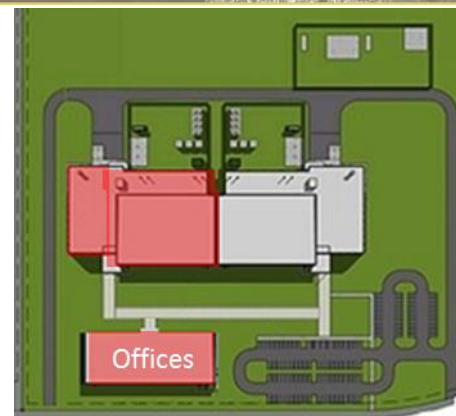




**BRIDG is an industry-friendly not-for-profit consortium for the manufacturing of advanced smart sensors and imagers - formerly known as**



- + **BRIDG** will drive manufacturing innovation through advanced materials, processes, and equipment for next-generation sensors, imagers, and integrated devices for a wide range of products
  - Including device designs, PDKs, and pilot-line production capabilities
  - 200mm platforms (300mm capable) with involvement by a broad set of supply chain companies
  - Programs and technology development opportunities to attract substantial global industry and government participation
- + **Site and Facilities**
  - Phase I state-of-the-art 109K sq. ft. Fab/Lab on 20-acre site
  - 500-acre master site High-Tech campus in Osceola County (NeoCity)
    - ➔ **Land available to companies that want to co-locate**
- + **Florida Funding (\$250M Initial & \$10M/yr CAPEX, \$5M/yr OPEX)**
  - Osceola County, University of Central Florida, Orlando EDC, State of Florida, Florida High Tech Corridor Council (Economic Development Initiatives w/UCF/USF/UF/FIU)



**Start-up Phase: Engage industry and define initial technology programs.**

**Phase I: Optics and Photonics Systems & Design Center**

**Phase II: Purchase & Install core tool set**

**Phase III – Install additional tool sets for specific device integration and support of industry driven program initiatives**

**Phase IV  
Launch complete production pilot line - capabilities to include US industry & DOD “Trusted Foundry” operation**

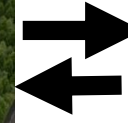
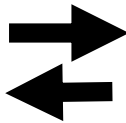
*Phases To Move Left  
Based on Industry Demand  
& Funding*

Begin Tool Installs



2015    2016    2017

### University/Lab Research



### Industry



#### CONCEPT:

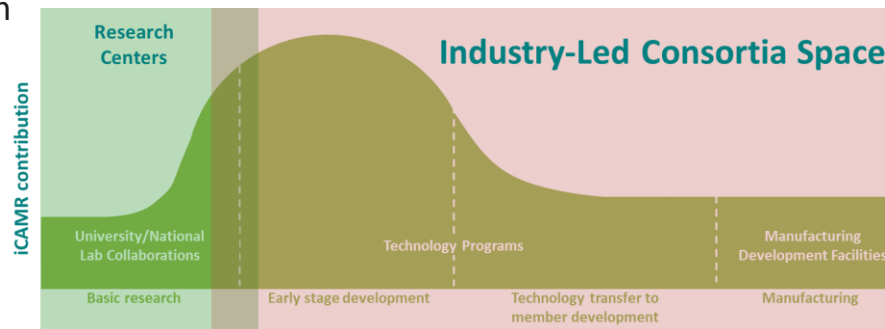
- Creative Ideas
- Centers of Excellence
- Novel Techniques & innovative technologies
- Fundamental Research
- Intelligence

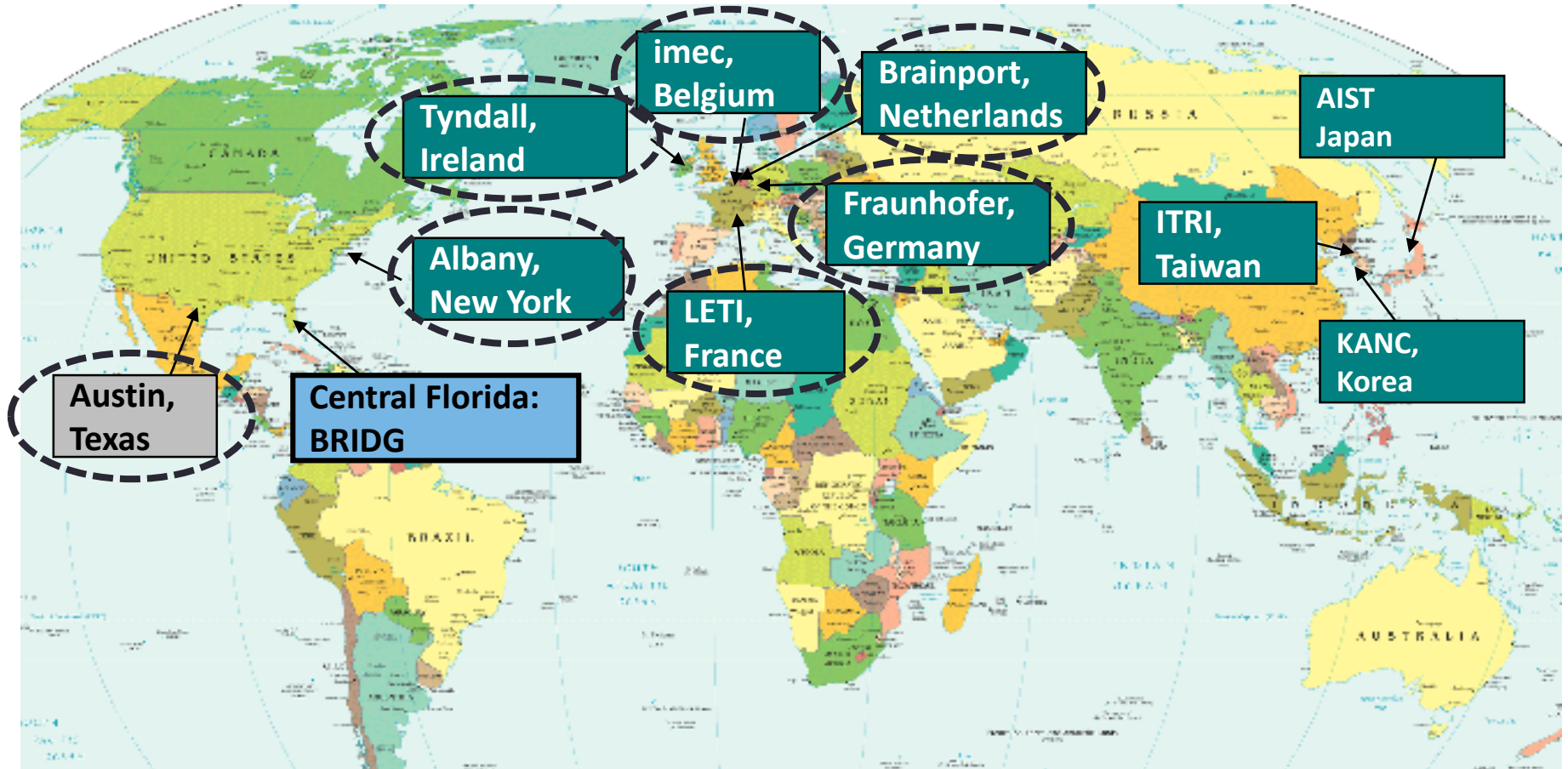
#### BRIDG INTEGRATION:

- Accelerate high potential technologies into next generation products & systems
- BRIDG and partners develop and provide commercialization infrastructure
- Capability for proof of concept, custom development, pilot production
- IP Protection


#### COMMERCIALIZATION:

- Integration of advanced silicon based devices
- Sensors & Photonics
- Nanotechnologies
- BioMedical devices/products
- NEMS / MEMS
- Emerging technologies
- 3-D Integration / Packaging
- Advanced Imagers & Lasers
- Integrated Systems





**Legend:**

 - Renowned manufacturing development centers

 - Benchmarked centers for BRIDG

*Note: many other US and international technology Hubs being launched*

1.

