

HEALTH

**Hans Bjerke (NRPA) TC-IR,
Michela Sega (INRIM) TC-MC and
Salvador Barrera-Figueroa (DFM) TC-AUV**
EURAMET GA, Reykjavik May 2013

Health is a value in itself

Public Health

Public health is defined as:

- “the art and science of preventing disease, prolonging life and promoting health through the organized efforts of society” (Acheson, 1988; WHO)

European Commission: Social Investment Package*

“Universal access to:

- **safe, high-quality, efficient healthcare services,**
- **.....**

can make an important contribution to economic productivity and social inclusion.”

*Brussels, 20.2.2013, SWD(2013) 43 Final

Outline: Health

- Introduction (already done)

Three presentations:

- Ionising Radiation (Hans Bjerke)

- Metrology in Chemistry (Michela Sega)

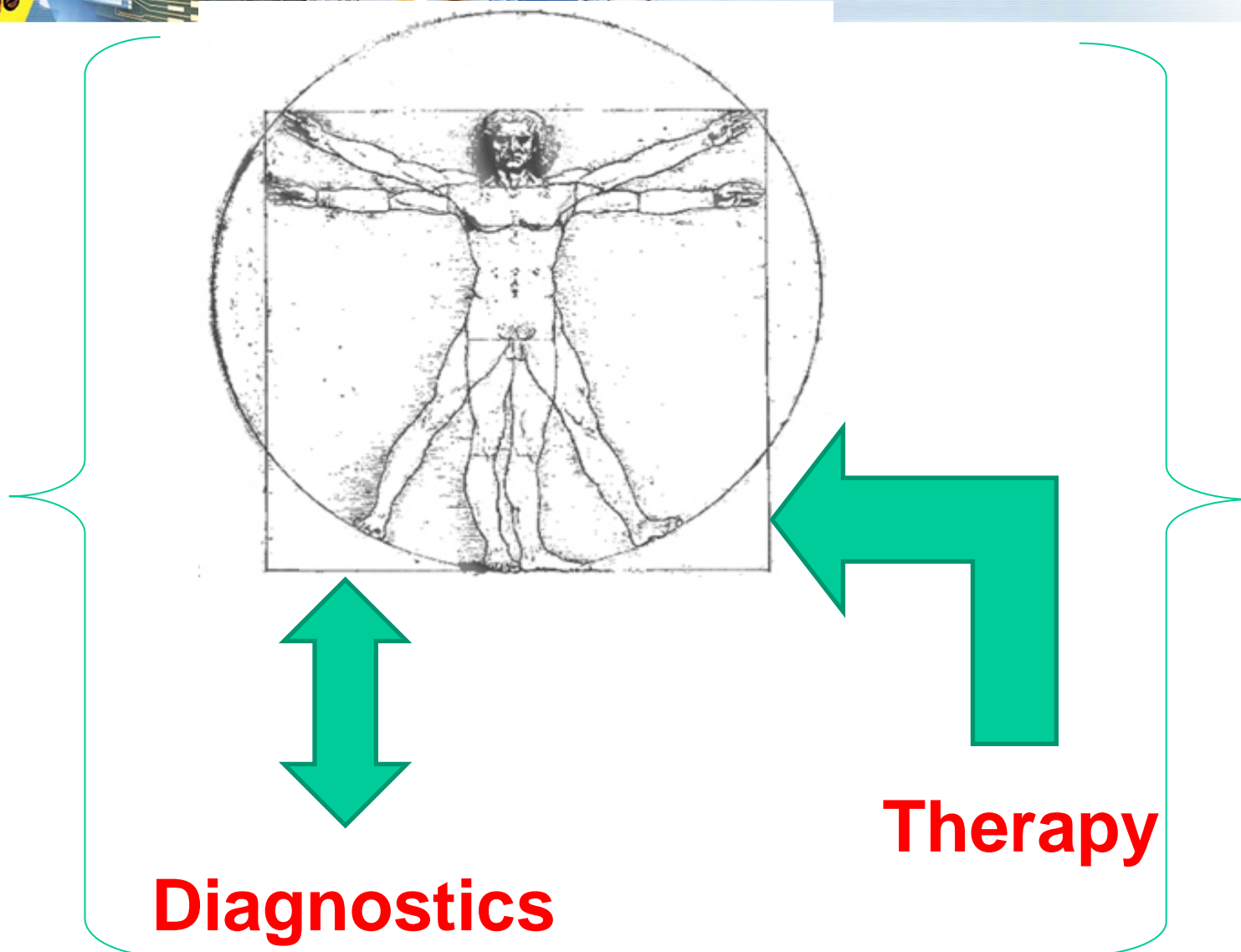
- Acoustics, Ultrasound and Vibration (Salvador Barrera-Figueroa)

Outline: Health

- Introduction (already done)

Three presentations:

- Ionising Radiation: radiotherapy in cancer treatment
- Metrology in Chemistry: metalloprotein, haemoglobin
- Acoustics, Ultrasound and Vibration: ears





Metrology for Radiotherapy using Complex Radiation Fields

JRP-h014 / MetrExtRT

Integration/efficiency: 10 NMI/DI + industrial + end users
Stimulation of innovation: Industrials involved (PTW, IBA, Carlzeiss) New dosimetry services (Gel 3D)

