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Progress report on WP4 in UC3M

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Outline

- What is WP4 for UC3M
- How the produced technology can be applied
- Prototype
- Firmware architecture
- Considerations, future work

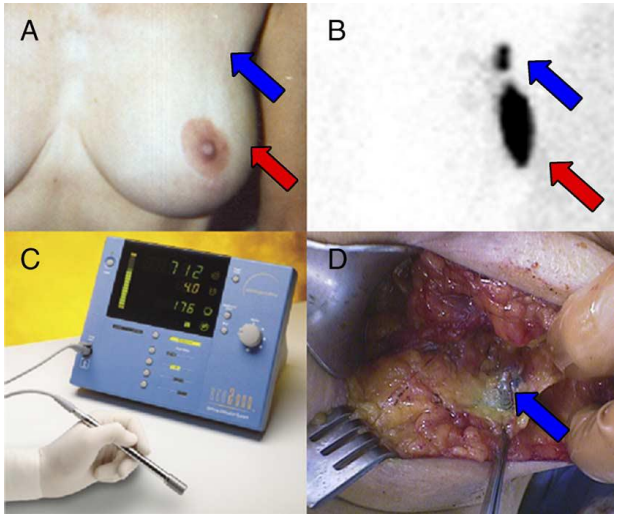
[M.S. Judenhofer, 2008]

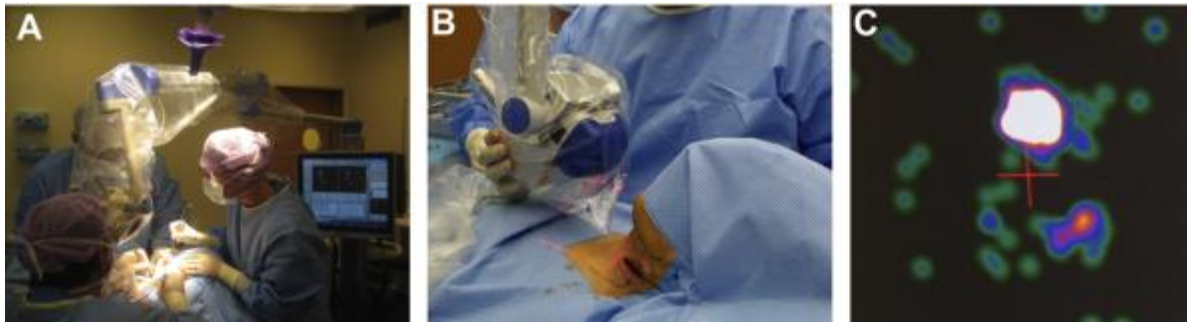
Work Package 4

- WP4: Developing next generation highly performing digital processing system, based on the next generation FPGA.
- For instance, Xilinx Zinq integrating programmable logic with micro processing features
- How can we use such an FPGA in a medical imaging scenario?

Intraoperative Gamma camera

- Portable handheld application, used to detect radioactive tracers on tumors, during operation.
- Several clinical uses
  - Sentinel lymph node removal
  - Parathyroid gland surgery
  - Radioimmunoguided surgery
  - 18F-fluorodeoxyglucose (FDG) radioguided surgery.





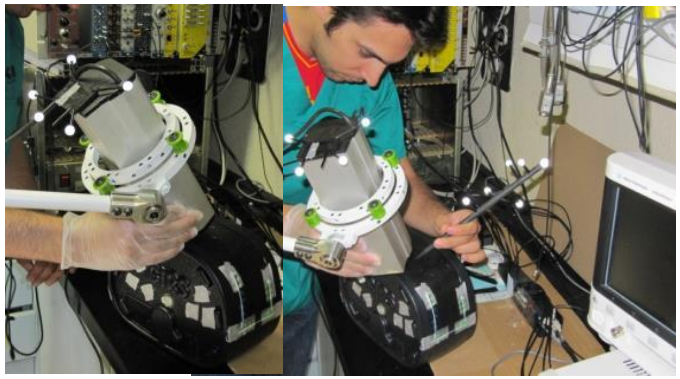
[Tsuchimochi 2012], [Wallace 2005]

