



On-Shoring the Next Generation of Advanced Packaging

June 29, 2022

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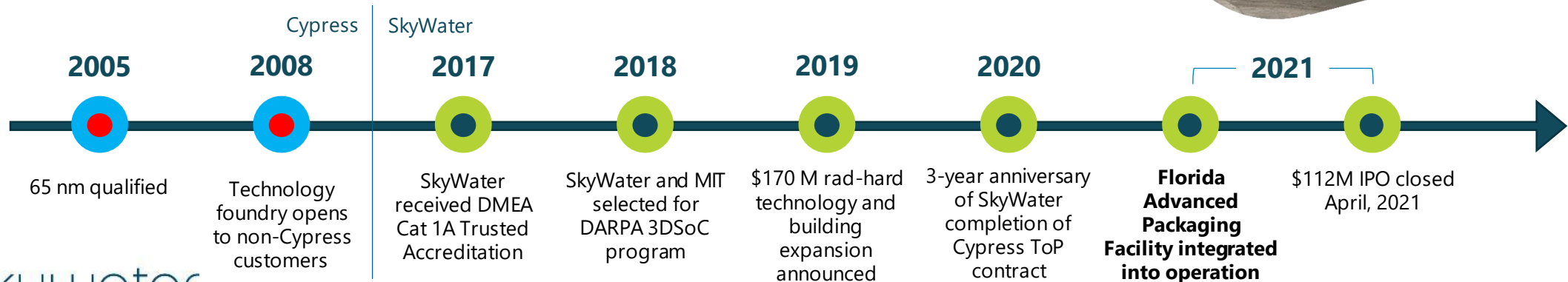
SkyWater Technology
Kissimmee, FL 3473



SKYWATER

We are the only **U.S.-owned** pure-play foundry.

Extending a legacy of manufacturing excellence to meet the industry's needs in a **post-Moore's Law reality**





SkyWater Minnesota

Bloomington, MN



OPERATION

200 mm equipment
91,000 ft² Cleanroom
Class 10 + SMIF
10,000 30 ML CMOS wafers or 50,000 MOSFET wafers
per month
90 nm+ feature geometries

CERTIFIED

ISO9001 / IATF16949 Automotive Certified
ISO13485 Medical Certified
ISO14001 Environmental Certified
DMEA Cat 1A Trusted
ITAR and Secure Processing Supported



Proprietary



SkyWater Florida

Kissimmee, FL

OPERATION

200 mm equipment
Size: 109,000 ft² total
26,000 ft² of class 1000
9,400 ft² of class 10,000

Notes

Site added to operation Feb 2021
DMEA Cat 1A Trusted – pending, planned 2H 2022
Facility will enable custom advanced packaging
solutions

We streamline the concept to production journey.

WHO WE ARE

Technology as a ServiceSM (TaaS)SM

Innovation as a Service



Manufacturing as a Service

Advanced Technology Services (ATS)

