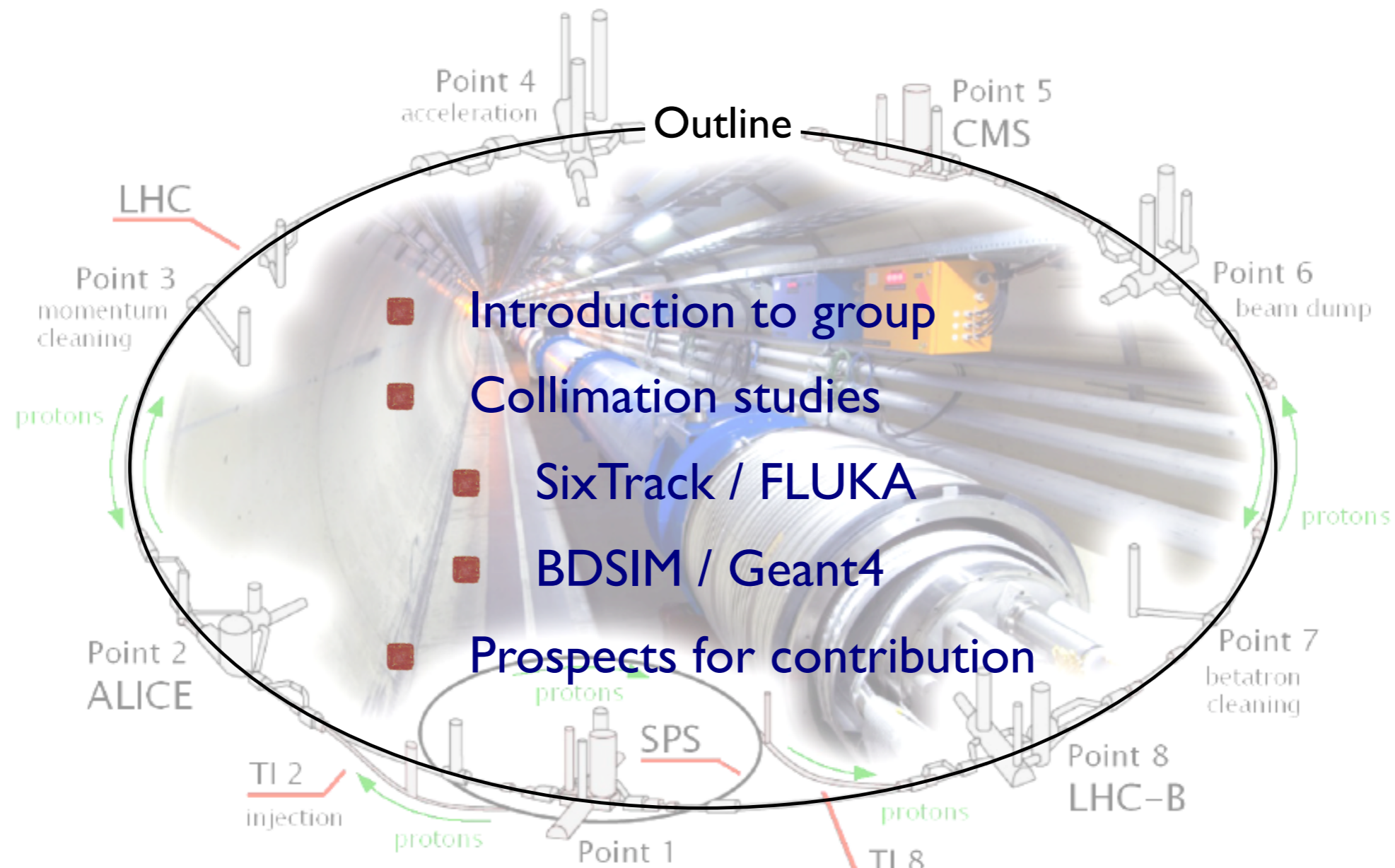# Royal Holloway contribution to LHC Collimation Studies

Stephen Gibson, Regina Kwee-Hinzmann, Laurie Nevay.

Eu-CARD2 WP11 kick-off, 9th December 2013

Outline

- Introduction to group
- Collimation studies
  - SixTrack / FLUKA
  - BDSIM / Geant4
- Prospects for contribution

Introduction

- **R**oyal **H**olloway, **U**niversity of **L**ondon is a member of the John Adams Institute for Accelerator Science together with the University of Oxford and Imperial College London.

- RHUL expertise includes:

  - Beam dynamic and beam loss simulations: original development and validation of BDSIM as a Geant4 extension toolkit for beamline simulations:

    - BDSIM applied to many beam delivery systems of ILC, CLIC, ATF2…

    - Recently developing BDSIM for beam losses simulations at the LHC.

    - SixTrack / FLUKA expertise for HL-LHC collimation studies.

  - Advanced instrumentation for beam diagnostics:

    - Resonant cavity beam position monitors.

    - Beam generated radiation monitoring.

    - Laserwires for electron and high power proton machines (LHC Linac4).

New group for LHC collimation studies

- New HL-LHC group formed at **R**oyal **H**olloway **U**niversity of **L**ondon:

  - Currently: 1 academic, 2 PDRAs + now recruiting 1 oPAC position.

 Stephen Gibson   Regina Kwee-Hinzmann   Laurence Nevay   oPAC

  - Strong collaboration with CERN BE dept, HiLumi WP5 collimation coordinator S. Radaelli and R. Bruce for SixTrack + FLUKA LHC simulation.

  - Building expertise with present SixTrack + FLUKA LHC, now moving to HL-LHC studies.

- Use existing RHUL developed BDSIM code for HL-LHC:

  - Seamless integration of particle interactions and loss (Geant4) with accelerator style tracking.

  - Fast export of MADX to standard loss simulation tools.

