Development of Experiment Environment for Acquisition of EEG Signals in Context of Human-Computer Interaction

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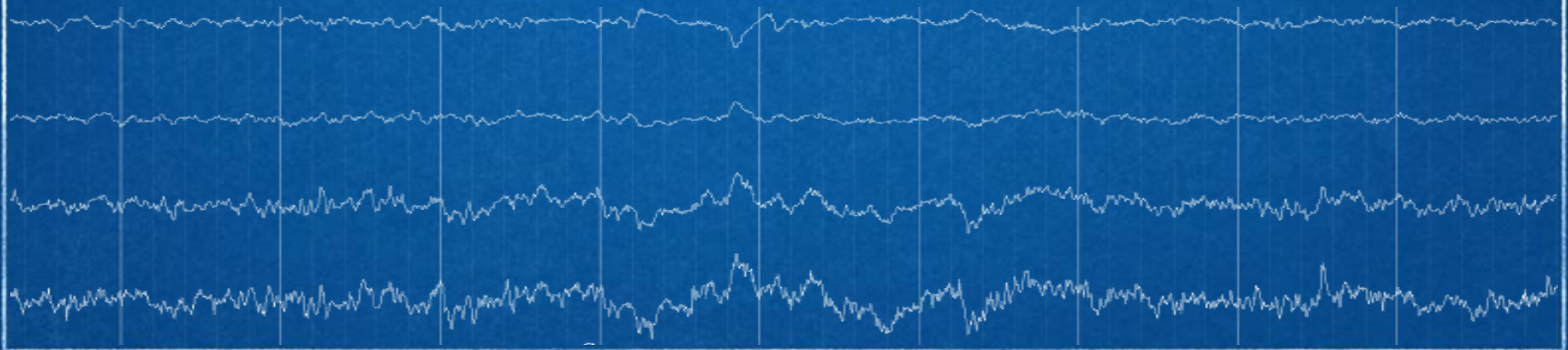
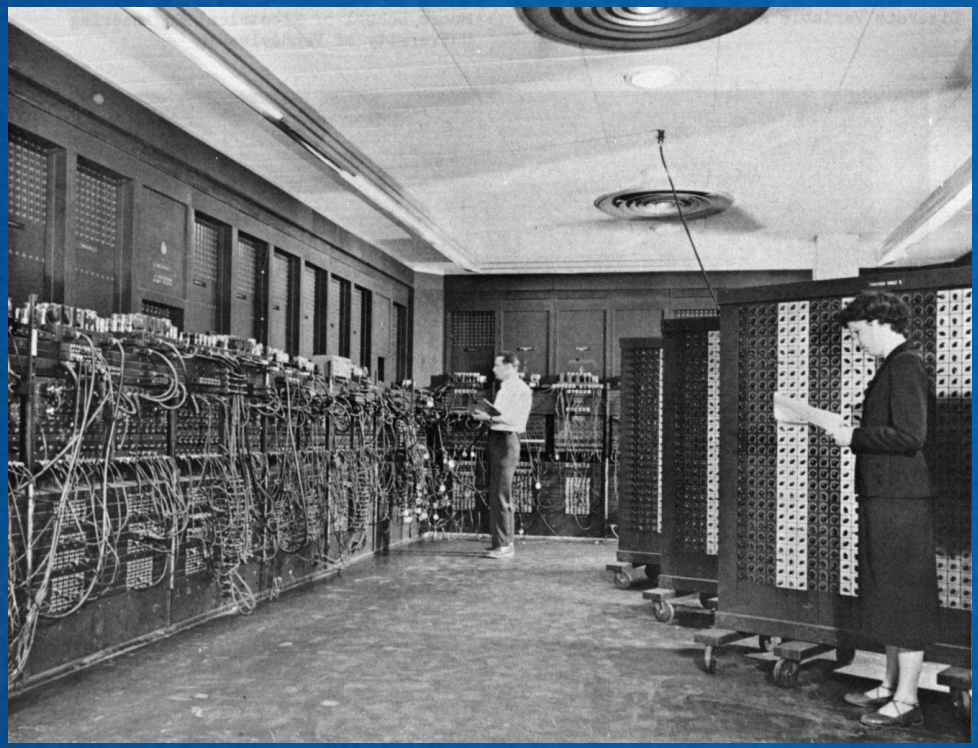


MAIN POINTS

- *Evolution of Human-Computer Interaction*
- *Origins of The Research*
- *Summary of Common Human Errors*
- *Preliminary Research Hypothesis*
- *Experiment Environment Setup*
- *Issues and Solutions*
- *How it works in practice*

THE EVOLUTION OF INTERATCTION WITH COMPUTER SYSTEMS

Computers of „yesterday"



ENIAC (circa 1947 to 1955 - Electronic Numerical Integrator And Computer) in Philadelphia, Pennsylvania. Glen Beck (background) and Betty Snyder (foreground) program the ENIAC in building 328 at the Ballistic Research Laboratory (BRL).
Source: Wikipedia (U.S. Army photo), Public Domain Photo

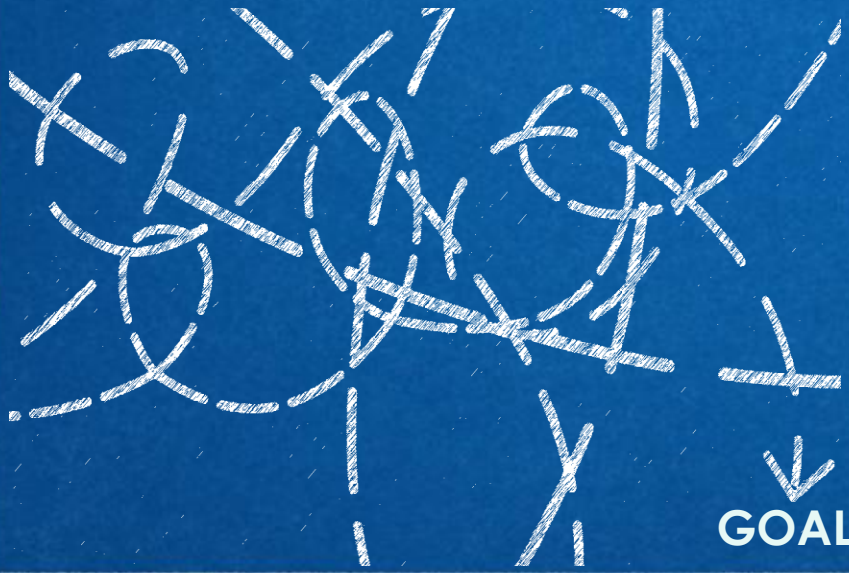
THE EVOLUTION OF INTERATCTION WITH COMPUTER SYSTEMS

Computers of „today”

THE EVOLUTION OF INTERACTION WITH COMPUTER SYSTEMS

- *Big Machines with tons of wires (ENIAC)*
- *Smaller machines programmed with cards*
- *Desktops and Personal Computers*
- *Phones/Tablets*

