Report for Silicon Detector Physics

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22 Jul 2021

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调研结果

- 总结了上周提到的哥廷根实验的I-V结果
  - 定义击穿电压V_{BD}，以80%V_{BD}的电流衡量最大噪声
  - 比较3.1型和3.2型的诸性能
  - 对辐照后sensor低温退火，测量I-V曲线
- 阅读Helmuth教材：信号形成
- 查阅到ATLAS团队的HGTD芯片提案，总结了探测器的要求：
  - HL-LHC的照射束：30~60mm高斯束宽，175~260ps的时间宽度；空间堆栈密度：1.8次/mm；
  - 时间分辨：小于60ps
  - 辐射硬度：7.35E15中子当量，8.1MGy

下一步计划

- 继续阅读ATLAS的HGTD提案，整理探测器的各项指标；
- 探测器输入输出函数的解析解。目标精确度到“数量级”

一点疑问

- 教材中在信号分析时，有不少涉及“运放”的地方，需要继续学习么？

哥廷根HPK实验

- 芯片图

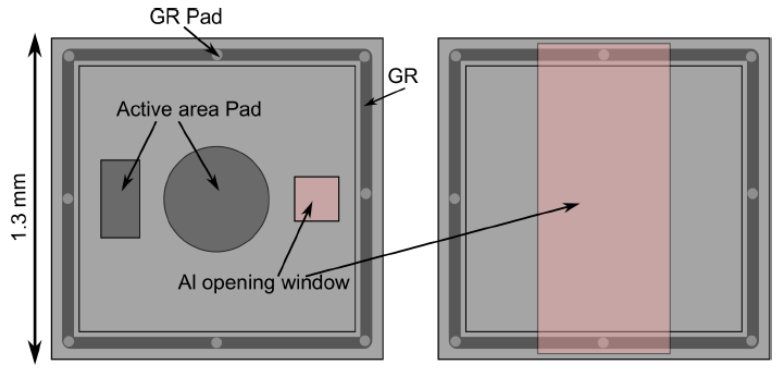
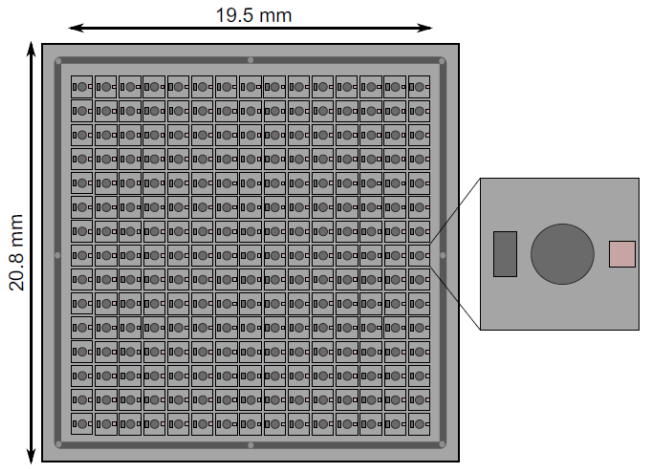


Figure 5.3: Single pad sensor from HPK surrounded by a guard ring with contact pads for probing on the active area and guard ring and an opening in the Al for testing. The opening on the backside is coloured in red. The front of a single pad sensor is shown on the left, the back on the right.



