ISRP 2002 abstract

Presenter/author	Title	Abstract
Guan, Jinhua** Hsiao, Hongwei** **Zhuang**, Ziqing* *) *National Personal Protective Technology Laboratory, NIOSH, Pittsburgh, Pennsylvania, USA* **) *Division of Safety Research, NIOSH, Morgantown, West Virginia, USA*	**Recapturing the Sizing Issues of Respirator Fit-test Panels for Emergency Response**	Ill-fit respirators may compromise the ability of emergency responders to act effectively in hazardous situations. This study reevaluated the Los Alamos National Laboratory (LANL) respirator fit-test panels for their effectiveness to provide sizing reference for the US military and civilian populations. The LANL panels were developed in 1974 based on the 1967-68 US Air Force Anthropometry Survey. The 1988-89 US Army Anthropometry Survey and the Civilian American and European Surface Anthropometry Resource (CAESAR) were involved in this evaluation. Data on face length and face width from the Army survey or CAESAR were fed into the full-facepiece panel, and data on face length and lip length from the Army survey were fed into the half-facepiece panel. Any individual whose bivariate dimensions fell out of panel boundaries was considered to be not accommodated. With adjusted racial distribution, the full- and half-facepiece panels were able to accommodate 90.1% and 93.1%, respectively, of the Army survey population. The full-facepiece panel was able to accommodate only 85% the CAESAR population. There was insufficient information for evaluating the ability of the half-facepiece panel to accommodate the CAESAR population. The LANL panels should be revised so that they can fit 95% of the current civilian population.

Recapturing the Sizing Issues of Respirator Fit-Test Panels for Emergency Response

Ziqing Zhuang, Ph.D.
Jinhua Guan, Ph.D.
Hongwei Hsiao, Ph.D.