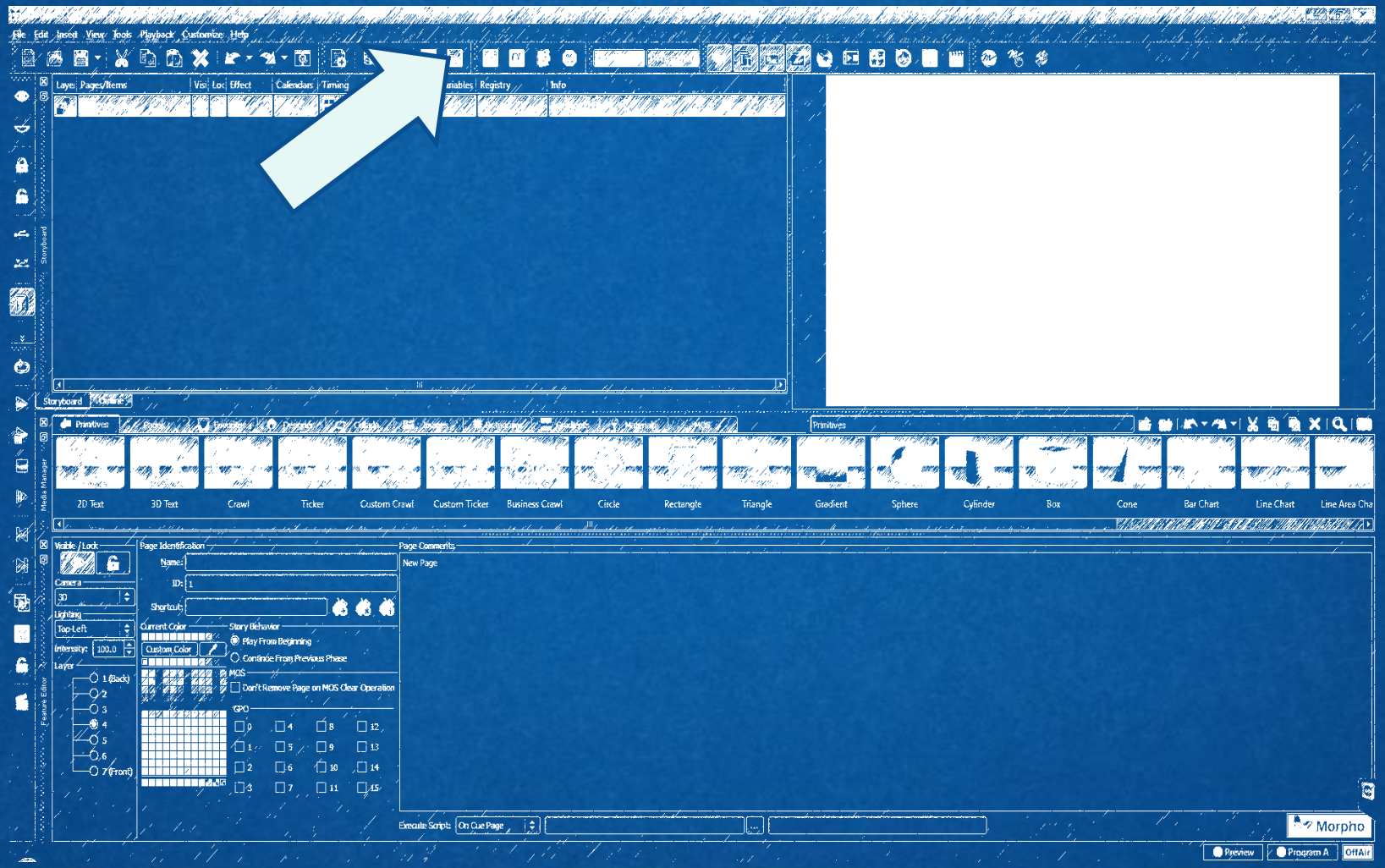
Yesterday's interaction



Interaction expected today

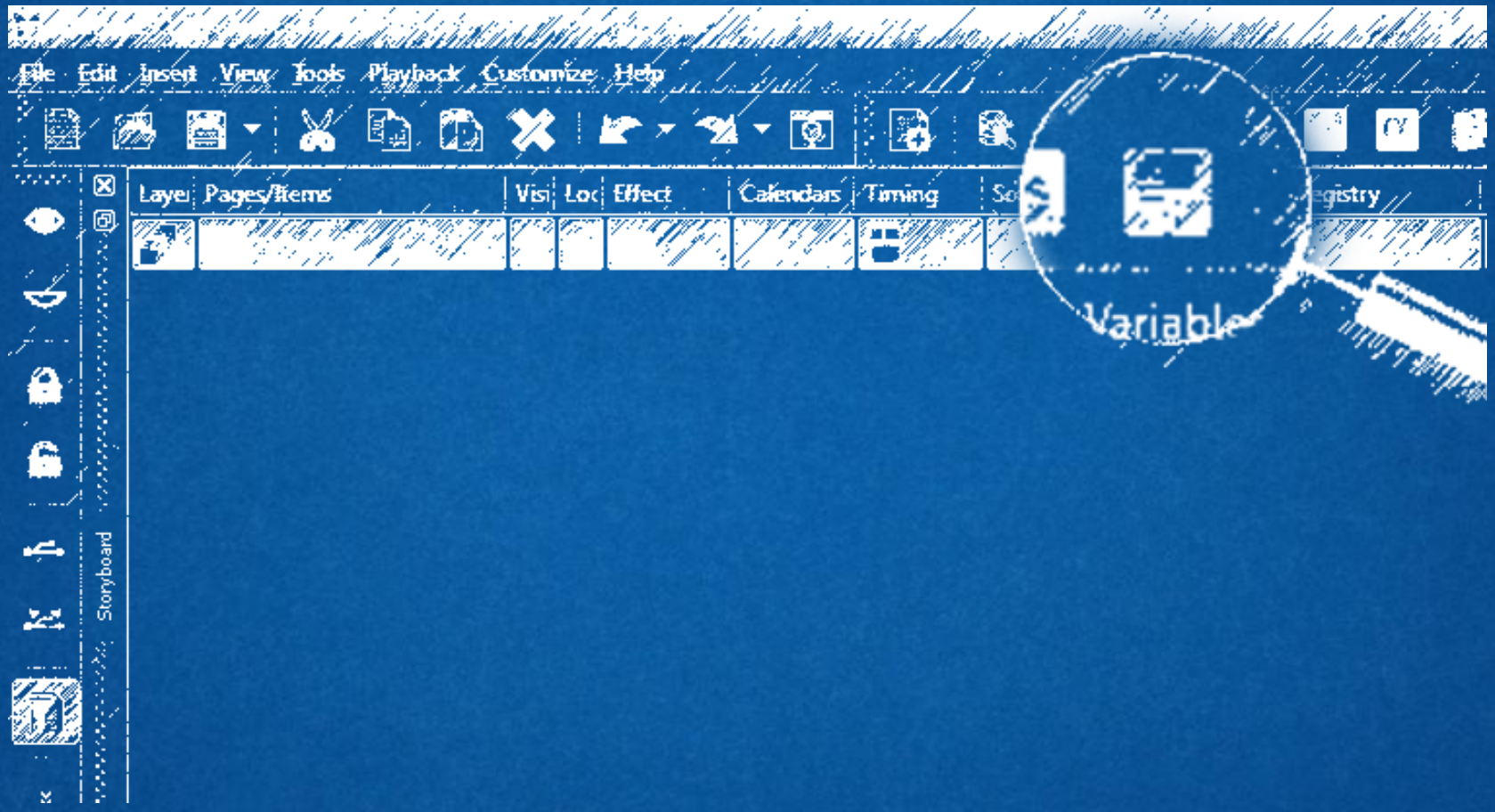
THE ORIGINS OF RESEARCH

- *The story of „UNEMPATHIC BUTTON”*



THE ORIGINS OF RESEARCH

- „UNEMPATHIC BUTTON" in closer look



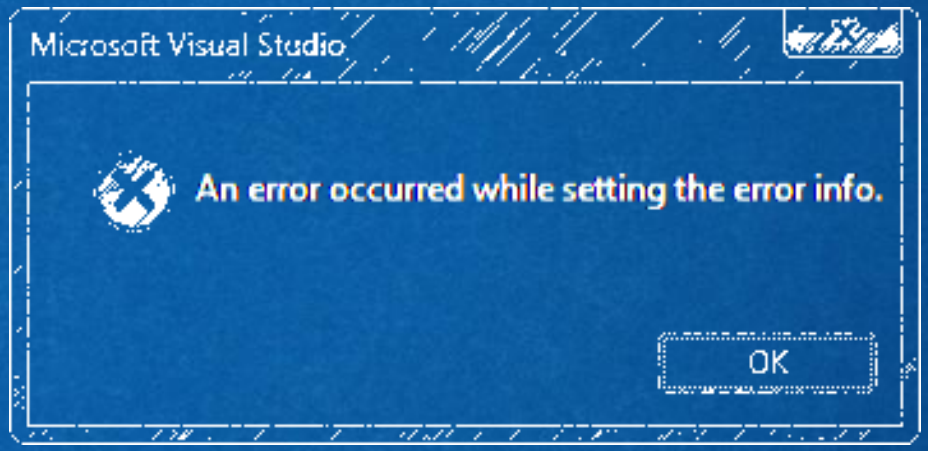
TODAY'S PROBLEMS

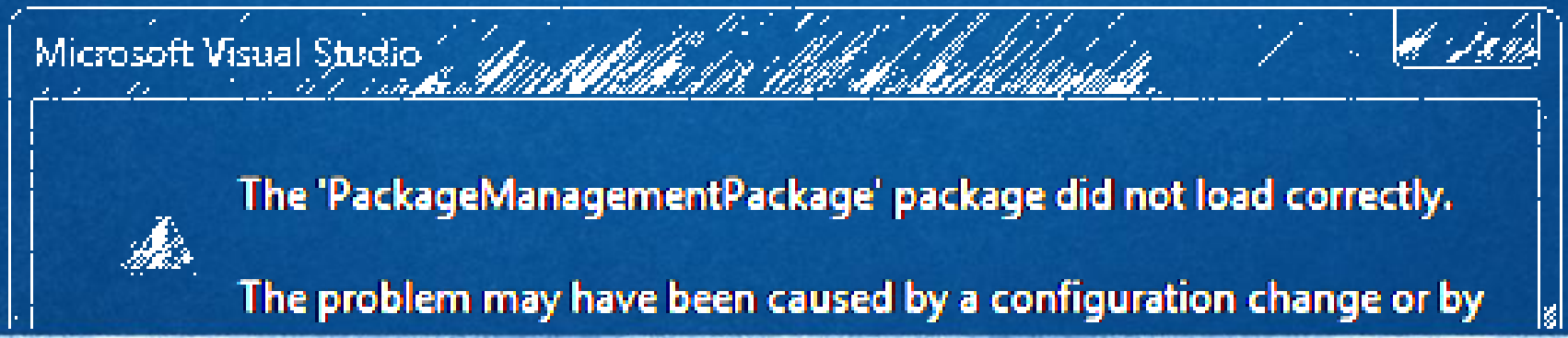
- *EXAMPLE FROM ONLINE SHOP AND MESSAGES FROM DESKTOP APPLICATION*

„Available to ship:

Currently not available

Free Shipping"





TO ERR IS HUMAN

EVERYDAY HUMAN ERRORS

- *MISTAKES*
  - *"mistakes are result from the choice of inappropriate goals and conscious deliberations"*
- *SLIPS*
  - *"result from automatic behavior, when subconscious actions that are intended to satisfy our goals get waylaid en route"*

Source: Norman, D. A. **The Design of Everyday Things.,** *Basic Books* 1988

PRELIMINARY RESEARCH HYPOTHESIS

- *Electroencephalography (EEG) allows to detect sources of slips and mistakes;*

- *That information allows such correction of the application that better adapts it to human cognitive capabilities;*

- *Changed user interface will be characterized by significantly fewer design flaws causing operational problems, than the original interface.*

A TEST ENVIRONMENT SETUP

a) Operator

b) EEG Receiver

c) Test Script

(list of tasks for subject)

