Software and Computing

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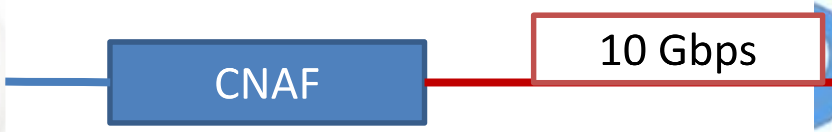
PADME General Meeting - LNF 1-2 March 2016

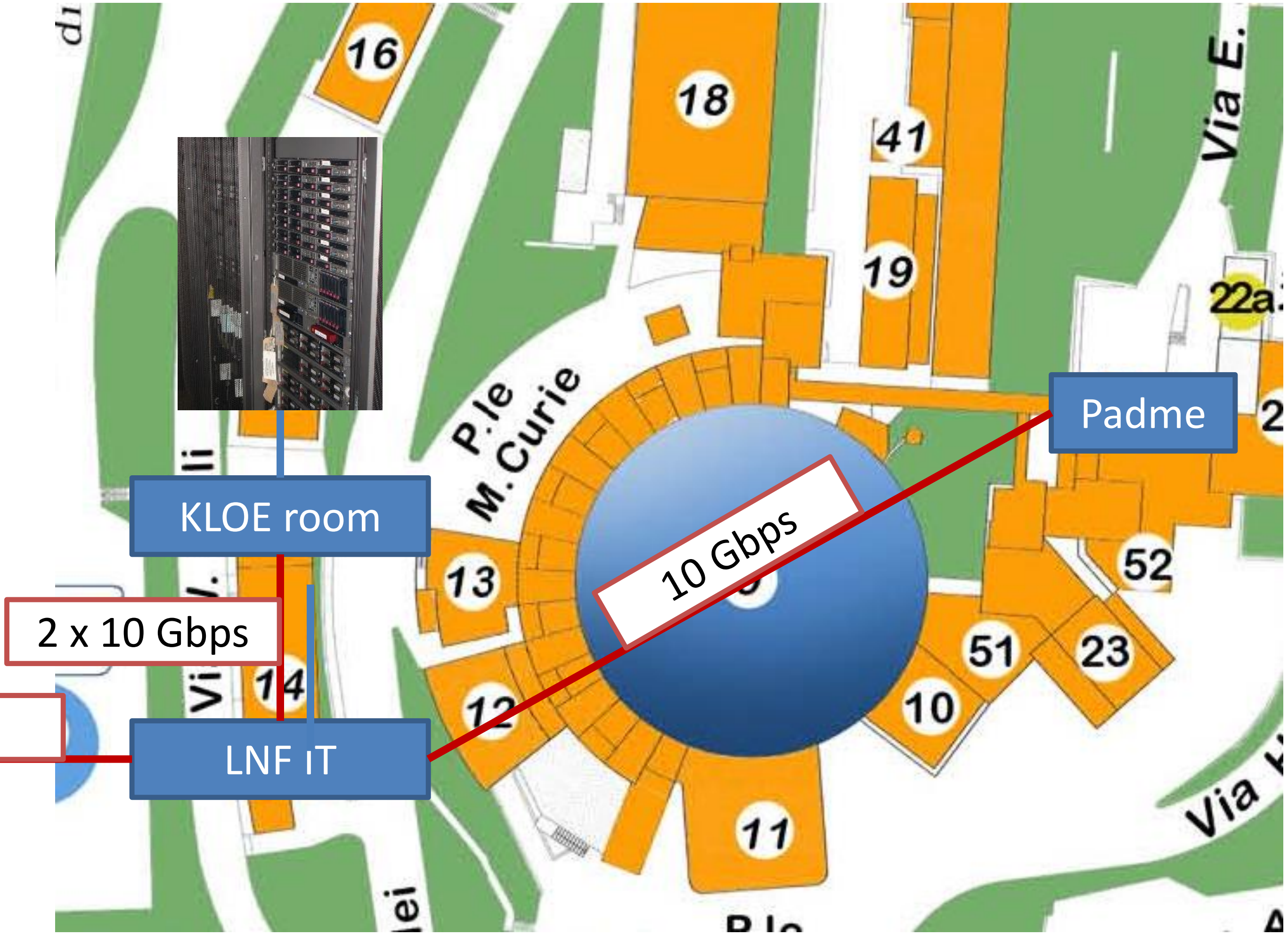
Computing Infrastructure 1

- Second hand computing nodes/storage from CERN
- Shared with LHCb
- To be installed in KLOE computing room
- 48 blades Dell (384 cores)
  - 2 x Intel(R) Xeon(R) CPU E5420 @ 2.50GHz 4core, 16 GB RAM
- NetApp FAS3240 with O(500 TB) storage (raw)
- A good starting point for the PADME computing infrastructure

Computing Infrastructure 2

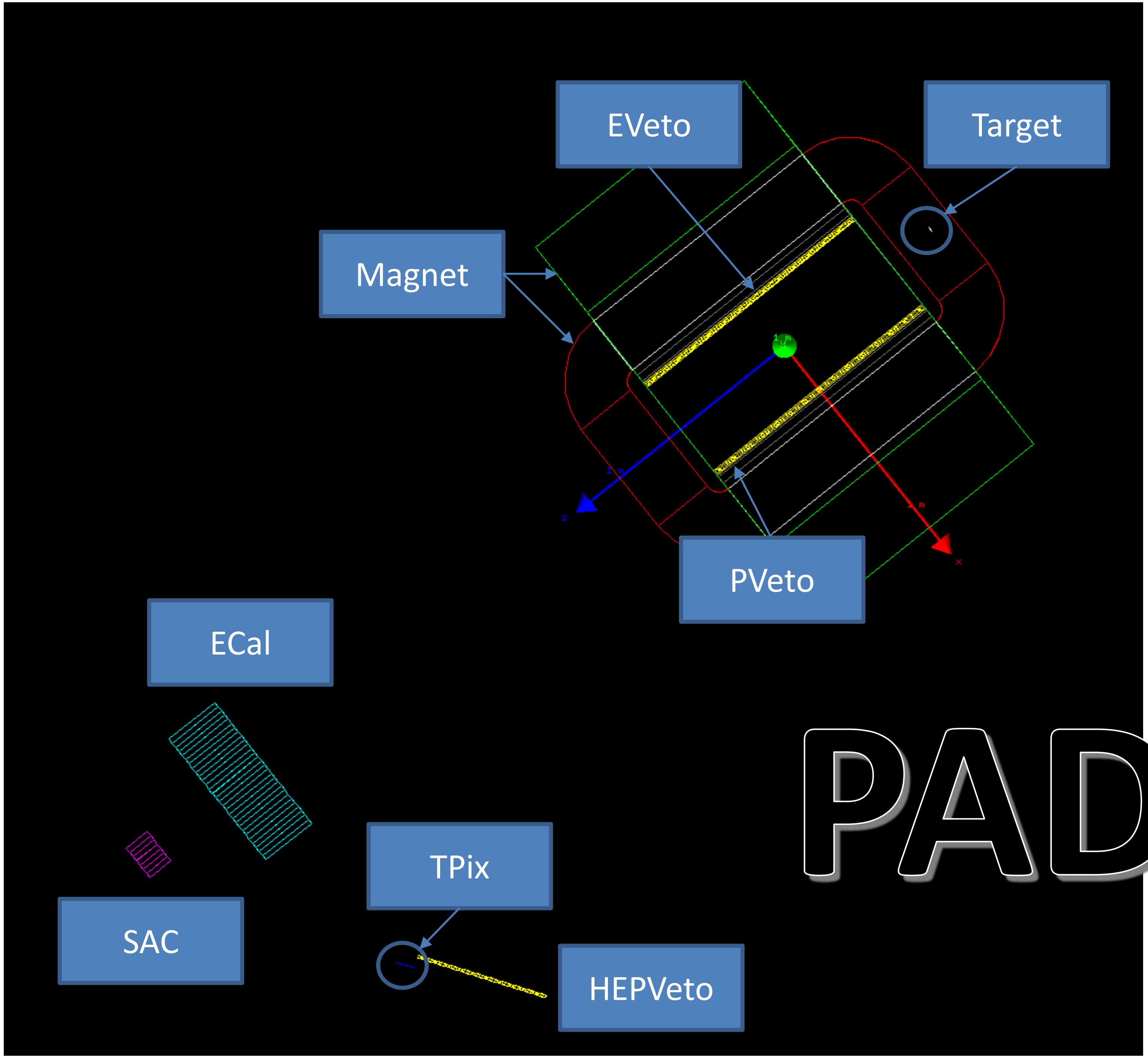
- Survey of the KLOE computing room Monday, Feb 29th
- Need to buy:
  - 6-8 racks → LNF
  - Network switch
    - probably 32 x 10Gbps ports
    - → shared LHCb-PADME





