

The hadron far forward beamline

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**Center for Frontiers
in Nuclear Science**

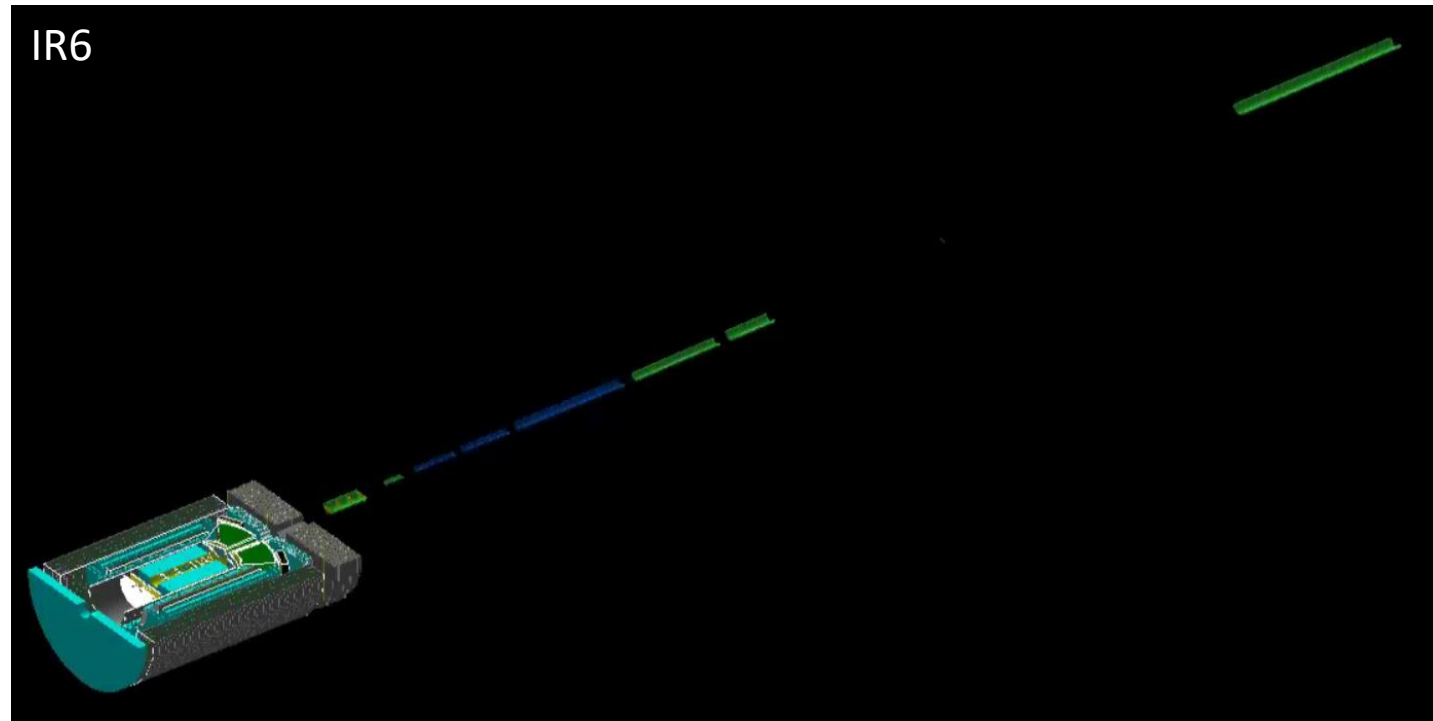


**Stony Brook
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The big picture

- The goal was to give a starting point for the forward physics that many people are interested in
- Making use of the general setup of the BeamLineMagnet subsystem we have implemented the IR6 and IR8 far forward beam lines
- For IR6 the detectors used for the YR studies were added as “virtual planes”
 - This should enable reproduction of the EIC-ROOT studies within the fun4all framework



- The next steps are really up to you:
 - The IR8 detector acceptances need to be defined within the context of the beamline
 - The specifics of each of the detectors (tracking for the B0 detectors and RomanPots, calorimetry) can be easily integrated within F4A after initial stand-alone performance studies

The code

Calibrations

<https://github.com/sPHENIX-Collaboration/calibrations/blob/master/Beam/>

G4_hFarFwdBeamLine_EIC.C

https://github.com/sPHENIX-Collaboration/macros/blob/master/common/G4_hFarFwdBeamLine_EIC.C

