Problem 2: Low-dose tomography for in vivo applications – phase-contrast microCT with absorbing objects and noisy projections

Challenge:
Commonly, low-dose CT is considered by reducing substantially the amount of required projections. For in vivo low-dose imaging especially of small animals fast scans are required to overcome motion artifacts. Hence, the amount of projections available is still significant (i.e. several thousand) but each of them with a rather poor signal-to-noise ratio. Furthermore, low-dose at synchrotron is commonly combined with phase-contrast imaging and phase-retrieval for which heterogeneous objects (i.e. strongly varying densities) are challenging.

Motivation:
Synchrotron microtomography in combination with hard X-ray phase contrast and phase retrieval offers the possibility to image living organisms with a very sensitive contrast modality. Furthermore the dose delivered to the sample can be reduced such as the living organisms can be imaged several time. Ultimately, this kind of in vivo microCT protocol should allow for longitudinal studies in small animal models using a more sophisticated contrast mode which should allow to depict soft tissue and hard tissue in a combined manner.

An example application would be the study of bone regeneration in a local defect support by bioceramic particles or scaffold: in the early stage the bioceramic is a dense material, decomposes with time, the newly formed bone is in a spongy state, i.e. closer to soft tissue while in its final stage the hard minieralised bone is developed. Being able to image all of those development stages would support the development of novel bone regeneration approaches, especially to investigate the bioresponse to novel materials.

Previous work / relevant literature:

(1) Stephen Dubsky, Stuart B. Hooper, Karen K. W. Siu and Andreas Fouras. Synchrotron-based dynamic computed tomography of tissue motion for regional lung function measurement. *J Roy Soc INTERFACE* 9**,** 2213–2224 (2012)
(2) T. Weitkamp, D. Haas, D. Wegrzynek, A. Rack. ANKAphase: software for single-distance phase-retrieval from inline X-ray phase contrast radiographs. *J.Synchrotron.Radiat.* 18**,** 617–629 (2011).

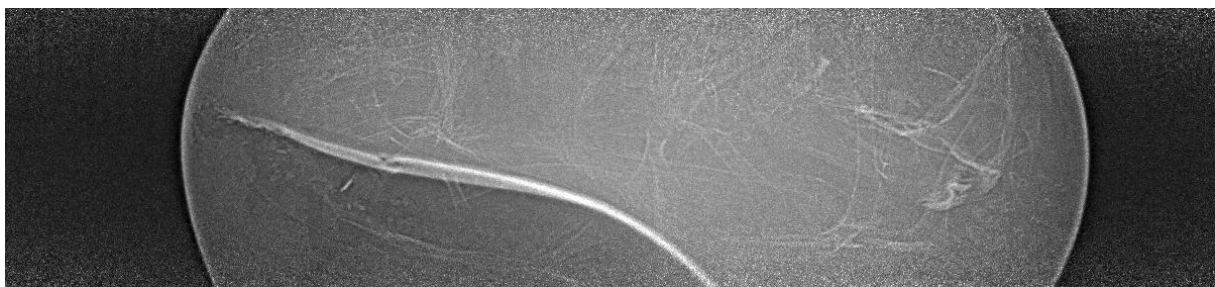**Example dataset :**   in vivo CT scan of a turtle embryo in its egg

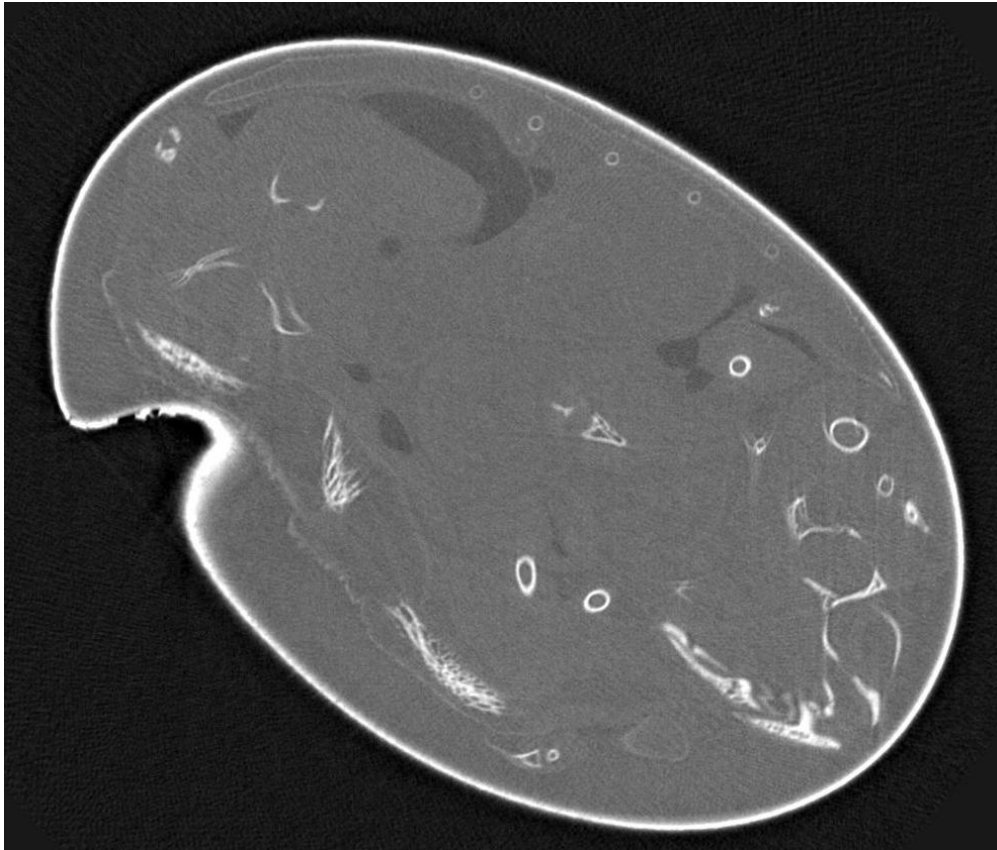**Figure 1**: *Projections of the in vivo turtle embryo, flat- and dark field corrected.*

Figure 2: Tomographic reconstruction, noted: the soft tissue is what is interesting.

Data: Data Exchange files (https://github.com/data-exchange/data-exchange)
Title: tomography_phase_projections
Remark: data are phase projections, not absorption data; values are negative

Projection data details
name: 009_height2

Energy:	37
ScanRange=	360
TOMO_N=	499
REF_ON=	0
REF_N=	501
DARK_N=	501
Y_STEP=	-50
Dim_1=	1200
Dim_2=	320
Count_time=	0.02
PixelSize=	35.4
Distances=	13500

Note: if using this data set in a publication please contact:

Alexander Rack alexander.rack@esrf.eu
for proper sample owner and facility credits.

Data and tomoPy script location:
ftp://extrema:!xtr3mA@ftp.esrf.fr/Challenges/LimitedData/ESRF02