



Problems of Gait Analysis in Medical cases

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Who are we?

Goethe Gait Lab



Johann Wolfgang von Goethe

1749 - 1832

Johann Wolfgang von Goethe

Templar (1770- Straßburg)

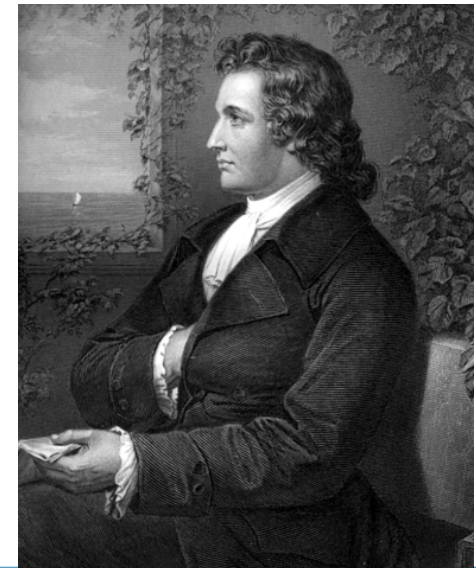
Literature (many languages: classics: Greek,
Latin, French, English)

Minstrelsy, drawing

Karl August,

Grand Duke of Saxe –
Weimar- Eisenach

Schiller



Goethe and Science

1799 – Metamorphosis of Plants
(Die Metamorphose der Pflanzen)

1806 – Metamorphosis of Animals
(Die Metamorphose der Tiere)

1832 – Theory of Colors
(Farbenlehre)

1775-1832 – Faust

Motion Analysis

Why?

Community Needs - Society

Hungarostudy 1998-2020

SE Institute of Behavioural Sciences

Hungarian population: once in two years 12 000 subjects

Once of Leaders of illness : **locomotor disease**
oftenest causes of Disability Pension

❖ **growing numbers of unnormal children**

Way of Remission: Exam

Painless
Simple for patents
Fast
Cheap
Good Data
3 D
Comparison

The correct Therapy comes from this Exam

Way of Remission: Exam

Painless

Simple for patents

Fast

Cheap

Good

3 D

Comp

HOW?

The correct Therapy comes from this Exam

Problem: Follow-ups of motions of the Human Body

The Human Recognition

Sensation + **Cognition** = **Recognition**



The Human Recognition

Sensation + **Cognition** = **Recognition**



The Human Recognition

Sensation + **Cognition** = **Recognition**



Cameras + **Workstation** = **Motion Capture**

The Human Recognition

Sensation + **Cognition** = **Recognition**

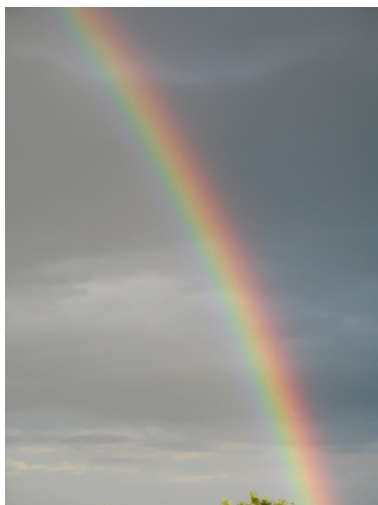


Cameras + **Workstation** = **Motion Capture**

OPTICAL FOLLOW-UP

Optical Follow-up

Equipment : **The light**

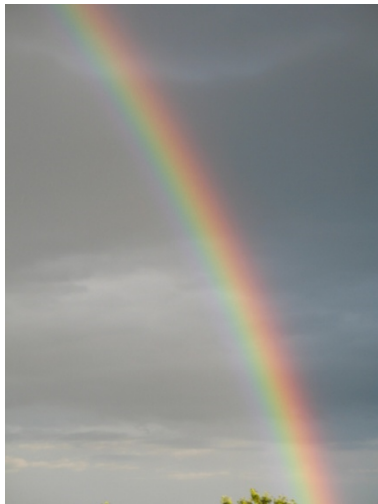


„A szem a Fényből születik a Fény számára”

Goethe: Színtan

Optical Follow-up

Equipment : **The light**

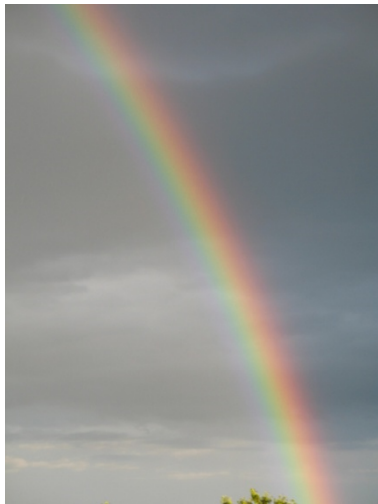


Know-how of Optical Follow-up

- ❖ Physiology
- ❖ Medical
- ❖ Engineering
- ❖ Animation

Optical Follow-up

Equipment : **The light**



■ Physiology and biomechanics

- Gait analysis and rehabilitation
- Biomechanics
- Body control, balance, motion coordination /kontroll
- Sport
- Space research
- Animal -researches
- Medical researches, Therapies, Checkups

■ Animation

- Games
- Film +TV
- Education

■ Engineering

- Ergonomy
- Simulation and visualization

■ Medical attendance

- Computer assisted therapy
- Dental implantation
- Surgery of throat, ears, and Nose
- Neurology
- Robot assisted surgery
- Biopsy
- Transcranial magnetic stimulation (TMS)
- Orthoped
- Spine surgery

Exam: Optical Follow-up

Calibration

Data gathering (AVI file) – more view

Trim

Digitize – **MARKERs** follow - up

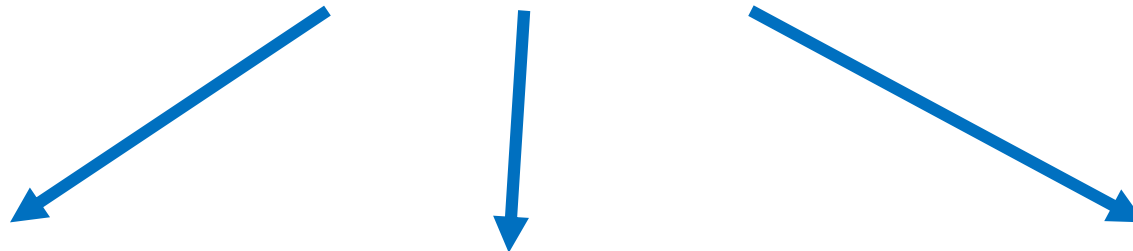
Transformation 2D – 3D

Filter

Data **output**

Data **Processing** (statistic)

MOTION ANALYSIS SYSTEMS

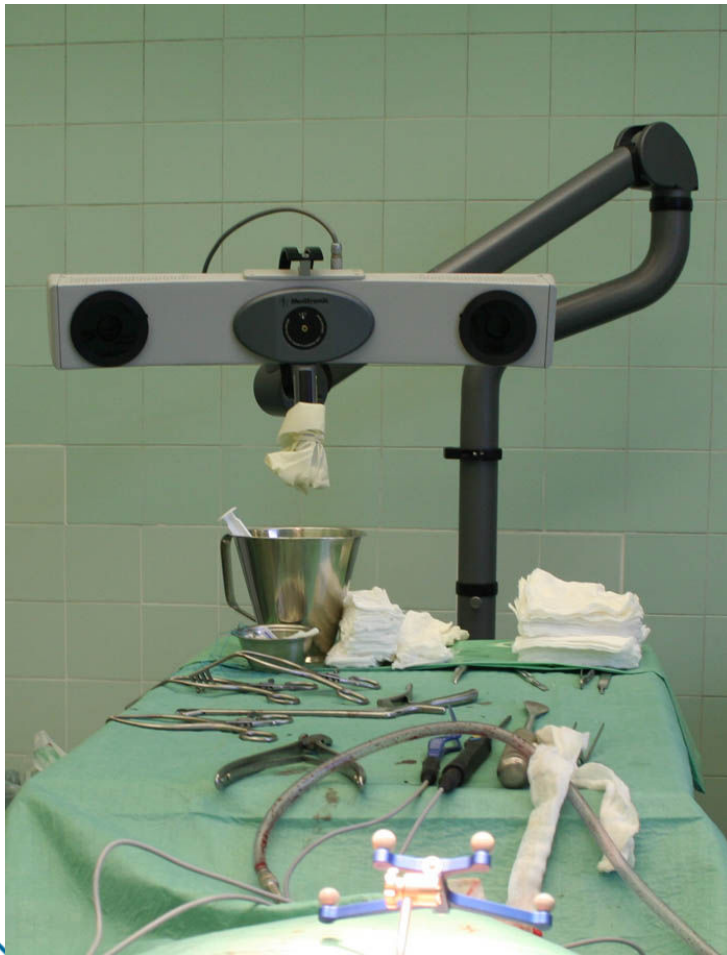


MEDTRONIC



300.000\$  **IEEE**

Medtronic – TREON
Medtronic Inc. Minneapolis , USA, 1949



Motion Analysis and Operation

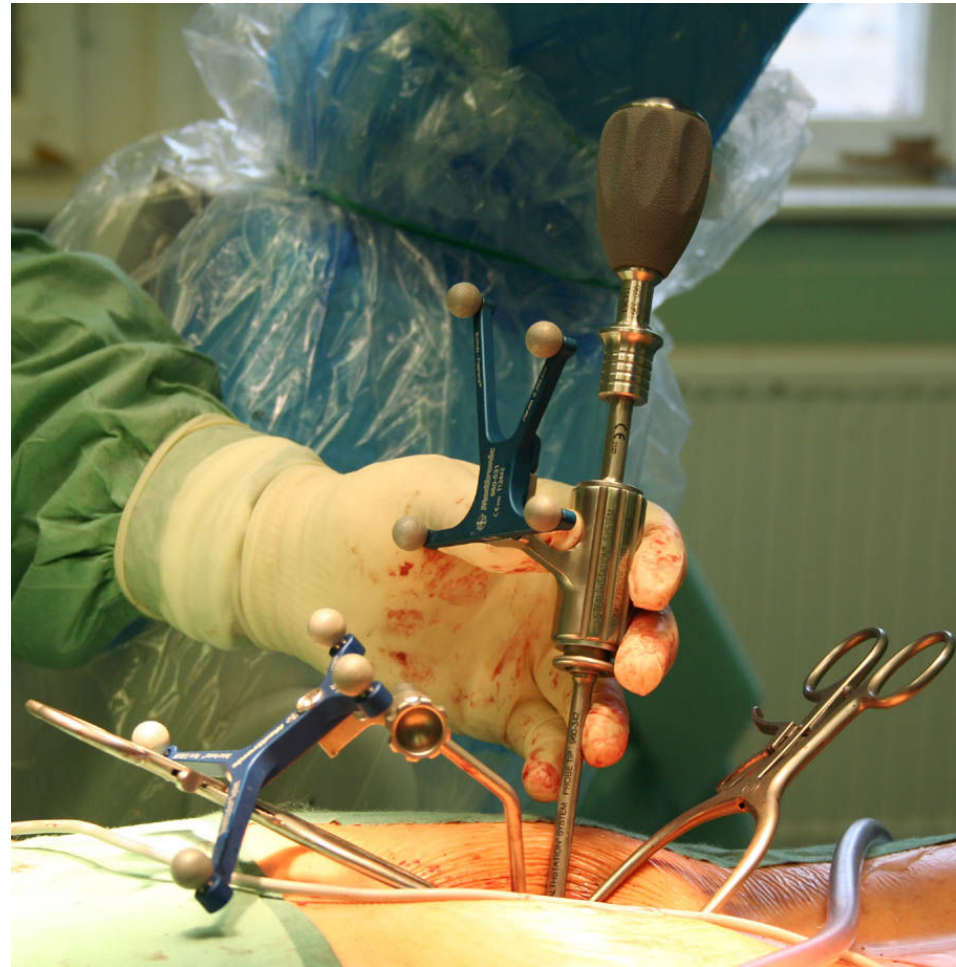
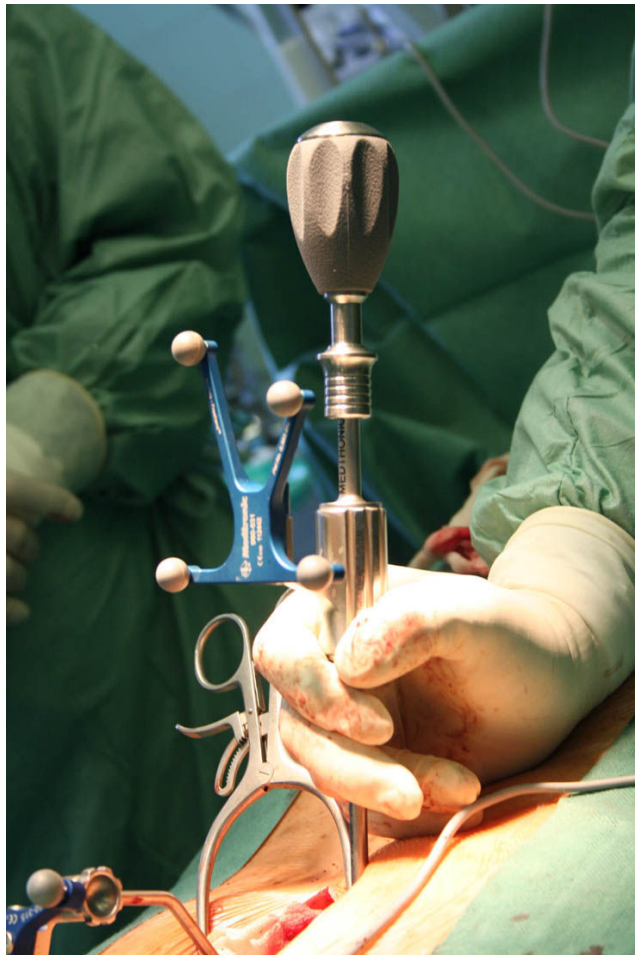