Fun4All_G4_EICDetector.C
G4Setup_EICDetector.C

https://github.com/sPHENIX-Collaboration/macros/blob/master/detectors/EICDetector/Fun4All_G4_EICDetector.C

```
206 auto *detZDC = new PHG4BlockSubsystem("zdcTruth");
207 detZDC->SuperDetector("ZDC");
208 detZDC->set_double_param("place_x",96.24);
209 detZDC->set_double_param("place_y",0);
210 detZDC->set_double_param("place_z",3750);
211 detZDC->set_double_param("rot_y",-0.025*TMath::RadToDeg());
212 detZDC->set_double_param("size_x",60);
213 detZDC->set_double_param("size_y",60);
214 detZDC->set_double_param("size_z",0.1);
215 detZDC->set_string_param("material","G4_Si");
216 detZDC->SetActive();
217 if(verbosity)
218     detZDC->Verbosity(verbosity);
219 g4Reco->registerSubsystem(detZDC);
```

- Detectors (and magnets) are implemented through parameters that feed into each Subsystem

```
251 //EIC hadron far forward magnets and detectors.
252 Enable::HFARFWD_MAGNETS_IP6=true;
253 Enable::HFARFWD_VIRTUAL_DETECTORS_IP6=true;
254 Enable::HFARFWD_MAGNETS_IP8=false;
255 Enable::HFARFWD_VIRTUAL_DETECTORS_IP8=false;
```

- Integration and different configurations can be easily done in “Fun4All_G4_EICDetector.C” macro
- The “Enable” flags make sure that you only implement only one set of magnets
- By default the magnets do not store hits and is a “blackhole” (absorbs and kill any particle hitting it)

Beamline configurations

- The beamline is implemented through the use of “standard” beamline files
- Both the IR6 and IR8 magnet strengths in the configuration files are for 275 GeV proton beams
 - A simple scaling should take you to other proton/ion beam energies
- The naming of the magnet is important: B^* is for dipoles, Q^* is for quads, S^* are for sextupoles

