

# THE FUNCTIONAL HEAD IMPULSE TEST (fHIT)



**Dr. Anirban Biswas**  
**Vertigo & Deafness Clinic**  
BJ-252, Salt Lake, Sector-2  
Kolkata-700091, India



# Introduction

- It evaluates the functional status of the **rotational vestibulo-ocular reflex (rVOR)** of the six semicircular canals at high frequencies of vestibular stimulation.
  - If the semicircular canals are defective, the rVOR is jeopardized
- 



# How to evaluate semicircular canals?

- Caloric test VNG/ENG,
  - Dynamic Visual Acuity (DVA) test
  - Gaze Stabilization Test (GST)
  - Video Head Impulse Test (VHIT)
- 

# Comparison with other tests

- In VHIT the degradation of visual acuity is not calculated but the gain of the VOR is calculated.
- In DVA degradation of the Visual Acuity (VA) on fast head movement is measured and if the loss of VA is more than  $0.2 \log \text{MAR}$  (the unit by which VA is measured) then the VOR is considered subnormal indicating a poor semicircular canal function

# Comparison with other tests

- In VHIT the impairment of VOR gain (not the loss of VA) on fast head movement is calculated.
- VHIT measures the gain of the VOR generated by the head movement
- It requires to measure speed of both head and eye movement .
- Since, head movement measurement is technically easy with gyroscopes and accelerometers but, measurement of eye movement is technically difficult and requires sophisticated high speed cameras and very complex computation.
- This makes VHIT a costly gadget that many practitioners find difficult to afford.

# Comparison with other tests

- FHIT does not calculate the quantity of the loss of Visual Acuity in logMAR as in DVA which requires testing VA with gradually smaller size of optotypes.
- This process requires quite a bit of time and increases the complexity of the test; fHIT just determines whether there is any loss of readability of a pre-determined *fixed* size optotype on sudden head movement



# Comparison with other tests

- fHIT objectively documents the performance of the patient's VOR in real life practical situation and is tested with a physiological stimulus (i.e., fast head movement which we always do in our day to day lives) unlike the un-physiological stimulus (hot & cold stimulation) used in the caloric test.
- 



# Why do we need fHIT??

- Functional test
  - Quick & easy to do
  - Does not require costly equipment set up
  - Qualitative approach
  - Results obtained are easily interpreted
- 

# fHIT Hardware :



00:00:43:08

fHIT place the sensor on the patient's forehead



*The 3 axis gyroscope and an accelerometer housed in a small box attached to the elastic headband that the patient wears*

# *The patient response unit*



*This calculator shaped device has the eight types of Landolt 'C's which are the replicas of the optotypes that appear on the computer screen.*

*The patient has to press the key that corresponds to the optotype appearing on the screen*

fHIT place the patient 1.5 meters from the screen



# fHIT an easy test. Start, Open, Close.

FHIT 3.0

Functional Head Impulse Test Professional Version

Powered by BeOn Solutions

Settings

Start New Analysis...

Open Analysis's File...

Close

BeOn Solutions Srl

HP ALL-in-One  
480x270 mm (21,7)  
1920x1080 px  
60 Hz

LogMAR: -----

Distance: -----

Serial USB: -----

Version fw: -----

Battery: -----

FPS: -----

Version: 1.2.3.0 Date: mercoledì 7 marzo 2018 Data Normative: LATERAL Present (v27.27) RALP/LARP Present (v26.26) (v25.25)

Scrive qui per eseguire la ricerca

ITA 15:29  
07/03/2018

# fHIT Age , Sex, Visual acuity

fHIT require only a few data of the patient: sex, age and visual acuity.

The screenshot displays the fHIT 3.0 software interface. At the top, the title bar reads "fHIT 3.0" and the main header says "Functional Head Impulse Test Professional Version". The interface is powered by Beon Solutions. A central dialog box titled "Start New Exam..." is open, prompting the user to "Insert Patient's Data.. Set up the correctly distance from Patient to Monitor!".

The dialog box contains the following sections:

- Patient Data:** Includes fields for Sex (Female/Male), Age (Years), and a numeric keypad.
- (LogMAR):** A vertical list of radio buttons from 0.0 to 1.0, with an eye icon.
- Monitor/Screen size:** Fields for Width (480 mm, 1920 px) and Height (270 mm, 1080 px).
- Patient Monitor Distance:** A dropdown menu set to "1500 (1.5 m)" mm.
- Optotype Size:** Fields for w/h, Width, and Height in mm and px.
- Background Video:** A checkbox for "Enable Background video".

At the bottom of the dialog box are "Close" and "Continue..." buttons. The background interface shows a "Settings" icon and a "Close" button. The taskbar at the bottom displays system information: HP ALL-in-One (480x270 mm, 1920x1080 px, 60 Hz), LogMAR, Distance, Serial USB, Version fvc, Battery, FPS, and the date "mercoledì 7 marzo 2018".