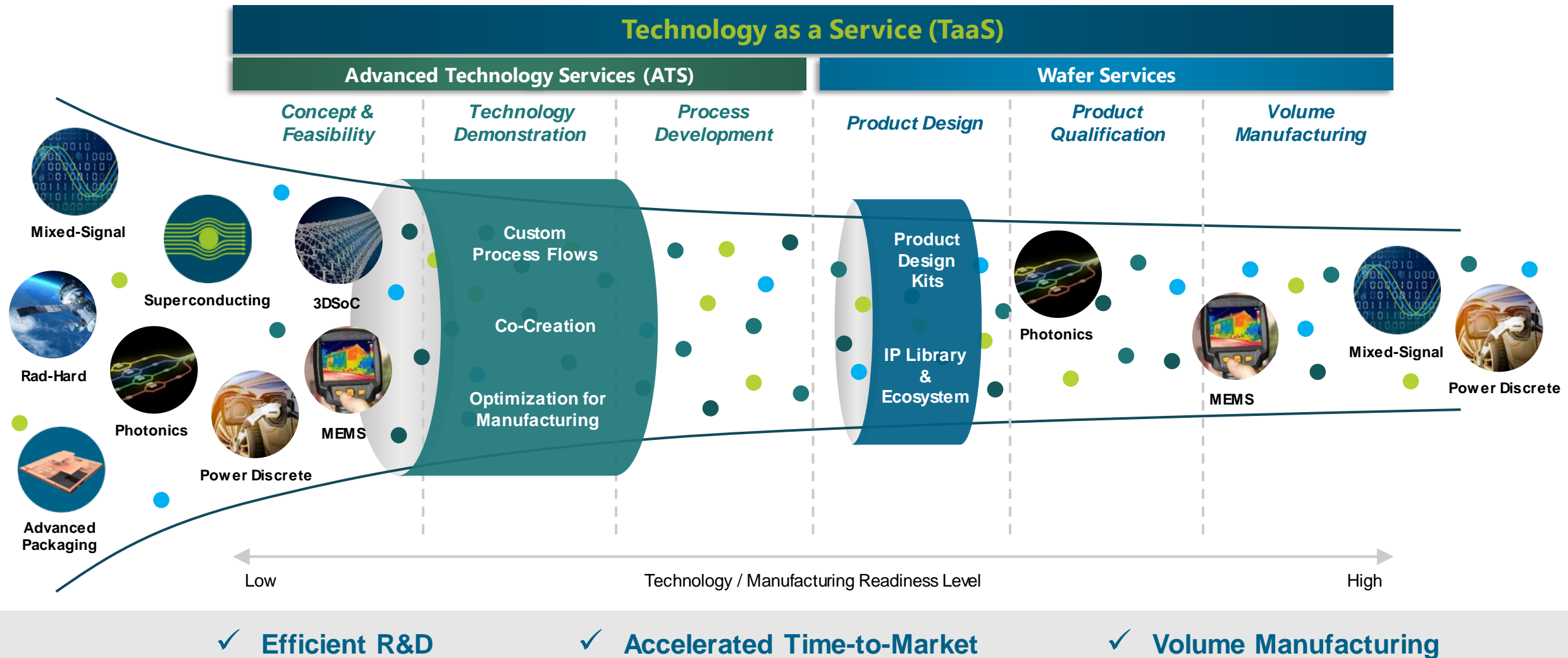
enable co-creation of differentiated solutions which are the unique expression of the combined customer/SkyWater multi-disciplinary technology teams.

Wafer Services









supply customers with ICs and microdevices for commercial or mission ready products.



Model Enables Early Foundry Engagement



Technologies & Markets

Platform	Aerospace & Defense	Advanced Computing	Automotive & Transportation	Bio-Health	Consumer	Industrial / IoT
 Mixed Signal	●		●	●	●	●
 Rad-Hard	●			●		
 Discrete Power	●		●		●	●
 Advanced Packaging	●	●	●	●	●	●
 Superconducting	●	●				
 3DSoCs	●	●	●	●	●	●
 Silicon Photonics	●	●	●	●		
 MEMS	●		●	●		●

SkyWater Florida

AP Facilities & Operations

Fab Building: 109,000 ft² total

- 26K ft² of class 1000 – 11.8K ft² available to grow
- 9.4K ft² of class 10,000 – 4.3K ft² available to grow

Electricity: Two power feeds to site

- ~22MW-h/day – utility able to support growth
- Uninterruptable Power Supply (UPS):
 - Safety (100%) & Tools (~60%)

Tools (69) / Capacity:

- 61 tools – 42 in use, 19 in installation/start up
- 8 tools with no current plans
- Capacity model in development

Systems / MES:

- Integrated MES system with SWMN
- Lot movement / controls

Certifications:

- ISO9001 audit ready: December 2021
- Trusted Foundry certification in process



Workforce:

