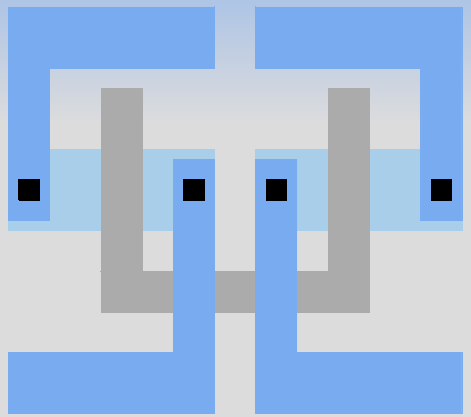
Towards CBM-XYTER

Stripe readout chip for the CBM experiment



Schaltungstechnik
und Simulation

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SuS Meeting

21.05.2007

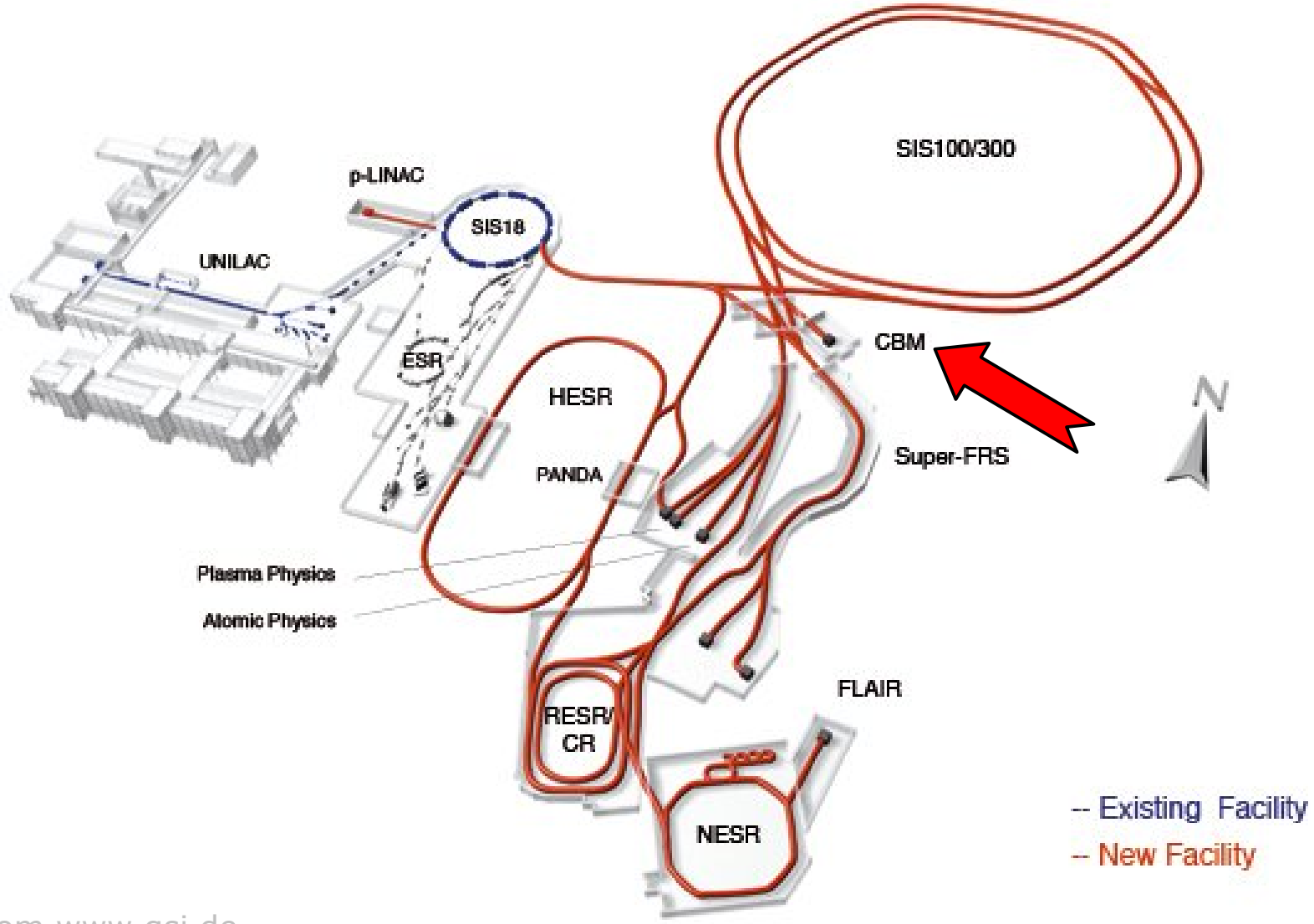
Facility for Antiproton and Ion Research (FAIR)