## PHOTONICS & HIGH SPEED ELECTRONIC SYSTEMS & DESIGN CENTER

System designs and component integration for a wide range of advanced products

2.

## ADVANCED MATERIALS AND DEVICE DEVELOPMENT LINES

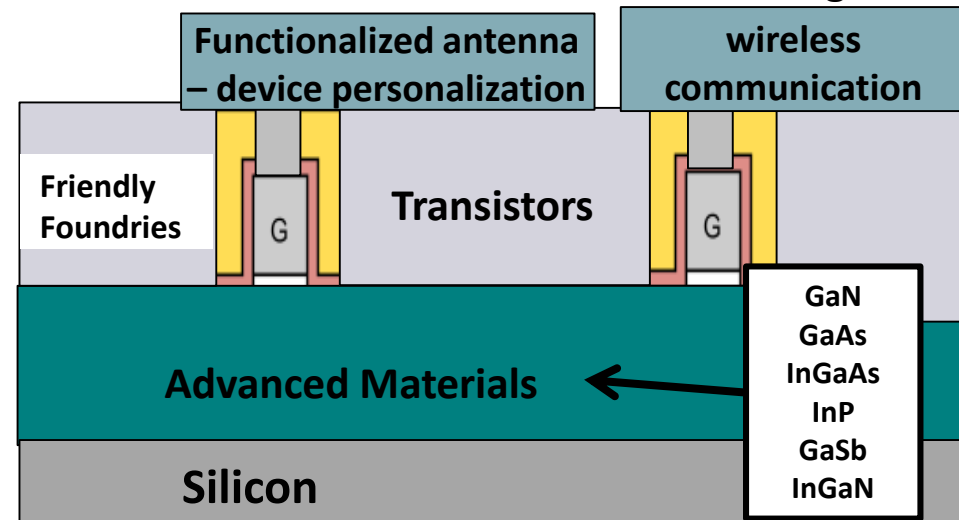
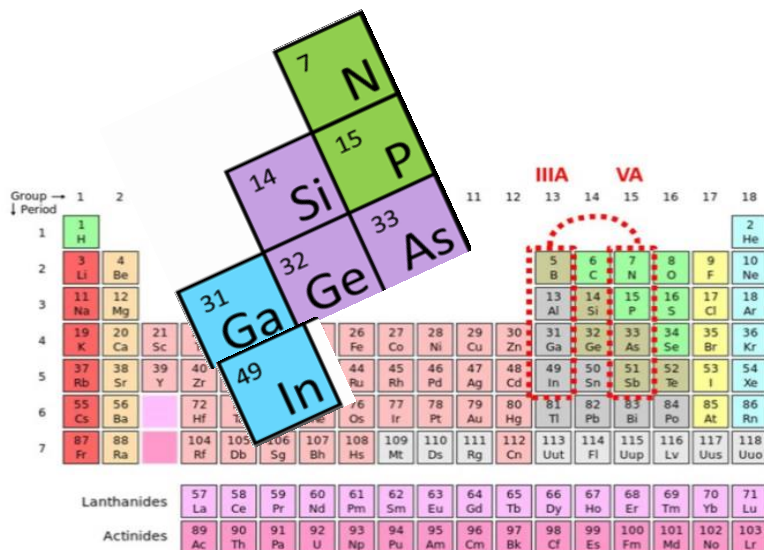
III-V and other novel materials integrated into Si based devices (CMOS, ASIC & Trusted Devices)

- *Sensors, Imagers, RF, Power, and other monolithically integrated devices*

3.

## 2.5/3-D DEVICE INTEGRATION, TEST & PACKAGING

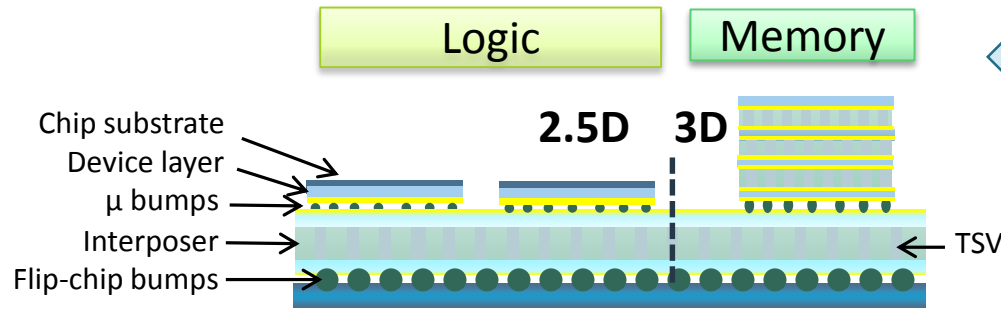
- Higher performance, systems
- Specialized test and packaging – advanced sensors and imagers