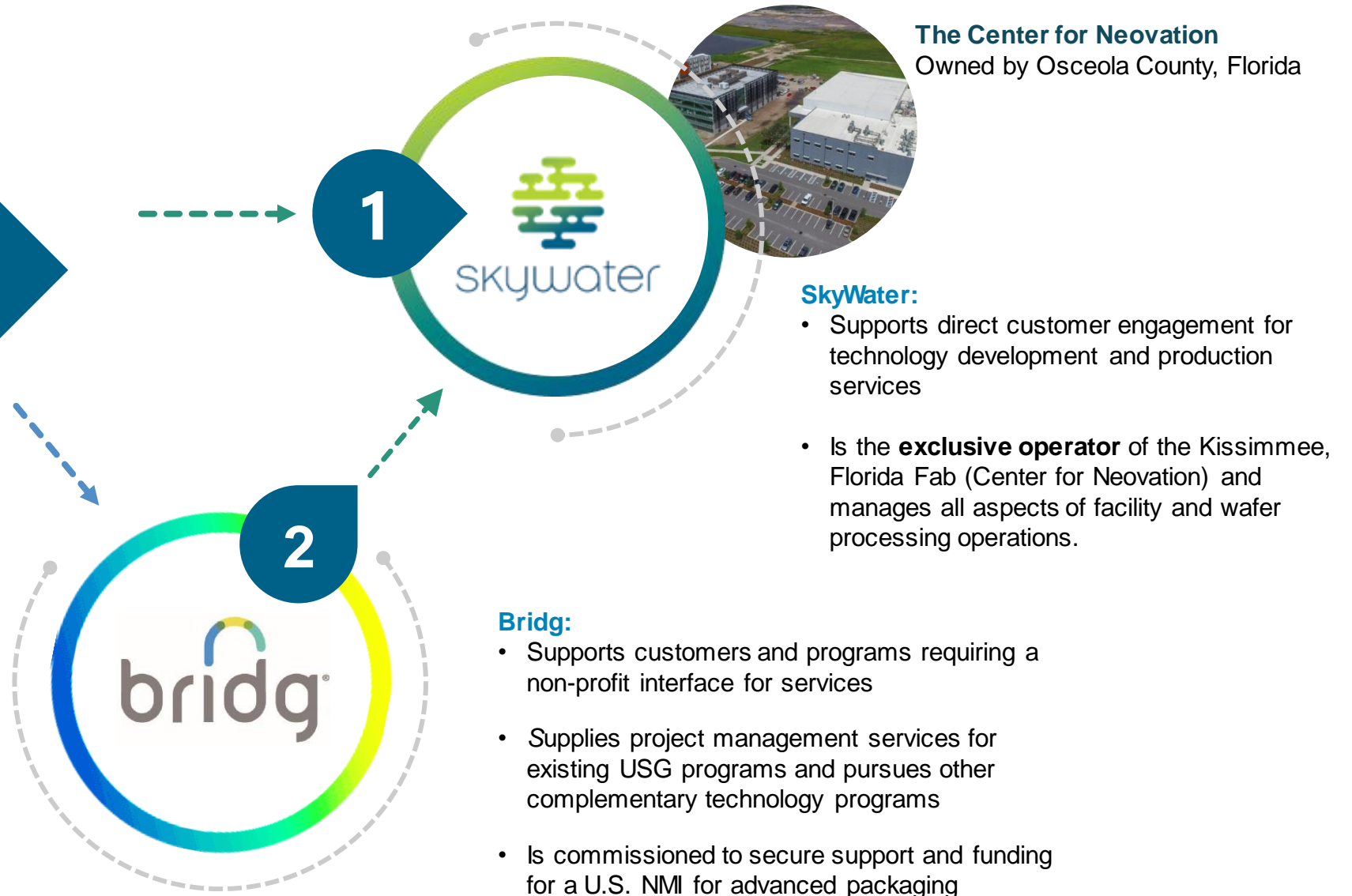
- Growing to 220 jobs at full utilization of fab space
- Transition to 24X7 work environment as ramp continues

The OC Office building

- 21,000 ft² office area (SW 4th floor)

Advanced Packaging Engagement Model

United States Government and commercial customers work with SkyWater in two ways: directly, or indirectly via non-profit Bridg.



