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

Newsletter – January 2021

The VIZTA project has reached 1.5-year activity, several meetings have gathered the representatives of all partners, the work got off to a good start, and first fruitful results have already enlightened the collaboration between the partners.

VIZTA objectives and means.

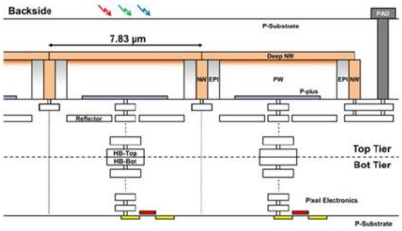
The objectives of the project are to develop innovative technologies for optical sensors and laser sources, for short to long-range 3D-imaging, and demonstrate their value in several key applications. Such objectives are addressed by building partnership ecosystems, exercise new 3D sensors and light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

VIZTA progress: significant steps in 18 months

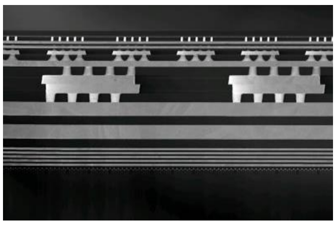
We propose hereafter a compilation of the different partners contributions starting from Technology developments, then components and application systems for short and long-range up to actions of exploitation and dissemination.

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

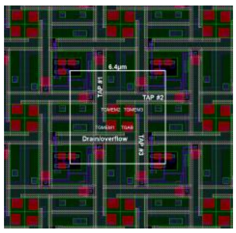
The WP2 is dedicated to advance device and technology development needed for the demonstrators used in the other work packages, and subdivided in 5 main tasks:



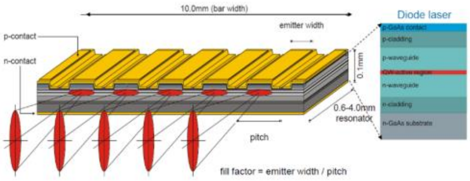
Advanced SPAD_3D



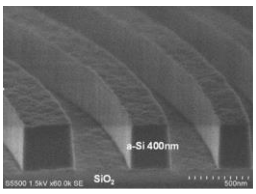
Hybrid Bonding solutions



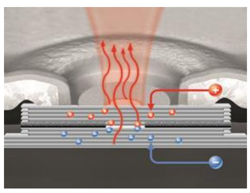
Lock-in pixels



High power Laser bar



Diffractive micro-lenses



VCSEL with integrated optics

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.

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- SPAD (Single Photon Avalanche Diode) and lock-in pixel development: **STMUK**, **ST SAS C2**, **ST SAS GNB** and **LETI** have collaborated to manufacture pixels for ToF prototypes using SPADs and lock-in pixels in STMicroelectronics' proprietary 3D stacked technology. The i-ToF pixel has now been embedded in the VIZTA sensor S2. The SPAD pixel has achieved all expected target specifications.

- New filter approach is being investigated at **CEA**.

- 3D Hybrid bonding: Double-stacked hybrid bonding short Loop wafers have been provided by **ST-SAS-C2** to **SEMILAB** for first characterization using Polarized Scanning IR (PSI) technique and IR overlay measurement. **SEMILAB** is optimizing these technologies specifically to be applicable for bonded wafers. Wafers had been pre-characterized at **STM SAS C2** facilities using Scanning Acoustic Microscopy (SAM) and nano-topography measurements. SAM and PSI cartographies have been compared to assess for the sensitivity of the respective techniques to the presence of Voids generally armful for the bonding quality. PSI images reveal areas on the wafer exhibiting high local stress in addition the area with presence of Voids that were already captured by SAM. Next step is now to better understand the origin of the observed stress and its potential impact in the bonding quality.

- F2B bonding in CEA has now a mask set for 1µm TSV hybrid bonding test vehicle fabrication.

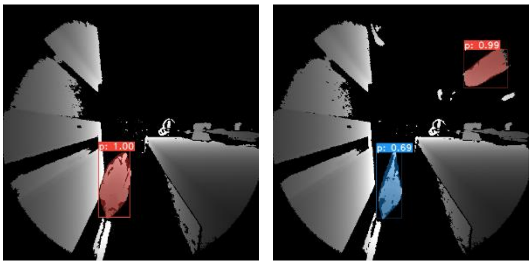
- VCSEL development: The feasibility of the VCSEL concept with 10 addressable zones and integrated GaAs optics for beam shaping has been successfully demonstrated by **TRUMPF**. Chips have been made and characterized, routes for improvements in the next project phase are identified.

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.

- **ST** is developing z-sensor prototypes. The on-going evaluations demonstrate good progress to confirm soon availability to applicative partners.

- **IDEMIA, IEE, DFKI, ISD, EDI, BCB, AAA** and **EURECAT** started the development of the applicative demonstrator's algorithms from the delivered specifications based on **ST** upcoming available z-sensor prototypes.

- **IEE** and **DFKI** progress on the in-cabin and smart building data sets for scientific research community, and shared some videos about their Anomaly Detection dataset : https://youtu.be/WjQzevh024w and their Detection and Segmentation in top-down view: https://youtu.be/54fjYbYmHqI .



- WP3 partners **ST, IDEMIA, IEE, DFKI, ISD, EDI, BCB, AAA** and **EURECAT** exchange each month their progress and regularly review the actions to address the technical challenges.

