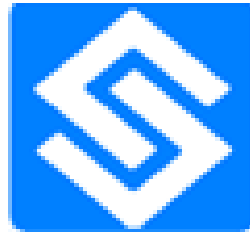
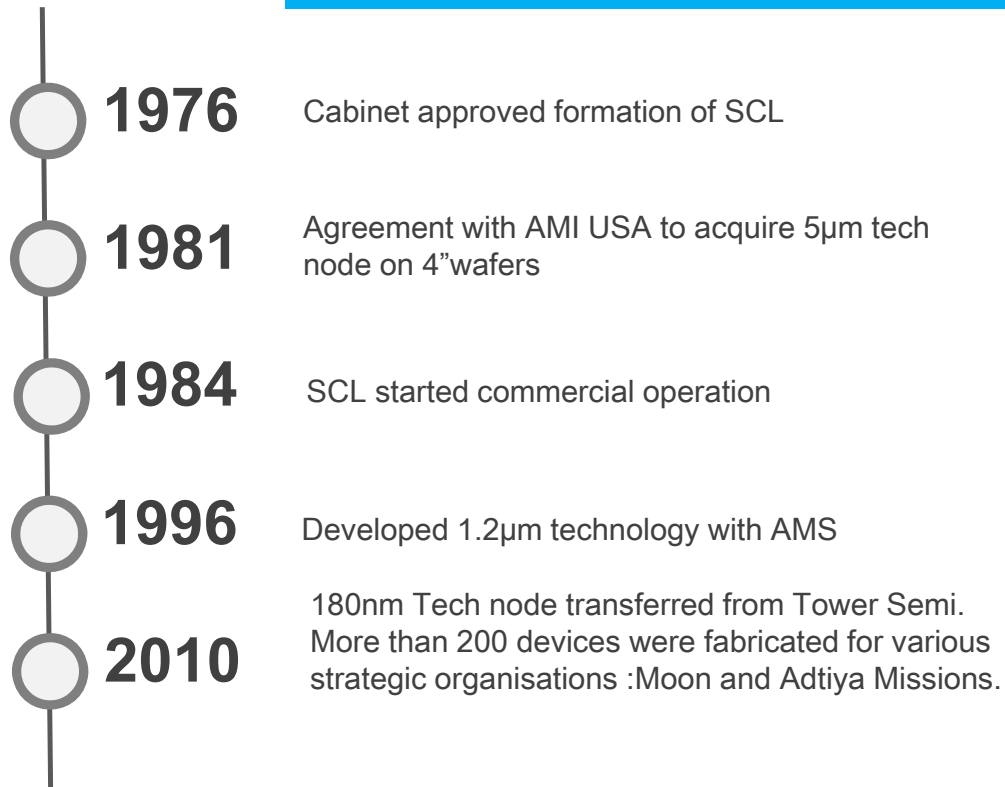


SEMI-CONDUCTOR LABORATORY: CAPABILITIES OVERVIEW

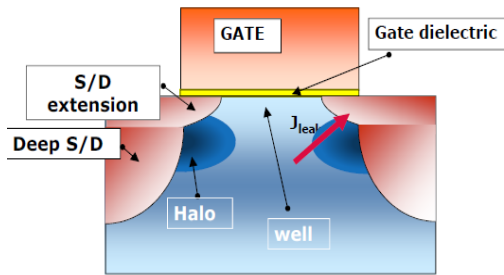
Kamaljeet Singh



Brief History

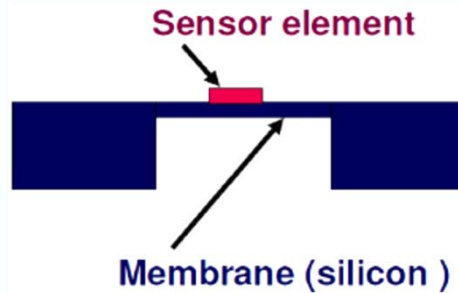


Fab-lines



8" Wafer Fab-line with 180 nm CMOS technology for VLSI

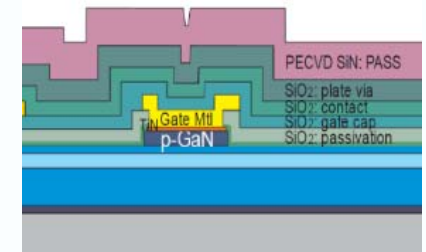
- Digital , Analog and Mixed Signal
 - Charge Coupled Devices
 - RADHARD Capability Developed
- 72 Equipment (Process & Metrology)



