UPDATE ON NIT EMULSION PILOT TEST

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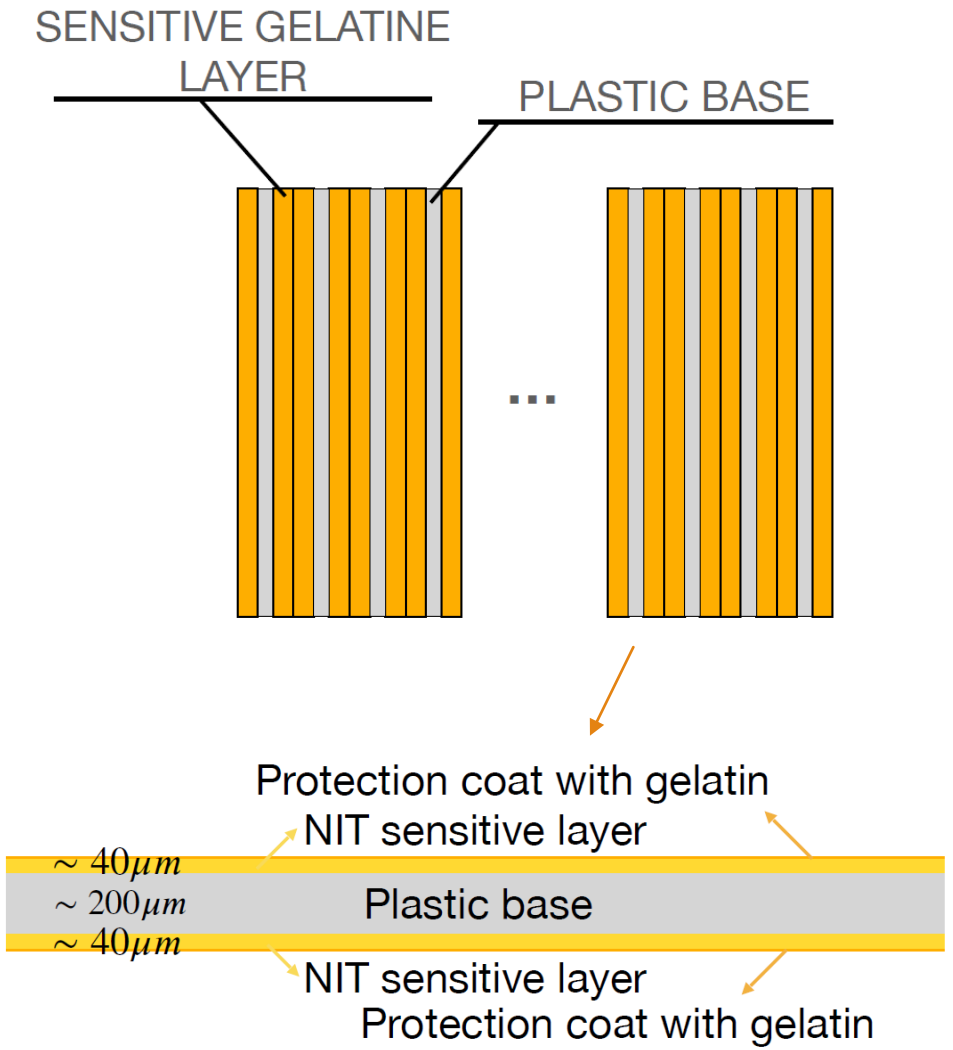
Direct Measurement of Target Fragmentation

- The goal of the project is the *direct* measurement of target fragments produced by a proton beam
- Target fragments have very short ranges

  → we will use Nano Imaging Trackers (NITs) which enable the detection of path lengths down to 100 nm
- The NIT emulsions will be both the target and the tracking device
- Each film will have two sensitive layers (40 μm thick) deposited on both sides of a plastic support (200 μm thick)