National Physical Laboratory

MKEH

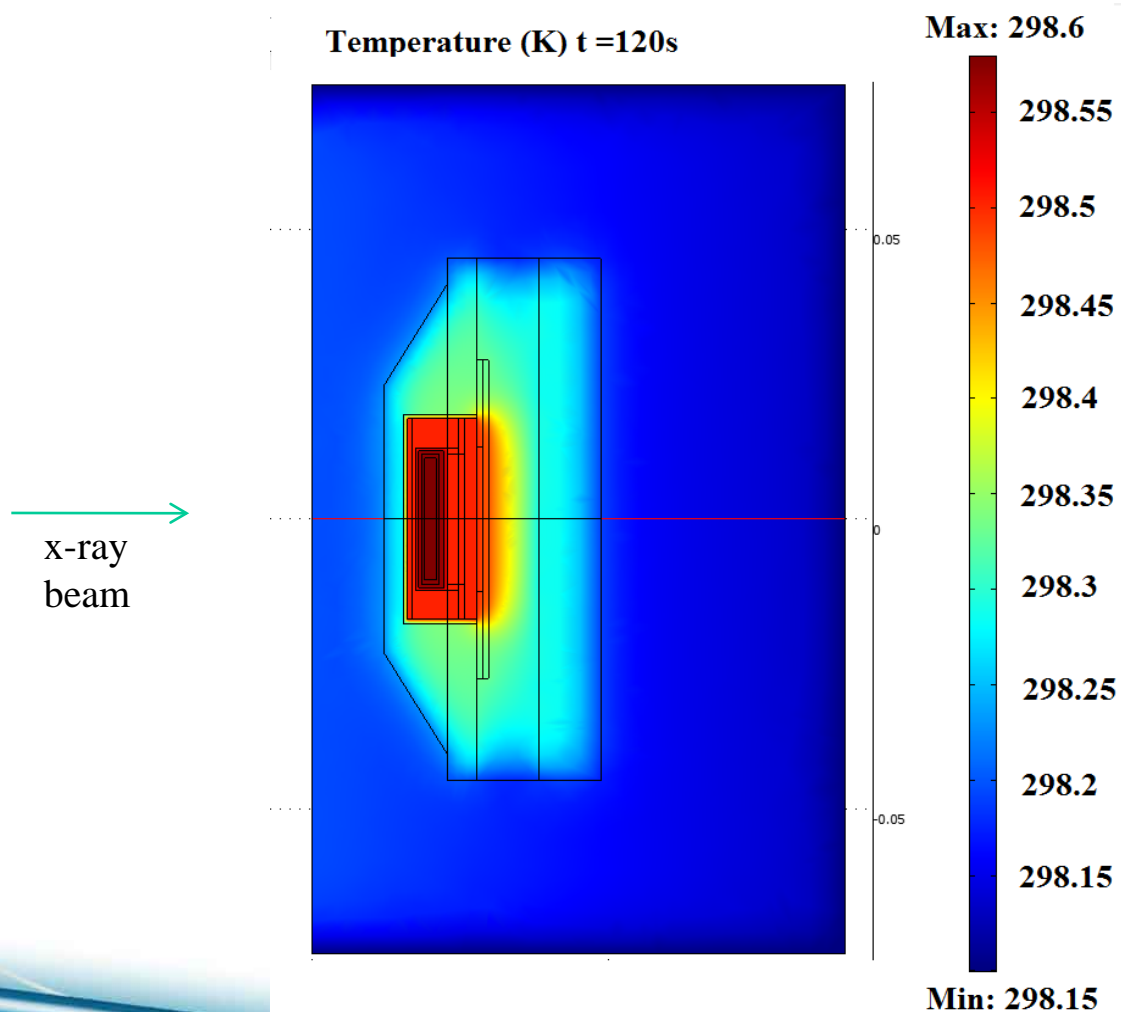
Scientific problem

1. Patient dosimetry are in absorbed dose to water, but some primary standards are not.
2. Modern high energy radiotherapy are delivered in small and complex fields
3. Paediatric proton therapy lacks traceable dosimetry

Application background

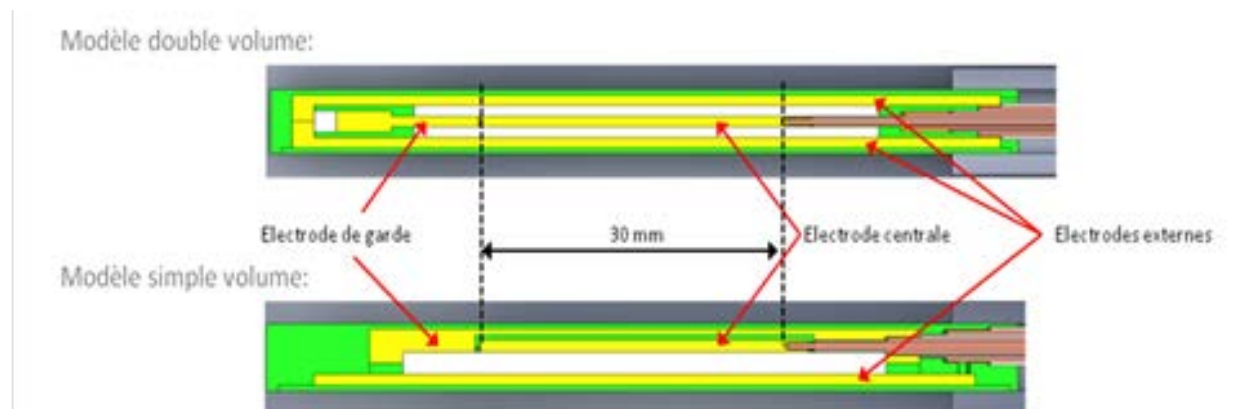
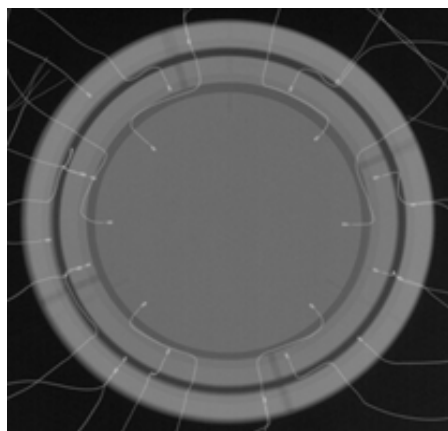
1. Standards are air kerma for Brachytherapy and medium energy x-rays
2. Reference dosimetry are in 10 cm x 10 cm fields
3. Conversion factors from cobalt-60 gamma beams are uncertain.