6" Wafer Fab-line dedicated to MEMS & Detectors Fabrication

- Silicon Technology
- Support for III-V devices

44 Equipment
(Process & Metrology)

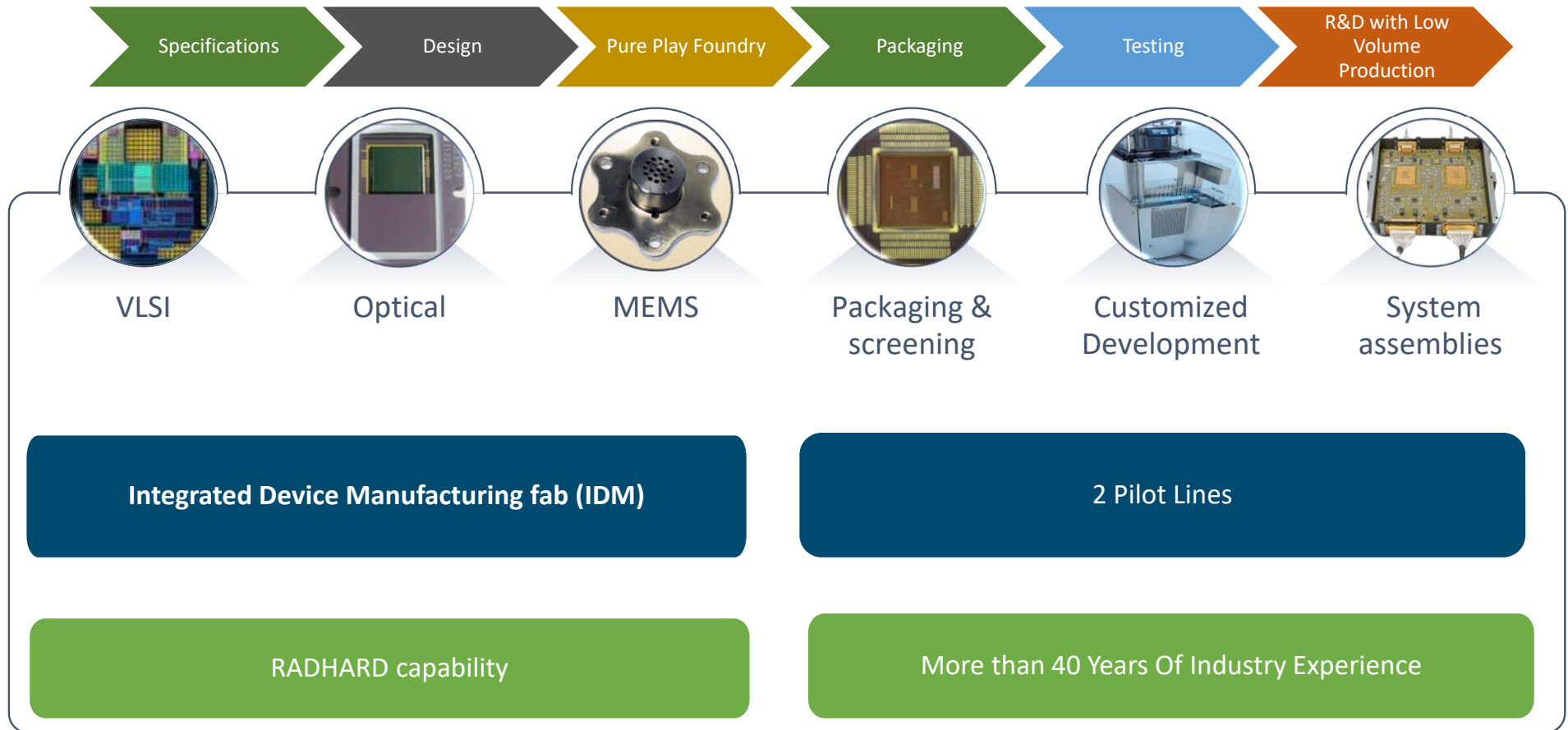


6" GaN on Si Technology :

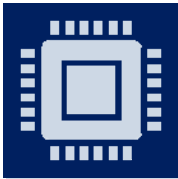
- Epitaxial growth of III-V
 - GaN on Si – Power HEMT e-Mode device for 200V and 650V
- 15 Equipment
(Process & Metrology)

SCL 180 nm CMOS fab is qualified as per JDEC JP001A guidelines

Integrated Device Manufacturer



Product Portfolio



CMOS (8")

- ANALOG/DIGITAL/ MIXED SIGNAL
- RF CMOS
- LOGIC
- HIGH VOLTAGE (R&D)
- RAD HARD



IMAGERS

- CCDs
- PHOTOMULTIPLIERS
- X – RAY DETECTORS
- CMOS SENSOR (R&D)



III – V (6/8")

- E-MODE HEMT (R&D)
- D-MODE HEMT (R&D)



MEMS (6")

- PTH SENSORS
- ACCELEROMETERS
- DETECTORS
- CMOS MEMS

Backend & Turnkey Solutions



Design Services

Design Enablement

Foundry Portfolio

Foundry Solutions

Backend Solutions

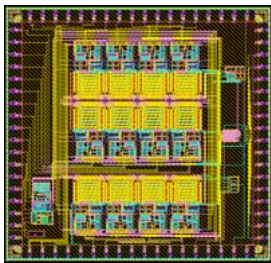
Turnkey Solutions

- **Package Solution Development**
- **IC Test Program Development**
- **IC Testing– ATE, Semi-ATE, MEMS**
- **Material Testing**
- **Modelling of Process, Device & Systems**
- **Prototyping/ Shuttle**
- **Mask design**
- **System Development Kits (Education)**



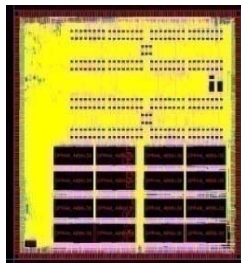


Analog



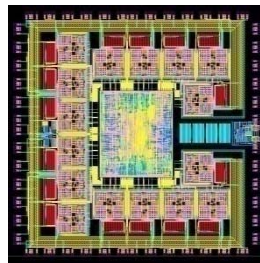
- ✓ ADC
- ✓ LDO
- ✓ DAC
- ✓ C-to-D
- ✓ Programmable bias generator

