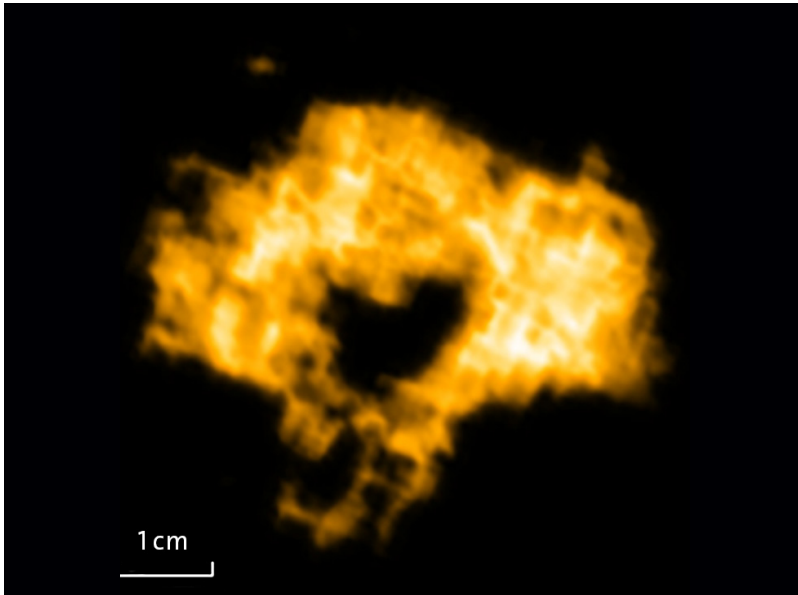




# IEMNews



Two fused medieval cervical vertebrae (C3+C4) from Sogn Murezi, Tomils, Switzerland, excavated 2003 (Terahertz image spectral range of 40 GHz – 0.7 THz, recorded at a frequency of 100 GHz)

Spotlight on the ongoing IEM research (by Patrick Eppenberger, Dr. med., Dipl Industrial Designer FH):

## Terahertz Imaging: an emerging imaging modality

Terahertz radiation (1 THz = 1012 Hz) is usually defined as the band in the electromagnetic spectrum lying between 100 GHz and 10 THz. [48,49 Grant]. Terahertz radiation can thus be viewed either as a very high-frequency microwave or very long-wavelength infrared radiation.

The technology for the detection and generation of terahertz radiation has significantly advanced over the past two decades, yet it still remains a challenge. Nevertheless, the terahertz spectrum has recently emerged as a new area for research in physics, chemistry and the life sciences. The currently investigated applications range from medical diagnostics over security applications to material inspection and even wireless data transmission technologies.

Of particular interest for the research on ancient human remains at our Institute is the fact that many organic substances have characteristic absorption spectra in the terahertz

frequency range. In addition, many non-polar materials are highly transparent in this frequency range, potentially permitting to look through optically opaque materials.

The current standard imaging methods in mummy imaging are X-ray and computed tomography (CT). However, ancient human remains are unique, and, thus, any technology with the potential to study these historic samples, while leaving them intact for future generations, deserves further investigation. Furthermore, due to its low energy levels (1–12 meV), terahertz radiation does not pose an ionization hazard such as X-ray radiation. In contrast to the mostly dry (and non-metallic) nature of ancient human remains, most living biological tissues contain substantial amounts of water. Penetration of Terahertz radiation through such tissues is thus extremely limited by the pronounced absorption of water in this frequency range. Yet this property is potentially advantageous as it can provide contrast between tissues with lesser