Extended particle accelerator located in Darmstadt at GSI

- Beams of all ion species (hydrogen to uranium) plus antiprotons
- High beam energy: 35GeV/u for uranium, 30GeV for antiprotons
- 18 research programs
- 2500 scientists and engineers from 45 countries involved
- 1200M€ total project costs
- Operation costs are estimated to be 118M€ per year
- First beam experiments in 2012, last component first operates in 2015

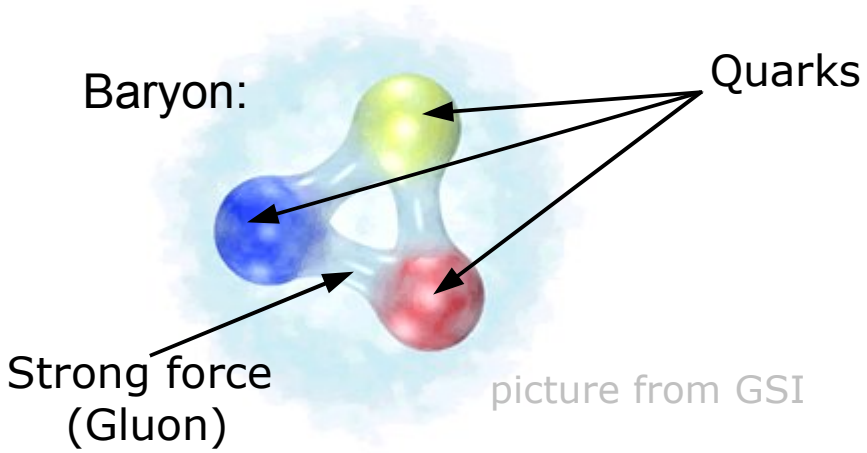
picture from www.gsi.de

FAIR - Facility overview



picture from www.gsi.de

The Compressed Baryonic Matter experiment (CBM)

