Science & Technology
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tkLayout - A Tracker Layout Modeling Tool

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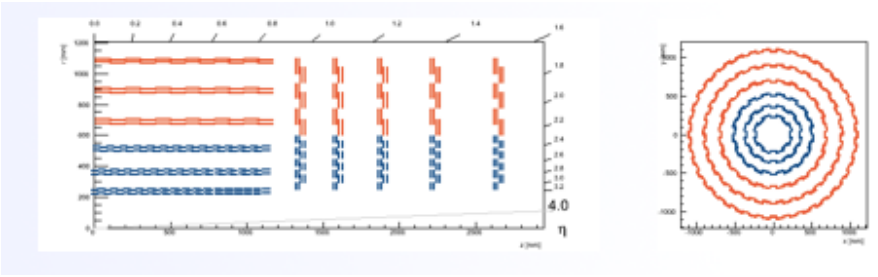
Intro

- What is tkLayout
- How it works
- Outputs
- Examples



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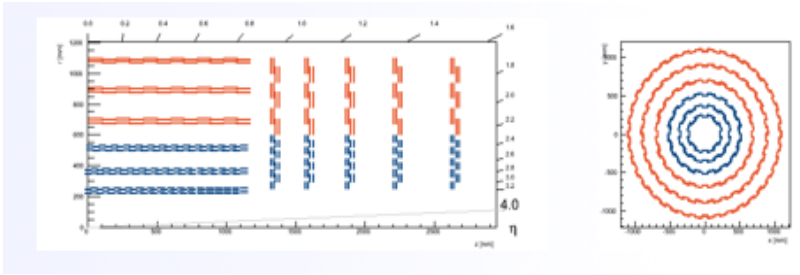
tkLayout

- Tool to evaluate tracker layouts
  - Rapidly explore different proposals for the tracker geometry, evaluating the key characteristics of each
  - Estimates tracking performances
  - Estimates track-trigger performances
  - Narrows down the parameter space
    (e.g. number & position of layers, strip or pixel pitch...)
  - Does not depend on optimized track reconstruction algorithms
  - Makes geometry files in XML format, which can be used as input for a full simulation of the tracker with Geant4

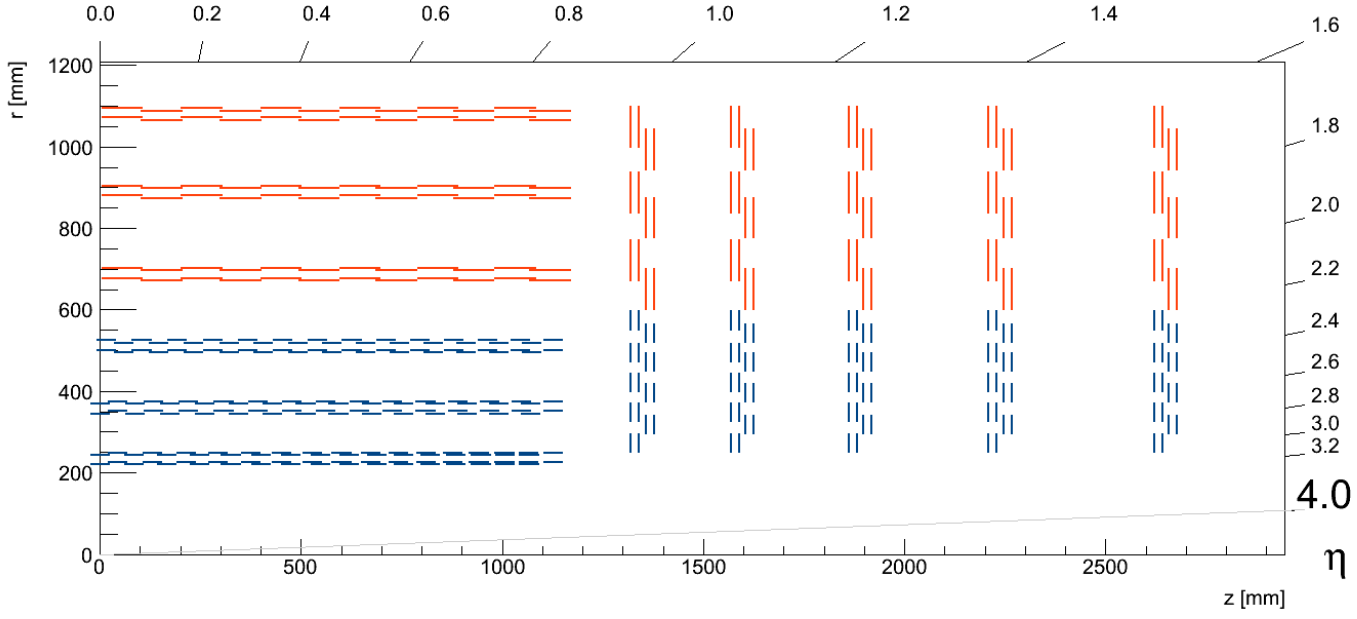
- Small number of input parameters
- Fast
- Simple
- Places detector volumes in 3D space
- Automatically assigns materials to volumes