# fHIT Functional Head Impulse test - Visual Acuity

LOGMAR

0.4

0.3

0.2

0.1

0.0



7/10

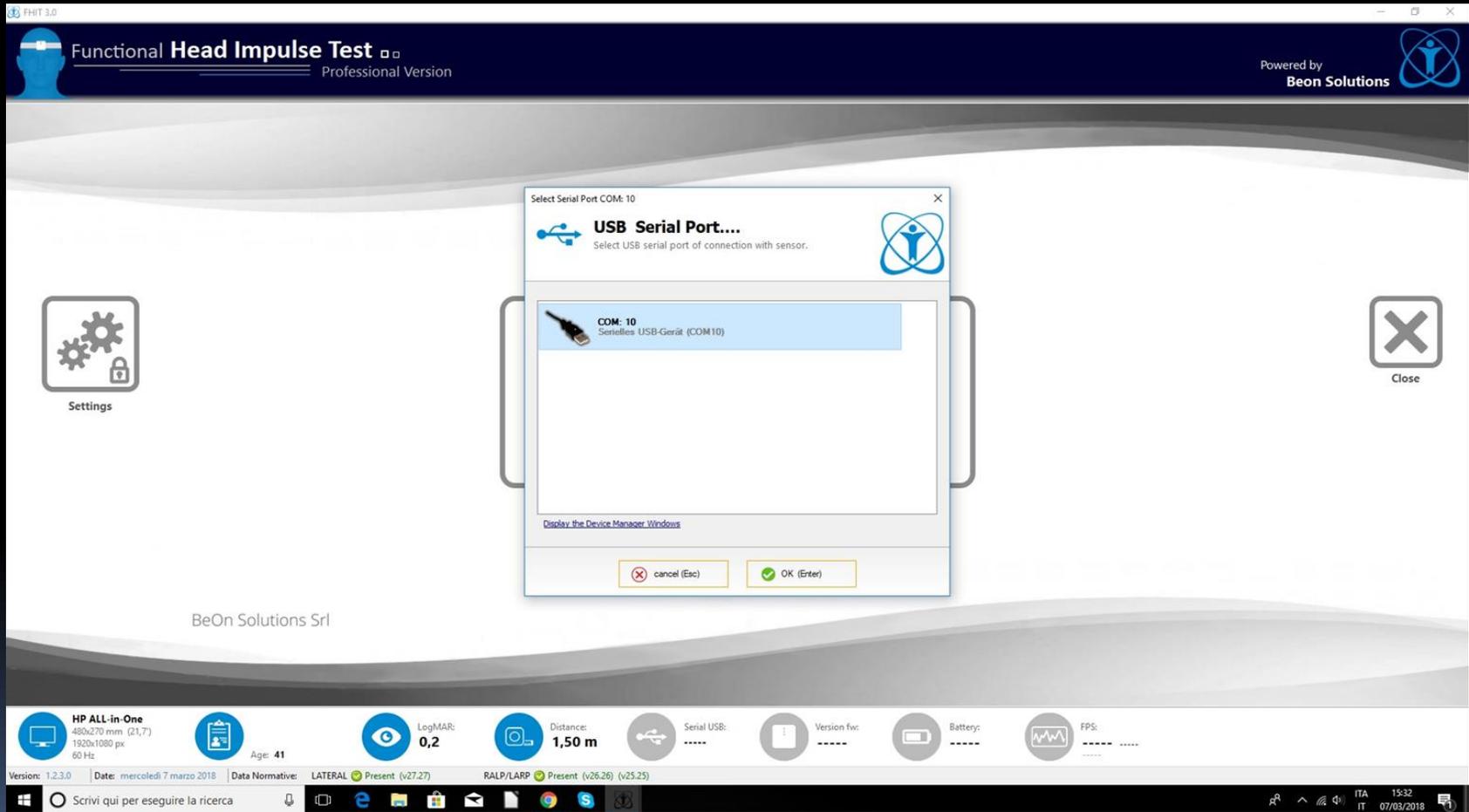
8/10

9/10

10/10

The software find the max visual acuity of patient and grow the optotype of 0.6 Log to do fHIT test.

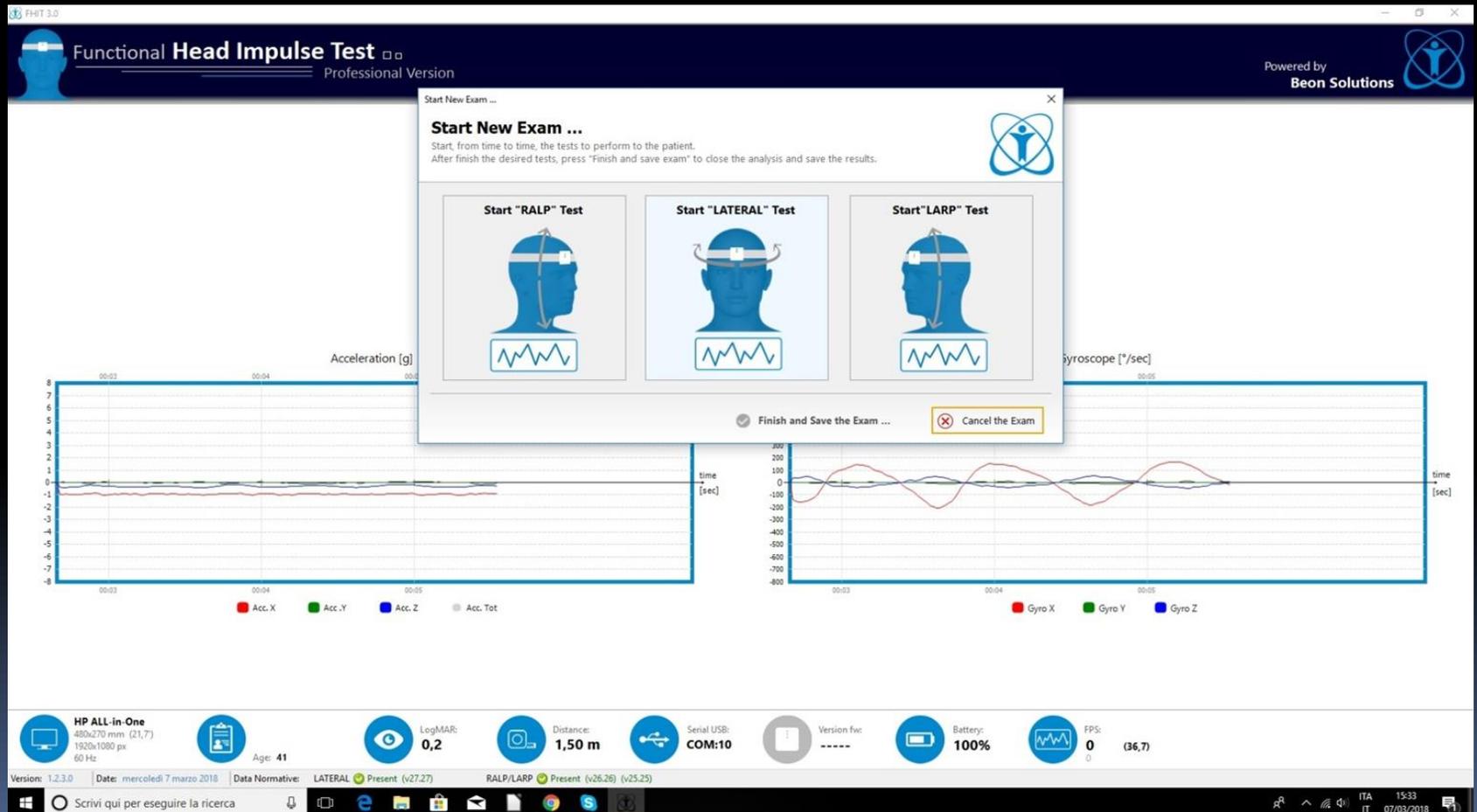
# fHIT Functional Head Impulse test



fHIT require to select and confirm the sensor.

# fHIT Functional Head Impulse test

You can choose to do RALP, LARP or LATERAL test.



# Functional Head Impulse test



The sensor must be placed on the patient's forehead. It must be well fixed and it must not move during the test.

The doctor have to keep his hands on the patient's cheeks, without touching the elastic band of the sensor

*The patient has to identify the optotypes correctly and press the identical key in the hand held device.*

C



*The patient responds by pressing the identical key in the hand held device.*

# RALP Test



*The test for the Right anterior and left posterior canals (RALP) being done. The operator stands behind the patient and rotates the head vertically in the plane of the right anterior and left posterior canals at a high speed*

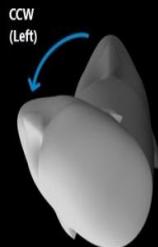
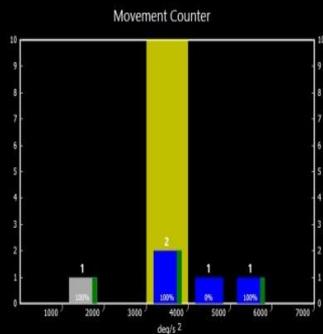
# LARP



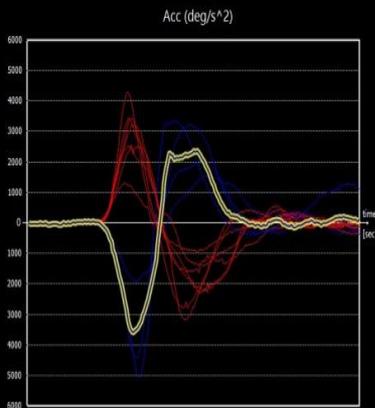
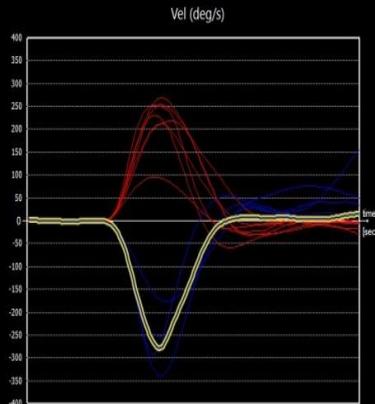
*The fHIT for the left anterior and right posterior canals (LARP) being done.*

(4/30) - 4

Z = 1,173



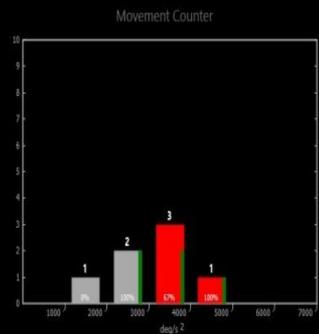
75,0% [89,9%]



Acc. Peak: 3570,6 deg/s<sup>2</sup>

4 - (4/30)

Z = 1,173



75,0% [93,2%]

While the test is being done, the operator can constantly monitor the acceleration and velocity graphically as well as the number of times the test has been done at each range (acceleration bin).