Digital



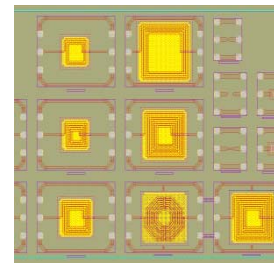
- ✓ Processor
- ✓ SPI
- ✓ CMOS Camera Configuration
- ✓ SADA ASIC
- ✓ CHC ASIC

Mixed Signal



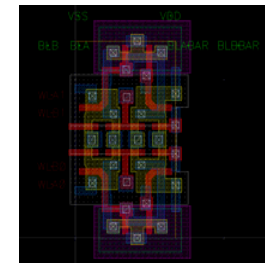
- ✓ Multi-core RDAS
- ✓ On-Board Controller
- ✓ Event Triggered
- ✓ DAS

RF



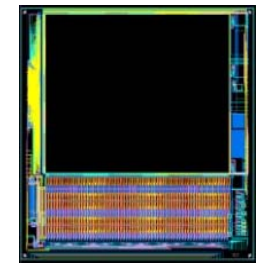
- ✓ Inductors
- ✓ VCO
- ✓ LNA
- ✓ Mixer

Memory



- ✓ 2 MBit, Synchronous SRAM
- ✓ 256K Bits, 32K X 8 Asynchronous SRAM
- ✓ DUAL PORT SRAM 4K x 8

Imaging



- ✓ Read Out Integrated Circuit (ROIC)
- ✓ Frame Transfer CCD imager
- ✓ Visible CCD TDI Imager

Sensors & Photo Diode



Physical Sensors/Actuator



- ✓ Pressure Sensor
- ✓ Temperature sensors
- ✓ Humidity sensor
- ✓ Acoustic Sensors
- ✓ Micro-thruster
- ✓ Micro-valve

Inertial Sensors



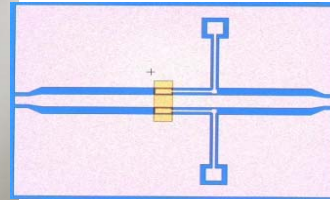
- ✓ Accelerometers
- ✓ Shock sensors
- ✓ G-switch
- ✓ Gyroscopes

Bio Medical Sensors



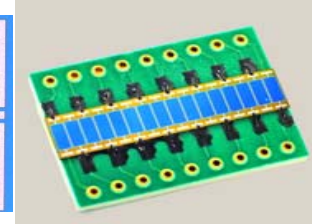
- ✓ Bio-Impedance Sensors
- ✓ Blood Cancer detectors
- ✓ Glucose Sensing

RF MEMS



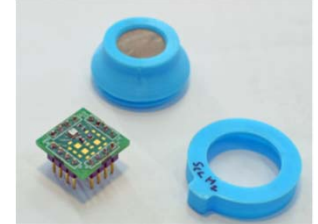
- ✓ RF Switch
- ✓ RF Antenna
- ✓ Varactor
- ✓ RF Filter

Photo Detectors



- ✓ Particle detectors
- ✓ Photo diode

Chemical Sensors



- ✓ Gas Sensor
- ✓ Cantilever based gas sensing

Moore & More...



Approaches at SCL

Method 1 (Integration on a chip)

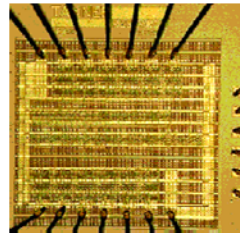


❑ Silicon On Chip (SOC)

1. Silicon



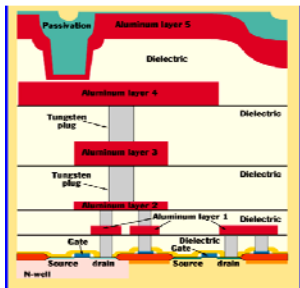
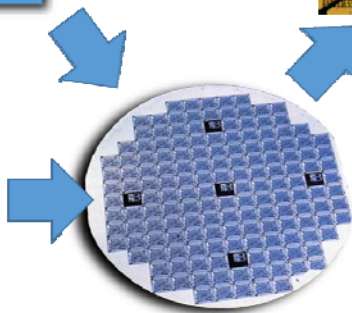
3. Chip



4. Product



2. Wafer

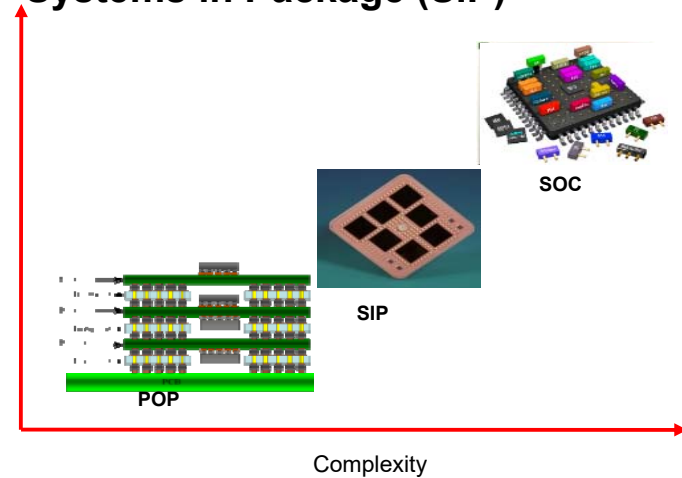


Method 2: Packaging (Technology independent)