d) VGA Monitor

e) VGA and Screen Recorder

f) Eye tracking System

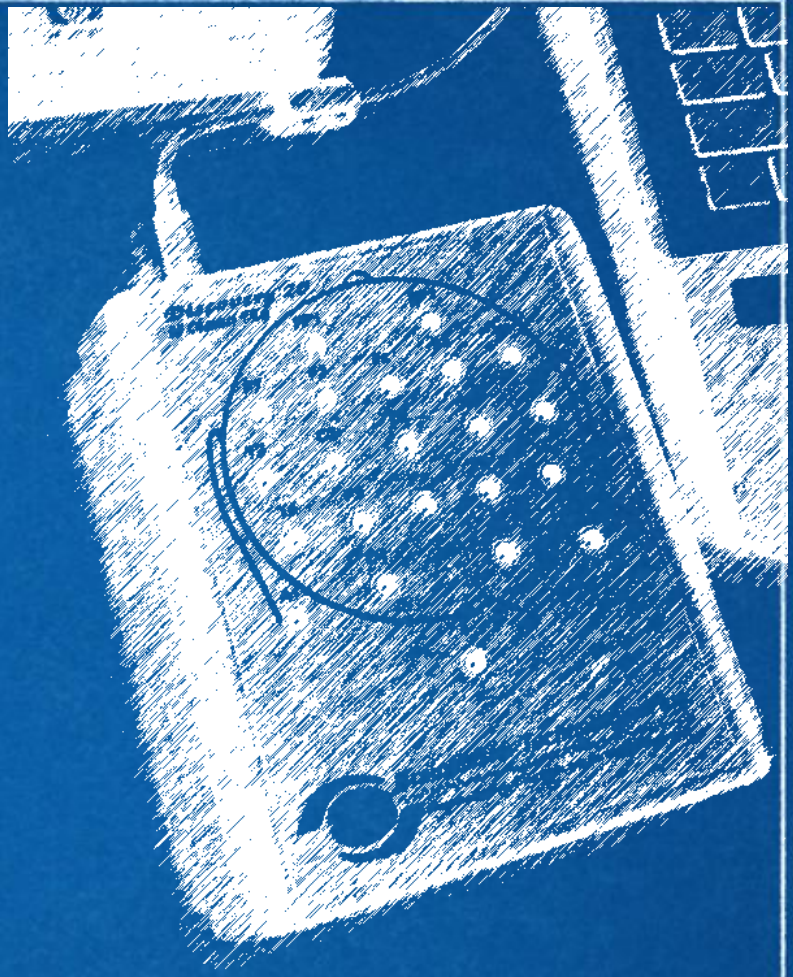
g) Video camera oriented on operator

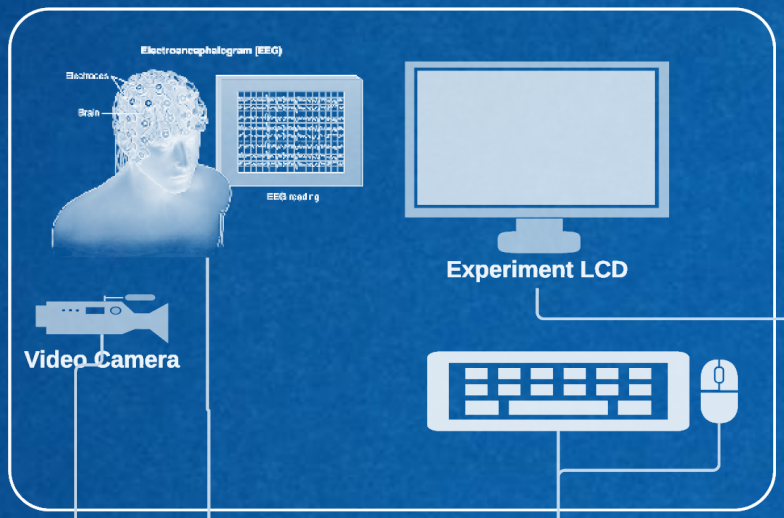
h) Tested GUI

i) Signal and Recordings Synchronisation

ii) TimeCode Camera Widget

SETUP DIAGRAM





BrainMaster 20000

EEG / Video

Ethernet

Experiment / Eye Tracking

DVI Splitter

Monitoring LCD

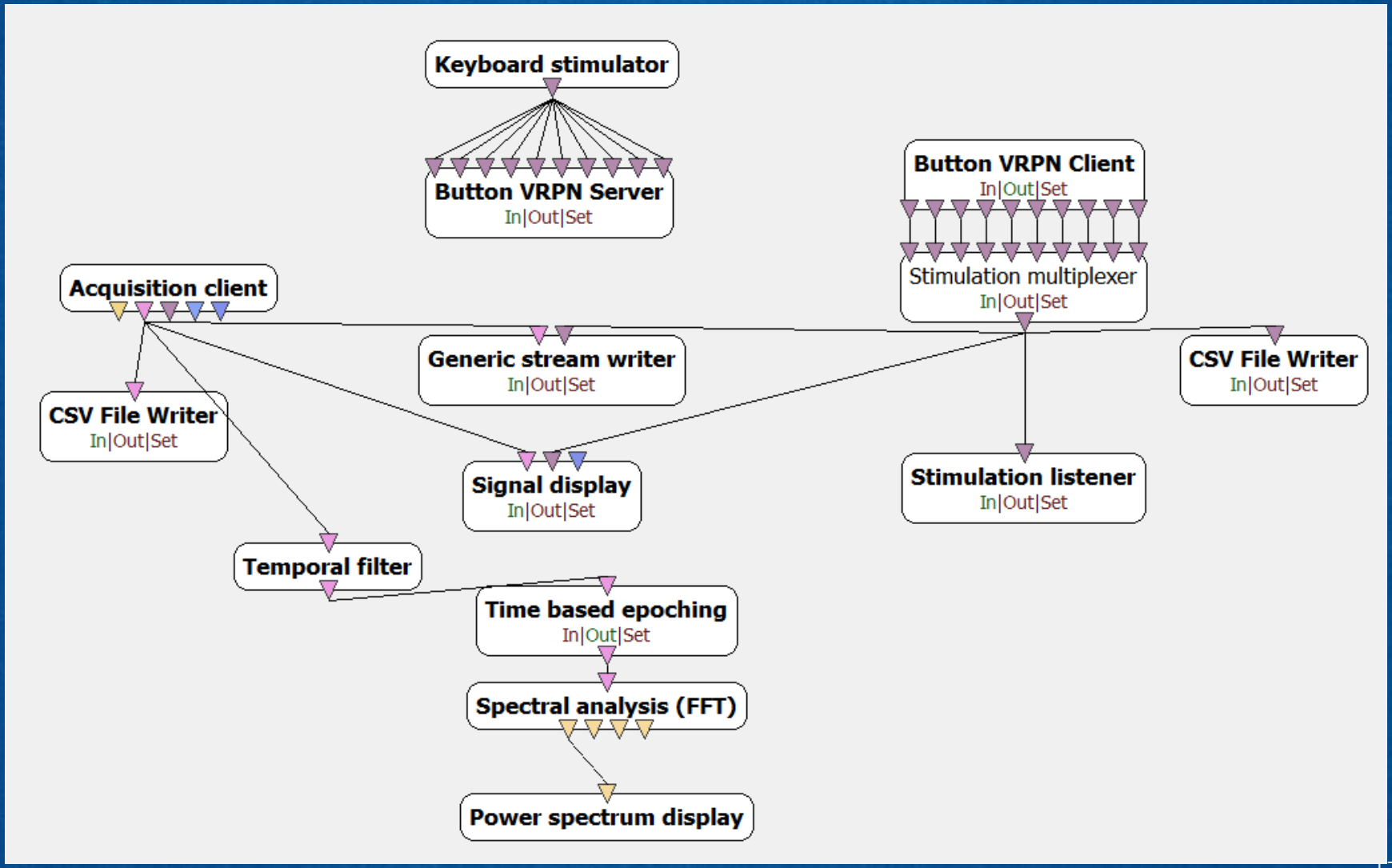
SIGNAL SYNCHRONISATION

- *EEG Signal (time 0 = beginning of session)*
  - *Synchronisation with Video Signal based on comparing time of stimulations with real time*
- *Tested Application*
  - *Sends information about stimulations to OpenVibe using VRPN protocol*
- *Video Signal (current time, as timecode)*
  - *Top part of the screen with timecode in mirror*
- *Eye Tracker (current time, as timecode)*
  - *Timecode saved together with rest of the screen*

