HITRI plus
Heavy Ion Therapy Research Integration

WP12 – Radiobiological Dosimetry and Quality Assurance

ULRIKE SCHÖTZ

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WP12 – Interacting Partners

Institute		Modelling	Biology
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MedAustron	thomas.schreiner@medaustron.at	giulio.magrin@medaustron.at	sylvia.kerschbaum-gruber@meduniwien.ac.at

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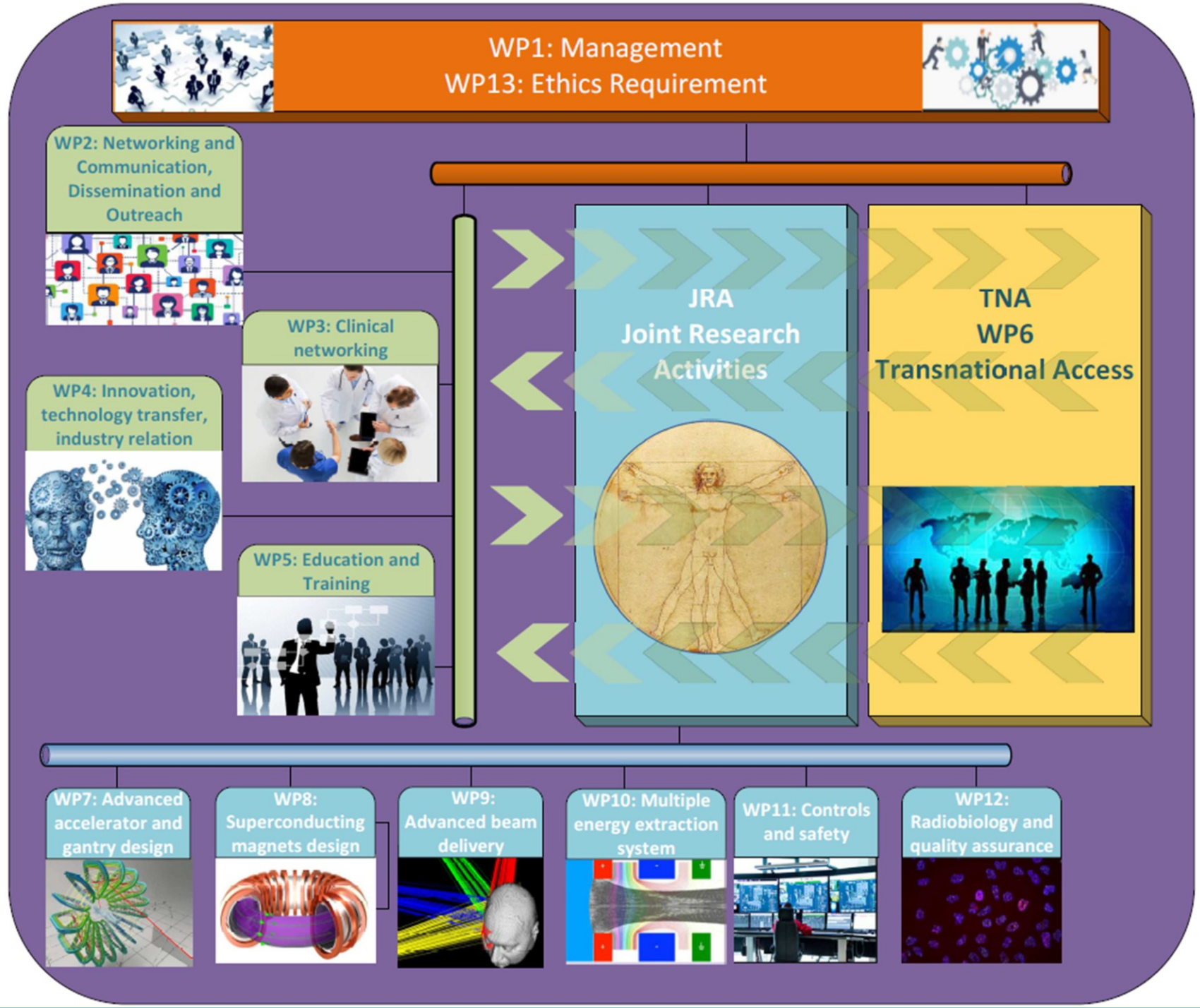
WP1: Management
WP13: Ethics Requirement
WP2: Networking and Communication, Dissemination and Outreach
WP3: Clinical networking
WP4: Innovation, technology transfer, industry relation
WP5: Education and Training
JRA
Joint Research Activities
TNA
WP6
Transnational Access
WP7: Advanced accelerator and gantry design
WP8: Superconducting magnets design
WP9: Advanced beam delivery
WP10: Multiple energy extraction system
WP11: Controls and safety
WP12: Radiobiology and quality assurance