MC Simulation

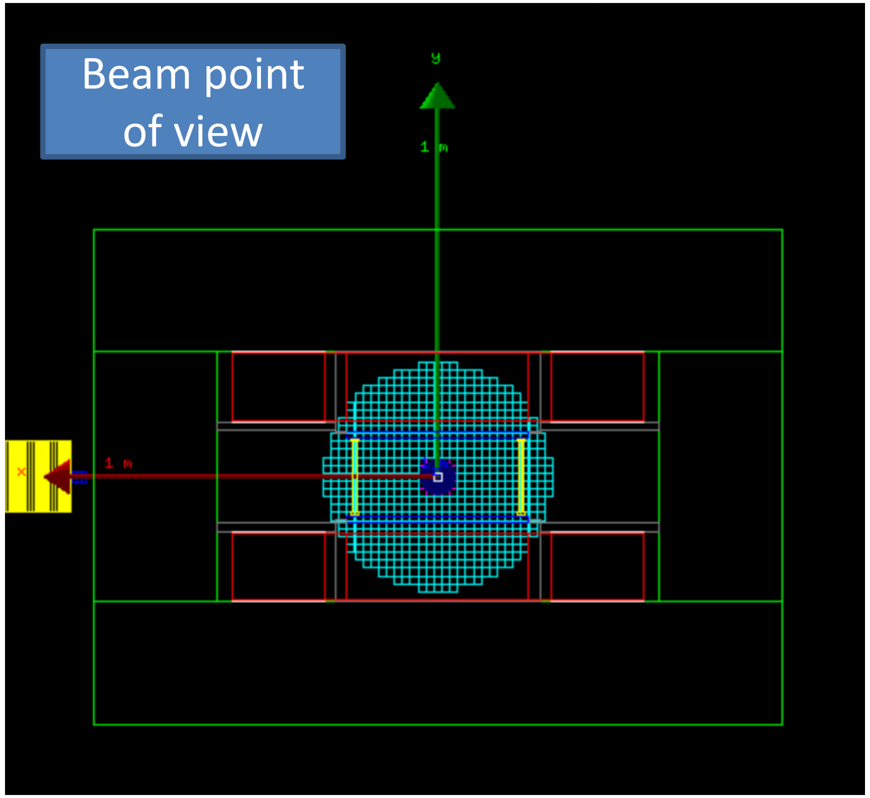
- Existing PADME simulation moved to GIT repository
  - https://github.com/eleonardi/padme → PadmeMC
- Modular design with subdirs dedicated to each detector
  - Magnet (including magnetic field)
  - Target
  - EVeto + PVeto
  - HEPVeto + TPix
  - ECal + SAC
- Geometry controlled via G4 datacards
  - Can change position and dimension of relevant parts (more on that later)