National Institute for Occupational Safety and Health

CDC Workplace Safety and Health

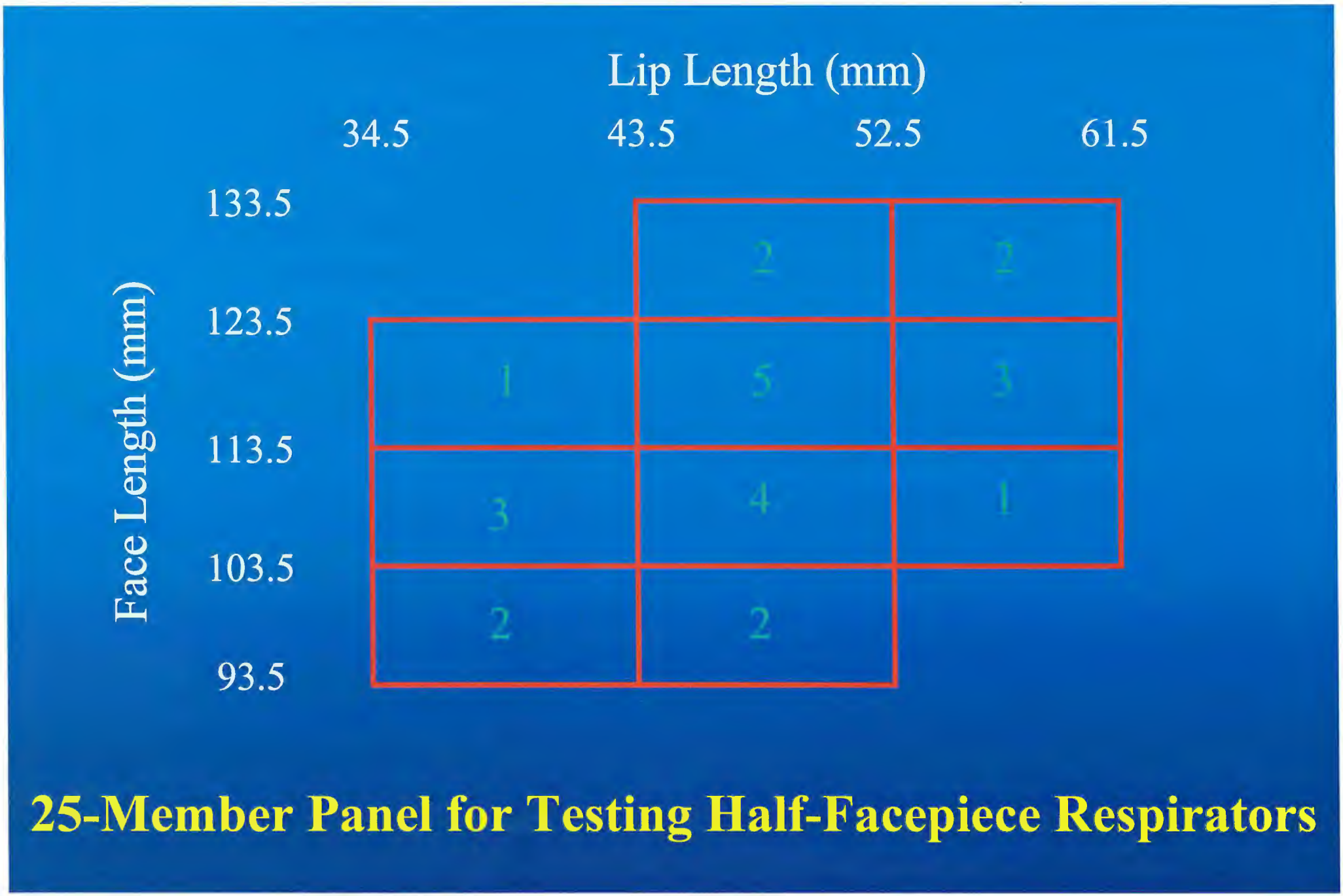
NIOSH

Background

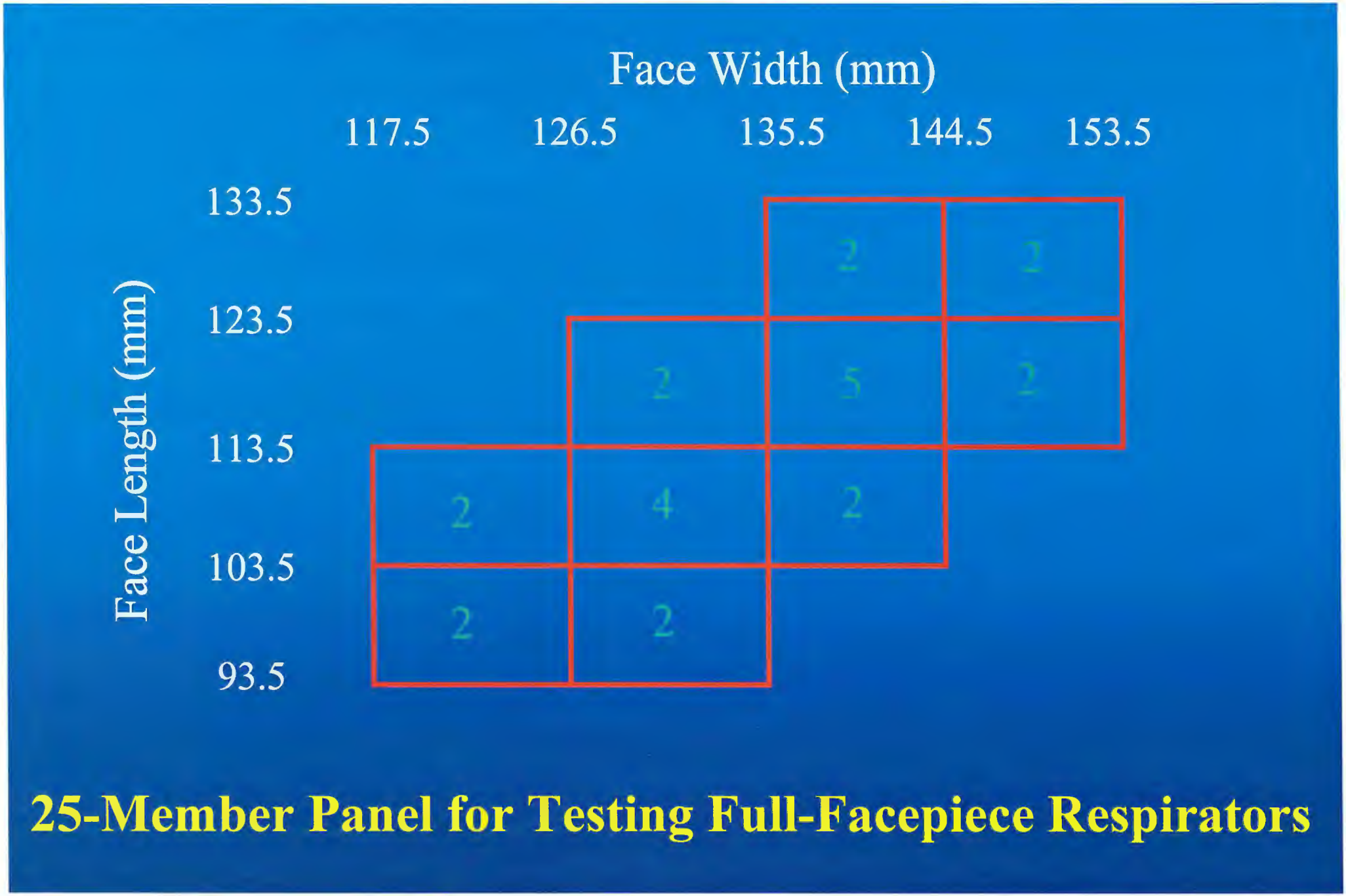
- OSHA requires individuals to be fit tested before wearing a respirator
- There is no fit-test in the NIOSH certification program for general industry use respirators
- Respiratory protection has become more and more important since emergency responders may face various hazardous chemical and biological agents