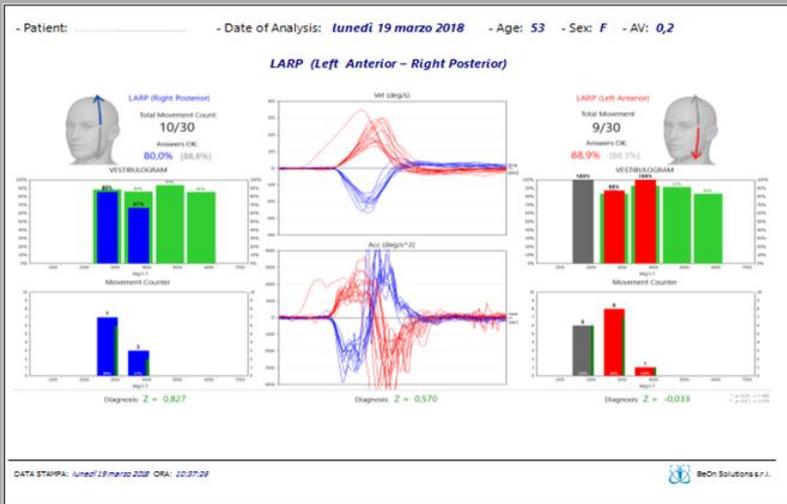
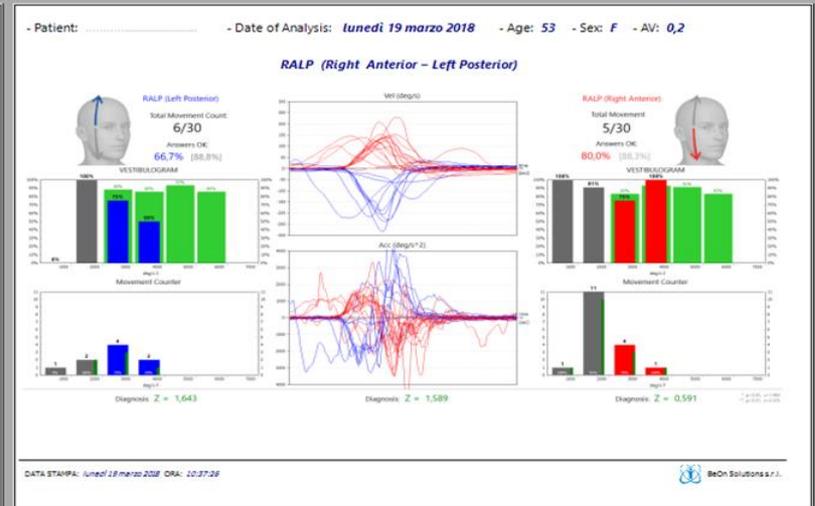
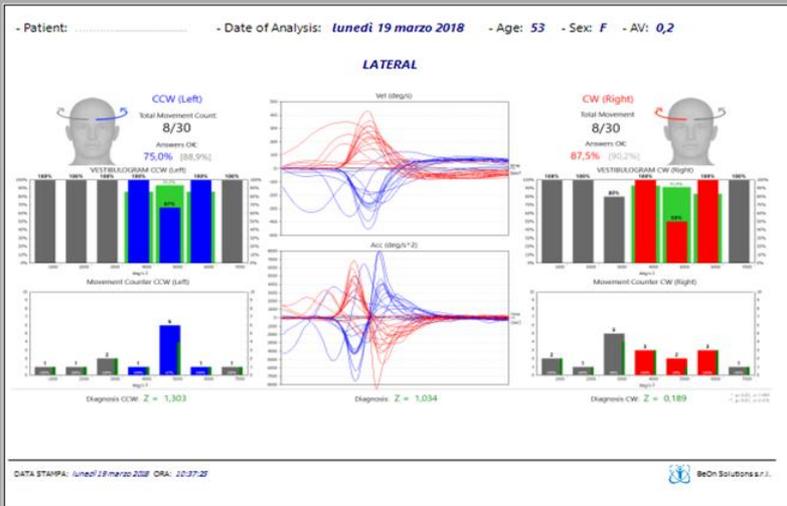
The movement highlighted in yellow is the last movement made.

In the above figure, the yellow marked one is a test for the left posterior canal.

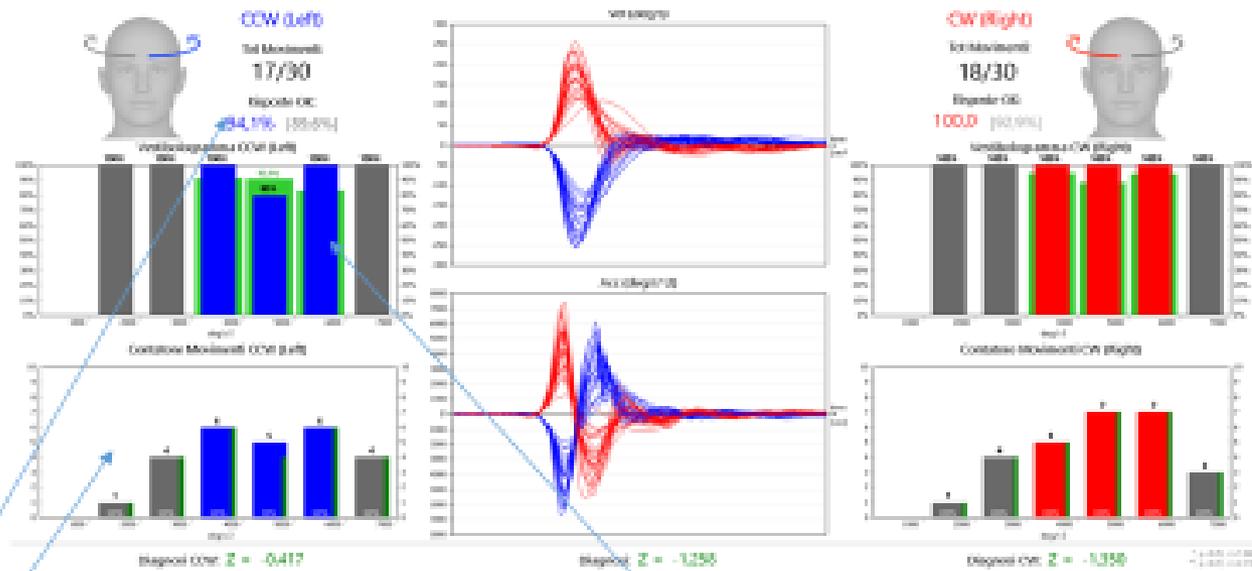
The left sided tests are marked in blue and the tests on the right canals (lateral / anterior / posterior) in red.