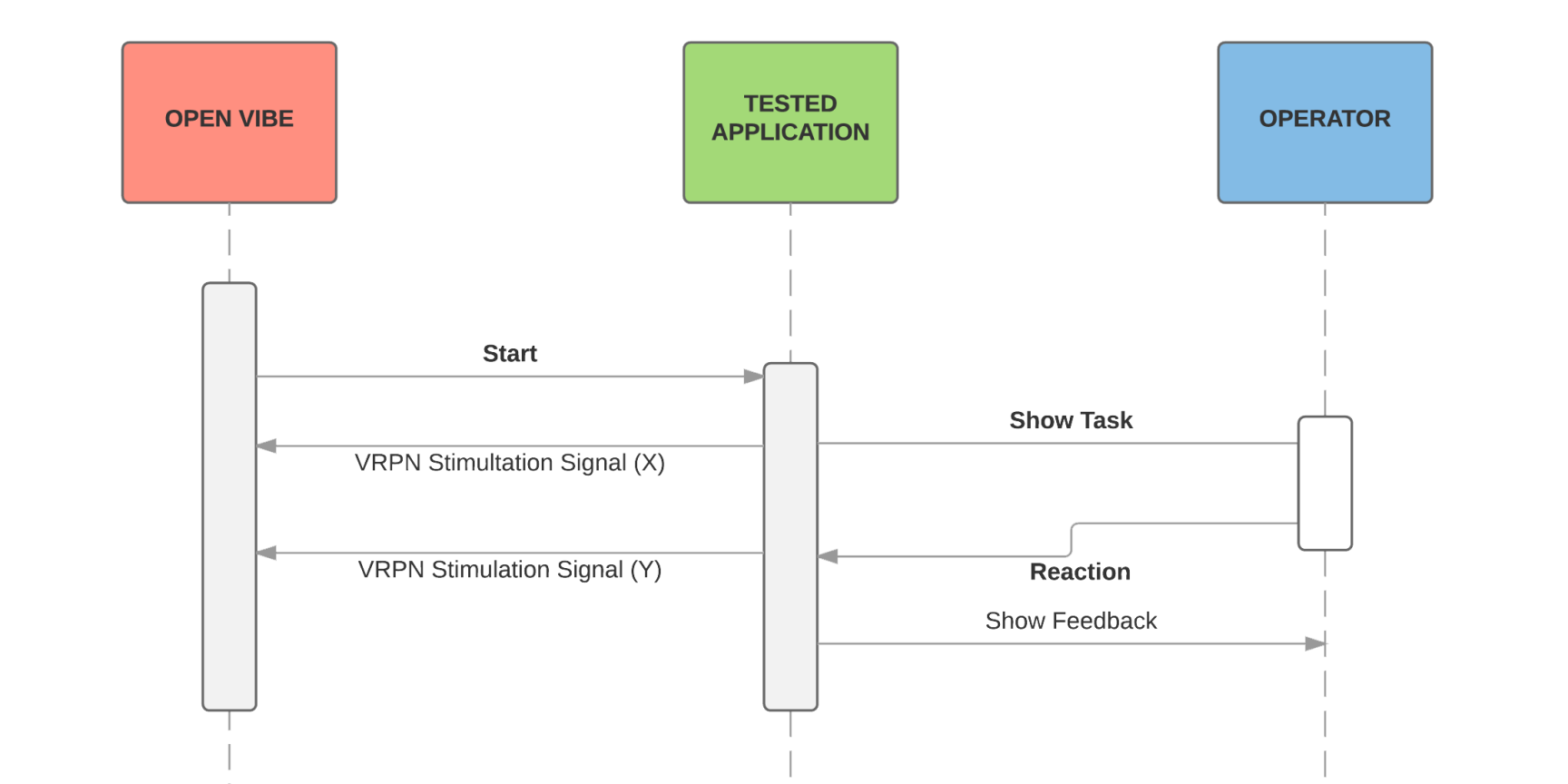
SIGNAL SYNCHRONISATION

Screen “timecode” in mirror

OpenVibe Scenario



SEQUENCE DIAGRAM

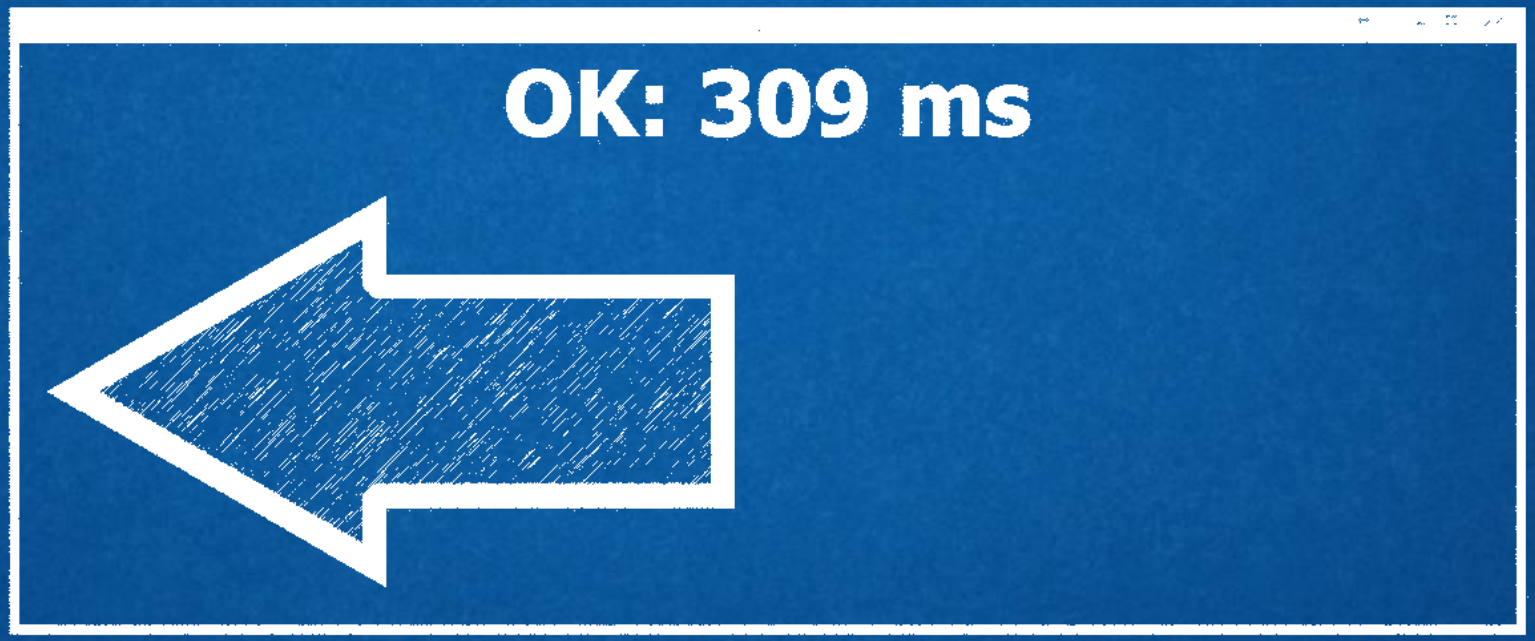


EXPERIMENT WORKFLOW

- *Laboratory preparation*
  - *Connect of all computers and devices*
  - *Peripheral configuration*
  - *Check connectivity and data recording*
- *Attach EEG equipment to operator*
- *EyeTracker callibration*
- *Start recording video signal, eye tracker system and EEG signal (with OpenVibe)*
- *Perform main experiment*
- *Disconnect operator from the EEG electrodes*
- *Save and preprocess signals from all sources*
- *Clean EEG equipment and lab*
- *Off-line signal processing*

