A scientific HDR Multi-spectral imaging platform

B. Dupont, Pyxalis, France.
OUTLINE

- HDPYX HDR Scientific Sensor platform
- First usage as hyperspectral device by Resolution Spectra and CSUG
- Perspectives
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A few words on Pyxalis

PYXALIS is a high-end CMOS Image Sensor supplier & Design house

A few figures:

- Founded in: 2010
- Team: 30 people
- Experience: 200 man-year experience in CMOS image sensors

• Located in Grenoble, France:
  700sqm offices, state of the art design center, full EO characterization

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A few words on Pyxalis

Pyxalis is a custom image sensor supplier in the field of:

- Medical
- Security
- Automotive
- Consumer
- Machine Vision
- Science
- Air and spaceborn applications

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HDPYX: Sensor architecture

• A semi-custom sensor, designed as modular platform
HDPYX: Sensor architecture

- A semi-custom sensor, designed as modular platform

  - Space born app.
  - Multi/hyperspectral application
    - With custom filters
  - Direct Xray
    - With ultra thick EPI
  - Q2 2017
  - BSI for UV enhancement
  - NIR optimized for Security
  - Custom dicing for large scanning area
  - Larger 5MP version
    - for microscopy for ex

This Paper

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HDPYX: Sensor architecture

A few specifications:
• 2800x1088 actives pixels
• 10\(\mu\)m pixel pitch
• up to 100 FPS
• 20 bits per pixel parallel data
• Processor based, instrument driven operating modes:
  • Rolling shutter
  • Global shutter
  • Low noise global shutter
  • Global reset
  • Integrating while read out (RWI)
  • Triggered acquisition
  • Triggered read out
HDPYX: Sensor architecture

- Pixel design:
  - In pixel dual gain
  - 6T pixel based
  - Global or rolling shutter
  - 2 gains in pixel
    - Ensures charge conservation!
    - Automatically switching gain during readout
    - Single readout chain

⇒ 90dB linear dynamic range

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HDPYX: HDR features

- **Dynamic range extension:**
  - Exposure time is changed line by line in a single image capture
  - Programmable integration time ratio
  - Interpolation filter to correct saturated values
  - Improves dynamic range up to 120dB

⇒ Single frame, single output, no post treatment required

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HDPYX: performances

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Low gain</th>
<th>High gain</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full well Capacity</td>
<td>85000</td>
<td>10500</td>
<td>e-</td>
</tr>
<tr>
<td>Temporal noise in darkness</td>
<td>25</td>
<td>2,6</td>
<td>e-rms</td>
</tr>
<tr>
<td>Conversion factor</td>
<td>12</td>
<td>125</td>
<td>µV/e-</td>
</tr>
</tbody>
</table>

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- Noise (1/f limited at source follower):

  ![Graph showing Temporal Noise VS I_{COL} in ERS, GH](image)

  - Nominal operating point
  - Ultra low noise mode

  Trade noise for speed if needed
HDPYX: performances

- Specific Ultra Low noise operating mode:

![Temporal Noise histogram for ROI Anag_REF (CVF = 133.75 μV/e^−, TSAT lin = 10.4 ke^-)](image)

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HDPYX: performances

- SNR over single tinT: shot noise limited

![Graph showing HDR Signal to Noise Ratio vs Mean Signal (LSB)]
HDPYX: performances

- Image lag: below $1 \text{ e}^-$
HDPYX: HDR images

Using only low gain

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Instrument design

Fringes on detector

Detector #1
Detector #2
Detector #3
Front view of Fizeau interferometer
Lateral view of Fizeau interferometer
Perspective view of Fizeau interferometer

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Sensor Module

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First products

SWIFTS-LA

high-throughput high-resolution spectroscopy:
Raman spectroscopy for process control, gas detection, hyperspectral imaging

ANAgRAM SWIFTS

Ultra High-resolution spectroscopy: typically 0.01 nm over 300 nm range laser characterization

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First Space mission

- **ATISE:**
  
  **Auroral Thermospheric and Ionospheric Spectrometer Experiment**
  
  - Spectral analysis of the Auroral emissions
  
  - Space weather
  
  - In the visible light
  
  - Prior Art:
    
    Arizona Airglow GLO experiment in UV range
ATISE Instrument

- 6U nanosat
- Instrument using 3 HDPYX with 6 Fizeau interferometer
- 6° by 1.5° FOV
- In the visible range: 380 nm to 900 nm
- Using 3 HDPYX detectors
ATISE Instrument

- First results using Argon plasma signature
ATISE Instrument

- First results using Argon plasma signature
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ATISE Instrument

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OUTLINE

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- Perspectives
• the instrument concept is valid and that sensor is suitable for production

• Sensor will be deployed in hyperspectral/multispectral systems

• From space applications:
  • Other missions with Cube sats are under discussions

• New variations around the detector for UV/NIR, Xray are under consideration
Thank you!
Come visit us on booth 1308!