Software Tools for Layout Optimization

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For the

Tracker Upgrade Simulations Working Group

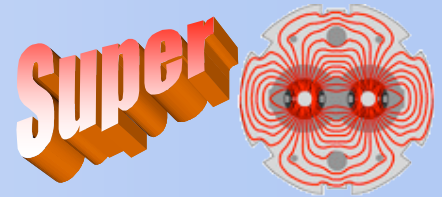https://twiki.cern.ch/twiki/bin/view/CMS/SLHCTrackerSimuSoftTools

HyperNews: hn-cms-slhc-trackersim@cern.ch

Tracker Upgrade Sim WG

- **We have a Tracker upgrade simulations working group that is performing simulation studies for layout optimization**
  - We have a modified version of the FastSimulation that can properly account for the tracking system granularity (runs faster than the Geant simulation)
  - We have two example strawman geometries set up that can be configured to study various geometry layouts (aimed at Phase 2)
    - Numbers and location in radius of layers
    - Addition of strixels (long pixels), mini-strips, and trigger doublet layers
    - Configurable pixel/strixel granularity in XML files
  - We are setting up two other geometries for specific studies
    - A very long barrel detector
    - A Phase 1 geometry using to Roland's options 1-5
  - We are using the standard tracking performance validation packages
    - Work to do in simplifying the performance packages for our studies
    - Work to do in enabling fast running at the highest pileup, and more realistic pileup for the FastSimulation

Simulation WG Task List
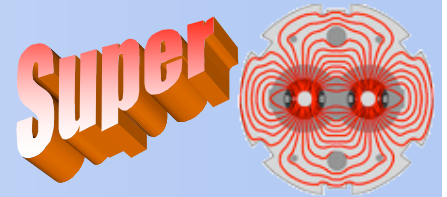
- Task list arrived at after a number of past presentations and discussions on strawman geometries and what simulation studies we should do, also discussed at a recent tracker upgrade steering group meeting

- Task list in order of priority, highest first (subject to change including additions to the task list), **Simulations studies**:

    - Studies to see whether a (buildable) trigger doublet would work, how many are needed and what their parameters should be

    - **Studies with an extra 4th barrel pixel layer and extra forward disk for both Phase 1 and Phase 2 LHC upgrade (compare to 5 layers?)**

    - Study the tracking and trigger performance of strawman A variations, (including forward region), at 10^{35} compared to the standard CMS geometry at 10^{34} to work towards a baseline geometry

    - Study the tracking and trigger performance of strawman B variations, (including the forward region), at 10^{35} compared to the standard CMS geometry at 10^{34} to work towards a baseline geometry