Packaging Solutions @SCL

- 3D packaging
- Package on Package (PoP)
- Multi Chip Modules (MCM) (TRL9)
- Systems in Package (SiP)

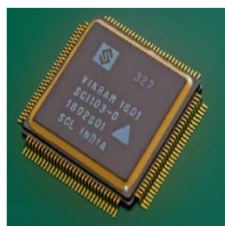
Lead Time



Packaging



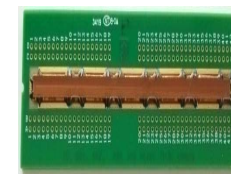
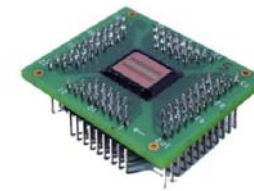
Ceramic



Metal



COB





- Varied sizes & technology nodes

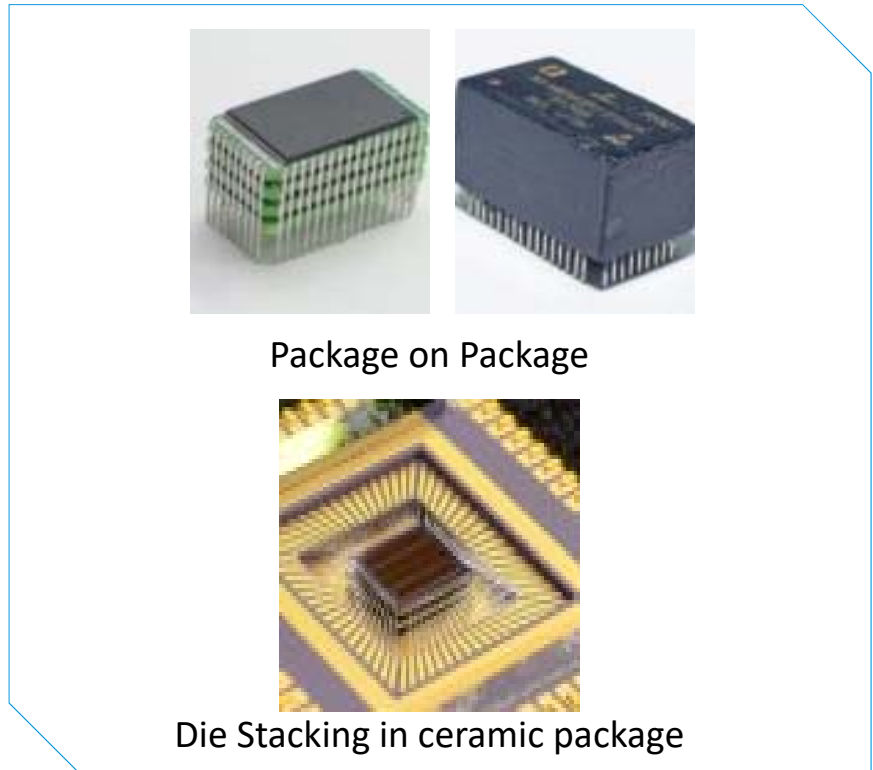
Multiple Power supply voltages

MULTICHIP MODULE

3D PACKAGING



2 Die MCM : 181 CPGA



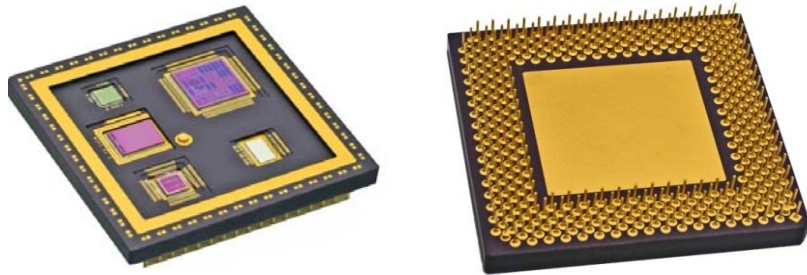
Package on Package

Die Stacking in ceramic package

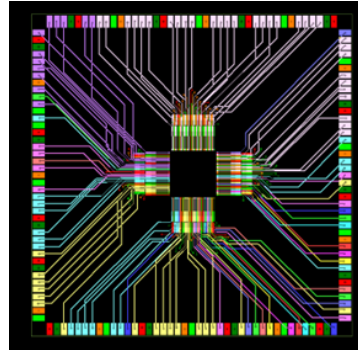


5 die MCM : 370 CPGA

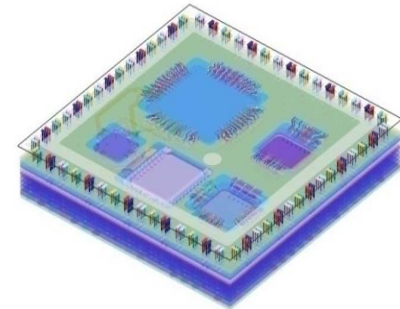
Capabilities



CPGA for 5 die MCM (SiP)