Core mid plane at 2.0 cm depth in water: calculation of the temperature distribution after a 120 s irradiation run



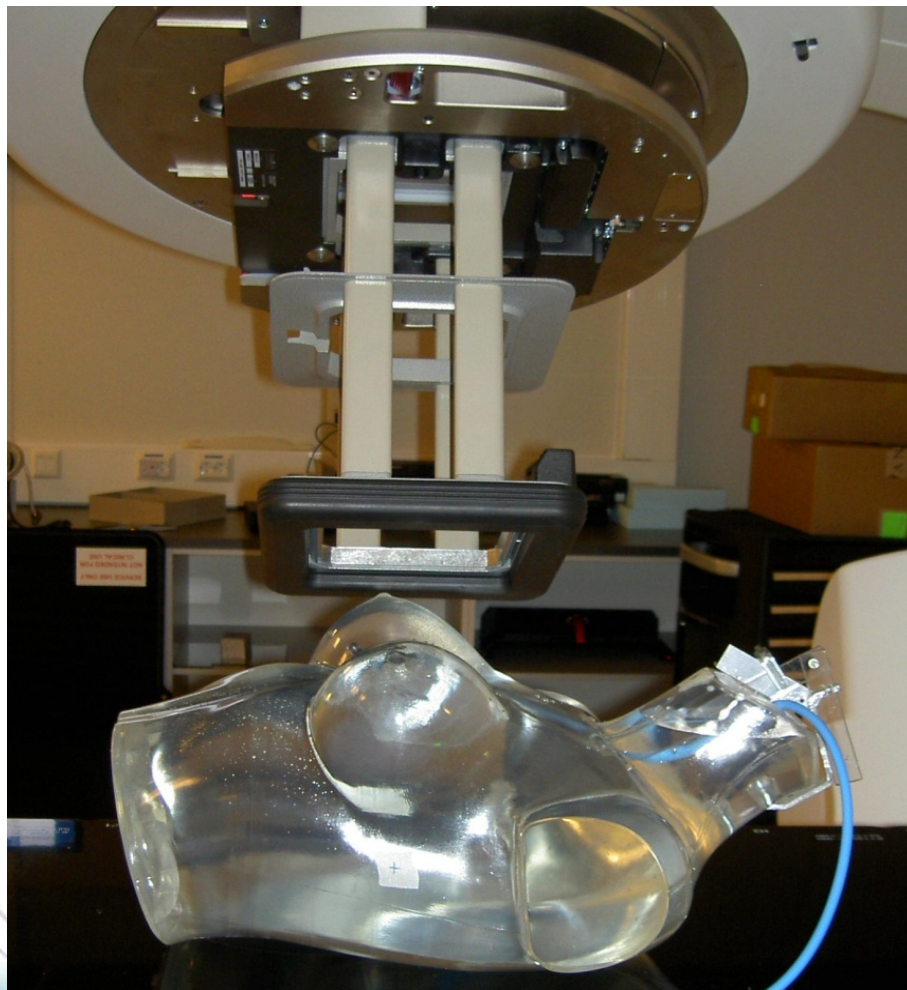
For medium energy X rays the absorbed dose to water has to be measured at 2 cm depth (IAEA protocol n°398)

Radiography of the sensitive element of the graphite calorimeter(left)
Cut view of the ion chamber design (right)



The white dots correspond to the thermistor embedded in the graphite to measure the temperature rise.