CALIBRATION



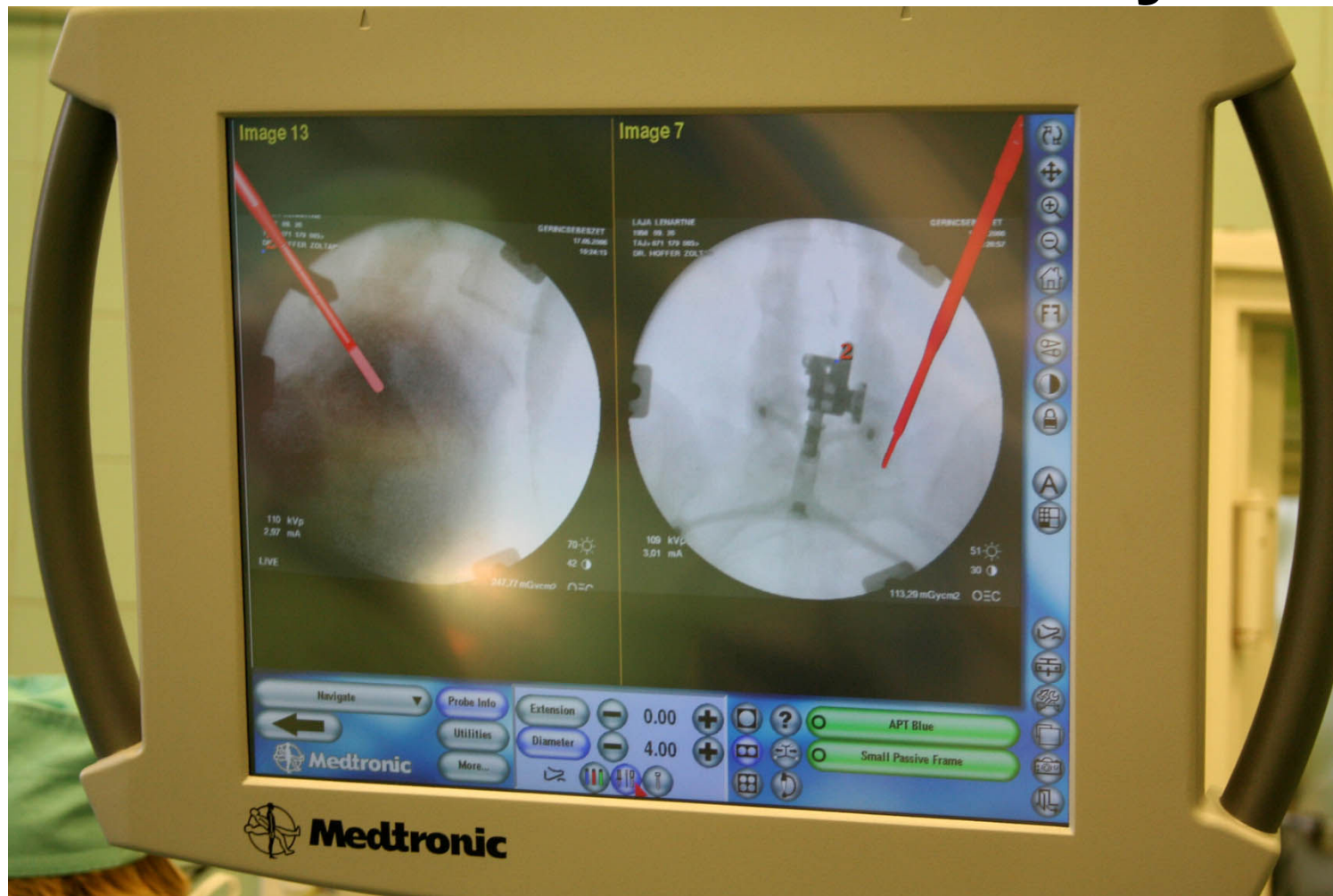
OPERATION :

markers and real - time X -ray



OPERATION :

markers and real - time X -ray



MOTION ANALYSIS SYSTEMS

VICON

MEDTRONIC



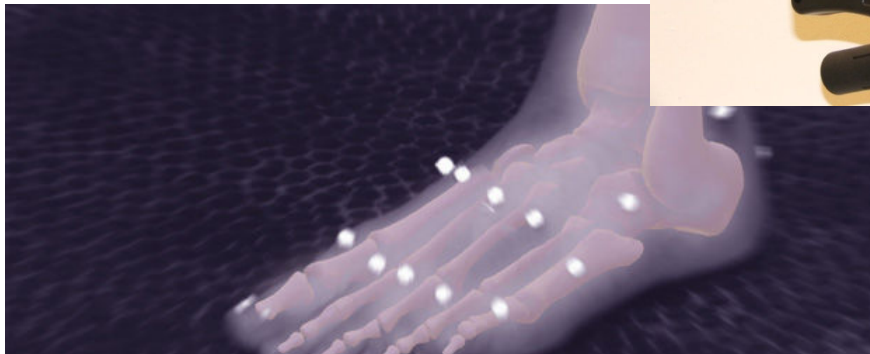
200.000\$



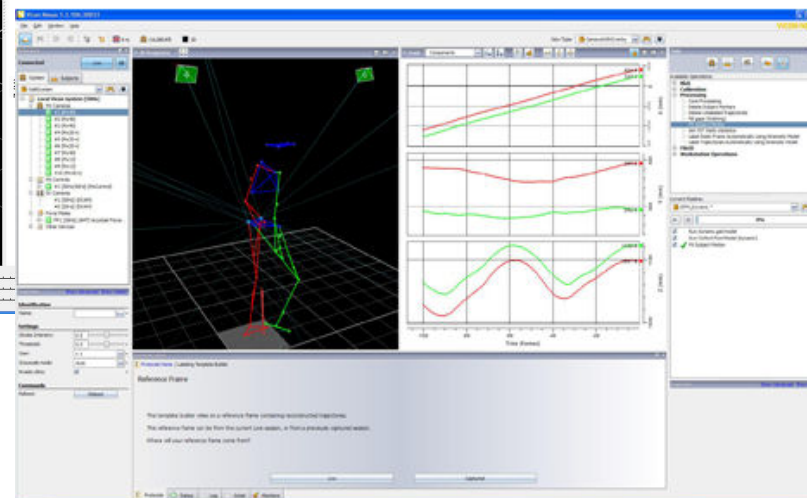
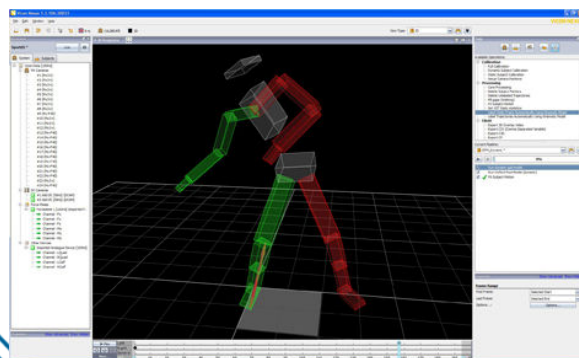
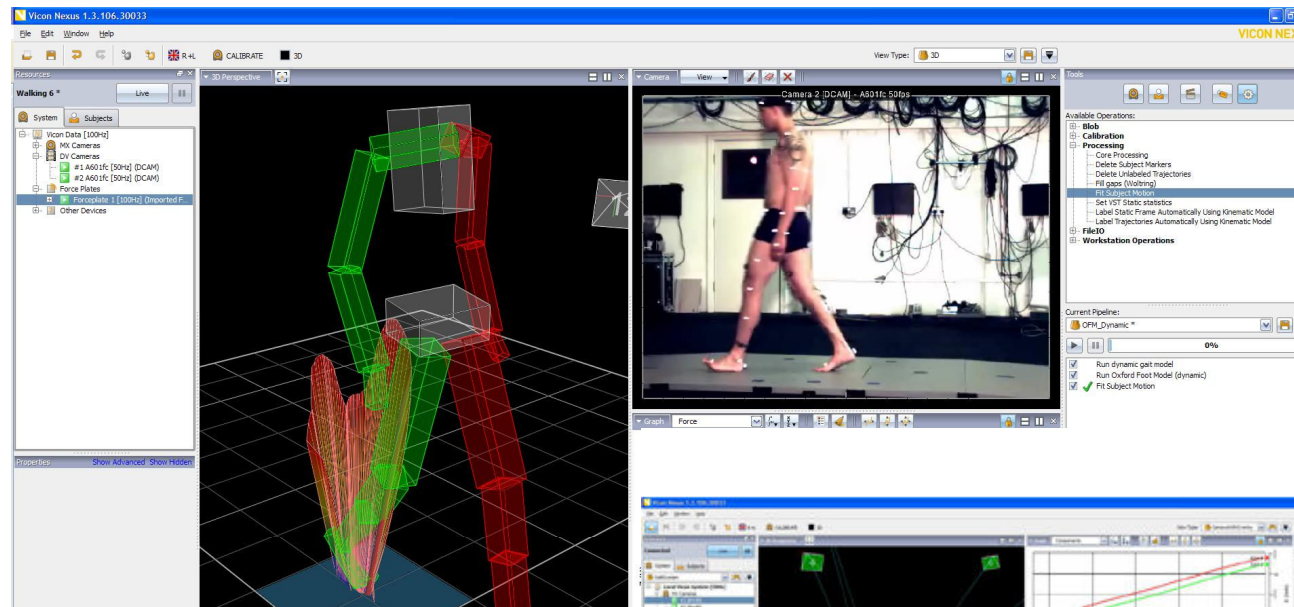
300.000\$ IEEE