CQFP

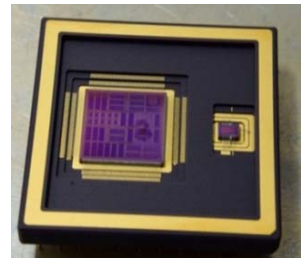


MCM Package simulation
(SI and PI Simulations)



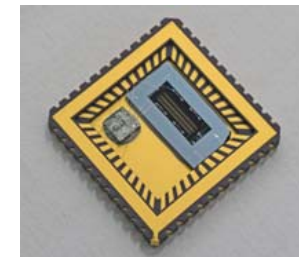
COB

(109mm long die, 400 wire bonds on short ends)



2Die MCM

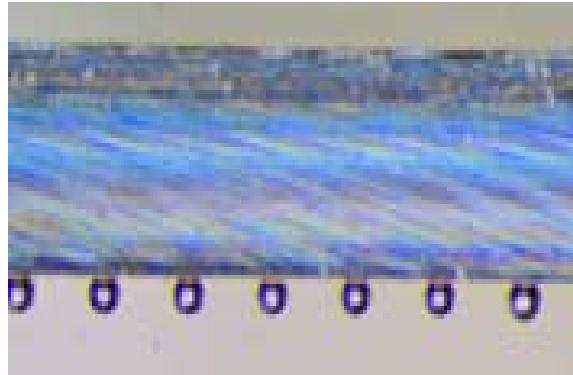
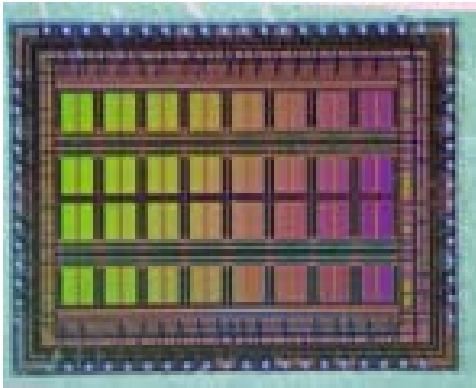
(16 layer 181 CPGA ,370 wire bonds)



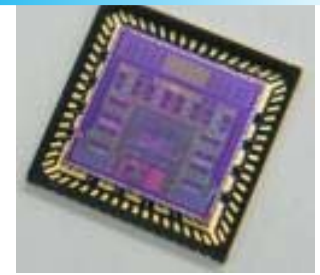
Accelerometer

Plastic Packaging

- CMOS Devices in Plastic Package
- Reduction in size & weight
- Flexibility of varied pin count
- Cost effective



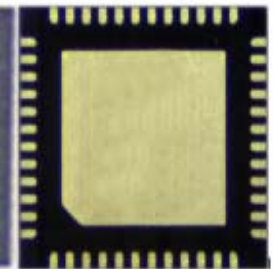
Die after bumping



PQFN64 (9mm x 9mm)

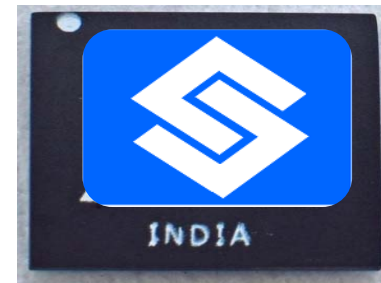


Top View

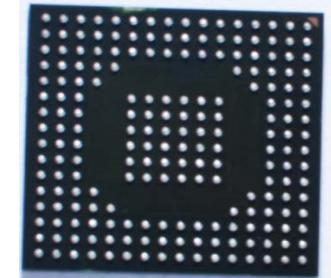


Bottom View

ADC-CQFP 64 to PQFN 48 (6mm x 6mm)



