TID test

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Motivation

- No TID study for the LGAD in the Atlas TDR
- Explore the effect of TID on the LGAD ? — assure the performance of the LGAD

LGAD radiation environment

- Radiation aim: 9.5Gy dose, dose rate(?)
- photon spectrum:peak 500-700keV, 95%< 10MeV; (HL-LHC photon spectrum?)

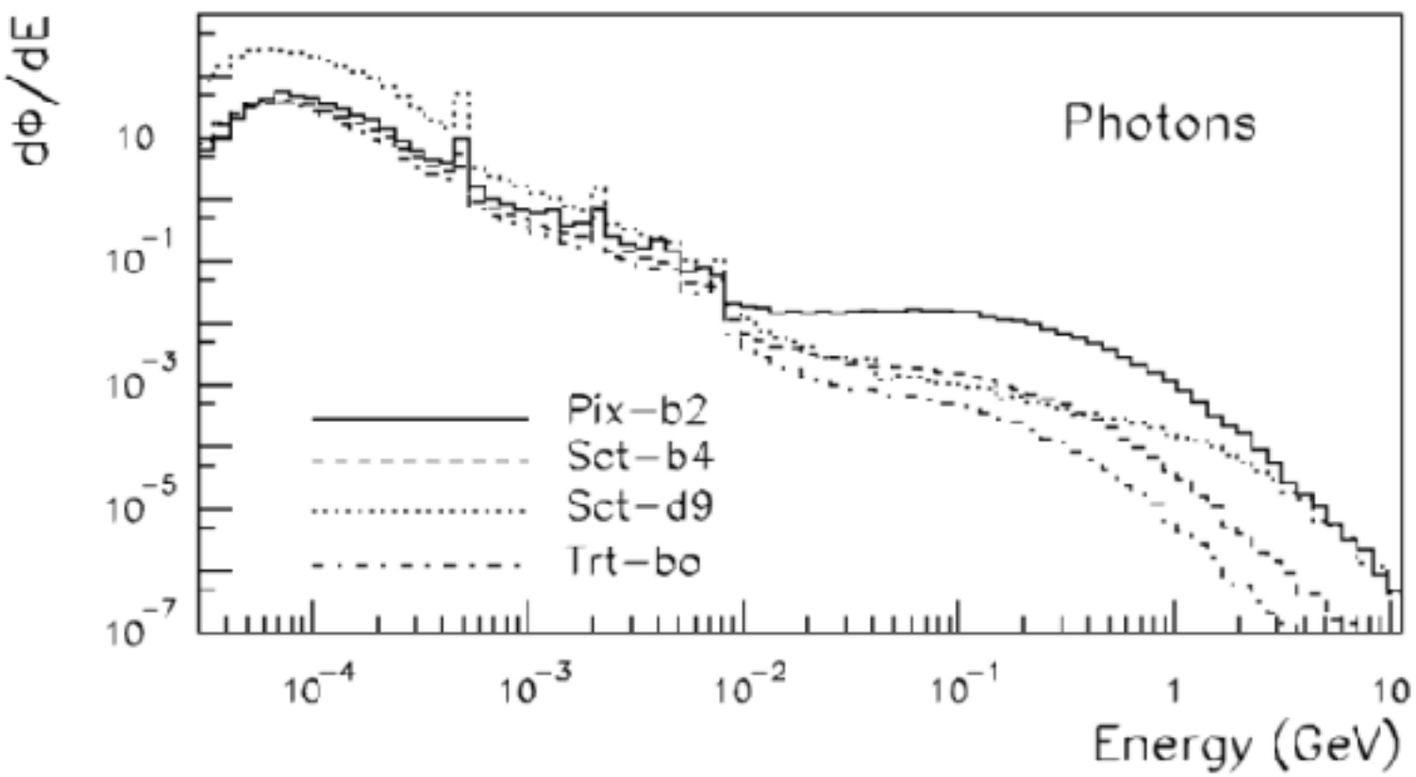
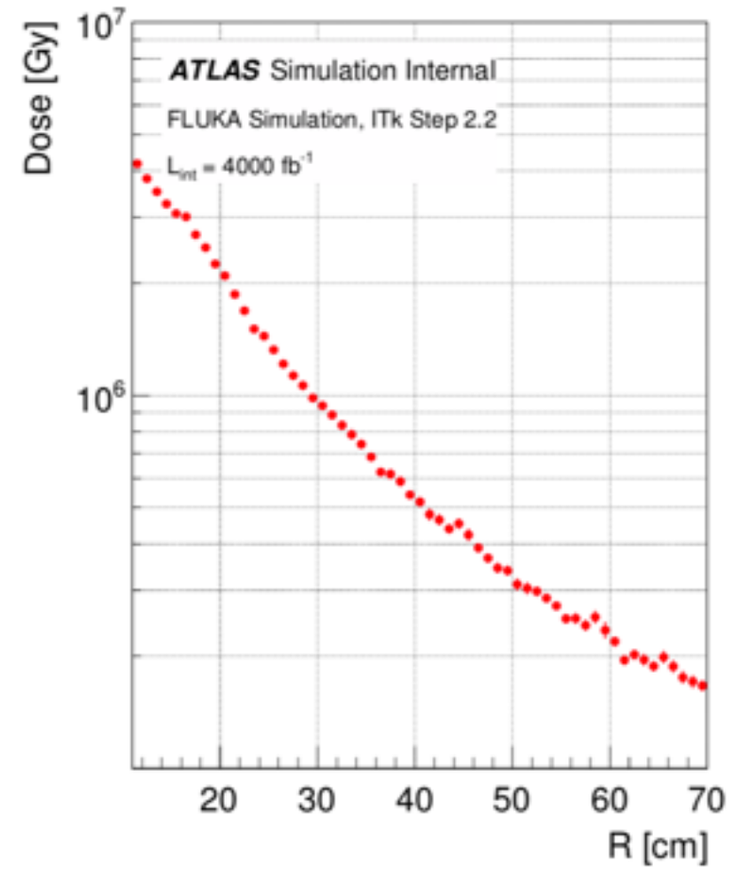


