Brazilian Application to RD51

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for the USP/UNICAMP group

The USP/UNICAMP Relativistic Heavy Ion Group

- Universidade de São Paulo (USP) and Universidade Estadual de Campinas (UNICAMP), Brazil,
  - Two of the best evaluated Universities in Latin-America
  - Several infra-structure facilities available

www.usp.br

www.unicamp.br

The USP/UNICAMP Relativistic Heavy Ion Group

- Members of the group that will be involved in RD51 (so far)
- USP
  - 04 faculties
  - 02 post-docs
  - 01 PhD student
  - 01 Master student
- UNICAMP
  - 01 faculty
- Collaboration with other institutes
  - Engineering School from USP
  - Research Institute for Nuclear Energy (National Institute)

The Group Background

- The group has a large experience in nuclear and particle physics instrumentation
- Development of several systems for the local low energy nuclear physics facility (8 MV Pelletron type accelerator)
- Member of the E864 AGS-BNL experiment
  - Participation in the construction and operation of the Hadronic Calorimeter
- Member of the STAR RHIC-BNL collaboration from1995 to 2013
  - Participation in the research and development of Silicon Drift Detectors for the Silicon Vertex Tracker
  - Coordination of installation, tests and electronics certification of the Electromagnetic Calorimeter

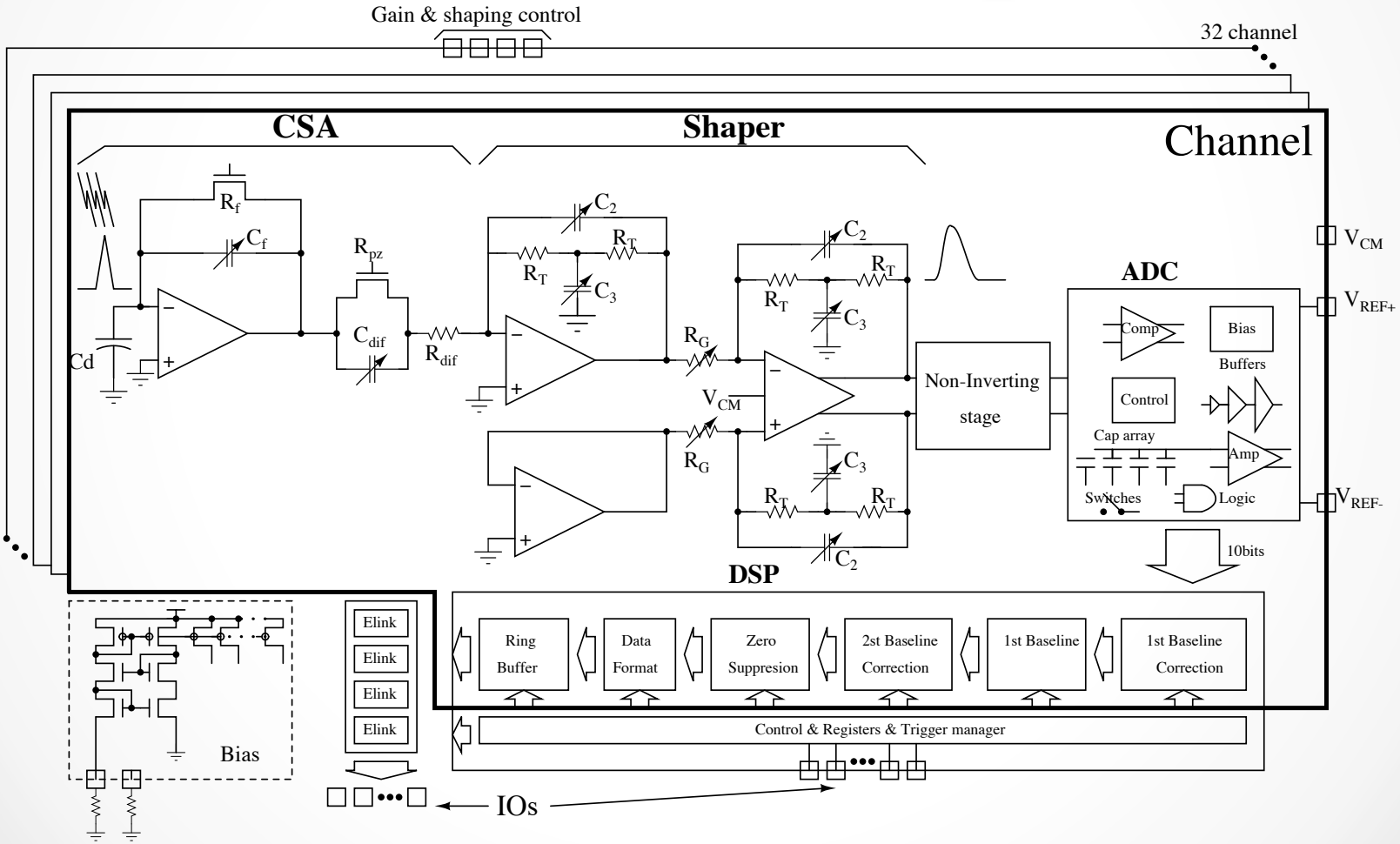
Current Projects

- Member of the ALICE-LHC collaboration since 2006
  - **The Brazilian group is responsible for the new front-end chip (called SAMPA) for the TPC and Muon Chamber detectors in the ALICE experiment**