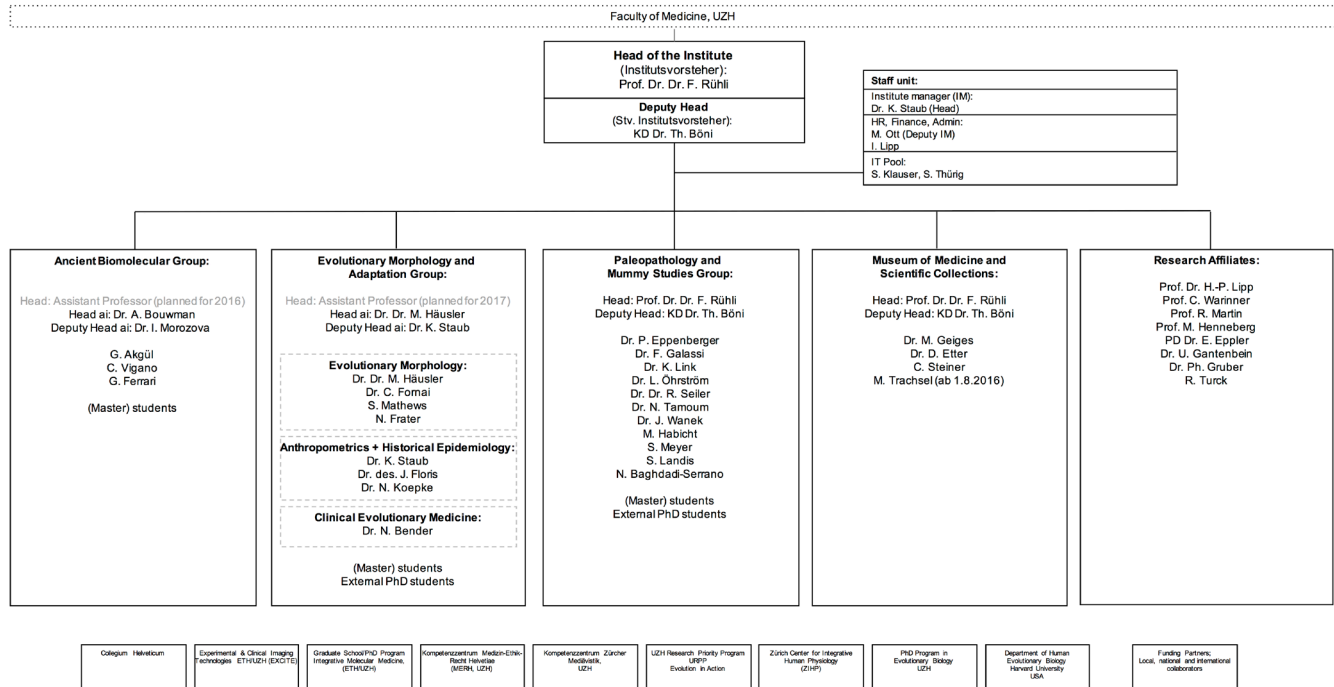
or higher degrees of water saturation. Promising preliminary studies, e.g. on diagnostic studies of melanoma and investigations of formalin-fixed tissue, demonstrate such prospective niche applications.

In an ongoing SNF and DFG funded interdisciplinary-project the Institute of Evolutionary Medicine, at the University Zürich collaborates with the Physics Department at the University Marburg/Germany (Prof. M. Koch) and the Department of Radiology, Medical Physics, University Medical Center Freiburg/Germany (Prof. M. Bock, Dr. U. Ludwig) combining the field of expertise of physicists, medical doctors, and Egyptologists. In the recent past this cooperation already yielded proof-of-concept studies in THz (and MR) imaging of ancient remains, resulting in a number of joint scientific publications.

**Dr. med. Patrick Eppenberger,**  
**Dipl Industrial Designer FH**

# IEM Organigram

## Institute of Evolutionary Medicine (IEM) (as of June 2016)



## Vision and Mission Statement

We are a leading international and globally connected research, teaching and service institute which is part of the medical faculty at the University of Zurich. We analyse ancient biological material and associated data to better understand modern human health issues and diseases. Due to specialist scientific expertise, excellent infrastructure and state-of-the-art methodologies, we are able to work on various interdisciplinary research questions in the context of the field of Evolutionary Medicine. Our core competencies include:

- In the area of morphology: Clinical Anatomy; Variability and adaptation of body morphology as a function of sex, robustness, time (Microevolution), socio-economic factors (etc.); Macroevolution of joint pathologies.