Intraoperative Gamma Camera

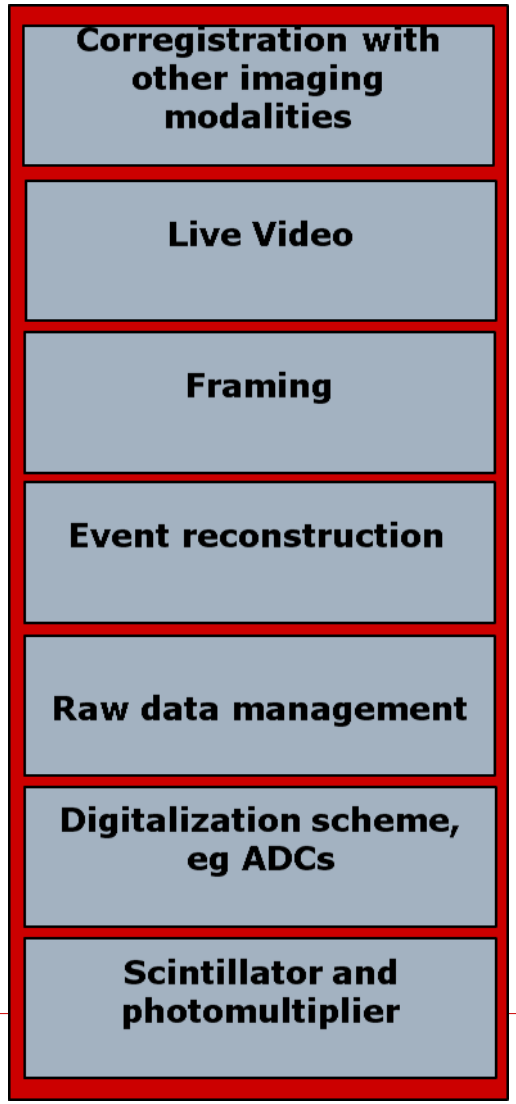
- What could an innovative design include?
  - Miniaturization of electronics
  - Broad spectrum processing, from low level event reconstruction, raw data management, live imaging, multimodal corregistration, eg with image-guided surgical systems .
  - Movement free back-end communication.
  - Handy and comfortable, lightweight, low power…

Intraoperative Gamma Camera

- What could an innovative design include?



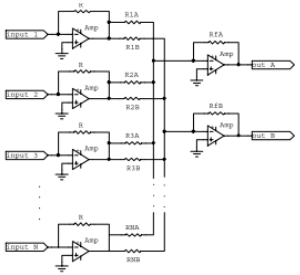
- Handy and comfortable, lightweight, low power…