- Complementary studies by Rob Appleby & Roger Barlow et al at the Cockcroft Institute using Merlin+FLUKA: an opportunity for collaborative UK contribution.
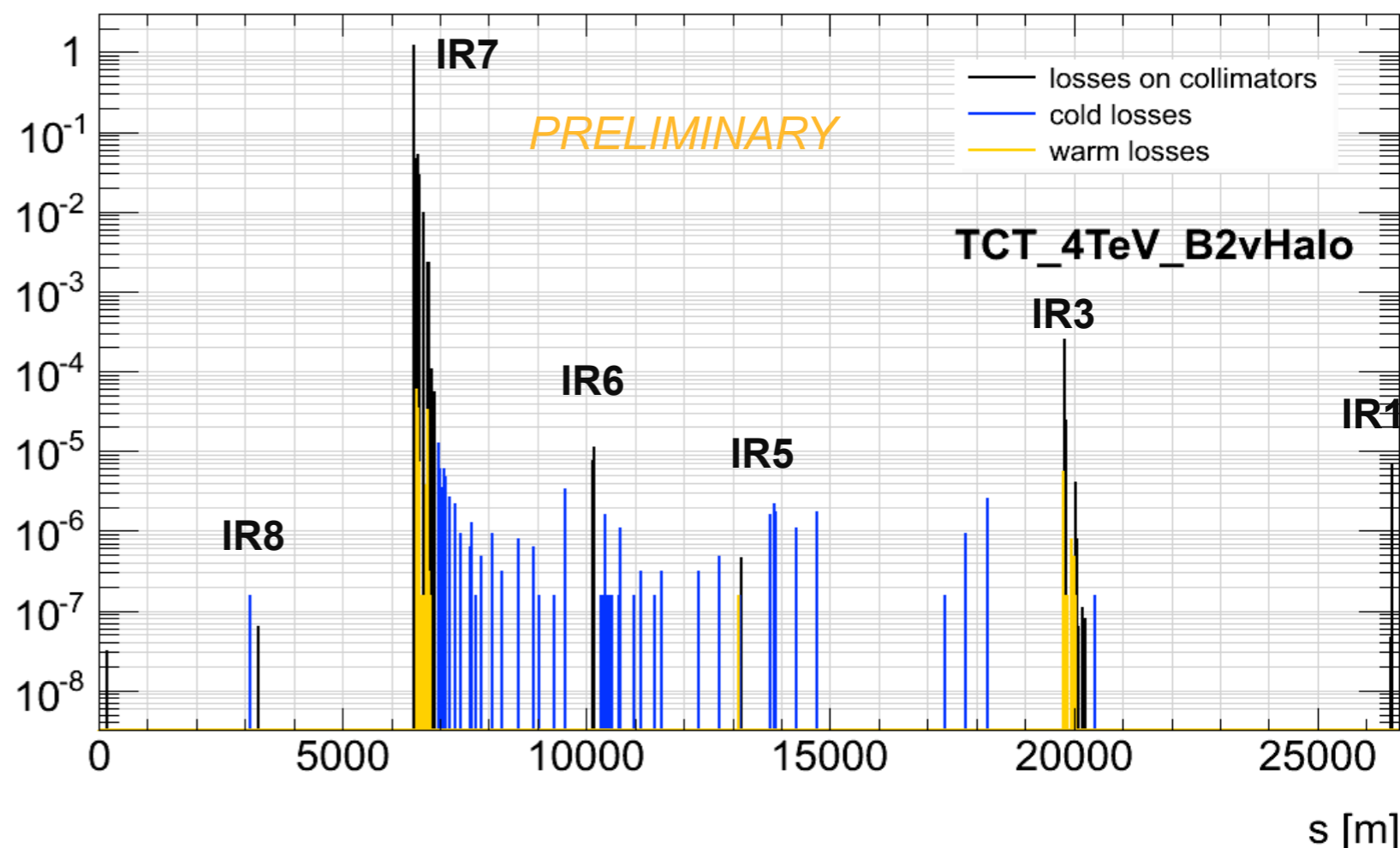
R.Kwee-H.

- **Beam halo simulations:**

  - 3.5 TeV beam energy simulations of CERN group recently extended to 4 TeV per beam.

  - Start with SixTrack simulation and calculate loss map around LHC ring:

    - Beam2 H+V Halo, optics for $\beta* = 60$ cm

example of input halo distribution to sixtrack

Collimator hits used as input to FLUKA
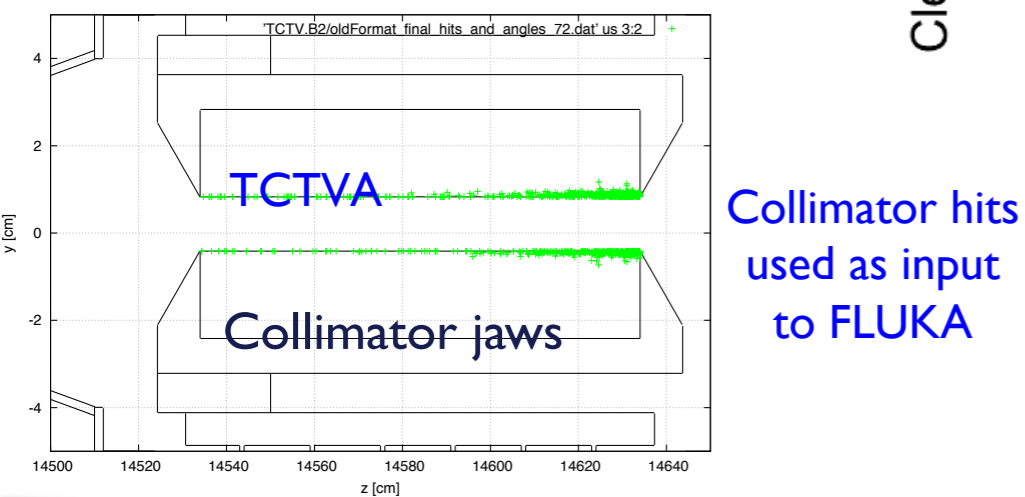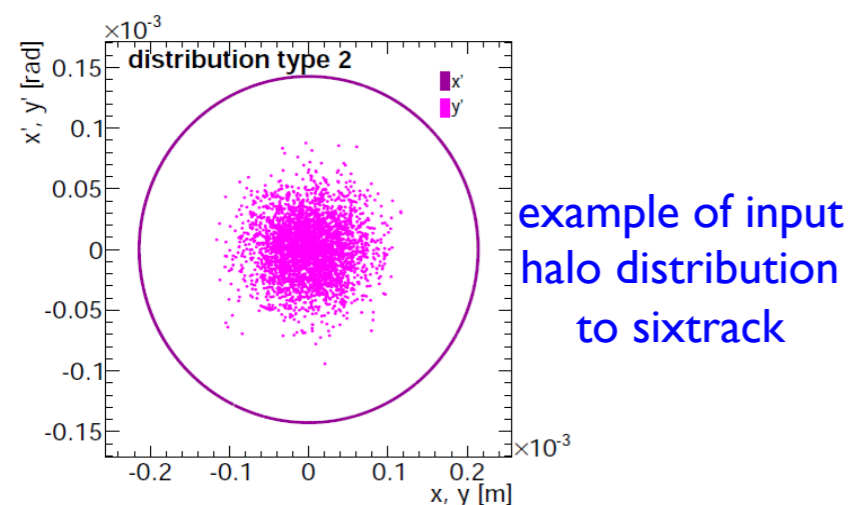
PRELIMINARY