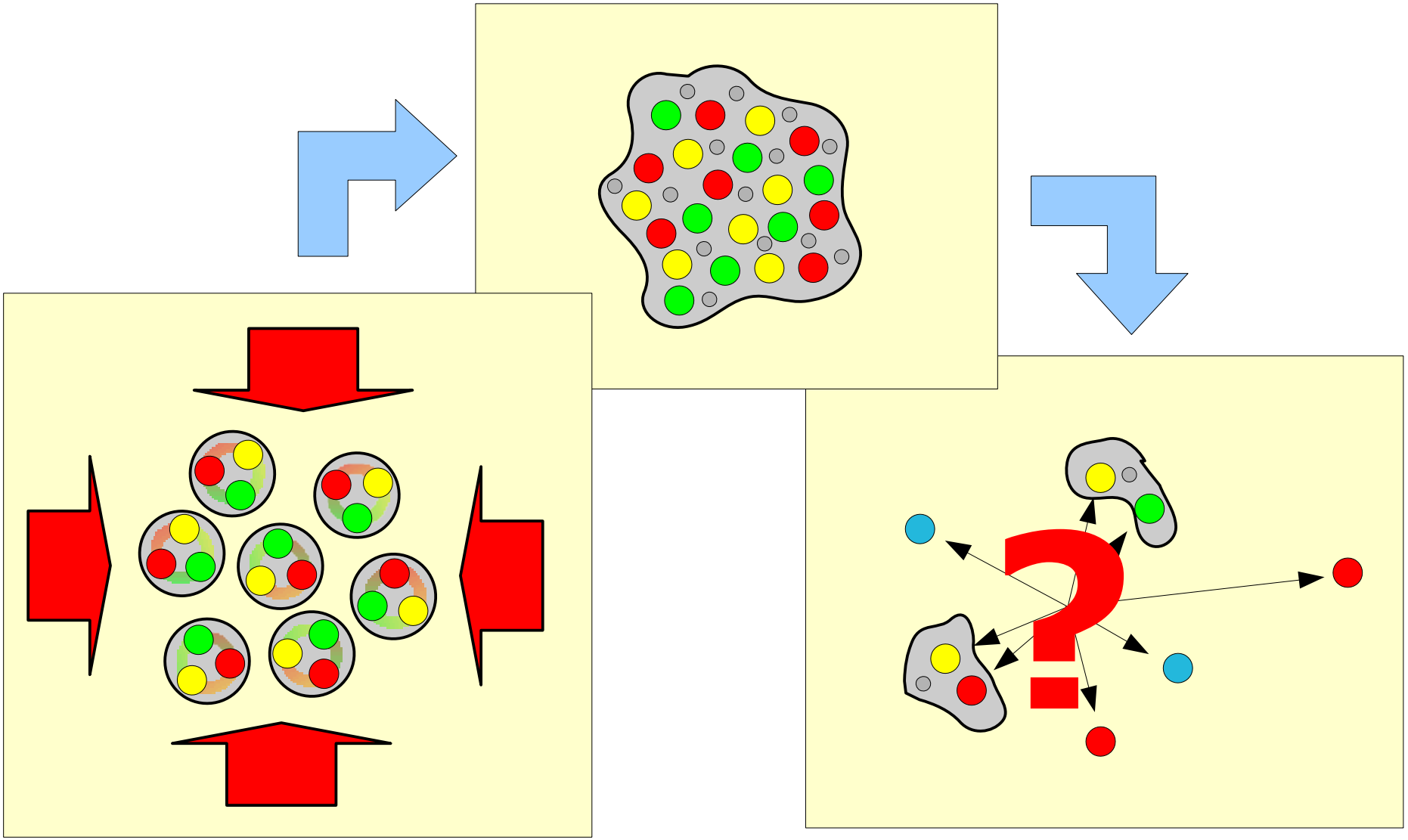


	Charge	Fermionen		
Quarks	2/3	u	c	t
	-1/3	d	s	b
Leptons	0	ve	vu	vT
	-1	e	μ	T
Generation		I	II	III