# The results and Interpretation

Chiudi



# Interpretation



Number of impulses for acceleration bin

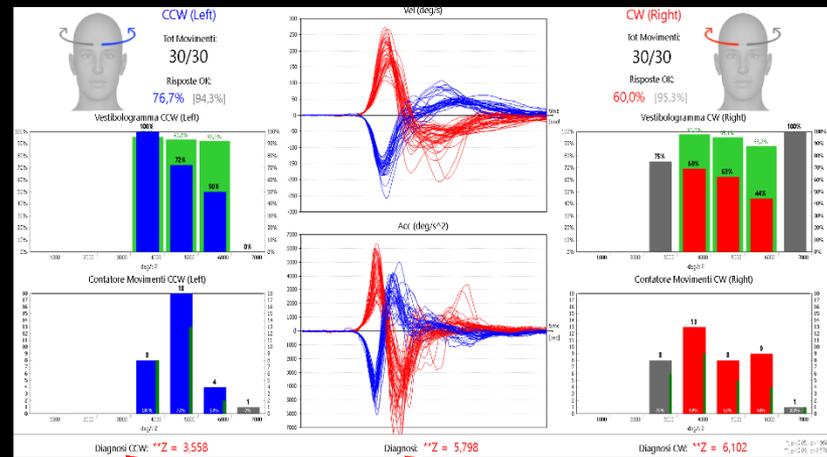
% of correct answers for acceleration bin  
 In green are reported normality thresholds

Total % of correct answers and normality thresholds in parenthesis

# Functional Head Impulse Test

Outcome= percentage of reading

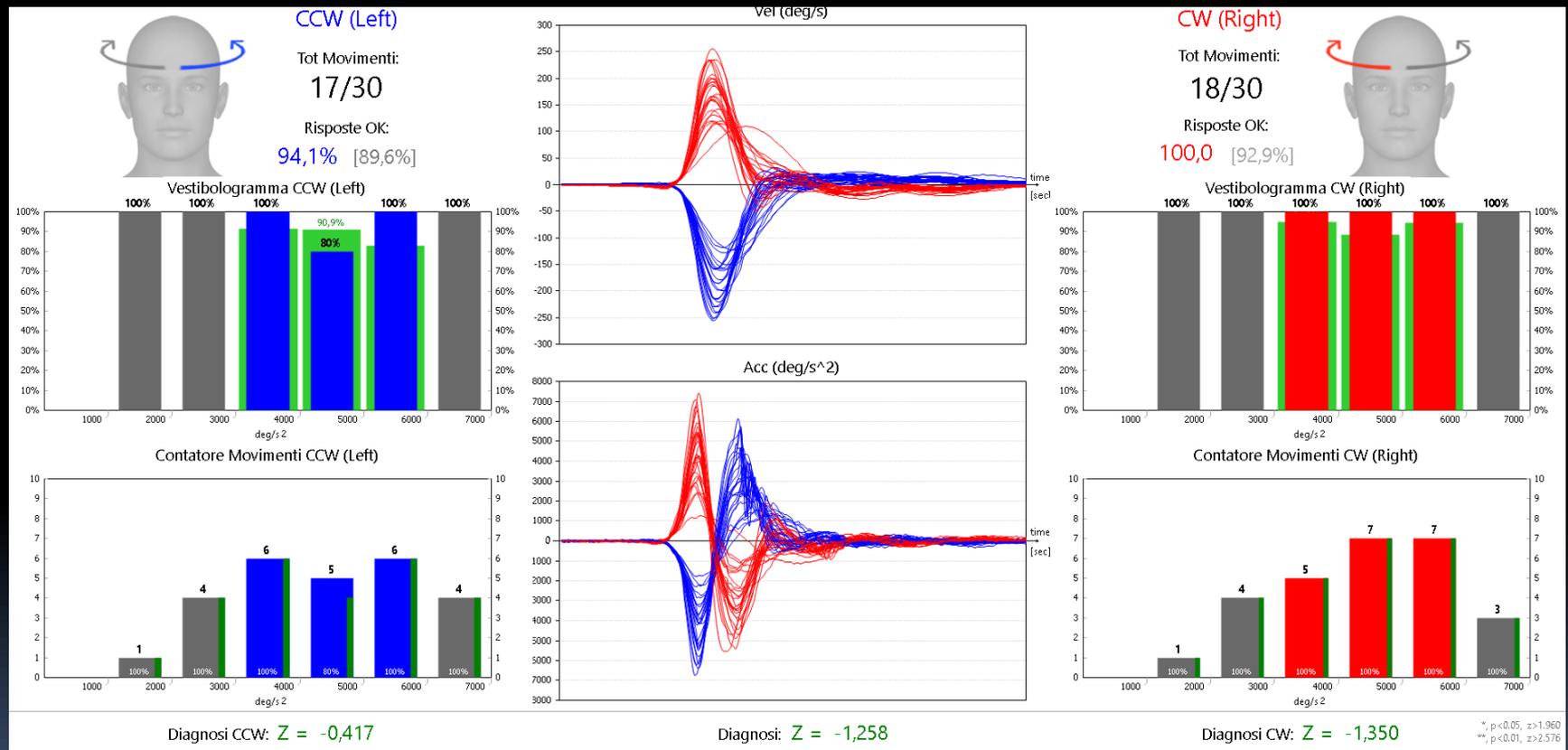
Patient



Z = Healthy  
Z\* = Deficit  
Z\*\* = Deficit

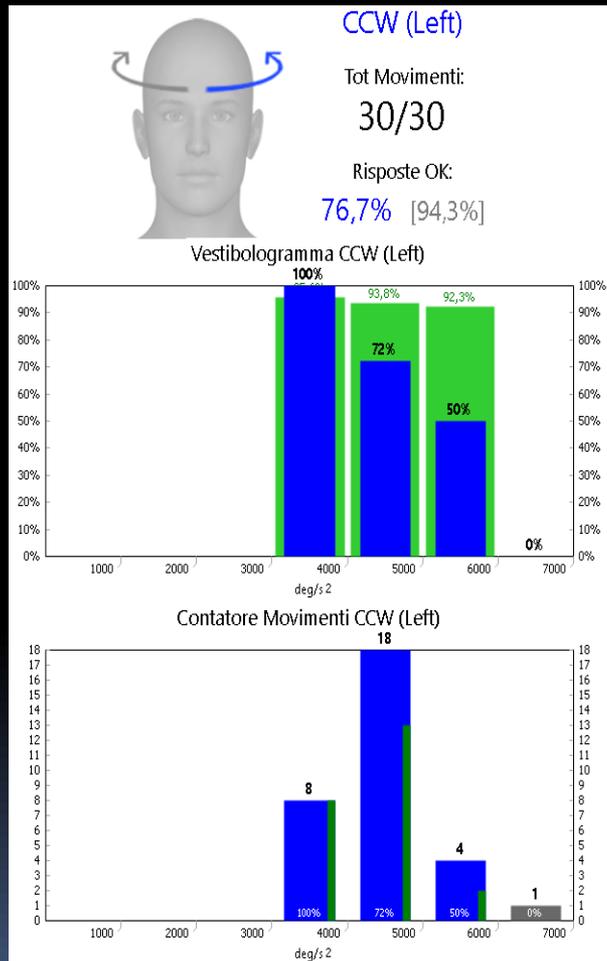
Z indicate the statistical comparison of patient responses with the group of normal subjects

