Newsletter – June 2022

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

The VIZTA project has now reached 3-Years of activity, several meetings have cemented relationships among the representatives of all partners, significant results have already emerged from the collaborations induced by this project. This June 2022 newsletter is proposing to take stock of the project status and achievements.

VIZTA objectives and means

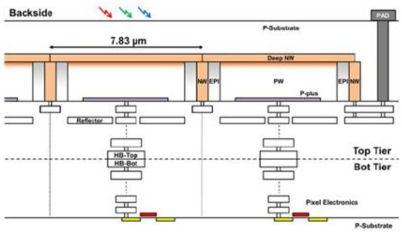
The objectives of the project are to develop innovative technologies for optical sensors and laser sources, for short to long-range 3D-imaging, and demonstrate their value in several key applications. Such objectives are addressed by building partnership ecosystems, exercise new 3D sensors and light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

VIZTA progress: significant steps in 36 months

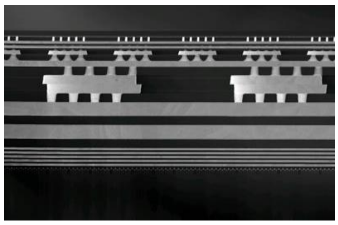
We propose hereafter a compilation of the different partners contributions starting from Technology developments, then components and application systems for short and long-range up to actions of exploitation and dissemination.

The VIZTA project developments are structured in 5 Work Packages (WP) focusing several tasks.

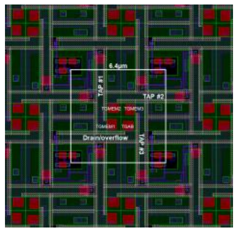
The WP2 is dedicated to advance device and technology development needed for the demonstrators used in the other work packages, and subdivided in 5 main tasks:



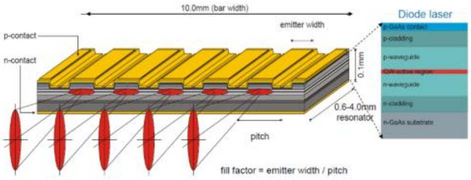
Advanced SPAD_3D



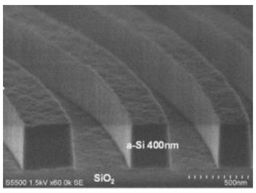
Hybrid Bonding solutions



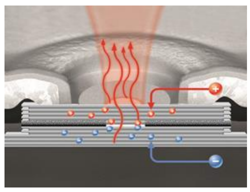
Lock-in pixels



High power Laser bar



Diffractive micro-lenses



VCSEL with integrated

- **Task 2.A - SPAD pixel**: A small new pitch diode has been defined with a clear set of performance targets
- **Task 2.C/D - RGBZ sensor**: In continuity with the Generation 1 demonstrator (RGGB 1.4µm / Z 2.8µm), the Generation 2 (RGBZ 1.4µm) has been tested without integrated infrared filtering solutions. This test chip with a Z pixel in voltage domain with a reduced pitch at 1.4µm exhibit a pulsed Parasitic Light Sensitivity value below 7% and an Impulse Response Time of 86% at 50MHz
- The full demonstration of T5 demonstrator with filtering solution with a pitch of 1.4µm for RGB and Z pixels is expected by the end of VIZTA project (deliverable D2.5 in October 2022)

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- **Task 2.E – Wafer stacking** During this 6-month period, collaboration with **[SEMILAB]** team has been pursued on the development of the new A-IR platform for IR overlay through regular meeting and discussion. All information on **[ST]** test wafers and associated industrial requirement have been exchanged to **[SEMILAB]**. For the new architecture of bonding, new test wafers have been processed correctly at bonding step and will need to complete the process flow in the **[ST]** fab for electrical test.
- **Task 2.F - F2B Bonding: TSV 1x5µm [CEA]** fabricated the 1x5µm TSVs by finding the appropriate parameters for etching and copper metallization. Hybrid bonding pads were also created to make the second bonding. First trials of second bonding (hybrid bonding) were performed. Electrical and morphological results were available for October 2022.
- **Task 2.G – VCSEL Development: [TRUMPF]** drives VCSEL array technology further and developed new VCSEL platform with monolithically integrated micro-optical elements for 3D sensing applications which can be tailored towards applications in smart glasses, face recognition or LiDAR. Based on chips smaller than 1mm power output of more than 3W in qcw operation and more than 10W in short pulses have been demonstrated. Pulse raise times are 5x shorter than with traditional VCSEL chips and the integrated optics guarantees inherent eye-safety.

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.

- Development of z-sensor prototype
  - **[ST]** delivered samples from Z-sensor S0 to **[ISD], [EDI], [BCB]**
  - **[ST]** delivered demo platform of Z-sensor S2 to the partners, including the software under Windows and Linux.
  - **[ST]** announced that This S2 is now becoming delivered as a standard product referenced **VD55H1** securing further supplies beyond VIZTA project completion.

