

顶点探测器像素芯片设计

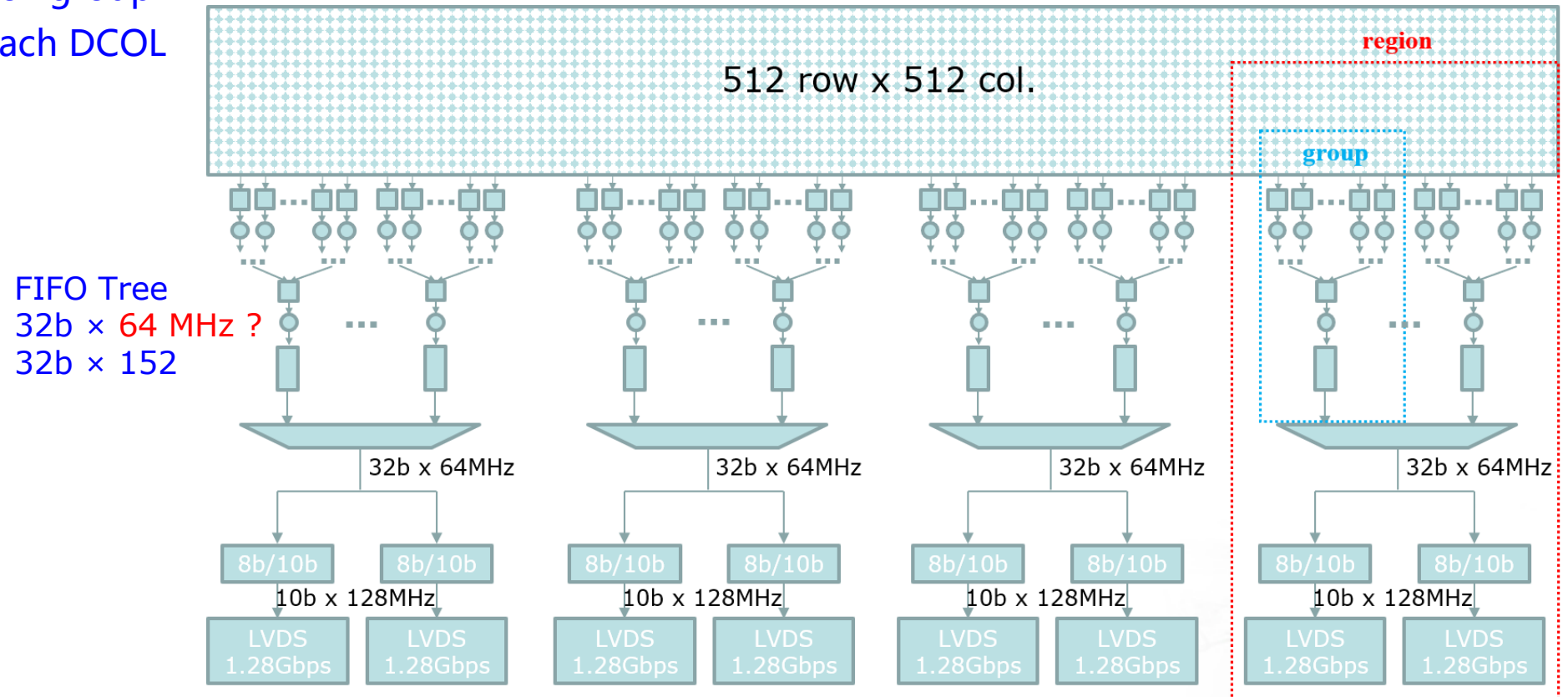
卢云鹏

2026/9/3



整体方案

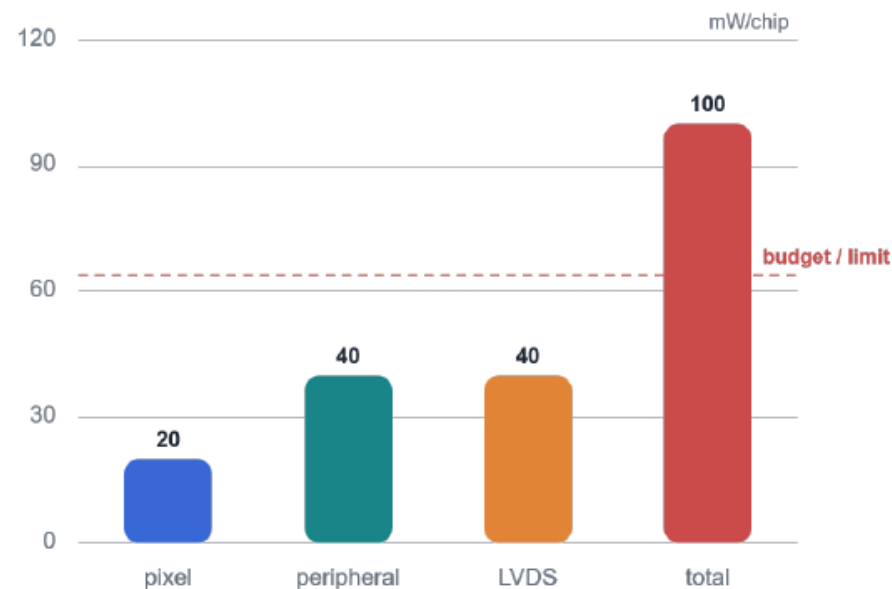
- 252 MHz pixel hit rate x 40 bit = 10.08 Gbps (Pixel hit rate = 200 MHz·cm⁻²)
 - 512 × 512 pixel
 - Regions = 4 groups + 2 x 8b/10b + 2 x LVDS transmitter
 - Groups = 16 double columns + 1 Shared FIFO tree
