



# THERMATRACKER

INTEGRATED BODY TEMPERATURE & HEART RATE MONITORING TECHNOLOGIES



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## DESIGN MOTIVATION

- HEAT EXHAUSTION IS THE THIRD LEADING CAUSE OF DEATH AMONG FOOTBALL PLAYERS AND IS A SERIOUS RISK FOR FIREFIGHTERS AND MILITARY PERSONNEL.<sup>1</sup>
- DEATH DUE TO HEAT STROKE IS ENTIRELY PREVENTABLE, YET CONTINUES TO OCCUR DUE TO THE SELF-SACRIFICE, TEAM-PLAYER MENTALITY AND LACK OF AWARENESS.
- THROUGH CONTINUOUS MONITORING OF CORE BODY TEMPERATURE AND HEART RATE BY AN OUTSIDE PARTY, WARNING SIGNS CAN BE DETECTED EARLY AND PREVENT HEAT EXHAUSTION IN AT-RISK INDIVIDUALS.

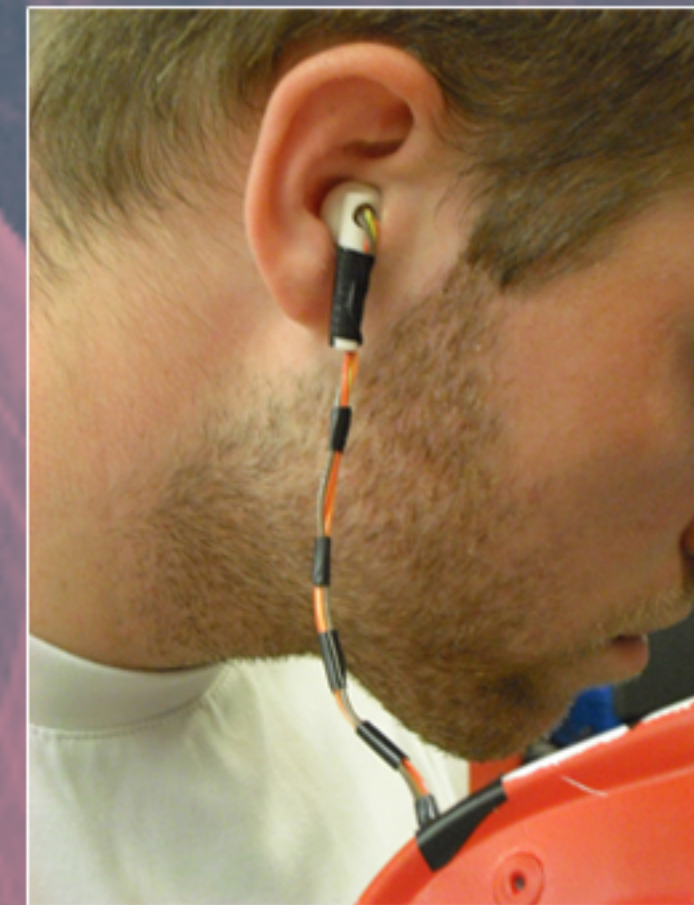
## PROTOTYPE



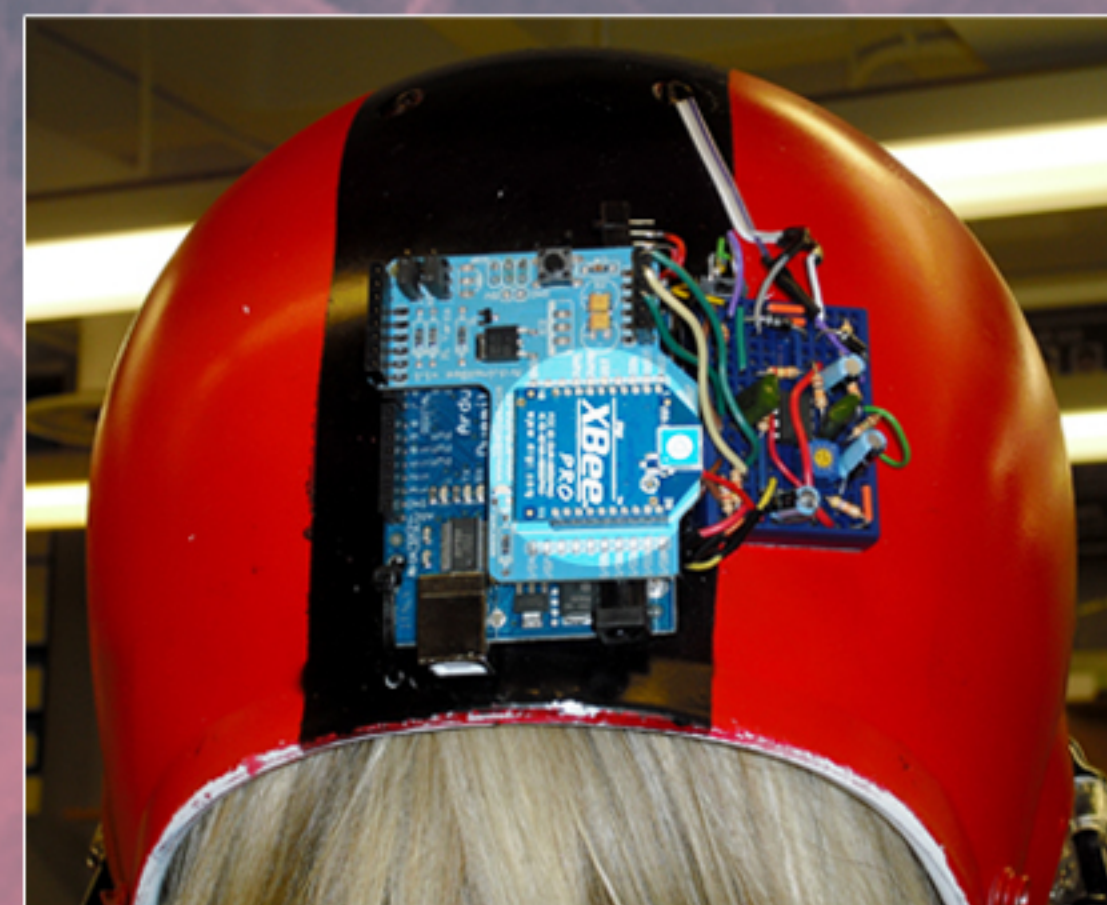
HELMET SIDE VIEW



HEART RATE SENSOR



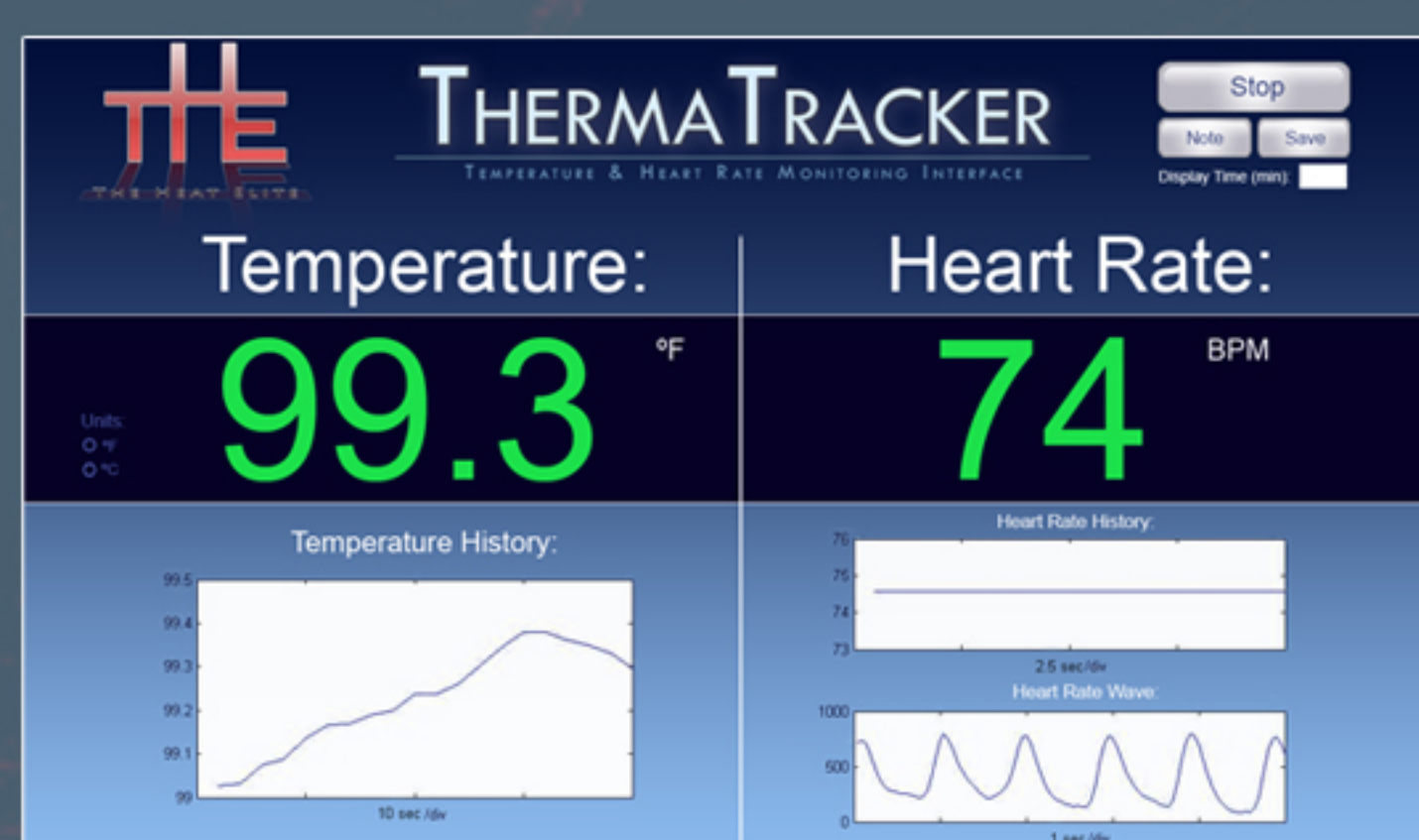
IN-EAR THERMOMETER



CIRCUITRY & WIRELESS TRANSMITTER

- BOTH THE HEART RATE AND TEMPERATURE SENSORS ARE SAFELY AND COMFORTABLY INTEGRATED INTO THE HELMET DESIGN BY USING THE EXISTING PADDING AND AVAILABLE SPACE.
- THE SIMPLE ADDITION OF TWO INFRARED LEDs AND A PHOTODIODE IN THE FOREHEAD PADDING ALLOWS FOR A WAY TO MEASURE HEART RATE THAT IS MORE COMFORTABLE THAN HAVING TO WEAR A CHEST STRAP OR ARM BAND.
- THE PROTOTYPE INCLUDES AN ERGONOMICALLY DESIGNED EARPIECE THAT POINTS THE THERMOPILE AT THE EARDRUM FOR ACCURATE CORE BODY TEMPERATURE MEASUREMENT. DURING HEAT EXHAUSTION, SURFACE BODY TEMPERATURE IS AN UNRELIABLE INDICATOR OF THE POTENTIAL RISK.
- THE THERMATRACKER PROVIDES THE ADVANTAGE OF WIRELESS COMMUNICATION BETWEEN THE USER'S DEVICE AND A SEPARATE MONITORING STATION. THIS IS DONE VIA RF TRANSMISSION BETWEEN TWO XBEE CHIPS.