Capabilities for Advanced Integrations



Silicon Interposers w/TSV



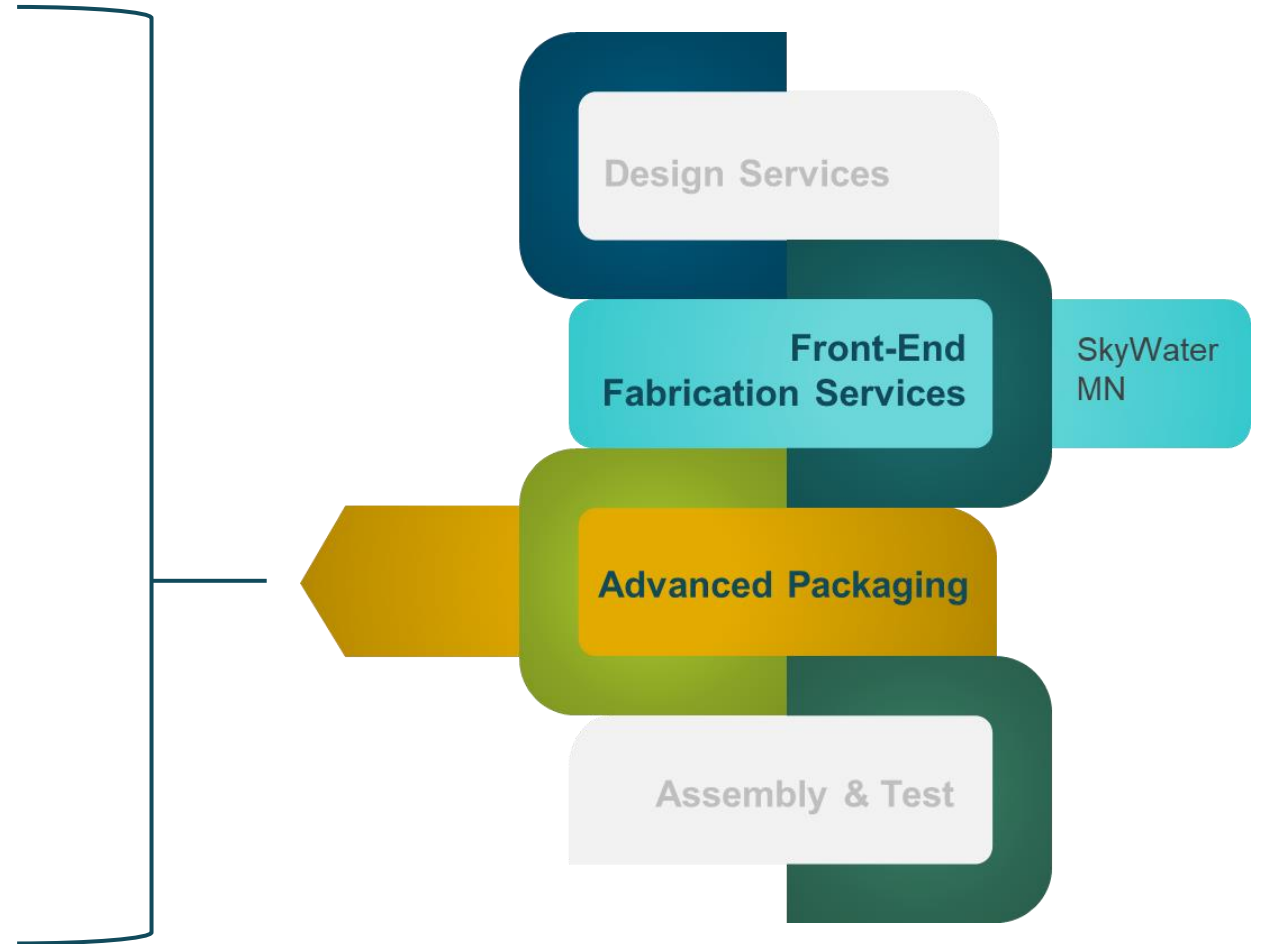
Hybrid Bonding



Fan-In/Fan-Out



**Solder Bumping
& Assembly**

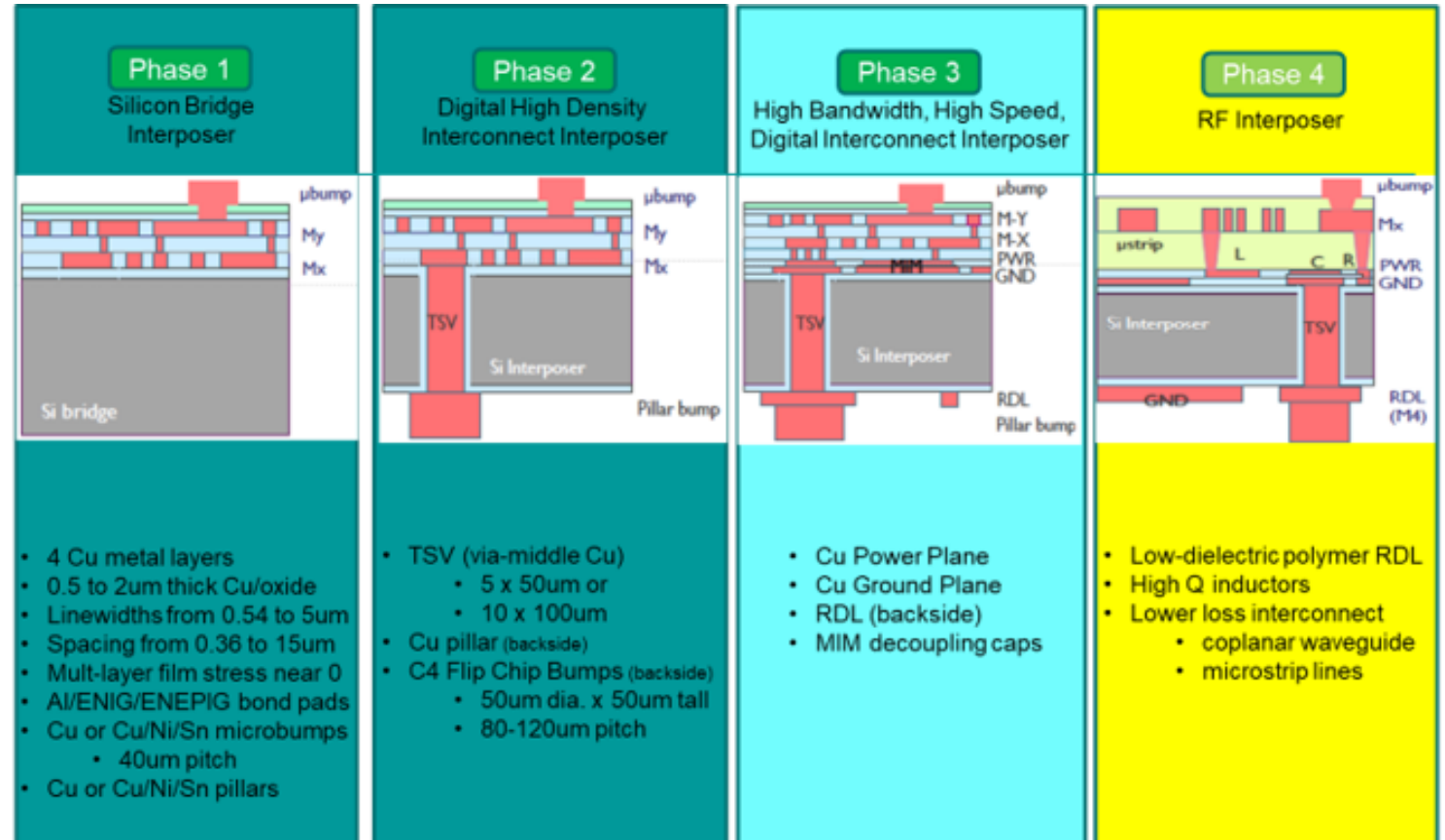


Si Interposer Development

Heterogeneous Integration & Advanced Packaging

*BRIDG Industrial Base Analysis and Sustainment (IBAS) Program

Establishes
silicon
interposer
capability for the
industrial base



2022

2023

Si Interposer Development