SixTrack beam halo losses provide input to FLUKA simulation of region upstream of experiments:

- Calculate particle energy spectra and azimuthal distributions at interface plane.

- Used as input to experiment Geant4 detector simulation
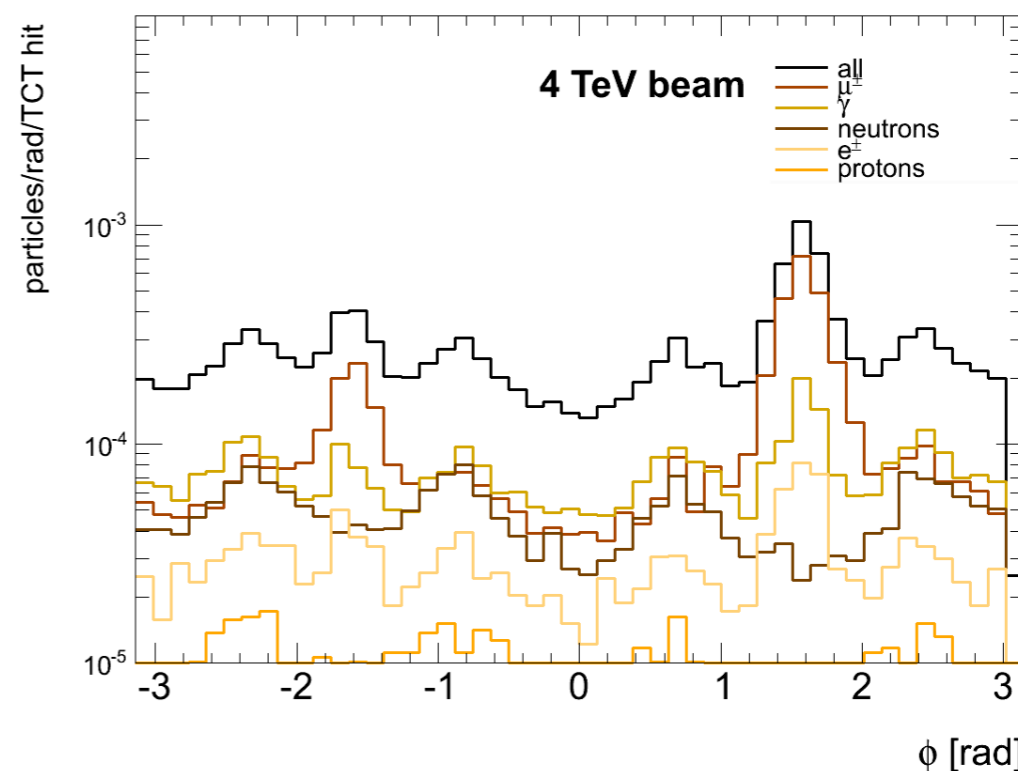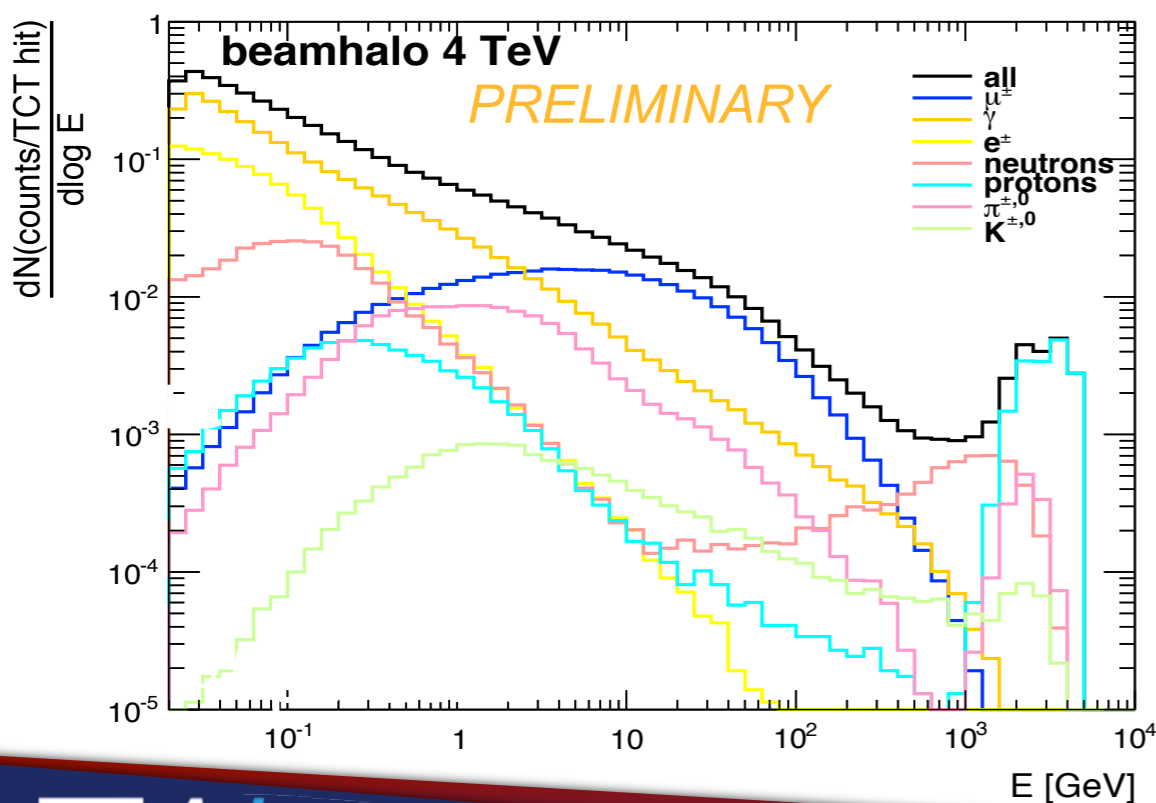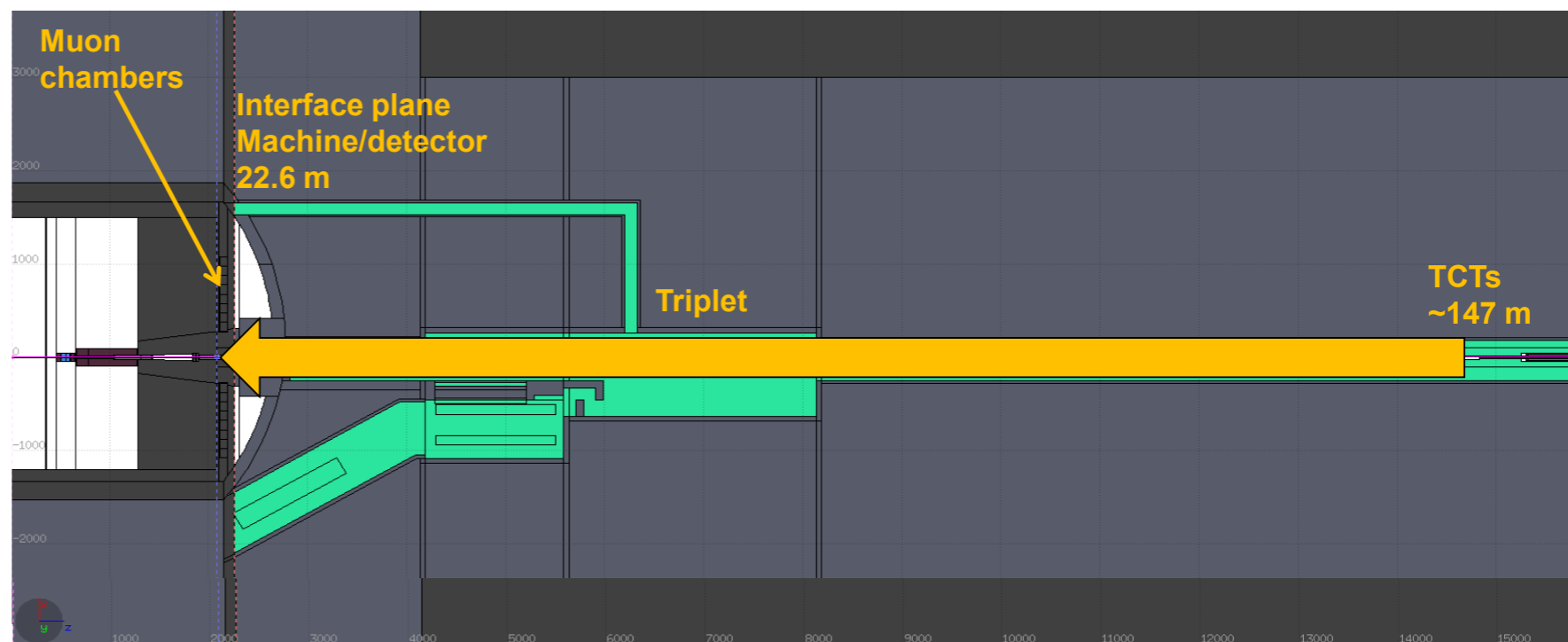
- Beam halo recently extended to an HL-LHC scenario:

- Presented during HL-LHC kickoff and collimation meetings, 11-15 November at Daresbury.