拟粒子辐射对sensor的损伤

哥廷根HPK实验

- I-V测量电路：大体一致，我们掌握更多细节

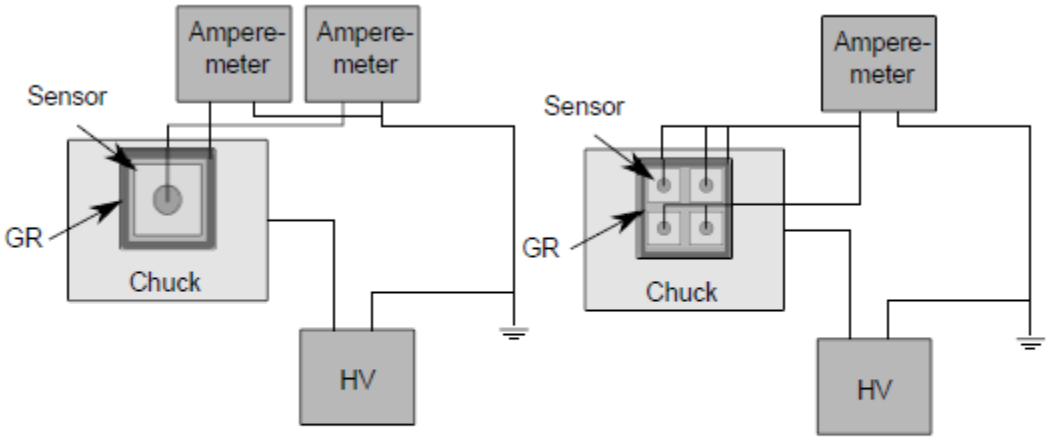
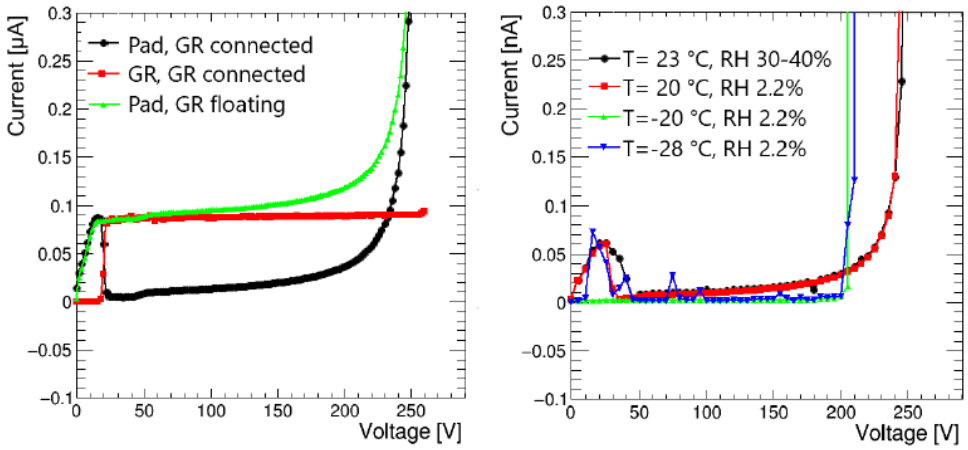


Figure 6.1: Schematic drawing of the measurement set-up in the probe-station with the HV-source and the amperemeter. A single pad sensor with a needle connected to the sensor pad and one needle connected to the guard ring (GR) (left) and a 2×2 array with alls four pads and the guard ring connected to the amperemeter (right).