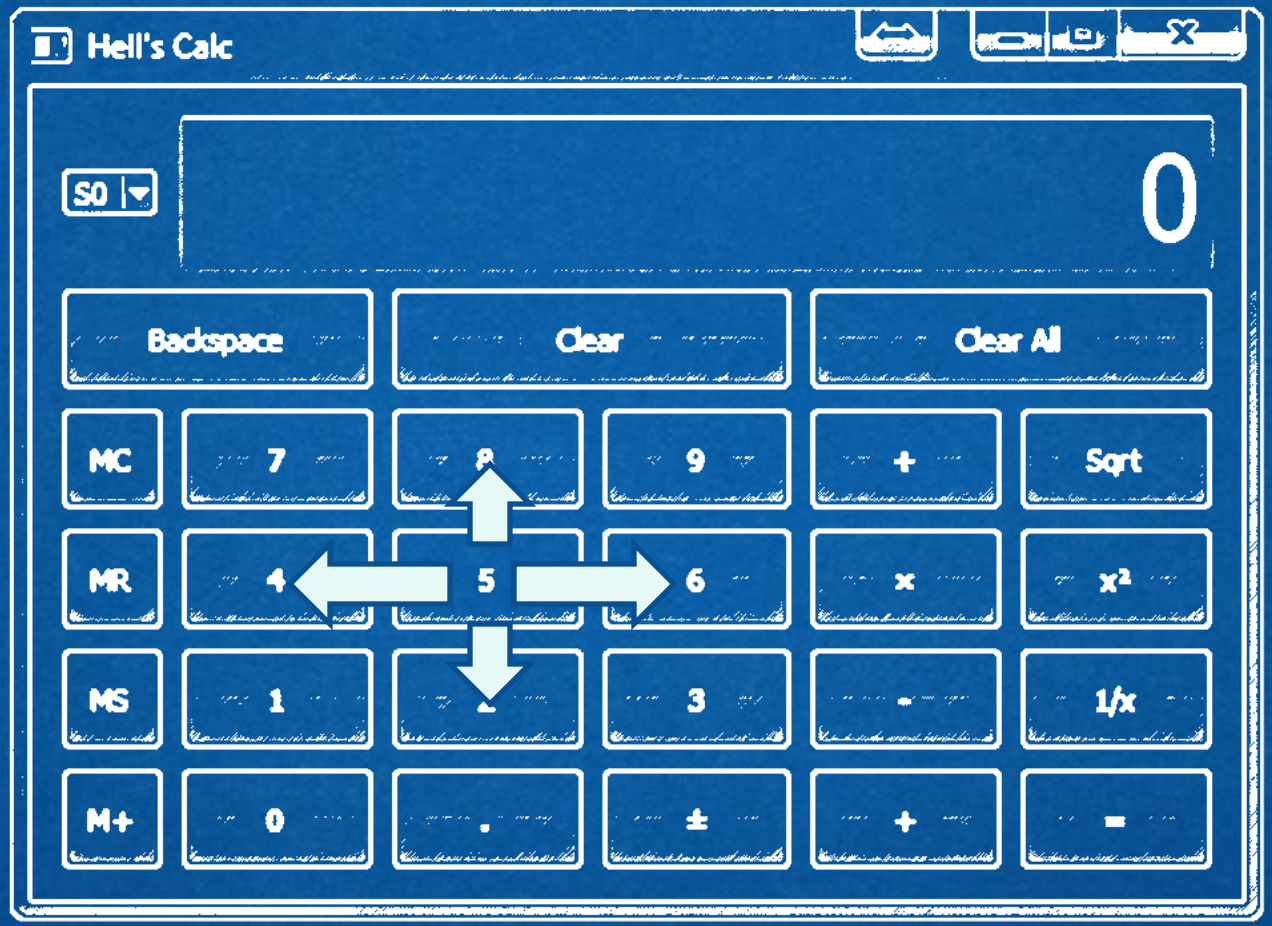
APPLICATIONS

- *Error Potential Stimulator*



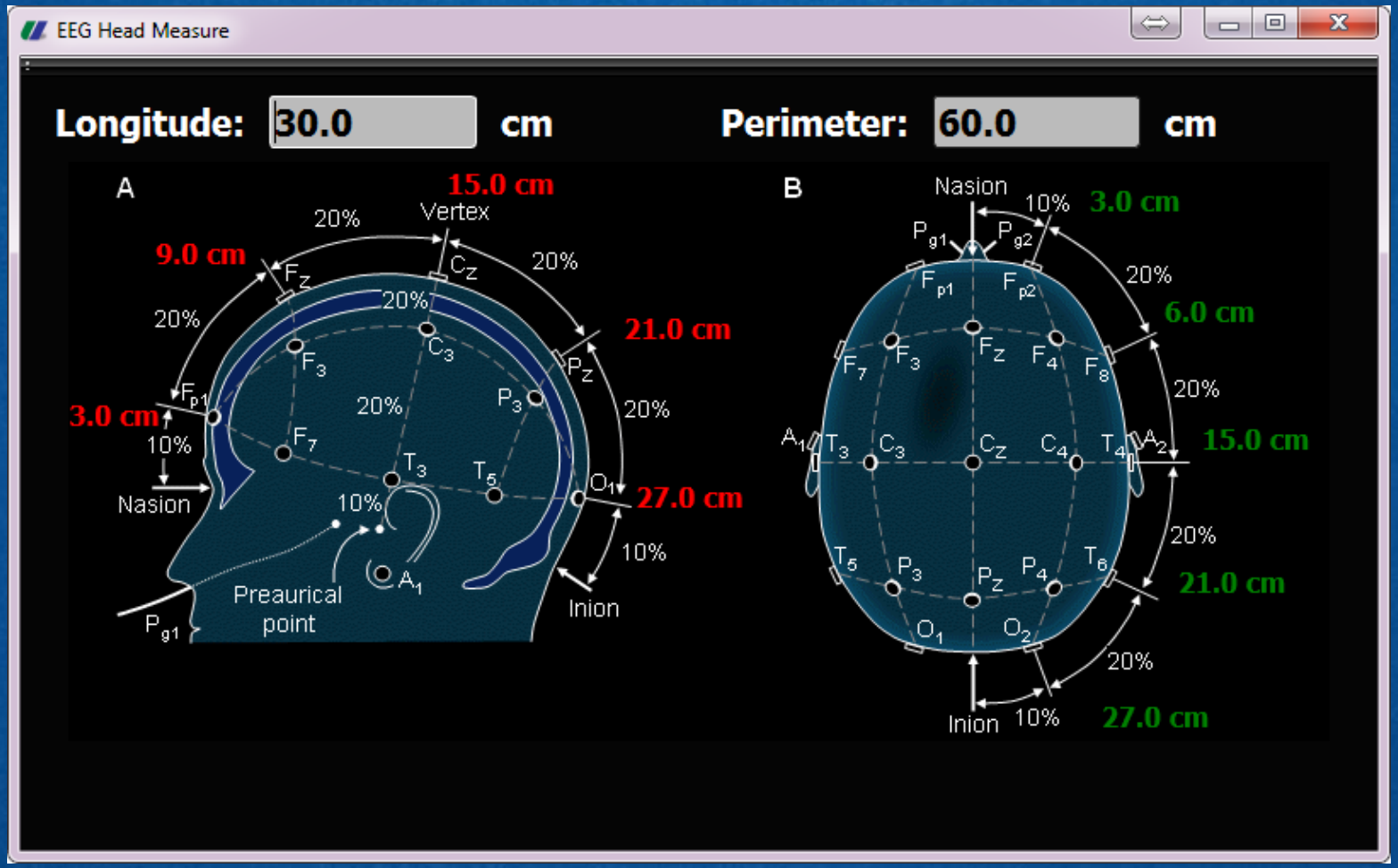