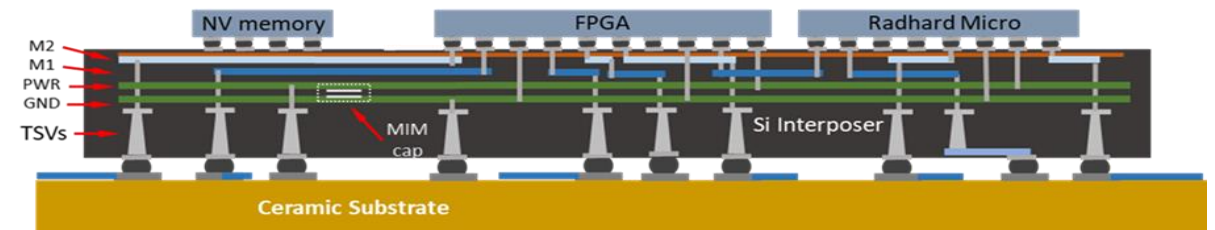
Heterogeneous Integration & Advanced Packaging

Technology Details

- Max reticle size: 22mm x 22mm
- TSV size: 10um x 100um (10:1 AR)
- TSV metal: Electroplated Cu
- Topside metallization: 4 layers
- Backside: RDL & Solder Bumps
- Daisy chain and functional hardware designs
- Assembly of topside components and interposer to substrate (via assembly partner)
- Design rule manual (beta version currently)