Background (Continued)

- Poor-fitting respirators may compromise the ability of emergency responders to act effectively in hazardous situations
- NIOSH incorporates fit testing into the certification of the new SCBA for emergency workers
- The respirator fit-test panels currently used in the U.S. are 25-subject panels, developed by Los Alamos National Laboratory (LANL) in 1972



25-Member Panel for Testing Half-Facepiece Respirators



25-Member Panel for Testing Full-Facepiece Respirators

Background (Continued)

- The panels are relied upon to provide sizing reference in a respirator fit-test
- The fit of respirators on the panels was assumed to represent the fit of respirators on user populations

Need for Evaluating the Panels

- The LANL panels are based on the data of 1967-1968 survey of U.S. Air Force
- Military data may not represent the great diversity in face size in civilian populations
- The demographics of the U.S. population have changed over the last 30 years

Race Distribution of 1967-1968 Air Force Survey Subjects and 2000 U.S. Population

Race	Air Force		2000 Census	
	Male (%)	Female (%)	Male (%)	Female (%)
White	98	91	71.6	71.4
Black	1	8	11.8	12.5
Hispanic	1	1	12.1	11.5
Asian/Pacific	-	-	3.7	3.9
American Indian	-	-	0.8	0.7

Need for Evaluating the Panels

- Face length, face width, and lip length have not been shown to be consistently correlated with fit factor
- Some other dimensions have also been shown to correlate with fit factor
- New data and technologies are available

Objective

- To reevaluate the Los Alamos National Laboratory (LANL) respirator fit-test panels for their effectiveness to provide sizing reference for the current US military and civilian populations