- In the area of imaging: application of modern imaging techniques (MRI, terahertz) on historical tissues; Radiological diagnosis of pathologies.

- In the area of ancient DNA: Co-evolution of diseases and the human genome (evolution of human pathogens, microbiome analyses etc.); Service for Archaeology/Historical Anthropology (paternity testing, sex determination).

- Maintaining a novel medical museum for the public and a medical history object collection for the scientific community.

- Ethical considerations for research on historical human tissues.

We will increase the recognition of the research field of Evolutionary Medicine and expand academic teaching of the subject within and outside the Faculty of Medicine. This will be of a sustainable value for our stakeholders at the University of Zurich, in the research community of evolutionary medicine and adjacent areas, to the economy and ultimately for society in general.

## Words from a UZH collaborator



Prof. Dr. Ueli Grossniklaus (left)  
Prof. Dr. Beat Keller (right)  
Codirectors of URPP Evolution in Action,  
Department of Plant and Microbial  
Biology, University of Zurich

The University Research Priority Program (URPP) “Evolution in Action: From Genomes to Ecosystems” was initiated in January 2013. From the outset, the Institute of Evolutionary Medicine (IEM; back then still the Centre for Evolutionary Medicine or ZEM) was one of the major participating institutions.

Applying evolutionary concepts to medicine allows for new ways to approach medical issues, e.g. the emergence and adaptiveness of human pathogens. We felt that it was crucial and timely for a program on “Evolution in Action” to include research projects in evolutionary medicine. We were thus very happy when Frank Rühli proposed projects that fit perfectly into the context of the URPP. Two PhD projects under the umbrella of the URPP Evolution in Action are currently being performed at the IEM: Giada Ferrari is working on the project “Virulence Evolution in Past Human Pathogens”, and Claudia Vigano’s thesis is entitled “Malaria and G6PD Deficiency Evolution in Europe”.

Beyond these joint research projects, other interactions with our collaborators at the IEM have been highly stimulating and productive: Frank Rühli, Abigail Bouwman, Claudia Vigano, and Giada Ferrari, who also serves as PhD student representative on the Steering Committee, have all been involved in various activities of the URPP Evolution in Action, including numerous public events. They have greatly contributed to networking among the many research groups of the URPP Evolution in Action, an important goal of which is the integration of the UZH community working on evolutionary questions. With great pleasure we learnt that the ZEM would become an independent institute in 2014. We are very pleased that the field of evolutionary medicine thus was strengthened at the UZH and is being recognized as an important and integral part of medicine. Looking forward to the second phase of the URPP Evolution in Action, which will start in January 2017, we anticipate many more fruitful interactions and research collaborations with the IEM.

**Prof. Ueli Grossniklaus and Prof. Beat Keller**

## Words from a new member of the IEM



Dr. phil. Joël Floris  
Evolutionary Morphology and  
Adaptation Group  
Institute of Evolutionary Medicine  
University of Zurich

Since 2003 I have seen three extremely different scientific cultures at the University of Zurich. First I was trained as a historian at the Philosophical Faculty (Historical Institute). Then, although I was officially registered with my PhD at the Philosophical Faculty, I was working as a doctoral student embedded in the Department of Economics of the Business, Economics, and Informatics Faculty. Finally, in September of 2015, I happily joined the IEM as a member of the Evolutionary Morphology and Adaptation Group.

Frank Rühli, Kaspar Staub and I as well as my main doctoral thesis supervisor Ulrich Woitek from the Department of Economics have had a strong working bond for many years. Our common interest in the changes in human morphology over the last 200 years and its causes brought us together about 10 years ago. Since then it has always been an enriching and fruitful collaboration between us. So it should be no surprise that my thesis deals with the standard of living and anthropometry (height, body mass index and birth weights) in Zurich and Basel in the first half of the 20th century. It is for me great pleasure and honour to now be affiliated to both institutes and therefore to be able to make our ties even stronger.

