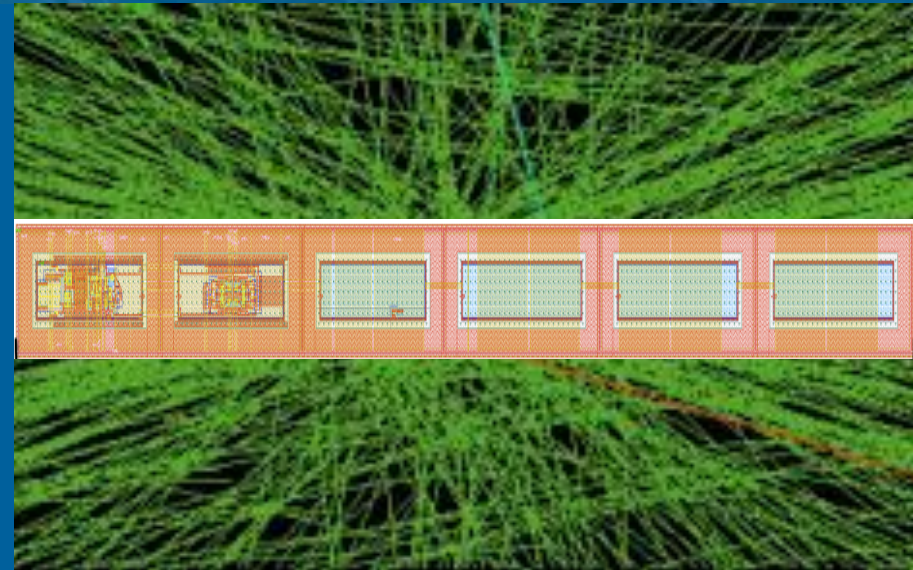


MONDAY 26 SEPTEMBER 2016

# CMOS TECHNOLOGY FOR TRACKING DETECTOR

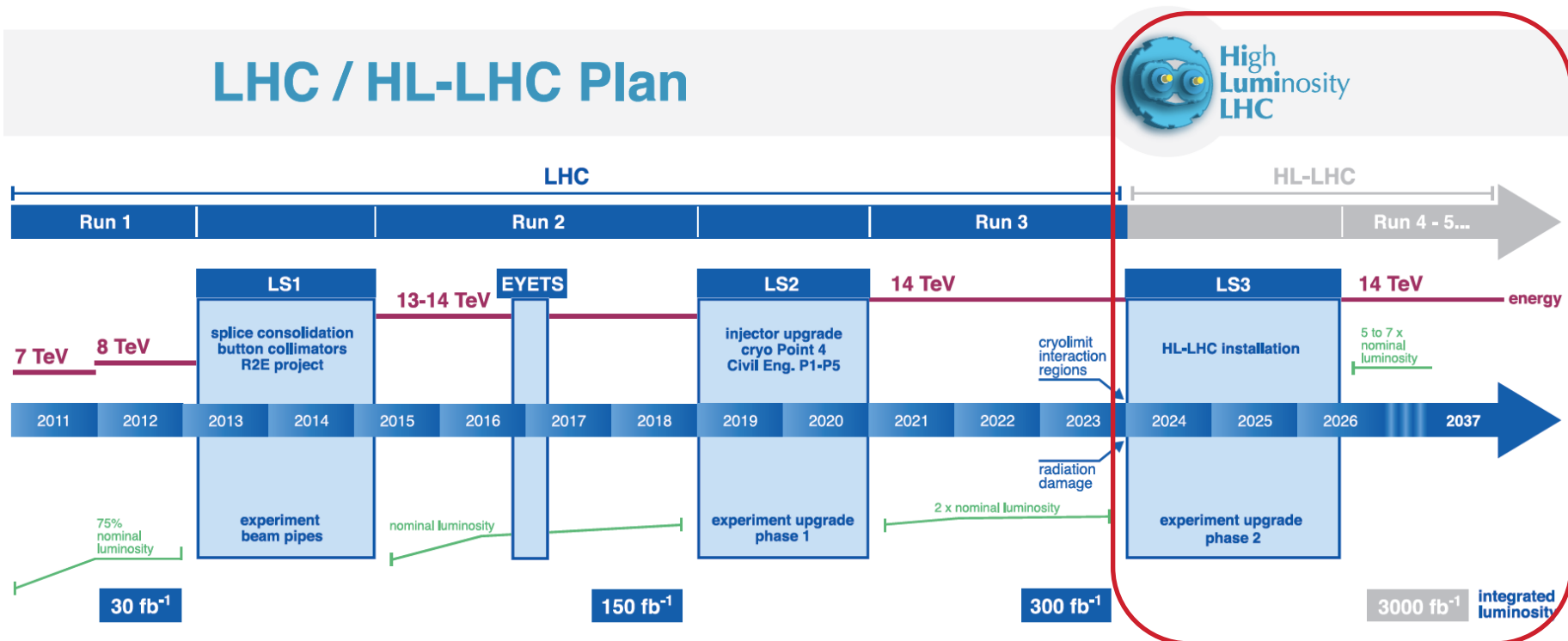
*- ATLAS PHASE II UPGRADE*

**RUI WANG**  
Smart postdoc  
Fantasy Detectors Division



# NEEDS

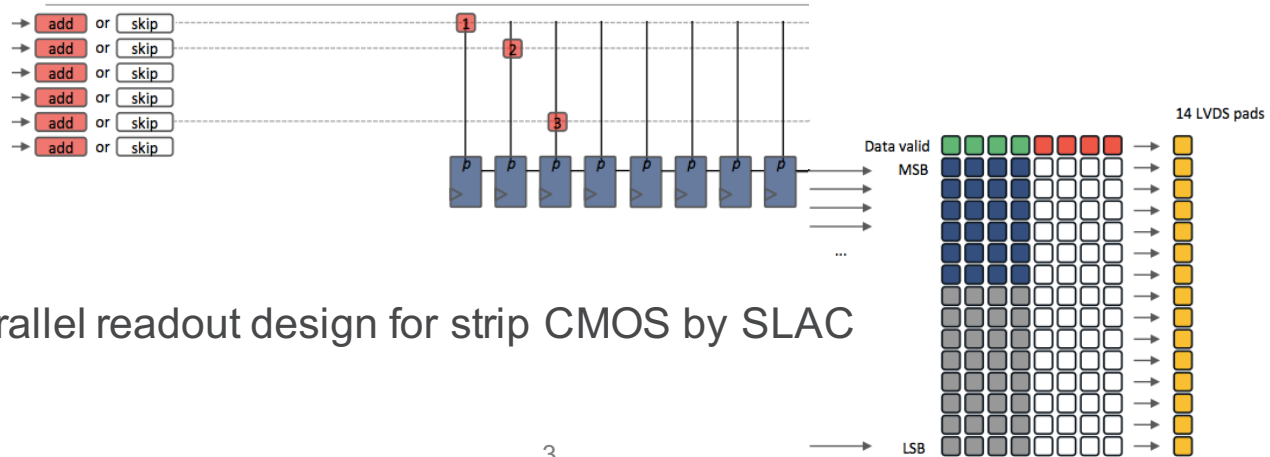
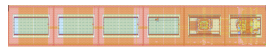
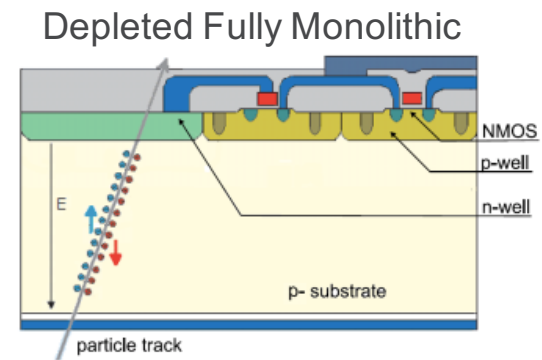
- LHC is moving towards its high luminosity (HL) phase
  - ATLAS will replace the whole inner detector with new designs
    - Improve track and vertex reconstruction



# CMOS

## Cheap alternative to the traditional Si sensors

- CMOS technology -- Electronics inside charge collection well
  - Modularized -> identical sub-pixels
  - Very fine pixels granularity: chain sub-pixels to form desired pixel size