VICON Motion Systems

Vicon Motion Systems Oxford UK, 1984



VICON : Motion Analysis , Animation, Ergonomy



MOTION ANALYSIS SYSTEMS

APAS



30.000\$

VICON



200.000\$

MEDTRONIC



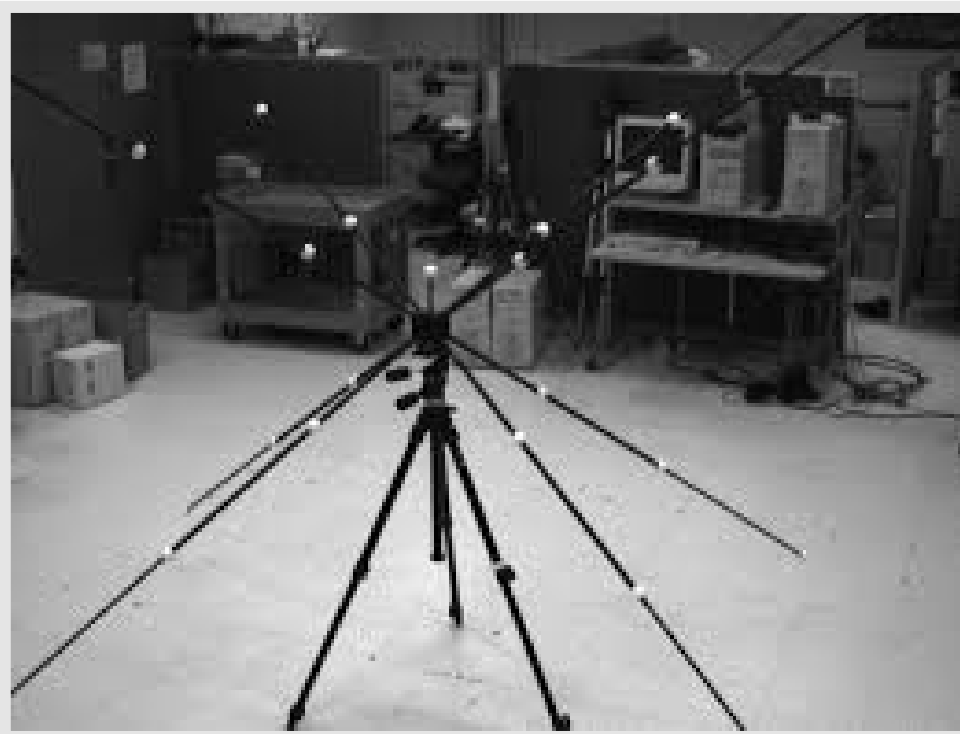
300.000\$

Ariel Performance Analysis System

Ariel Dynamics Inc.
USA, Ca, San Diego
1968



Calibration (APAS)



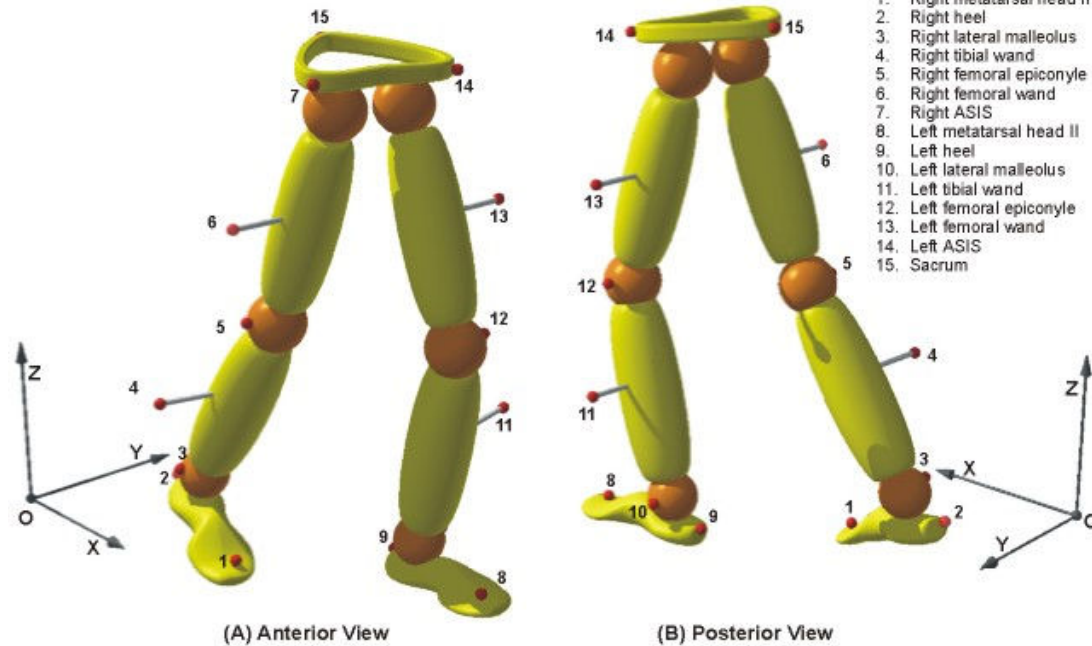
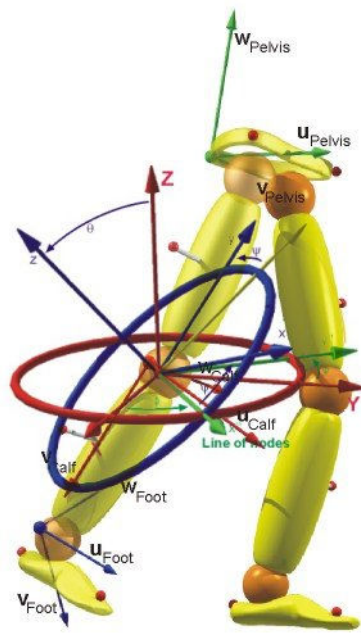
1968

Important
parameters?

No documentation

Error 5%

Body model (APAS)



