VIZTA

Vision, Identification, with Z-sensing Technologies and key Applications

Newsletter – October 2022

The VIZTA project has completed its 3.5 Years full duration, strong relationships among the representatives of all partners have been established and significant results have emerged from the collaborative developments, both at technology level as well as at applicative and emerging product levels. VIZTA consortium is proud to share here some of its main achievements.

VIZTA objectives and means

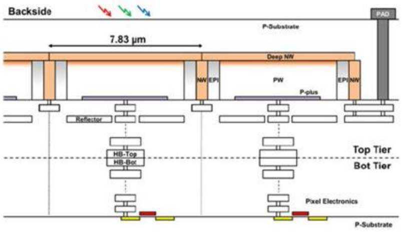
The objectives of the project are to develop innovative technologies for optical sensors and laser sources, for short to long-range 3D-imaging, and demonstrate their value in several key applications. Such objectives are addressed by building partnership ecosystems, exercise new 3D sensors and light sources in the key applications, using the new developed innovative technologies.

VIZTA progress: significant achievements in 42 months

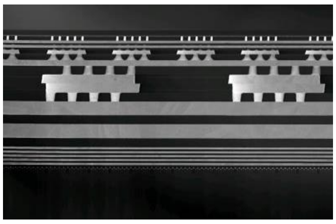
We propose hereafter a compilation of the different partners contributions starting from Technology developments, then components and application systems for short and long-range up to actions of exploitation and dissemination.

The VIZTA project developments are structured in 3 Work Packages (WP) focusing several tasks.

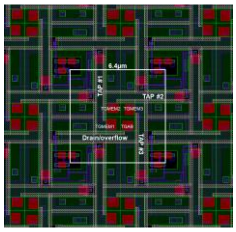
The WP2 is dedicated to advance device and technology development needed for the demonstrators used in the other work packages, and subdivided in 5 main tasks:



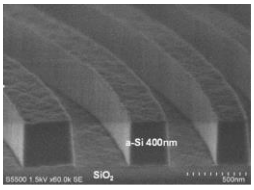
Advanced SPAD_3D



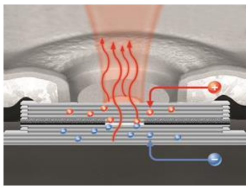
Hybrid Bonding solutions



Lock-in pixels



Diffractive micro-lenses



VCSEL with integrated optics

- **Task 2.A -** SPAD pixel: A new small pitch diode is currently being manufactured to achieve state of the art performance targets
- **Task 2.C/D - RGBZ sensor** The RGBZ imager T5 is functional under incandescent ambient light. Good performances are reported for this prototype. Fine tuning of doping and calibration of micro lenses are required to reach state of art RGB images and appropriate iTOF performances. A color demosaicing process was developed during VIZTA to minimize the impact of the missing information of the iTOF surface. 3D-colored images are obtained by fusion of the color and depth information.
- **Task 2.E – Wafer stacking** State of the art hybrid bonding pitch was demonstrated at ST during the last period of VIZTA and a fully functional wafer testing cabability with very accurate positioning was developed at SEMILAB
- **Task 2F – 2 layers VIZTA Test Vehicle with hybrid bonding and 1x5µm High Density TSV.** *[CEA-Leti]* has successfully demonstrated the full integration by morphological and electrical characterizations. Morphological results confirmed the good connectivity of the 1x5µm TSVs within the 3D layers stack. Encouraging electrical results have been obtained for our Kelvin and Daisy Chains structures (R < 1Ω).