Roadmap

- Phase I – Qualified Q2/2022
- Phase 2 & 3 – Qualified Q4 2022/ Q1 2023

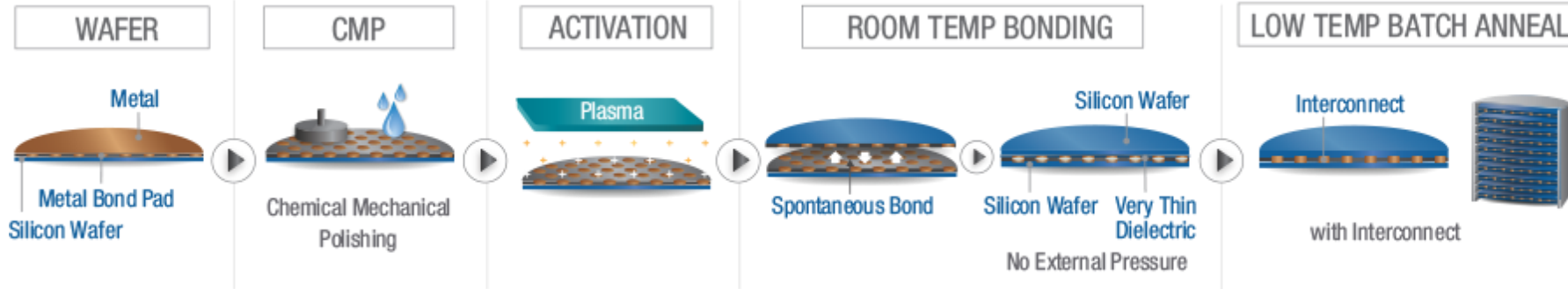
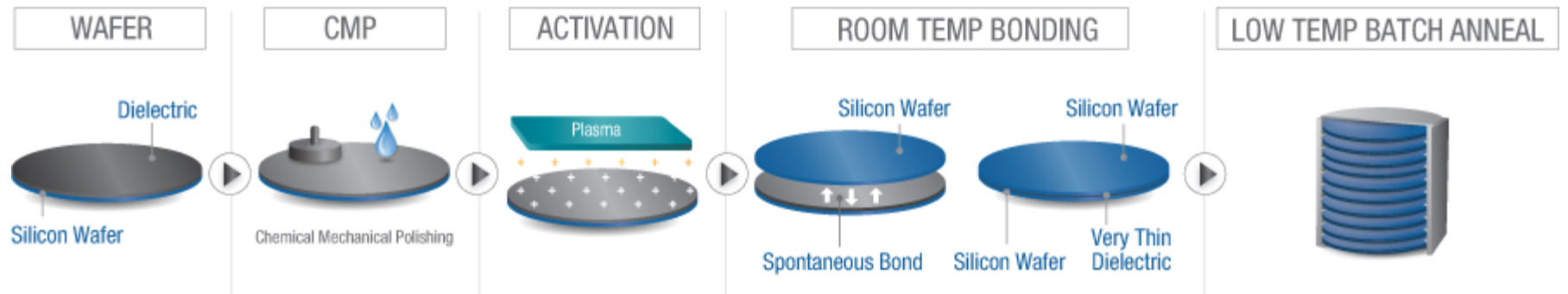


- Phase 4 – Target qualification date Q3 2023

Hybrid Wafer Bonding

Heterogeneous Integration & Advanced Packaging

Adeia ZiBond®
technology: hybrid
bonding **without**
electrical
interconnect



Adeia DBI®
technology:
hybrid bonding
with electrical
interconnect

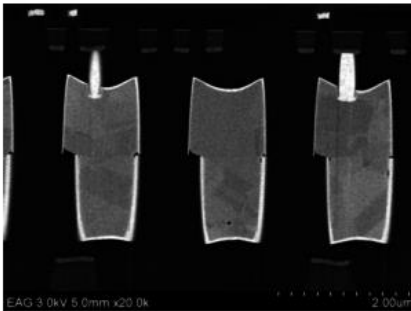
SkyWater licensed the Adeia ZiBond® and DBI® wafer-to-wafer bonding technologies in May 2022

Hybrid Wafer Bonding

Heterogeneous Integration & Advanced Packaging

Technology Details

- Bonding performed at room temperature to eliminate CTE-driven misalignment
- Support for high density interconnect at small pitch
- Enables extremely small interconnect length

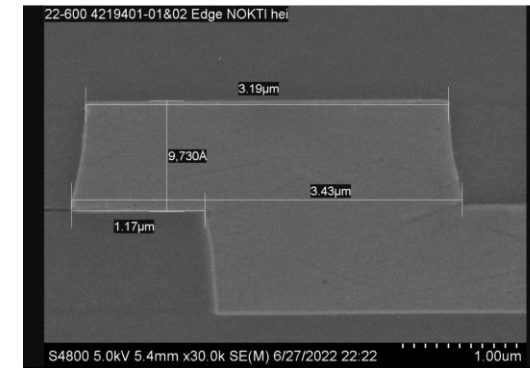


1µm pitch



Roadmap

- Zibond® & DBI® tech transfer – Q2/Q3 2022
- Initial customer engagements active in Q3/Q4 2022