Helen Hayes Hospital

Sun Gait System



Goethe Gait Lab

1. Cameras

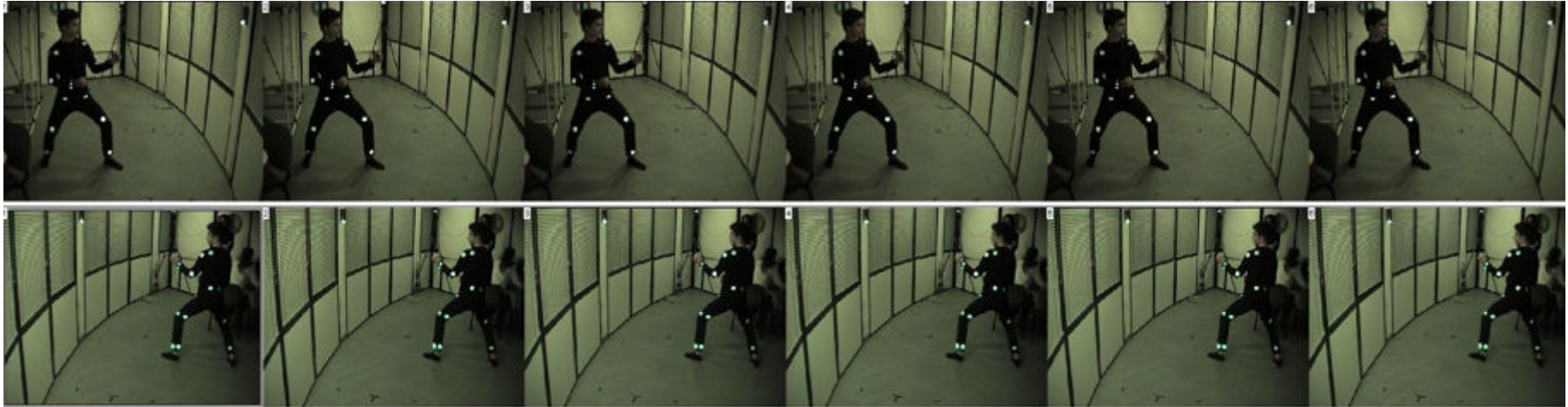
VIS or IR

4 or more cameras



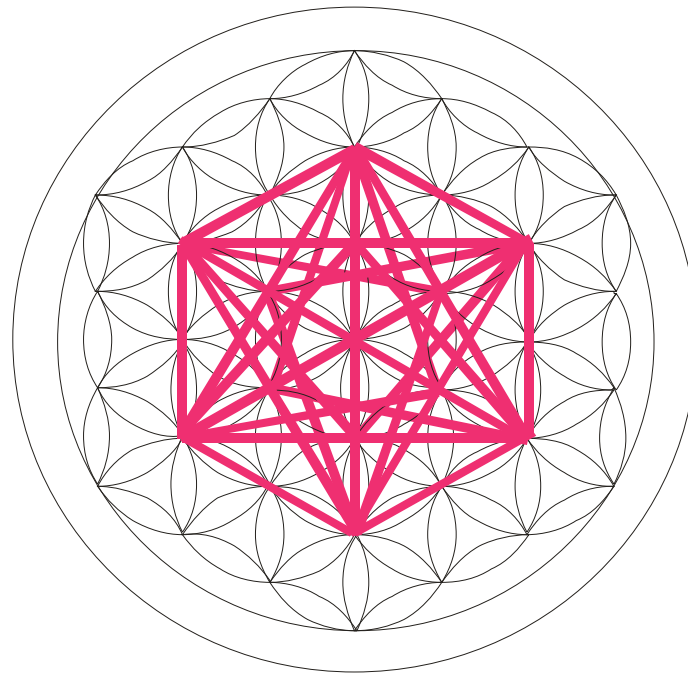
online

2. Trimming



online

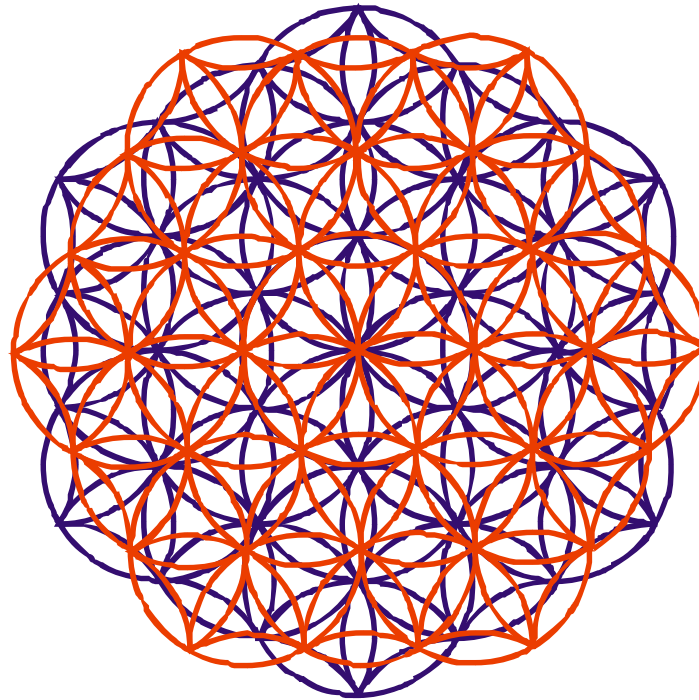
3. Calibration



3. Calibration Web

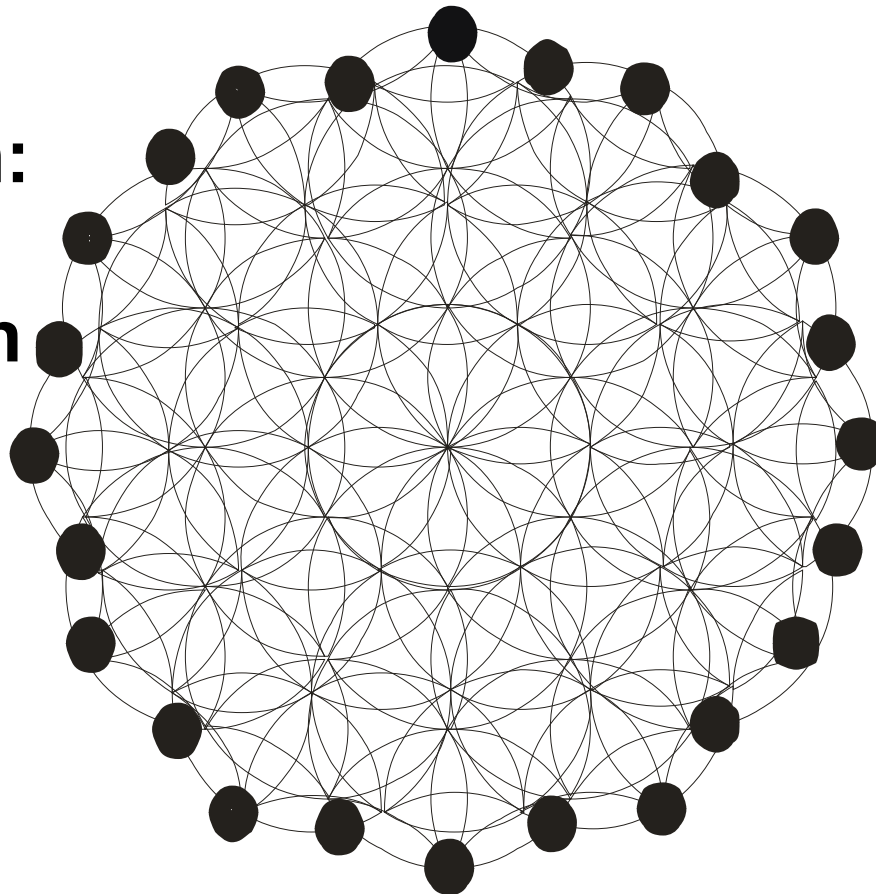
Calibration of room:

**declare the position
of cameras**



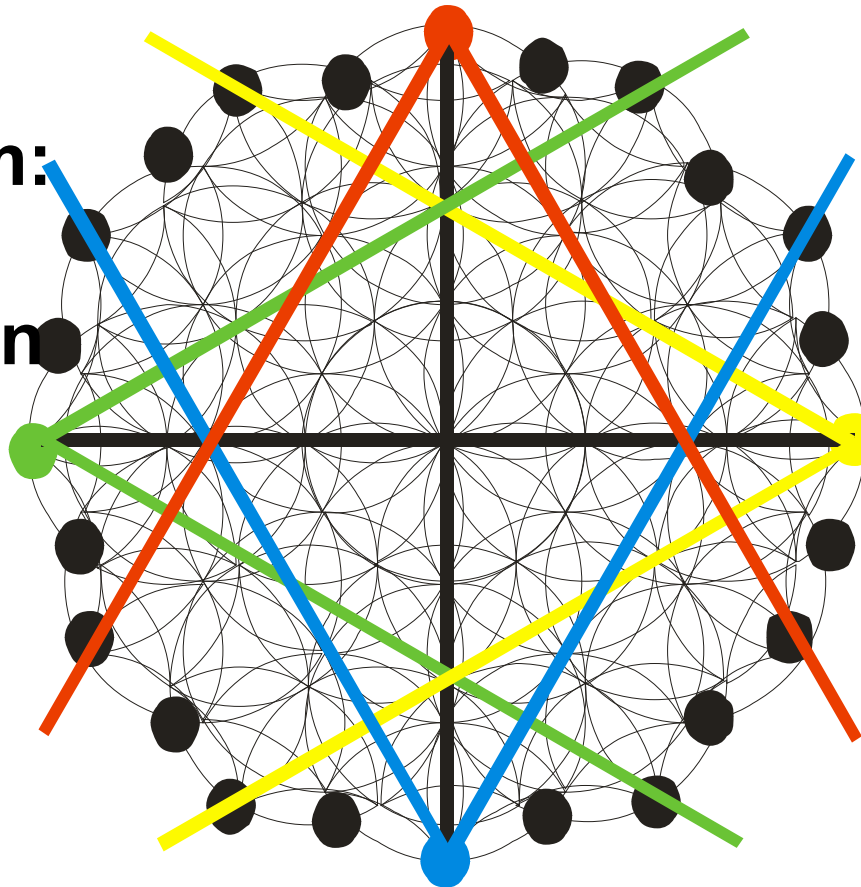
Calibration of room:

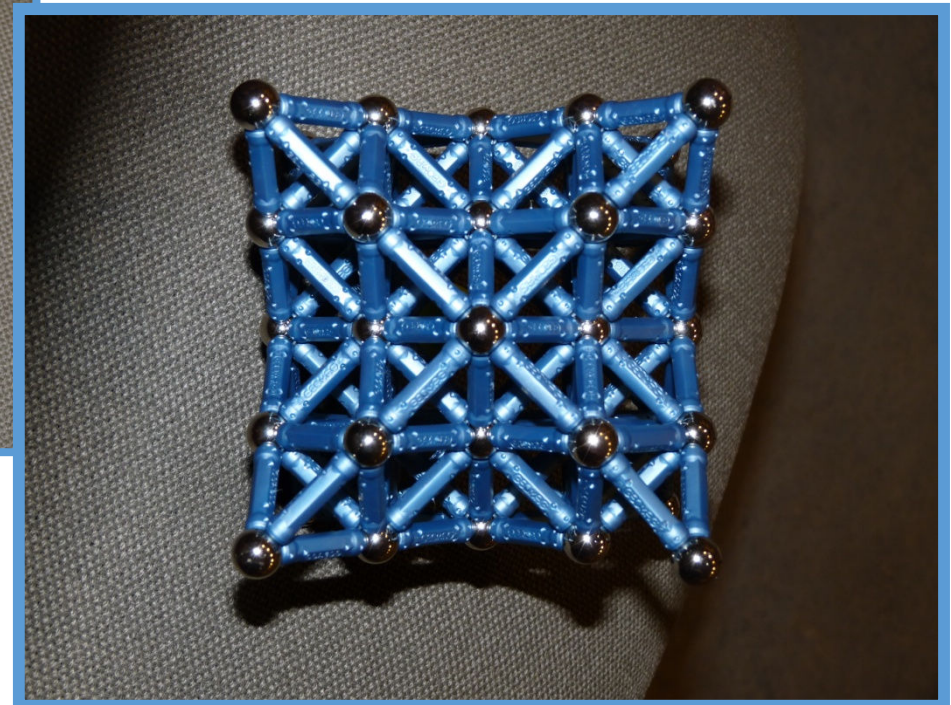
**declare the position
of cameras**



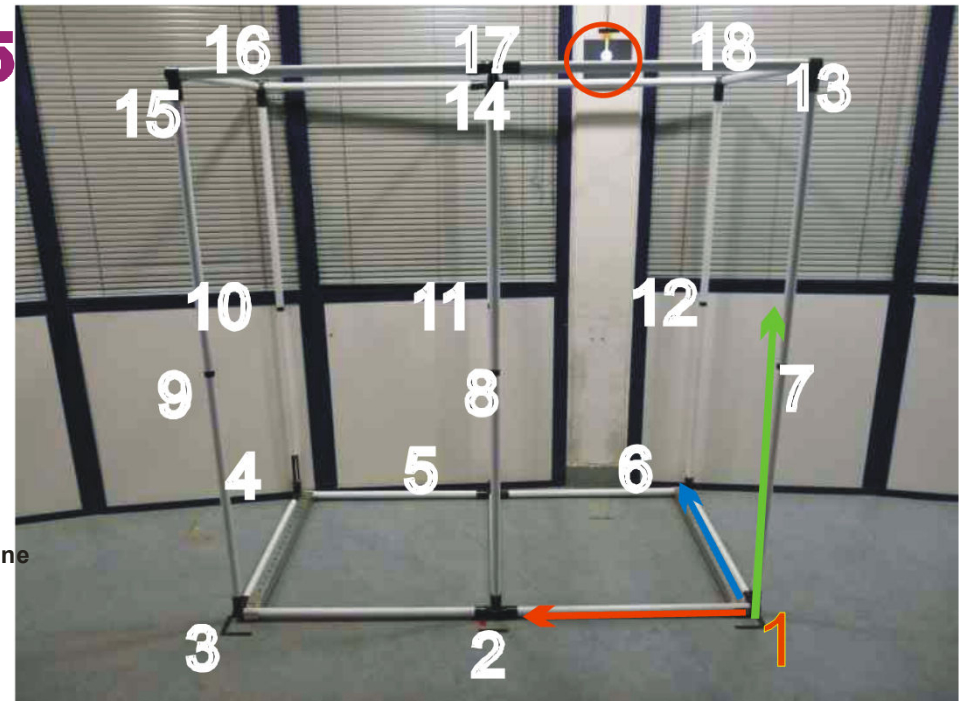
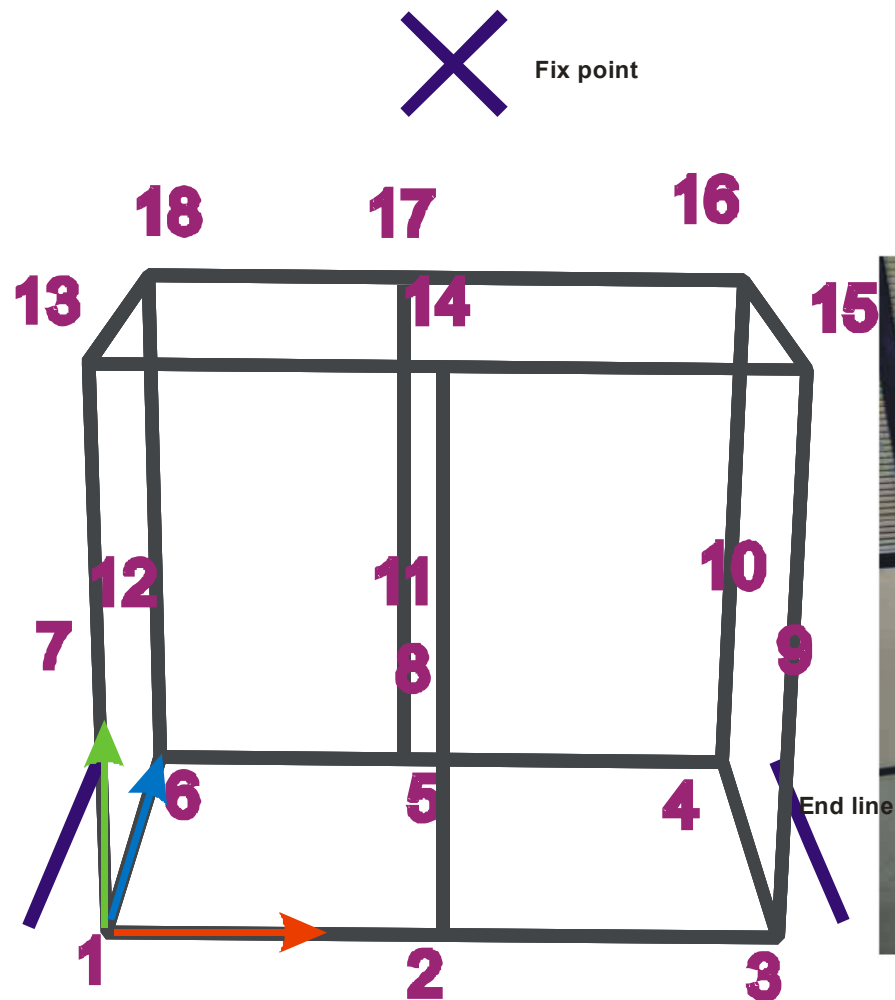
Calibration of room:

