

## Break out discussion definitions

- 1) Dosimetry
  - 2) Cell/animal irradiations and positions
  - 3) QA and beam monitoring
- - Dose calibration of intense beams
    - Micro beams
    - FLASH currents
    - Require a modality that will not be affected by dose rates
    - Ionisation chambers can suffer from ion recombination and space charge effects at high currents
      - Ongoing studies – e.g. EMPIR network
    - Graphite calorimetry is dose rate independent (NPL)
    - Alanine – dose rate and energy independent (NPL service)
  - Patient positioning
    - CBCT
    - x-rays
    - other?
    - Proton radiography?
  - Cell irradiations
    - Cell positioning systems
      - 2D stages
      - Robotic arms such as at Christie
    - Beam QA and range modifications
    - Simulations of setups
    - Hypoxia cabinets for FLASH studies
    - Analysis facilities close by
  - Cell imaging
    - Molecular imaging
    - Cell level chemistry
    - activation
    - Mass spec
    - Chemical changes inside cell during treatment
  - QA Services
    - Depth dose curve measurements
    - Beam uniformity
    - Beam Current
    - Beam position
    - Treatment Planning System checks
  - Online Dose monitors
    - Ionisation chambers
    - Scintillators (SciWire etc.)
    - CMOS detectors
    - Low material budgets to maintain low energy beam
    - Photoacoustics
    - Prompt Gamma
    - PET
    - Bioluminescence
  - Beam Diagnostics
    - BPMs
    - Intensity Monitors
    - Non invasive in beam line

- Energy Measurements
  - ToF (LGADs) <https://physicsworld.com/a/ultrafast-detectors-line-up-for-proton-beam-energy-measurements/>
  - MLFC
- Feedback systems
  - LhARA beam structure requires fast feedback from all of the above to alter treatment / interrupt
  - Triggered delivery
  - Magnetic focusing
- Speed!
  - Short sharp pulses will require fast detectors, systems, analysis, feedback