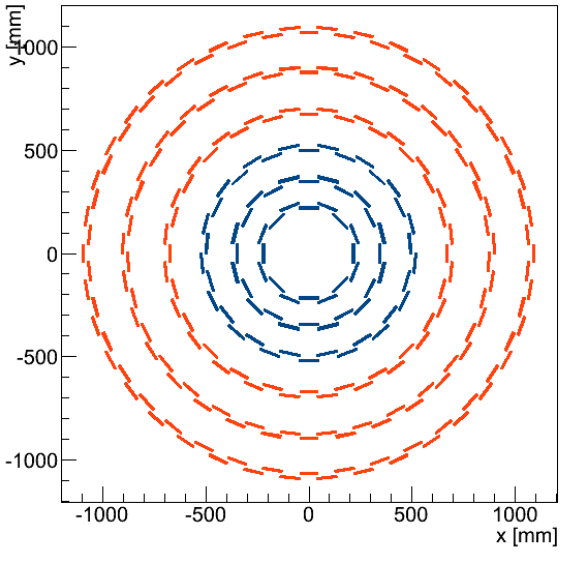
- It is not a replacement for a full MC simulation
  - physics channels
  - occupancy
  - efficiency



Building Geometry

1. General geometrical layout of tracker
   - number of discs/layers
   - volume boundaries
   - module shapes
2. Details about modules
   - type of modules in particular layer
   - no of sensors,
   - distance between modules,
   - (size of trigger windows)
3. Details about materials
   - The material is assigned to each module volume without any detail about the geometric distribution of material within the module itself.



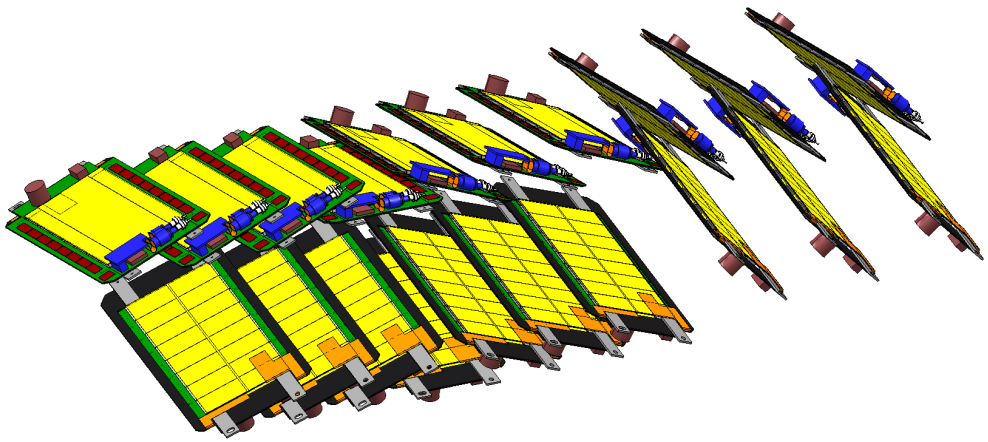


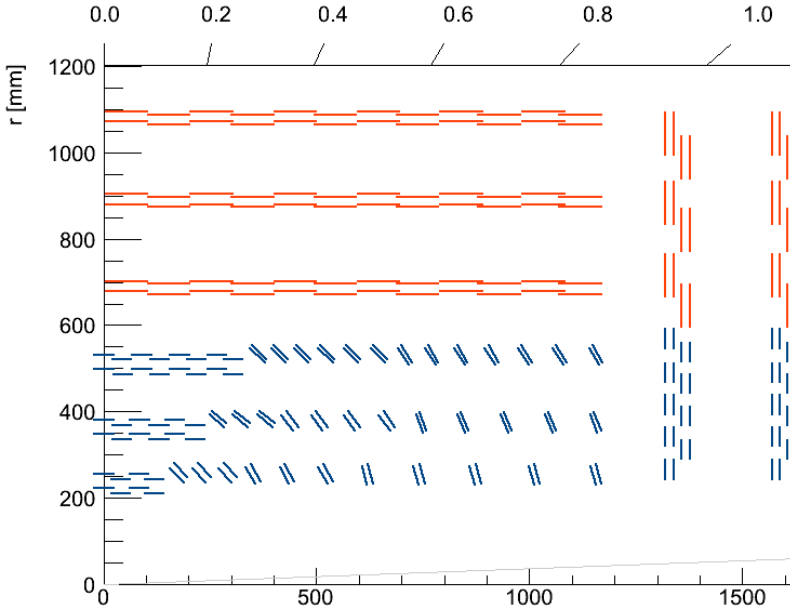
Modules

- Various types of modules available
  - pixel (single sided pixel module)
  - r-phi (single sided strip module)
  - stereo (double sided strip module)
  - p_T modules (provide local measurement of the p_T)