**declare the position
of cameras**



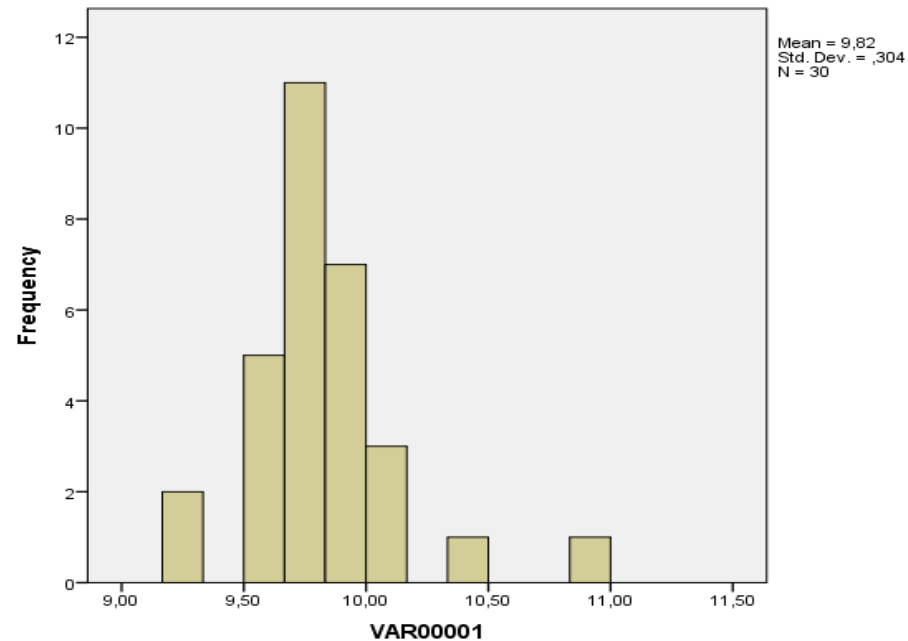


...and a calibration cube WITH WEB



Errors of GGL

❖ Velocity and acceleration – 400 measurements



Errors of GGL

- ❖ Velocity and acceleration – 400 measurements

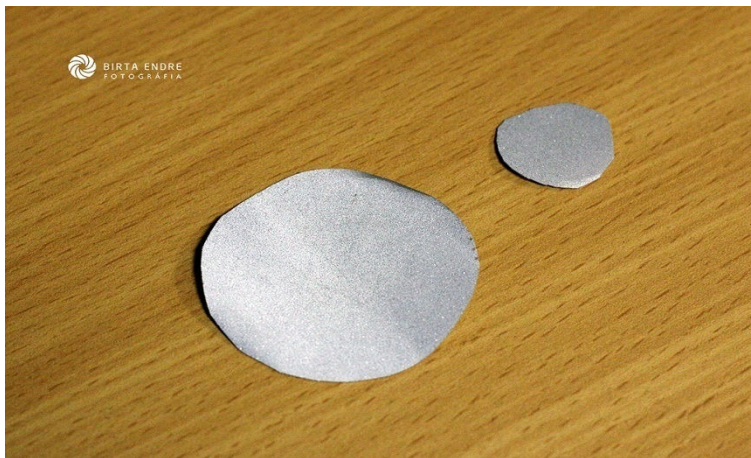


9,82 m/s²

error < 1%

4. Markers – own innovation

Passive marker



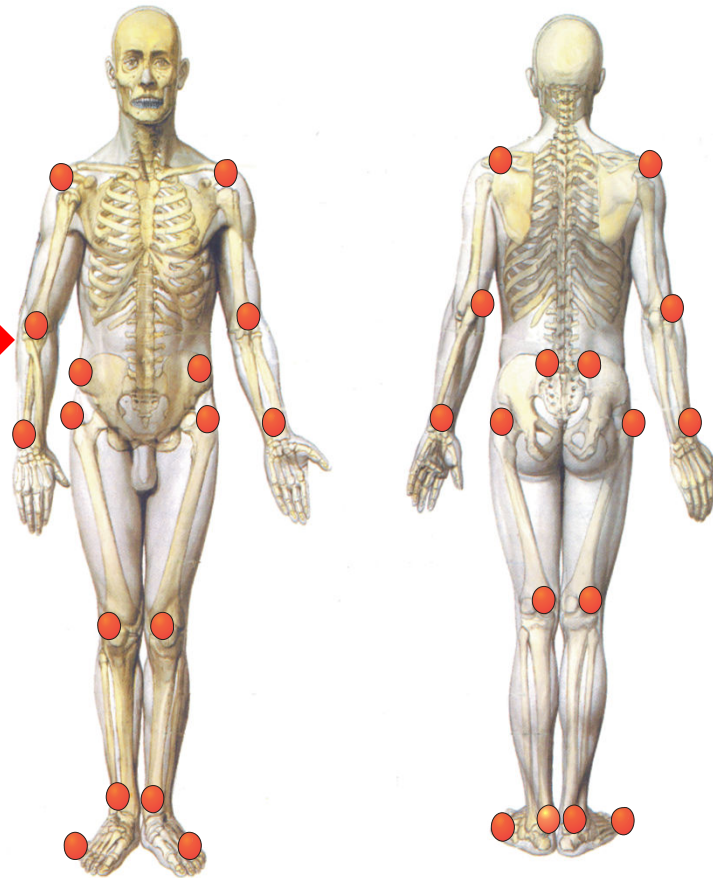
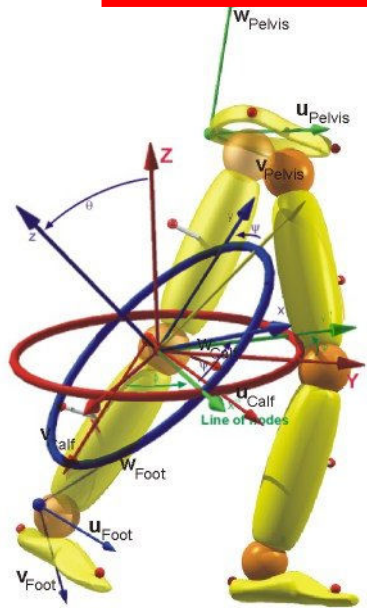
Active marker



5. Testmodell

Modified Dempster model

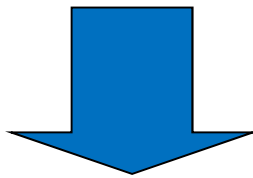
full body
markerset with
marker – triplets
on each joint



5. Bodymodell

1. System – generated
2. User generated with special needs
3. Counting from anthropometric data
All individual model

Need anthropometric measure kit
Mathematics model (Human Gait)



Weight
Height

6. Examination

Subjects wear **black** suits

Retroreflective markers on „key- points” of
Body

Motion Captured with more cameras
simultaneously from **more view** (own
innovation)

Films **are stored.**

6. Examination

GGL calculates displacement, velocity and acceleration data from views and generates **3D data** automatically
These data analysed **statistically** (own innovation)

Light (refracting angle, visible, non- visible ,
retroreflection)

Optical (cameras, lens, speed)

Control coordinate system)

Hardver (storage, number of cameras)

Softver (data processing)

Time (under time)

Data (Storage, server

Price

Light

GGL

Vicon

Medtronic

Light usage

VIS/IR/NIR

IR / NIR

IR





Optical

GGL

Vicon

Medtronic

Number of cameras

4 or more as needed

2 -16

2

Type of cameras

Sony/Panasonic
- VHS , micro
HIKVISION OR More

Vicon MX

Optotrak

16 million pixel

Speed

Normal /
High speed/ ONLINE

Normal

Normal

Frecquency

50/60Hz

50/60Hz 240/1000HZ

50/60Hz

Storage

AVI

spec.