High Luminosity LHC
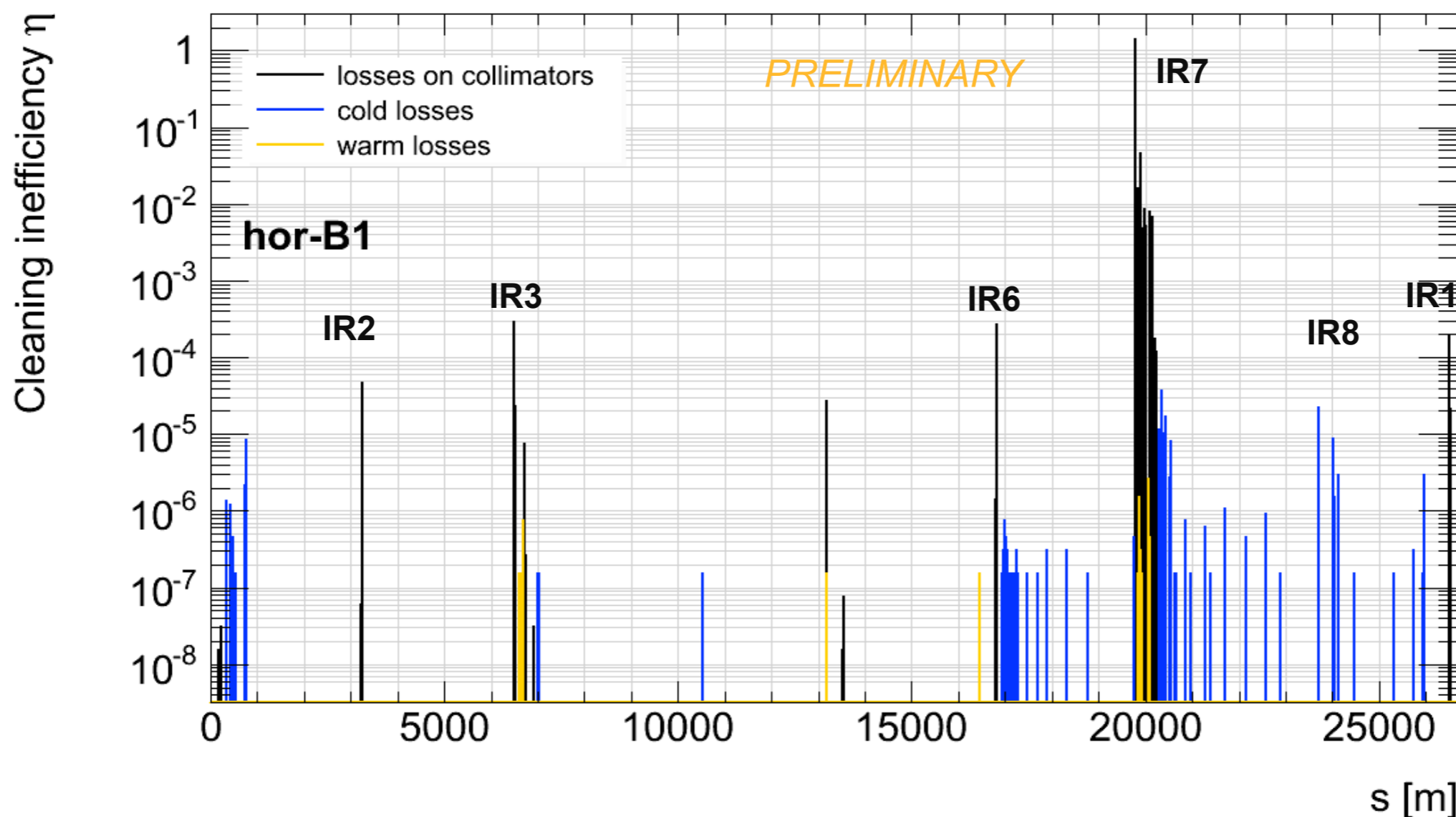
- Beam Delivery Simulation (BDSIM): a Geant4 based toolkit for diagnostic and loss simulation.

  L. Nevay et al

  - Code dynamically switches between accelerator style tracking and particle interactions and loss by Geant4.

  - Can apply spatial and shower energy cuts so that required level of geometric detail is simulated.

  - First LHC model developed by importing MADX optics and building geometry from generic components.