ICAMR Initial Technology Development Programs					
Short-Loop Flows		Technology and Product Development Areas			
A	Imagers	1) Initial imager Short-Loop flows will be for IR imager product development and Photon-X next generation imagers 2) Other Photonic Opportunities: THz, UV, Visible, SWIR, MWIR, LWIR, Multi-spectral, Hyper-spectral, VCSELs,...			
B	GaN on Si	Sensor based transducer, RF, & Power ( liquid sensors, absorption based eNose, Chemical sensing, Spectroscopy based sensing,...)			
C	2.5/3-D Interconnect	Heterogeneous Integration (Si, III/V, Photonics)			
D	Private Industry	Private industry partnership and technology transfer - ReRAM			
Markets and Applications					
	Aerospace, Defense, and Homeland Security	NanoMedical, Health, and Wellness	Environmental Food & Agriculture	Robotics Autonomous Systems Manufacturing Energy	Advanced Device Hardware & Software Integration IoT/Cybersecurity/Smart Communities/Entertainment
1	Airline Security - explosives gas	Wound evaluation kits	Air & Water quality monitors	Pattern Recognition imagers	<b>Develop and merge advanced devices with cloud computing and on-line service solutions</b>
2	Detecting concealed weapons	Home diagnosis kits	Toxic waste characterization	Proximity detection systems	
3	Detect chemical warfare agents	Bacterial fouling detection	Heavy metals monitoring	Vision guidance systems	Advanced Hardware - High performance sensors - Integrated photonics - Application specific devices
4	Non-destructive testing	Medical sterilization	Crop monitoring and control	Multisensor based dynamic auto-routing system	SMART communities, cities, homes, highways, energy,...
5	High-precision inspection	Airborne disease - Bio	Produce spoilage monitoring	Obstacle avoidance systems	Integrated hardware/software systems for government, industrial, and personal hacking prevention
6	Structural health monitoring	Airborne contaminants - air quality	Food contamination monitoring	Autonomous mobility design	Entertainment World - from park security to enhanced customer experience systems
7	Radiation detection	Heart condition monitors	Detect Phenolic compounds	Tactile sensors	
8	Hot objects (IR Missile plumes)	Cancer/Disease early warning gas sensors	Detect Pesticides / Herbicides	Advanced RF and power electronics	Energy optimization
9	Sonar imaging and sensing - Threat detection/evaluation	Implantable sensors - Medication release - Heart functions	Monitoring of farm & lab animal conditions	Methane gas image sensors for oil & gas point of operation monitoring	
10	"See through" threat detection imagers	Advanced Medical Analysis - Portable skin disease evaluation sensor	Precision farming - Localize treatment and control	Chemical imagers - Quality control	Continuous monitoring of chemical in industrial waste
11	Harsh environment sensors-process				
12	Surveillance imagers for offshore platform monitoring			Continuous monitoring of chemical in industrial waste	Precision infrastructure monitoring (see-through) e.g. weldings, construction parts of boats, planes, cars,...)
13					

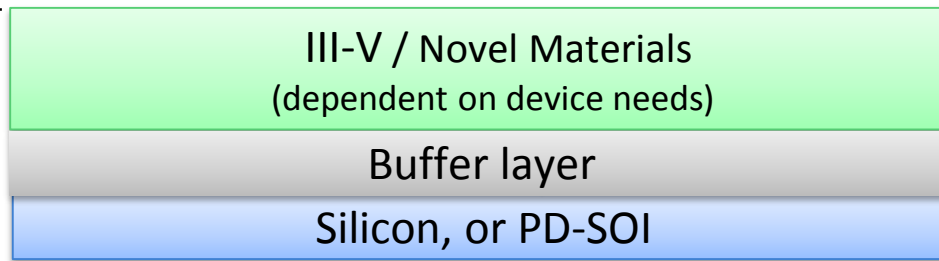
## Multi-Node (<22nm) CMOS, 3-D Integration Pilot-Line

BRIDG:  
Interconnect and  
Personalization  
“Trusted Foundry”



*Outsource: Transistor arrays - Specified / mixed CMOS nodes*

BRIDG:  
III-V on Si,  
or PD-SOI



Device / System  
Integration

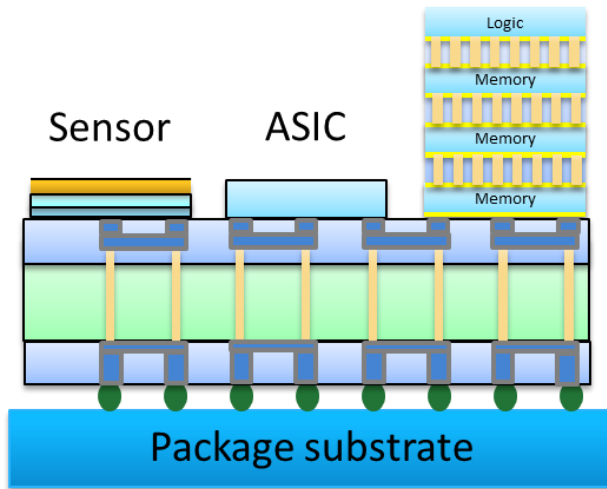
Sensors  
Photonics  
Power & RF  
Wireless  
communication

Advanced Materials Development Line – key performance attributes:

*GaN, GaAs, InGaAs, InP, SiGe, PbSe, Ge*; others - CNT, SiC, C, Graphene, Magnetic (MOCVD/CVD/ALD tools)

- High sensitivity
- Low Power
- Harsh environments performance

2.5 / 3-D provides solutions to the computing roadmap which address challenges faced by conventional scaling

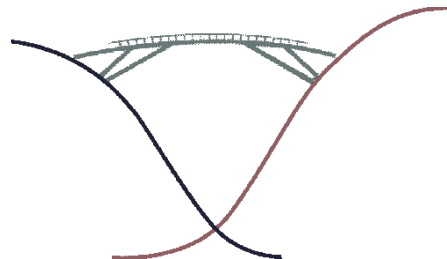


## Improved performance

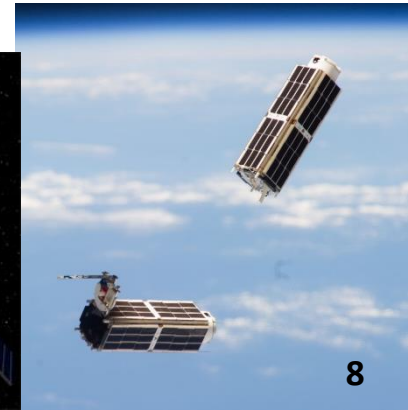
- Heterogeneous Integration (Si, III/V, Photonics)
- Ultra-High Density (Wide I/O -  $10^6$ )
- Power Consumption and System Response Time
- Robust Operating Temperature Range (77K to 673K)

## Improved Form Factor

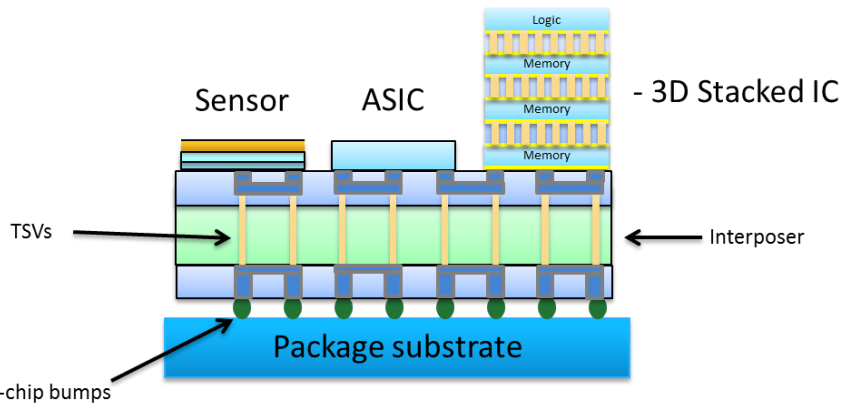
Transform traditional sensing techniques allowing continuous monitoring and the ability to monitor more...