APPLICATIONS

- *Hell's Calc*

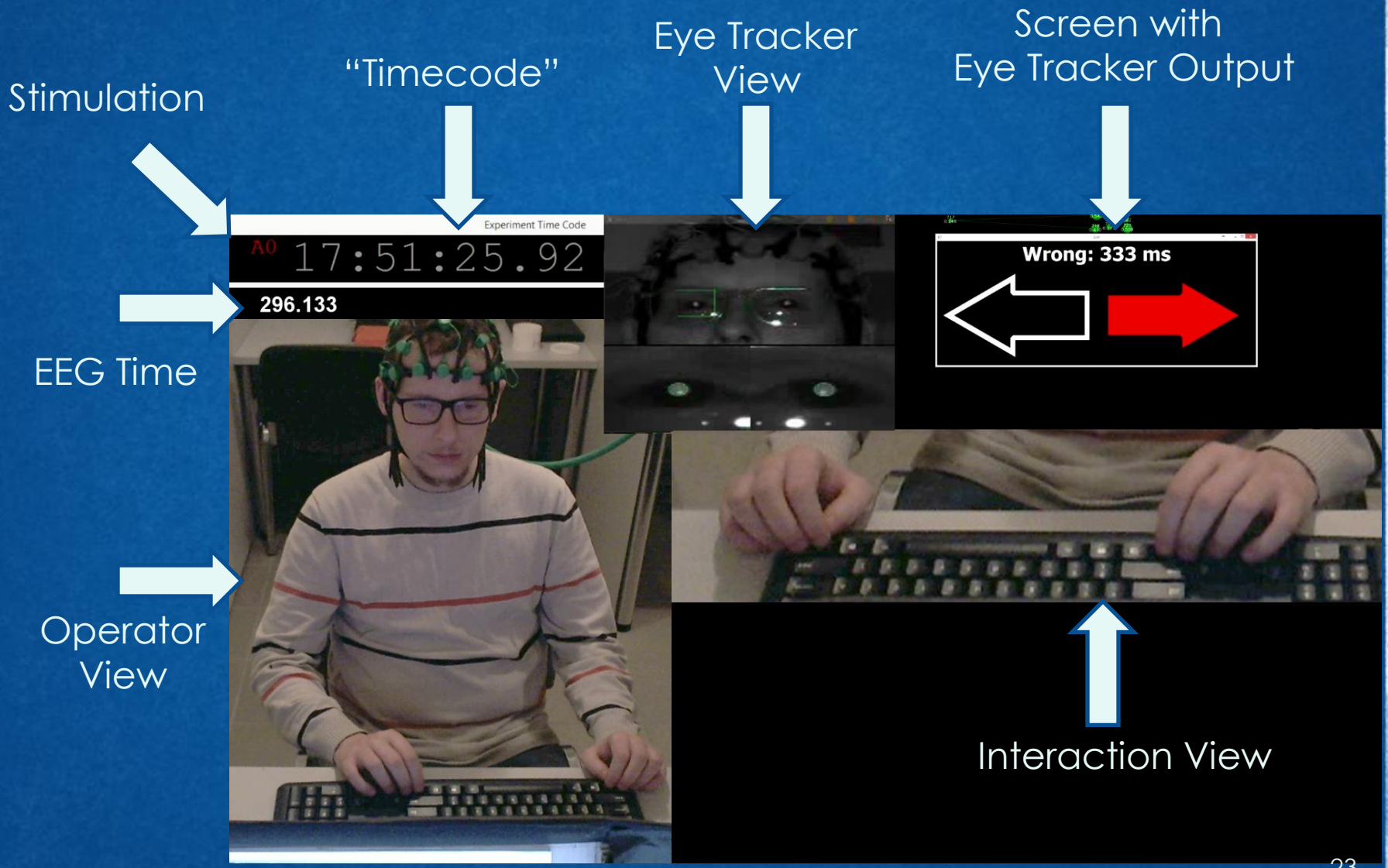


APPLICATIONS

- *EEG Head Measure*



HOW IT WORKS IN PRACTICE?