### GRAPHICAL USER INTERFACE



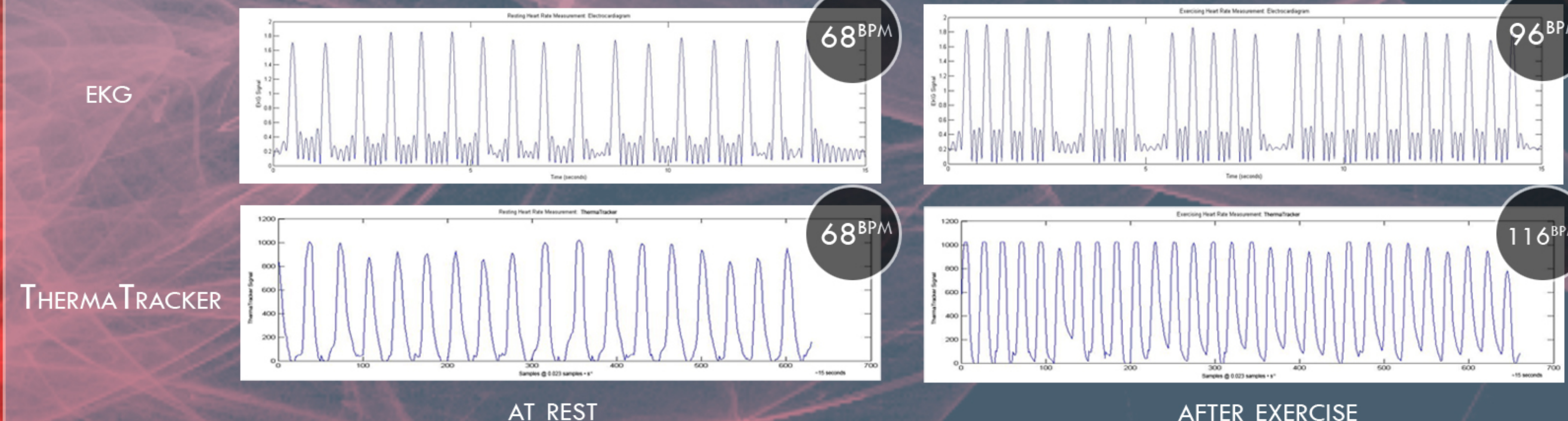
### TEMPERATURE & HEART RATE THRESHOLDS

	TEMP (°F)	HEART RATE CALCULATIONS
SAFE RANGE	< 102°	HR MAX = 205.8 - (0.685 x AGE)
DANGER OF HEAT EXHAUSTION	102-103.9°	WARNING (HRmax-HRrest) x 0.93 + HRrest
HEAT STROKE	≥ 104°	ALARM (HRmax-HRrest) x 0.97 + HRrest