# Healthy Patient :

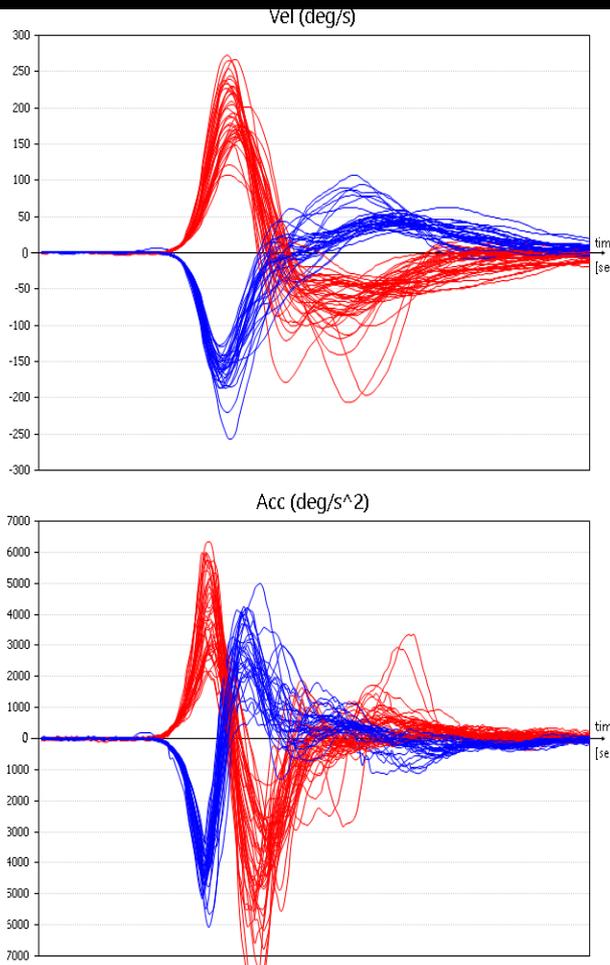


\* p < 0,05, z > 1,960  
\*\* p < 0,01, z > 2,576

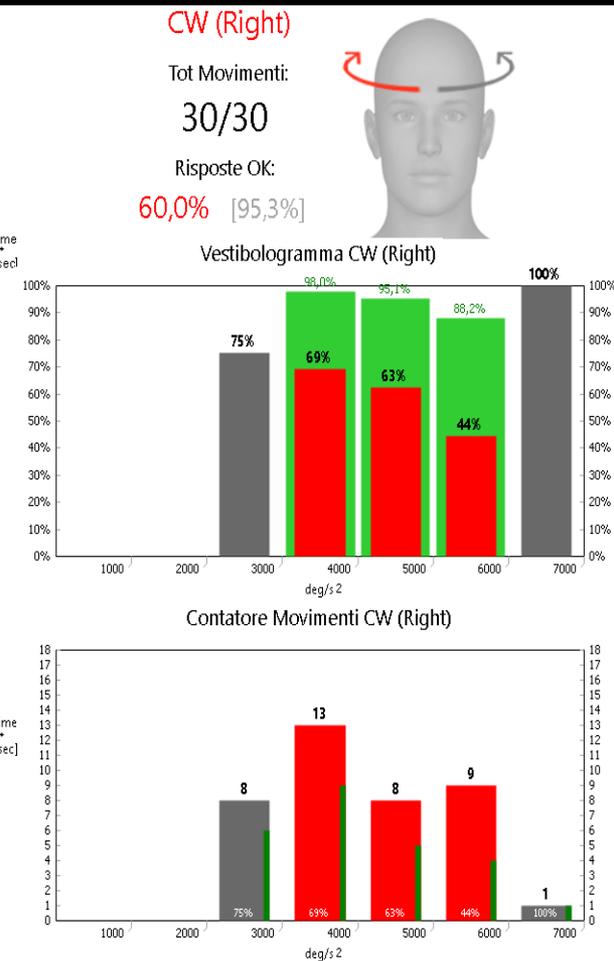
# B/L Canal Deficit patient:



Diagnosi CCW: **\*\*Z = 3,558**



Diagnosi: **\*\*Z = 5,798**



Diagnosi CW: **\*\*Z = 6,102**

\*, p<0,05, z>1,960  
\*\*, p<0,01, z>2,576

# LEFT ACUTE VESTIBULAR NEURITIS

Data referto: 15/05/2017

Operatore referto: utente utente

## Impulso della testa

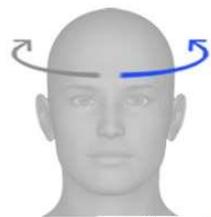
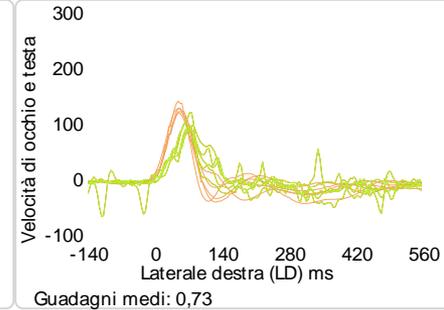
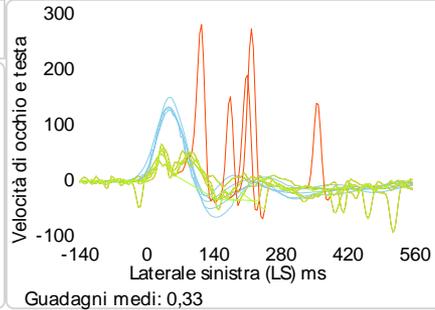
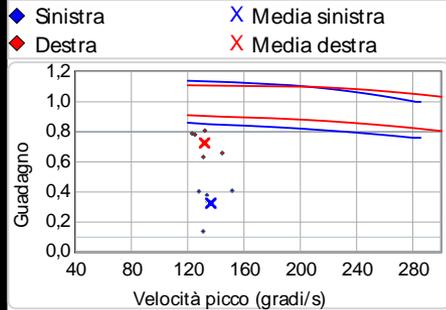
Prova impulso laterale: 05/04/2017 12:02:32

Operatore della prova: utente utente

$\bar{x}$  Sinistra: 0,33,  $\sigma$ : 0,1

$\bar{x}$  Destra: 0,73,  $\sigma$ : 0,07

Asimmetria relativa: 55%

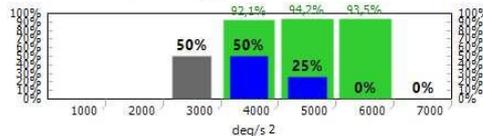


CCW (Left)

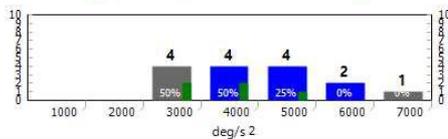
Tot Movement: 10/30

Answers OK: 30,0% [93,3%]

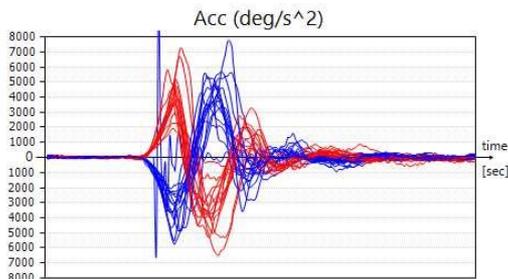
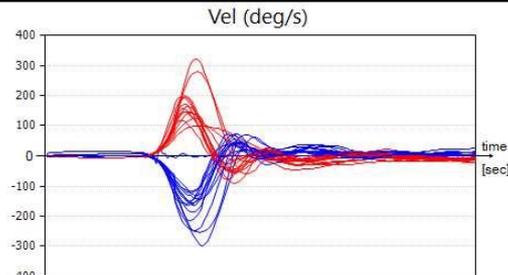
Vestibologramma CCW (Left)