SkyWater DBI 4µm pads 8µm pitch

W2W ZiBond®

W2W DBI

D2W DBI Ultra

2022

2023 & beyond

Fanout Wafer Level Packaging

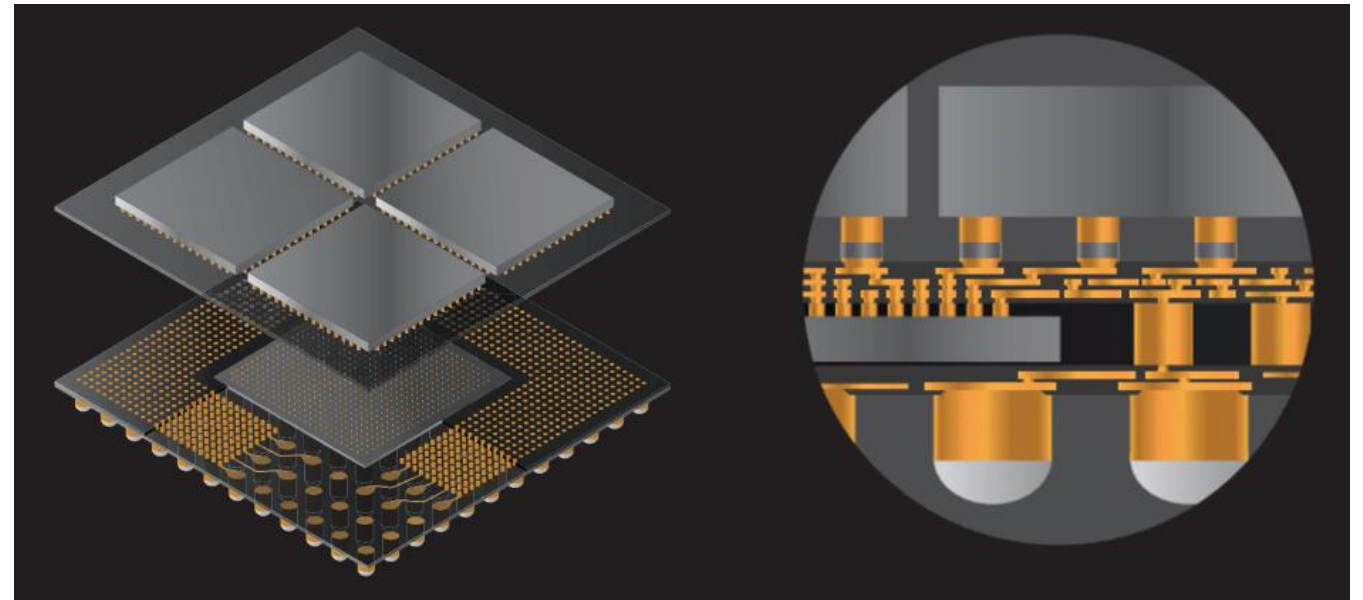
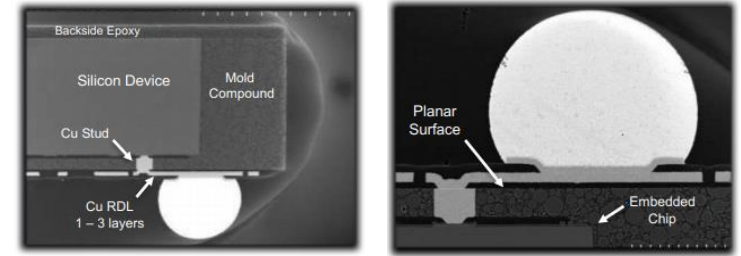
Heterogeneous Integration & Advanced Packaging

Fan-Out Wafer Level Packaging:

- Enables IO extended beyond Si
- Chips-first, chips-up fan-out technology with fully encapsulated active region

Why Deca M-Series:

- Highest volume FOWLP technology deployed today
- Superior reliability and yield
- Supports multiple die integration in a single package
- Forward looking Gen 2 incorporates additional RDL layers, smaller RDL line/space dimensions, and 20um I/O pitch die