International and national collaborations are important but we should never forget that interdisciplinary collaborations and dialogues can just lie right around the corner at the University of Zurich itself. The IEM, too, provides with its three distinct research groups a fantastic in-house opportunity for great and creative interdisciplinary scientific work.

**Dr. phil. Joël Floris**

## IEM-Publications (Selected publications since last IEM News 9/2015)

Armocida E, Böni T, Rühli F, Galassi F (2016). Does acromegaly suffice to explain the origin of Pulcinella? A novel interpretation. *European Journal of Internal Medicine*, 28:e16-7.

Bentham J, Rühli F, Staub K, Faeh D, Gutzwiller F et al. for the NCD Risk Factor Collaboration, (NCD-RisC) (2016). A century of trends in adult human height. *eLife* 2016;5:e13410.

Bouwman A, Bodiba M, Öhrström L, Mosothwane M, Steyn M, Rühli F (2016). Radiological and genetic analysis of a Late Iron Age mummy from the Tuli Block, Botswana. *South African Journal of Science*, 1(1/2):1-7.

Bouwman A, Rühli F (2016). Archaeogenetics in evolutionary medicine. *Journal of Molecular Medicine*:1-7.

Bruggisser M, Burki D, Häusler M, Rühli F, Staub K (2016). Multivariable analysis of total cholesterol levels in male Swiss Armed Forces conscripts 2006-2012 (N = 174,872). *BMC Cardiovascular Disorders*, 16(1):1-13.

Deuel J, Schaer C, Boretti F, Opitz L, Garcia-Rubio I, Baek J, Spahn D, Buehler P, Schaer D (2016). Hemoglobinuria-related acute kidney injury is driven by intrarenal oxidative reactions triggering a heme toxicity response. *Cell Death and Disease*, 7:e2064.

Di Cesare M, Bentham J, Rühli F, Staub K, Faeh D, Gutzwiller F et al. for the NCD Risk Factor Collaboration, (NCD-RisC) (2016). Trends in adult body-mass index in 200 countries from 1975 to 2014: a pooled analysis of 1698 population-based measurement studies with 19.2 million participants. *Lancet*, 387(10026):1377-1396.

Fornai C, Benazzi S, Gopher A, et al. (2016). The Qesem Cave hominin material (part 2): A morphometric analysis of dm2-QC2 deciduous lower second molar. *Quaternary International: The Journal of the International Union for Quaternary Research*, 398:175-189.

Galassi F, Rühli F (2016). Depiction of differential etiologies of dwarfism by Il Veronese (1528-1588). *Journal of Endocrinological Investigation*, 39(5):593-594.

Galassi F, Rühli F, Ashrafiyan H (2016). Alexander of Tralles and the first portrayal of a placebo by illusion in the 6th century AD. *Clinical Trials*, 13(4):450.

Galassi F, Bianucci R, Gorini G, Paganotti G, Habicht M, Rühli F (2016). The sudden death of Alaric I (c. 370-410AD), the vanquisher of Rome: A tale of malaria and lacking immunity. *European Journal of Internal Medicine*, 31:84-87.

Galassi F, Galassi S (2016). A case of Horton's disease (with its potential neurological symptoms) depicted in a portrait by Andrea Mantegna. *Neurological Sciences*, 37(1):147-148.

Galassi F, Gruppioni G, Ruggeri A, Bianucci R, Rühli F (2016). Luigi Calori (1807-1896). *Journal of Neurology*:Epub.

Galassi F, Habicht M, Rühli F (2016). Dante Alighieri's narcolepsy. *Lancet Neurology*, 15(3):245.

Galassi F, Rühli F (2016). A case of temporal arteritis in Filippino Lippi's (1459-1504) Saint Frediano? *Clinical Rheumatology*, 35(7):1891-1892.

Habicht M, Bouwman A, Rühli F (2016). Identifications of ancient Egyptian royal mummies from the 18th Dynasty reconsidered. *American Journal of Physical Anthropology*, 159(S61):S216-S231.