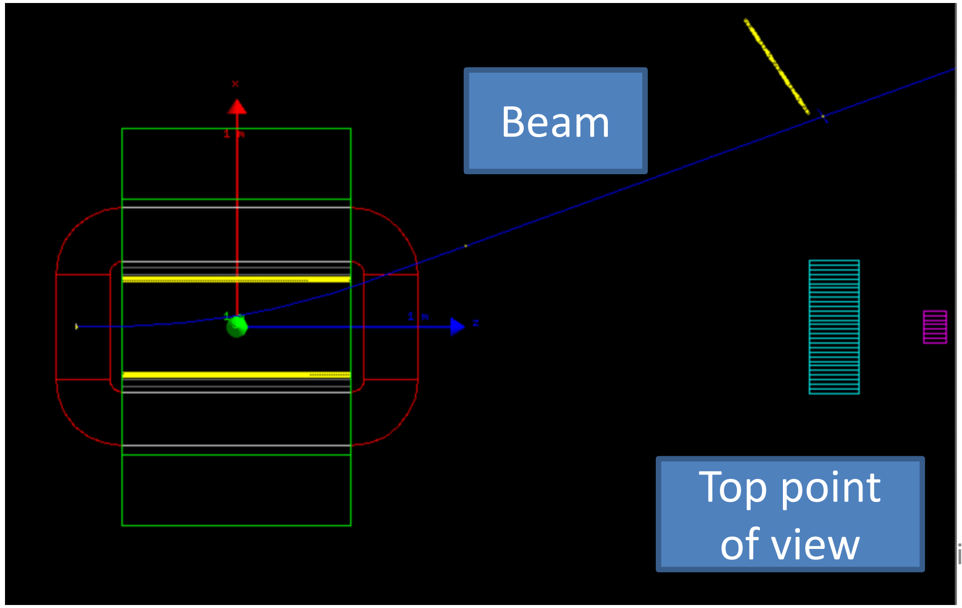


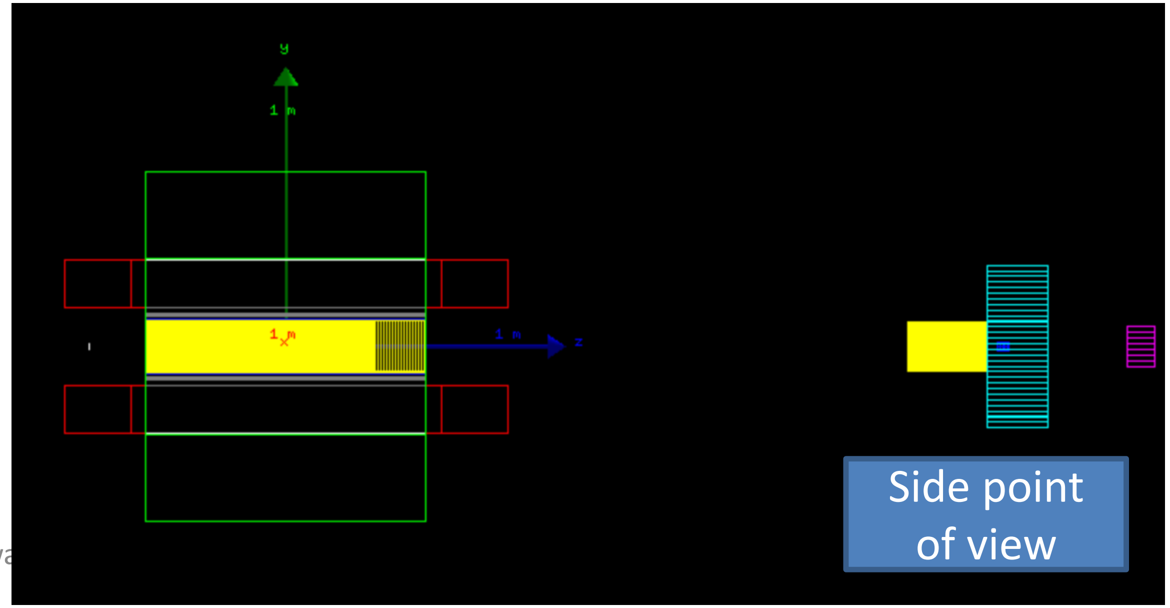
PADME

Reference coordinates

- Origin of the coordinate system: center of the magnet yoke
- X axis: horizontal pointing in the direction of the e^+ bending
- Y axis: vertical pointing up
- Z axis: along the beam axis pointing forward