哥廷根HPK实验结果

- 环境测量



- GR的连线不影响击穿电压V_{BD}的测量
- V_{BD} 达到1微安的外偏压
- 温度与V_{BD}呈正相关，湿度不影响V_{BD}

哥廷根HPK实验结果

- 型号测量

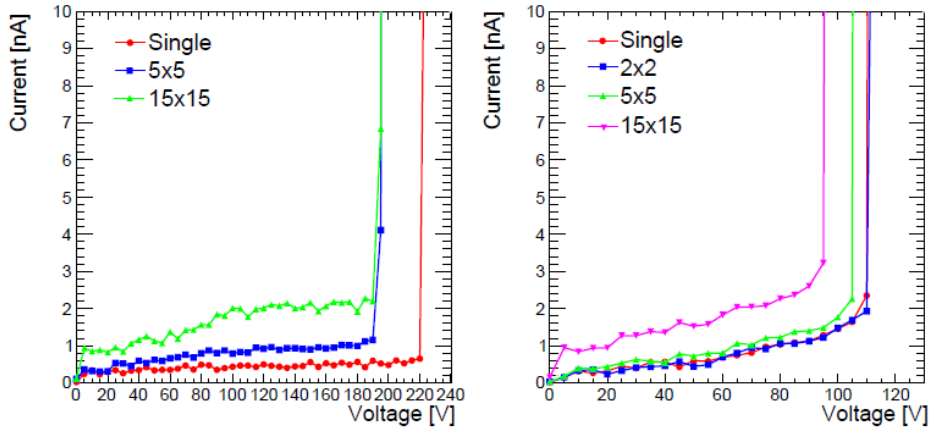


Figure 6.3: Comparison of IV-curves of single pad sensors, 5×5, and 15×15 measurements "Type 3.1" (left) and IV-curves of single pad sensors, 2×2, 5×5, and 15×15 of "Type 3.2" (right).

- 阵列越大，整体电流越大，击穿电压越小。因为相邻的sensor互相影响
- 3.2型比3.1型更容易被击穿，因为前者掺杂较多

哥廷根HPK实验结果

- 均匀性测量（3.2型）
  - 样本平均击穿电压：125.4V
  - 样本标准差：0.4V
  - 所有pad均值127V，标准差5V

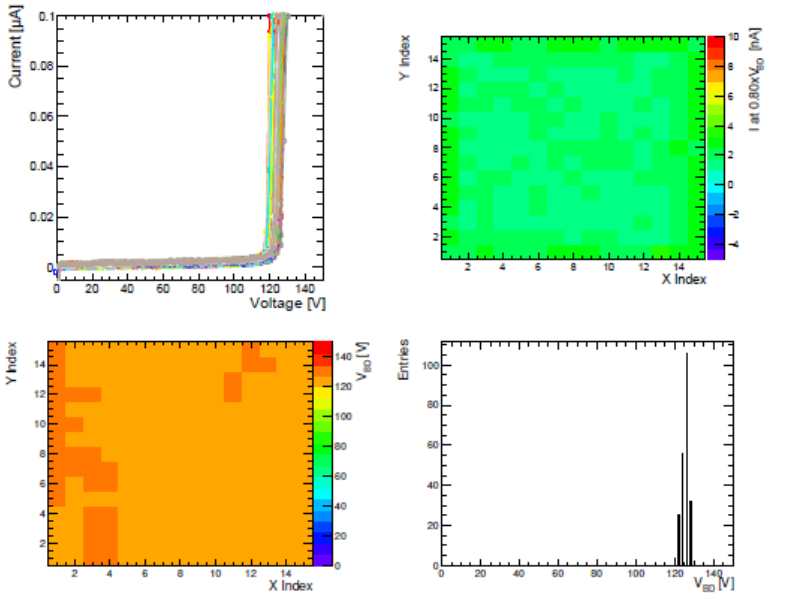


Figure 6.4: On the top left, the IV-curves of all pads of the 15×15 array of wafer 18 with an inter-pad gap of 95 µm, and a slim edge of 500 µm of set P2 are shown. The top right plot is a 2D plot of the currents at 80 % of the breakdown voltage. The bottom left plot shows the breakdown voltage of the sensor as a 2D plot and the bottom right plot shows a histogram of the breakdown voltage.