Intraoperative Gamma Camera prototype

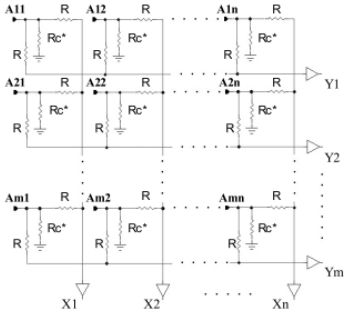
Detector electronics miniaturization

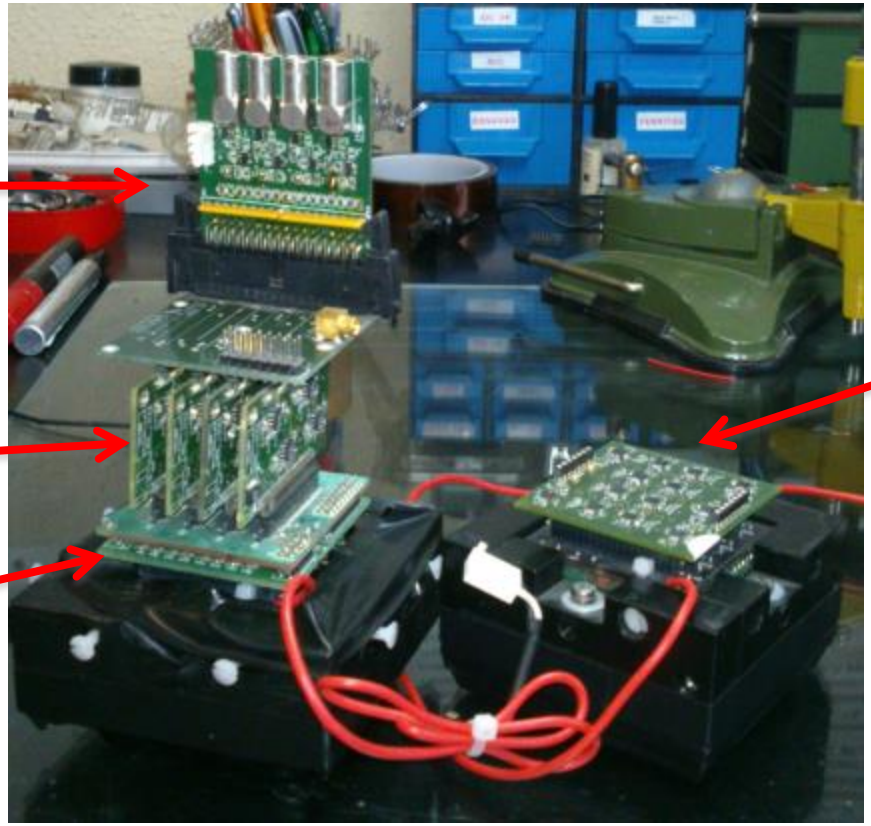
Part3 - Anger Logic 16→4(Xa,Xb,Ya,Yb)



Part2 Amplification

Part1 – Charge distribution network 64→16(8x+8y)





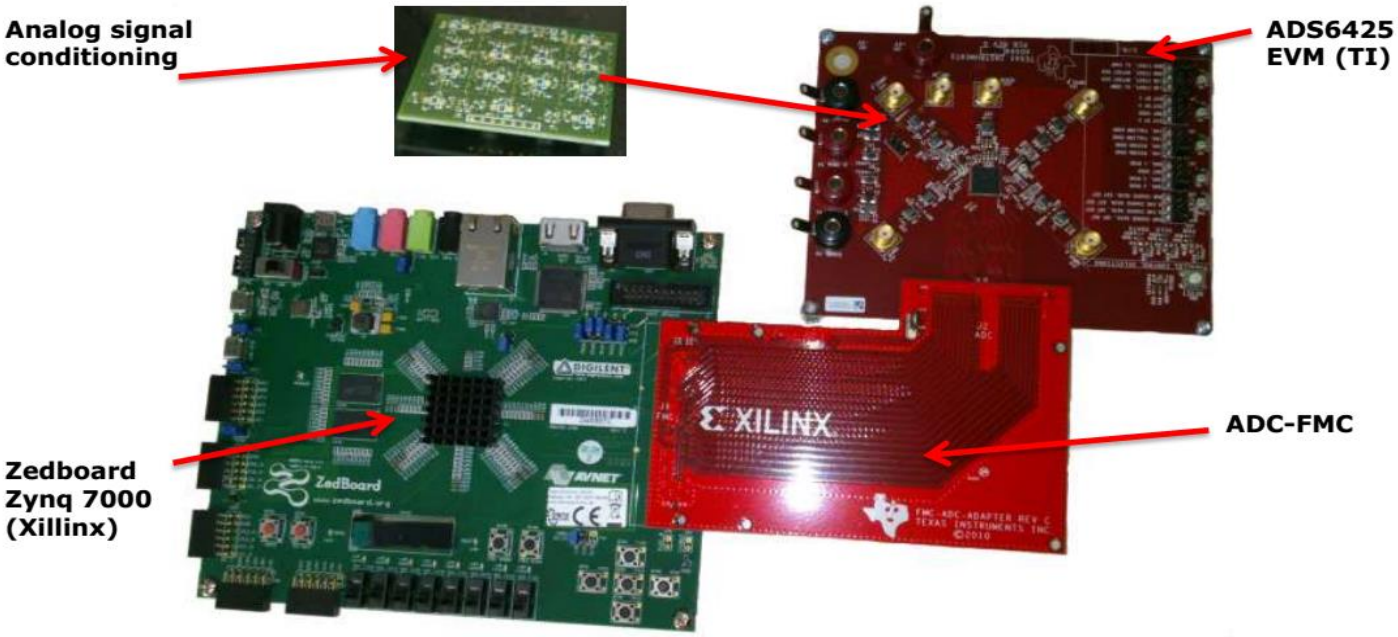
Single PCB
- **Charge distribution**
- **Amplification**
- **Anger logic**