ECSEL Joint Undertaking

VIZTA

This project has received funding from the ECSEL Joint Undertaking (JU) under grant agreement No 826600. The JU receives support from the European Union's Horizon 2020 research and innovation programme and France, Sweden, Greece, Spain, United Kingdom, Germany, Luxembourg, Latvia, Hungary. The VIZTA project results presented reflect only the author's view. The Commission is not responsible for any use that may be made of the information it contains

- **Task 2.G – VCSEL Development:** In VIZTA [**TRUMPF**] **Photonic Components** developed the technology for the new product platform **ViBO** (stands for VCSEL with integrated Backside Optics). This revolutionizes the VCSEL technology and offers superior performance for illumination in 3D sensing applications as well as cost advantages compared to standard VCSEL devices that are combined with external optics.
  Lenses are directly etched into the GaAs substrate (Figure1). This enables a breakthrough in miniaturization. The monolithically integrated optics on wafer level is not removable guarantying life-long laser safety without additional interfaces. Furthermore, the **ViBO** product platform allows tailored illumination profiles: uniform flood illumination is possible as well as multi-spot illumination for consumer or automotive applications such as LiDAR. Addressability of multiple zones on a chip is implemented for enhanced illumination and sensing schemes (Figure 2).

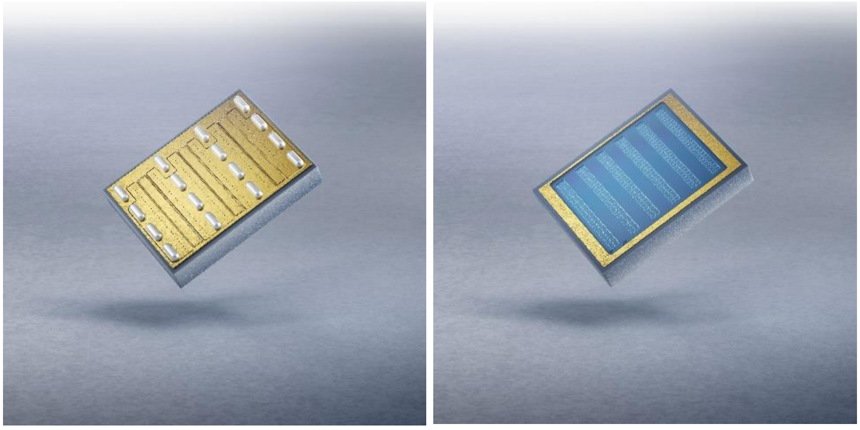


Figure 1:

ViBO chip contact side (left) and optics side (right). Lens structures are directly etched into the GaAs.

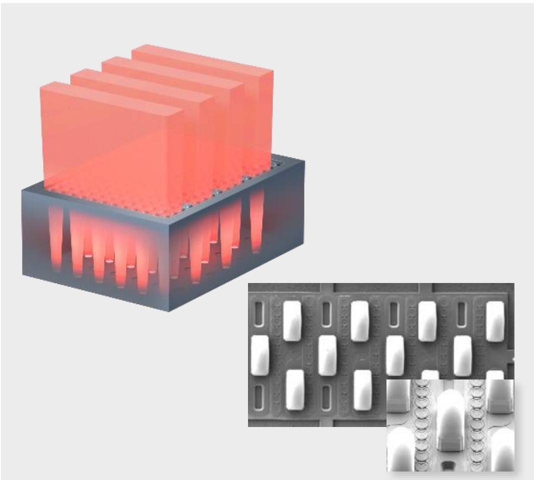


Figure 2:

Scanning line system made with an addressable stripe pattern.

The electron microscope pictures show details of the contact side of the chip.

The WP3 consists in development and realization of several demonstrators of Z sensing applications with low range 3D sensors: Biometric system, in-cabin monitoring system, smart building management, 3D multi-camera system for Industry 4.0, automotive driver monitoring systems with 3D mapping and finally mobile robotics for smart cities.