  - Small thickness -> small depletion depth
- Can highly integrate the whole module on one single chip (Monolithic)
  - Build in digital readout chain
  - Parallel readout is possible -> highly reduce the need for bump bonding



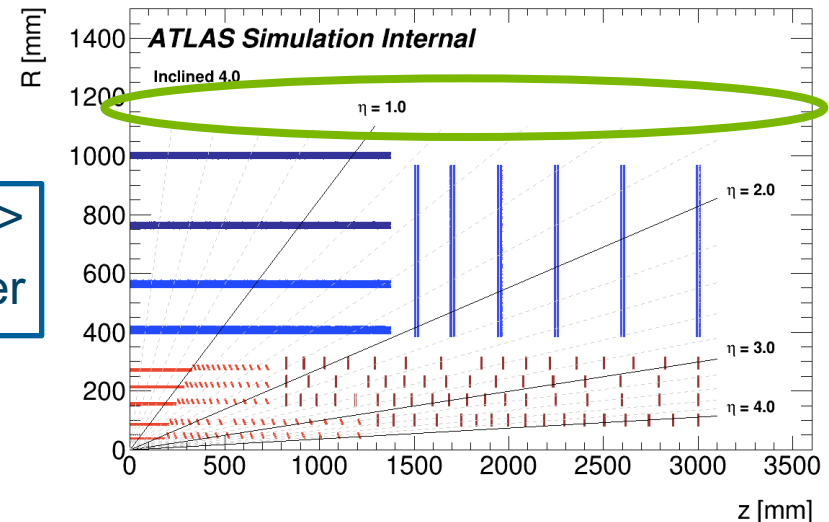
# CMOS

## Cheap alternative to the traditional Si sensors

- Proposals plan for building 5<sup>th</sup> layer outside the 4<sup>th</sup> strips using CMOS
- Worldwide CMOS R&D organization in side ATLAS has been formed, Argonne is on the list
  - We are already contributing to the strip CMOS efforts
  - Opportunity to join the Pixel effort, collaborating with USCS, Geneva and etc.
- Argonne has a good starting point
  - Starting with the pixel assembly effort
  - Lots of DAQ project for ATLAS phase II

