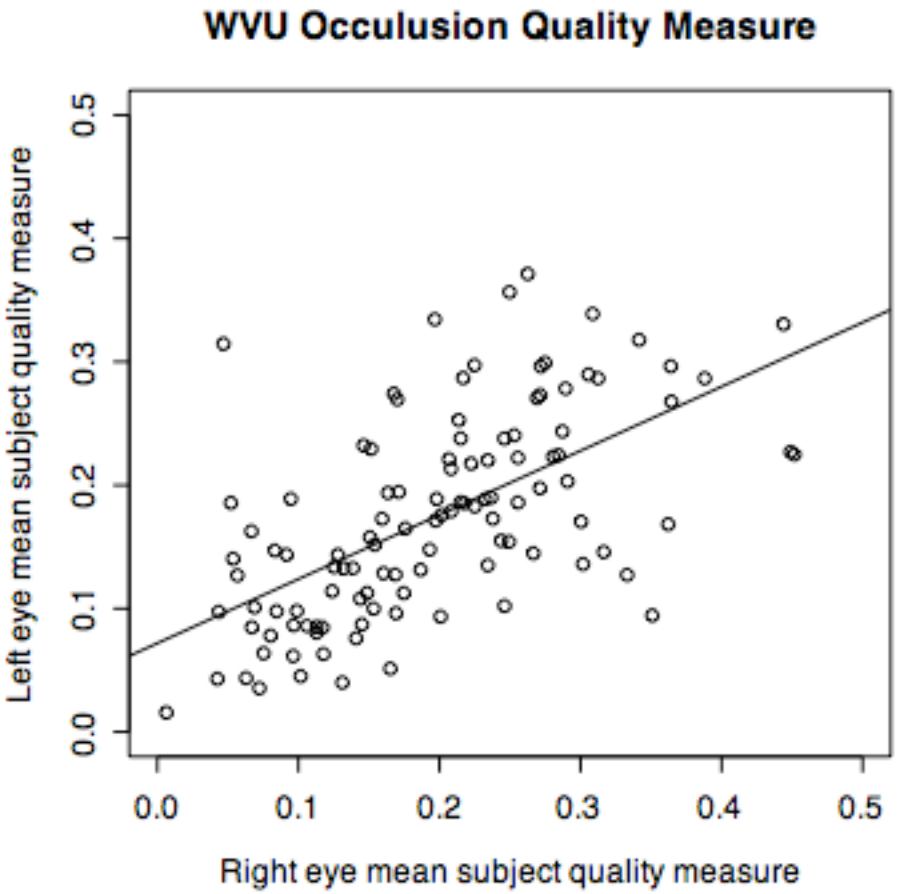


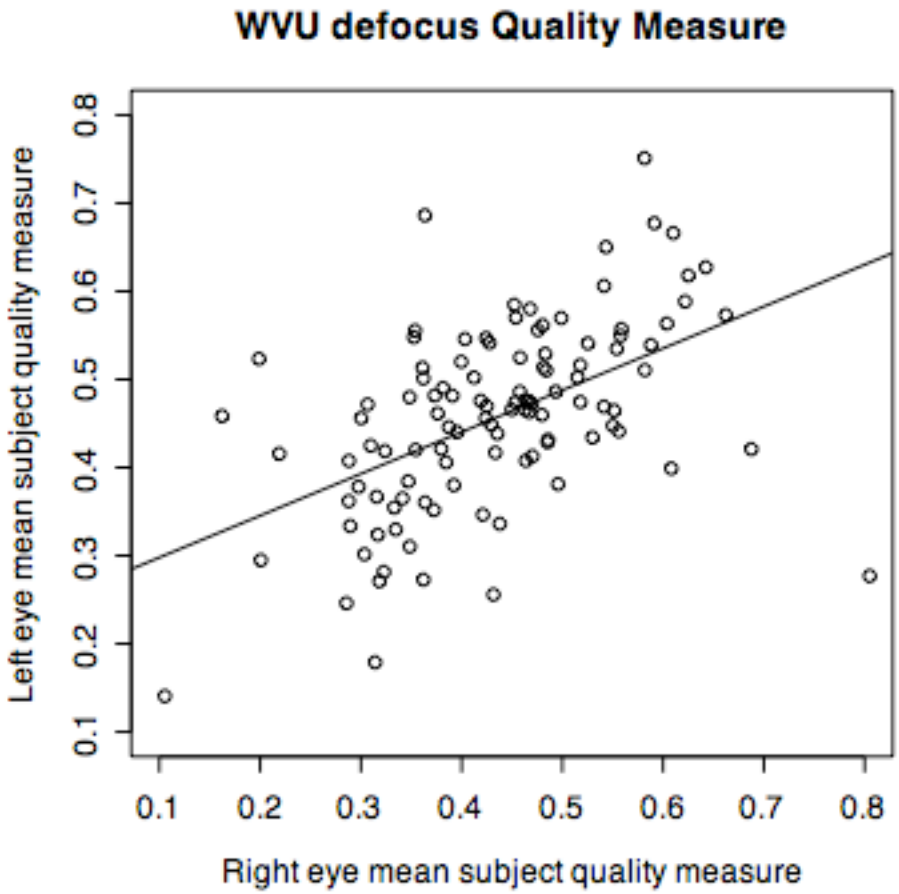



# Eye Independence-Summary



# Quality Measures



# ICE 2006 Schedule

- 1 April 2006
  - ICE 2006 Protocol released
- 15 June 2006
  - Executables submission deadline
  - ICE 2006 evaluation begins
- December 2006
  - ICE 2006 Final Report released