- <u>Development of z-sensor prototype</u>
  - [ST] delivered demo platform of Z-sensor S2 to the partners, including the software under Windows and Linux.
  - [ST] has released to open market the S2 die as a standard product referenced **VD55H1**

S2 camera (ST)

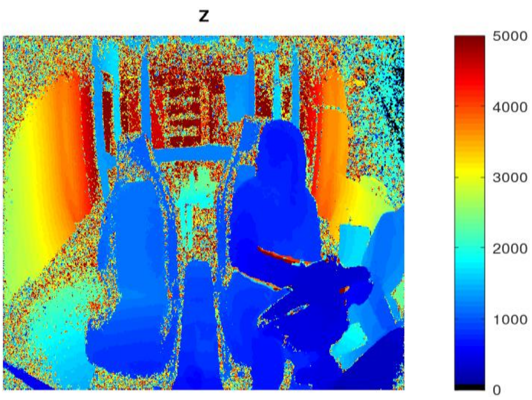
VDH55H1 Product release (ST)

This project has received funding from the ECSEL Joint Undertaking (JU) under grant agreement No 826600. The JU receives support from the European Union's Horizon 2020 research and innovation programme and France, Sweden, Greece, Spain, United Kingdom, Germany, Luxembourg, Latvia, Hungary. The VIZTA project results presented reflect only the author's view. The Commission is not responsible for any use that may be made of the information it contains

- <u>Development of application demonstrators</u>
    - <u>Security</u>
        - **[IDEMIA]** specified a new robust biometric system for human identification in Z-sensor stacked layer. The biometric algorithms have been exported to the target embedded execution environment and have been optimized. **[IDEMIA]** have an initial 3D face recognition demonstrator available
        - S2 sensor has been integrated in a live demonstrator, and algorithms have been implemented in industrial components; demonstrator implements an access control scenario: Enrolment and then verification of identity, improvement of 3D rendering, spatial filtering, noise reduction and per pixel calibration permitted to reach high performances versus presentation attacks

3D face acquisition views using S2 sensor (IDEMIA)

    - <u>Automotive & smart building</u>
        - **In-cabin automotive demonstrator AS2: (DFKI+IEE]** worked on real-time embedded demonstrator for occupant detection and sensing based on Kinect Azure; performance in terms of mean Average Precision (mAP) over 4 classes on a given dataset is 91,11%. S2 evaluation kit adapted to wide field of view and integrated in driving simulator. A Verified and optimized algorithm for in-cabin functions has been delivered; the integrated final demonstrator hardware for in-cabin scenarios is completed and functional
        - **Smart building management demonstrator AS3: (DFKI+IEE]** worked on real-time demonstrator of deep-learning person detection and segmentation algorithm, Performance in terms of mAP on dataset is 88.62%, Real-time demonstrator for multi-lane access control application; Verified and optimized algorithm for smart building functions; final demonstrator hardware for smart building is completed and functional
        - **[IDNEO]** presented S2 platform working in real time and in real scenario for drowsiness detection analysis in a vehicle. The quality of the signal extracted is high with a person's coefficient of similarity with the gold standard of 0.99. This KPI targeted for breathing extraction correlation is now satisfactory achieved



In-cabin modified S2 3D picture (IEE/DFKI)

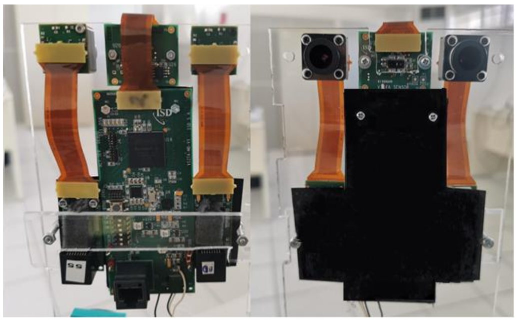
Smart building bench (IEE/DFKI)

Drowsiness detection (IDNEO)

    - <u>Industry 4.0</u>
        - **[ISD]** integrated of **ST** Z-sensor S0 in a complex/dense multi-camera system, such integration was successfully conducted and permits to enhance efficiently the low distance capabilities
        - **[EDI]** has integrated components into a robot for waste recycling, with the training data for perception system. Tests were conducted with addition of acoustic system, as well as decision tree for selecting correct plastic type. A navigation system was developed for the additional demo component - an autonomous mobile robot
        - **[BCB]** has been successful to model a bakery line while acquiring and overlapping thermal and 3D images