哥廷根HPK实验结果

- 均匀性测量（3.1型）
  - 样本平均击穿电压：192.65V
  - 样本标准差：0.06V
  - 所有pad均值200V，标准差8V

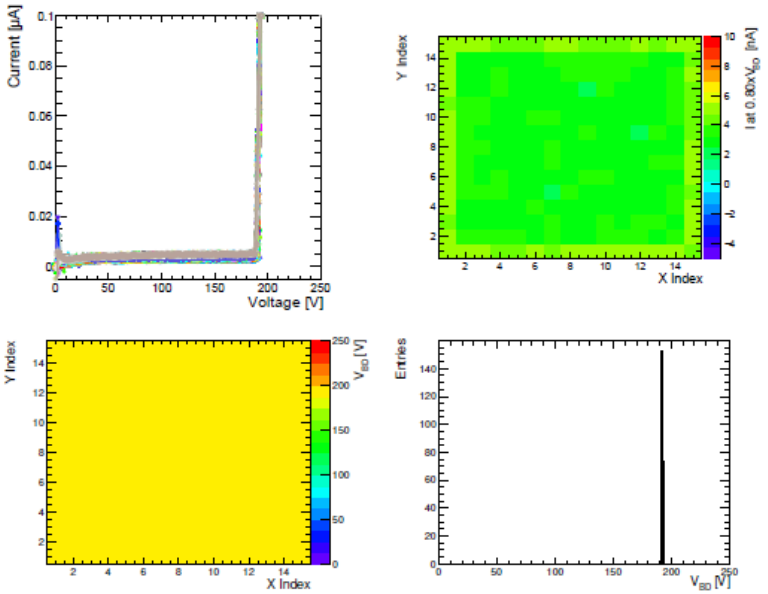
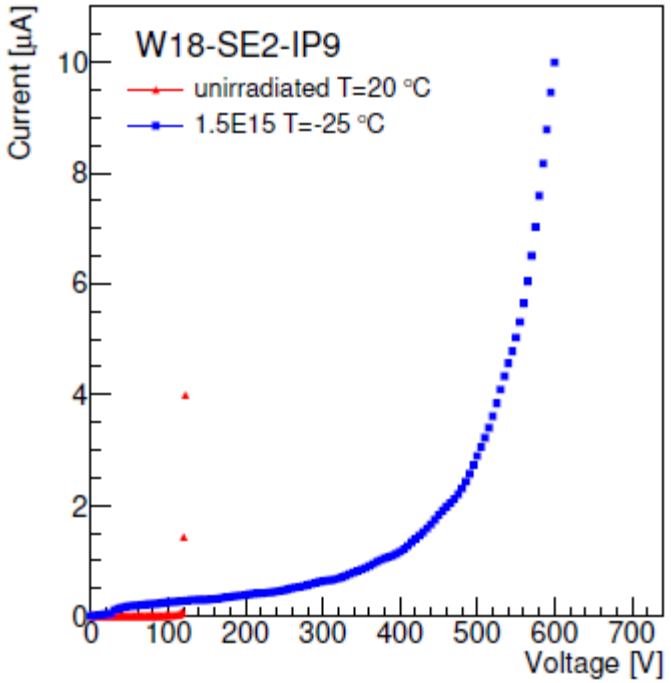


Figure 6.5: The complete analyses of the measurement of W18-LG15x15-SE5-IP9-P3 sensor. On the top left, the IV-curves of all pads of the sensor are shown. The top-right plot is a 2D plot of the currents at 80 % of the V_{BD}. The bottom left plot shows the V_{BD} of the sensor as a 2D plot, and the bottom right plot shows a histogram of the V_{BD}.

