Direct Read-out Detectors for ATLAS

Common Features:

75 μm pitch, no intermediate strips

minimize capacitance: narrow implants, wide p-blocking implants

Choices:

Read-out:	<u>double-sided</u>		<u>single-sided</u>
Coupling:		AC coupled vs. DC-coupled	
Bulk:		p-bulk Vs n-bulk	
Charge collected:			n-side vs. p-side
Biasing:	poly R vs. punch through		poly R vs. punch through vs. direct
n-side Isolation:		p-implant vs. spray	
Guard Rings:		Bias Ring Only vs. Multiple Guards	

Read-out:

	PRO	CON
Double-sided	less material	float electronics or voltage across caps
Single-sided	choose best side	
	decouple detector and FEE biasing	

Coupling:

	PRO	CON
DC- coupling	simple	DC current flows into FEE
AC - coupling	separate biasing of detector and FEE	Break-down

Bulk:

	PRO	CON
n-bulk / n-strips	well known properties	junction change sides at inversion
	low capacitance after inversion	higher capacitance before inversion
	depletion voltage lower	
	(both pre- and post-rad)	

Charge collected:

	PRO	CON
holes	well understood	marginal after inversion
		longer pulses
electrons	short collection time	need p-blocking implant
	robust after inversion	

Biasing:

	PRO	CON
Poly resistors	rad hard precise	
Accumulation		no good
Punch-through	simple	not radiation hard not precise too large?
Fox-FET		not radiation hard noise contribution not understood (SVX)
direct (DC coupling)		need to ground all strips FEE bias and detector coupled

n-side Isolation

	PRO	CON
p-implant	well defined performance	possible breakdown
p-spray	simple	does not work with all strip geometries

Guard Rings

	PRO	CON
Bias Ring only	least dead space ?	bulk and surface currents added
Multiple Guards	higher breakdown voltage?	more space used

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Conservative choice for long-term operations with additional "head-room"

before radiation damage:

- yield of bad strip with large currents: AC - coupling
- yield of shorted capacitors: single - sided
- testability: common biasing, (access to strip implants), guard ring

after radiation damage:

- ultimate fluence:
  - leakage currents : AC- coupling
  - depletion voltage: single-sided, n-bulk, n-strips,
- surface damage: poly resistors, p-blocking implants

Proposal for direct read-out ATLAS detectors: "Separation of Functions"

- n-bulk
- single-sided
- n-strips
- AC - coupling
- Poly resistors
- p-implants
- at least one guard ring

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Noise Measurements with Binary r-ϕ Modules