08/11/2021

**Procedure outline for dose mapping/calibration and samples irradiation**

*G. Ciovati, X. Li, M. McCaughan, J. Vennekate*

1. **Commissioning Phase (week 1 & 2)**
2. **Rail calibration**
   1. Mark each sample holder in the center
   2. Mark Ti window flange upper center
   3. Drive each holder to match the center positions  
       verify it with the target camera  
       set corresponding positions in the control system.
3. **Dose mapping and calibration**
   1. Set an X-ray screen on the holder behind the target rail system.
   2. Set a dummy target (Aluminum block) with one X-ray screen in front of it. Alternatively tape the X-ray screen to the rail.
   3. Set up four 75 mL target cells with dosimeter rods taped to the front are placed on the remaining seats.
   4. The target carousel (ITGM604) is operated to place the dummy target in front of the beam exit window
   5. PSS set to RUN, close up UITF.
   6. Beam is accelerated through the MeV section and directed to the beam dump
   7. Verify that the pressure along the beamline (VIPM603, VIPM604A, VIPM604B, VCGM604) is <1e-7 mbar
   8. Open valve VBVM602
   9. Measure and tune the beam profile through the irradiation beamline using both Viewers and Harps
   10. Energize solenoid at the target current of 110 A
   11. Measure the beam energy and energy spread (8 MeV, Use MeV spectrometer line and harp701)
   12. Measure the beam current with Faraday Cup and Beam Current Monitor (100 nA)
   13. Monitor the beam current for a duration time, ~ 40 mins, save the current data during this time. Keep the BCM on for every irradiation and save the relevant data.
   14. Beam is ready to be delivered on 1st target
   15. Verify beam size at target with X-ray screen (~50 mm diameter)
   16. Put Faraday cup in the beamline
   17. Move the 1st target cell in front of the beam exit window
   18. Deliver beam for 1 kGy dose, remove Faraday cup  
       Refer the irradiation time from the FLUKA simulation table.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Front of the window | **1kGy** | **5kGy** | **10 kGy** | **20 kGy** |
| Time (mins) for solenoid | 1 | 5 | 10 | 20 |
| Time (mins) for raster | 1.8 | 9 | 18 | 36 |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Inside water, 2 rods | **1kGy** | **5kGy** | **10 kGy** | **20 kGy** |
| Time (mins) for solenoid | 1 | 5 | 10 | 20 |
| Time (mins) for raster | 2 | 8 | 16 | 32 |

* 1. Record the beam current, irradiation start time and end time on the commissioning sheet.
  2. Repeat steps 2.16 - 2.19 to move each target in front of the beam exit window and deliver 5 kGy, 10 kGy and 20 kGy
  3. Shut off beam
  4. PSS to Open
  5. Retrieve the rods from each target
  6. Replace sample holders with 60 mL sample holders with rods inside water.
  7. PSS to Run
  8. Place dummy target in front of beamline exit window
  9. Verify beam profile and beam energy
  10. Deliver 1 kGy, 5 kGy, 10 kGy and 20 kGy to each target cell (i.e. repeat steps 2.16 - 2.19)
  11. Shut off beam
  12. PSS to Open
  13. Retrieve rods from each target (and label them)
  14. Repeat steps 2.3-2.31 using the raster coils instead of the solenoid.

*Total required dosimeter rods: 104*

1. **Samples Irradiation (week 3 & 4)**
   1. Fill each of the four target cells with DI water with 10 g/L 1,4-dioxane.
   2. Tape 2 dosimeter rods at the front at the outer most positions from commissioning.
   3. The 5th target is the solid aluminum dummy target with X-ray screen.
   4. Follow steps 2.5 to 2.19 to irradiate one sample at 1 kGy, one at 5 kGy, one at 10 kGy and one at 20 kGy.
   5. Retrieve the samples, fill the VOA vials with the irradiated samples.
   6. Thoroughly rinse each target cell with DI water and wipe dry with AlphaWipe cloth.
   7. Fill each of the four target cells with DI water with 100 g/L 1,4-dioxane.
   8. Follow steps 2. to 6.
   9. Fill each of the four target cells with secondary effluent water with 10 g/L 1,4-dioxane.
   10. Follow steps 2. to 6.
   11. Fill each of the four target cells with secondary effluent water with 100 g/L 1,4-dioxane.
   12. Follow steps 2. to 6.
   13. Fill one target cell with DI water with 10 g/L 1,4-dioxane, one with DI water with 100, g/L 1,4-dioxane, one with secondary effluent water with 10 g/L 1,4-dioxane and one with secondary effluent water with 100 g/L 1,4-dioxane.
   14. Follow steps 2. to 6. but irradiate each sample with the same 2 kGy dose.
   15. Repeat steps 1. to 14. using the raster coils instead of the solenoid

*Total required dosimeter rods: 80*