Movement Counter CCW (Left)



Diagnosis CCW: **\*\*Z = 7,624**



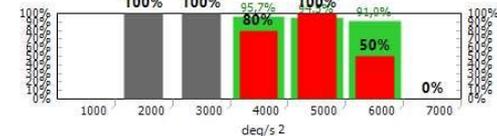
Diagnosis: **\*\*Z = 6,413**

CW (Right)

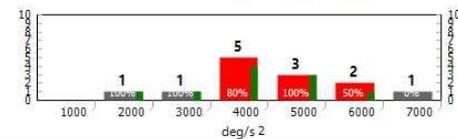
Tot Movement: 10/30

Answers OK: 80,0% [94,0%]

Vestibologramma CW (Right)

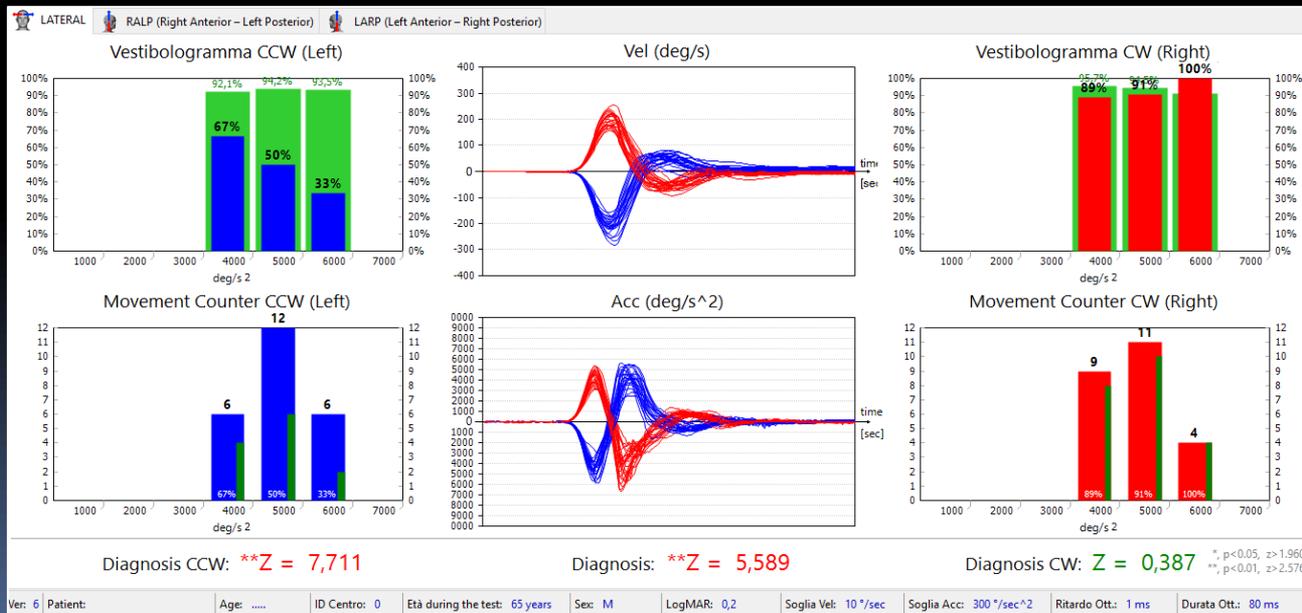
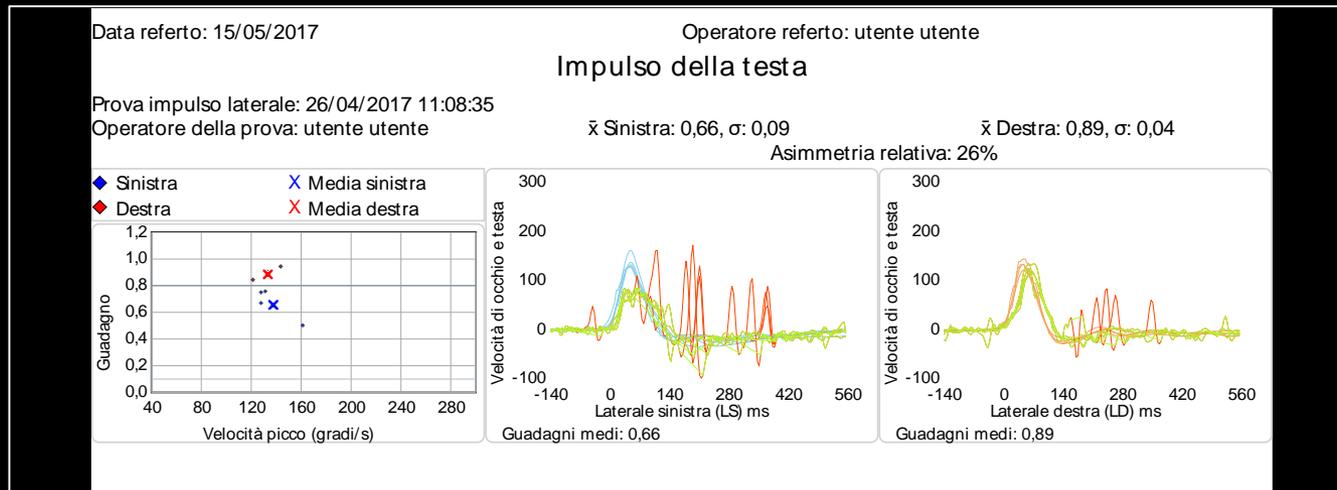


Movement Counter CW (Right)



Diagnosis CW: **Z = 1,726**   
 \*, p<0,05, z>1,960   
 \*\*, p<0,01, z>2,576

# LEFT ACUTE VESTIBULOPATHY (FOLLOW-UP 3 MONTHS)



# LEFT VESTIBULAR NEURITIS 6 MONTHS FOLLOW-UP (RECOVERY)

Data referto: 15/05/2017

Operatore referto: utente utente

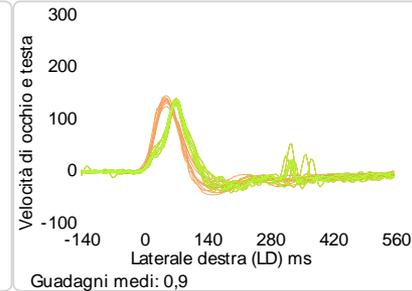
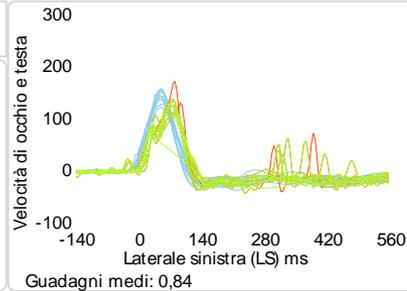
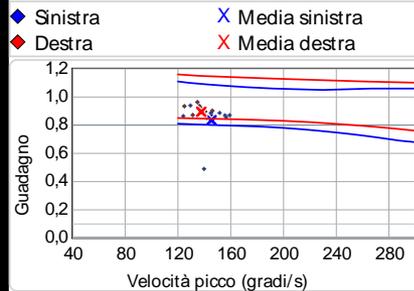
## Impulso della testa