Same collimators as previous design

Previous design **Current design**

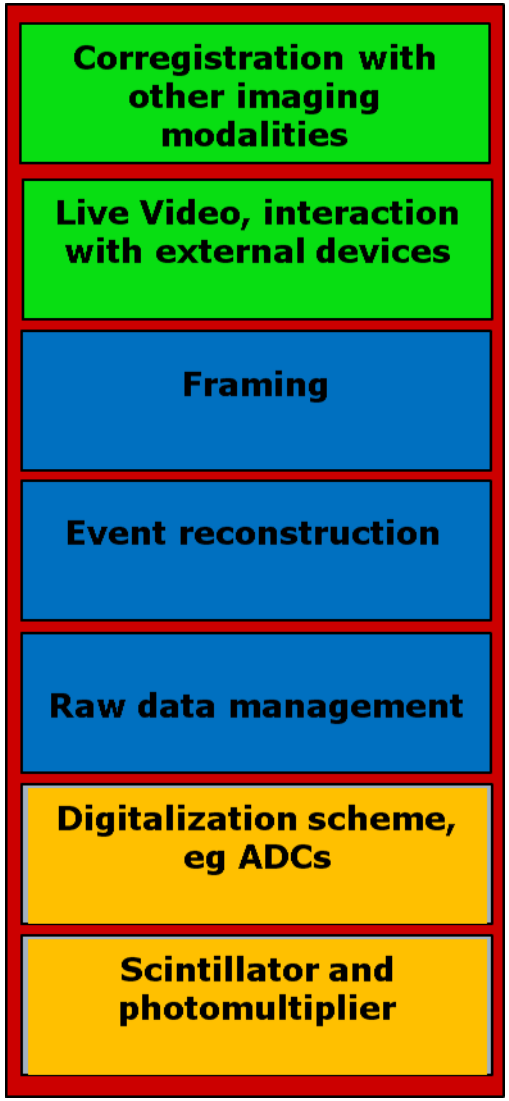
Intraoperative Gamma Camera prototype

- A single Texas Instruments ADS6425 at a maximum rate of 125MHz.
- The innovative hybrid FPGA, Xilinx Zinq7020