SAMPA chip

- Why do we need a new front-end chip for the ALICE upgrade (Run 3)?
  - Interaction rate Pb-Pb:
    - from 8 kHz → 50 kHz
  - Trigger rate Pb-Pb:
    - from max. 3.5 kHz → 50 kHz
- Upgrades:
  - TPC with GEMs and trigger-less read-out
  - MCH electronics: from 1 kHz → 100 kHz

SAMPA chip


Gain & shaping control
32 channel
CSA
Shaper
Channel
R_f
C_f
R_{pz}
C_2
R_T
C_3
Cd
C_{dif}
R_{dif}
R_G
V_{CM}
Non-Inverting stage
ADC
Comp
Bias
Buffers
Control
Cap array
Amp
Switches
Logic
10bits
V_{CM}
V_{REF+}
V_{REF-}
DSP
Ring Buffer
Data Format
Zero Suppresion
2st Baseline Correction
1st Baseline
1st Baseline Correction
Control & Registers & Trigger manager
Elink
Elink
Elink
Elink
Bias
IOs

SAMPA

- Specifications
  - 32 channel amplifier-shaper-ADC-DSP
  - triggerless/continuous & triggered readout
  - < 600 e @ 25 pF (TPC), < 950 e @ 40 pF (MCH)
  - bi-polarity input
  - 10 bit ADC – 10/20 Msamples/s
  - on ASIC base-line correction and zero suppression
  - 4 x 320 Mbit/s serial outputs
  - **130 nm TSMC CMOS process**

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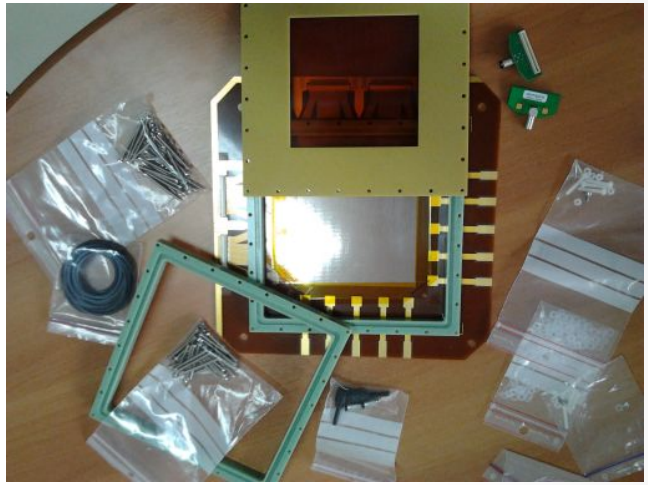
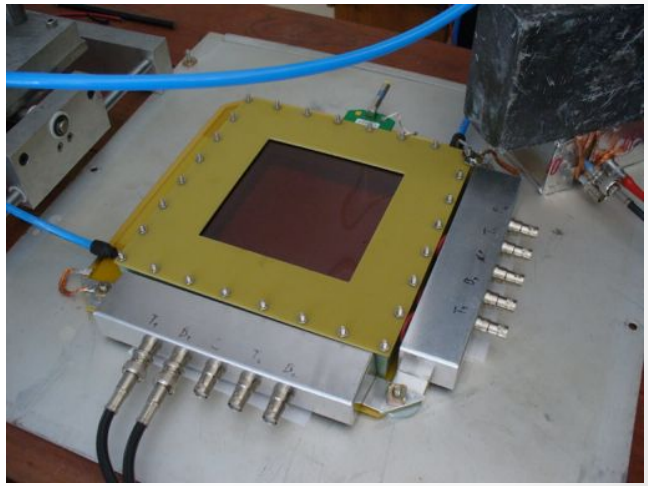
  - **Initiating the participation in the GEM R&D studies for the ALICE-TPC**

GEM R&D

- First detector commissioned
- GEM kit from CERN (developed within RD51 collaboration)
- First detector characterization obtained with X-rays from radioactive sources (55Fe or 241Am) or X-ray tube (up to 50kV, 200 μA).



