# 4D Tracking @ SLAC

- Pioneered the **High Granularity Timing Detector** (HGTD) at ATLAS
  - Designed the 20ps TDC of the ASIC chip (**Bojan Markovic**)
  - HGTD Physics and Simulation convenership for 6 years (**Ariel Schwartzman**)
- Currently investigating **4D tracking** detectors for future HL-LHC upgrades beyond Run 4, and future colliders
  - https://cds.cern.ch/record/2870326
- Expertise  in designing pixel front-end ASIC with both TDCs and ADCs for various applications.
  - Recent examples of timing circuits include **TDC designs for high-energy physics, ultra-fast photon science, and biomedical imaging, and ADC designs for high-energy physics and photon science**
- Within DOE's HEP Detector R&D program funding, we developed a **TDC architecture in 28nm CMOS capable of reaching 6.25ps timing resolution within core area of 45μm x 20μm** and average power consumption of 18.4 μW for 10% occupancy (2.9 μW for 1% occupancy)

# RDC3 plans
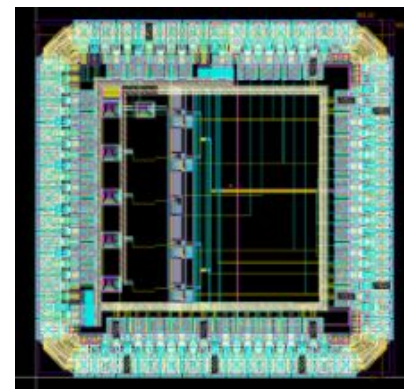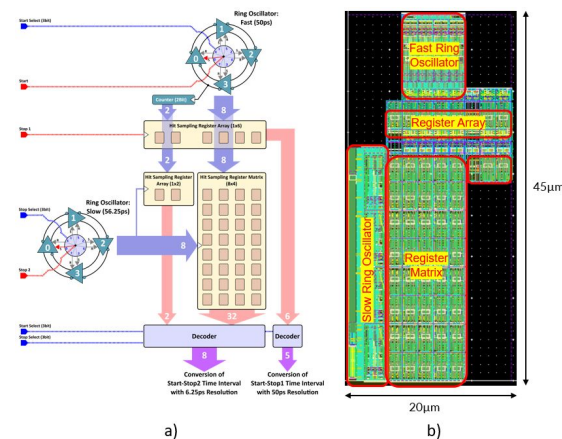
- DOE's HEP Detector R&D program - SLAC project focused on development of **electronics for 4D in 28nm node**:

  Abstract submitted
  - Sub-10ps TDC (**Bojan Markovic**)
  - Constant fraction discriminator (CFD) (**Victor Turbiner, EE Ph.D student**)
  - ADC (**Aldo Pena Perez**)

- DOE's Accelerate Innovations in Emerging Technologies - ***3D Integrated Sensing Solutions* project** (SLAC, Fermilab, LLNL)
  - Develop LGAD sensors in commercial 12" CMOS process and couple to dedicated front-end in 28nm with wafer-to-wafer bonding (**Julie Segal, Christopher Kenney, Lorenzo Rota, Bojan Markovic**)

  Abstract submitted

- **Physics, simulation, and detector optimization**
  - HL-LHC 4D tracking upgrade and future Higgs Factories and high energy colliders (**Ariel Schwartzman + students)**
  - 4D Clustering/Seeding/Tracking algorithms and physics event reconstruction
  - Synergies with 5D calorimetry