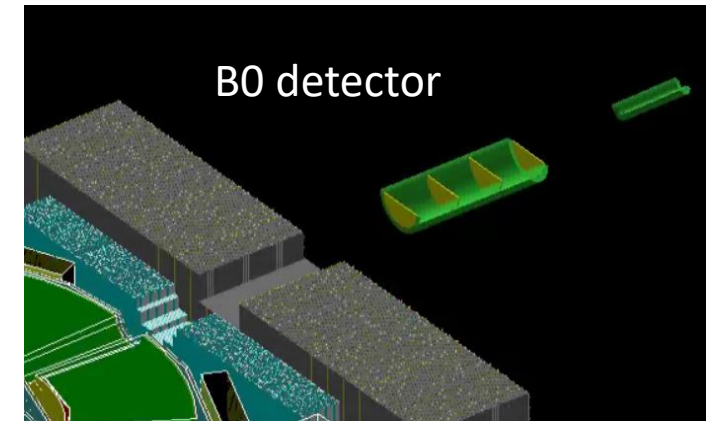
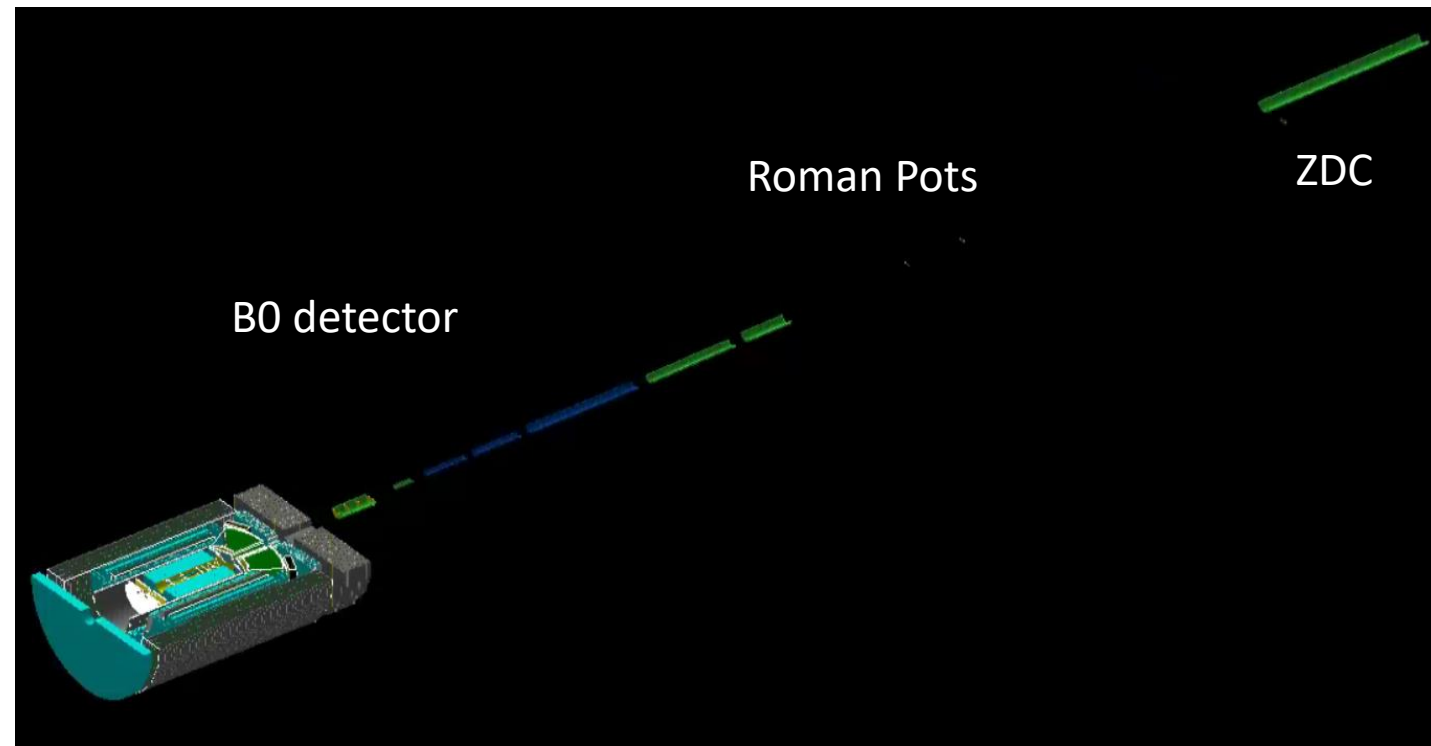
```
1 ## -----
2 ## adapted from YF: ion_35mrad_IP2_15Mar2021.txt (downloaded on 3/29/21)
3 ## https://gitlab.com/eic/escalate/g4e/-/blob/511b4f84c241abc4f2890c93807f0e12b72565fd/resources/ip8/mdi/ion_35mrad_IP2_15Mar2021.txt
4 ## for 275 GeV protons
5 ##
6 ##   name      center_x center_y center_z rin(z-in) rin(z-out)  dout  length  angle   B   gradient
7 ##           [m]      [m]      [m]      [m]      [m]      [m]   [m]   [mrad] [T]   [T/m]
8 ##
9 BXUS01 -0.597507719  0      -17.73979064  0.04  0.04  0.28  4.5    24.5   -4.280739283  0
```

<https://github.com/sPHENIX-Collaboration/calibrations/blob/master/Beam/>

- center_x/y/z: position of the center of the magnet volume
- rin: radius of the aperture for the magnet at the “low”-z end of the magnet
- rout: radius of the aperture for the magnet at the “high”-z end of the magnet
- dout: outer diameter of the magnet
- length: z-extent of the magnet
- angle: rotation around the vertical axis (y)
- B: field strength for the dipole magnets
- gradient: field strength for quadrupole magnets