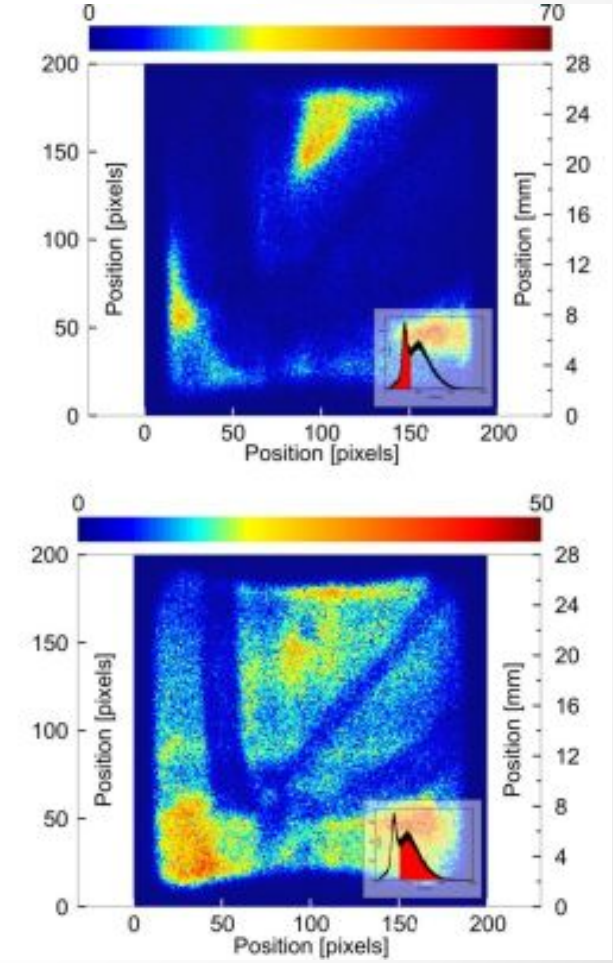


Current Projects

- Member of the ALICE-LHC collaboration since 2006
  - The Brazilian group is responsible for the new front-end chip (called SAMPA) for the TPC and Muon Chamber detectors in the ALICE experiment
  - Initiating the participation in the GEM R&D studies for the ALICE-TPC
- **Further applications of the SAMPA-MPGD system**
  - **Further test the SAMPA integration with MPGD-based detectors**
  - **Development of MPGD-based applications for neutron measurements and X-ray imaging**

Further applications

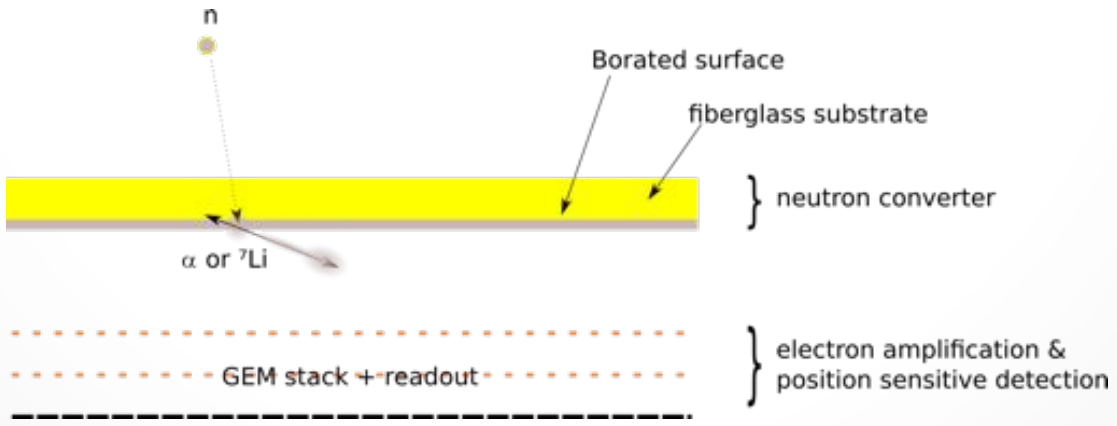
- **X-Ray imaging**
- Could be used in History of arts, Geology, Archaeology, Medicine, etc.
  - On the right, an example with a wing of a common quail (courtesy from H. Natal da Luz)
- SAMPA will provide more electronic channels, dispensing resistive charge division and improving position resolution
- Collaboration with other groups from USP



Further applications

- **Neutron Detection**
- Absorption of neutrons with 10B
- Collaboration with the National Research Institute for Nuclear Energy

$$n + {}^{10}B \rightarrow {}^{7}Li^{*} + {}^{4}He \rightarrow {}^{7}Li + {}^{4}He + 0.48\ MeV\gamma + 2.3\ MeV(93\%)$$
$$\rightarrow {}^{7}Li + {}^{4}He + 2.8\ MeV(7\%)$$



Final Considerations

- The participation of the Brazilian group in the RD51 collaboration is a very important opportunity to enhance our involvement in instrumentation projects
- On the other hand, the tests and development of the integration of the SAMPA chip with MPGD detectors could be useful for several groups working within the RD51 collaboration