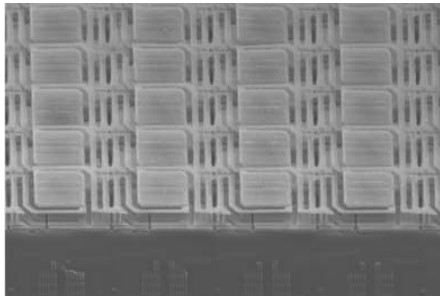
ASIC in PBGA168



CMOS-MEMS INTEGRATION

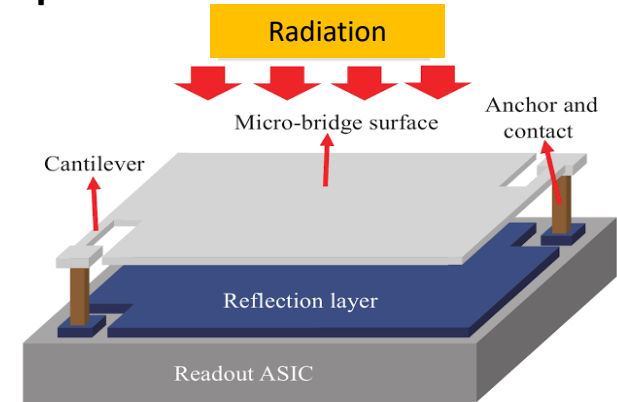


Integration of CMOS-MEMS wafers using CMOS-compatible process

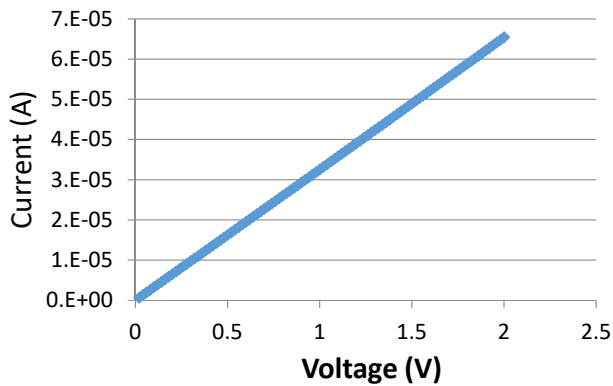


SEM Image of Released Structure

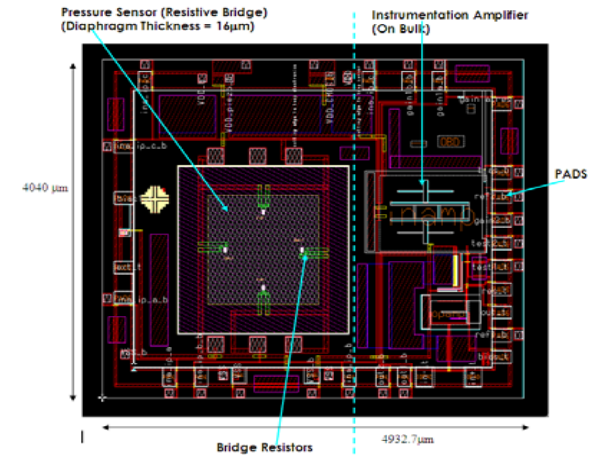
- 640x480 array
- Top Layer : Thin film
- Hanging structure



Schematic



Integrated Pressure sensor



SCL uniqueness: End to end realization and delivery



37mm x 31mm



$\phi 21\text{mm}$



$\phi 12\text{mm}$



$\phi 9\text{mm}$



$\phi 6\text{mm}$

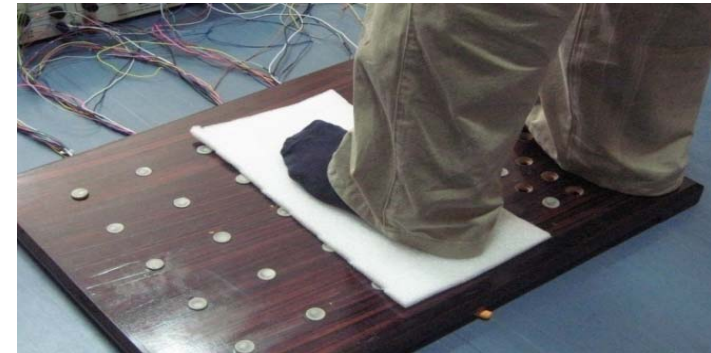


$\phi 3\text{mm}$

Evolution of Pressure Sensor Package



MAP/TMAP Sensor



Diabetic foot mapping

Spin off



Semi-Conductor Laboratory
Ministry of Electronics and Information Technology (MeitY)
Government of India.

| Pressure | Temperature | Time |
|------------|-------------|--------------|
| 977.0 mbar | 20.8 °C | 16:20:05 |
| 14.2 psi | | |
| 97.8 kPa | 69.4 °F | |
| 733.3 Torr | | Date |
| 0.965 atm | 293.9 K | Feb 26, 2024 |

Pressure sensor

24-Bit ADC SC1218

Temperature sensor

USB Port

Pressure/Temperature Sensor

Semi-Conductor Laboratory
Ministry of Electronics and Information Technology (MeitY)
Government of India.

SCL INCLINOMETER

| | X-Axis | Y-Axis | Z-Axis |
|------------------|--------|--------|--------|
| Tilt (Degrees) | 3.5 | 7.7 | 8.5 |
| Acceleration (g) | 0.06 | 0.13 | |
| Capacitance (pF) | 0.13 | 0.29 | |

Inclinometer/Tilt Sensor

Customized Products



Combination of various processes/technologies

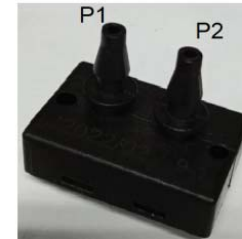
Customization as per the requirements

Vacuum packaging to achieve Q-factor (~ 1000)

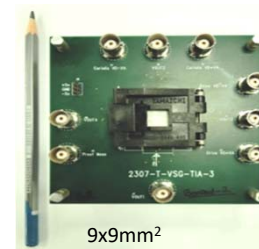
Miniaturized application board

Heater on flexible substrate

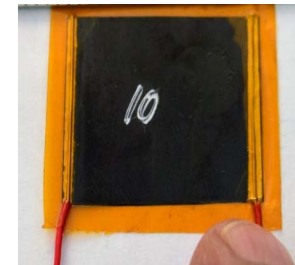
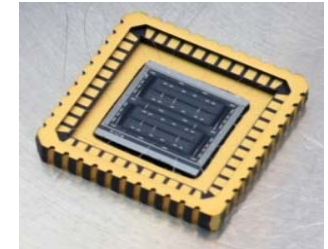
Combination of sensors