Materials and Methods

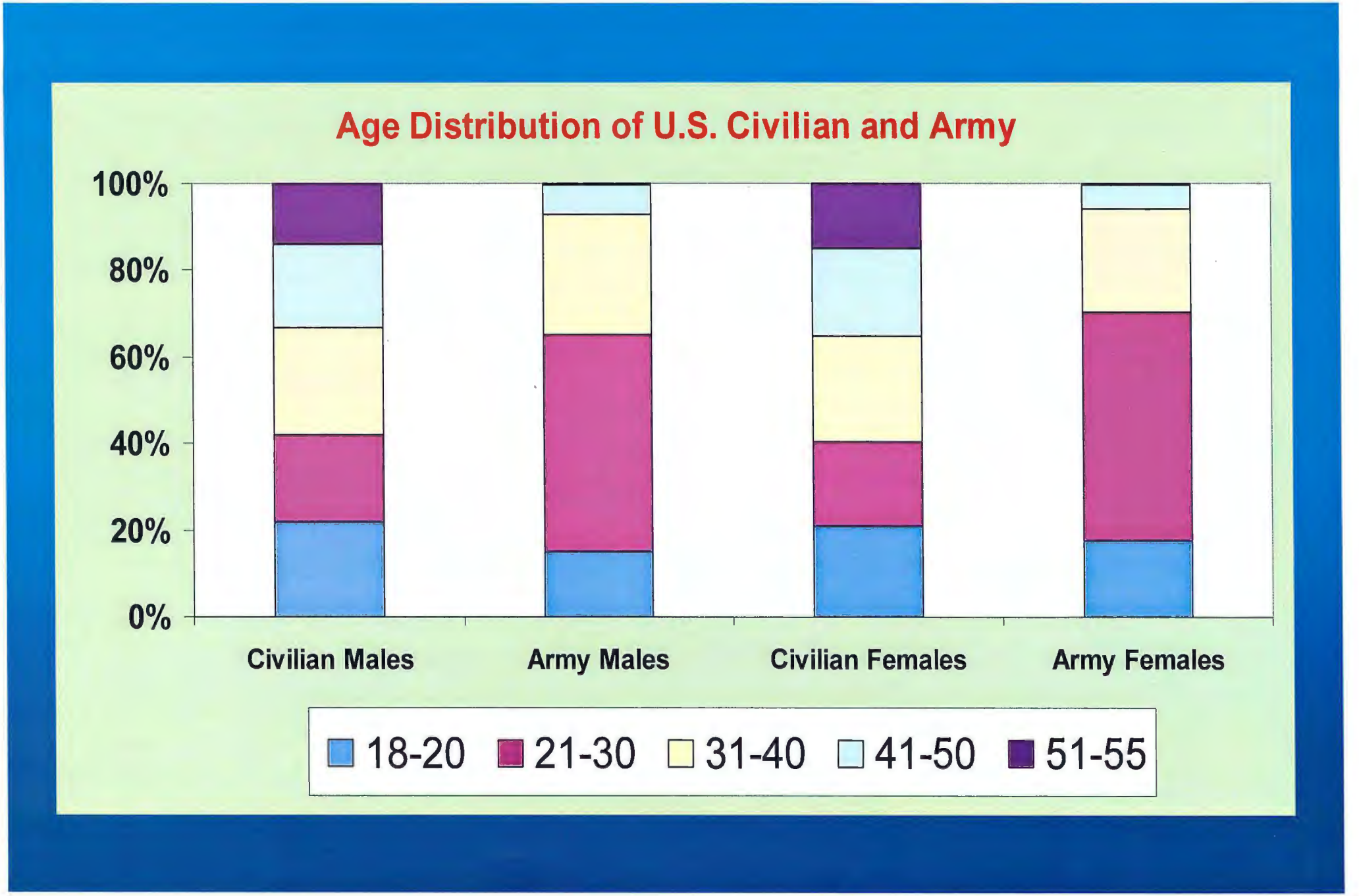
- The data from the 1987-1988 anthropometric survey of U.S. Army men and women
- CAESAR (Civilian American and European Surface Anthropometry Resource) data for 2391 civilian subjects
- Race data from 2000 U.S. census
- Age data from CPS 2000

Army Survey

- **3982 subjects in the working database**
  - Stratified random sampling (age/sex/race)
  - Biographical questionnaire
  - 132 body dimensions