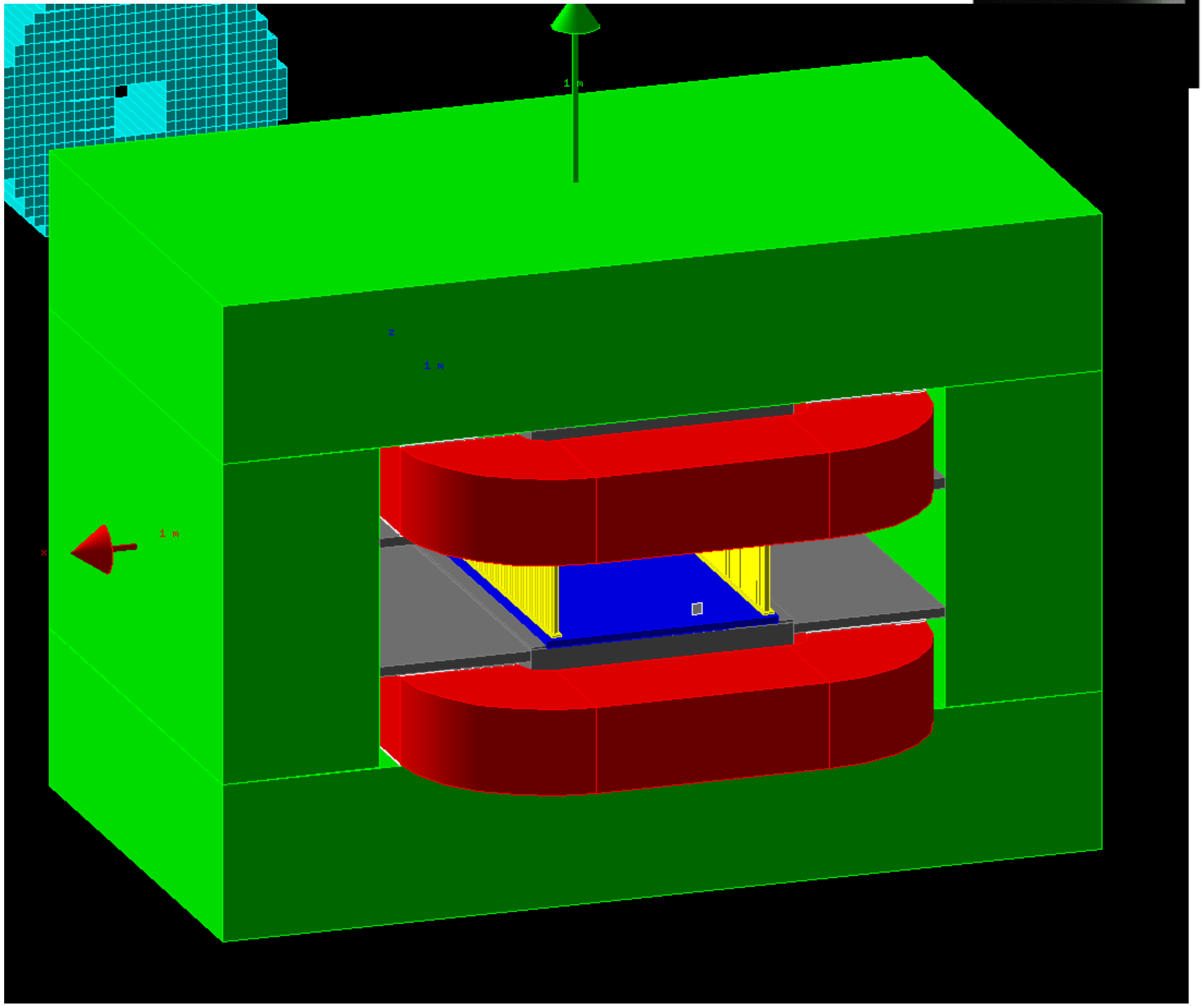






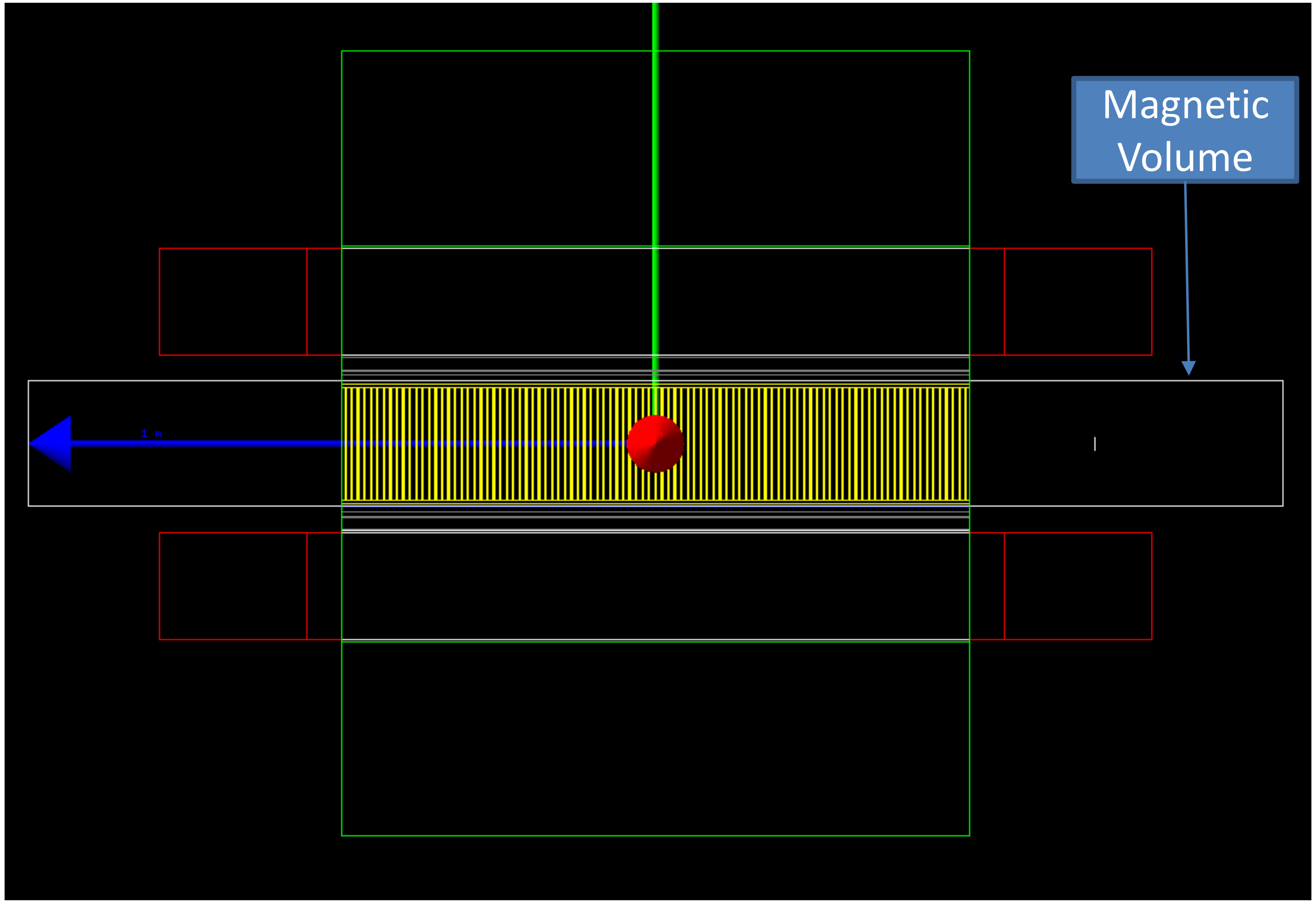
Magnet

- Yoke and coils modeled according to Cesidio’s survey on CERN magnet
- Cooling pipes not there (needed?)



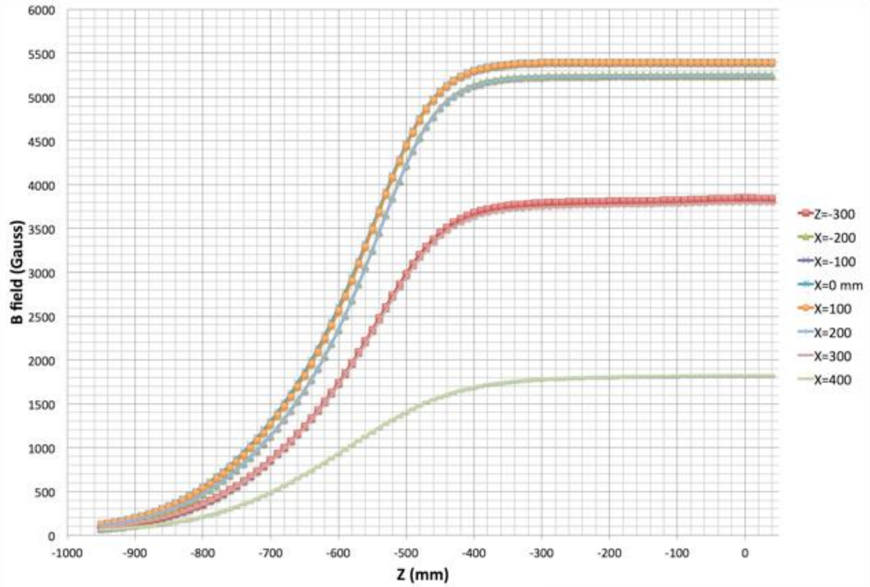
Magnetic Field 1

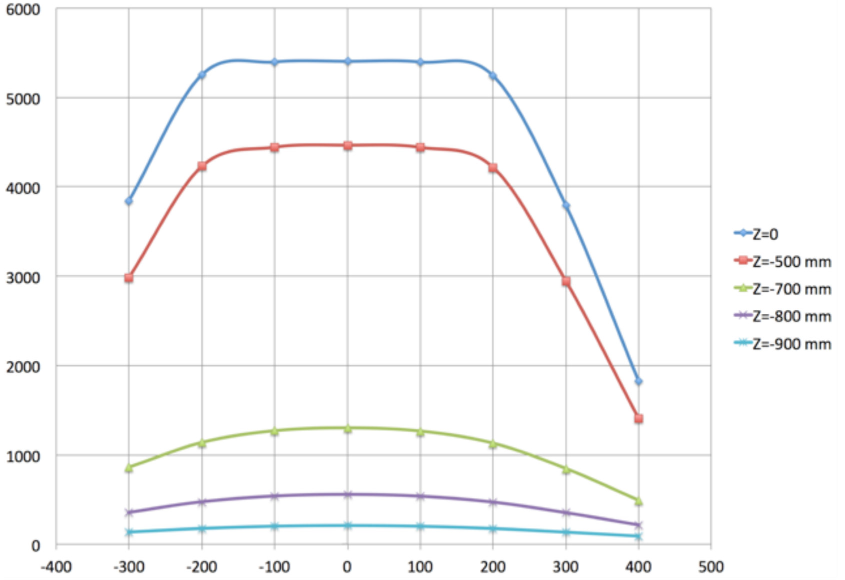
- Magnetic field is defined inside a volume which extends 50cm before and after the magnet yoke
- Target, EVeto, and PVeto are positioned inside this volume
- Current magnetic field map:
  - based on old CERN measurements
  - Y component only
  - Varies only along Z
  - Constant inside yoke
  - Gaussian tails at yoke borders