spec

synchronisation

manual / automatic

Automatic

Automatic



Optical

GGL **Vicon** **Medtronic**
Calibration web

Number of
cameras

4 or more cameras used 2-10 2

Type of cameras

Sony/Panasonic
- VHS, micro
Mitsubishi, Nikon, Canon, Vicon, Medtronic

declares positions of cameras

Speed

Normal
High speed

Normal

Frequency

50

60HZ

50/60Hz

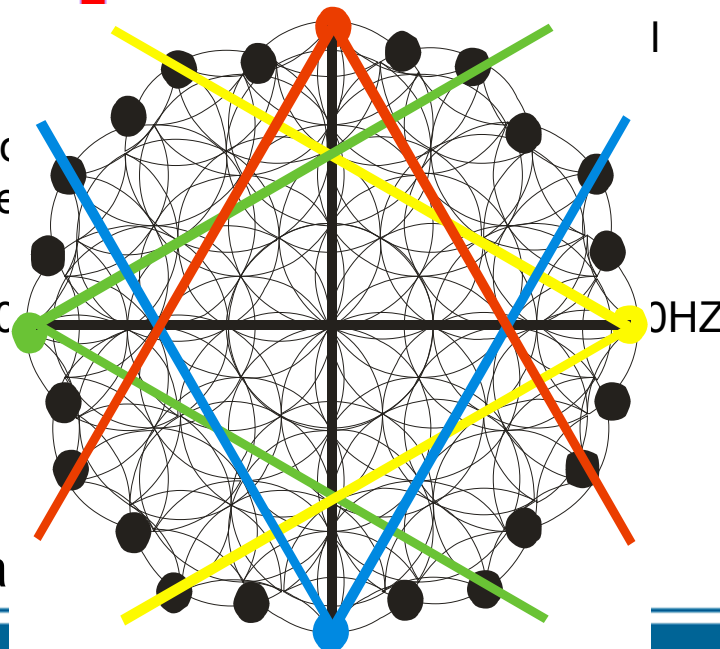
Storage

spec

synchronisation

manual

Automatic



CONTROL

GGL

Vicon

Medtronic

CHES



CONTROL

GGL

Vicon

Medtronic Calibration web

CHES



CONTROL

GGL

Vicon

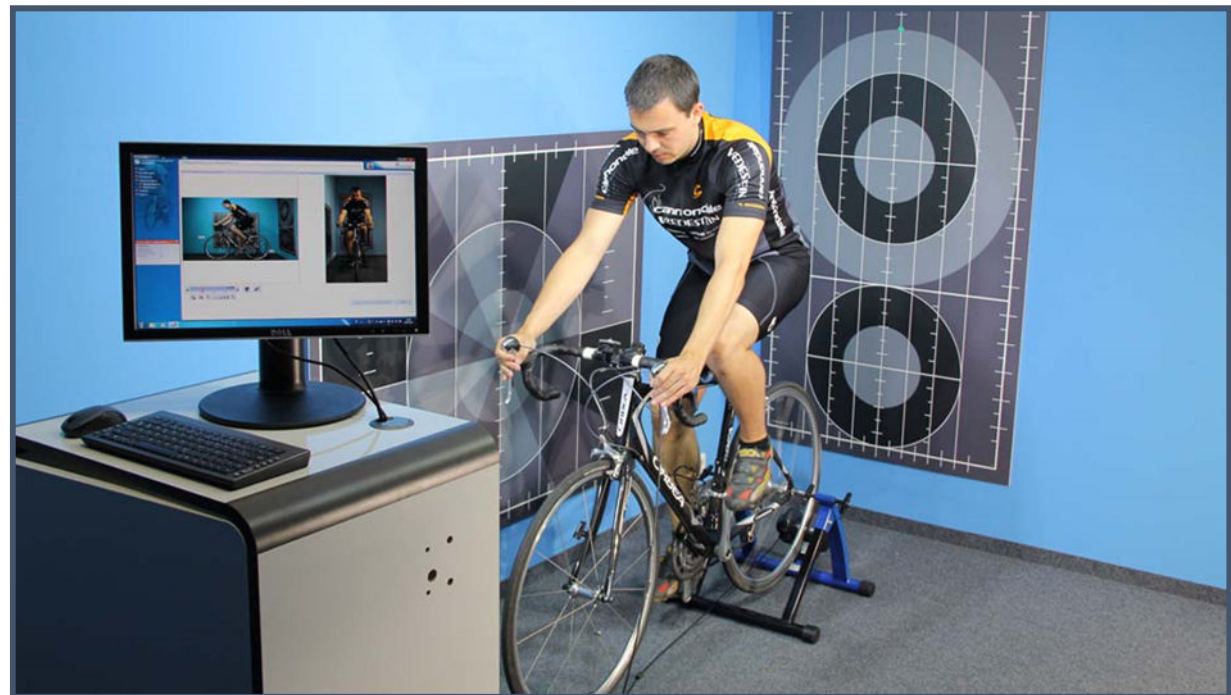
Medtronic

Calibration

CHESS

chess

web



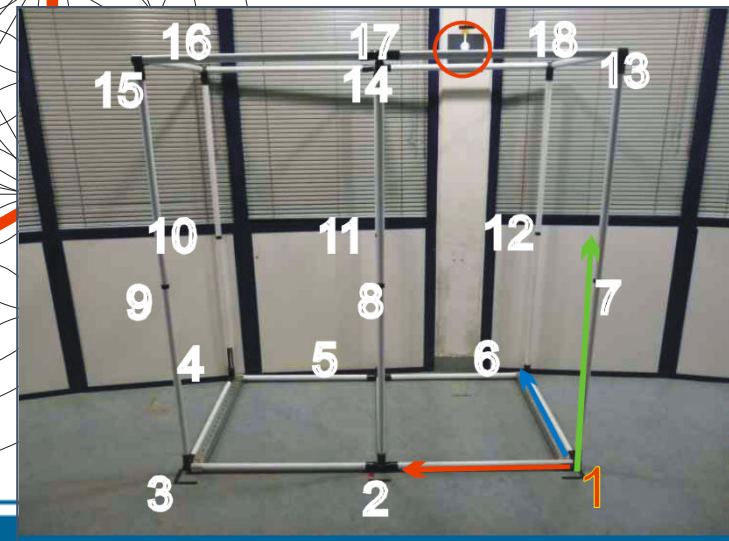
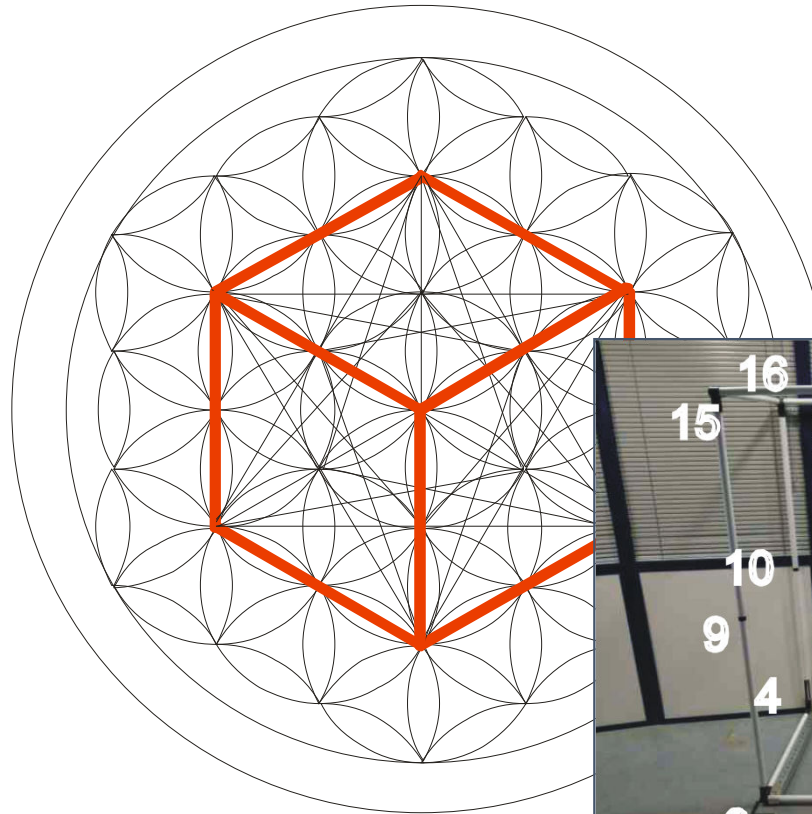
CONTROL

GGL
SPHERE WEB+
CUBE

Vicon
CHESS

Medtronic
CALIBRATION
ON WEB

CHESS



CONTROL AND BODYMODELL



CALIBRATION

MARKERTYPE NUMBER OF MARKERS DIAMETER OF MARKERS

BODYMODEL

GGL

Calibration **cube+**
Calibration Web

Active and passive

40

1 - 5 cm

Dempster, **Helen Hayes**,
Vaughan, Sun, Jensen

Our **full Body GGL**
model

User definition

Vicon

cube
Active and
passive

150

1 - 5cm

Helen Hayes +
300 model

User definiton

Medtronic

Calibration
web

Passive

512

1 cm

Helen Hayes

HARDVER

GGL

Vicon

Medtronic

HARDVER

Normal PC
plasticity

Vicon
innovation ,
fix,

Medtronic
innnovation
fix

Digitize

Automatic /Manual

Automatic

Automatic



SOFTVER

GGL

Vicon

Medtronic

SOFTVER

Moduls

Program -
family

Fluoronav

Transform

Manual/
Automatic

Automatic

Automatic

Filter

Manual/
Automatic

Automatic

Automatic

TIME

GGL

Vicon

Medtronic

**Data
processing**

half hour

realtime

Plasticity

yes

no



DATA



GGL

Vicon

Medtronic

Data display

Display

Automatic

Automatic
Real -time

Data output

txt, Excel

ASCII
MATLab ,
Excel

min
Distance of Two
points

0,1 cm

0,1

0,1 - 0,01

inch

mm – cm – m –
km

Range

cm

mm  **IEEE**

DATA output:

Every points

Three planes

Displacement of motion

Velocity of motion

Dinamic of motion (Acceleration)

Range of joints' motion

Analysis

Statistical data processing (own innovation)

