

# Jennifer Sibille (ESR)



Start date: 01 April, 2009

Home Country: USA

## Education Background:

- BS in Physics and Mathematics, May 2006
  - Louisiana Tech University, Ruston, LA, USA
- MS in Physics, December 2008
  - University of Kansas, Lawrence, KS, USA
    - “Charge Collection Efficiency Measurement of CMS Pixel Detector”

# Jennifer Sibille

PAUL SCHERRER INSTITUT



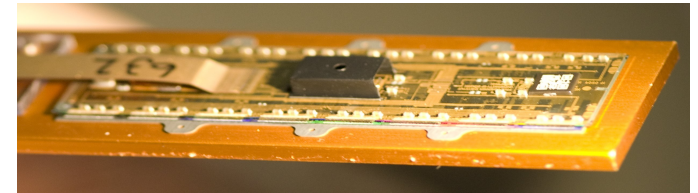
## Present Status:

- Institute: Paul Scherrer Institut (PSI), Villigen, CH
- Project: P2 Hybrid Pixel Detectors
- Supervisor: Dr. Tilman Rohe
- University: University of Kansas, Lawrence, KS, USA

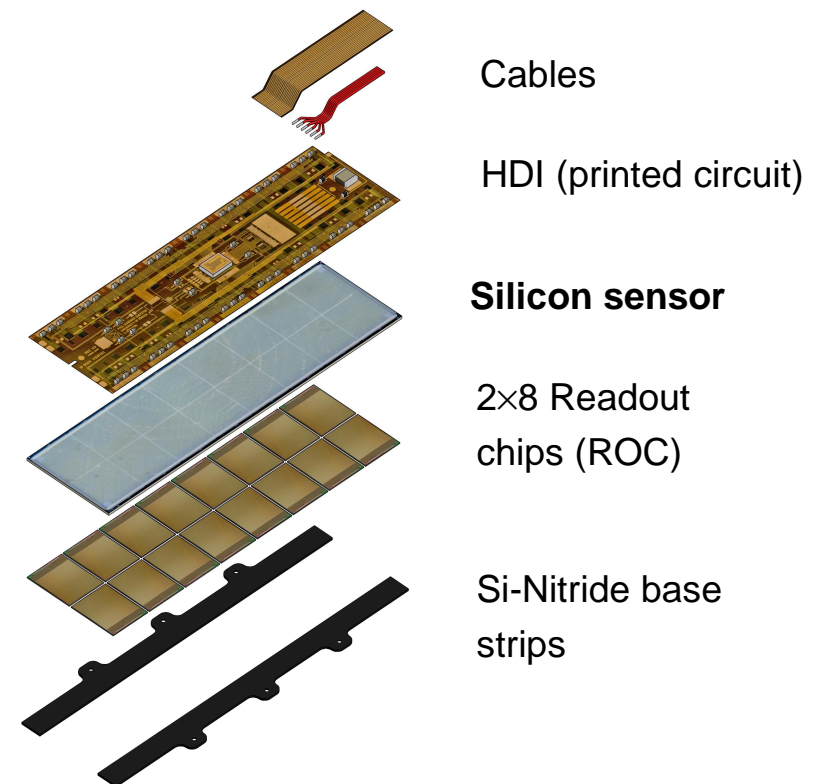
Thesis adviser: Dr. Alice Bean

# Project Overview

- Motivation: Tracking detectors at LHC and X-FEL are exposed to large radiation doses which degrade performance after a few years
- Project Focus: Cost-effective and radiation-hard hybrid pixel detectors using standard components
- First step is to understand operational limit of current detectors
  - Measurements and simulations of the degradation of sensors as a function of integrated fluence