- Development of application demonstrators
  - Security
    - **[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 are currently being optimized. **[IDEMIA]** have an initial 3D face recognition prototype 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; demonstrator evaluation is ongoing for presentation attacks.

  - Automotive & smart building
    - **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 mAP over 4 classes on dataset D3.11 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 has been delivered.

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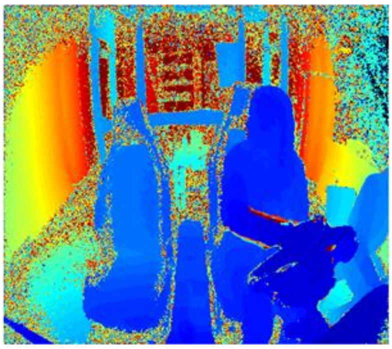
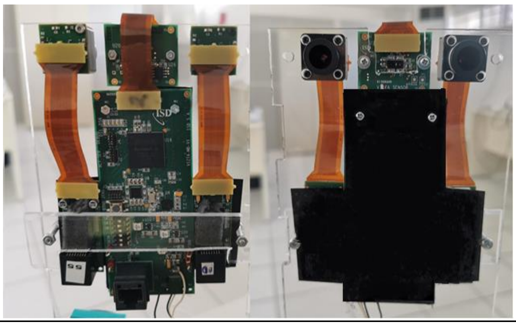
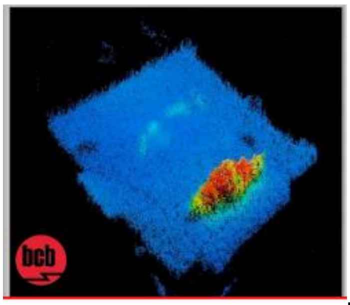
- **Smart building management demonstrator AS3: [DFKI+IEE]** worked on real-time demonstrator of deep-learning person detection and segmentation algorithm, Performance in terms of mAP on dataset D3.15 is 88.62%, Real-time demonstrator for multi-lane access control application; Verified and optimized algorithm for smart building functions; final demonstrator hardware for smart building has been prepared.
- [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. (KPI 3.10 for breathing extraction correlation passed).

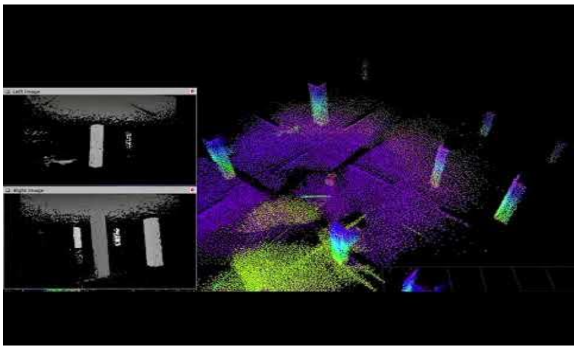


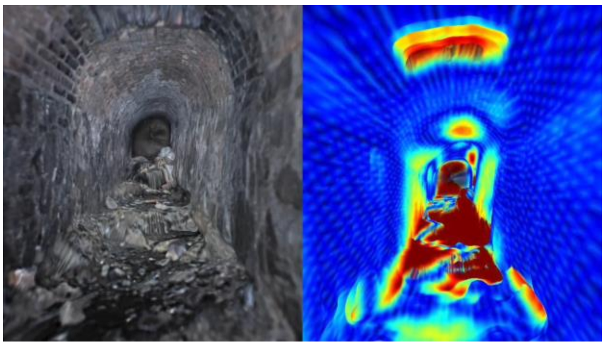
- Industry 4.0
  - [ISD] integrated of **ST** Z-sensor S0 in multi-camera system
  - [EDI] has integrated most components into a robot for waste recycling, with the training data for perception system. Tests are being conducted with addition of acoustic system, as well as decision tree for selecting correct plastic type. A navigation system was developed for an additional demo component: an autonomous mobile robot
  - [BCB] has been successful to model a bakery line while acquiring and overlapping thermal and 3D images





- Mobile robotics
  - [EURECAT] continue 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 continue, using a drone and a ground robot.
  - [EURECAT] is preparing a validation campaign on-site inside a real tunnel





ECSEL Joint Undertaking
VIZTA

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The **WP4** consisted initially 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 two 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.