Fanout Wafer Level Packaging

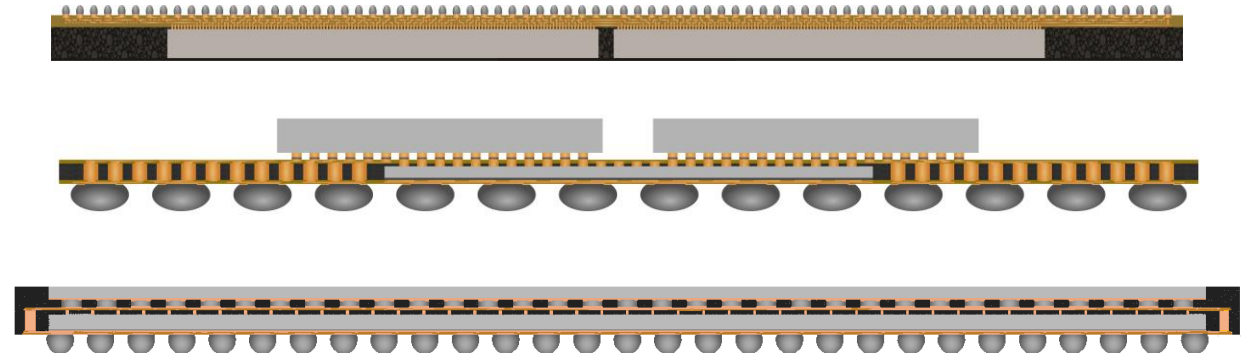
Heterogeneous Integration & Advanced Packaging

Technology Details

- M-Series process supports
 - 2 RDL layers, min.10um line/space
 - 55um die bond pad pitch, min.
 - Multiple die in package with 100um die spacing (min)
- M-Series Gen2 extends to
 - 4+ RDL layers, min. 2um line/space
 - 20um die bond pad pitch, min.
 - <75um die spacing

Roadmap

- 200mm demo test vehicle completed Q1 2023
- Gen 2 technology development in 2023
- Initial customer processing engagements in late 2022 – early 2023



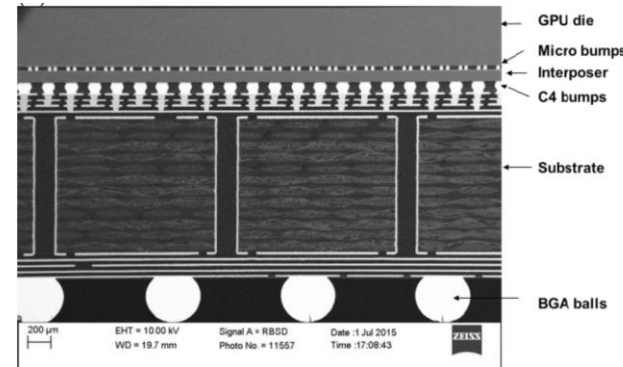
Solder Bumping & Assembly

Heterogeneous Integration & Advanced Packaging

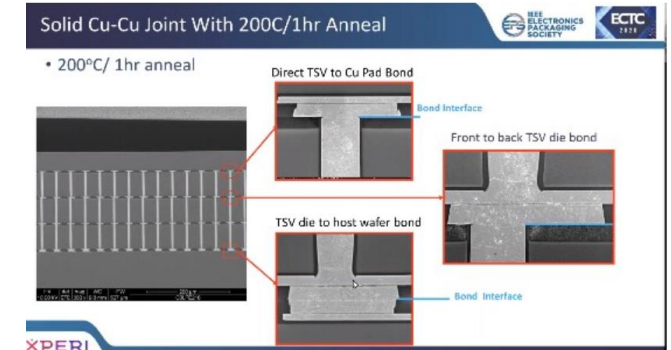
Enable turn-key solutions for HI in a secure environment

Future Advanced Packaging Capability

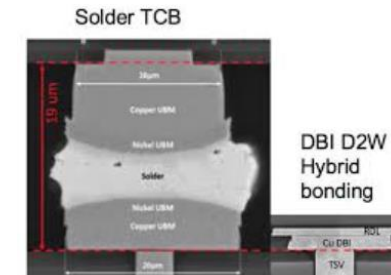
- UBM and C4 Solder bumping
- Cu pillar micro-bump
- Sn-Pb and Pb-free alloys
- Die assembly to interposer or substrate



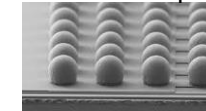
Conventional Solder Bump



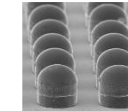
Direct Bond Interconnect (DBI®)



Solder Bumping



Solder Capped Cu-Pillar



2022

2023

2024

Solder Bumping & Assembly

Heterogeneous Integration & Advanced Packaging

Future Capabilities

- C4 and Cu pillar bumping
- UBM/solder bump bond pads
- NCP/NCF and capillary underfill
- Thermal compression bonding (TCB)
- Mass reflow
- Ultra fine pitch DBI® ($\leq 10\mu\text{m}$ pitch)
- Die to wafer assembly

Roadmap

- Current external partners for
 - UBM & solder bumping
 - Cu pillar bumping
 - Assembly: TCB & mass reflow (partner)

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**Are you working on an idea? Let's talk.
Get in touch today!**

For more information:

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Contact SkyWater:

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