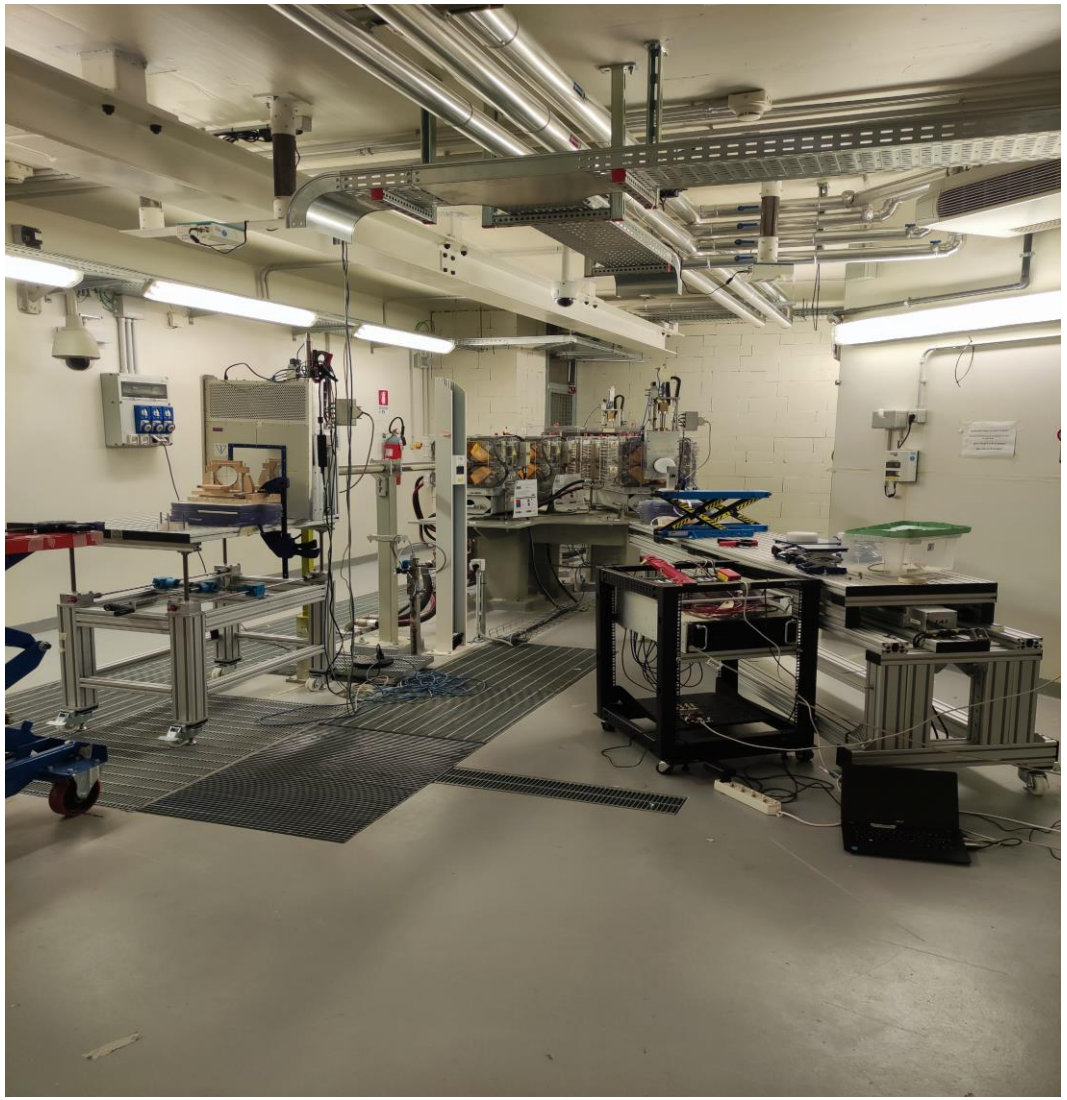


Emulsion Production for Trento Test Beam

- We will perform our first test exposure with NIT emulsions at proton therapy centre in Trento on the **27th-28th of February**
- Emulsion production is scheduled to start the **13th of February** at LNGS (gel production and pouring will take a week)
  - We will produce a single A4 sheet (21,0 cm x 29,7 cm) to be cut into 20 smaller pieces (5 cm x 5 cm)
  - The remaining pieces will be used for test developments
  - The Emulsion Cloud Chamber will be assembled on the 24th of February and it will be brought to Trento on February 27th
  - The day after the exposure the emulsions will be brought to LNGS for the development (and later to Naples for the first scanning tests)

