SNRI 2020 proposal for lab : Understanding performance of analog-to-digital converters for radiation detector systems

Stefano Argirò, Giovanni Mazza

INFN Torino, Università di Torino

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Topic

- Modern HEP experiments requires high resolution (10-14 bits) ADCs.
- Evaluating performances of these ADCs is not trivial and requires knowledge of the main ADC metrics.
- Choice of the right instrument is also crucial to a correct characterization.
- The lab will consist of short lessons on ADC test base concepts interleaved with "hands on" activity.
- Case study is the 12 bits, 160 MS/s radiation tolerant ADC designed for the CMS ECAL upgrade.

Proposed activity

Lesson topics

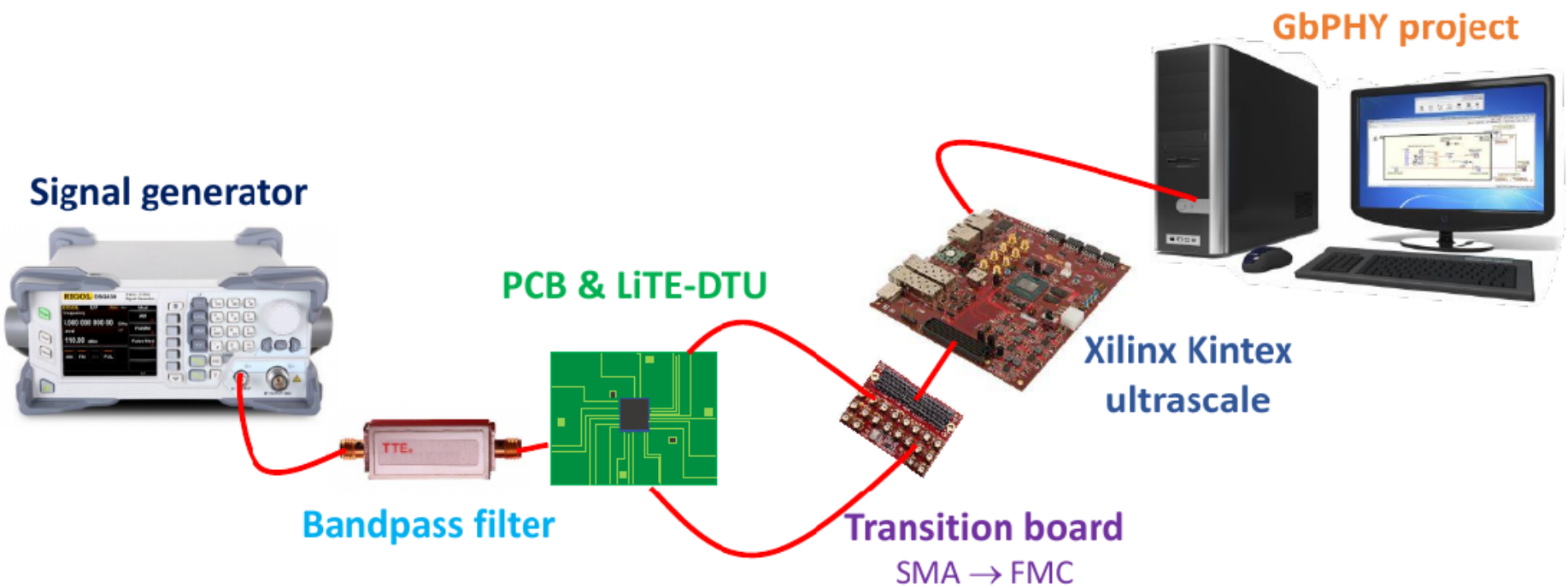
- ADC static characterization : gain error, offset error, DNL, INL
- ADC dynamic characterization : the sinewave method
- ADC dynamic metrics : SNR, SNDR, ENOB, SFDR, THD
- Effect of clock jitter on ADC performances
- $\sim$1.5 h