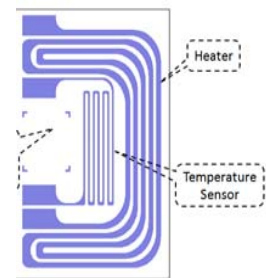
Thermal Flow Sensor



Gyro

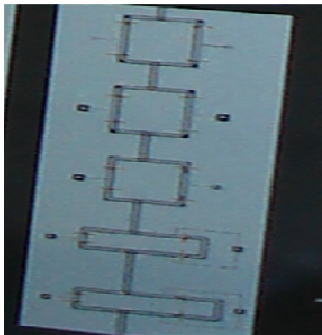
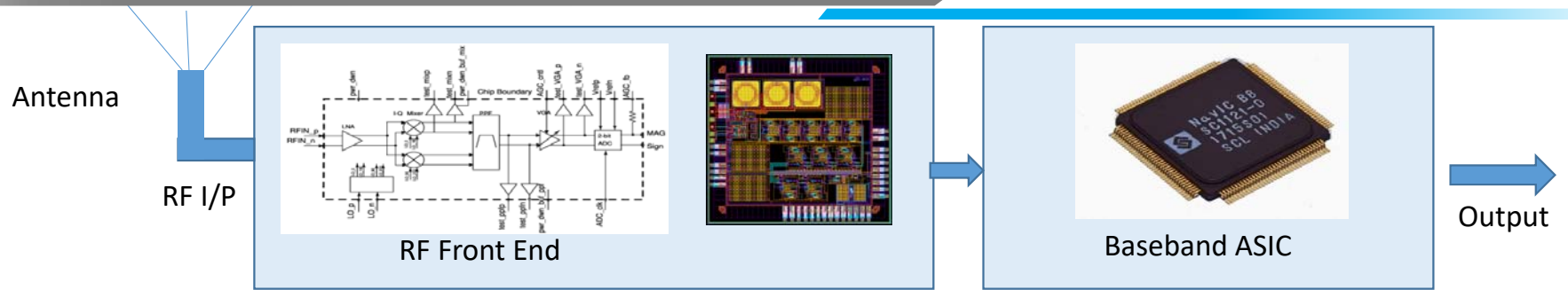


Flexible Heater

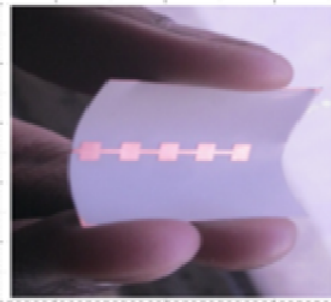
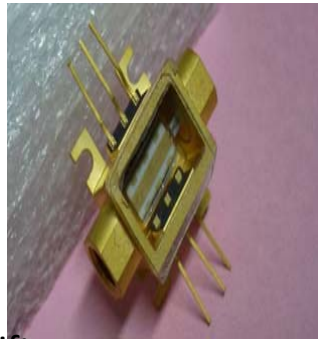


Heater & sensor

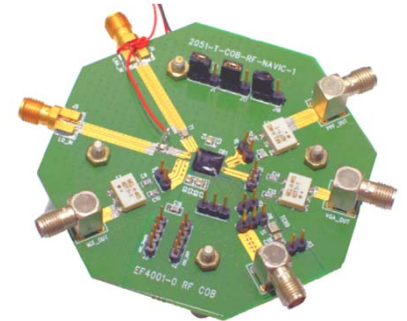
RFIC & RF Devices



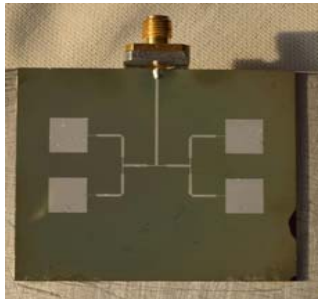
Phase shifter



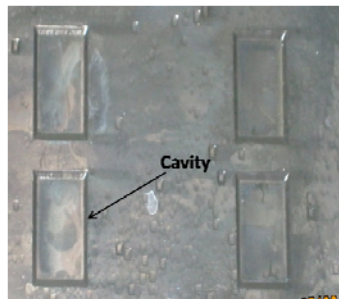
Flexible antenna



Chip on Board for Testing



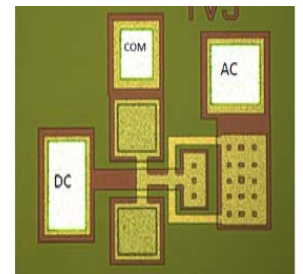
Top & Bottom



Cavity



Human Phantom



Varactor

PRODUCTS FOR MEDICAL TECHNOLOGY (MedTech)



Device

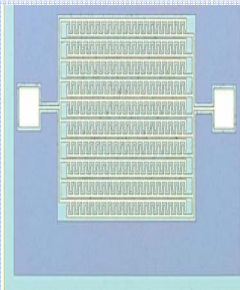
Sensor Image

Collaboration

Brief Specifications

Remarks

Capacitive Sensor for detection of Cancer in White Blood Cell (WBC)



Academia

Nominal capacitance is of 5 pF at 20 KHz of frequency which reduces to 4.2 pF at 5000 KHz

- Detects the malignancy in Leukocytes of Human blood sample.
- Provides a quick time saving measurement with early detection of cancer compared to conventional clinical detection.