Exposure Details for Trento Test Beam

- For the exposure we will use the physics line and select the initial energy to be 200 MeV
  - Simulations are on-going to define the optimal exposure geometry and the eventual need for mechanized supports
- Given the low interaction probability (for 20 NIT emulsions it is estimated to be around 1%), we are aiming to reach an occupancy of 10.000 protons/cm^2
  - Assuming that the effective sensitive area of the emulsions will be 4x4 cm^2 then we can integrate about 160.000 protons
  - We expect about 1600 total events and about 40% of them in the emulsion gel

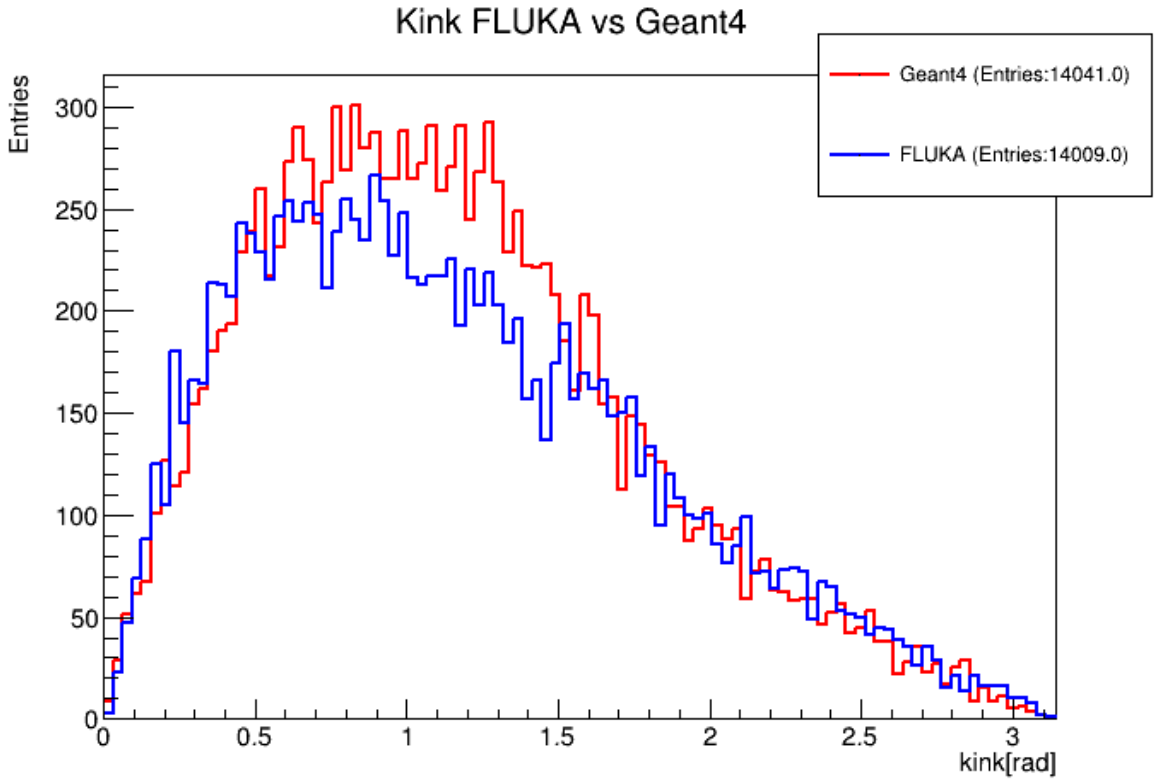


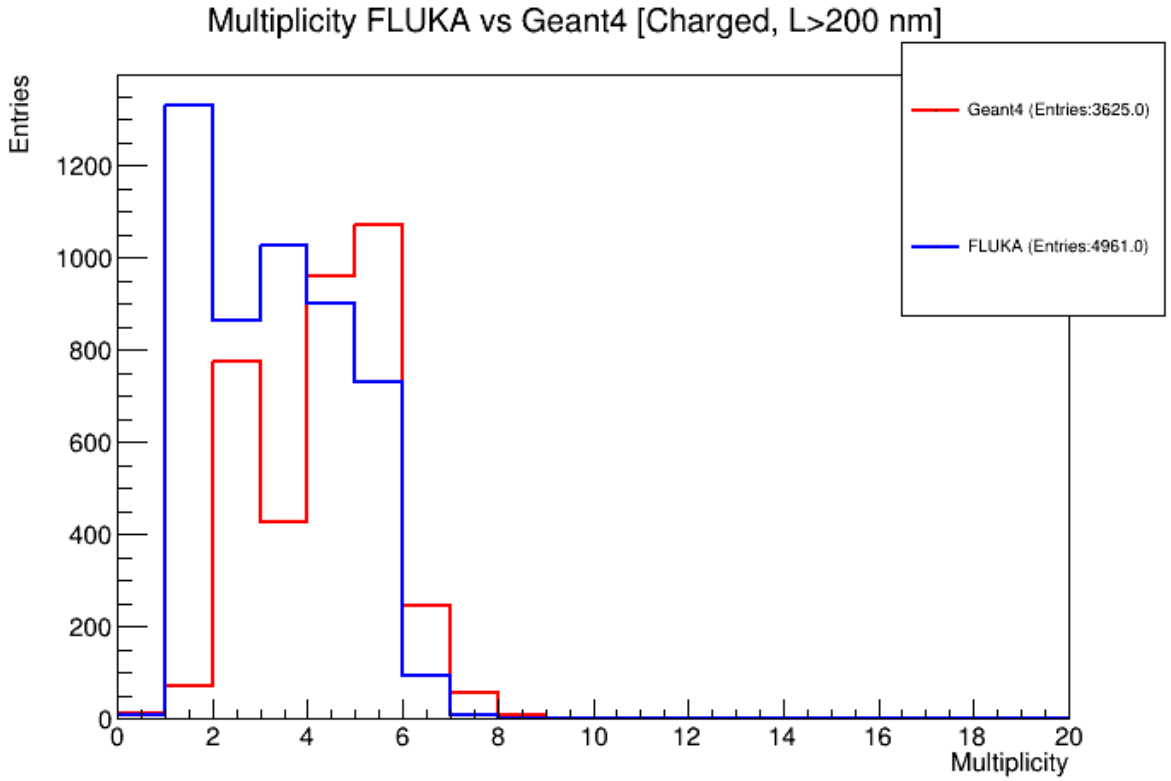
Estimating the Interaction Probability with Geant4

- As an exercise, I produced some simulations with Geant4 concerning the NIT test beam and compared them with previous results obtained with FLUKA
  - 1 μm production threshold for e-, e+, gamma, protons (Geant4)
  - 1 keV transport threshold (FLUKA)
- In both simulations, 100.000 protons @200 MeV imping on 100 NIT emulsions (2x40 μm emulsion thickness + 200 μm polystirene support)
  - FLUKA predicts about 4960 inelastic interactions → ~ 5% interaction probability
  - Geant4 predicts about 3625 inelastic interactions → ~ 3.6% interaction probability
- Despite the difference in the number of interactions, the number of secondary charged fragments predicted by the two simulations is very similar

Estimating the Interaction Probability with Geant4

- These plots only contain charged fragments with a track length of at least 200 nm
- The multiplicity is very different between FLUKA and Geant4 simulations





Conclusions

- Defined the timetable for the upcoming test beam at Trento (27-28 February)
- NIT emulsions production starting from February 13th
- MC simulations are on-going as well as discussion with Trento group to define the optimal exposure geometry
- The aim is to integrate 160.000 protons on a 4x4 cm^2 area
  - About 1600 total events expected (~ 640 in the emulsion gel)
- The first scanning tests will be performed in Naples starting on March

Back up

Geant4 Physics Lists

- The following physics lists have been used:
  - G4EmStandardPhysics_option4, G4EmExtraPhysics, G4EmPenelopePhysics
  - G4RadioactiveDecayPhysics, G4DecayPhysics, G4StoppingPhysics
  - G4HadronElasticPhysicsHP, G4HadronPhysicsQGSP_BIC_HP, G4IonBinaryCascadePhysics, G4NeutronTrackingCut