The WP4 consists of **two automotive 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 2 developed solutions aim to overcome the cost and reliability drawbacks of current LIDAR systems and address the problem of perception capability in restricted visibility conditions with adverse weather conditions. Further processing of said point-cloud for example to generate target detection and classification are not covered in the project.

ECSEL Joint Undertaking

VIZTA

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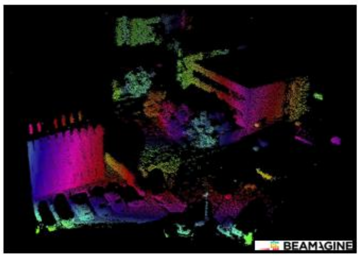
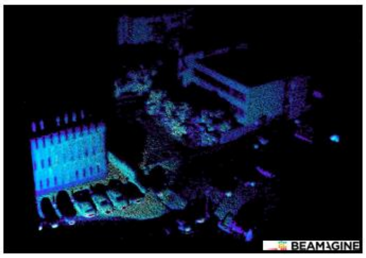
- The MRL demonstrator will operate at around 900nm wavelength and aims an automotive application related LiDAR demonstration with a TRL of 3 to 5 and being true solid-state without any moving parts. The MRL consortium involves the partners **ST**, **CEA**, **III-V-LAB** and **IBEO Automotive Systems**. The R&D work targets a large sized latest generation SPAD array with enhanced sensitivity and an efficient high power 2D scanning Optical Phased Array approach. Technology developments in high-power laser diodes with high beam quality and GaN related laser drivers complete this work package. Together with novel scan and signal processing algorithms a way will be paved to achieve a compact and low-cost medium range LiDAR.
    - The VIZTA MRL will represent a Lidar demonstrator, which applies a novel scanning solution based on Optical Phase Array (OPA). The key components are laser, laser driver and OPA, as the illuminator, as well as a SPAD Receiver Chip.
    - While developing a high-power laser with short pulses, **III-V-Lab** achieved to finish processing of three different epitaxial structures in three different generic geometries and complete characterization of all three structures. Based on these experimental results and the modelling results, the best lasers were nominated. The design for the 2nd generation of the laser began accordingly. Two laser drivers, which represent two different approaches to achieve the requirements, such as short pulses and high repetition rate, are purchased. The electrical and optical characterization of the one, which was delivered with the supplier laser, started and is still in progress. The second driver was characterized electrically to an extensive level.
    - For development of the OPA, **LETI** characterized the first mask set (VIZ0), containing various circuits. Some of the main features were validated. They finished also the second mask set (VIZ1) to launch the fabrication. Furthermore, the OPA characterization system was improved significantly. The OPA control mechanism through FPGA is under preparation by **IBEO.**
    - Concerning the development of the SPAD receiver Chip by **ST**, a SPAD test chip, designed by University of Edinburgh on **ST** technology, was tested, and is used for first attempts of the TDC implementation by **IBEO**. This SPAD chip is being re-specified by **ST** and **IBEO** to make a re-designed version with higher performances and compatibilities with VIZTA MRL demonstrator.
- The LRL system aims to overcome the cost and reliability problems of current LIDAR systems and addresses the problem of limited perception capability in restricted visibility conditions in adverse weather conditions. The LRL demonstrator uses the more eye safe wavelength at 1550nm instead of the common 905-940nm bands. 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 coupled with appropriate optical sources and detectors. For timing and financial reasons, the sensors in the project are intended as proof-of-concept (POC). They will therefore not comply with an ultimate production targeted system. Further processing of generated point-cloud for example to generate target detection and classification will not be covered in the project. The LRL demonstrator involves VIZTA partners, **III-V Lab**, **Beamagine**, **LETI**, **Keopsys**, **Quantel**, **UPC** and **Veoneer**.
    - The COVID-19 shut-down has had significant effects on parts of the work, resulting in a 9-month delay with delivery D4.2 'High power 1550nm laser bar gen1' due to the temporarily suspension of work in the fabs at **III-V Labs**. This delay has replicated to the work by **Quantel**. Careful rearrangement of their work has limited the overall delay of the LD illuminator to about 4 months. Partner **CEA-LETI** has managed to proceed with their work on the MEMS mirror roughly on schedule, as did partner **UPC** and **Beamagine** who have adopted modular use of Commercial-Of-The-Shelf (COTS) components for the building of the system demonstrator.

Urban scene



Depth coded as false color



coded in detected intensity
dark blue = faint signal / light blue = intense signal

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Within the WP1 – consisting in Exploitation and Dissemination of the results obtained in each development WP, individual workshops with several partners have been carried out to prepare the update of the exploitation plan by **ALTER** and to redefine, if necessary, the identified exploitation results. In parallel, those partners who are developing components within the project are carrying out component compliance activities to assure the safety of their potential future products.

During COVID-19 time, conferences are moved into webinar, and partner's contribution are converted into this new communication style. Meetings are moved not only in style, but also through the calendar, so most contributions are shifted in time. A paper has been proposed by LETI ("*Three-dimensional hybrid bonding integration challenges and solutions toward multi-wafer stacking*", L. Arnaud et al.), and several contributions are announced for the next quarter. Finally, ST assures the continuous project management with the support of Ayming in WP5; during the last period, the 18 EB meeting via vision-conference was successfully organized in November 2020.

Summary

After 18-month activity, the VIZTA project and its consortium are fully operational and generate first 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 results in a dynamic collaborative spirit while addressing concrete exploitation targets. In the next coming months, the demonstrators will be delivered as proof of concept, leading the path to industrial products.

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