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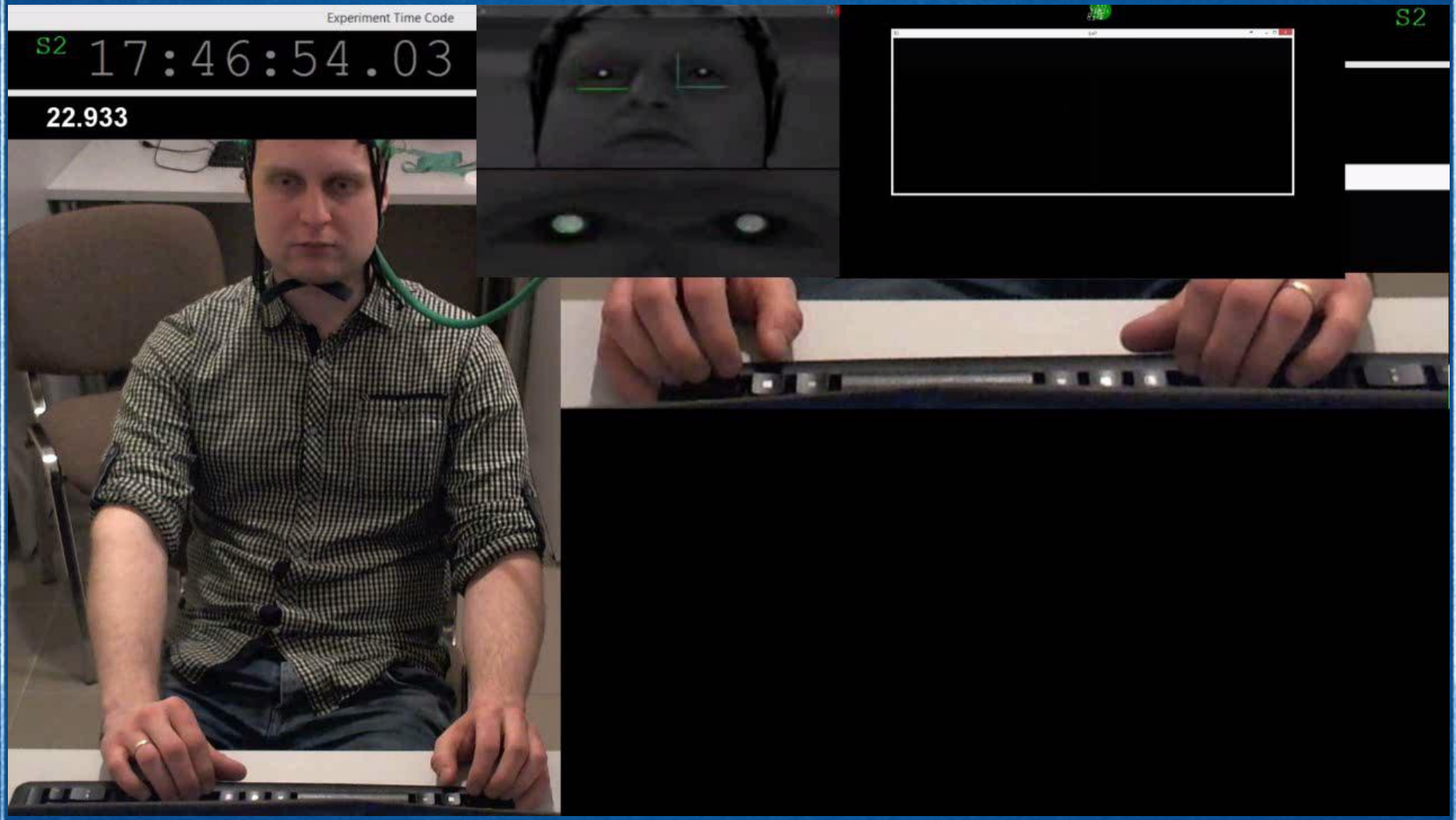


OTHER TECHNICAL EXPERIMENT OBSTACLES

- *GazePoint software on second monitor*
- *Issues with external keyboard connected to laptop*
- *Changes of machines IP numbers from session to session*
- *Low framerate of the camera and EyeTracker system*

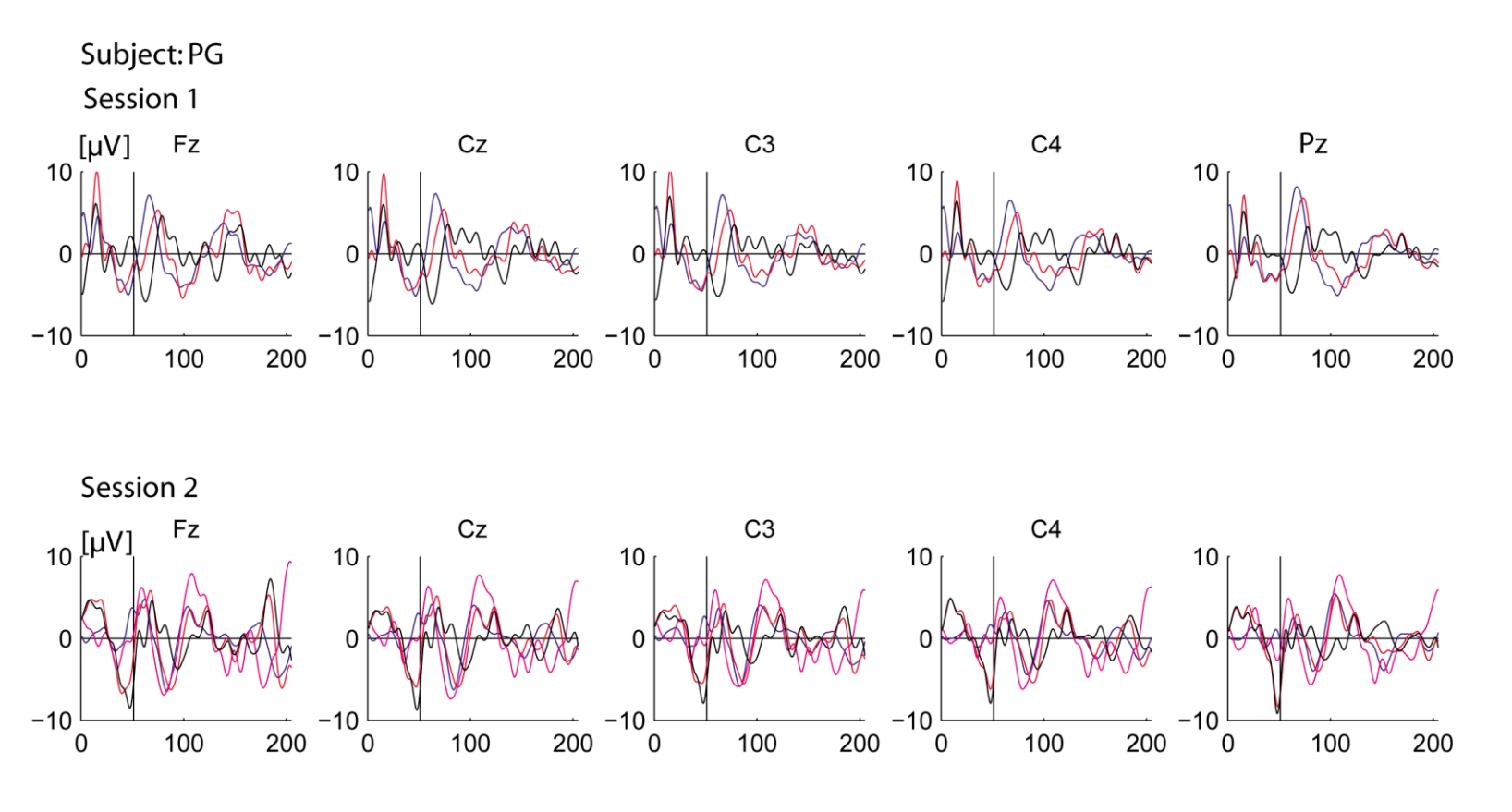
THANK YOU

DISCUSSIONS

- *Where EEG method may not be useful in context of testing Human-Computer Interaction*
  - *Areas where traditional methods are efficient and good enough*
  - *Situations, when cause and effect of the problem appear in significantly different time*
  - *When certain „obstacle" in human-computer interaction is implemented on purpose*
  - *When given problem is not notticed by operator*

FIRST RESULTS

Average EEG for error, correct, simulated error and difference error-minus-correct at channels Fz, Cz, C3, C4 for one subject



C = Correct Response (blue) ; E = Wrong Response (red) ; fE = False Wrong Response (magenta) ; E-C = Wrong Response - Correct Response (black)
time: -200 to 600ms (0s = time of feedback)