- The MRL demonstrator will operate at around 900nm wavelength and aims an automotive application related LiDAR demonstration with a TRL of 3 to 4 and being true solid-state without any moving parts. The MRL consortium involves the partners [**ST**]**, [IBEO]**, [**CEA**], [**III-V-LAB**]. The R&D work includes a 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 pave the way to 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.
        - 905nm LASER and T4.2.D GaN driver **[III-V Lab]:** The driver is operational up to at least 15.5A; the clamping system and the interposer used as a laser submount allow for lasers to be rapidly mounted or swapped. This driver can be used for any laser diode mounted on the interposer. All 905nm laser types show short pulse operation using the system driver. Output optical power greater than 10W has been demonstrated with an array of 16 ridge lasers with 4mm long cavities. Such an array of ridge lasers is a scalable approach. A tapered LEG laser shows optical powers between 6W and 8W. All laser types follow expectations for short pulse peak power.
        - High power laser coupling **[LETI]**: VIZTA lasers must be very powerful (1-10+W) and exhibit single mode operation. **[III-V-labs]** has achieved this, but the price to pay is an output mode with an impractical form. We study a method of coupling a tapered laser to the OPA PIC without intermediate optics. This method requires that the laser facet be placed very close from the OPA chip edge. The etched facet of the OPA chip must protrude over the substrate. A new coupling bench has been constructed and validated. The laser can be positioned in 6 axes with nanometric precision; the laser positioning system can support the weight of the laser + driver for future pulsed emission tests. First tests showed coupling to the PIC, but we need lasers with specific packaging specifications to continue testing
        - Assembly of components for emission module almost complete **[LETI],** waiting for final OPA chips (additional process steps needed due to layout error). Laser-OPA coupling demonstration: Bench complete and operational. Development of OPA-side coupling structures (VIZ1), and new process for protruding waveguide facet. Preliminary results are encouraging.
        - A SPAD Receiver Chip (SRC1) designed by University of Edinburg (UoE) was delivered by **[STMUK]** to **[IBEO]** for verification of various TDCs • Due to limitations introduced by SRC1 (small size of the array and large size of the package), **[ST]** and **[IBEO]** decided for a new design of SRC2. Full set of specifications was issued by September 2021 by **[IBEO]** and **[ST] /** (UoE) • Task 4.2.A was stopped in December 2021 with **[IBEO]** stop and soon withdrawing information
        - Demonstrator module integration **[LETI]**: Motherboard and Daughterboard PCB have been designed, fabricated and received; a wire bonding test has been performed by **[ST]**. the Copper OPA mount/heatsink has been designed, fabricated and received; next step: OPA chip delivery for final assembly.

- 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 demonstrator involves VIZTA partners, [**III-V Lab**], **[Beamagine]**, **[LETI]**, **[Keopsys]**, **[Quantel Technologies]**, **[UPC]** and **[Veoneer]**
    - For timing and financial reasons, the sensors in the proof-of-concept demonstrators will not comply with any ultimate production targeted units but are selected to achieve a reasonable demonstrator to prove the viability of the sensor systems to affordable achieve increased performance also in adverse weather

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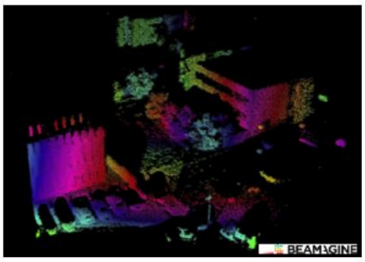
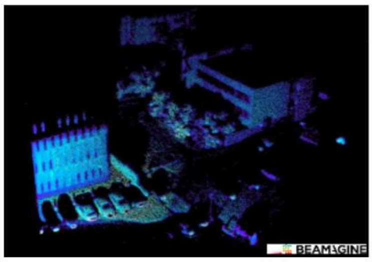
conditions.

Urban Scene



Urban scene
with depth coded as false color



Urban scene coded in detected intensity
dark blue => faint signal
light blue => intense signal

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

- Remaining individual workshops were held, and the exploitation plans were updated. Activities with Horizon Result Booster (HRB) within module C were terminated and HRB has delivered Final Report to the consortium.
- The activities with HRB within Module A were finished and HRB has delivered Final Report to the consortium with recommendation for further cooperation within Module B.
- [ALTER] together with the partners have prepared the deliverable 1.6 Assessment of VIZTA demos. Within this action regulations aspects and standards were studied by [ALTER] and recommendations were given to partners to avoid risks of non-compliance at the time to market introduction.
- Still impacted by COVID-19 time, conferences are partially moved into webinar or coming back in presence.
- Papers have been published by [EDI], [CEA-LETI] and [ALTER]. [DFKI], [Trumpf] and [ALTER] were active at conferences and Seminars. Promotion on articles or active partner participation to conference is done on our website and on LinkedIn for all events related to VIZTA

Finally, ST assure the continuous project management with the support of [Benkei] in WP5; during the last period, the M36 EB meeting was successfully organized in May 2022, in Madrid, thanks to partner **[ALTER].**

Summary

After 36-month activity, the VIZTA project and its consortium confirmed 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 results in a fruitful collaborative spirit while addressing concrete exploitation targets. In the next coming months, some more demonstrators will be presented with representative KPIs assessments, leading the path to industrial products or services deployments that will be pursued even after the VIZTA project termination planned in end October 2022.

Follow us to stay tuned for further news…

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