Prova impulso laterale: 05/04/2017 11:26:03  
Operatore della prova: utente utente

$\bar{x}$  Sinistra: 0,84,  $\sigma$ : 0,12

$\bar{x}$  Destra: 0,9,  $\sigma$ : 0,03

Asimmetria relativa: 7%



### CCW (Left)

Tot Movement: 10/30  
Answers OK: 100,0% [93,3%]

Vestibologramma CCW (Left)

Movement Counter CCW (Left)

Diagnosis CCW:  $Z = -0,823$

### CW (Right)

Tot Movement: 10/30  
Answers OK: 100,0 [94,0%]

Vestibologramma CW (Right)

Movement Counter CW (Right)

Diagnosis CW:  $Z = -0,823$

Vel (deg/s)

time [sec]

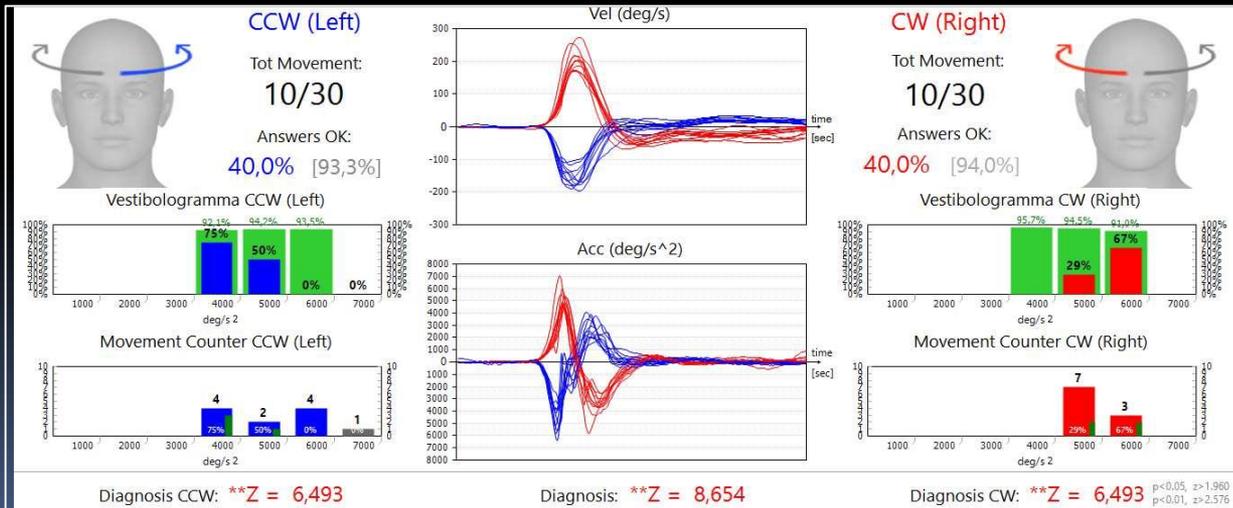
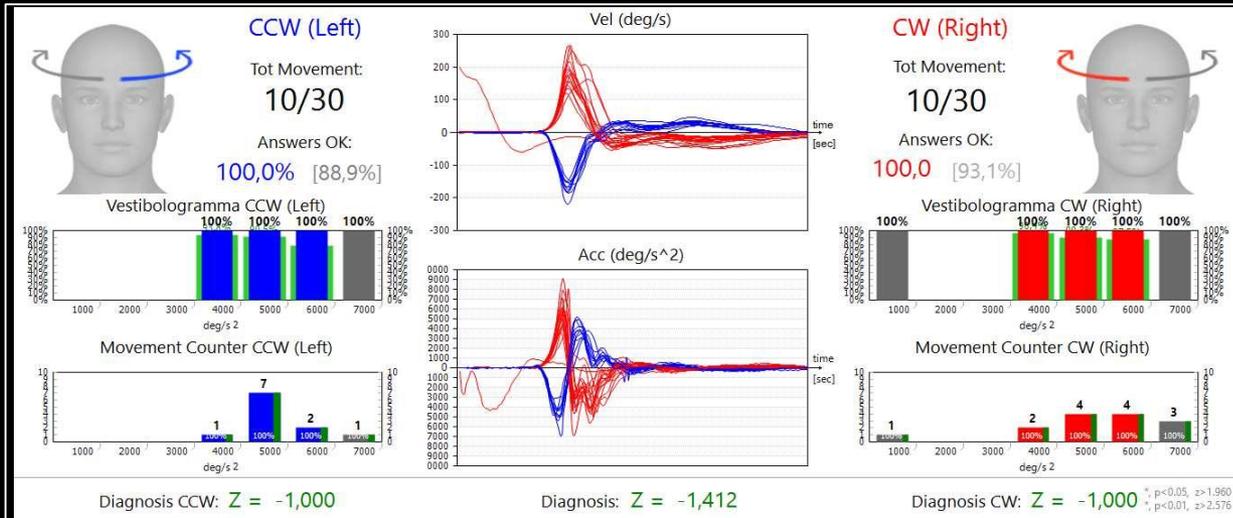
Acc (deg/s^2)

time [sec]

Diagnosis:  $Z = -1,164$

\*  $p < 0,05$ ,  $z > 1,960$   
 †  $p < 0,01$ ,  $z > 2,576$

# VISUO-VESTIBULAR NEUROPHATY in VESTIBULAR MIGRAINE



With rotating frame on



# Conclusion:

- fHIT is hence a very useful addition to the neurotologist's diagnostic armamentarium and a boon to the clinician in many ways.
- We have been using the system in our clinic for the last 18 mths and it has been a fascinating experience



# Vestibular Rehabilitation - V Gym



# Introduction

- fHIT is not only a diagnostic device but also a therapeutic device where specific targeted physical therapy to stimulate the diseased canal is possible.
  - Modern vestibular physiotherapy entails specific organ targeted exercises for specific disorders after modern vestibulometry has very precisely diagnosed the disorder
  - V-Gym is a device for rehabilitative process of targeted canal disorder.
- 

# V gym Principle

5



# The Hardware & Set up

■ The v Gym device consists of:

A sensor mounted on an elastic band

- provided with an accelerometer and a gyroscope,
- connected via Bluetooth to a smartphone or tablet device

An app developed by Beon Solutions.

- The patient wear the sensor as shown in picture on the right

The tool allows to perform the exercise in different conditions

sitting;

standing;

walking.