Overlay of MADX coordinates and GEANT4 elements

LHC geometry

"Typical" FLUKA geometries
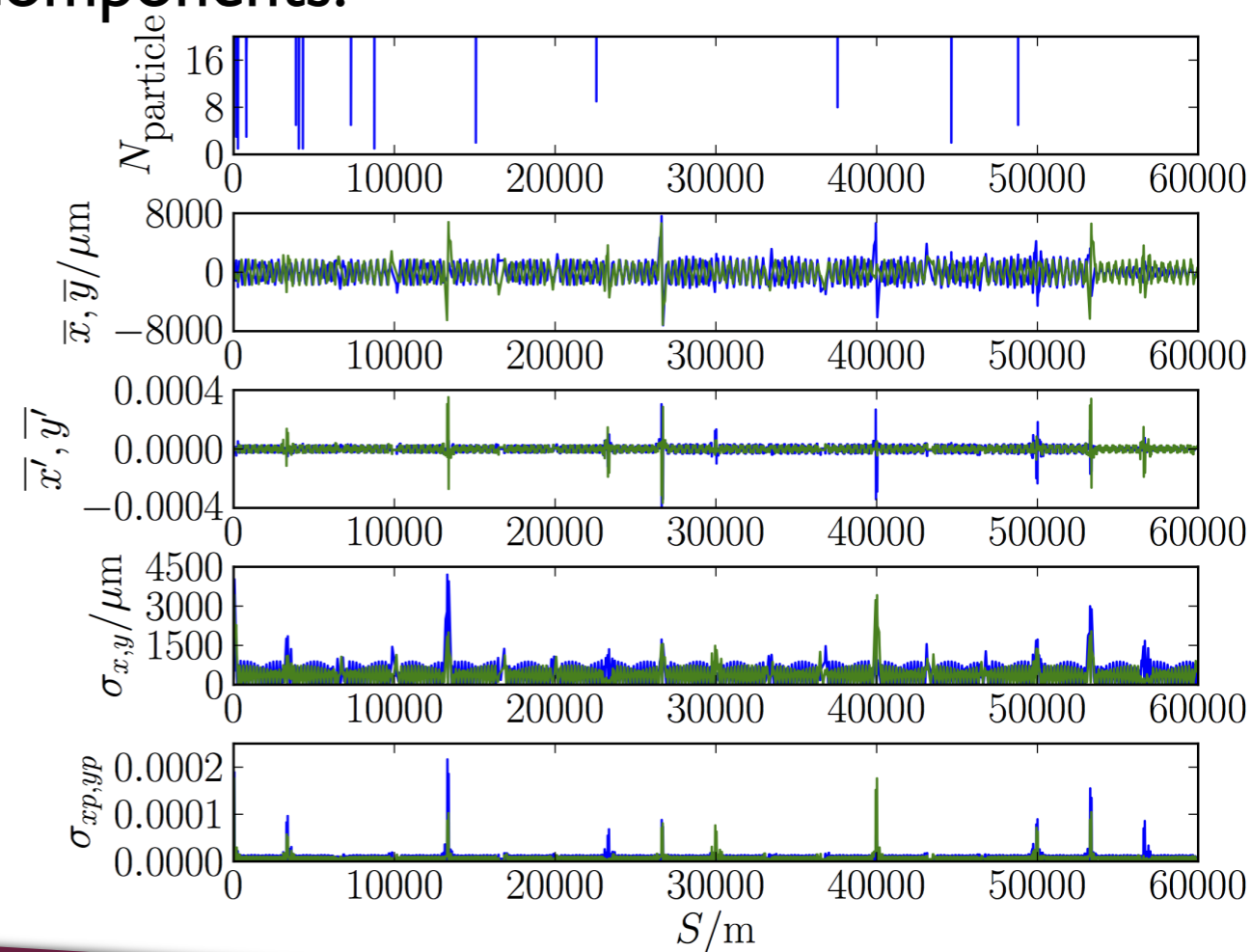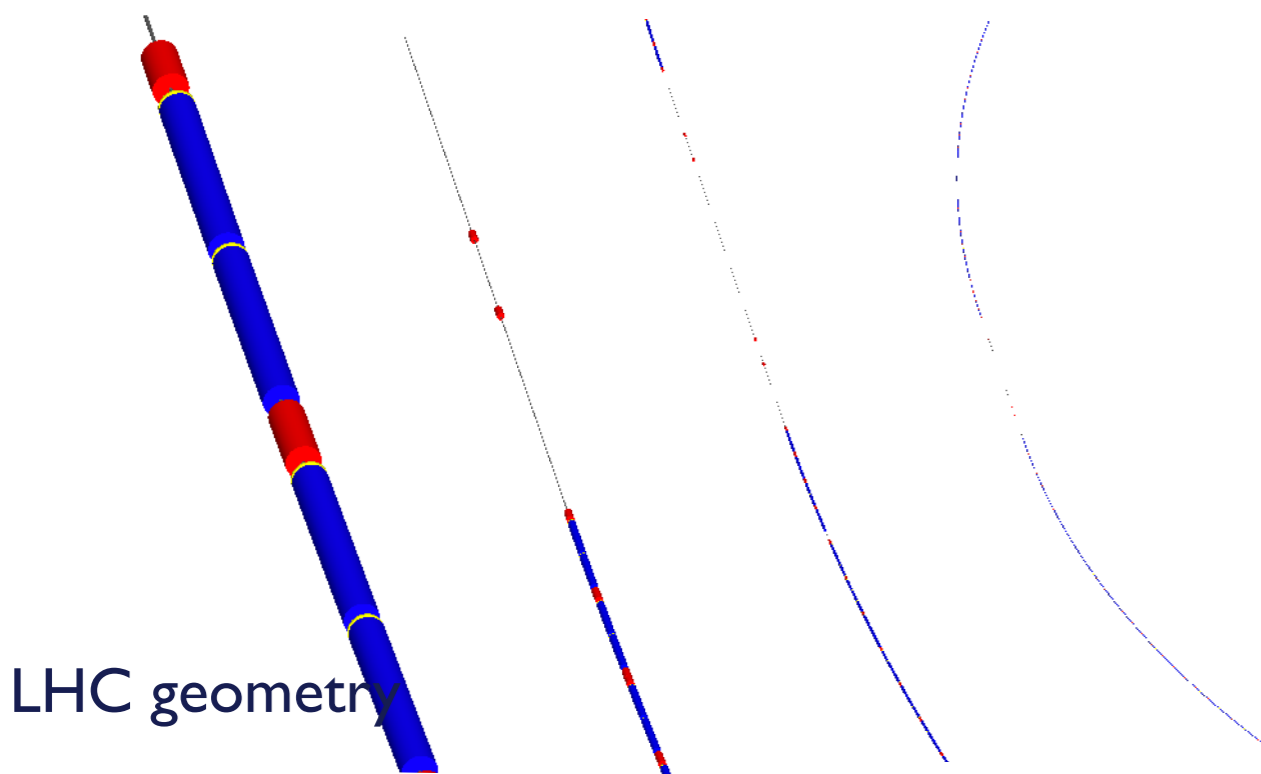