BRIDG Confidential

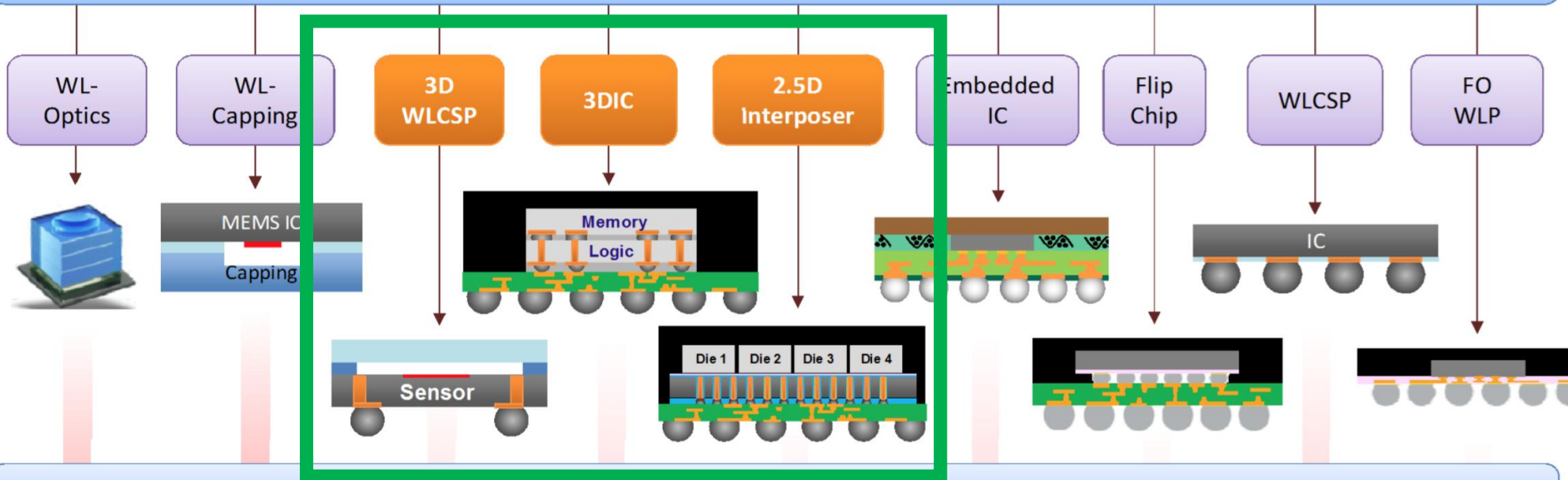


## Ultra High Density Interposer (Active since Jan 2016)



- Develop fabrication and assembly process for an order of magnitude beyond current state-of-the-art 2.5D/3D Integration
- Device scale connections (TSV, Interposer, Bumps) at  $1 \times 10^6$  density
  - Interposer pitch decreased from 45 to 5  $\mu\text{m}$
  - TSV pitch reduced from 180 to 8  $\mu\text{m}$
  - Depth from 100 to 50  $\mu\text{m}$
- Accelerate to achieve ITRS targets in the next 4 years
- Exploring Additive Interposer Manufacturing

## Advanced Packaging Platforms



## Middle-End Process Steps

Wafer Bonding

TSV

RDL

$\mu$ Balling

Bumping

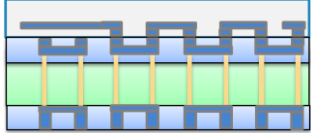
Balling

**Focus Areas**

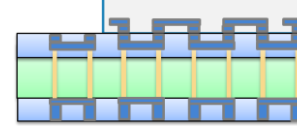
Reference: Invensas



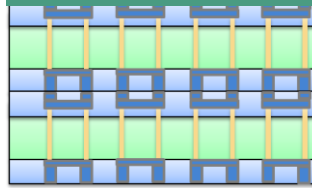
## Si Device Wafer to Interposer



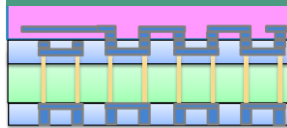
## Si Chip to Interposer



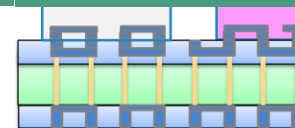
## Stacked Interposer (TSV)



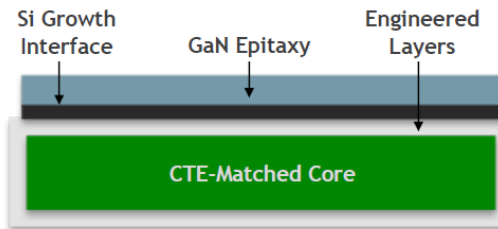
## III/V Device Wafer to Interposer



## III/V and Si Chip to Interposer



## Deploy Quora Substrate Technology (QST) for 2.5/3D Interposer



- Fabricate Demonstration Device on UHDI
- Electrical Characterization
- System Integration (THz, LIDAR)

Scope Additive Manufacturing Capabilities and Partners

Develop System Integration Proposal

Demonstrate System Integration

## ➤ Imaging technologies



Comparison of visible imagery (left) of a landscape by haze with clear SWIR imagery (right). FPA's and SWIR cameras can see through rain, mist and fog.

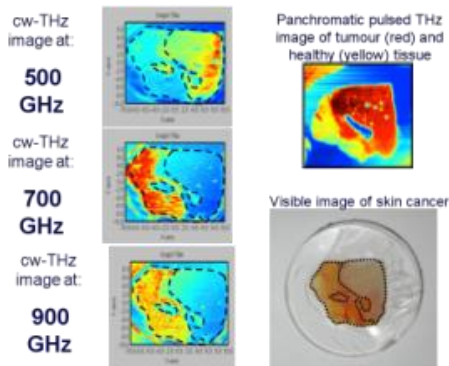
Color rendered image of a powered-up circuit board.