- Different shapes
  - rectangular
  - trapezoidal

- Different orientation
  - parallel to the beam
  - orthogonal to the beam
  - tilted

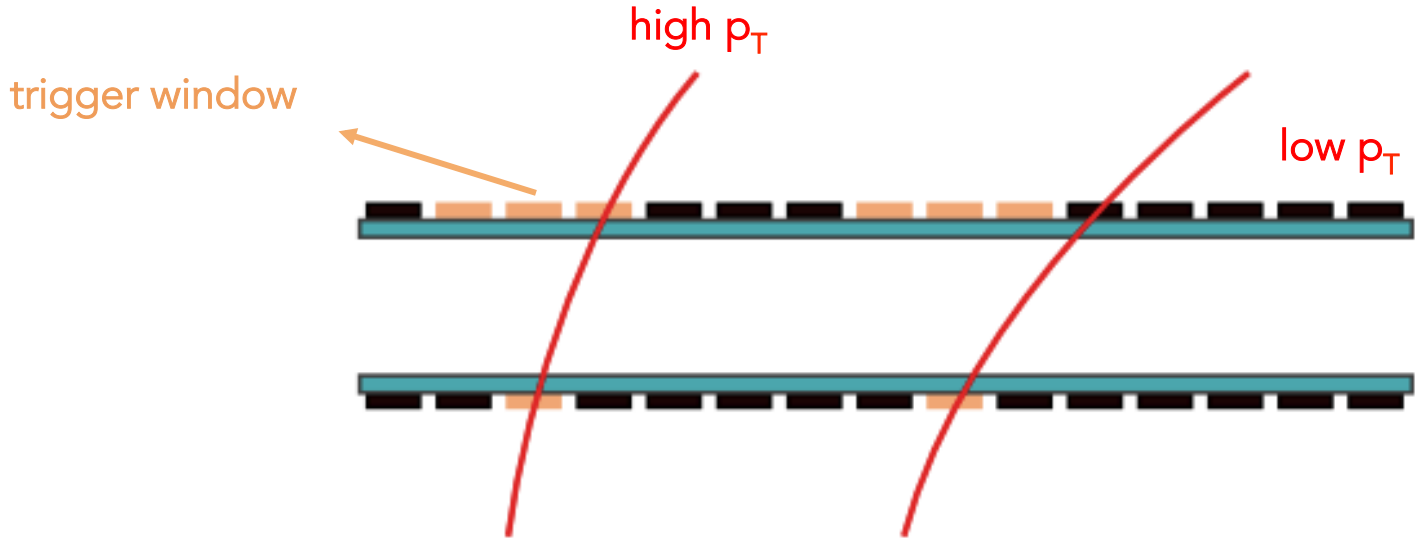




Modules

p_T modules (PS, 2S and 2P)

- The more complex modules (developed for CMS tracker upgrade)
- Low p_T track filtering
- Consist of two closely placed sensors, with a variable separation between them



- The high-p_T tracks will cross almost orthogonal to the surface
- The low-p_T tracks will cross at a wider angle
- Optimise trigger windows and (or) sensors spacing to obtain consistent p_T selection (one of the parameters in tkLayout is *triggerWindowSize*)

Tracking performances

The estimate of tracking performances of the analyzed geometry is made starting from the first principles.

- A charged particle moving in a homogeneous magnetic field follows circular trajectory in the plane perpendicular to the field and a linear one in the plane parallel to the field (high p_T assumed)
- perform two independent fits to projections of particle's trajectory in these two planes
    - has been tested by simulating the current CMS tracker and comparing the actual resolution with that predicted by tkLayout

No fit actually needed – the error matrix can be calculated analytically

- use measurement errors to estimate the errors in track fit parameters (intrinsic resolution of the interaction points)
- add effects of the multiple scattering (deviation from the ideal track)