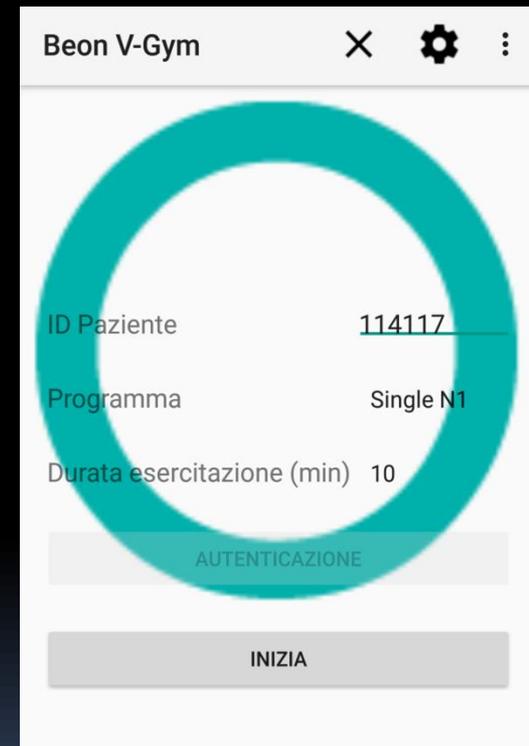
# The Application - Working

## Main functions

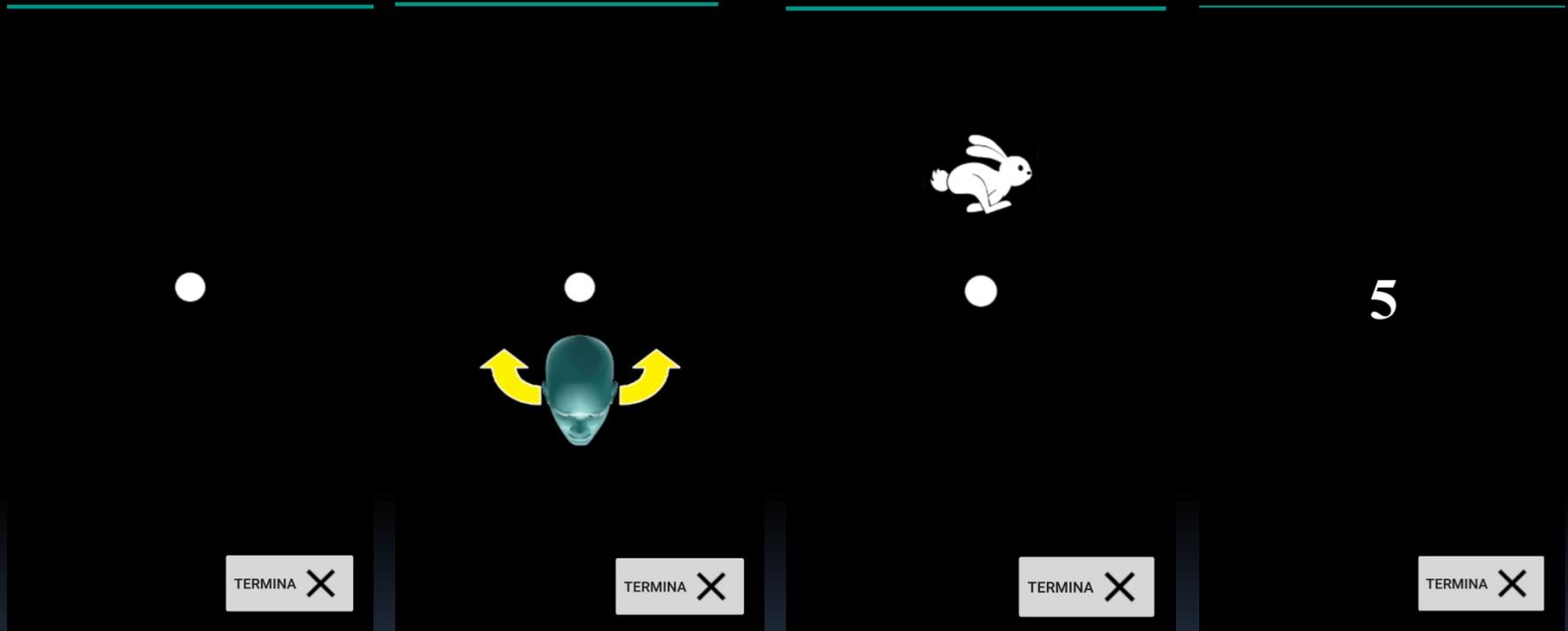
1. User sign in
2. Set Patient ID
3. Set rehabilitation program
4. Set exercise duration
5. Start!

## Other functions

- & Access to setting screen
- & Sensor reset
- & Exit from app



# During the exercise the user sees the following screens



The patient moves the head fixing the point in the screen.

If the movement is too narrow the software suggests to move the head more widely.

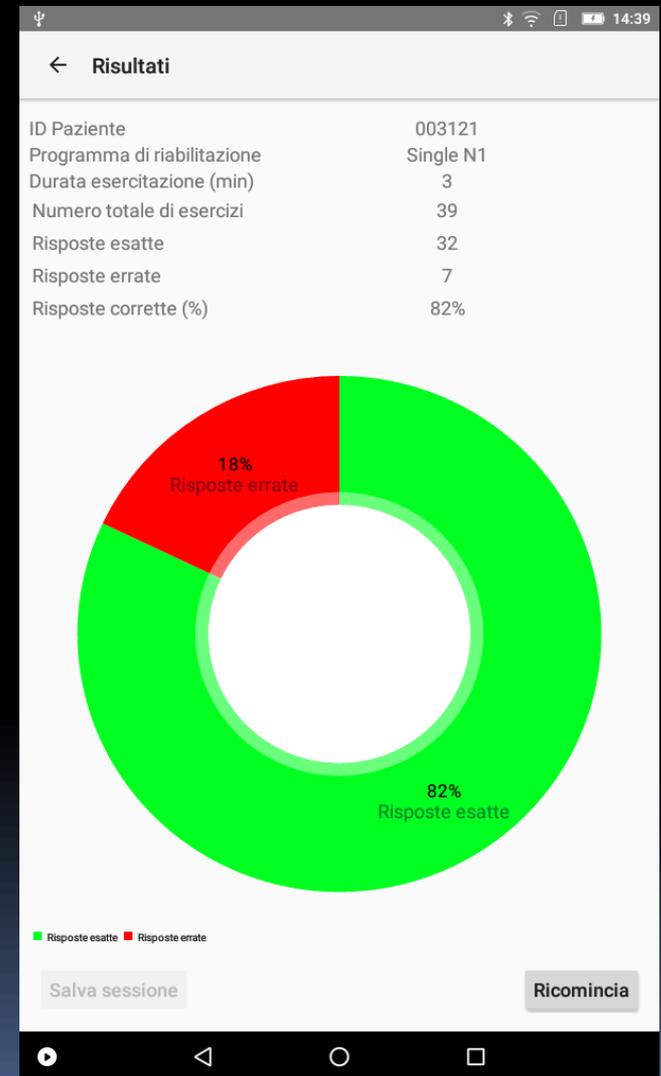
If the movement is too fast the software suggests to move the head slower

If the movement is correct a number or a letter will appear.

# V Gym - App - End of exercise

In the end of the time's exercise appear a summary of exercise parameters:

- 🔗 Effective duration
- 🔗 Number of movements performed
- 🔗 Percentage of correct answers
- 🔗 Saving of session data



# V Gym



**V GYM**

# V Gym - Rehabilitation programs

Program	Description
Single N <sub>1</sub> , N <sub>2</sub> , N <sub>3</sub>	Single movement, narrow angle (15°)
Single W <sub>1</sub> , W <sub>2</sub> , W <sub>3</sub>	Single movement, wide angle (30°)
Multi N <sub>1</sub> , N <sub>2</sub> , N <sub>3</sub>	Multiple movement, narrow angle (15°)
Multi W <sub>1</sub> , W <sub>2</sub> , W <sub>3</sub>	Multiple movement, wide angle (30°)
Sport 1, 2, 3	Targeted at healthy subjects

# fHIT Rehab





# Conclusion

- This new device is a boon to neurotologists because of its very simple mechanism which practically does not ever go out of order due to its extremely simple technology, its affordability and of course its very precise diagnostic and therapeutic functions.
- 