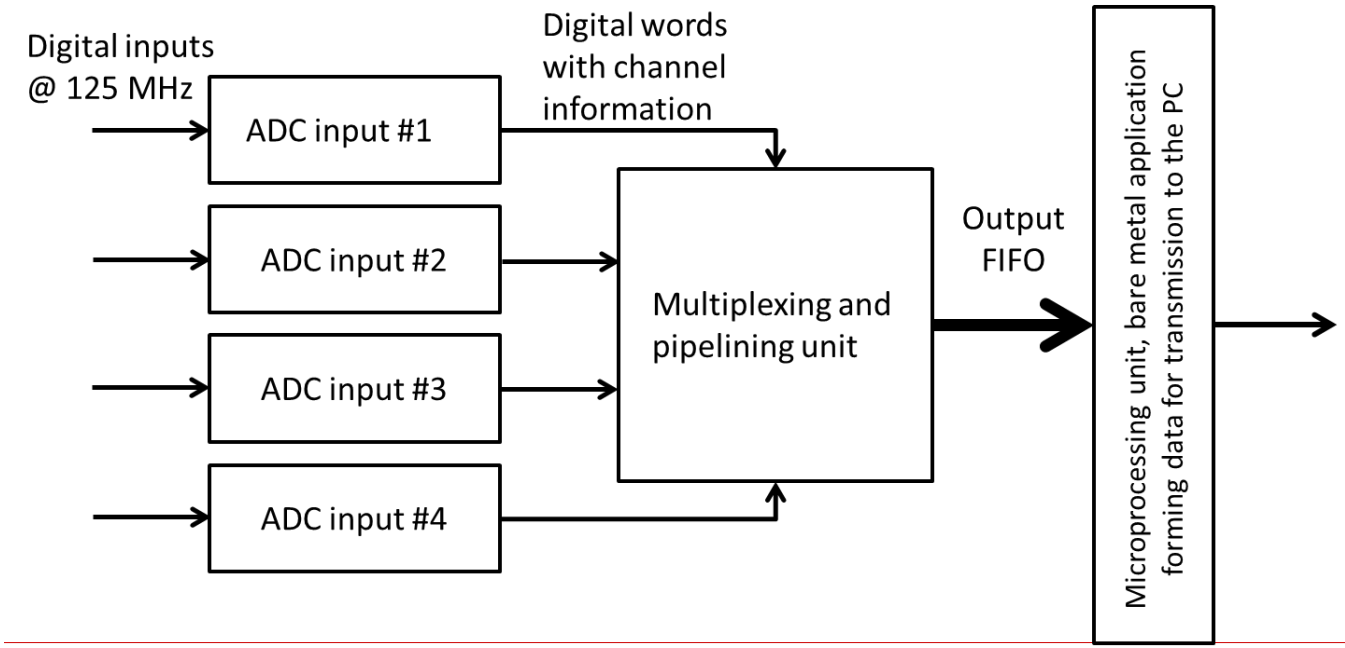
XILINX ZYNQ

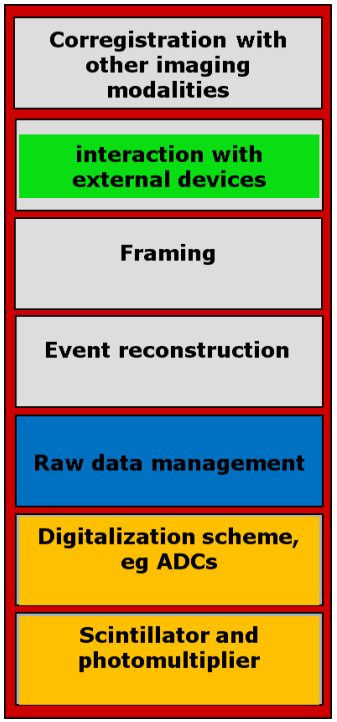
- Software programmability of an ARM-based processor , cabable of hosting a full lightweight operational system as RPi, Archlinux or the dedicated Xilinux.
- Firmware programmability of an FPGA equal in size and considerations to an Artix (not high end) FPGA.