WP12 – key structure

EC requested funding: 200.000 Euro

Distribution between partners:

- UMR, 55.000 €
- UKHD/HIT 80.000 €
- CNAO 20.000 €
- GSI 25.000 €
- MedAustron 20.000 €

MS12

- Generation of a standardized dosimetry for collaborative radiobiological experiments between the facilities

Dissemination activity

- Scientific publication (1)
- Participation at conferences (>)

Work package number [9]	WP12	**Lead beneficiary** [10]	15 - UMR
Work package title	JRA6 - Radiobiological Dosimetry and QA		
Start month	1	**End month**	48

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WP12 - Objectives

Dosimetry standardization for radiobiological experiments

- Evaluate and compare research results between European ion therapy centres.
- Create dosimetry standard operating procedure
- Approach to compare treatment plans
- Enable collaborative experiments between the facilities
- characterization of mixed radiation field using silicon detectors, TEPC, amongst others could further improve the quantification of the physical uncertainties influencing biological read-outs.

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WP12 – Partners and Work

Task12.1 (UMR) - In vitro joint experiment for Radiobiological dosimetry and quality assurance

- Joint experiments will be performed by each partner individually
- Start: a survey among the participants will be circulated in order to create a common standard operating procedure
  - A commercial cell line selected according to its wide use for radiobiological studies will be purchased
  - Clonogenic assay experiments using particles and X-ray, survival experimental data at different depths /LETs, dose level,s Hypoxic and normoxic conditions; Phantom provided by GSI

Task12.2 (UKHD/HIT) - Modelling joint experiment for radiobiological dosimetry and quality assurance

- survey of the planning software and options available among the centres
- plans will be created with the clinical TPS and re-calculated with Monte Carlo (MC) engines when available
  - comparisons with RayStation and FRoG
  - Adequate biological models will be chosen for normoxia (LEM IV, mMKM UNIVERSE) and hypoxia (LET-base approach)
  - Comparison of model predictions and experimental survival data

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WP12 – Deliverables and Milestones

D12.1	Study design and joint radiobiological experiments in all facilities	Month 1-36
D12.2	Comparison of modelling and joint results (lead UKHD/HIT)	Month 1-40
D12.3	Final report and Summary	Month 41-46

To Do: clarification of detailed scheduling

MS12 Generation of a standardized dosimetry for collaborative radiobiological experiments between the facilities

Risk Phantom design cannot be equivalently used at all participating centres due to variation in beam application (Low)

To Do: clarification of phantom administration

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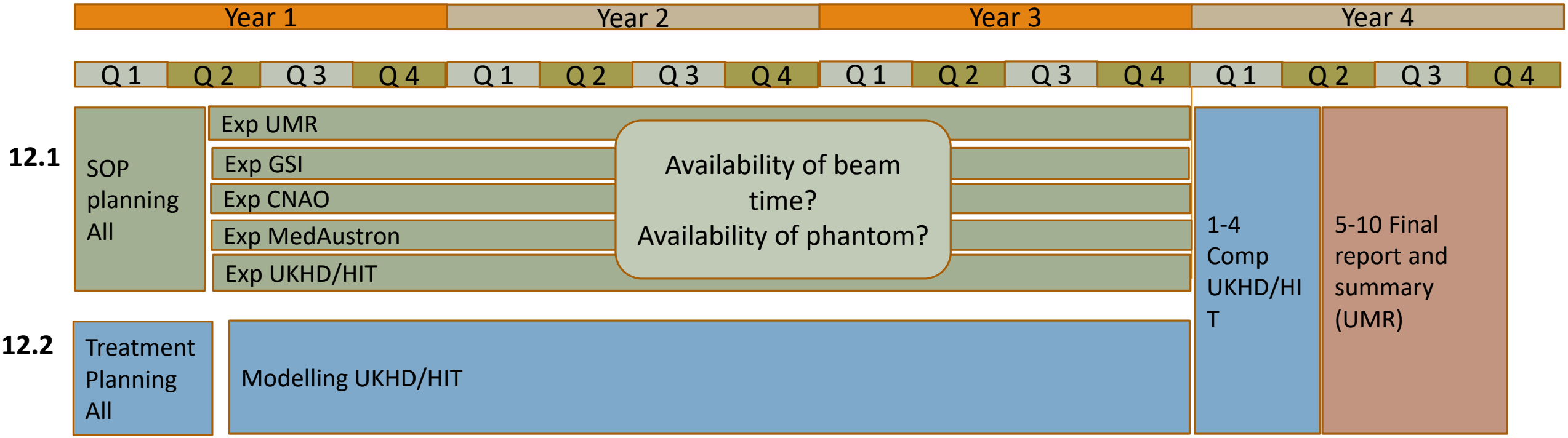
WP12 – Timeline