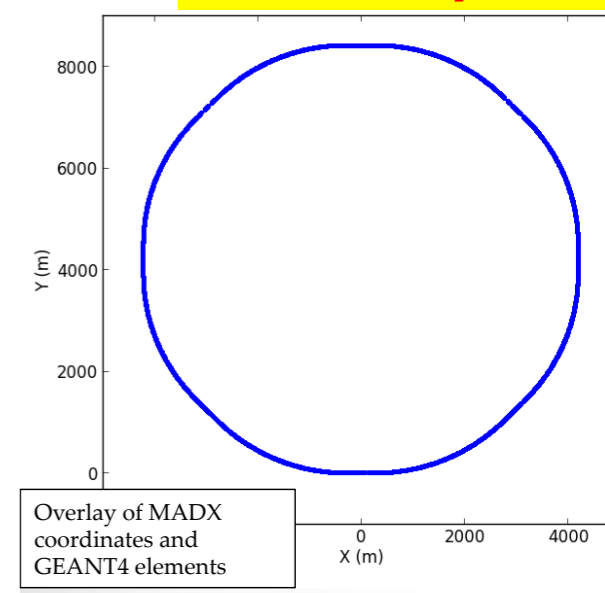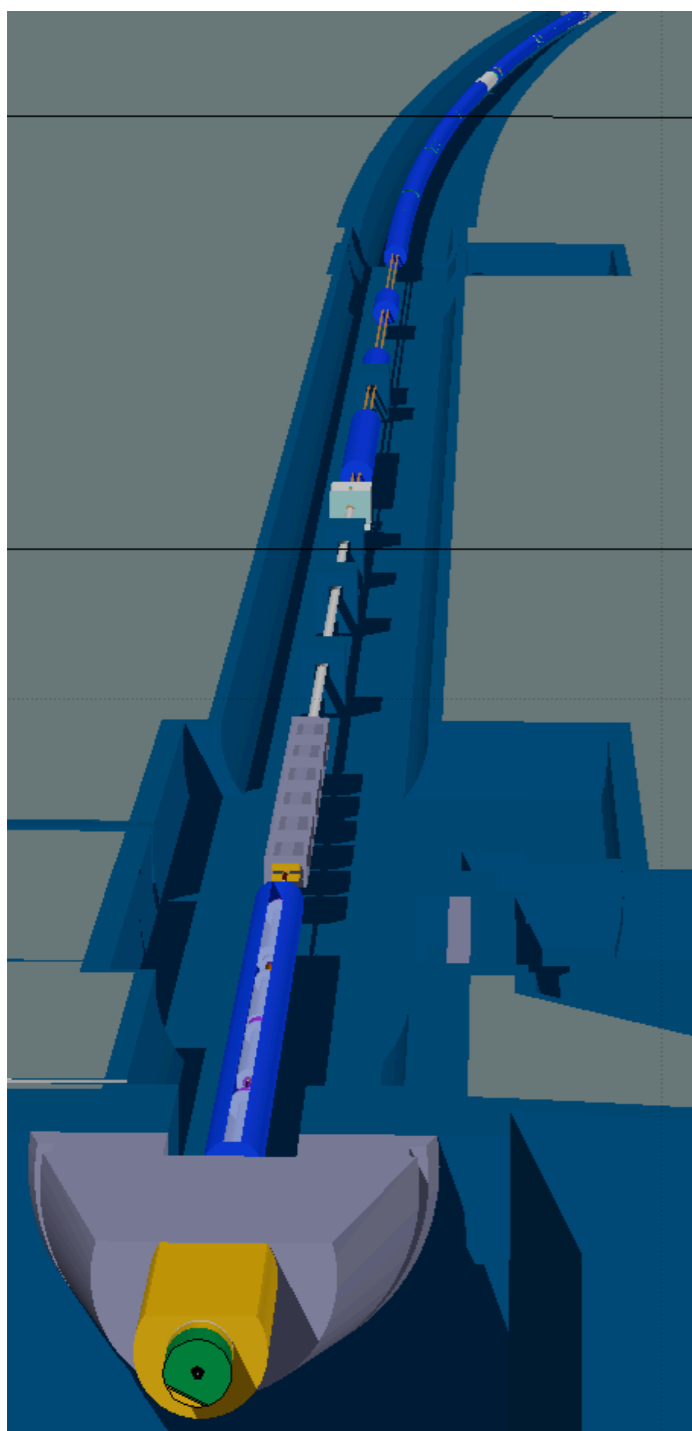
- Aim to include the detailed geometry of collimators and the interaction regions.