Outputs

- tkLayout writes outputs to web page

ShortTilted3xPS_3x2S_5disks_longer_uncut – Geometry

mersi.web.cern.ch/mersi/layouts/.current/ShortTilted3xPS_3x2S_5disks_longer_uncut/index.html

razno Google Jelena Stribor

ShortTilted3xPS_3x2S_5disks_longer_uncut – Geometry | 3xPS_3x2S – Geometry

ShortTilted3xPS_3x2S_5disks_longer_uncut

layouts

geometry | geometry (pixel) | bandwidth | trigger cpus | power | material (outer) | material (pixel) | weights (outer) | resolution | resolution (pixel) | resolution (trigger) | trigger | info | log page

layers and disks

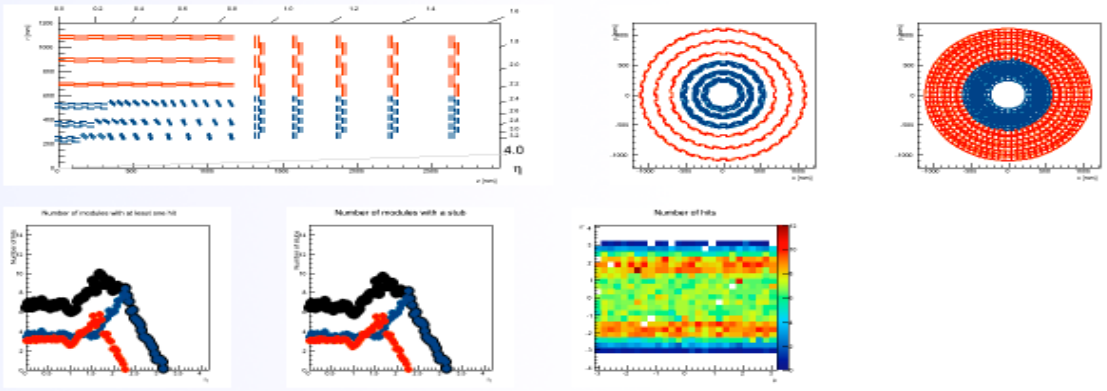
Layer	1	2	3	1	2	3	Total
r	244.467	368.392	521.857	686.000	887.901	1080.000	
# mod	522	910	1476	1152	1488	1824	7372
# rods	18	26	36	48	62	76	

Disk	1	2	3	4	5	Total
z	1349.445	1597.452	1891.039	2238.583	2650.000	
# mod	676	676	676	676	676	6760

Ring	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
r_{min}	238.877	285.997	316.784	364.412	391.549	441.174	464.735	513.328	544.898	594.872	665.086	770.394	832.952	939.308	994.500
r_{max}	285.137	332.257	363.044	410.672	437.809	487.434	510.995	559.588	591.158	695.372	765.586	870.894	933.452	1039.808	1095.000