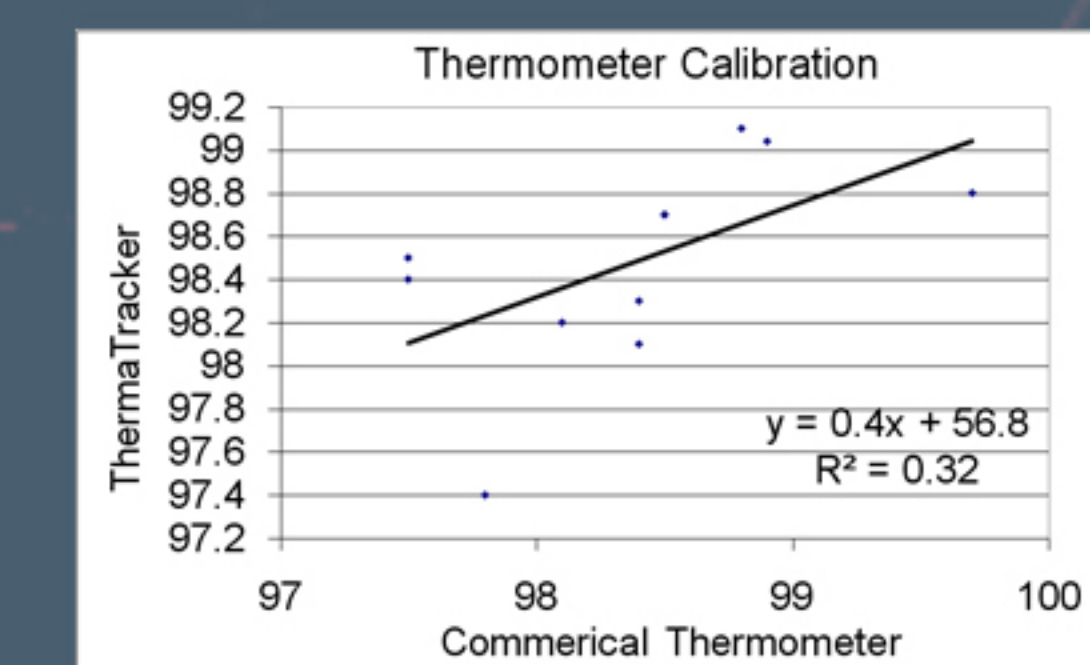
## DESIGN SPECIFICATIONS

- OUR DEVICE IS UNIQUE IN ITS ABILITY TO MONITOR BOTH HEART RATE AND CORE BODY TEMPERATURE AND TO DO SO CONTINUOUSLY AND WIRELESSLY.
- HEART RATE IS MONITORED AT THE FOREHEAD VIA PHOTOPLETHYSMOGRAPHY (PPG). THIS TECHNOLOGY RELIES ON THE AMOUNT OF INFRARED LIGHT REFLECTED BY THE BLOOD, WHICH CHANGES WITH PULSATILE FLOW. THE REFLECTED LIGHT CAN BE DETECTED BY A PHOTODIODE AND TRANSLATED INTO A VOLTAGE WAVE FORM.<sup>2</sup>
- CORE BODY TEMPERATURE IS MEASURED IN THE EAR VIA A THERMOPILE THAT DETECTS INFRARED RADIATION FROM THE EARDRUM.<sup>3</sup>

## TESTING DATA



- HEART RATE MEASUREMENTS OBTAINED FROM THERMATRACKER EXHIBIT STRONG CORRELATION TO EKG DATA.
- PRELIMINARY RESULTS SHOW CALIBRATED TEMPERATURES TAKEN FROM THERMATRACKER CORRELATE WITH THOSE MEASURED BY COMMERCIAL IN-EAR THERMOMETER WITHIN 0.4°F.



## FUTURE PLANS

- THE CIRCUIT REQUIRES MINIATURIZATION IN ORDER TO BE INCORPORATED INTO THE HELMET PADDING WITHOUT DISRUPTING THE INTEGRITY OF THE HELMET.
- IN ORDER TO EXPAND OUR MARKET, THE DEVICE COULD BE ADAPTED INTO A HEADBAND TO SUIT THE NEEDS OF OTHER HIGH PERFORMANCE ATHLETES, WITH AN OPTIONAL PERSONAL MONITORING DEVICE FOR INDIVIDUALS SUBJECTED TO EXTREME TEMPERATURES.

## ACKNOWLEDGEMENTS

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## REFERENCES

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2. ALLEN, J. "PHOTOPLETHYSMOGRAPHY AND ITS APPLICATION IN CLINICAL PHYSIOLOGICAL MEASUREMENT" PHYSIOL. MEAS. 28(2007) R1-R39
3. TERNDRUP, TE. "AN APPRAISAL OF TEMPERATURE ASSESSMENT BY INFRARED EMISSION DETECTION TYMPANIC THERMOMETRY" ANN. ENER. MED. DECEMBER 1992; 21: 1483-1492