- Detailed LHC models exist in FLUKA.

- Checking feasibility of auto-conversion of FLUKA geometry to Geant4:

  - Challenging due to different geometry descriptions.

  - Conversion looks possible via mesh file

 - Need to verify memory consumption with large models.

IR7

Long Straight Section

right side IR1
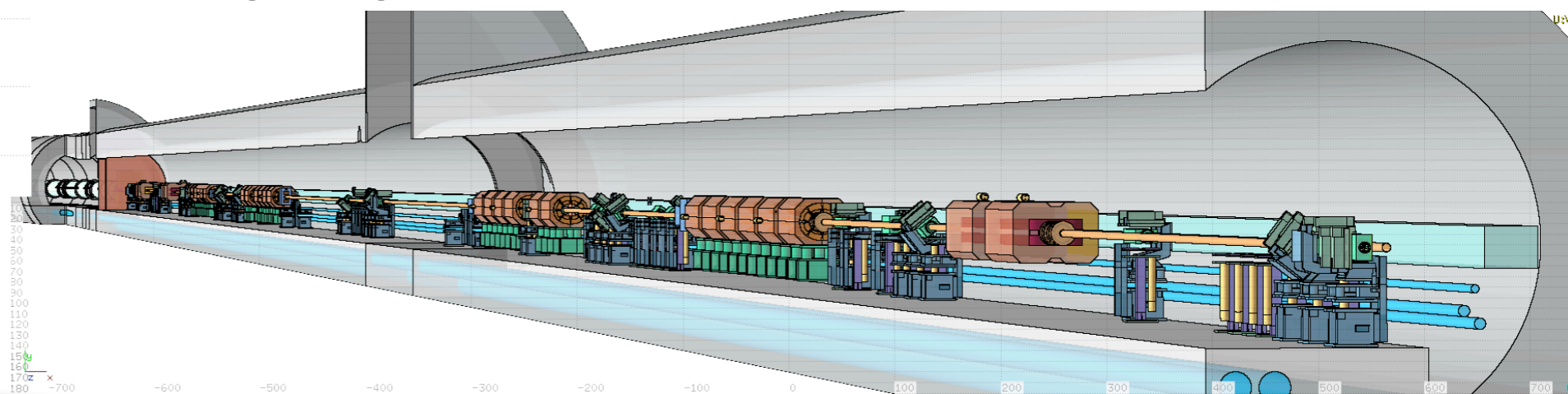
- Conversion checked using external Constructive Solid Geometry (CSG) package, Cubit.

- Example: LHC quadrupole geometry

  - Conversion looks possible via Cubit / STL mesh file: working in simple tests.

  - Next step is to automatically assign material description to each region.