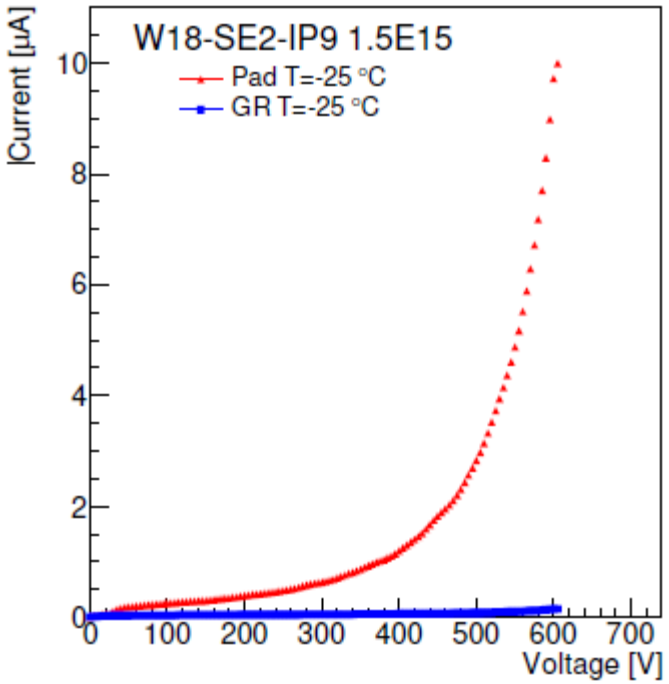
哥廷根HPK实验结果

- Yield
  - Good sensor：两种型号都在99%以上
  - Perfect sensor：阵列越大，比例越小
- 辐照后IV测量：1.5E15中子当量
  - I-V曲线
  - 辐照后的漏电流成因复杂，有待理论分析



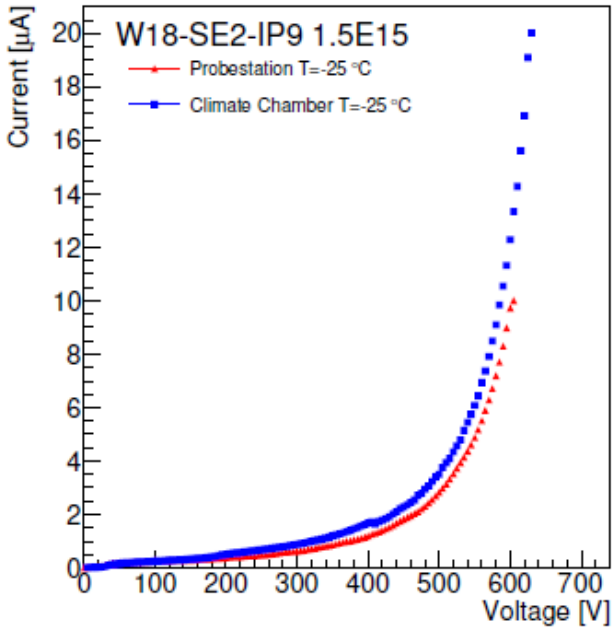
哥廷根HPK实验结果

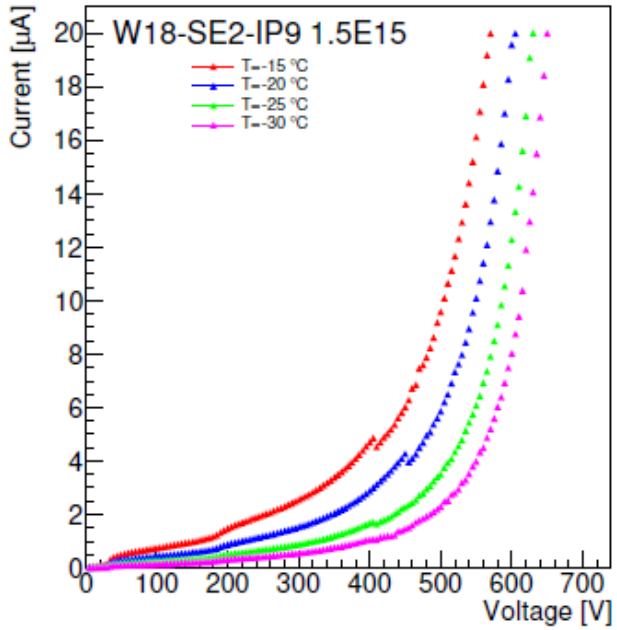
- 辐照后IV测量：1.5E15中子当量
  - 辐照后V_{BD}：5μA的外偏压
  - Pad和GR的I-V测量：为排除GR等的干扰



哥廷根HPK实验结果

- 辐照后IV测量：1.5E15中子当量
  - Probe-station与Climate Chamber测量的比较
  - （意义未明）





谢 谢！