Magnetic Field 2

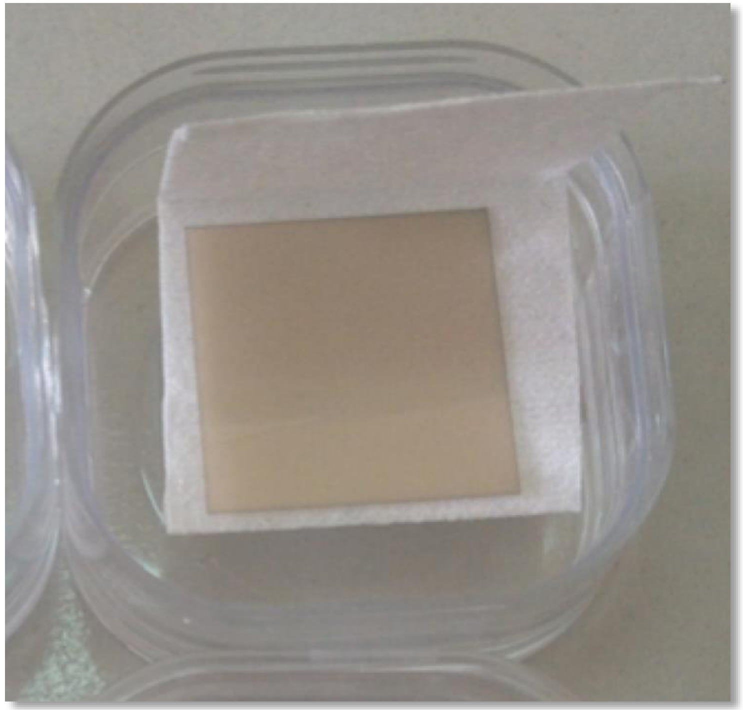
- New field map being measured at LNF:
  - Scan along Z with 1cm steps
  - Scan along X with 10cm steps
  - Scan along Y with 5 cm steps
  - Measure only Y component inside yoke
  - Measure X,Y,Z components at yoke borders





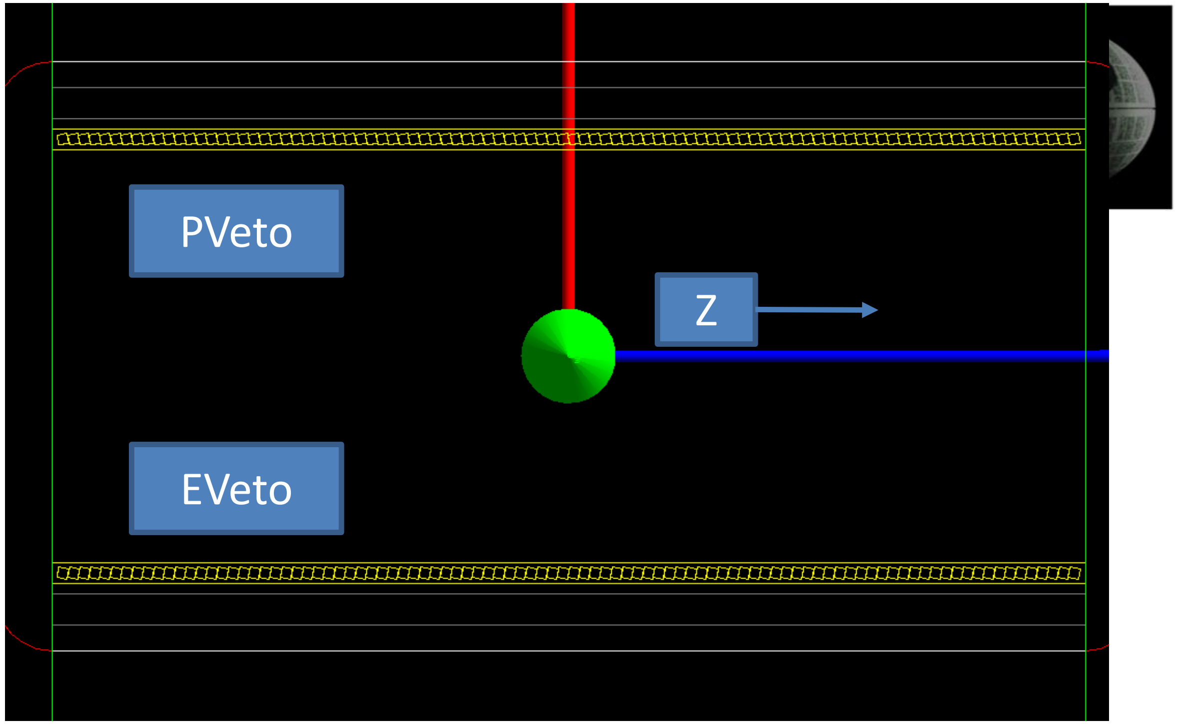
Target

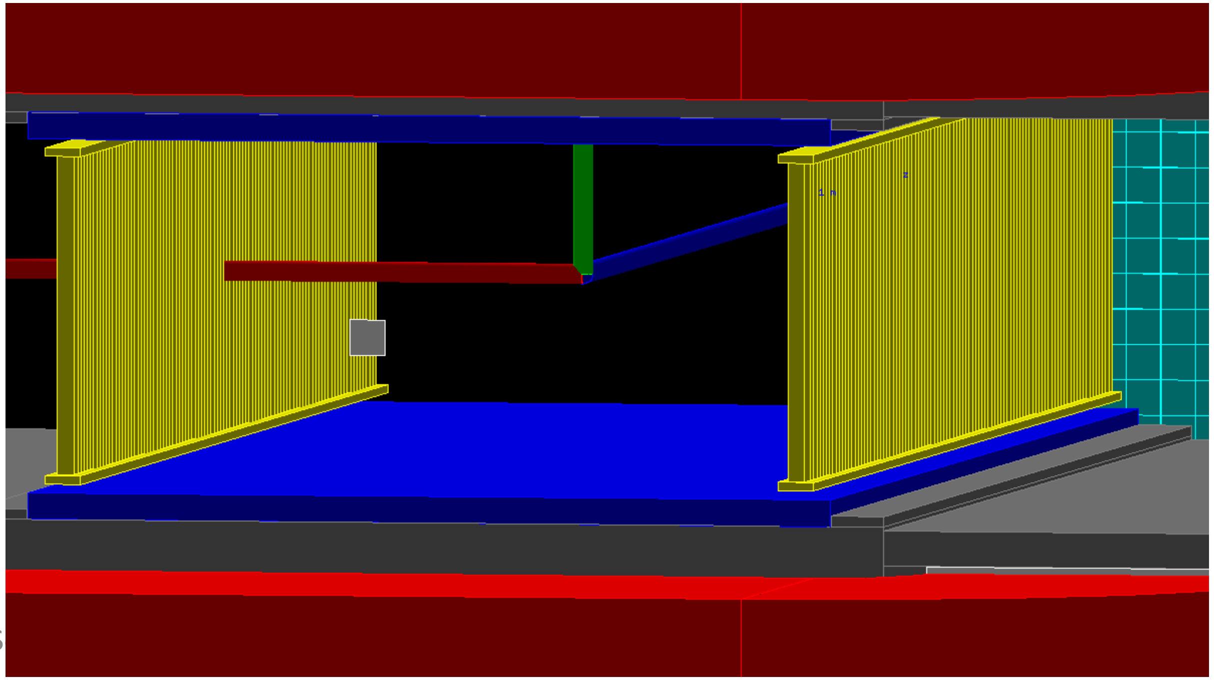
- Target is a homogeneous diamond box
  - Size: 2cm x 2cm x 100μm
  - Position: 20 cm before the front face of the magnet yoke
- More details were discussed on a dedicated talk at Target working group