    - Studies of a very long barrel detector of mini-strips

    - **Studies of Roland's option 1 to 4 for Phase 1 LHC upgrade**

    - **Studies of the tracking performance of the standard CMS detector at Phase 1 luminosities**
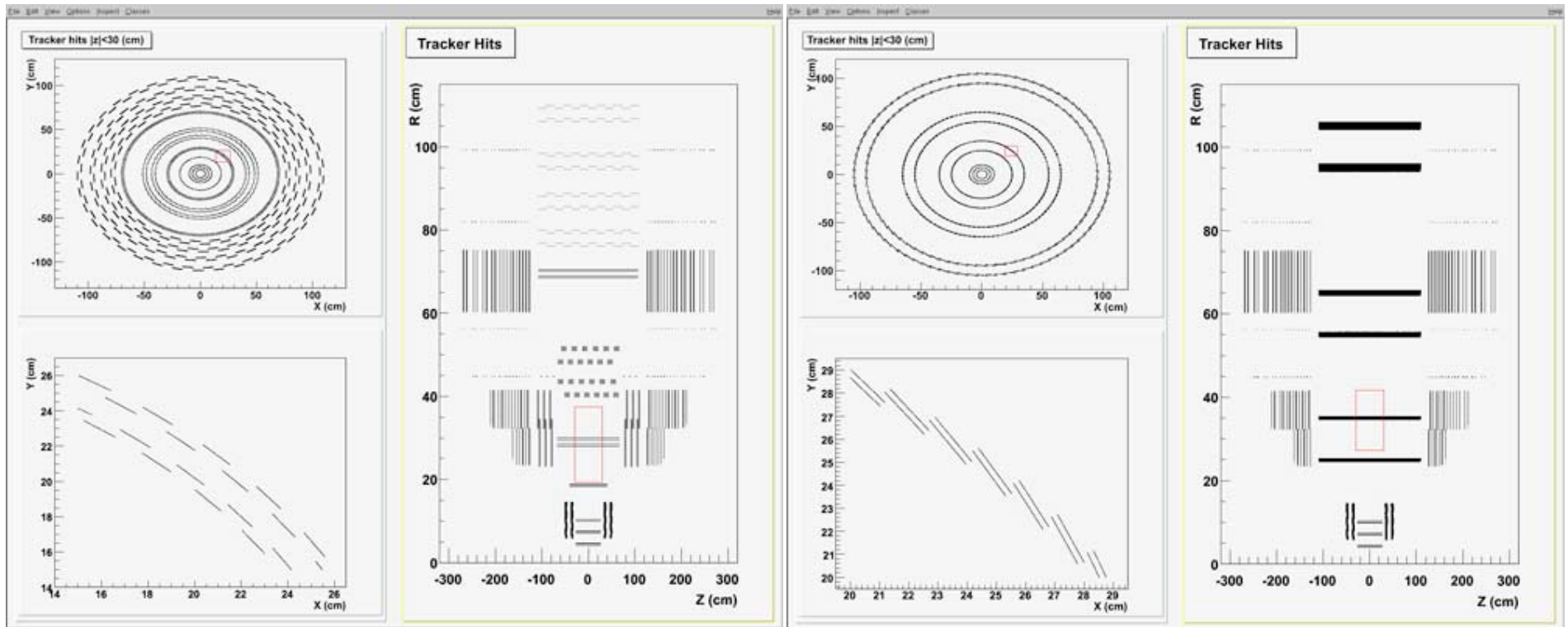
Updated Task List 2
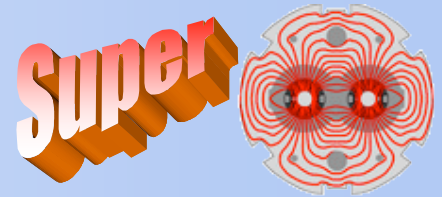
- Task list continued in order of priority, highest first (subject to change including additions to the task list): **Software and performance tools**
  - Create set of performance benchmarks or plots for comparison of different tracking geometries
  - Create interface code for use by the trigger group to generate L1 tracking trigger primitives
  - Work on more realistic pileup for FastSimulation and enabling fast running of the highest pileup setting
- The task list is quite general, more specific studies and details are given in the twiki page https://twiki.cern.ch/twiki/bin/view/CMS/SLHCTrackerSimuSoftTools
- Additions, suggestions, comments, etc. are welcome!
- Contributions to any of the tasks are extremely welcome!