Race Distribution of 1988 Army Survey Subjects and 2000 U.S. Population

Race	Army		2000 Census	
	Male (%)	Female (%)	Male (%)	Female (%)
White	65.8	51.5	71.6	71.4
Black	25.8	41.7	11.8	12.5
Hispanic	3.9	2.5	12.1	11.5
Asian/Pacific	1.5	1.4	3.7	3.9
American Indian	0.6	0.7	0.8	0.7
Mixed/Others	2.4	2.2	-	-


Age Distribution of U.S. Civilian and Army
100%
80%
60%
40%
20%
0%
Civilian Males
Army Males
Civilian Females
Army Females
18-20
21-30
31-40
41-50
51-55

CAESAR Project

- 2,391 civilian subjects in the United States
- Stratified random sampling (age/sex/race)
  - Biographical questionnaire
  - 40 Traditional body dimensions
  - 3D scans of 3 postures

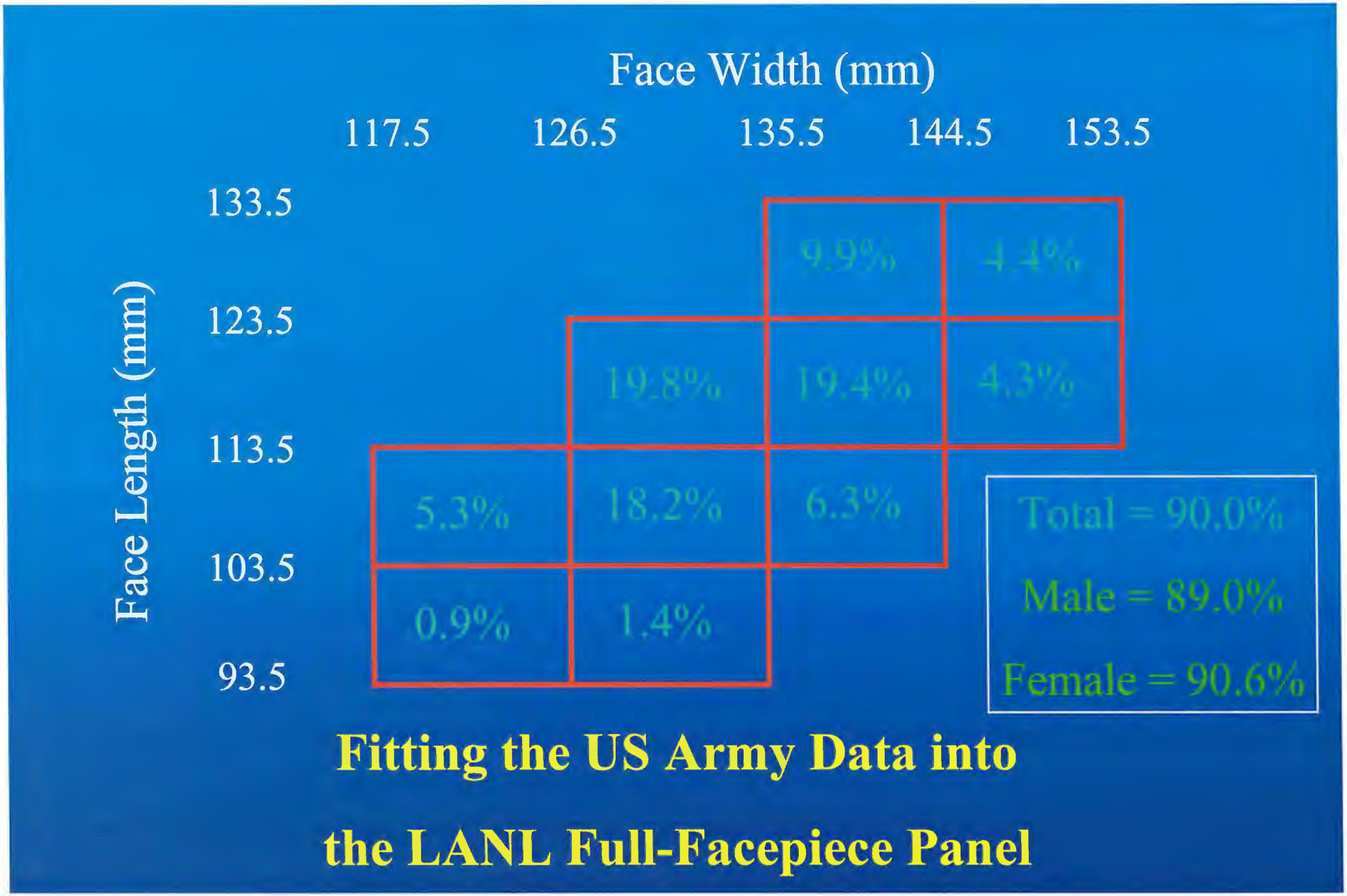
Race Distribution of CAESAR Subjects and 2000 U.S. Population