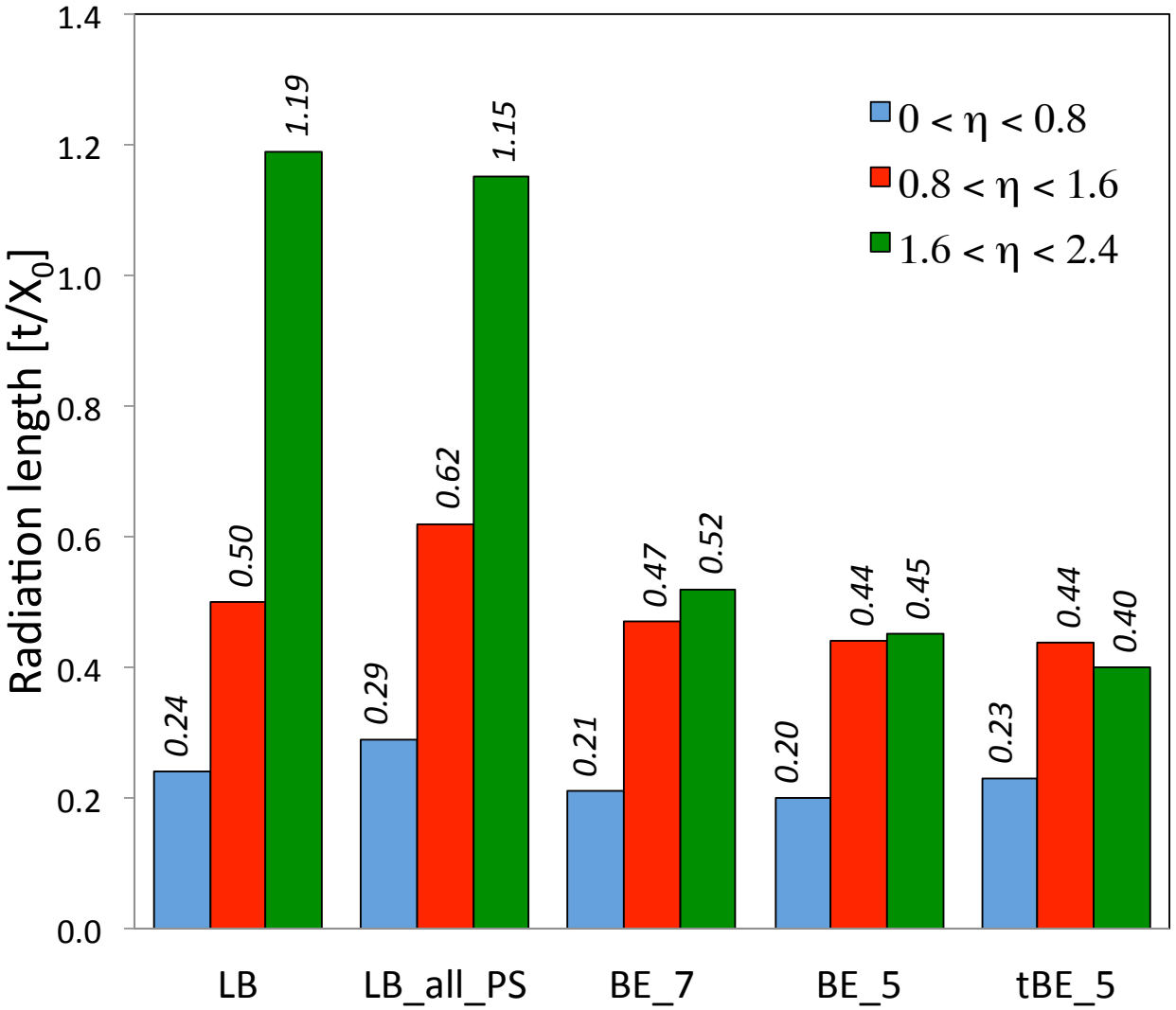
modules

plots



CMS tracker optimisation

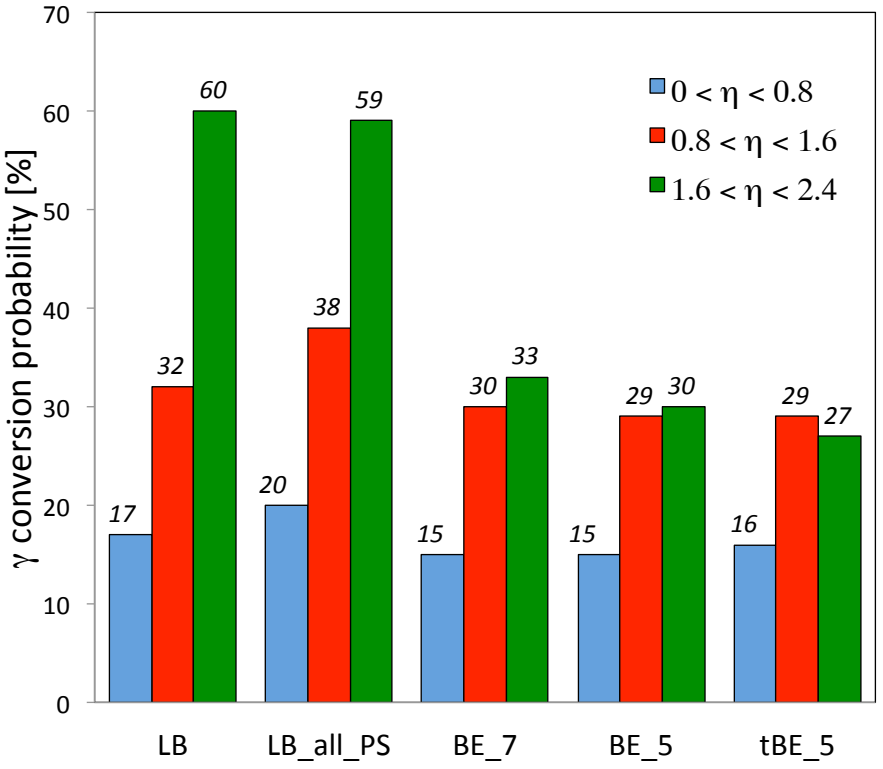
Material Budget

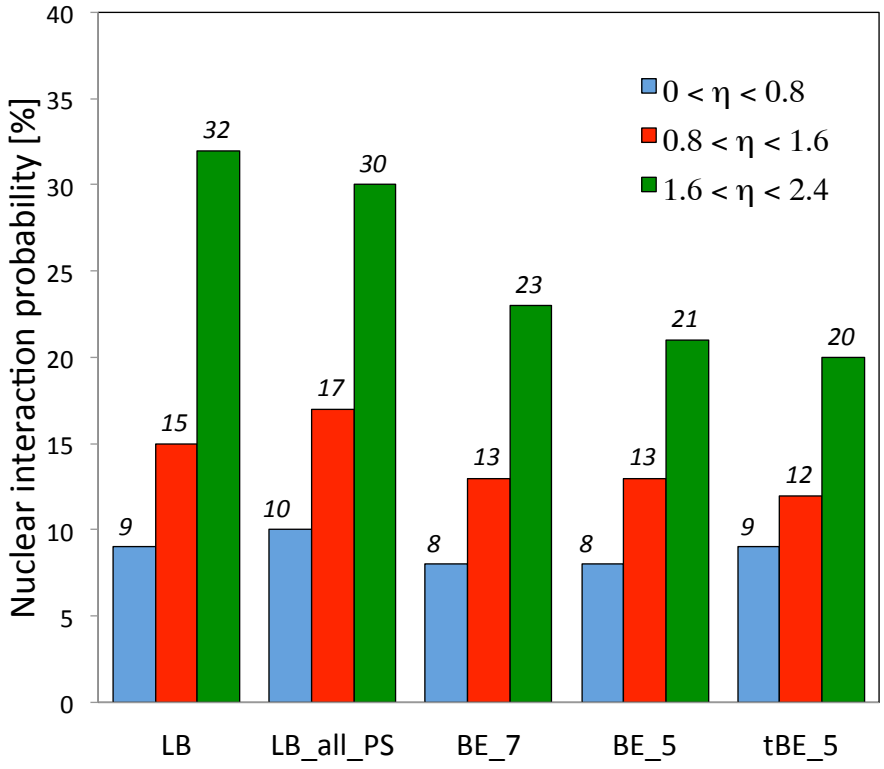


Alternative tracker designs for CMS upgrade

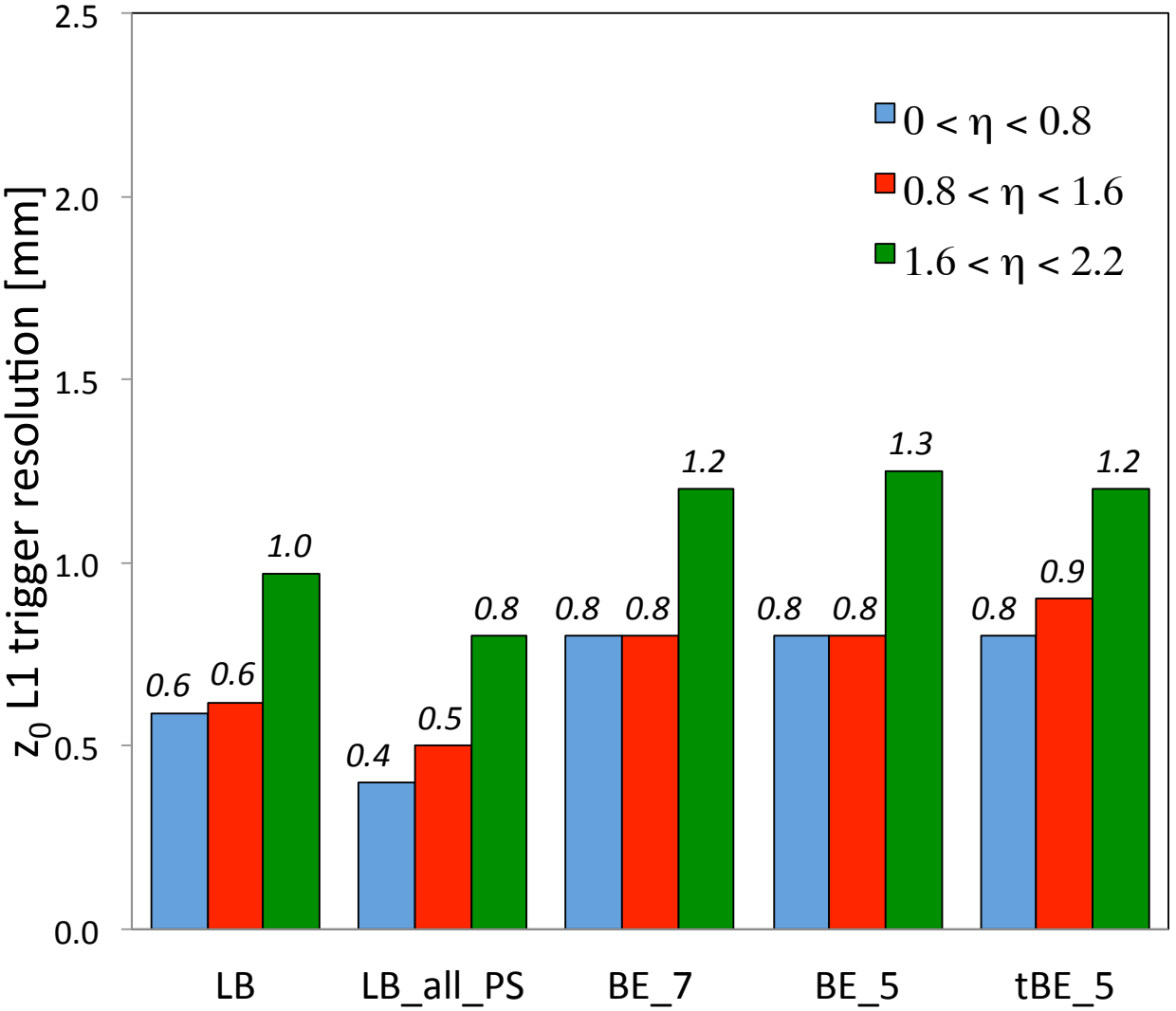
- LB
- LB_all_PS
- BE_7