Bio Impedance Sensor for Catheter



Hospital

Impedance range : 1 – 10,000 kΩ with frequency sweep up to 100 kHz.

Measures electrical Impedance of mucosa cells of esophagus, for detection of GERD (Gastro-Esophageal Reflux Diseases)

Pulse Oximeter



DOE

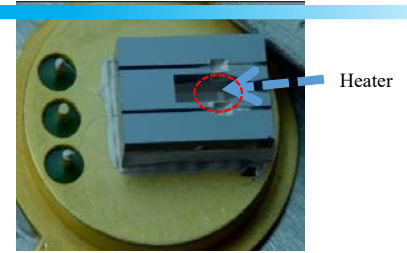
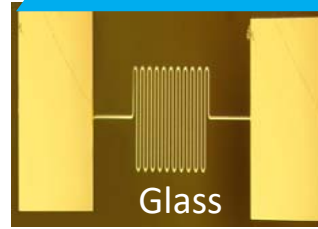
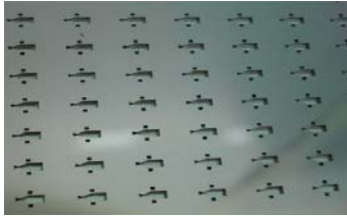
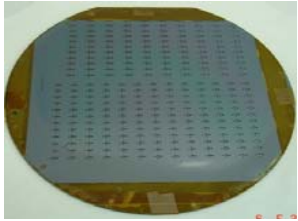
Oxygen Saturation (SaO₂): 0-100%

Pulse Rate (BPM):: 30-240 bpm

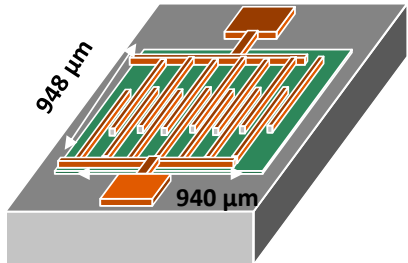
Tend Data Storage Capacity up to 100 Patients / 24Hrs Runtime



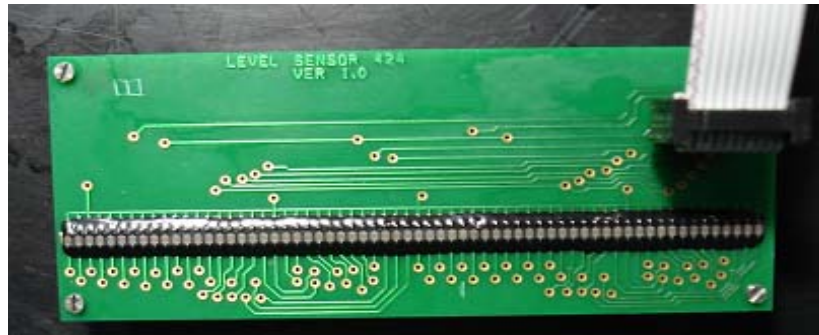
Concept to Implementation



Interdigital Capacitor



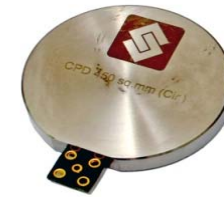
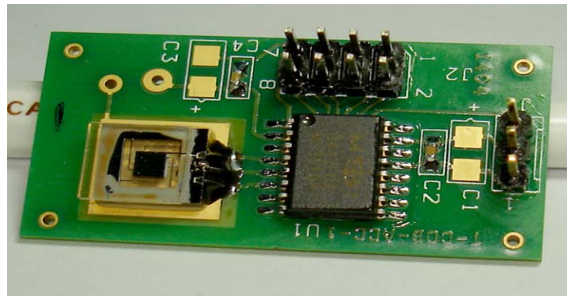
Si Chamber with embedded heater



Liquid level sensing



Accelerometer



Particle monitoring



Multiplexed Analog Signal Processor - MANAS ALICE Experiment – CERN, Geneva (2007)



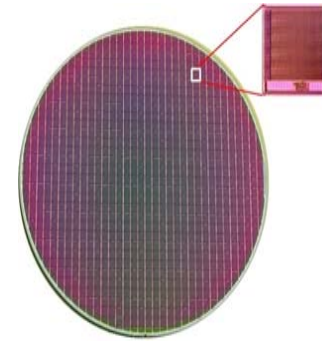
- Front End- SINP, Kolkata
- Backend Design in SCL
- 1.2 μm N-well CMOS Technology

Large scale production of a mixed signal ASIC

Total qty: 1,10,000

- 88,000 for Dimuon Spectrometer
- 88,000 for Photon Detector

Radiation Hardened LDOs RH - Low Dropout Voltage Regulators



- 1.2V and 1.8V Output
- 1.6A Full load
- 3.3V Supply



Chip-on-Board

- Device 1 - 1.2V/1.6A
- Device 2 - 1.8V/1.6A

Delivered a total of
30,000 dies to
GSI, Germany

Summarization



- **Unique IDM with CMOS & MEMS foundry**
- **R&D with emphasis on reliability**
- **In-house packaging, testing & quality assurance facility**
- **Quality products for niche sectors & international institutions**
- **Flexibility in process design**
- **Design expertise of varied domain**
- **Complete turnkey solution provider**

THANK YOU ALL