  - Only collimator description needed for initial beam loss map studies…
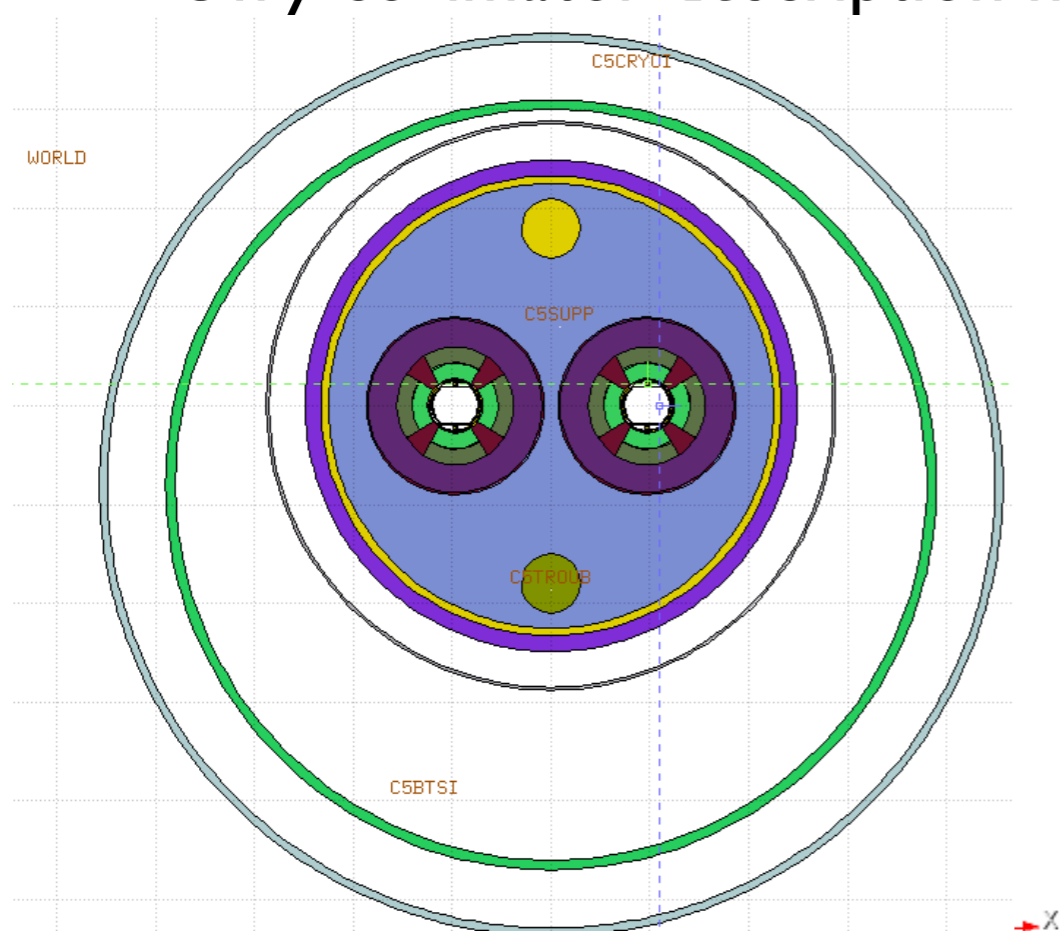
FLUKA quadrupole input
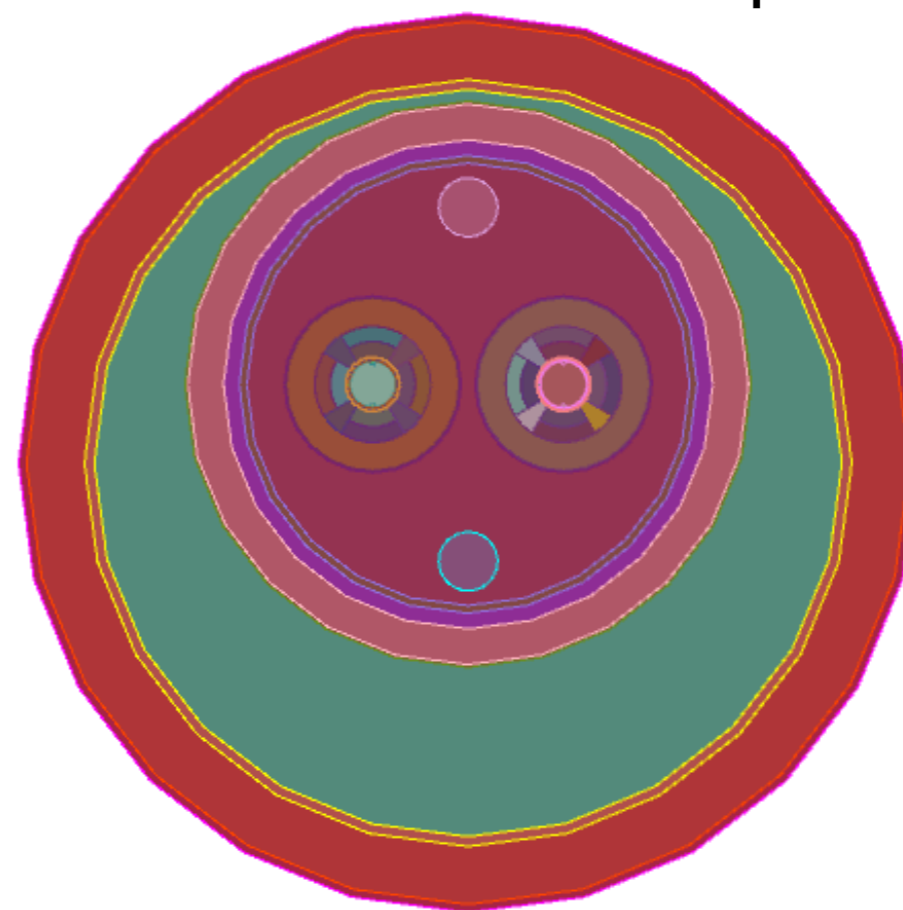
Converted to STL for G4/BDSIM
(Load via GDML tesselated solid)

- Detailed simulations of LHC are underway to understand beam backgrounds and tune the collimator configuration for HL-LHC.

- BDSIM is being further developed for LHC studies as part of HiLumi and EuCARD2 projects.

- Novel collimator materials (Mo-graphite) could be readily simulated in BDSIM through Geant4 material description.

- Would enable characterization of new materials and through collaboration allow ongoing comparison with other codes: SixTrack / FLUKA and Merlin.