Fig. 1. Examples of particle fluence energy spectra (particles/cm/GeV/interaction) at various locations in the inner detector{IanDawson, 2000}



(b) Nominal ionising dose for HL-LHC.

Radiation experiment setup

Radiation equipment：

- MultiRad160 (available)： dose rate range (?): energy(?), x ray spectrum(?)

Radiation test setup

MultiRad 160 radiation test plan:

- **aim dose:** 100 Mrad，dose rate: 2Gy/hr，time consuming 1 week
- **test sensor:** without bias (with bias in the future?)
  1. 3~4 HPK single pad LGAD sensor (Type 3.1 and 3.2)
  2. one 5x5 HPK sensor with UBM (type 3.1)
- **annealing:** 80 min at 60○C (according to the LHC operational condition) （other annealing setting in the future?）

LGAD performance test

Test the LGAD performance before and after irradiation:

- **Electrical characterisation: I-V and C-V (leakage current) — available**
- **Charge, gain and signal-to-noise**
- **Efficiency**
- **Time resolution**
- **Uniformity, inter-pad gap and edge region**

New x/γ radiation equipment

high dose rate? shorten the radiation time? the effects of different dose rate on the sensor?

Northwest Institute of Nuclear Technology: nuclear (contacting)

- γ ray:

1. Max dose rate **10^{11} Gy/s,** energy 2.5 MeV, pulse width 15ns;

2. Max dose rate **10^{9}** Gy/s, energy 0.9 MeV, pulse width 150ns

- x ray :

1. energy fluence rate **1～6 J/cm²; energy 20～100 keV; pulse width 35ns**。
2. **energy fluence rate 150 J/cm²; energy 0.1～1.5 keV; pulse width 45ns**。