CMS barrel pixel module



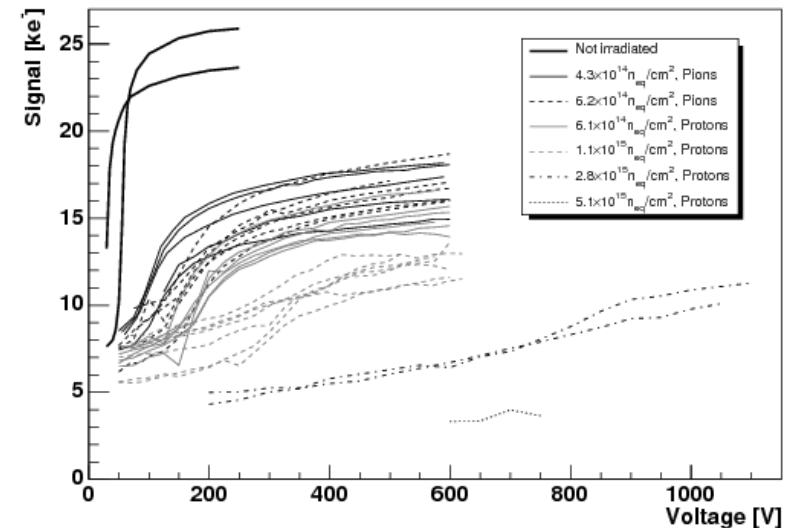
Exploded view

# Charge Collection Efficiency (CCE)

- With radiation damage, charge is trapped by defects in silicon
  - > Get smaller signal
- Test samples irradiated up to fluence of  $5 \times 10^{15} \text{ n}_{\text{eq}}/\text{cm}^2$  to see how much charge is lost
- Sr-90 source
- Find that even at high fluences, we can collect a significant charge if we use a high bias voltage



Cold box for testing irradiated samples



Collected charge vs. bias voltage for samples irradiated to different fluences

# Interpixel Capacitance

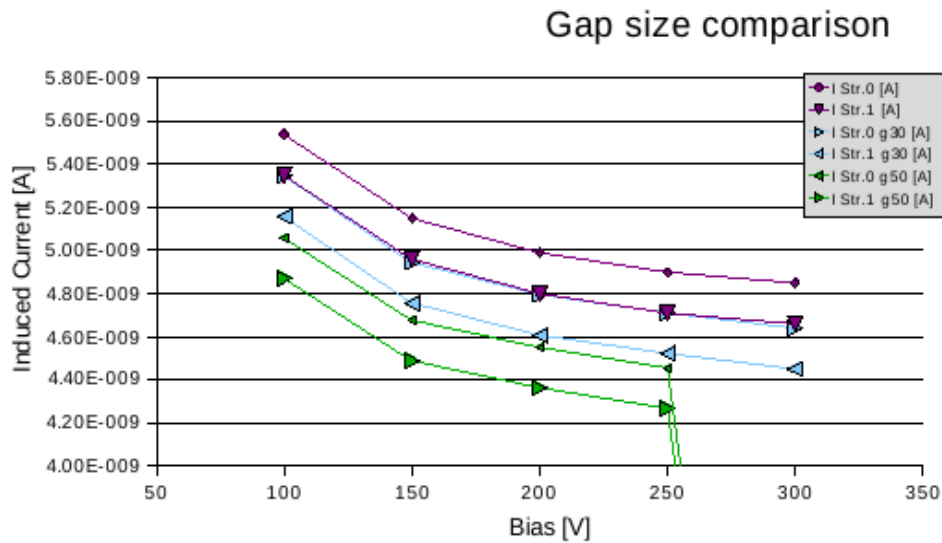
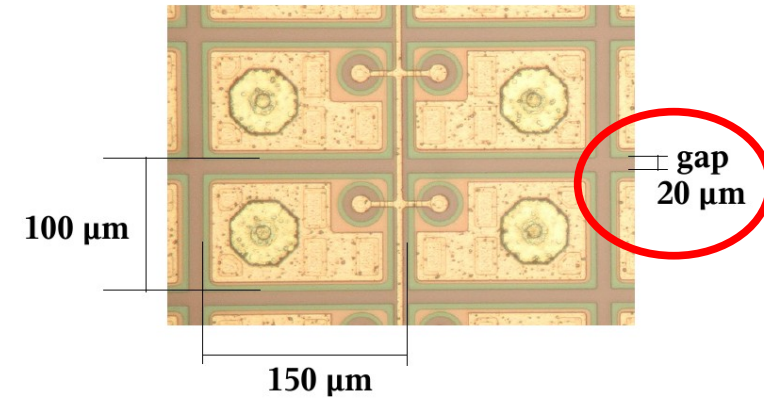
Capacitance is related to noise, time-walk, cross-talk