EVeto + PVeto

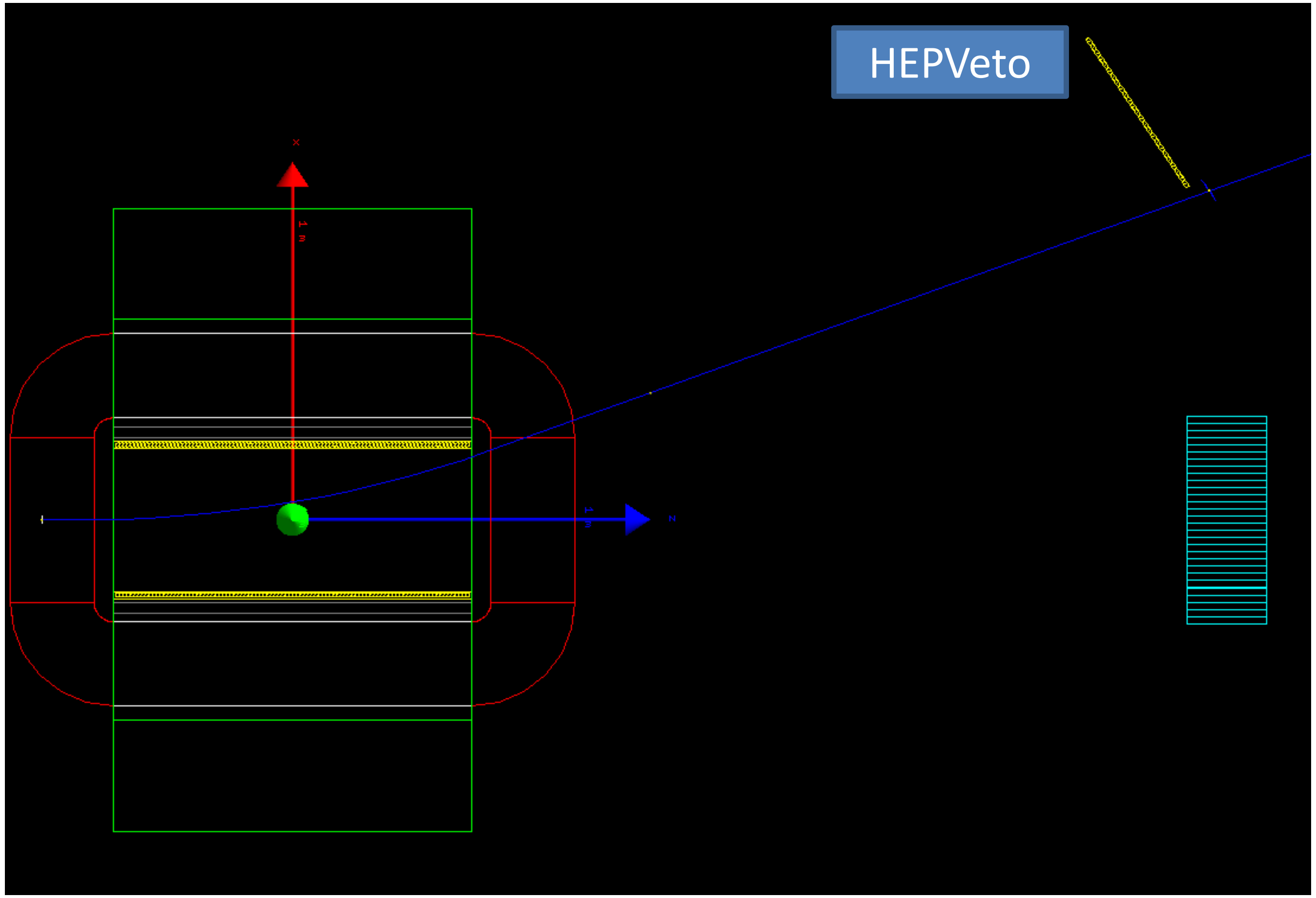
- O(100) 1 cm x 1 cm x 18 cm scintillator fingers vertically positioned along Z inside the magnet yoke
  - Exact number will depend on final layout. Currently 96.
- EVeto at X = -20 cm, PVeto at X = 20 cm
- Small tilt (10°) around Y axis
  - Allows a support structure which guarantees correct positioning of fingers
  - Reduces cracks for low energy e^+/e^-