Jeong C, [...], Warinner C (2016). Long-term genetic stability and a high-altitude East Asian origin for the peoples of the high valleys of the Himalayan arc. *PNAS*:201520844.

Liao W, Henneberg M, Langhans W (2016). Immunity-Based Evolutionary Interpretation of Diet-Induced Thermogenesis. *Cell Metabolism*, 23(6):971-9.

Morozova I, et al. (2016). Toward high-resolution population genomics using archaeological samples. *DNA Res.* 2016 Jul 19, Epub.

Ozga A, [...], Warinner C (2016). Successful enrichment and recovery of whole mitochondrial genomes from ancient human dental calculus. *American Journal of Physical Anthropology*, 160(2):220-228.

Panczak R, Held L, Moser A, Jones P, Rühli F, Staub K (2016). Finding big shots: small-area mapping and spatial modelling of obesity among Swiss male conscripts. *BMC Obesity*, 3(10):1-12.

Perciaccante A, Rühli F, Galassi F, Bianucci R (2016). Gangrene, amputation, and allogeneic transplantation in the fifth century ad: A pictorial representation. *Journal of Vascular Surgery*:Epub.

Rühli F, Häusler M, Saniotis A, Henneberg M (2016). Novel modules to teach evolutionary medicine: an Australian and a Swiss experience. *Medical Science Educator*:Epub(18.4.16).

Rühli F, Galassi F, Häusler M (2016). Palaeopathology: Current challenges and medical impact. *Clinical Anatomy*:Epub(31.3.16).

Schaer C, [...], Schaer D (2016). Haptoglobin Preserves Vascular Nitric Oxide Signaling During Hemolysis. *American Journal of Respiratory and Critical Care Medicine*, 193(10):1111-1122.

Wanek J, Rühli F (2016). Risk to fragmented DNA in dry, wet, and frozen states from computed tomography: a comparative theoretical study. *Radiation and Environmental Biophysics* 55(2).

You W, Henneberg M (2016). Meat consumption providing a surplus energy in modern diet contributes to obesity prevalence: an ecological analysis. *BMC Nutrition*, 2(22).

Özen A, Ludwig U, Öhrström L, Rühli F, Bock M (2016). Comparison of ultrashort echo time sequences for MRI of an ancient mummified human hand. *Magnetic Resonance in Medicine*, 75(2):701-708.

## Upcoming dates

- 9th World Congress on Mummy Studies, Lima, Peru, August 10-13, 2016
- 21st European Meeting of the Paleopathology Association, Moskau, Russia, August 15-19, 2016
- 3rd Bolzano Mummy Congress – Ötzi: 25 years of research, Bolzano, Italy, September 19-21, 2016
- Economics and Human Biology Conference, Tübingen, Germany, October 15-16, 2016

## New IEM-Members

The IEM is happy to welcome the following members to the institute:

- Dr. med. Nicole Bender (Evolutionary Morphology and Adaptation Group)
- Dr. med. Patrick Eppenberger (Paleopathology and Mummy Studies Group)
- Dr. Nadia Tomoum (Paleopathology and Mummy Studies Group)
- Dr. David Etter (Special Project Support)
- med. prakt Michael Strässle (MD-Student, Evolutionary Morphology and Adaptation Group)
- Mathieu Robin (Master-Student MNF, Ancient Biomolecular Group)

## Selected media reports

- RTS Radio, 7 January 2016
- El Pais, 11 January 2016
- News.Discovery.com, 9 February 2016
- Repubblica, 17 February 2016
- Der Spiegel, 23 February 2016
- SRF Einstein, 8 March 2016
- TheConversation.com, 15 March 2016
- Forbes.com, 15 March 2016
- SRF Tagesschau, 1 April 2016
- Tagesanzeiger, 1 April 2016
- News.Discovery.com, 23 May 2016
- Sonntagszeitung, 12 June 2016
- Forbes.com, 28 June 2016

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