- backup

HGTD location

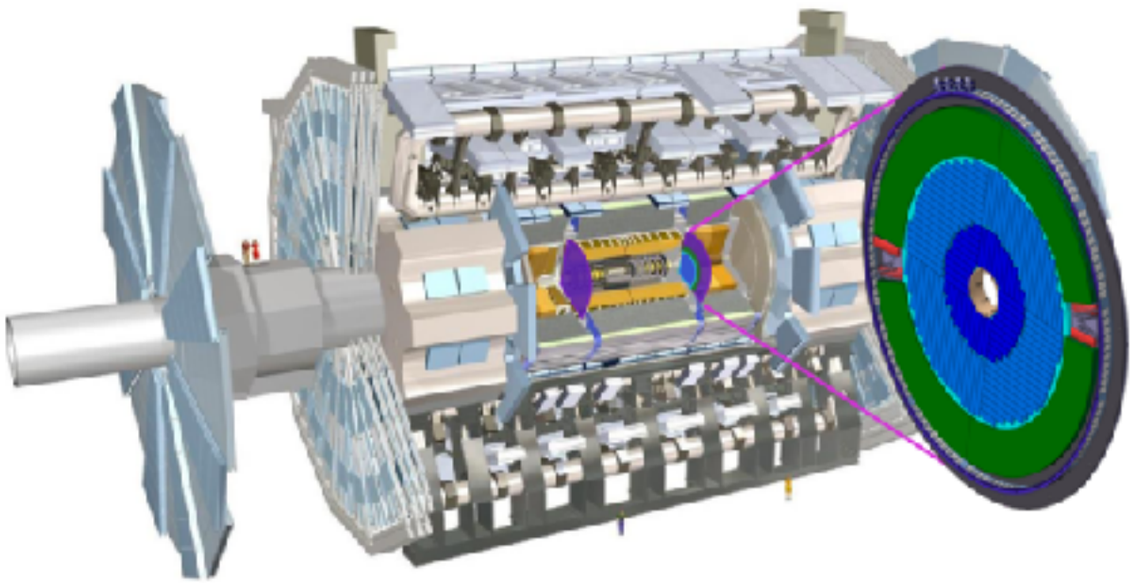
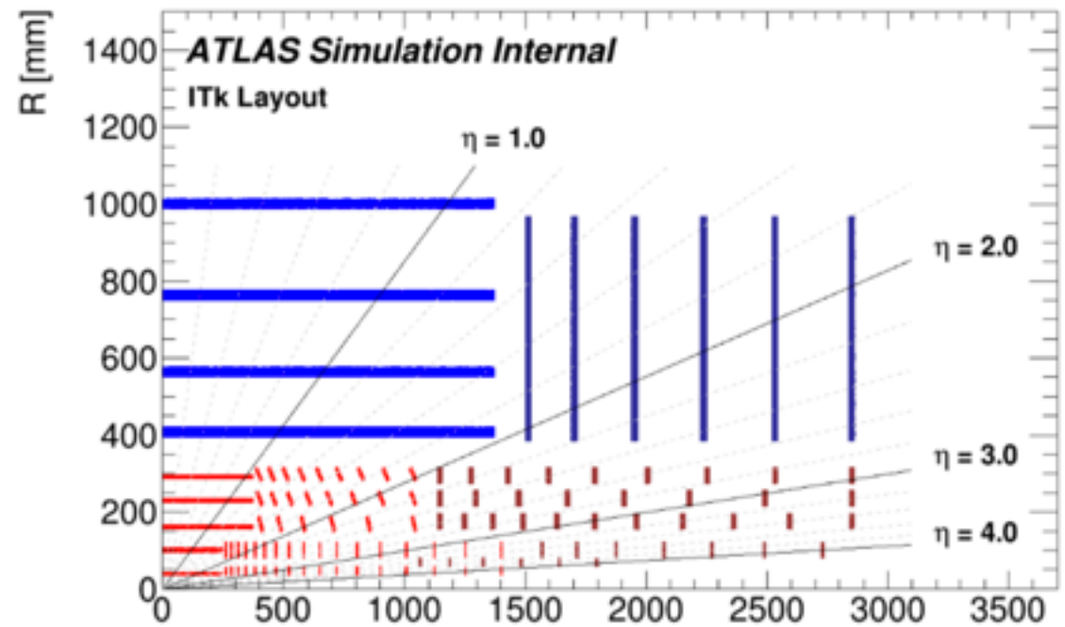


Figure 2.4: Position of the HGTD within the ATLAS Detector. The HGTD acceptance is defined as the surface covered by the HGTD between a radius of 120 mm and 640 mm at a position of $z = \pm 3.5$ m along the beamline, on both sides of the detector.



Pseudo-rapidity coverage	$2.4 < \lvert\eta\rvert < 4.0$
Thickness in z	75 mm (+50 mm moderator)
Position of active layers in z	$z = 3443, 3454, 3468, 3479$ mm
Radial extension:	
Total	$110 \text{ mm} < R < 1000$ mm
Active area	$120 \text{ mm} < R < 640$ mm
Pad size	1.3×1.3 mm^2
Sensor thickness	50 μm
Number of channels	3.59M
Active area	6.4 m^2
Average number of hits per track:	
$2.4 < \lvert\eta\rvert < 3.1$	≈ 2
$3.1 < \lvert\eta\rvert < 4.0$	≈ 3
Time resolution per track	< 50 ps

Table 2.1: Main parameters of the HGTD.

unit

1Gy=1J/Kg

3 模拟设备

辐射源	辐射装置	简要指标
γ射线	高剂量率γ源	剂量率10^{11}Gy／s，光子能量2.5MeV，脉冲宽度15ns
	RS－20加速器	剂量率10^{6}Gy／s，光子能量1.5MeV，脉冲宽度100ns左右
	“晨光号”加速器	剂量率10^{6}Gy／s，光子能量1MeV，脉冲宽度25ns
	钴源辐照装置	剂量率4.5μGy-1Gy／s，光子能量1.25 MeV，稳态辐照

3 模拟设备

辐射源	辐射装置	简要指标
X射线	高剂量率γ源	硬X射线：能注量6J／cm²，光子能量20～100keV，脉宽35ns 软 X射线：能注量 150J／cm²，光子能量0.3keV，脉冲宽度45ns
	“闪光二号”加速器	能注量1J／cm²，光子能量500keV，脉冲宽度60ns
	DPF-200脉冲X射线源	能注量6mJ／cm²，光子能量5～50 keV，脉冲宽度150ns

3 模拟设备

辐射源	辐射装置	简要指标
电子束	“闪光二号”加速器	能注量400J／cm^2，电子能量0.8MeV，脉冲宽度80ns
	“晨光号”加速器	能注量1J／cm^2，电子平均能量0.25MeV，脉冲宽度40ns
中子	JM-400中子发生器	中子产额10^{11}中子／秒，能量14MeV，稳态工作
	脉冲反应堆	中子注量率 10^{16}中子/cm^2.秒，脉宽8ms