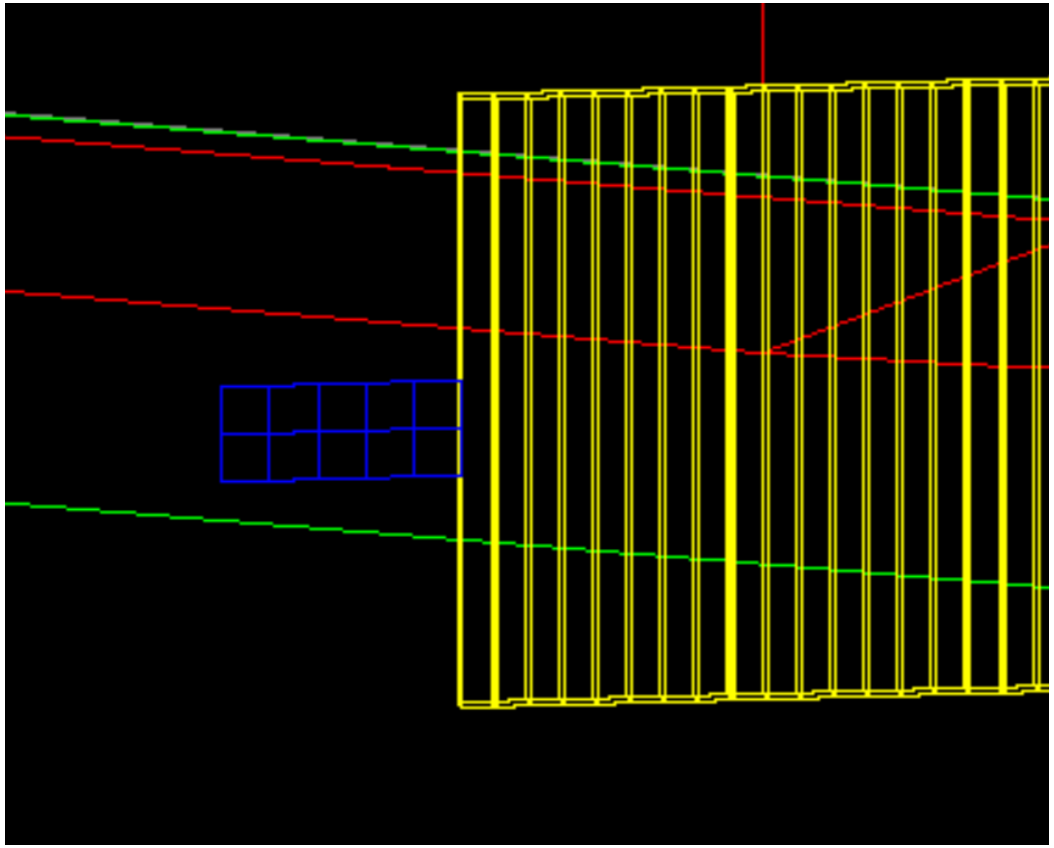
HEPVeto

- Row of 1 cm x 1 cm x 18 cm scintillator fingers to collect e^+ with energy "just below" beam energy
- Length (i.e. number of fingers) depends on requirement of overlap with PVeto
  - Currently 50 fingers
- Exact position/angle to be defined
  - Currently: Z aligned with ECal, X = 93 cm, rotated by 56° around Y
- Will probably add a small tilt to fingers (P/EVeto style) to eliminate cracks



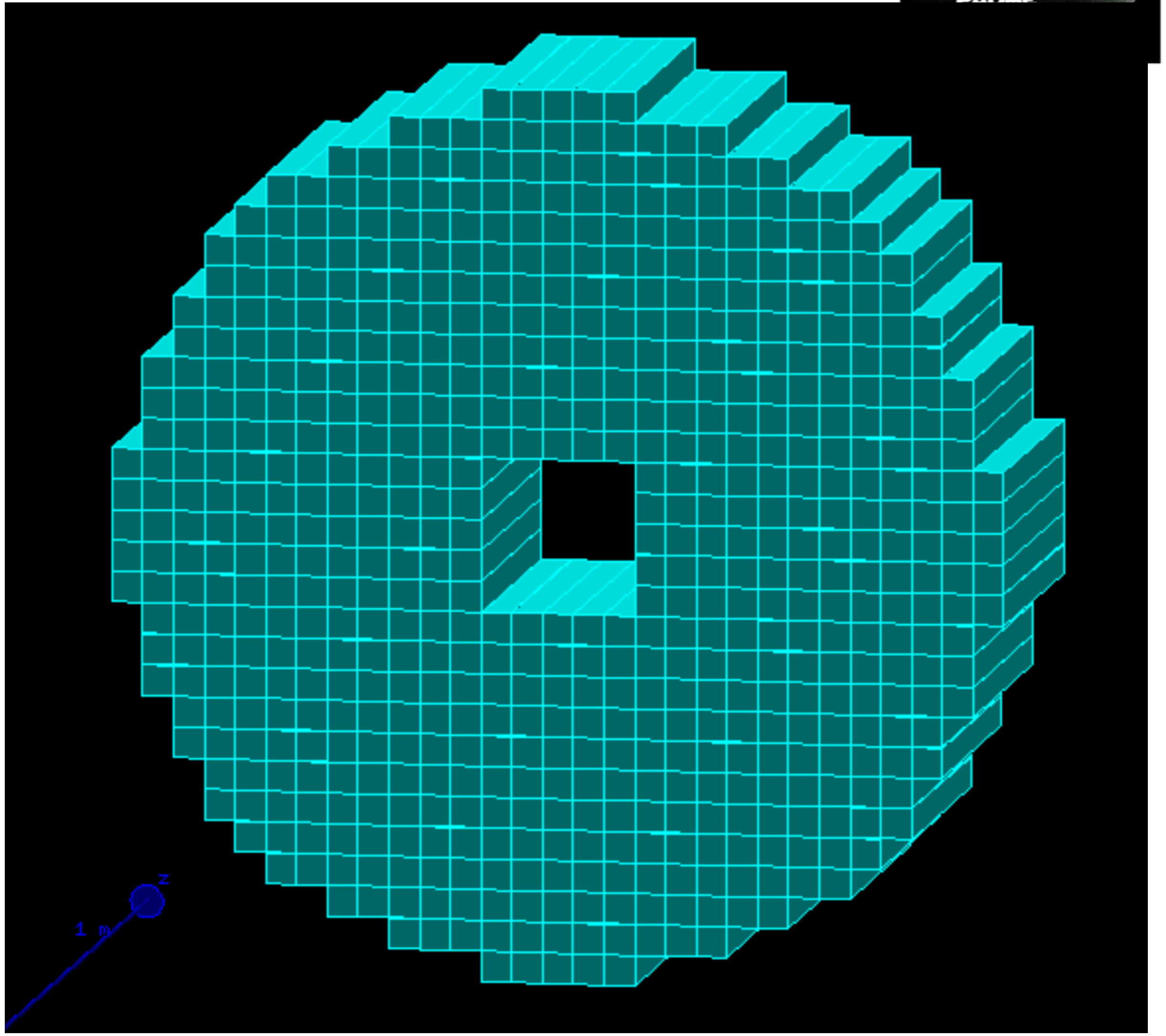
TPix

- Set of silicon chips to «take a snapshot» of the beam spot
  - Final design still to be defined
  - Currently: 2 x 5 chips, 14 mm x 14 mm x 100 µm, 256 x 256 pixels