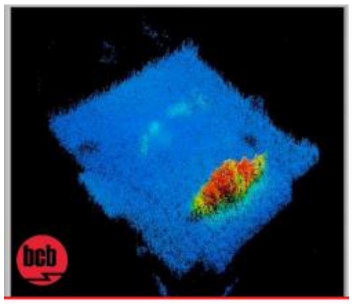
ECSEL Joint Undertaking
VIZTA

This project has received funding from the ECSEL Joint Undertaking (JU) under grant agreement No 826600. The JU receives support from the European Union's Horizon 2020 research and innovation programme and France, Sweden, Greece, Spain, United Kingdom, Germany, Luxembourg, Latvia, Hungary. The VIZTA project results presented reflect only the author's view. The Commission is not responsible for any use that may be made of the information it contains



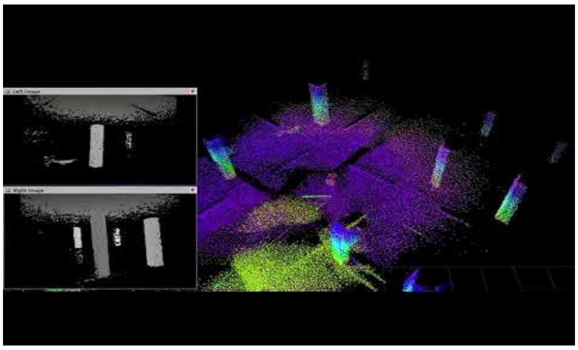
Specific board using S0 sensors (ISD)

Sensors in waste robot (EDI)



Bakery Line model (BCB)

- <u>Mobile robotics</u>
    - **[EURECAT]** has performed developments for VIO / SLAM / Scene reconstruction / object recognition and tracking for autonomous aerial inspection**.**
    - **[EURECAT]** improved and optimized the proposed SLAM algorithm for its real-time integration on-board the aerial vehicle. Tests and benchmark vs other available methods completed, using a drone and a ground robot.
    - **[EURECAT]** has successfully conducted a validation campaign inside a tunnel



Indoor test of drone equipped with S2 (EURECAT)

Tunnel tests configuration (EURECAT)

The WP4 consists of **two automotive pulsed-light LIDAR demonstrators**, one focusing on a Medium Range LIDAR (MRL) unit and another one for Long-Range LIDAR (LRL) with the development of appropriate optical sources and detectors. The two developed solutions aim to overcome the cost and reliability drawbacks of current LIDAR systems and validate new solutions. Further processing of said point-cloud for example to generate target detection and classification are not covered in the project.

- The MRL demonstration will operate at around 900nm wavelength and aims to show innovative solutions of true solid-state without any moving parts. The MRL consortium involves the partners **[ST]**, **[CEA]**, **[III-V-LAB]**. The R&D work targets an efficient high power 2D scanning Optical Phased Array (OPA) approach. Technology developments in high-power laser diodes with high beam quality and GaN related laser drivers completes this work package. Together with novel scan and signal processing algorithms a way will be paved to achieve a compact scalable and low-cost medium range LiDAR emission solution

    The VIZTA WP4 MRL team developed a Lidar emission demonstrator, which applies a novel scanning solution based on Optical Phase Array (OPA). The key components are laser, laser driver and OPA Photonics Integrated Circuit (PIC). Hera are the main results achieved:

    - All 905nm **[III-V-LAB]** laser geometries showed short pulse operation with the system driver; optical power higher than 10W is demonstrated with 4mm long cavity and a geometry with a scalable approach; Planar tapered laser shows optical power of 8W; The different laser geometries met expectations for short pulse peak power.
    - High power laser coupling: VIZTA lasers must be very powerful (10W +) and monomodal operation; **[III-V-labs]** and **[CEA]** studied a method of coupling a tapered laser to the OPA PIC: this method requires the laser facette to be placed very close to the OPA chip edge. Coupling bench was constructed and validated. Laser is positioned in 6 axes with nanometric precision. First tests showed light coupling and permitted to assess the power losses budget and potentialities for future integrated scaled solutions.