The key issue is to build detectors with an area large enough to measure the whole radiation beam

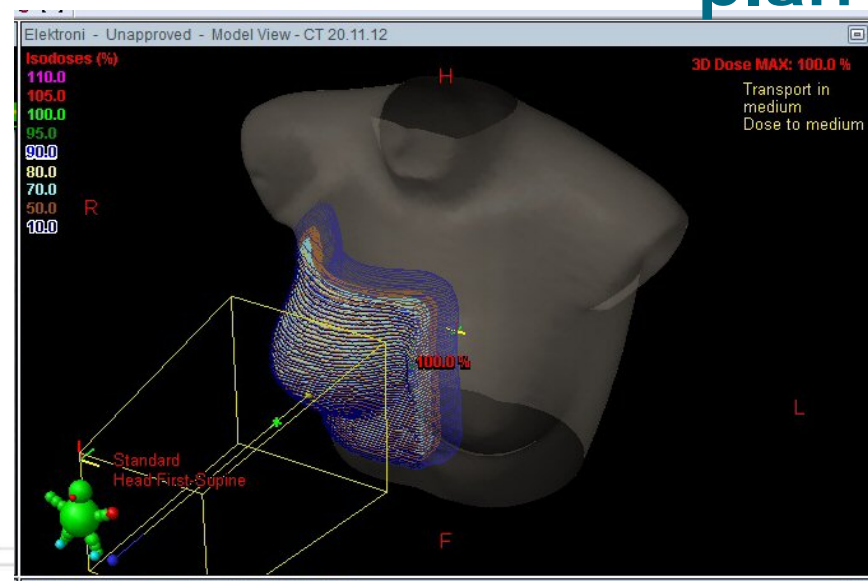


Further steps :

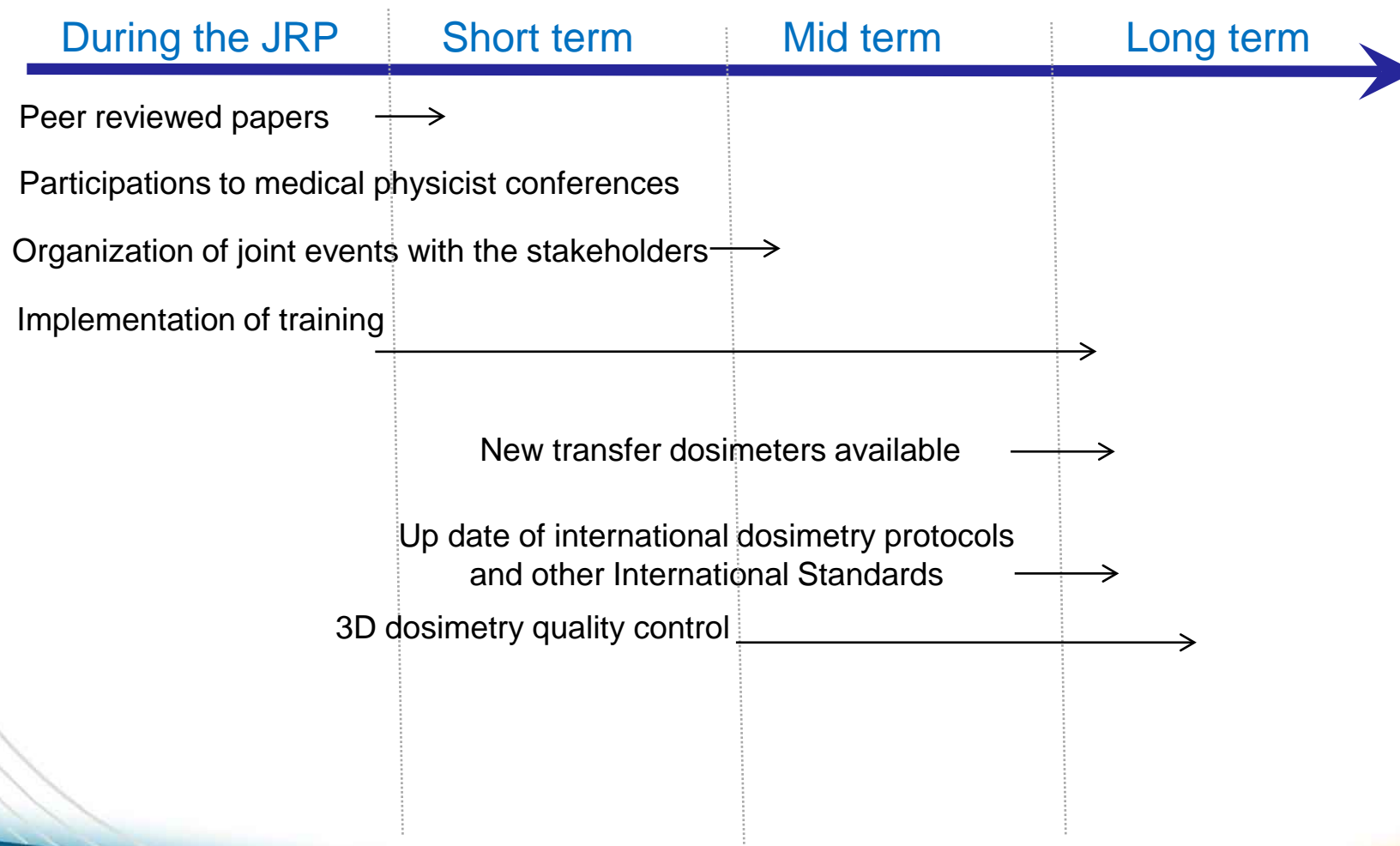
Add lung and bones

Computer control of the detector movements

Calculation of dose plan



Health impact, planned



Health impact output

IR: EURAMET JRP MetrExtRT (Hans Bjerke)

1. one quantity for dosimetry in radiotherapy;
absorbed dose to water
2. secure modern radiation treatment in small fields, and
3. dosimetry for paediatric treatments in proton beams
will be traceable to primary standard