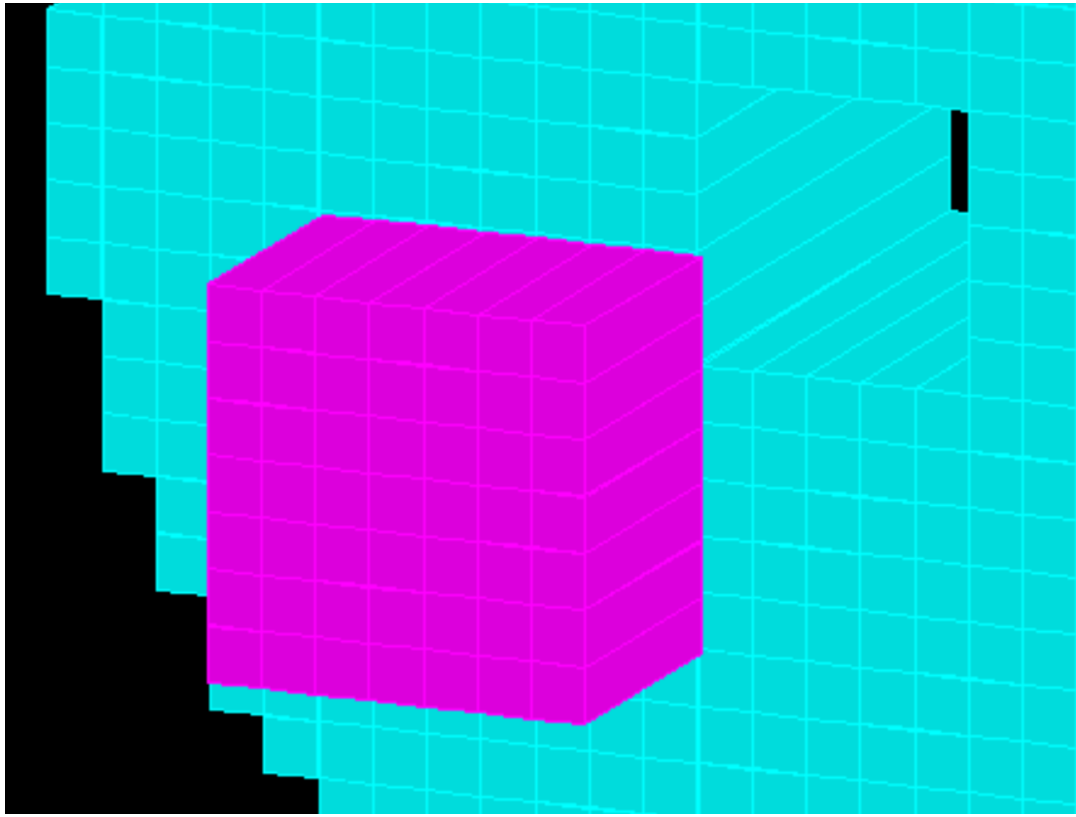
ECal

- «Box» of 29x29 BGO crystals 2 cm x 2 cm x 22 cm each
- Central squared hole 5 x 5 cry
- External circle at r = 28.5 cm
- Inter-crystal gap of 100 µm
  - Currently Vacuum
  - To be replaced with paint
- Crystal positions can be specified:
  1. Algorithmically, by defining inner and outer radius
  2. With a detailed crystal map



SAC

- Box of 7 x7 «crystals»
  - PbGl or Barium fluoride
  - 2 cm x 2 cm x 10 cm each
- Placed behind the Ecal central hole
- Inter-crystal gap of 100 μm
  - Currently Vacuum
  - To be replaced with paint



Beam

- **A precise simulation of the BTF beam is mandatory**
- Beam of primary positrons currently generated with:
  - 40 ns bunch time structure
    - flat within 150 ps micro-bunch
    - 350 ps delay between micro-bunches
  - Number of e^+ with Poisson distribution
  - E_{beam}=550 MeV with Gaussian distribution (σ = 55 MeV)
  - Central (x,y=0,0) position with Gaussian distribution (σ = 0.7 mm)
  - Horizontal with Gaussian emittance (σ = 1 mrad)
- Beam is generated at the front face of the Target
- Will move to a more realistic beam model (see Paolo's slides)

Special beams

- UBoson decays
  - One of the primary e^+ is replaced with a Uboson + γ decay within the Target (decay of Uboson not simulated, can be easily added)
- Three photons events
  - One of the primary e^+ is replaced with a 3γ final state within the Target
  - 3γ final states are generated independently and read during run time
  - Need rotation to direction of primary e^+ (now horizontal boost)
- Calibration
  - Single γ of given energy generated just after the Target and pointing to selected zones of ECal/SAC
  - Will add a single e^+/e^- with tunable energy to calibrate P/EVeto

Datacards

- Relevant simulation parameters can be changed via datacards
  - Detectors positions
  - Size of main detector components (e.g. length of crystals/fingers)
  - Magnetic field on/off and magnitude
  - Beam type and parameters
  - Switch on/off single detectors
- Full set of available datacards shown in vis.mac file in PadmeMC

```
#  Primary positrons setup
#/beam/n_e+_poisson_on false
#/beam/bunch_structure_on false
#/beam/bunch_time_length 40. ns
#/beam/ubunch_time_length 150 ps
#/beam/ubunch_time_delay 350 ps
#/beam/position_x 0. cm
#/beam/position_y 0. cm
#/beam/position_spread_on false
#/beam/position_x_spread 0.7 mm
#/beam/position_y_spread 0.7 mm
#/beam/momentum 550. MeV
#/beam/momentum_spread_on false
#/beam/momentum_spread 55. MeV
#/beam/direction 0. 0. 1.
#/beam/emittance_on false
#/beam/emittance_x 0.001
#/beam/emittance_y 0.001
```

Persistency

- A ROOT-based persistency infrastructure is being created
- Each detector must define its own definition of «MC hit» based on the G4 simulated energy deposits
  - Need collaboration with people working on each detector
- The MC persistency classes will be included into the PADMERoot library
  - MC files will be directly readable by interactive ROOT

Physics Lists

- Full review of the G4 physics lists used in the simulation
- Move to the new G4.10 physics list schema

```
#include "G4ComptonScattering.hh"
#include "G4GammaConversion.hh"
#include "G4PhotoElectricEffect.hh"

#include "G4eMultipleScattering.hh"
#include "G4MuMultipleScattering.hh"
#include "G4hMultipleScattering.hh"

#include "G4eIonisation.hh"
#include "G4eBremsstrahlung.hh"
#include "G4eplusAnnihilation.hh"
#include "G4MuIonisation.hh"
#include "G4MuBremsstrahlung.hh"
#include "G4MuPairProduction.hh"
#include "G4SynchrotronRadiation.hh
```

```
#include "G4hIonisation.hh"

//#include "G4EmExtraPhysics.hh"       //M. Raggi 17/07/2014
//#include "G4VModularPhysicsList.hh" //M. Raggi 17/07/2014
//#include "G4PhysicsListHelper.hh"   //M. Raggi 17/07/2014

// INTRODUCING NUCLEAR REACTIONS
#include "G4GammaNuclearReaction.hh"  //M. Raggi 17/07/2014
#include "G4PhotoNuclearProcess.hh"   //M. Raggi 17/07/2014

#include "G4QGSModel.hh"
#include "G4ExcitedStringDecay.hh"
//#include "SetFragmentationModel.hh"
#include "G4TheoFSGenerator.hh"
ECC  ECC ECC
```

April test beam

- Same SW as november
- Need to clean data on HP server
- Need input from L.Foggetta to have access to beam parameters
- Will try to merge TPix DAQ into general DAQ
  - SW has just arrived: will look into it