Comparability

Earlier status

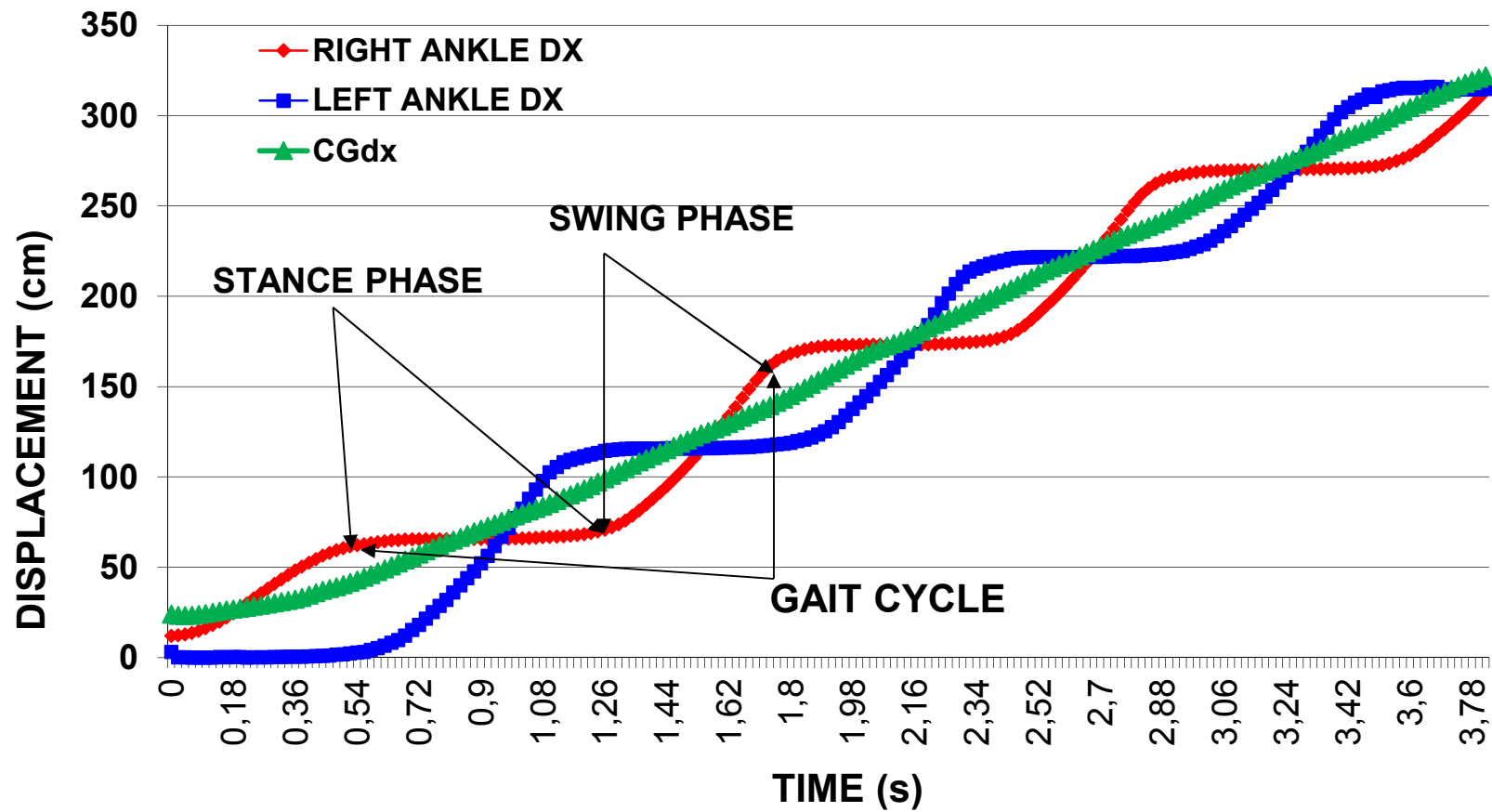
Normal population

Data from literature

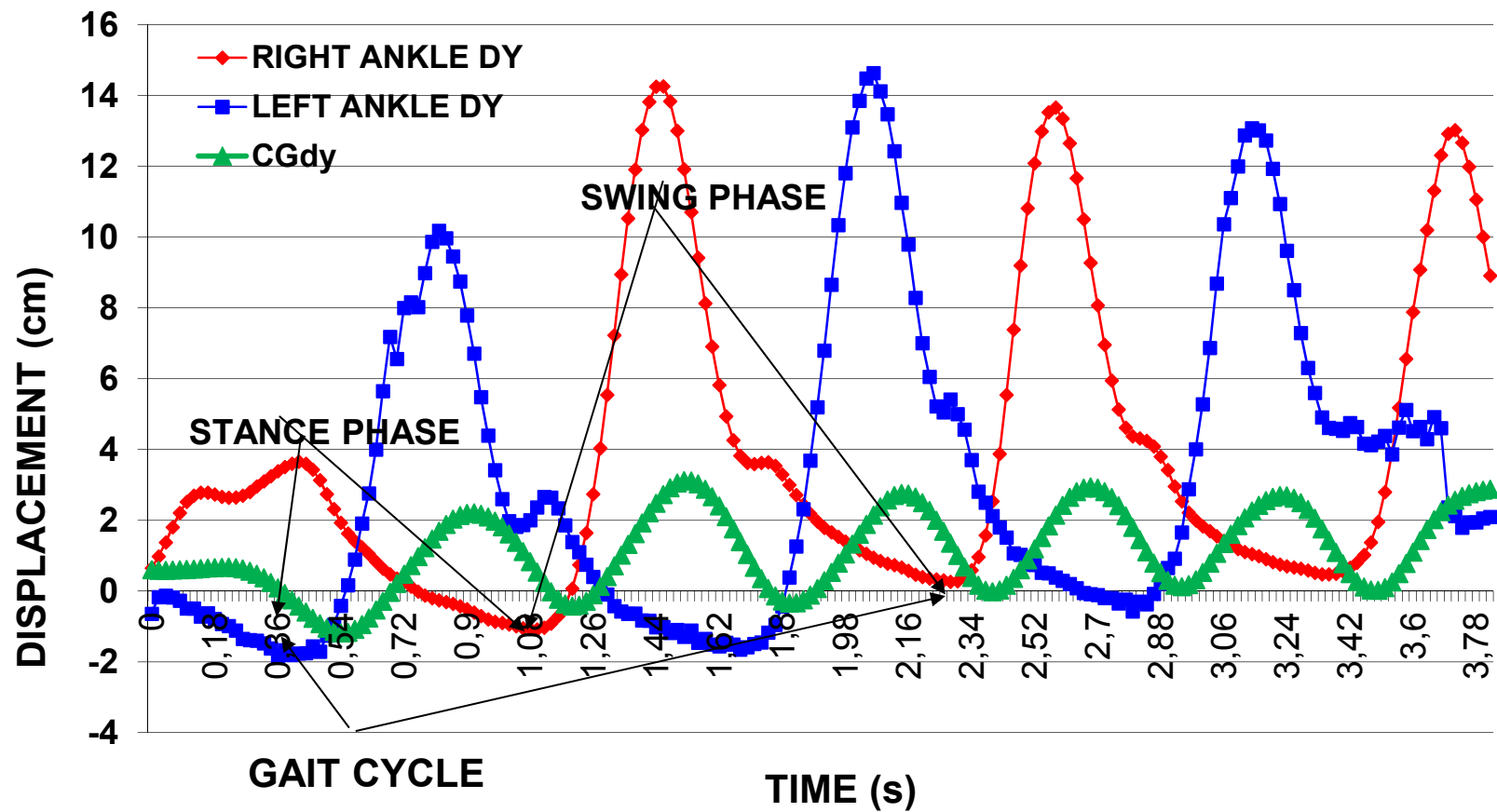
Other groups (other disabilities)

Same groups (same disabilities: patient's status is worse or better)