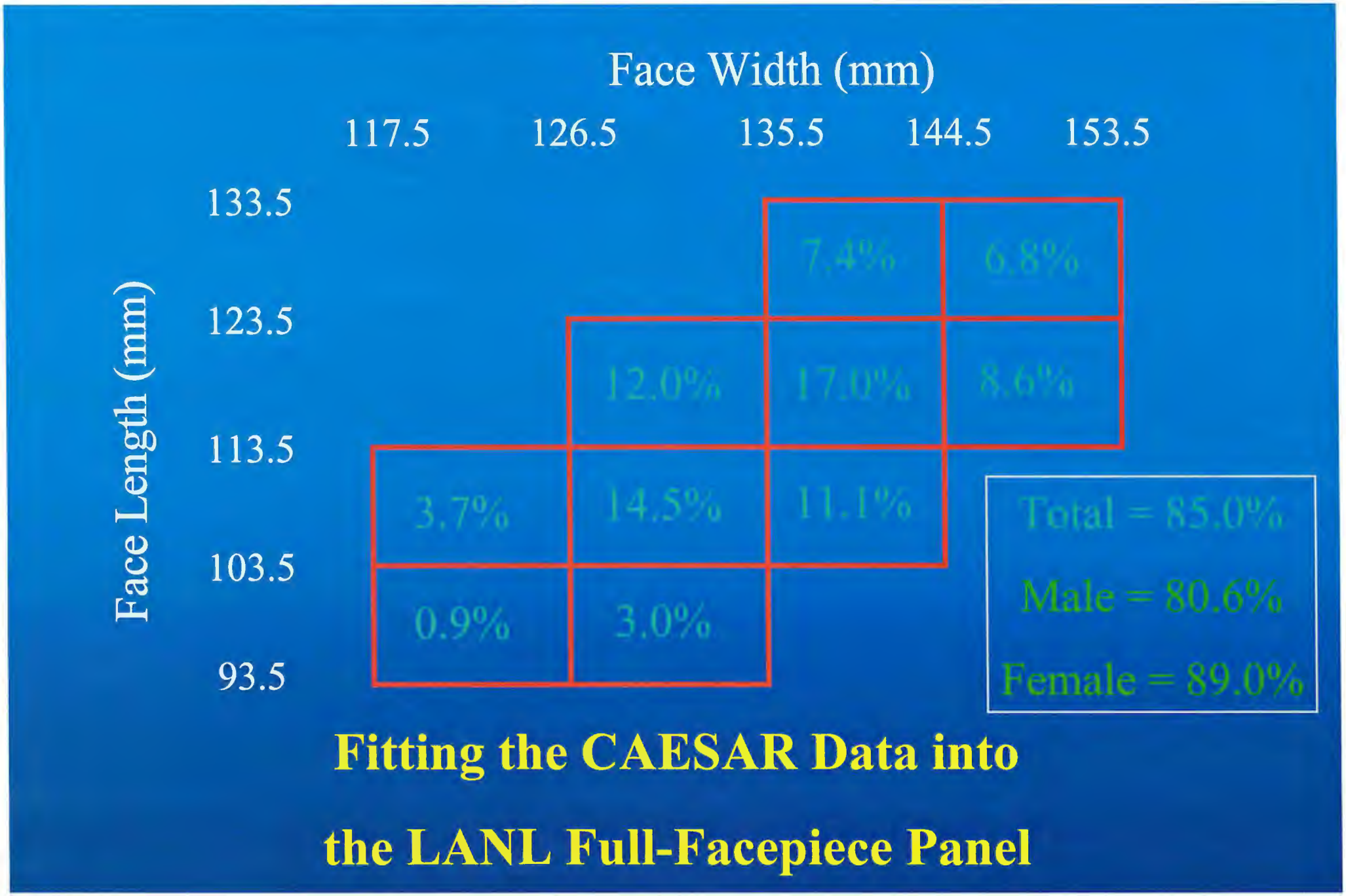
Race	CAESAR		2000 Census	
	Male (%)	Female (%)	Male (%)	Female (%)
White	77.4	76.3	71.6	71.4
Black	10.3	11.7	11.8	12.5
Hispanic	2.9	1.4	12.1	11.5
Asian/Pacific	7.4	7.4	3.7	3.9
American Indian	0.3	0.3	0.8	0.7
Mixed/Others	1.9	3.0	-	-