Trade-off between low capacitance and small gap

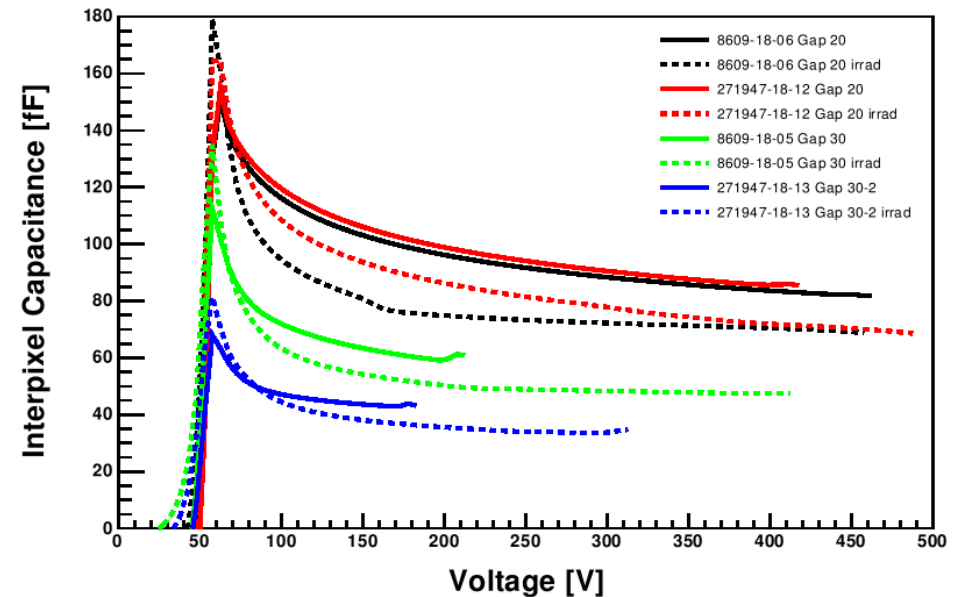
New method to measure capacitance

Trend of measurements is reproduced in simulations

Different scaling, work to match scaling ongoing



Simulation of interpixel capacitance for different geometries



Measurement of interpixel capacitance for different geometries and fluences

# Single-sided sensors

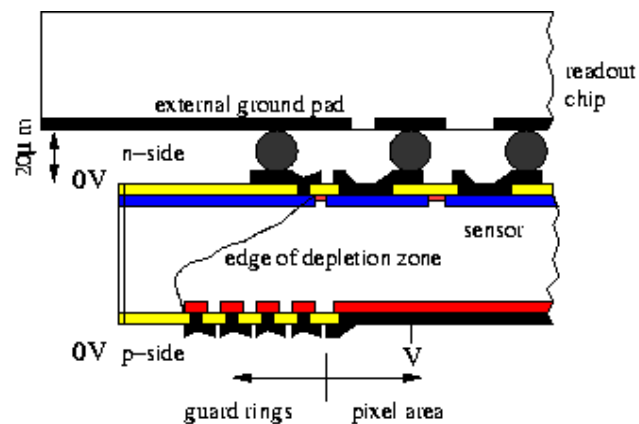
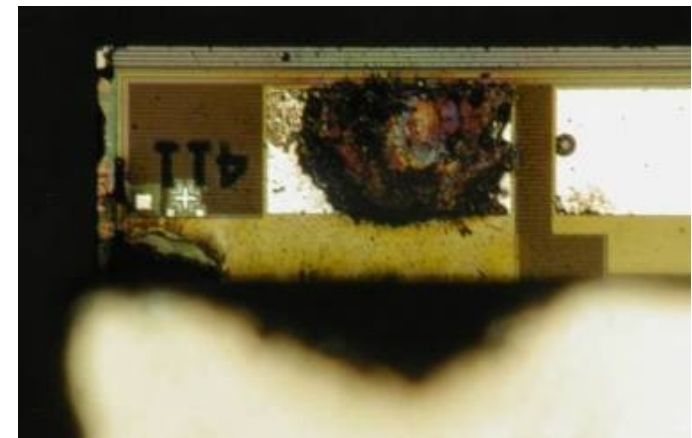
Apart from bump-bonding, sensors are most expensive part of detector -> try to reduce costs

Single-sided processing cheaper (factor 2-3!)