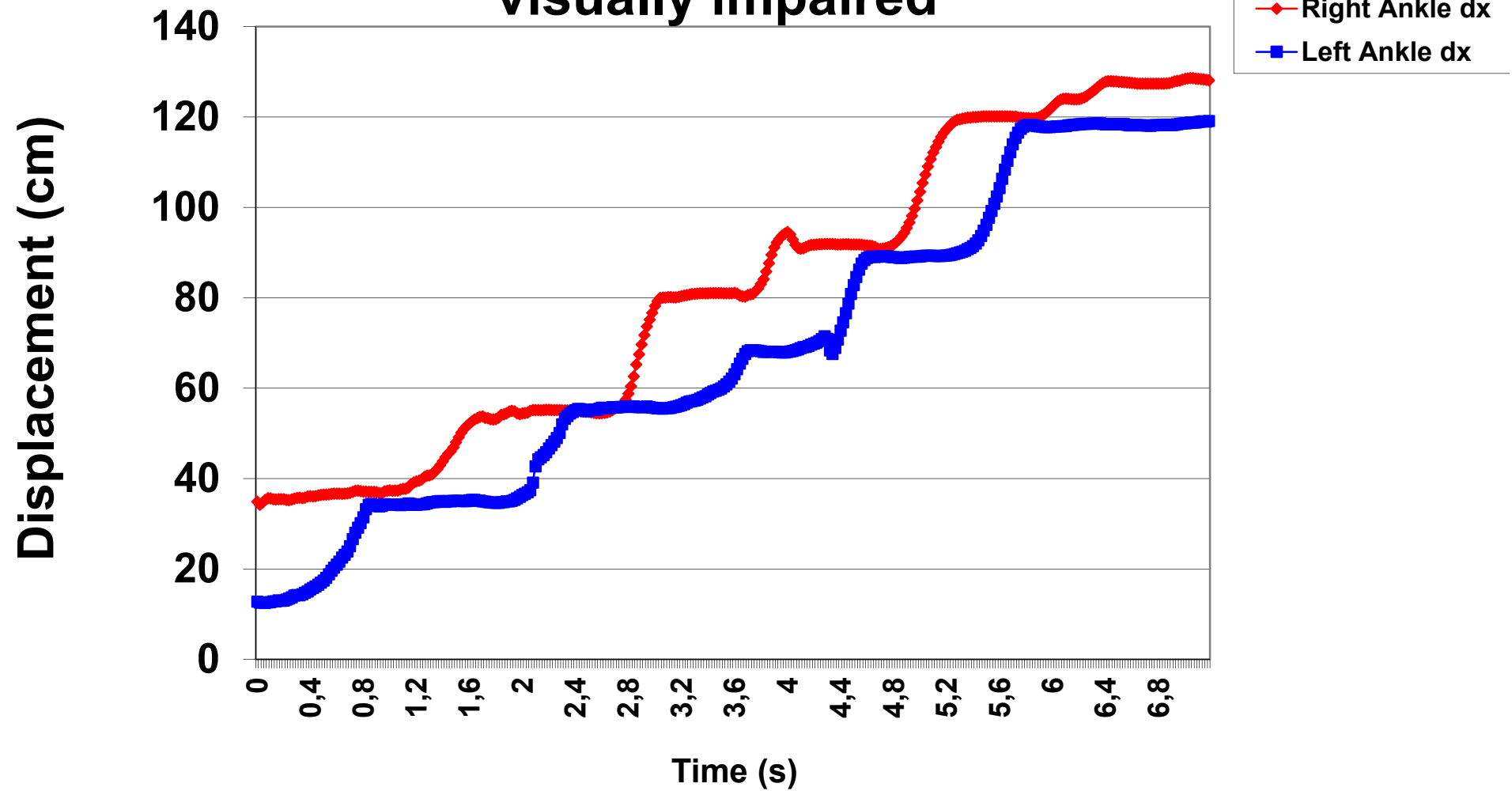
Normal gait in Sagital plane



Normal gait in Vertical plane

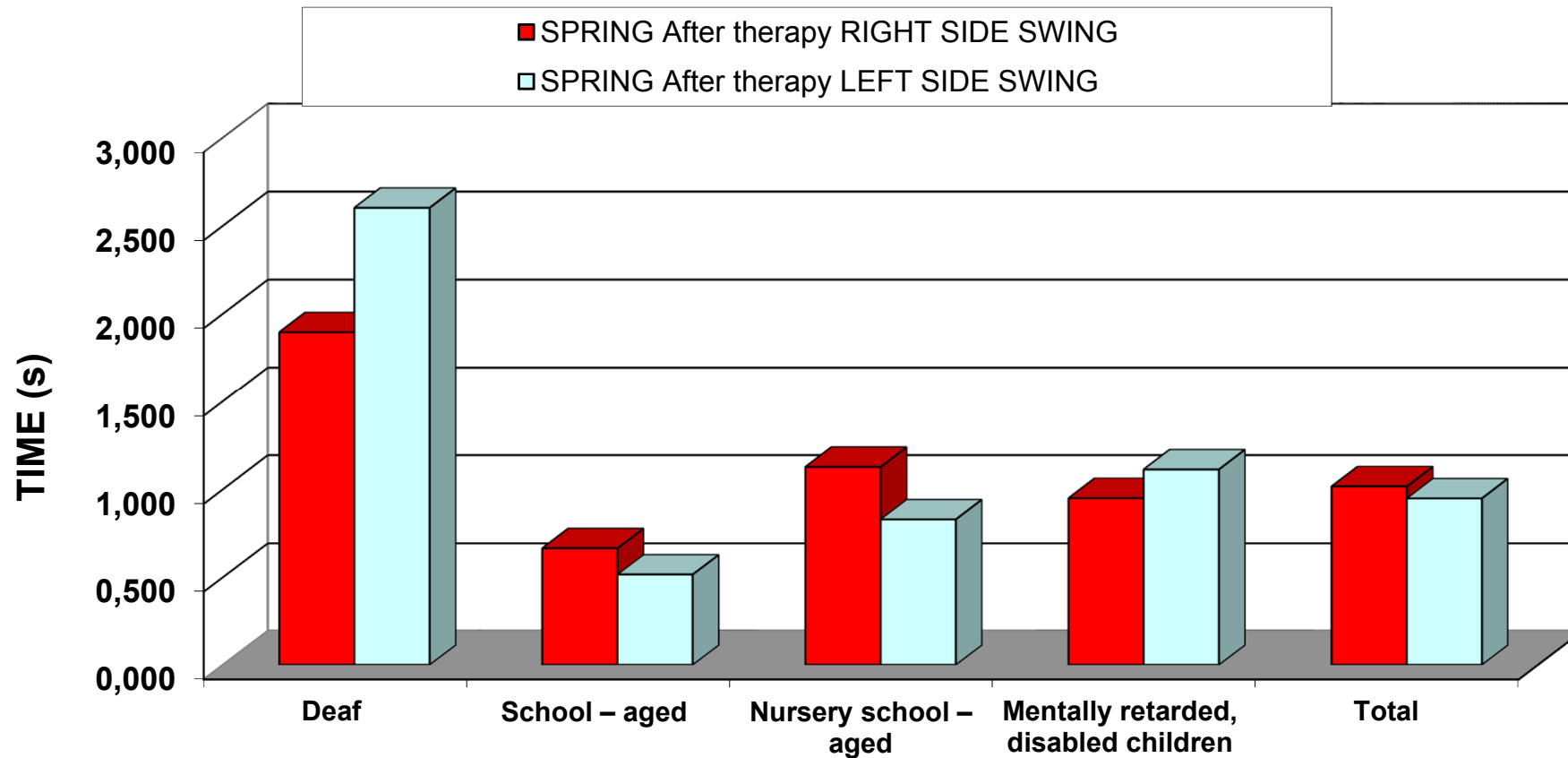


Gait Cycle in Sagittal Plane visually impaired



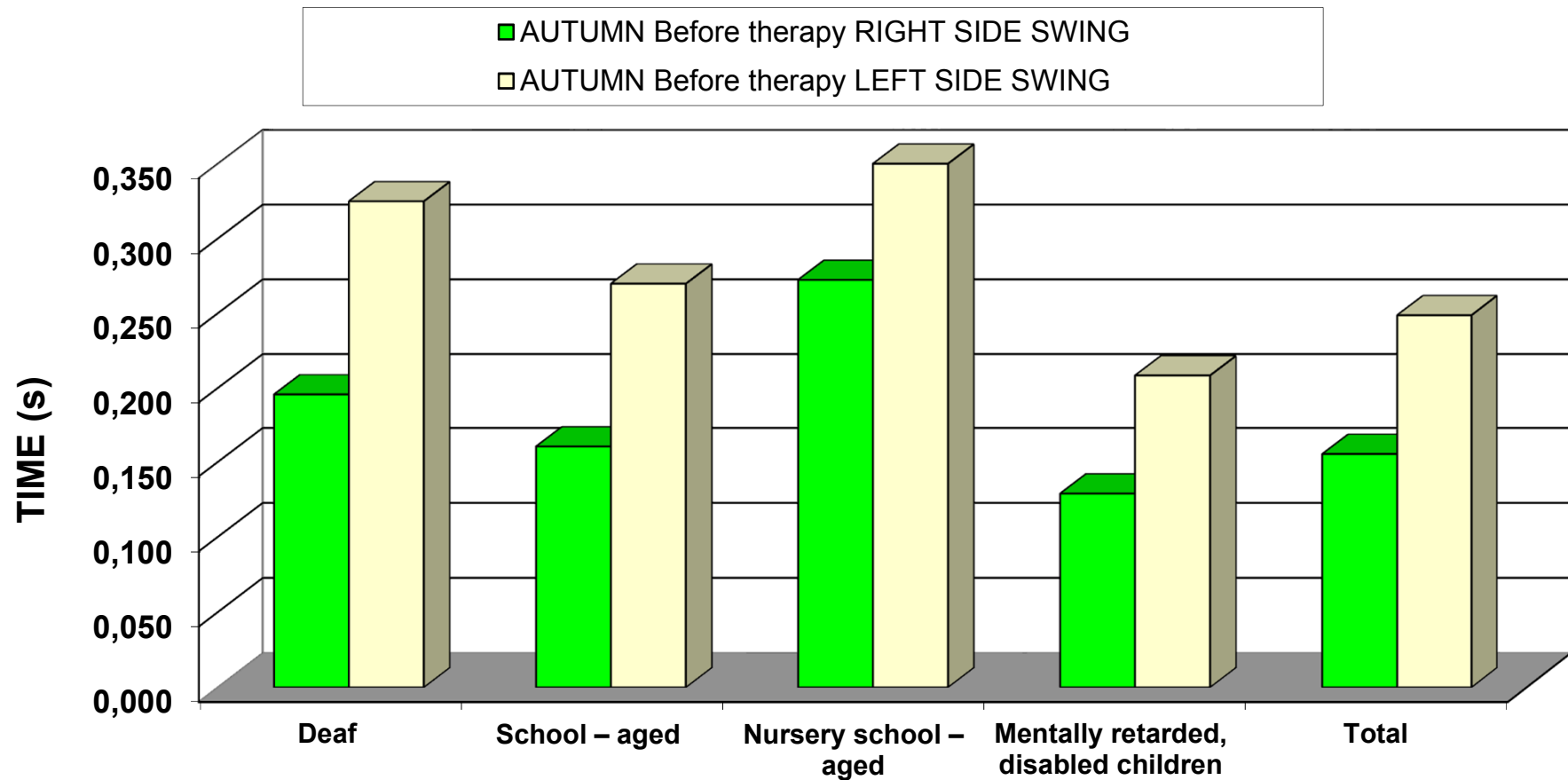
Ankle in Vertical Plane

distance of swing phase of highest points (max- max)

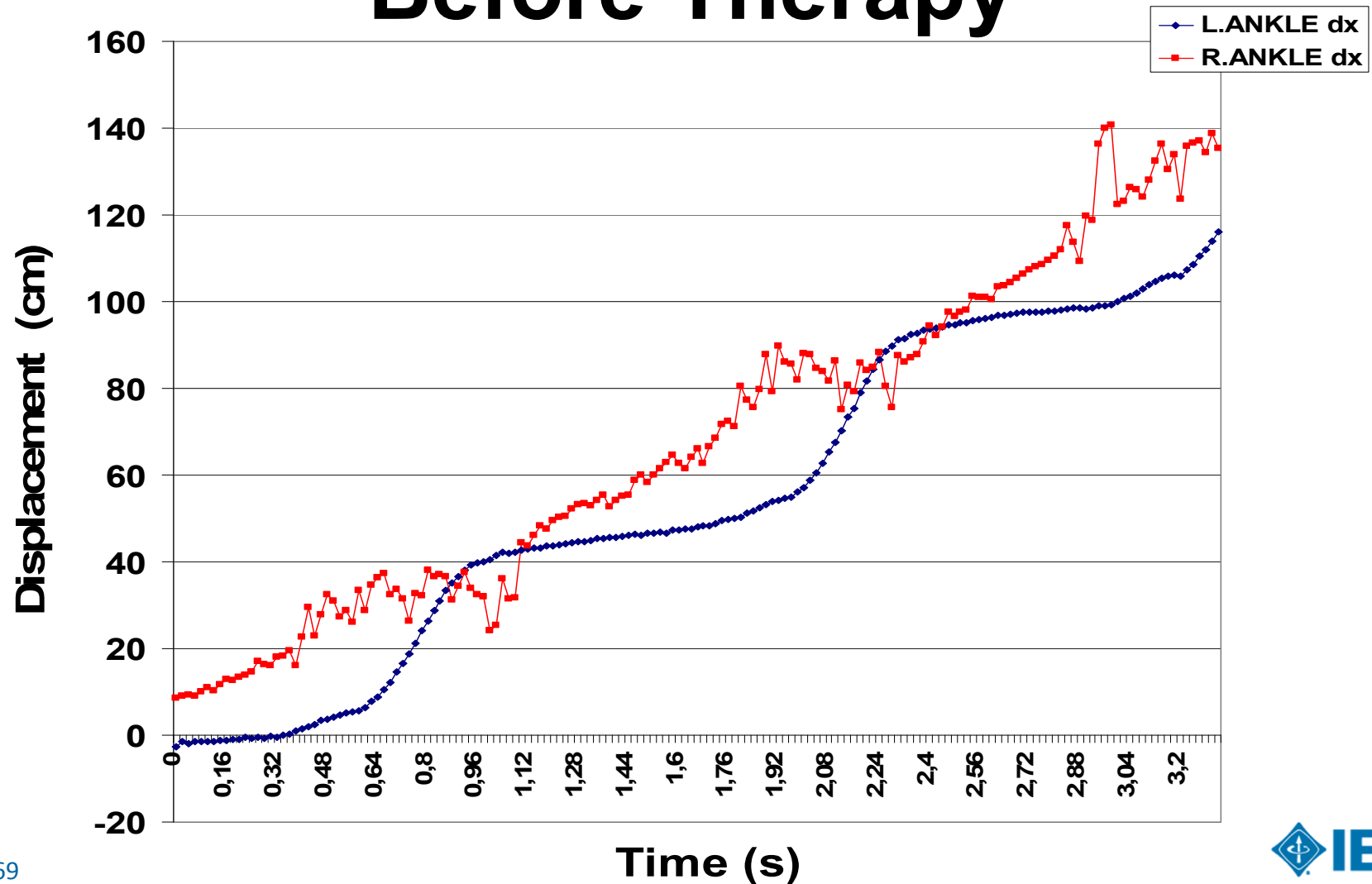


Ankle in Vertical Plane

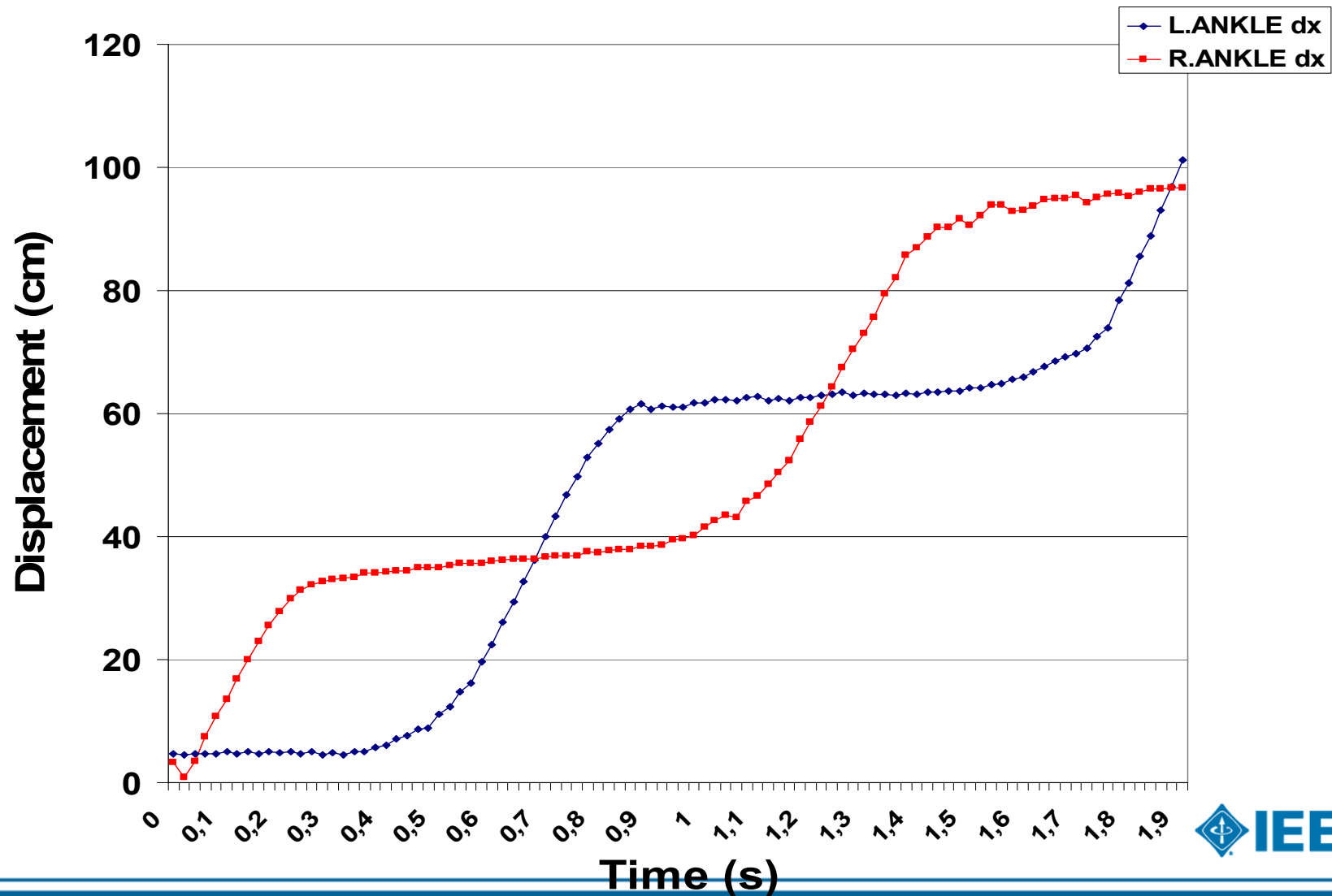
distance of swing phase of highest points (max- max)



RA gait in Sagital plane Before Therapy



RA gait in Sagital plane After Therapy without staff



Results:

Rehabilitation 7733
Status
Condition **MEASUREMENTS**
Therapy
Effects of therapies
Innovation of Therapies
Education of rehabilitation therapies
(patients and therapist)

Results:

Sport
Status
Consultancy
Plan
Equipments



Rehabilitation



Rehabilitation