Existing Strawman Geom

- Two example strawman geometries as starting points for studies of Phase 2 layouts
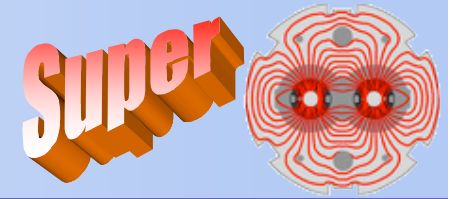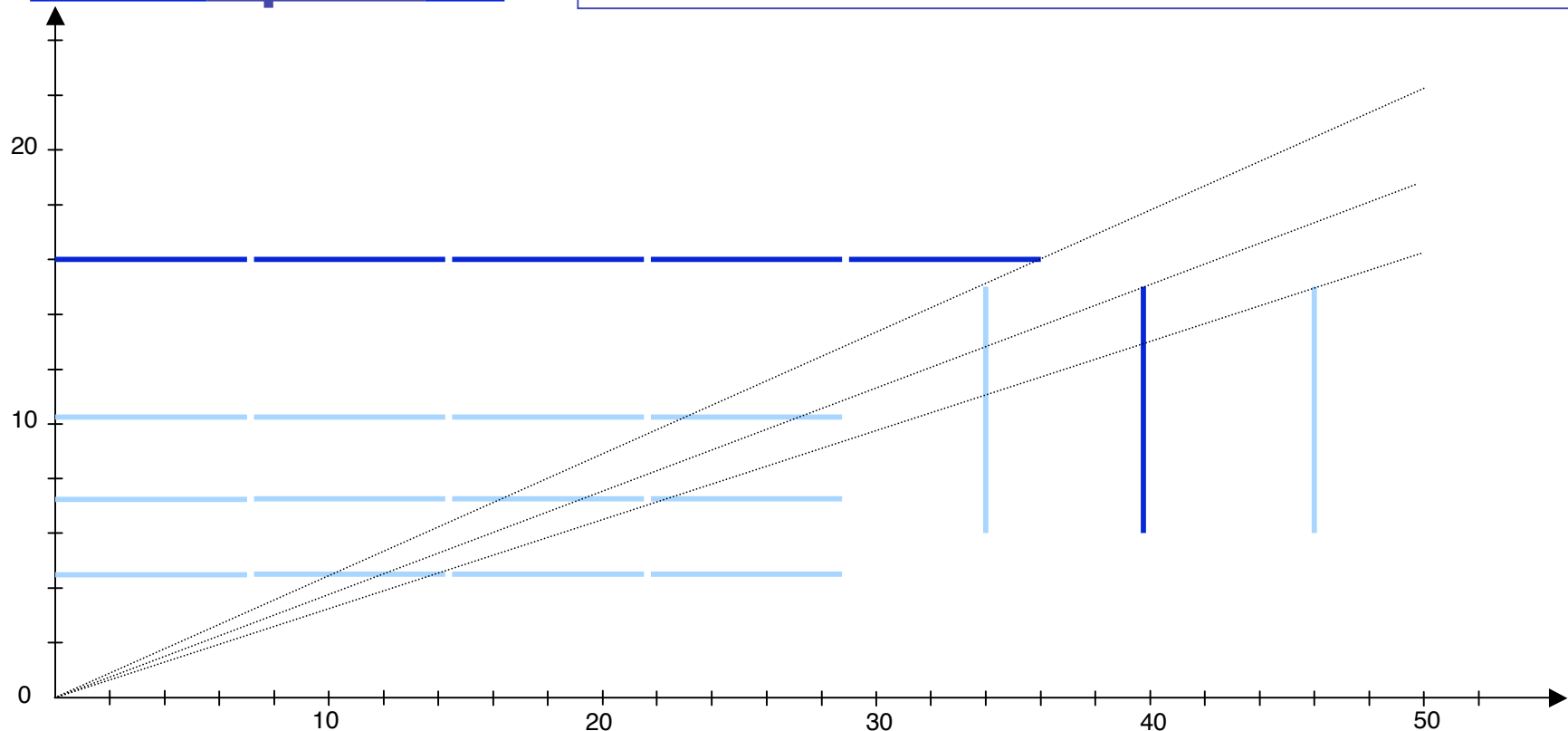

Strawman A

Strawman B

- We can start with strawman A to study Roland's BPIX Option 5

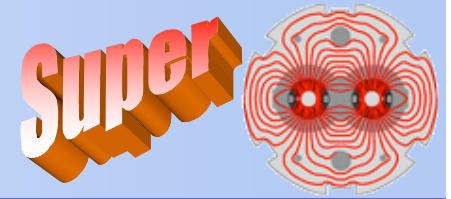## BPIX Option 5:   4 Layer BPIX Replacement/Upgrade