Sensor -> PIXEL/strip CMOS testing setup ->  
Caribou system-> FILEX -> Hardware Trigger

- Pushing for possibility to industrialise the production
  - reduce the cost



# CMOS R&D

- **Why is Argonne the Place to Do the Work/Development?**

- We are one of the two Labs in US which is going to do the pixel module assembly for the ATLAS Phase II upgrade
- We have experts on detector R&D
- Ongoing cooling and DAQ project for ATLAS Phase II upgrade
- Accessible resource at Fermilab

- **Is there a benefit to HEP?**

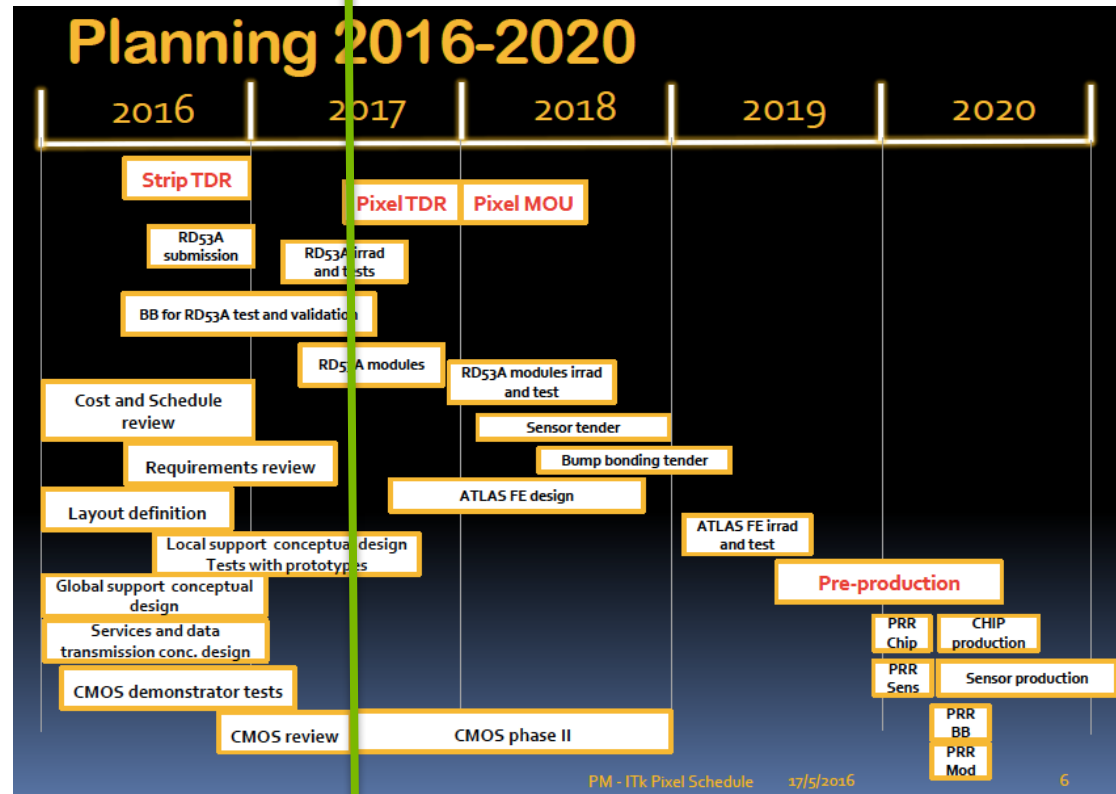
- Future detectors will try to use low cost, low power and small granularity
- Experts on Si sensor and solid detector

- **Are there applications outside HEP?**

- Plenty, was first investigated by the industry and the interest keeps growing these years

# CMOS R&D

- Do you have a vision for evolving the idea from proof of concept to field application?
  - Summer 2017 for ATLAS Pixel upgrade
- Any idea how long this will take?
  - ~1.5 year production if CMOS get approved by ATLAS
  - Long term project for further detectors



# SWOT ANALYSIS OF IDEA

## OPPORTUNITY

- Does technology enable new scientific opportunities?
  - Less material and better resolution leads to higher precision and wider phase space that we can explore on colliders
- Can we significantly reduce a detector cost?
  - Yes. If we can industrialise

## WEAKNESSES

- What are we lacking to perform the work?
  - Experience on Si sensor R&D

## STRENGTHS

- What advantage does Argonne have to perform the work?
  - Full chain testing from sensor to DAQ
  - Supporting structure construction project -
    - > Cooling system
  - Experts on DAQ

## THREATS

- What's the competition?
  - Planer sensor, 3D and etc.
- What might be a “show-stopper”?
  - Only for short term project: ATLAS does not support CMOS for phase II production
- What if the idea doesn't work out?
  - Several experiments planed in the future