 - 140 words for each group
 - Time stamp on each DCOL



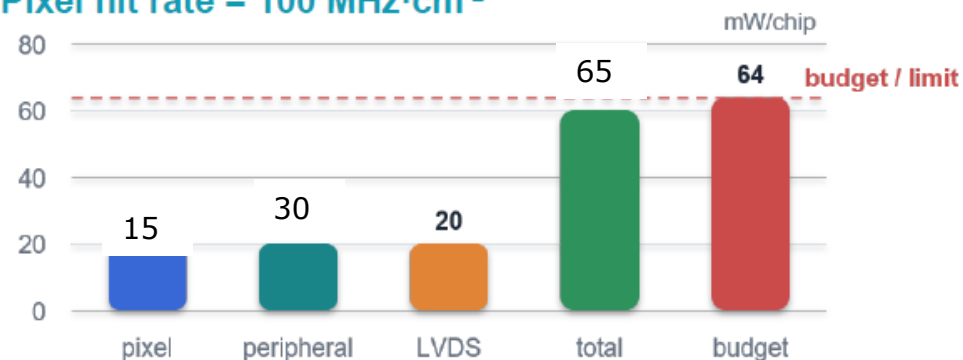
Operating Condition

- 最内层 pixel hit rate = 200 MHz/cm²
 - 平均功耗 = 100 mW / 1.6 cm² = 62.5 mW/cm²
 - 利用 beam pipe 提高散热能力
- 次内层 pixel hit rate < 100 MHz/cm²
 - 系统时钟频率降低一半
 - 数据传输模块关闭一半
 - 平均功耗 = 65 mW / 1.6 cm² = 40.6 mW/cm²
 - 接近满足 < 40 mW/cm² 的散热要求