- BE_5
- tBE

γ conversion probability & nuclear interaction probability

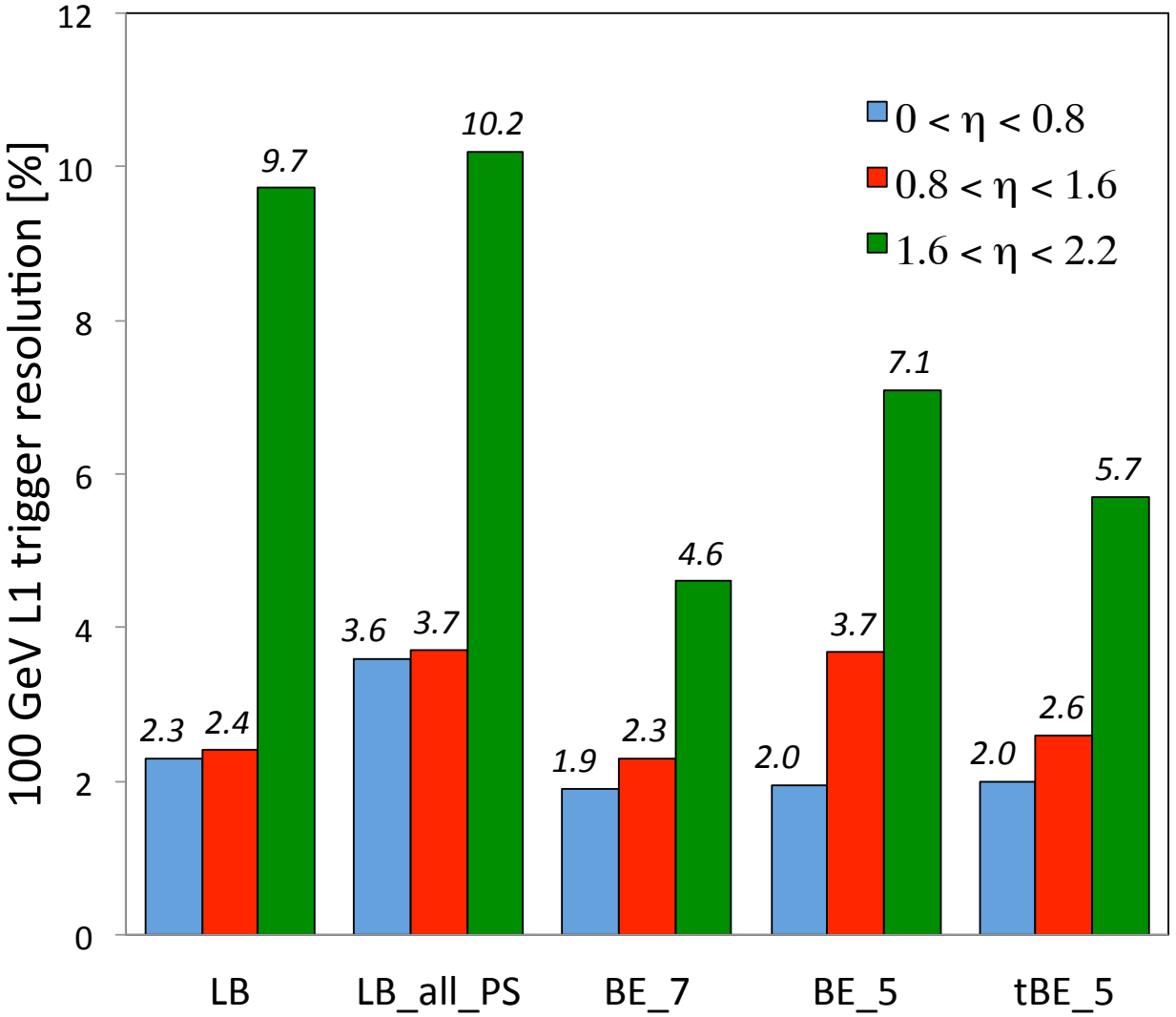




resolution of the track z_0 impact parameter

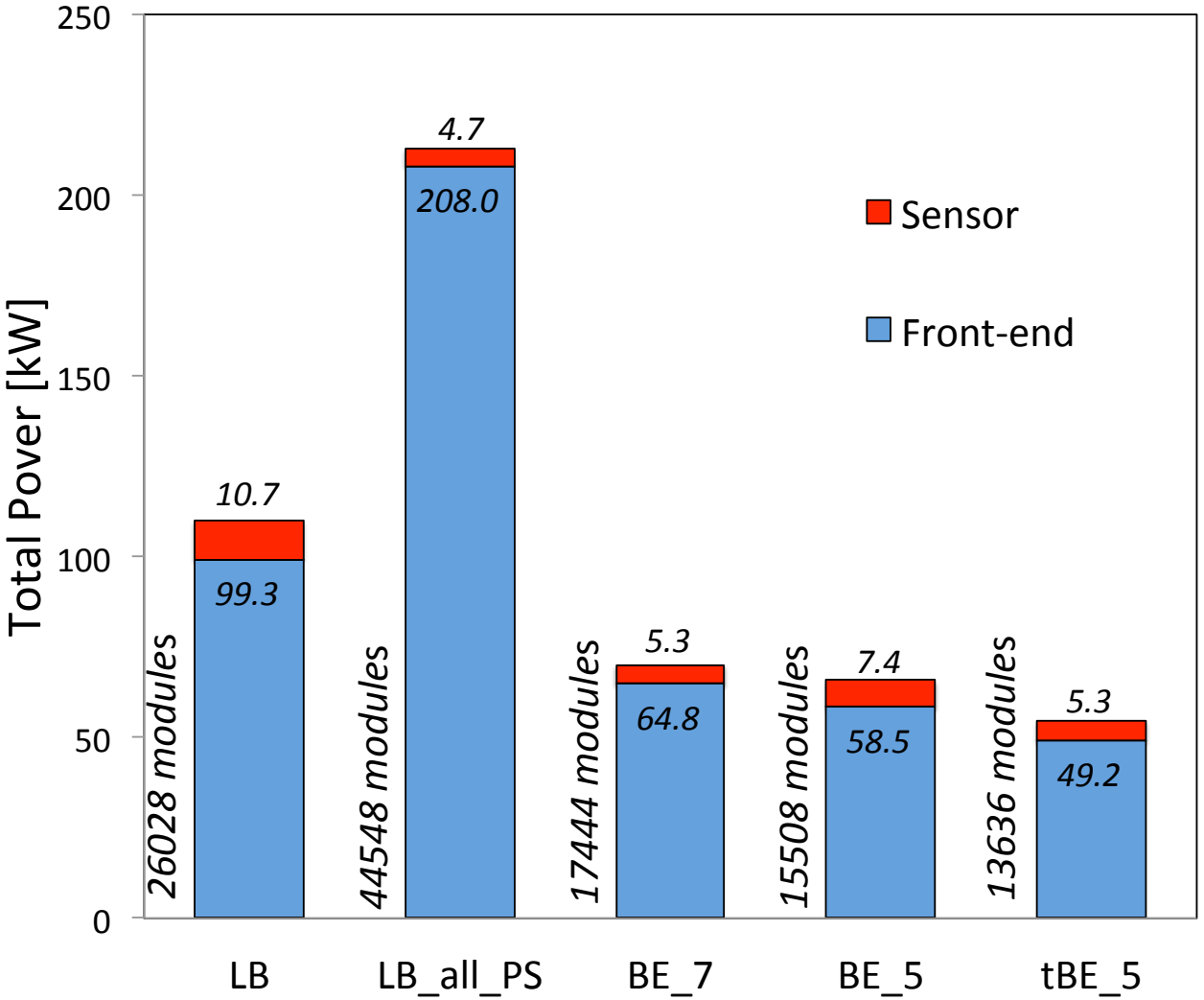


p_T L1trigger resolution



Examples

power consumption - one of the major challenges for tracker readout systems at the high-luminosity LHC



Conclusion

- tkLayout is a free generic tool
- Fast running
- Simple
- Has been thoroughly validated
- No dependence on track reconstruction algorithm tuning
- Gives fair comparison between different tracker designs
- Gives estimate of tracking and track-trigger performances
- Produces geometry in *xml* files that can be as geometry input for a full simulation of the new tracker with Geant4
- Full geometry studies can be pursued on a few geometries identified by tkLayout

- https://code.google.com/p/tkgeometry/source/checkout