## ➤ LiDAR (Light detection and ranging)

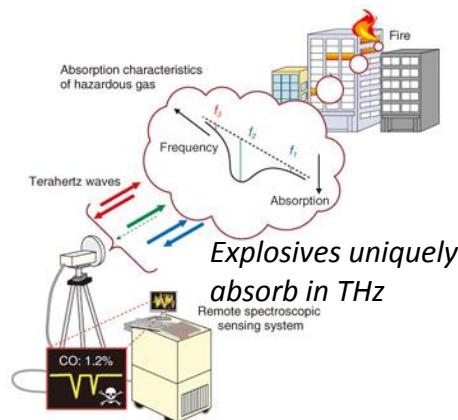


High-performance LiDAR sensor - support unmanned vehicle

## ➤ THz imaging



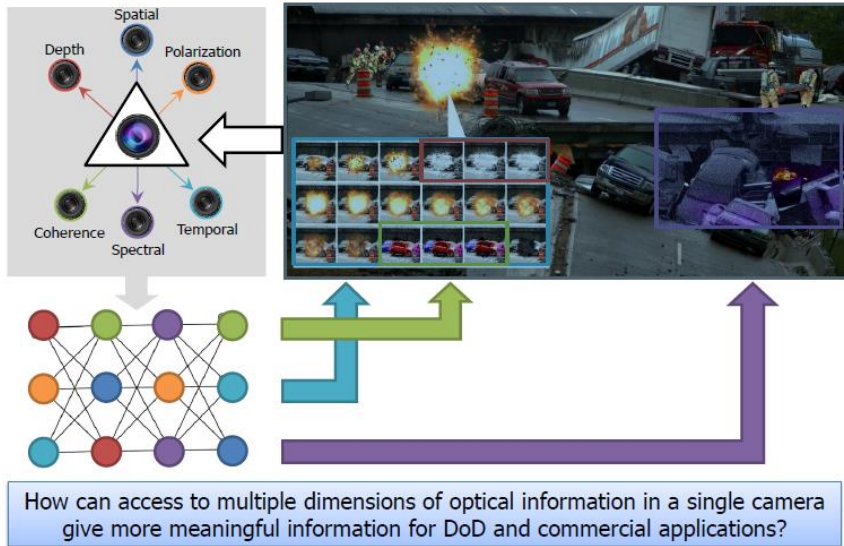
Detect pre-cancerous conditions



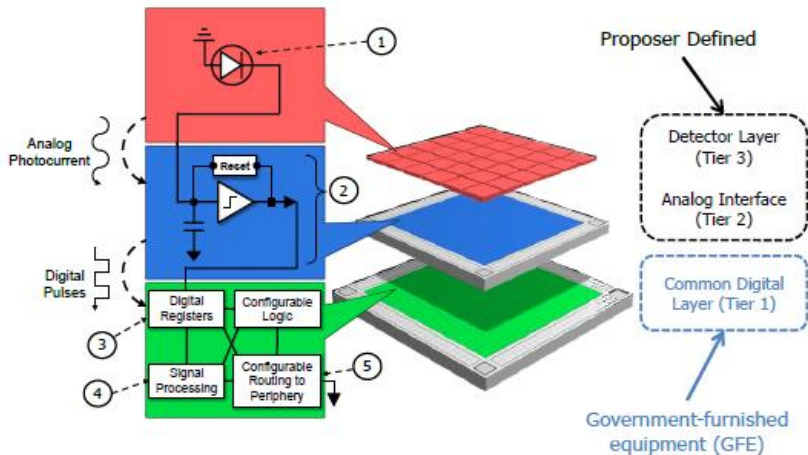
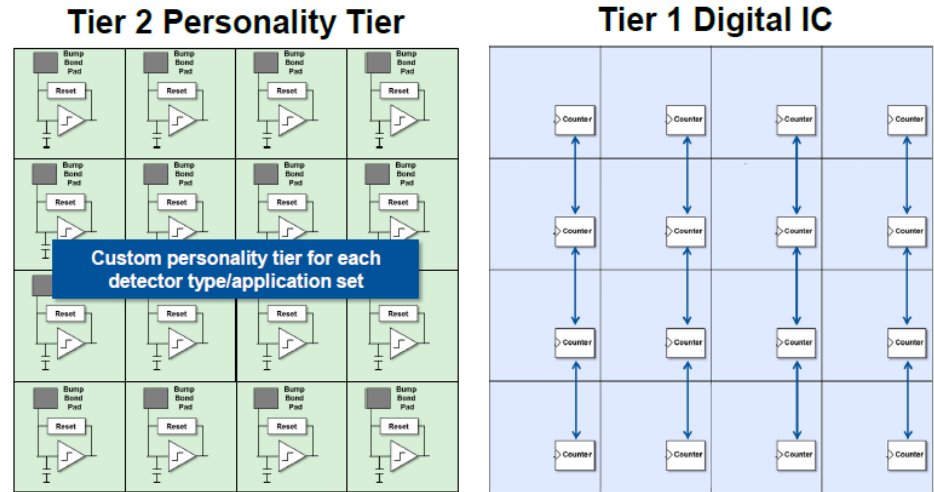
## SYSTEM AND DESIGN CAPABILITIES:

- ✓ Commercial component integration
- ✓ Unique component fabrication and integration
- ✓ New component design & development