Pixel hit rate = 200 MHz·cm⁻²



Pixel hit rate = 100 MHz·cm⁻²

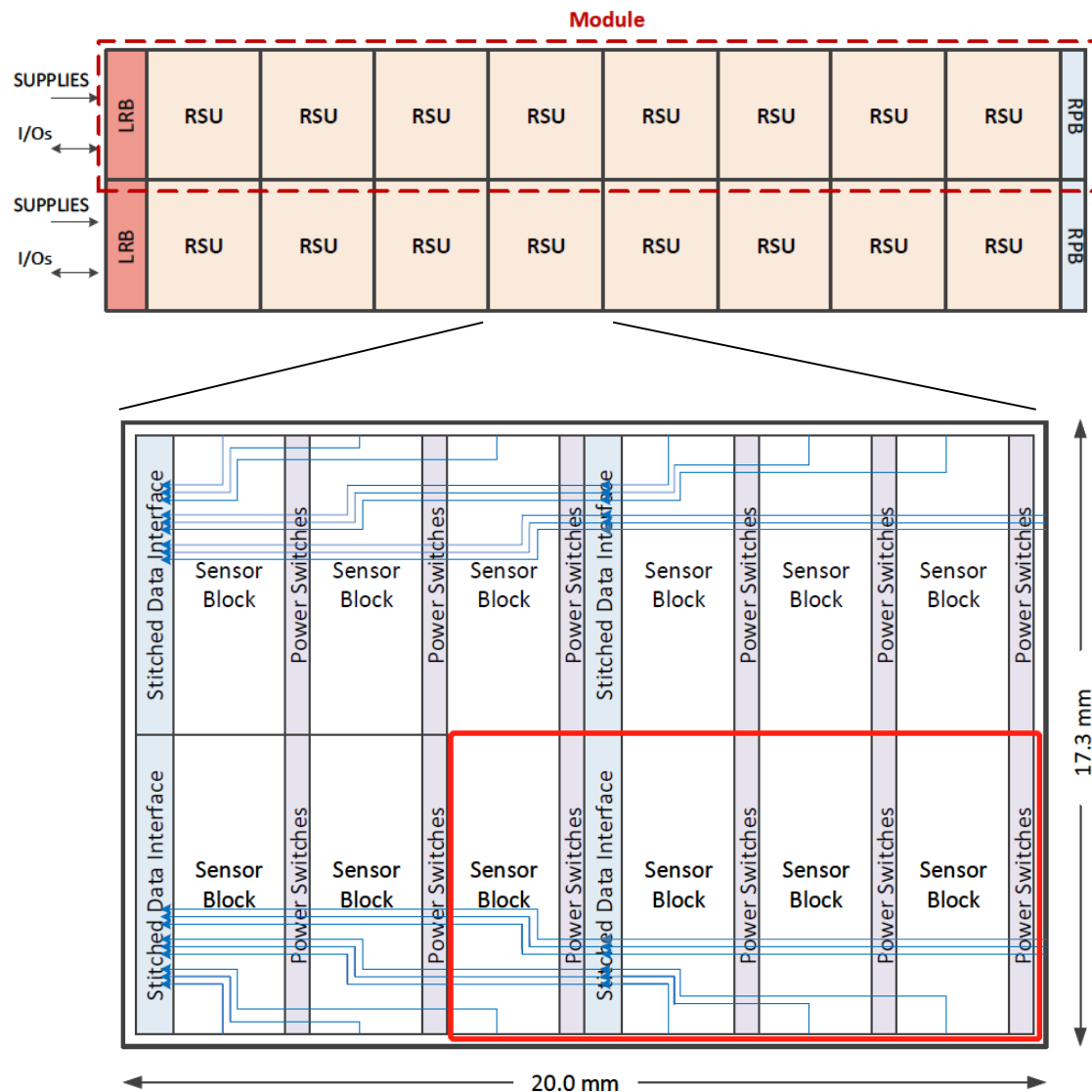


Stitching兼容性

- 目前的单芯片设计相当于Stiching RSU里面的4个sensor unit

- [CEPC reference detector TDR](#)
- 每个region对应一个sensor unit
- Region尺寸8.2mm x 15.4/4mm, 取决于最终的像素尺寸
- 每个region有独立的数据缓存和数据传输
- 额外的模块设计和验证:

Power Switches和Stitched Data Interface



人员与分工

Task	Responsible person	Affiliation
Integration and verification	卢云鹏, 熊浩	IHEP
Process and analog front-end	张颖	IHEP
Matrix readout logic	李彤	NCU
Readout scheme and FPGA verification	卢云鹏, 郁晗	IHEP
Peripheral data readout	焦元鸿, 颜骏远, 李新杰	NWPU
PLL & Serializer & LVDS	Quanwei Hu	CCNU
DAC	Baoshu Hao	CCNU
Negative biased PAD	Ping Yang & Student	CCNU
Analog buffer	熊浩	IHEP

具体设计与推进

- 建议把具体设计讨论放在周四例会之后
 - 每个designer汇报设计进展
 - 需要深入讨论的问题可另行安排时间

Task	目前的工作推进方向
性能指标评估	从occupancy, pixel dead time, 读出速度等各方面能否满足Hit rate
Analog Front-end	Diode设计（结合TCAD），FPN优化，版图规划
Matrix readout logic	根据郁晗的模型加入freeze和ROM逻辑；提供RC和门延迟参数给郁晗；根据时序仿真结果迭代确定长线驱动的buffer尺寸与数量
Readout scheme and FPGA verification	按照李彤的逻辑电路进一步细化模型；根据李彤的延迟参数进行时序仿真，多次迭代确定hit读出时序；在FPGA上验证像素阵列逻辑和数据读出方案
Peripheral data readout	修改外围读出电路的group和region宽度；利用郁晗的双列模型检验EOC逻辑和数据读出rtl代码；进行初步的功耗评估以确定读出方案
PLL & Serializer & LVDS	1.28 Gbps LVDS设计，与外围读出确认PLL设计要求（640M/64M/32M）
DAC	6 电压DAC+6电流DAC，跟张颖确认动态范围（特别是VERESET）



学术报告

- 今天下午3: 30, 有zoom链接

EXPERIMENTAL PHYSICS DIVISION SEMINAR
INSTITUTE OF HIGH ENERGY PHYSICS, CAS

Tracking requirements and detector technologies @ FCC-ee



Speaker: Prof. N. De Filippis
Host: Guang Zhao
Time: 3:30 pm, 3rd Sept., 2026
Location: 122 Multidisciplinary Building
Indico: indico.ihep.ac.cn/event/30581
Zoom ID: 9749 7146 606
Password: 260903

Abstract:

The Future Circular Collider (FCC-ee) offers unprecedented opportunities for both precise measurements at the Z pole and in the Higgs sector and search for new physics through high-luminosity electron-positron collisions. Fully exploiting this physics potential requires an ultra-precise tracking system capable of vertexing, momentum measurement, reconstruction of displaced vertices and particle identification. That put considerable demands on the detector technologies and a super control of the systematic uncertainties. Some benchmark analyses are chosen to study the dependence of their sensitivity on some aspects of the detector performance. This talk explores the status of the IDEA detector proposal and subdetectors technologies to cope with the requirements and ensure the relevant performance.

About the speaker:

Prof. N. De Filippis made a fundamental contribution to the discovery of the 125GeV boson and measurement of its properties with the CMS experiment at the LHC by developing an analysis to look for a Higgs boson decaying into two gauge Z bosons and then into charged leptons. Along the path of shading light on the reality of the Higgs mechanism, he worked on constraints on Higgs self-couplings via the non-resonant double Higgs production (for several final states), and on the search for BSM physics via the resonant double Higgs production at the LHC. Prof. De Filippis leads currently also the effort for the project of a drift chamber as the main tracking device for the IDEA detector proposal at FCC-ee. He is also involved in inspecting the performance of machine learning tools to improve the signal to background performance for physics analyses, by using high performance computing.

Starting from 2018 he has been Associate Professor at the Physics Department of "Politecnico di Bari" and Visiting Courtesy Professor at Florida State University, Tallahassee, US. He was CMS LPC Distinguished Researcher at the LHC Physics Centre (LPC) Fermilab, Batavia, US in 2018 and 2019. In 2011 he was Associate fellow grant by INFN and CERN to work at CERN. He was researcher with a "contrat a duree determinee" financed by the CNRS at "Laboratoire Leprince-Ringuet", "Ecole Polytechnique" (Palaiseau, France) between 2007 and 2009.