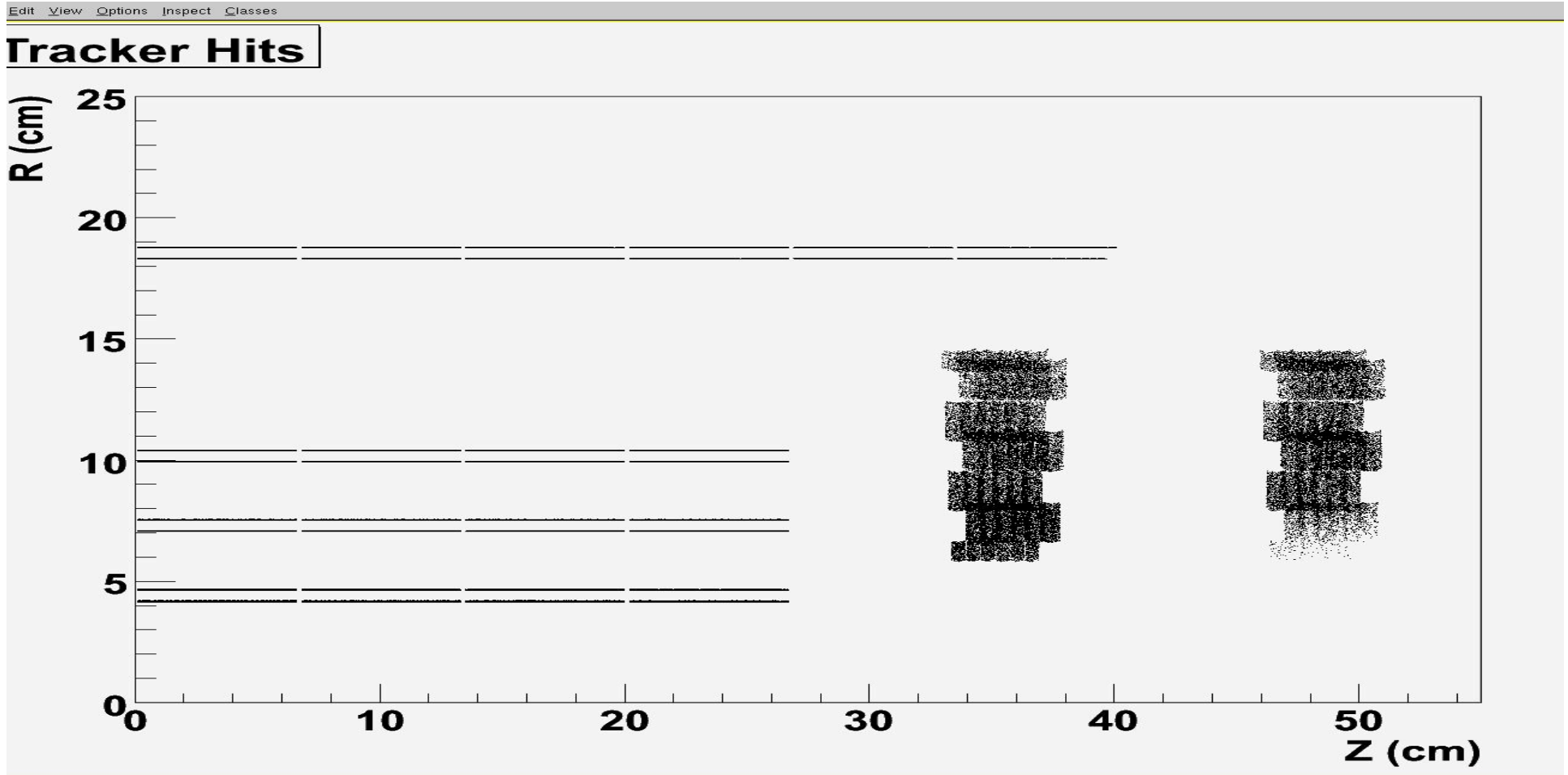Roland's proposed 4th pixel & 3rd forward disk layout
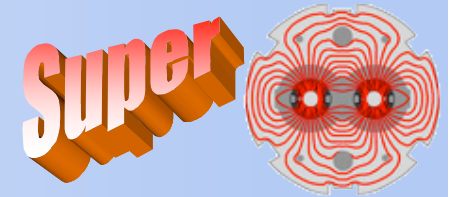
Pixels: 4th Barrel & 3rd Disk

- Closeup of Strawman A 4th pixel layer in CVS version

- Need to set up Phase 1 geometry with material changes and 4th layer

|	Option	Layer/Radii	Modules	Cooling	Pixel ROC	Readout	Power
as 2008	0	4, 7, 11cm	768	C_6F_{14}	PS46 as now	analog 40MHz	as now
	1	4, 7, 11cm	768	C_6F_{14}	2x buffers	analog 40MHz	as now
	2	4, 7, 11cm	768	CO_2	2x buffers	analog 40MHz	as now
	3	4, 7, 11cm	768	CO_2	2x buffers	analog 40MHz μ-tw-pairs	as now
	4	4, 7, 11cm	768	CO_2	2xbuffer, ADC 160MHz serial	digital 320MHz μ-tw-pairs	as now
	5	4, 7, 11, 16cm	1428	CO_2	2xbuffer, ADC 160MHz serial	digital 640 MHz μ-tw-pairs	DC-DC new PS

Example of Things to Study
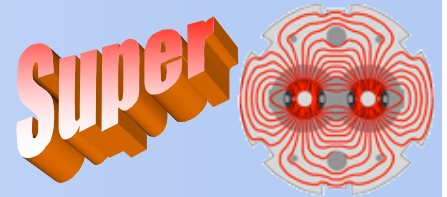
- Will be creating a separate Phase 1 strawman geometry with only the pixel detector changed.