EMRP

European Metrology Research Programme
► Programme of EURAMET

The EMRP is jointly funded by the EMRP participating countries
within EURAMET and the European Union

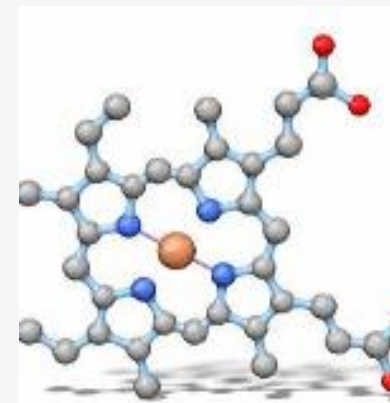


HLT 05: Metrology for metalloproteins (Metallomics)

PTB, BAM, LGC, LNE, TUBITAK UME, UNIABDN, DKFZ, LU

A **metalloprotein** is a protein containing a metal ion within its structure. An example is **haemoglobin**, which contains iron and carries oxygen in the blood.

Metalloproteins are important markers for conditions ranging from deficiency diseases to Down's syndrome. They are also used in cancer treatment



Normative requests:

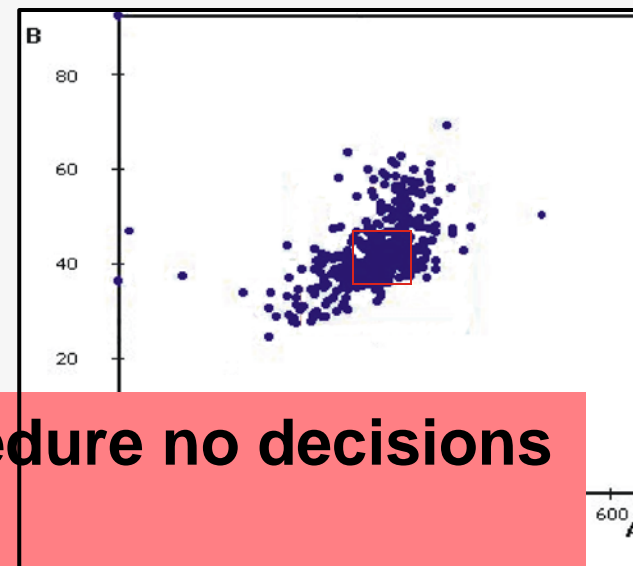
- the EC-directive covering *in vitro* diagnostic medical devices (IVD-directive 98/79/EC) requires assurance of “the traceability of the values assigned to calibrators and control materials [...] through reference measurement procedures and/or available reference material of higher order”.
- the standard EN ISO 17511:2003 demands reference measurement systems including reference measurement procedures for the determination of analytes in samples of human origin.

However, no reference measurement procedures with results traceable to the SI exist up to now for many of the metalloproteins.

Spread of results in an interlaboratory comparison on ferritine

Method	No. of part.	Median / $\mu\text{g/L}$	SD / $\mu\text{g/L}$	RSD / %
All methods	501	249.386	32.623	13.081
Fluorescence	33	244.242	40.195	16.457
Kit 4	22	247.7	36.744	14.834
Luminescence	355	249	31.862	12.796
Kit 4	48	275.189	20.357	7.357
Kit 13	39	182.459	40.074	21.963
Kit 30	160	258.045	27.336	10.593
Kit 40	56	245.368	34.023	13.866
Kit 100	10	250.000	30.000	12.000
Kit 1000	10	250.000	30.000	12.000
Immunochemical	10	250.000	30.000	12.000
Kit 28	25	242.488	18.991	7.832
Kit 30	48	270.787	29.379	10.849
Kit 38	5	251.6	6.731	2.675
Magnetic Particle Med. IA	18	234.778	22.267	9.484
Kit 128	16	238.688	20.237	8.478

Without reference measurement procedure no decisions possible about which result is correct!



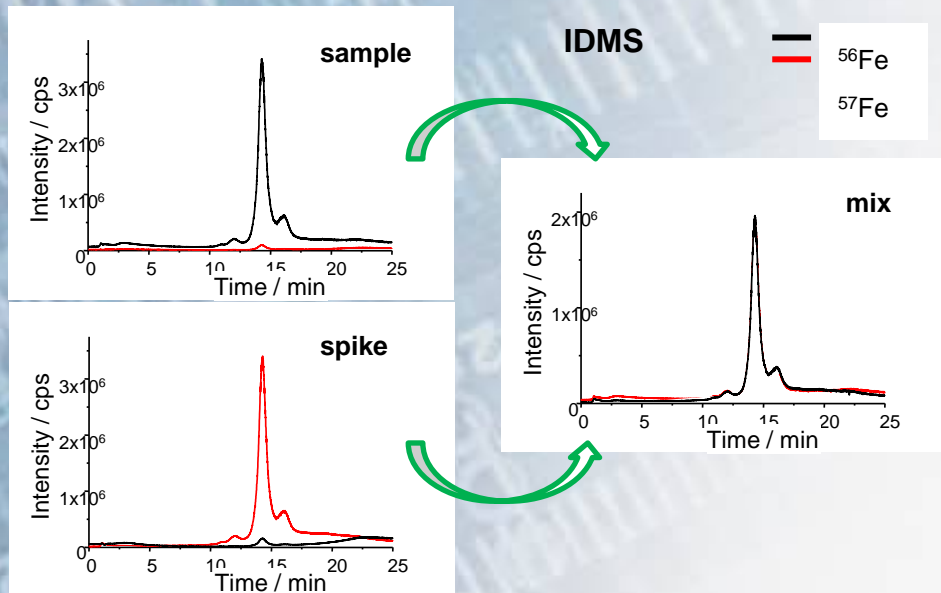
Interlaboratory comparison for ferritin²