**DARPA** ReImagine Concept



**RelImagine 3D ROIC Approach**

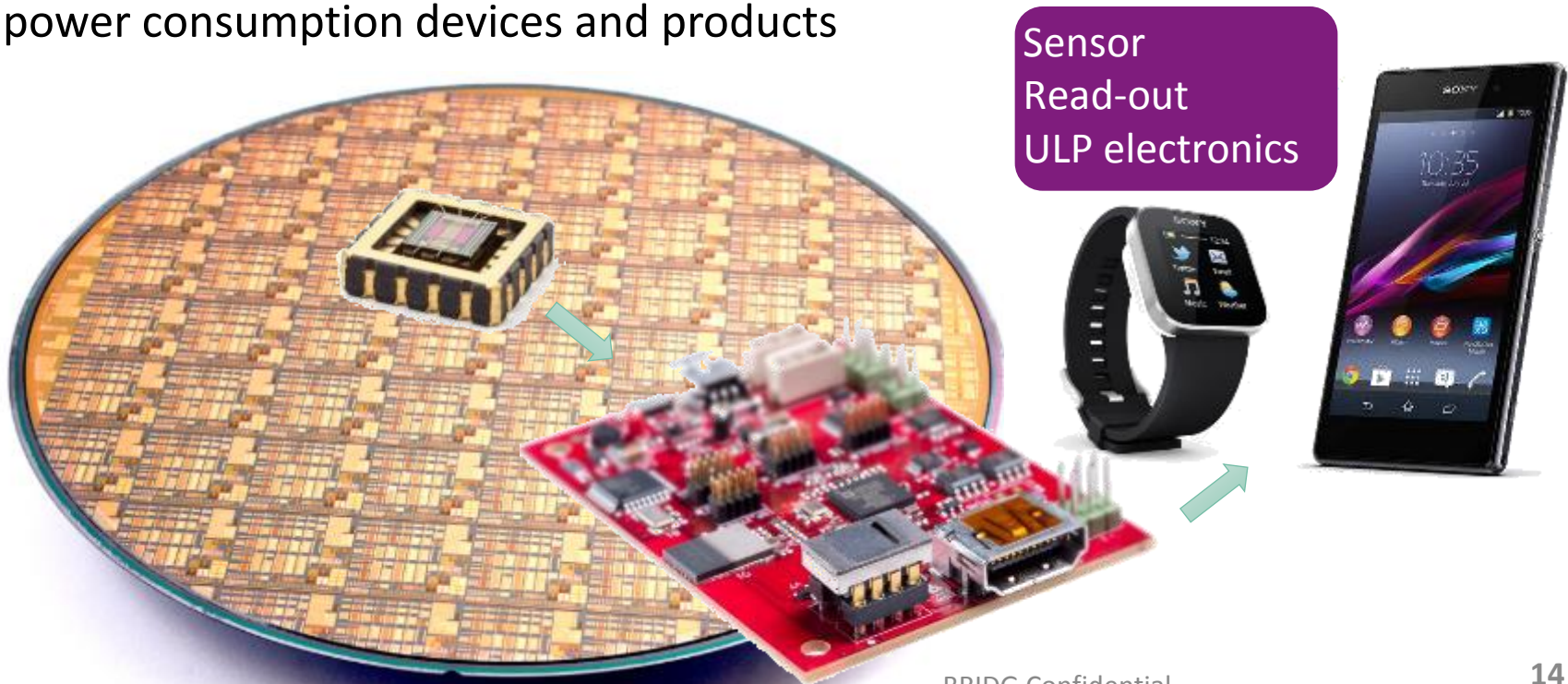


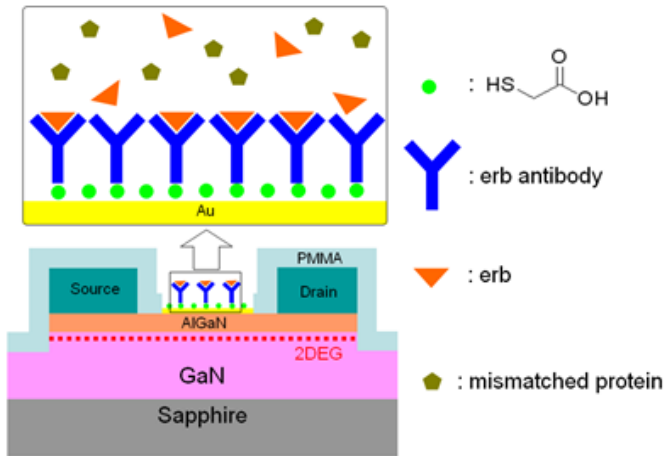
Opportunities to support this program:

- Detector layer material systems
- 2.5/3D Integration

## ***GaN Power, RF, imagers and sensors on Si (200mm)***

- Ultra high resolution imagers for medical, security, Environmental, manufacturing, automotive, & other industry based applications
- PPM / PPB Sensors - functionalized with polymers, ionic liquids, metalorganics
  - Biomolecule detection ( DNA, antigens, neurotransmitters)
  - Usable for inorganic gases-  $H_2$ ,  $O_3$ ,  $CO_2$ ,  $NH_3$  and Volatile Organic Compounds (i.e. BTX, Formaldehyde, etc.)
  - Electrochemical detection ( pH, ions)
- Harsh environments with wide operating temp range (up to 1100 °C)
- Low power consumption devices and products



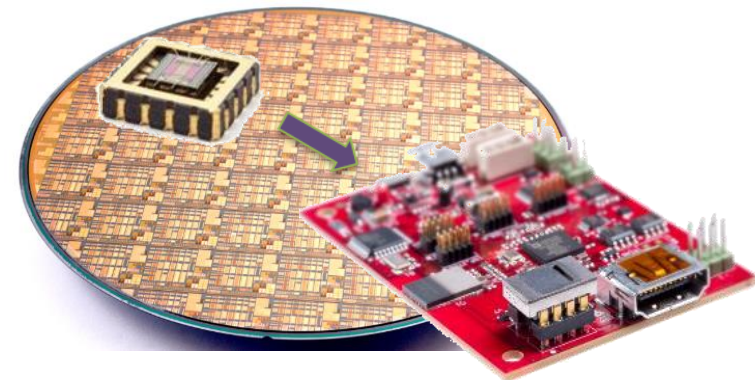


Schematic for Protein Detection with High Electron Mobility Transistors (HEMT)

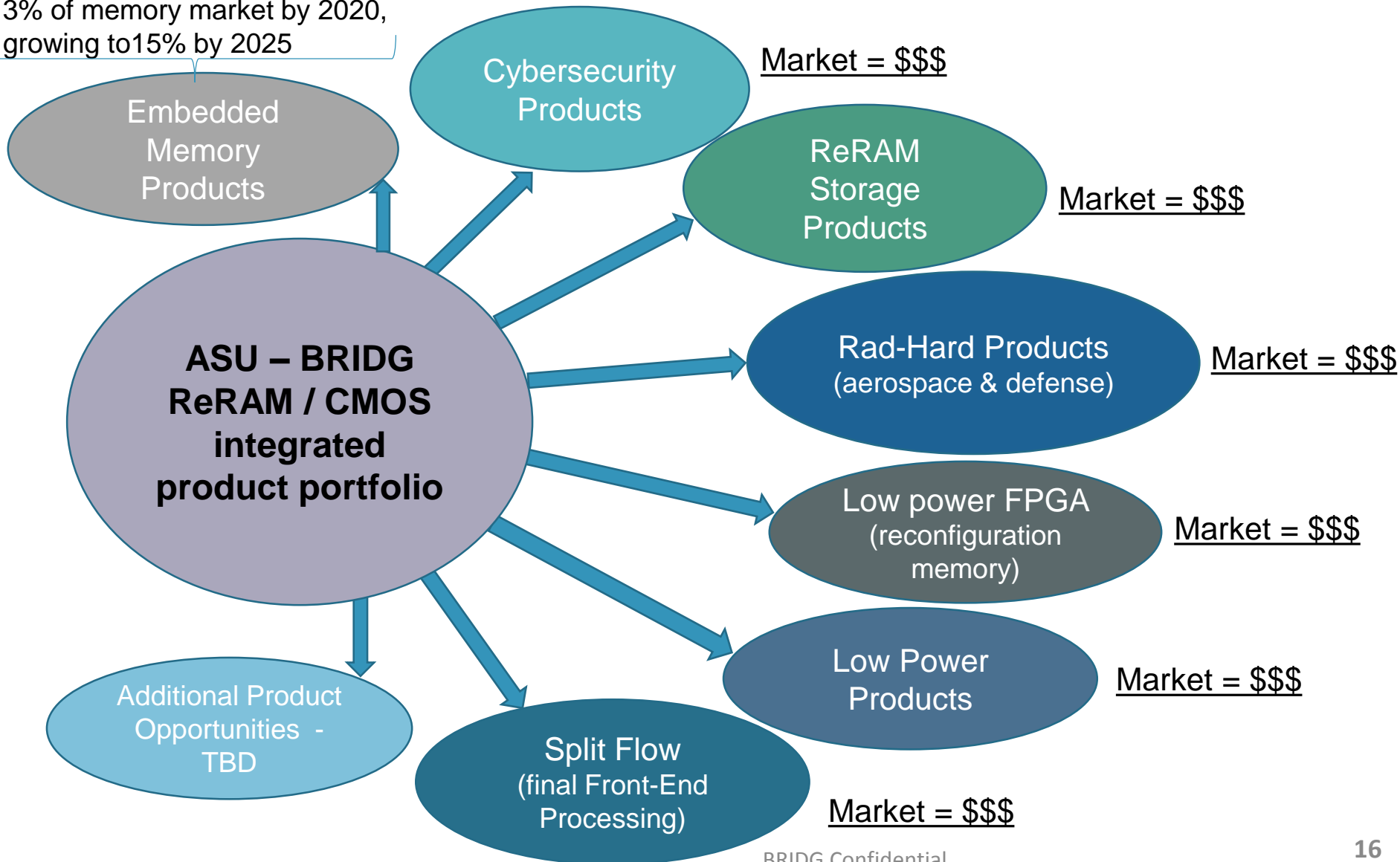
Gallium Nitride (GaN)-based High Electron Mobility Transistors (HEMTs) have been shown to be a viable solution for a myriad of chemical and biological sensing applications (e.g., gases, toxins, cancers, biomarkers such as glucose, heavy metals, and marine pathogens)