This project has received funding from the ECSEL Joint Undertaking (JU) under grant agreement No 826600. The JU receives support from the European Union's Horizon 2020 research and innovation programme and France, Sweden, Greece, Spain, United Kingdom, Germany, Luxembourg, Latvia, Hungary. The VIZTA project results presented reflect only the author's view. The Commission is not responsible for any use that may be made of the information it contains

- 2D Emission module integration **[LETI]**, **[ST]:** Motherboard and Daughterboard PCB have been designed, fabricated, and received; wire bonding test has been performed by **[ST]**; the Copper OPA mount/heatsink has been designed, fabricated and received, final assembly is in progress with 2D capable OPA new generation design.

- The LRL demonstrator uses the more eye safe wavelength at 1550nm. The longer 1550nm wavelength will allow a higher emitted power level while maintaining eye safety class 1 level. A multiplexed single point detector will be used.

The LRL demonstrators involves VIZTA partners, [**III-V Lab**], **[Beamagine]**, **[LETI]**, **[Keopsys]**, **[Quantel Technologies]**, **[UPC]** and **[Veoneer]**

- Several demonstrators were designed and validated showing high potential of solutions in term of performance and costs.
- **[LETI]** developed innovative micro-mirrors process able to sustain high power laser beams.
- **[QUANTEL]** completed a high performance, cost competitive, fiber laser source.
- **[Keopsys]** successfully integrated high power laser bar source provided by **[III-V Lab]**
- For timing and financial reasons, the **[III-V La**b] sensors in the proof-of-concept demonstrators will not comply with ultimate production targeted units but were selected to achieve a reasonable demonstrator to prove the viability of the sensor systems to affordably achieve increased performance also in adverse weather conditions.
- **[Veonner, Beamagine]:** A successful test of automotive use case "lost cargo/road debris" was conducted in last September with detection up to around 200m with relatively high ambient light.

Within the WP1 – consisting in Exploitation and Dissemination of the results obtained in each development WP,

- **[ALTER]** was monitoring the activities concerning the IPRs and VIZTA products/services which were introduced in the market. Together with the partners has prepared the deliverable 1.8 Exploitations actions report. This deliverable contains summary of the partners´ actions to assure correct protection of the IPRs, summary of the products and services introduced to the market, details about testing of some components according to the applicable standards.
- Still impacted by COVID-19 time, conferences are partially moved into webinar or coming back in presence.
- Papers have been published by **[EDI], [CEA], [DFKI-IEE], [ST]** and **[Trumpf]. [IEE], [DFKI], [Beamagine]** were active at conferences and Seminars**. [ALTER]** was active on industrial meetings.
- Promotion on articles or active partner participation to conference have been provided on our website and on LinkedIn for all events related to VIZTA.

Finally, ST insured the continuous project management with the support of [**Benkei**] in WP5; during the last period, the M42 EB meeting was successfully organized in October 2022, in Grenoble, thanks to partner **[ST].**

Summary

Completing its 42-month planned duration, the VIZTA project and its consortium achieved significant outcomes in Technologies and Applications systems. The deliberate choice to gather complementary industrial actors across the supply-chain from equipment tools up to system OEMs with scientific support from academics and RTOs resulted in a fruitful collaborative spirit while addressing concrete exploitation targets. This resulted in several domains demonstrations with representative measured KPIs achievements, leading the path to future industrial products, methodologies, techniques or services.

Follow us to stay tuned for further news…

This project has received funding from the ECSEL Joint Undertaking (JU) under grant agreement No 826600. The JU receives support from the European Union's Horizon 2020 research and innovation programme and France, Sweden, Greece, Spain, United Kingdom, Germany, Luxembourg, Latvia, Hungary. The VIZTA project results presented reflect only the author's view. The Commission is not responsible for any use that may be made of the information it contains