²Referenzinstitut für Bioanalytik www.dgkl-rfb.de

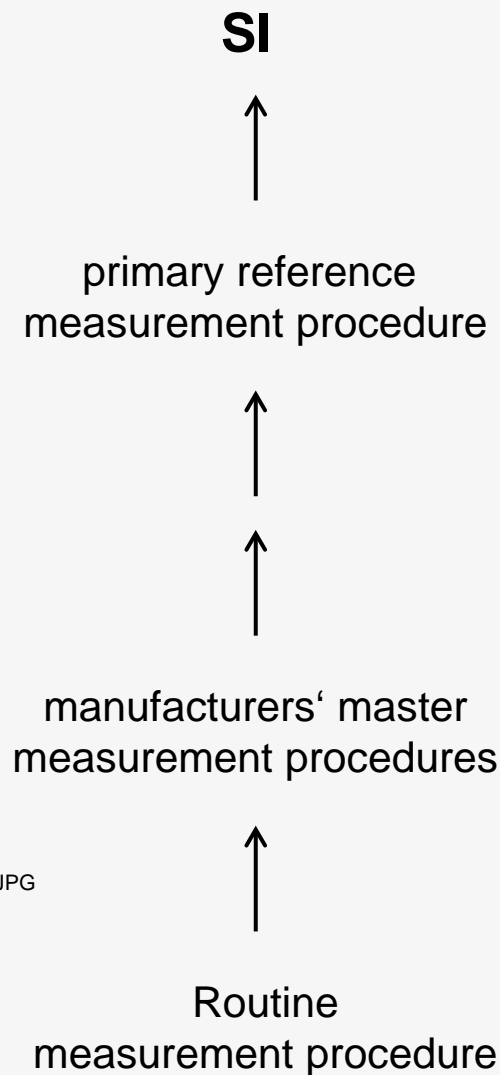
- WP 1** Non-covalently bound metalloproteins:
transferrin, hemoglobin
- WP 2** Proteins with non-covalently bound metalloenzymes:
superoxide dismutase, ceruloplasmin
- WP 3** Covalently bound metalloproteins, metallodrugs and mediating metabolites in cancer chemoprevention and treatment:
selenoproteins, Pt-adducts of DNA and proteins
- WP 4** Development of new and complimentary methods (PTB, BAM, REG1 (DKFZ))