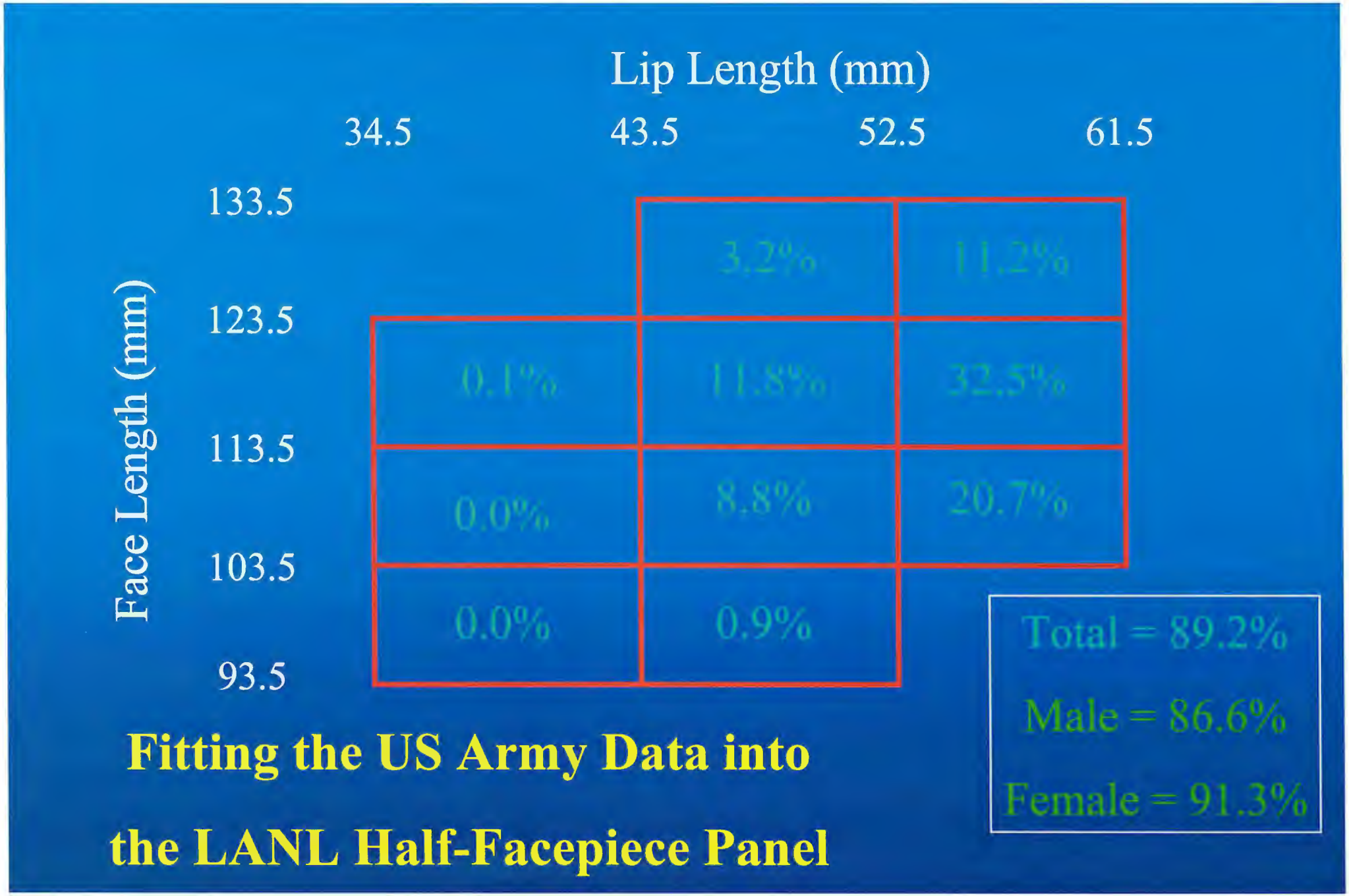
Data Analysis

- Ability of the full- and half-facepiece panels to accommodate 90% of the US Army and CAESAR populations
- Statistical analysis of the bivariate distributions of face length/face width and face length/lip length

Results


Face Width (mm)
117.5
126.5
135.5
144.5
153.5
Face Length (mm)
133.5
123.5
113.5
103.5
93.5
9.9%
4.4%
19.8%
19.4%
4.3%
5.3%
18.2%
6.3%
0.9%
1.4%
Total = 90.0%
Male = 89.0%
Female = 90.6%
Fitting the US Army Data into
the LANL Full-Facepiece Panel


Face Width (mm)
117.5
126.5
135.5
144.5
153.5
Face Length (mm)
133.5
123.5
113.5
103.5
93.5
7.4%
6.8%
12.0%
17.0%
8.6%
3.7%
14.5%
11.1%
0.9%
3.0%
Total = 85.0%
Male = 80.6%
Female = 89.0%
Fitting the CAESAR Data into
the LANL Full-Facepiece Panel


Lip Length (mm)
34.5
43.5
52.5
61.5
Face Length (mm)
133.5
123.5
113.5
103.5
93.5
3.2%
11.2%
0.1%
11.8%
32.5%
0.0%
8.8%
20.7%
0.0%
0.9%
Total = 89.2%
Male = 86.6%
Female = 91.3%
Fitting the US Army Data into
the LANL Half-Facepiece Panel

Results (continued)

- It is not practical to evaluate the ability of the half-facepiece panel to accommodate the CAESAR population
  - Lip length not available
  - Digitizing scan data to obtain lip length may not be accurate due to image resolution

Summary Statistics for Face Length and Face Width

Variable	US Air Force		CAESAR	
	Male	Female	Male	Female
Face Length (mm)	120.3	106.3	121.8	111.8
Face Width (mm)	142.3	129.0	143.8	133.7

Multiple Regression

- Independent variables include survey, age and race
- Female subjects
  - Survey accounted for 16% (FL) and 14% (FW)
  - Age and race played a marginal role
- Male subjects
  - Age, race and survey played a marginal role

Discussion

- The inability of LANL panel to accommodate the CAESAR subjects was likely due to the military recruitment practice in the 60s and demographical change of the US population over the last 30 years

Conclusions

- The LANL full- and half-facepiece panels were able to accommodate 90% of the Army survey subjects
- The LANL full-facepiece panels was able to accommodate only 85% of the CAESAR subjects
- Respirator fit-test panels based on military data are not representative of civilian workers

Further Research

- Anthropometric survey of respirator users
- Development of fit-test panels using the new survey data

Questions ?