"Hands on" lab topics

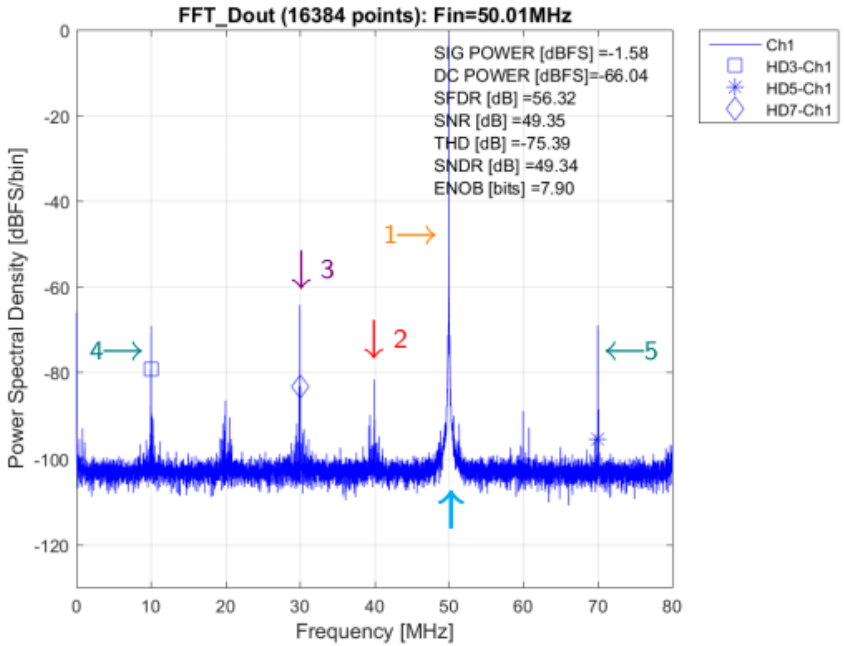
- ADC measurement and metrics calculation
- ADC calibration
- Influence of the input signal non-idealities
- Influence of the clock signal non-idealities
- $\sim$1.5 h for 4-5 partecipants per working position (1-2)

ADC test setup

- For the evaluation of ADC noise and linearity, a sinewave signal at $\sim$ full scale is applied
- The signal is filtered with high selectivity filters and sent to the ADC
- The streams are acquired byf an FPGA board and stored in a personal computer in csv files
- Data are analyzed off line with dedicated software

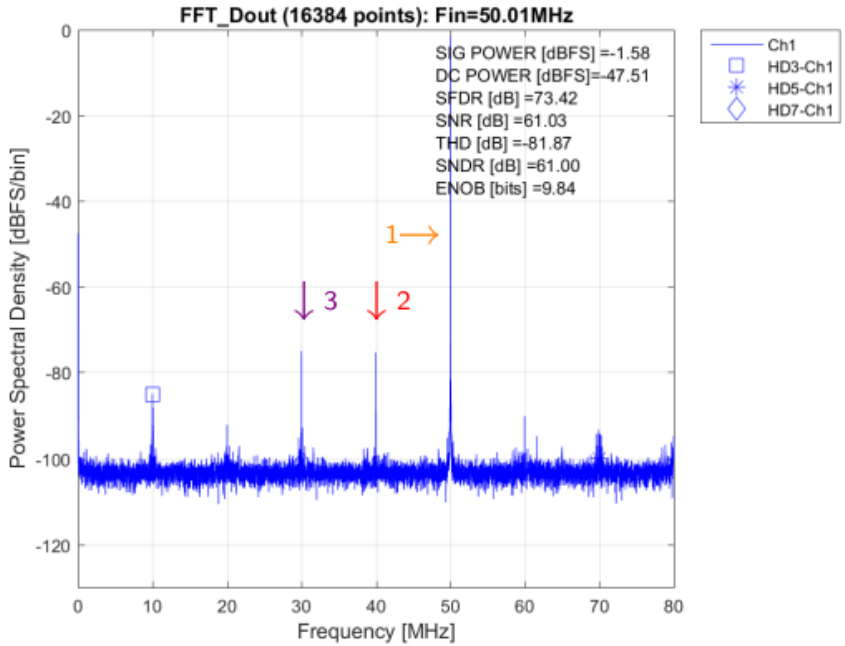


Example of data analysis



50 MHz FFT with internal clock

- 1: $f_{in} = 50$ MHz
- 2: 40 MHz spurs
- 3: $f_S/2 \pm f_{in}$
- 4 and 5: 40 MHz $\pm f_{in}$



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People involved

- Stefano Argirò [UniTo, staff]
- Giovanni Mazza [INFNTo, staff]
- Simona Cometti [Unito,postdoc,tbc]
- Dario Soldi [Unito,postdoc,tbc]