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WP12 – Factors that Govern Radiation Dose and its Distribution

Depth dose, buildup and falloff of dose with depth in medium or tissue:

- depends on type and energy of radiation beam
- depends on composition of tissue

Distance from source:

- affects dose rate if different from that used for dosimetry
- affects ratio of primary radiation to scattered radiation
- affects dose falloff through sample

Radiation field size:

- affects the flatness of the radiation field since the edges of a large field are at a greater distance from the radiation source than the center of the field, which results in a lower dose rate at the edges than at the field center
- causes dose rate changes with the change in field size due to variations in the amount of scatter
- contributes to a lower effective energy at the field edges due to a higher proportion of scatter radiation

Filters that are in the radiation field in order to “harden” the beam:

- have a major impact on the effective energy of the beam
- significantly reduce the dose rate

Use of any materials or sample containers in the beam, even those that are under or beyond the irradiated sample or animal must be accounted for in dosimetry:

- for their beam attenuation
- for their side and back-scatter onto the sample

Even self-contained fixed-source irradiators exhibit significant variations in dose within the sample chamber.

Adapted from „The Importance of Dosimetry Standardization in Radiobiology” Volume 118 (2013) http://dx.doi.org/10.6028/jres.118.021

WP12 – Protocols

Survey

- Consider all factors mentioned on previous slide
- What are your conditions for X-ray irradiation?
- What are your conditions for 12C irradiation?
- Details of beam application?
- Is the phantom in all its dimensions applicable?
- Can hypoxia be induced und given circumstances?
- Which research and clinical TPS are in use?
- Is recalculation of TP with MC engines applicable?

Survey

- Anything else? ……

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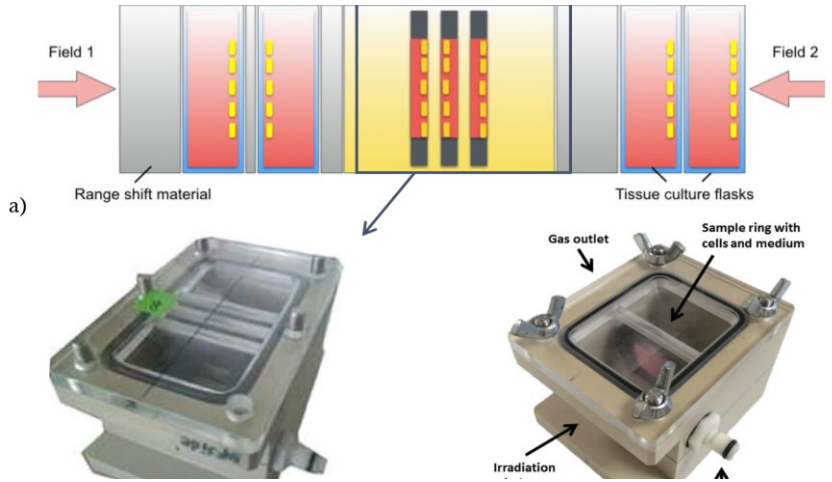
WP12 – Protocols

Measurements

- X-ray
- 12C
- 0, 1, 2, 3, 4, 5, 6 Gy
- Variations of oxygen: 0%, 0,5%, 21%
- Target depth: at different positions of the SOBP?

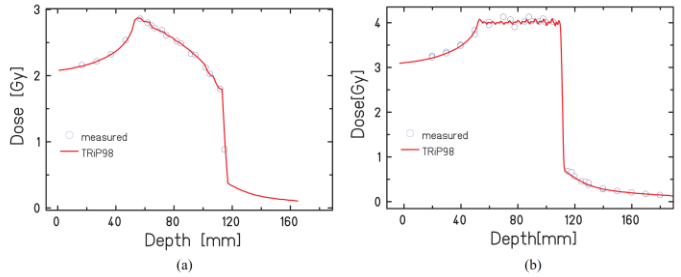
- Anything else? ……

Adapted from Sokol et al., 2017 Phys. Med. Biol.



Details phantom and biological irradiation:
Olga

Details treatment planning and modelling:
Andrea



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Thank you for your attention.

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