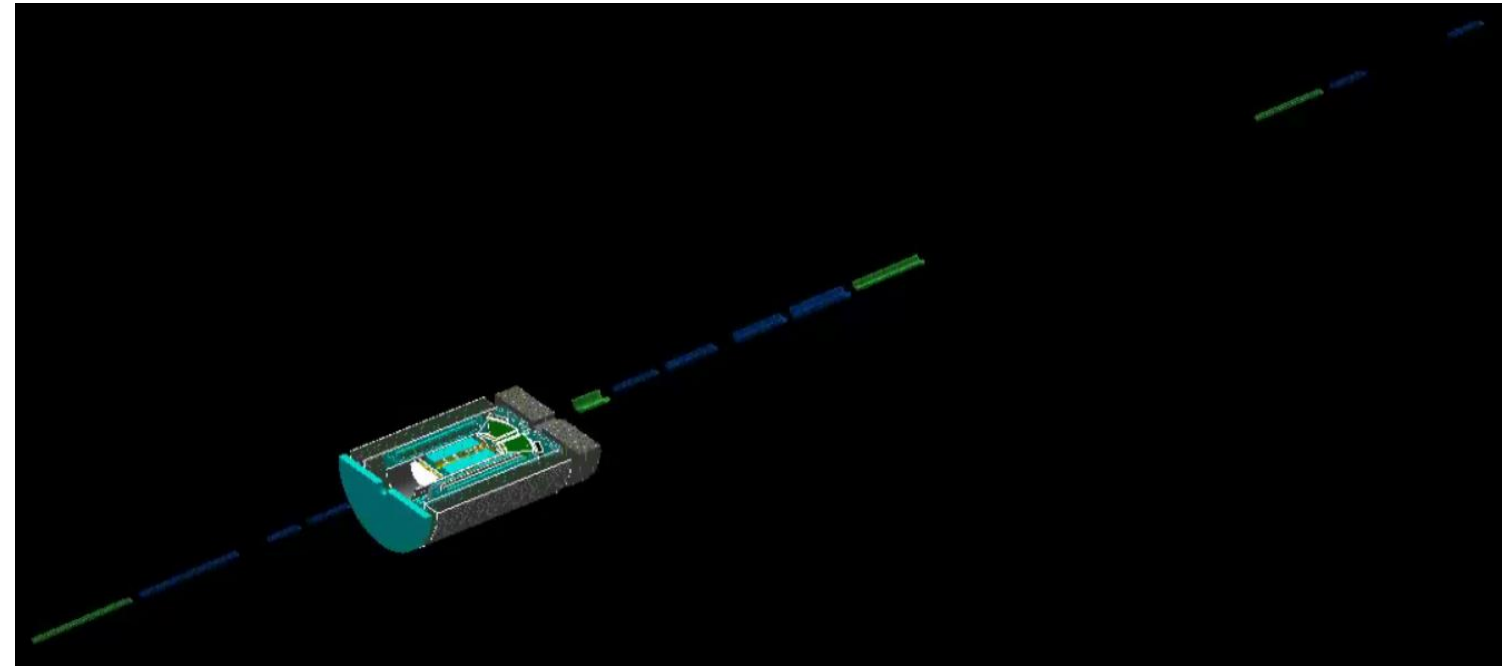
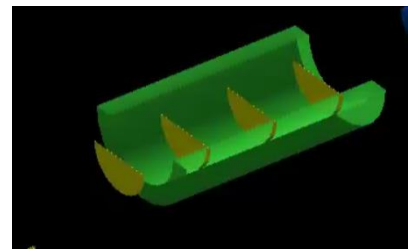
IR6 implementation

- This is really what was used for the YR studies
- The 3 detectors “tracking” systems:
 - B0 detector: set of 4 planes inside the B0 dipole. The difference from EIC-ROOT is that these detectors don’t have an acceptance hole so some acceptance cuts will be needed
 - The Roman Pots: 2 tracking planes at 26 and 28 m DS of the IP
 - The ZDC: 1 tracking plane at 37.5 m downstream of the IP
- All of these detectors will give you the “truth” information allow you to establish the most sensitive acceptances for your favorite physics



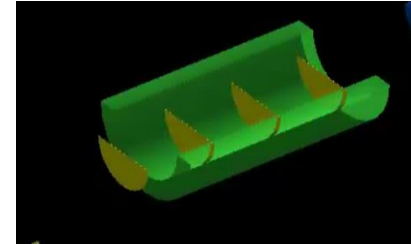
IR8 implementation

- Currently only beamline magnets are properly implemented
- You can put in IR6 detectors but they will have overlaps with the magnets
- There is an odd issue where some of the detectors are not visible in the visualizer (where are the Roman Pots on the right?) but the detectors are registered with Fun4All and hits are generated



Near term TODOs

- The IR8 “truth” detectors need to be implemented
- The macro should take the ion beam into account and automatically scale the strengths of the magnetic fields



Detailed studies

- Depending on what kind of studies are of interest I can imagine a couple of scenarios:
 1. Physics reach studies: mostly can be done with what is in place and some basic smearing (requires development of analysis tools – see Joe’s talks, and perhaps small tweaks to the locations of these virtual planes)
 2. Detector implementation: develop (within Fun4All) a detailed subsystem as described by Chris making sure you get the performance that you want. Remove the virtual plane in the G4_hFarFwdBeamLine_EIC.C and add your subsystem to the Fun4All_ECCE.C setup macro