<http://www.ptb.de/emrp/metallomics.html>

Goal: Establishing of a traceability chain for metalloprotein analysis **PTB**



http://www.kamiyabiomedical.com/images/Kit_Pics/KAI-023_600.JPG

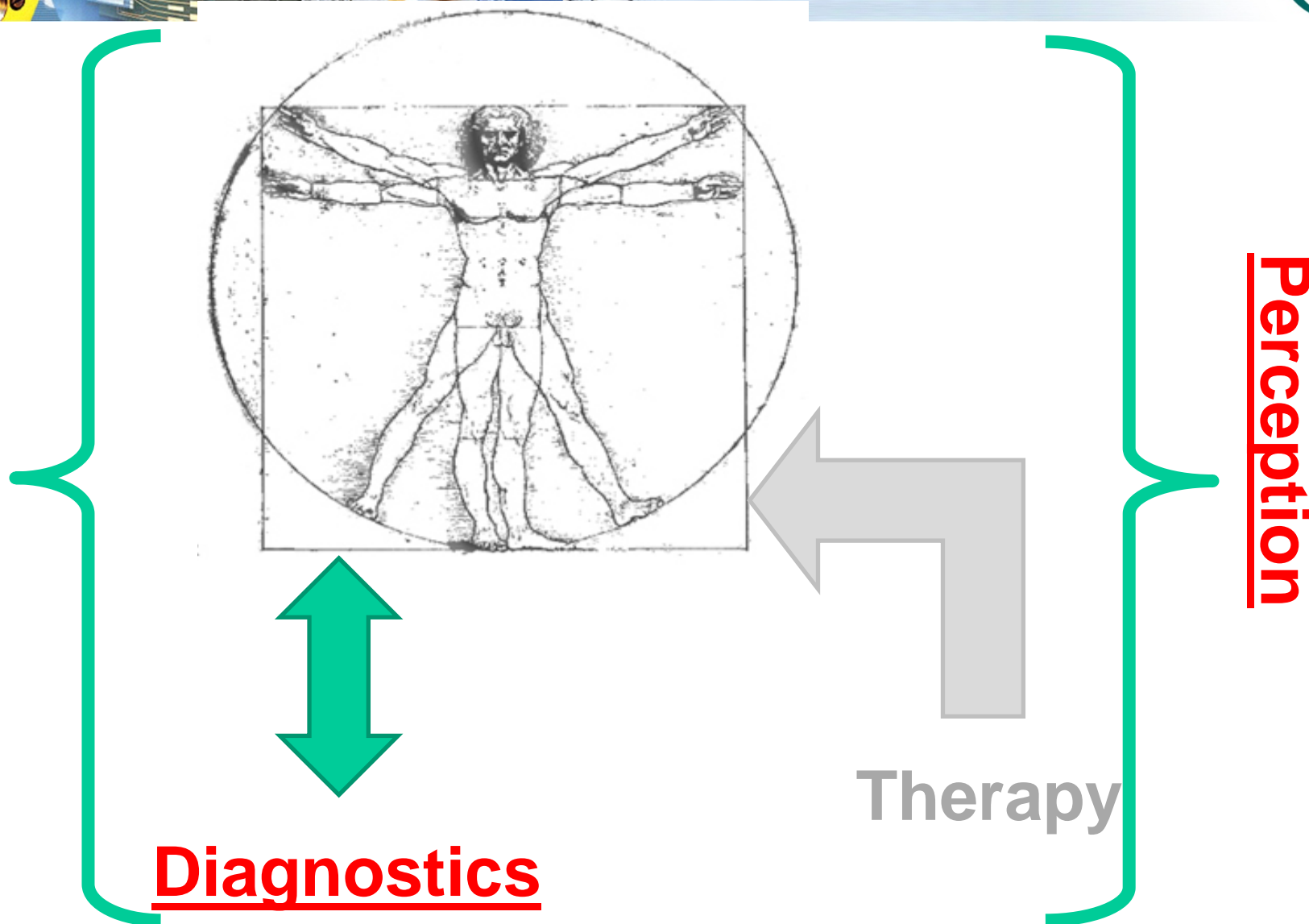


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- **Development of a reference measurement procedure applicable to metalloproteins**
- **Establishment of a metrological traceability chain to field lab**
- **Improve the quality of measurement results in patient samples**
- **establish compliance with the EU regulations and thus ensure improved diagnosis and patient treatment**
- **Reliable diagnoses and therapies**

<http://www.ptb.de/emrp/metallomics.html>



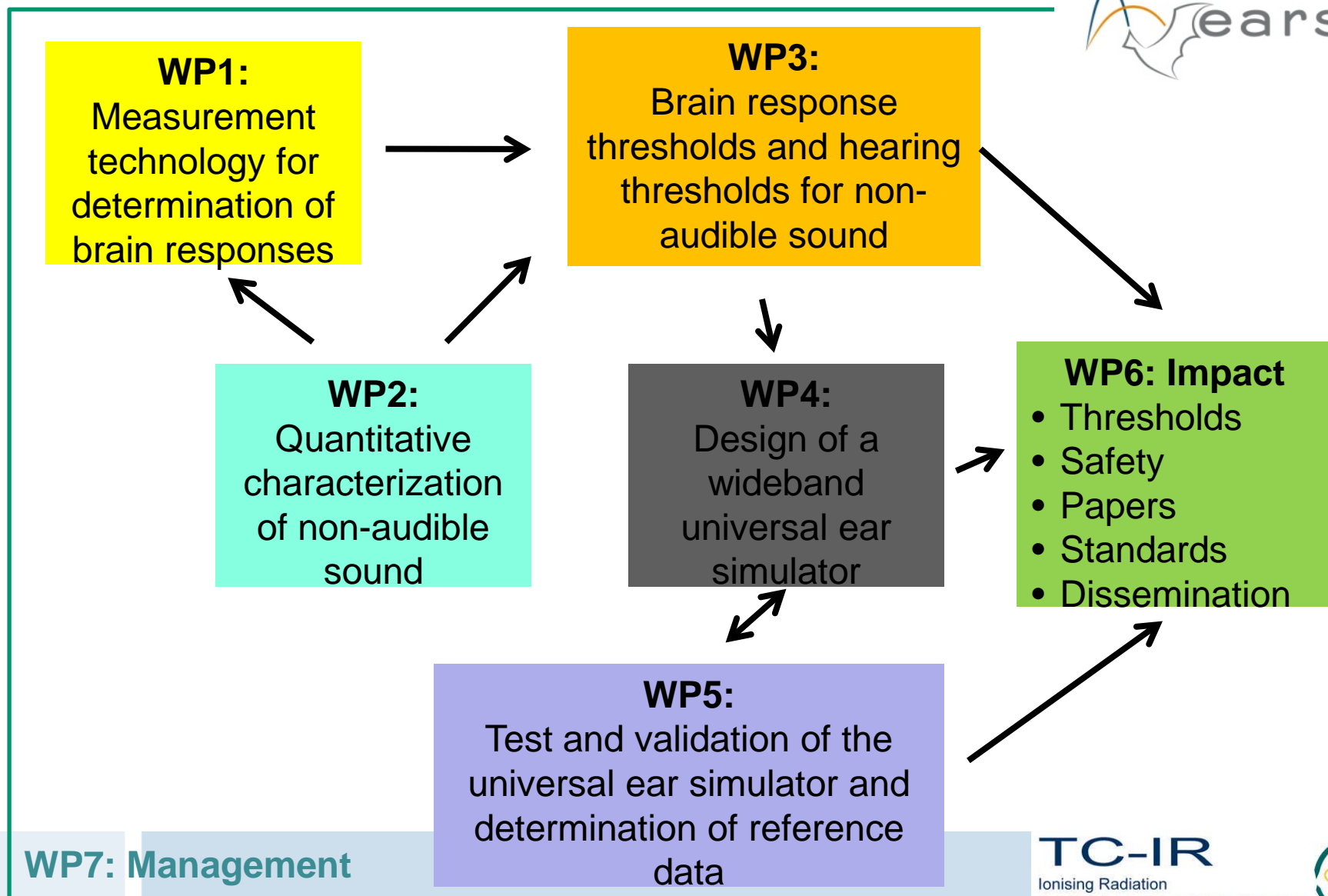
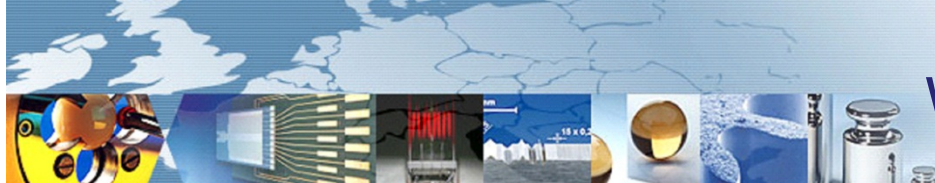