- Simulation studies of this Phase 1 strawman geometry should include studies of
  - Occupancies and data rates (power)
  - Track quality
  - Track reconstruction efficiency and fake rates
  - Material and conversion effects; integration with other systems
  - Trigger possibilities (HLT; even L1 multiplicity?)

- Variations for what? Need input
  - Location of layers and disks
  - Phi rotation vs. upper & lower layers; Lorentz angle compensation
  - Granularity of pixel layers
  - Long barrel vs forward disks
  - Is a beam pipe upgrade a possibility?! (e.g. ATLAS)

Twiki Page Task Table
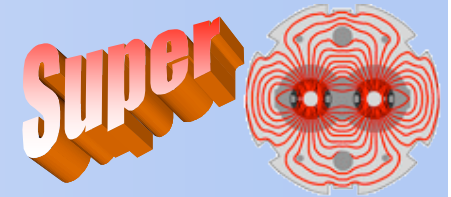
- **Task table still being filled out**

Simulation Studies Table

| Task	People working on it	Document link
Performance of 1-2 pixel doublet(s) for L1 Muon Trigger	Eric Brownson, Harry Cheung, Mike Weinberger	L1 Muon Track Trigger Studies ?
Performance for an extra 4th inner barrel pixel layer	Kevin Givens, Xingtao Huang	4th Pixel Layer Studies ?
Tracking performance of strawman A	Carlo Civinini, Alessia Tricomi	Strawman A Studies ?
Tracking performance of strawman B	Mark Pesaresi	Strawman B Studies ?
Tracking performance of long barrel strawman	Mike Weinberger	Long Barrel Studies ?
Study Roland's option 1 to 4 for Phase 1 pixel upgrade	?	
Study performance of CMS for Phase 1 luminosity	?	
Study possible beam pipe upgrade	?	

Simulation Software and Performance Benchmark Tools Table

| Task	People working on it	Document link
Create tracker performance benchmark package	See linked page	Performance Benchmarks
Create and maintain strawman and baseline tracker geometry	See linked page	Example Strawman Geometry
Create TPG interface code	Mike Weinberger	Trigger Primitive Generator ?
Produce code for correct pileup simulation in the FastSimulation	?	Pileup for SLHC ?
Produce code for L1 ECAL objects in the FastSimulation	?	

Summary
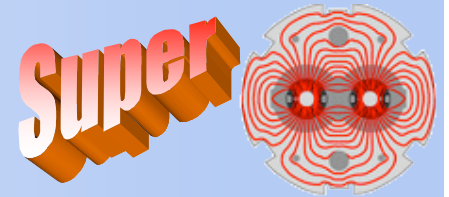
- We made good progress on the most important items on our WG initial task list, and it is time to consolidate and focus on simulation studies, including studies needed for Phase 1

- We have a prioritized task list with a set of simulation studies that we need to do to give input to the other tracking upgrade working groups
  - Task lists are still quite general, but specific tasks are being tackled by people and starting to be listed in the twiki pages
  - Unclear for priority of Phase 1 simulation studies, would like to get input from this meeting

- The software tools are ready to enable people to start the simulation studies; and some studies have started (mainly for Phase 2)

- We need more people to work on the simulation studies, in particular for Phase 1

Backup Slides
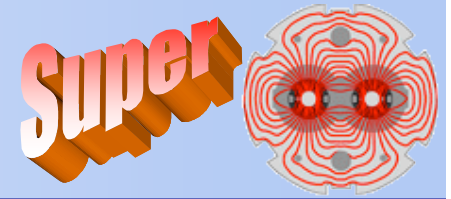
- Standard Geometry

Full Tracker radiography