Detection	Mechanism	Surface Functionalization	Detection Limit
<b>1. Gas</b>			
H <sub>2</sub>	Catalytic dissociation	Pd, Pt	10ppm
CO <sub>2</sub>	Absorption of water/charge	Polyethylenimine/starch	1%
CO	Charge transfer	ZnO nanowires	50ppm
O <sub>2</sub>	Oxidation	InZnO	5%
<b>2. Toxins</b>			
Botulinum	Antibody	Thioglycholic acid/antibody	1ng/ml
Anthrax protective antigen	Antibody	Thioglycholic acid/antibody	2ug/ml
<b>3. Cancers</b>			
Breast cancer	Antibody	Thioglycholic acid/c-erbB antibody	
Prostate specific antigen	Antibody	Carboxylate succinimyl ester/PSA antibody	10 pg/ml
<b>4. Biomarkers</b>			
DNA	Hybridization	3'-thiol-modified organosulfonates	
Chloride ions	Anodization	Ag/AgCl electrodes, InN	10 <sup>-6</sup> M
Lactic acid	LOX immobilization	ZnO nanorodes	167nM
Glucose	GOX immobilization	ZnO nanorodes	0.5nM
Proteins	Conjugation/hybridization	Aminopropylsillane/biotin	
pH	Absorption of polar molecules	Sc <sub>2</sub> O <sub>3</sub> , ZnO	±0.01
KIM-1	Antibody	KIM-1 Antibody	1 ng/ml
Traumatic brain injury (TBI)	Antibody	TBI Antibody	1ug/ml
<b>5. Heavy Metals</b>			
Hg <sup>2+</sup> with Na <sup>+</sup> , Pb <sup>2+</sup> , Mg <sup>2+</sup> ions	Chelation	Thioglycholic acid/Au	1nM
<b>6. Marine Pathogens diseases</b>			
Perkinsus marinus	Antibody	Thioglycholic acid/anti-P marinus antibody	1%
Vitellogenin	Antibody	Thioglycholic acid/anti-vitellogenin antibody	1% serum of 4ug/ml

Tech Challenges	
Scale Up of Novel Materials	
Fab and Device Integration	x
Modeling, Simulation, and Design Tools	
PDKs and Device Libraries	
Reliability, Test and Eval	x
Advanced Packaging	x
System Product Integration	

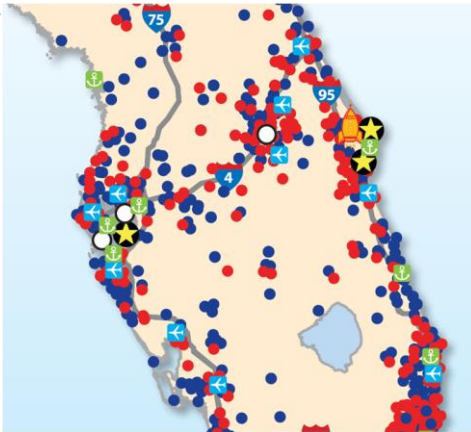


3% of memory market by 2020,  
growing to 15% by 2025



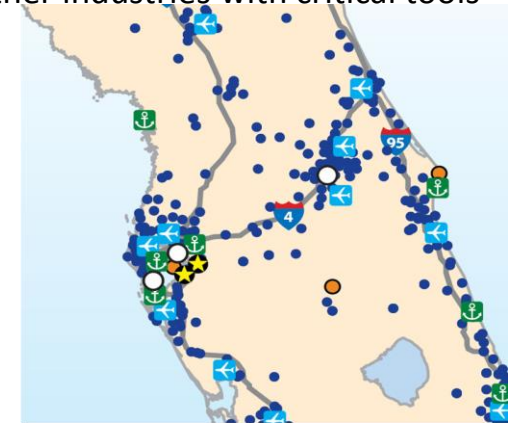
## ★ AVIATION / AEROSPACE

Home of Kennedy Space Center, Florida has 470+ companies ranging from aircraft and missiles to space exploration and manufacturing



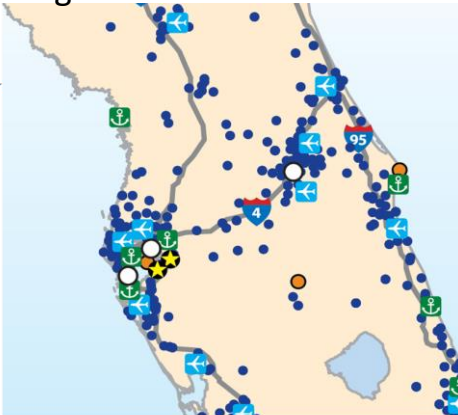
## ■ OPTICS & PHOTONICS

2,000+ specialists employed in some 100 companies in the region's optics and photonics sector providing defense, communications and other industries with critical tools



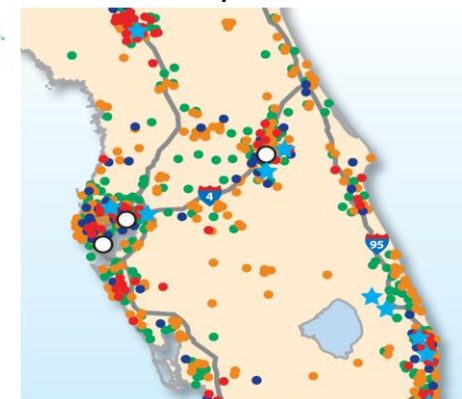
## ★ DEFENSE & HOMELAND SECURITY

The region is home to 20 major military installations, 3 unified combatant commands, 2 academic security institutes and nearly all of the nation's leading contractors



## ◆ HEALTH LIFE SCIENCES

1,100+ biotech, pharma & medical devices companies and 214 hospitals; including some of the nation's most highly regarded research centers and health systems



## 200mm Equipment Acquisitions

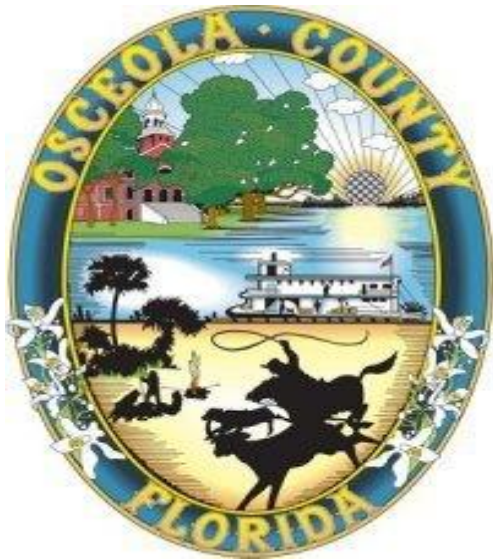
CD SEM - SEM5 Hitachi 9200
CMP - AMAT Mirra Trak (Cu/W)
CMP - AMAT Mirra Trak (Oxide)
Coat / Dev - TEL ACT8
CVD - HDP - AMAT Centura
CVD - AMAT Centura -2 chambers (W)
CVD - Novellus Concept2 Sequel (TEOS, SiN, SiO2)
Defect Inspection - KLA 2139 - Bright Field
ETCH – AMAT CENTURA Metal Etch
ETCH - AMAT CENTURA Oxide Etch
ETCH -AMAT CENTURA Poly Etch
Ion Implant - Varian E500 EHPi (Medium Current)
PVD -AMAT ENDURA (Chambers: Cu, TaN, Al, TiN, RPC)
Faith Reader
Faith Reader
Faith Reader
Laser Scribr
NADA Tech Sorter
NADA Tech Sorter
Stepper - Nikon i-Line (NSR-2205i12D)
Faith Wafer Transfer Tool
Tel Alpha 8s (NEUT)
Tel Alpha 8s (NEUT)
Tel Alpha 8s (GATE)
Tel Alpha 8s (Nitride)
Tel Alpha 8s (POLY)
Tel Alpha 8s (N+)
Tel Alpha 8s (Sinter)
Wafer Scrubber -DSS2 OnTrak Scrubber
4pt Probe - CWI
Single Wafer Wet Processing - SEMSYSCO Triton
Deep Silicon Etch - SPST
Chemical (Electrolyte) Analyzer – ECI