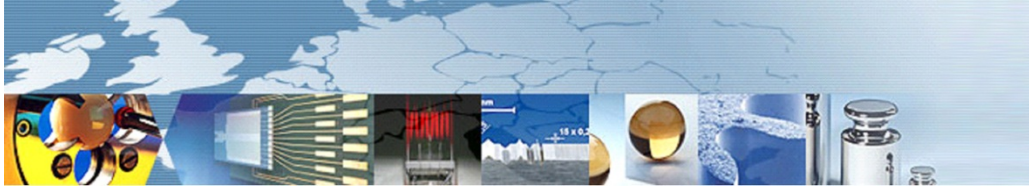
Non-audible sound:

- Limited understanding of perception and lack of rationale for exposure limits and absence of metrological underpinning
- No primary standard for >20 kHz, no measurement methods

Universal ear simulator:

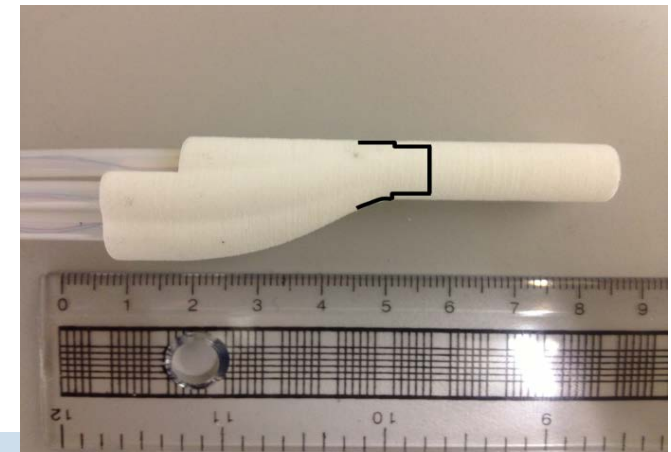
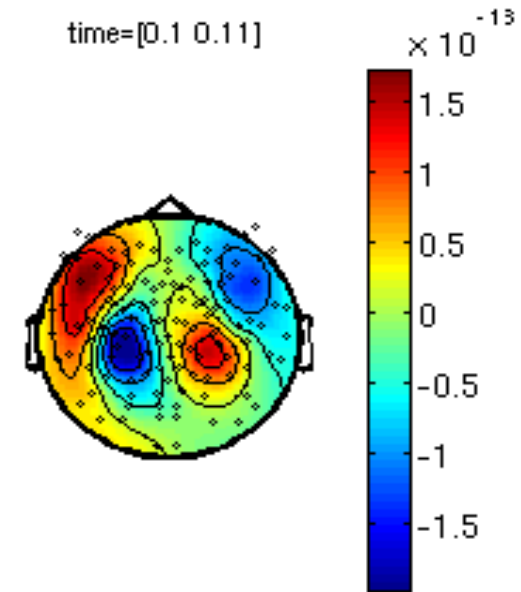
- Ear simulators are developed mainly for pure tones and only for adults: Need for particular devices for children and newborns
- Existing devices and protocols are complex: extension needs new approach \Rightarrow cost reduction and flexible handling and application

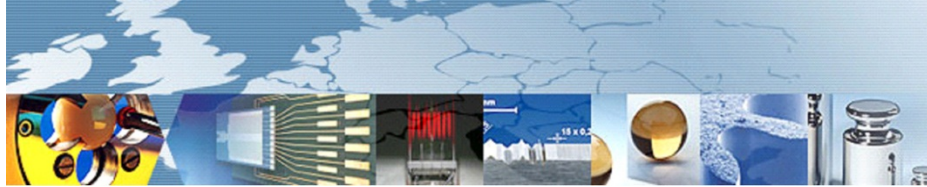




Status: Measurement technology for determination of brain responses to non-audible sound

- Novel method for brain signal measurement technology for deep sources
- Novel acoustic sources for infra- and ultrasound in “magnetic” environment using tubes and MEMS
- Development of a primary free-field calibration technique for airborne ultrasound till 150 kHz
- Development of methodologies for the measurement of non-audible sound at typical emission sites





Design of a wideband universal ear simulator

- Extended and comprehensive literature review for knowledge of ear parameters
- Questionnaire by stakeholders for requirements of a new ear simulator
- Modeling of ear canal, influence of geometry
- Summarizing requirements and conditions
- First ideas for design