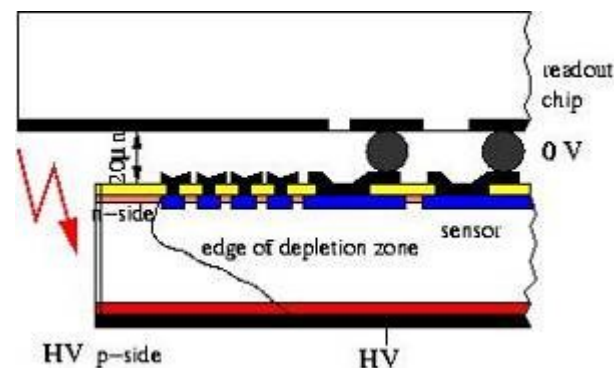
BUT edges of chip remain at high voltage in single-sided sensors

- Risk of sparking to readout chip (ground)

Need a cheap and reliable method to prevent this problem in order to be feasible



Double-sided



Single-sided

Maybe can cover edges with another material to prevent sparking?

- Tried two different glues (Araldit and EPO-TEK 301) without success

Next steps:

- Try another glue (EPO-TEK 302)  
- Chemical vapor deposited polymer

# Milestones and Deliverables



- First milestone and deliverable achieved
  - P2-M1 Definition of Specifications (m6)
  - P2-D1 Simulation of signal response and electrical properties (m12)
  - Related documents can be found under “Projects” here:
    - <http://mc-pad.web.cern.ch/mc-pad/>
- Upcoming milestones and deliverables
  - P2-M2 Sensor layout (m24)
  - P2-D2 Final detector characterization (m36)

# Overview of Training



## Network training events

- Detector readout electronics (Krakow, Poland, Sept 2009)
- Detector simulation and data analysis (Hamburg, Germany, Jan 2010)

## Other technical training

- XI ICFA School on Instrumentation in Elementary Particle Physics (San Carlos de Bariloche, Argentina, Jan 2010)
- Attended course "Statistical Methods and Analysis Techniques in Experimental Physics" at ETH Zurich, Spring 2010
- PSI Summer School on Particle Physics - "Gearing up for LHC Physics" (Zuoz, Switzerland, Aug 2010)

## Education/Outreach

- Help supervise US students at PSI as part of PIRE program

## Complementary training

- German language courses, beginner through level B1



# Presentations and Publications



- V. Radicci, T. Rohe, J. Sibille, Sensor optimisation for the upgrade of the CMS pixel barrel, Presentation given at 14<sup>th</sup> RD50 Workshop on Radiation hard semiconductor devices for very high luminosity colliders, Freiburg, Germany, 3-5 June 2009, <http://indico.cern.ch/contributionDisplay.py?contribId=9&sessionId=0&confId=52883>
- V. Radicci, T. Rohe, J. Sibille, Design of CMS Pixels for an LHC Upgrade, Poster presented at 1<sup>st</sup> MC-PAD Network Training Event in Krakow, Poland, Sept 2009, and at ICFA Instrumentation School in Argentina, Jan 2010
- T. Rohe, J. Acosta, A. Bean, S. Dambach, W. Erdmann, U. Langenegger, C. Martin, B. Meier, V. Radicci, J. Sibille, P. Trub, Signal height in silicon pixel detectors irradiated with pions and protons, Nucl. Instr. and Meth. A, Volume 612, Issue 3, Proceedings of the 7th International Conference on Radiation Effects on Semiconductor materials, Detectors and Devices - RESMDD 2008, 11 January 2010, Pages 493-496, ISSN 0168-9002, DOI: 10.1016/j.nima.2009.08.012.
- T. Rohe, A. Bean, W. Erdmann, H.-C. Kastli, S. Khalatyan, B. Meier, V. Radicci, J. Sibille, Radiation hardness of CMS pixel barrel modules, Nucl. Instr. and Meth. A, In Press, Corrected Proof, Available online 2 April 2010, ISSN 0168-9002, DOI: 10.1016/j.nima.2010.03.157.