UEFC-4900 TEMESCAL Evaporator
Goniometer - Rame-Hart
Overlay - Inspectrology
Wet Bench – JST (Clean Diff)
X'PERT3MRD Panalytical XRD, XRR, XRT
KLA F5x Ellipsometer, Film Thickness, Stress Measure
Cassette/Box Washer - Flouroware
Photoluminance/Defect Measure – KLA
SUSS MABA8 Mask/Bond Aligner w/Plasma Activation
SUSS XB8 100kN Bonder
SUSS DSM8/200 Gen2 Bond Alignment Metrology

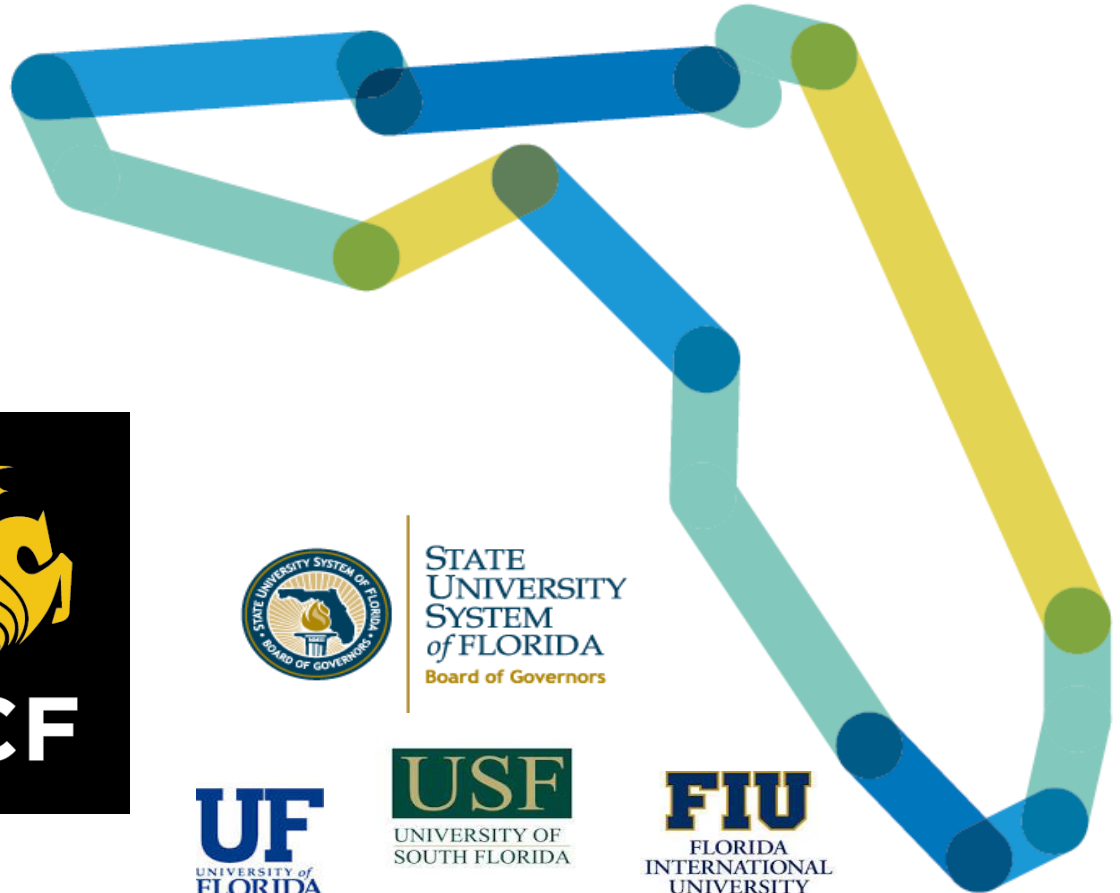
## Core Equipment List for 2017

MOCVD Tool
193nm and e-beam lithography (2018)
RTP
ALD Tool
Micro Transfer Printing
Materials Coater
Asher
Batch Solvent Hood
Microscope
Profiler
SEM with FIB
AFM
SAM
Hall measurement tool
Temporary bonder
De-Bonder
Wafer grinder
Tape and Frame
Parts Anneal Furnace (III/V)
Plasma Dicer
High Alignment Accuracy Pick and Place Tool

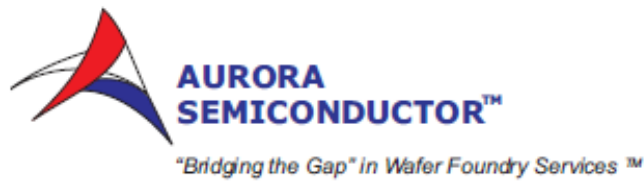
“Florida grown” infrastructure investment with roots deeply embedded in the region and state.



STATE  
UNIVERSITY  
SYSTEM  
of FLORIDA  
Board of Governors



# Momentum!!




# NEOCITY

ideate > create > innovate without limits



BRIDG is located off US-192 inside NeoCity, a 500-acre technology district inspired by an ethos of collaboration and designed to transform the way we ideate, create, and innovate.

# Join Us



magnetizing a global economy  
to thrive within a place conceived  
through an ethos of collaboration

powering the innovation  
and development of technologies  
we can't even imagine yet

Join us in the next  
evolution of  
innovation!

**BRIDG**  
200 NeoCity Way  
NeoCity, FL 34744  
[jallgair@GoBRIDG.com](mailto:jallgair@GoBRIDG.com)



[GoBRIDG.com](http://GoBRIDG.com)

The logo for BRIDG features a stylized arch above the letter 'i'. The arch is composed of a blue segment on the left, a yellow segment at the top, and a teal segment on the right. Two green circles are positioned on the yellow segment. Below the arch, the word "bridg" is written in a lowercase, sans-serif font. The letters 'b', 'r', 'd', and 'g' are a dark grey-blue, while the 'i' is white with a dark grey-blue outline.

# bridg

Bridging the Innovation Development Gap

[GoBRIDG.com](http://GoBRIDG.com)