XILINX ZYNQ – Firmware prototype

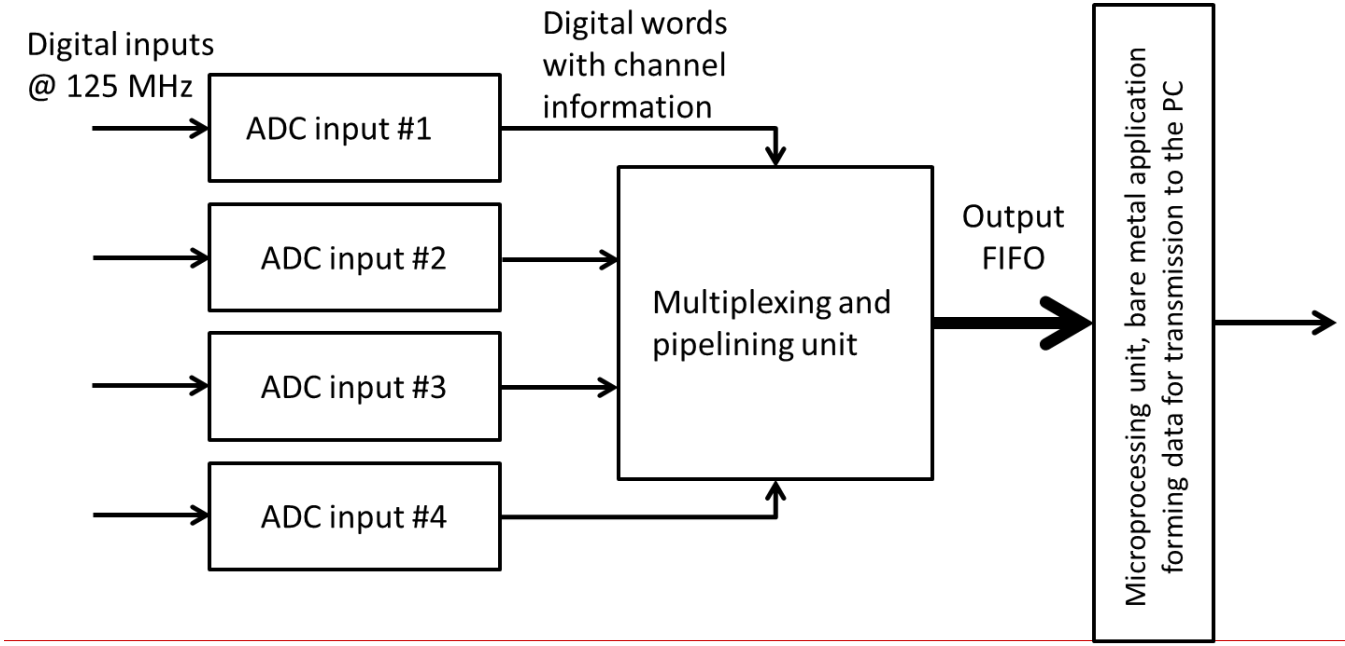
- Initial prototype (R. Chil) included a light version
- Algorithmic development from raw data was undertaken on PC
- Hopeful results

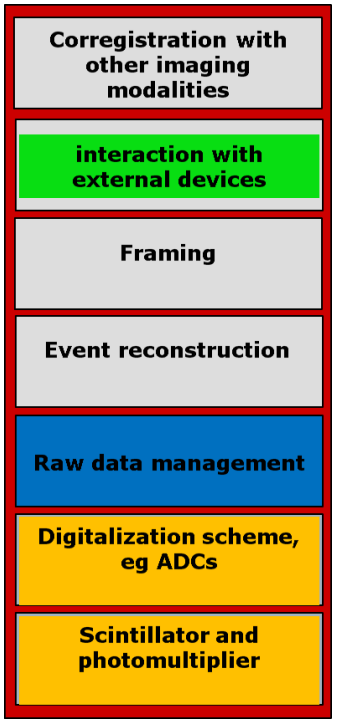




XILINX VIRTEX VI– Firmware prototype

- We have moved our processing in the Nutaq
- More inputs and automated data interface
- Better understanding of signal nature





Future work - Considerations

- Could a lightweight linux on an ARM core handle live video + corregistration?
- Could a commercial battery power the design for sufficient time, with sufficient power dissipation etc?
- Could we make all of this electronics and functionality fit inside a handheld device without external module?
- How will the communication with external devices (eg screen) be realized?

This scenario falls within specifications of the OWC, real conditions testing is pending

Intraoperative Gamma Camera

System Specifications:

1. Maximum data stream of 1.25MB/s
2. 1 meter radius, half sphere orientation inclination
3. Objects or people blocking the line of sight (redundancy is proposed).
4. Drops in signal rate are allowed if recovery doesn't take more than two or three seconds.
5. Asymmetrical duplex communication is required in order to calibrate and adjust the device.
6. With different proposed configurations of the operating room, using optical wireless communication (OWC) can be a possible solution for the readout of the gamma camera.

The end

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