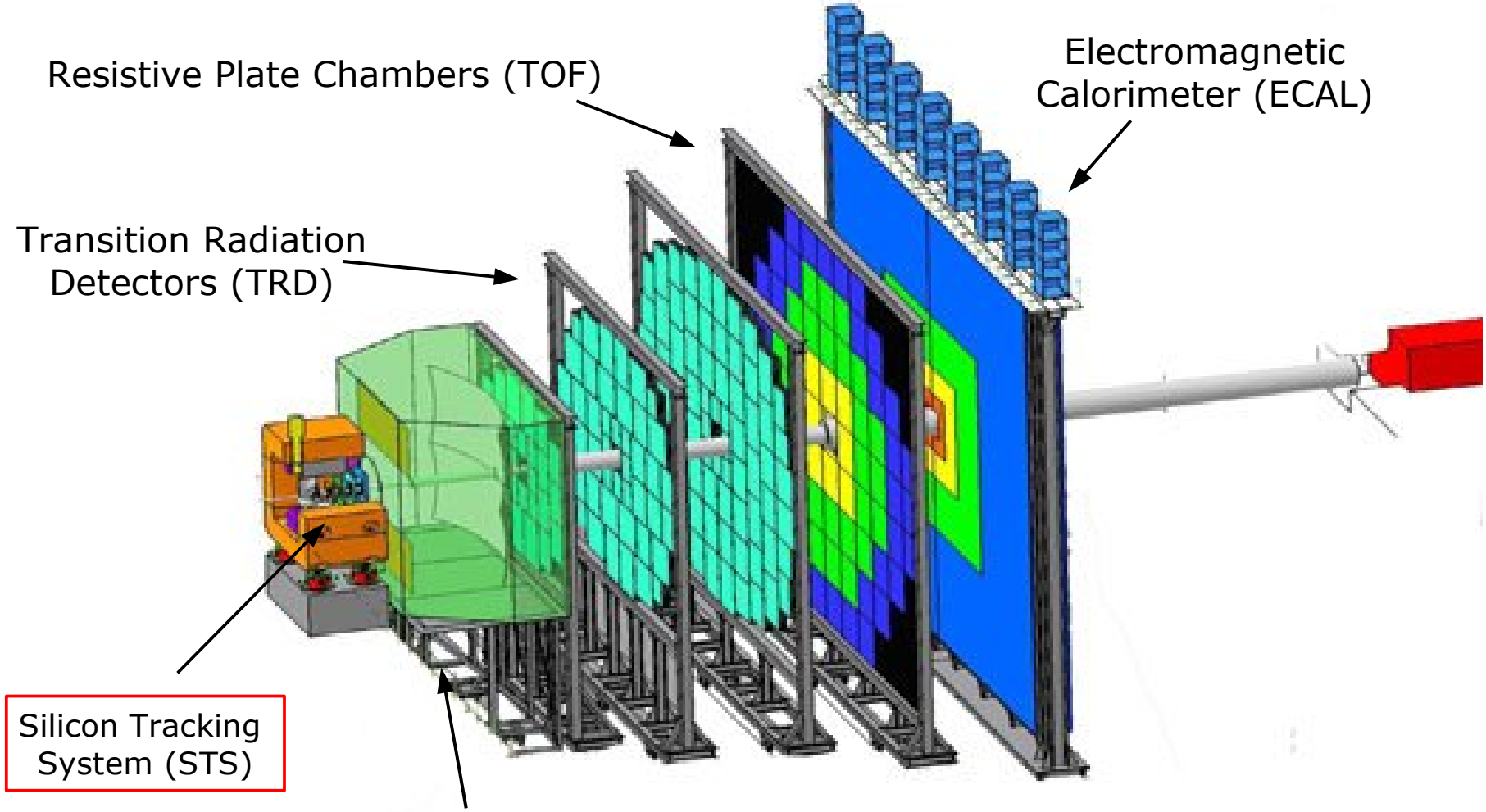
Standard Model

- Baryon: subatomic particles made of three quarks (e.g.: Proton: uud)
- Strong force: holds quarks together
- Gluons: strong force carrier particles
- Idea of CBM: compress baryonic matter until a quark-gluon-plasma emerges, then detect and analyse resulting particles (next slide)
- High compression: reached by colliding beam ions with fixed target foil
- Good introduction into particle zoo: www.particleadventure.org

Generating the Quark-Gluon-Plasma (QGP)

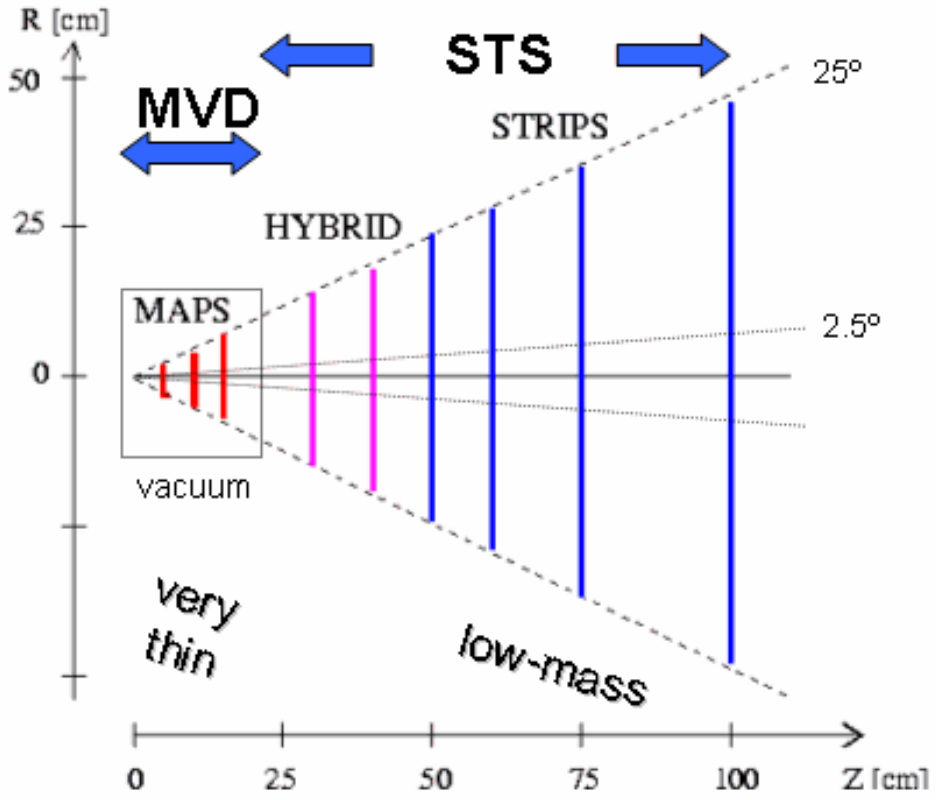


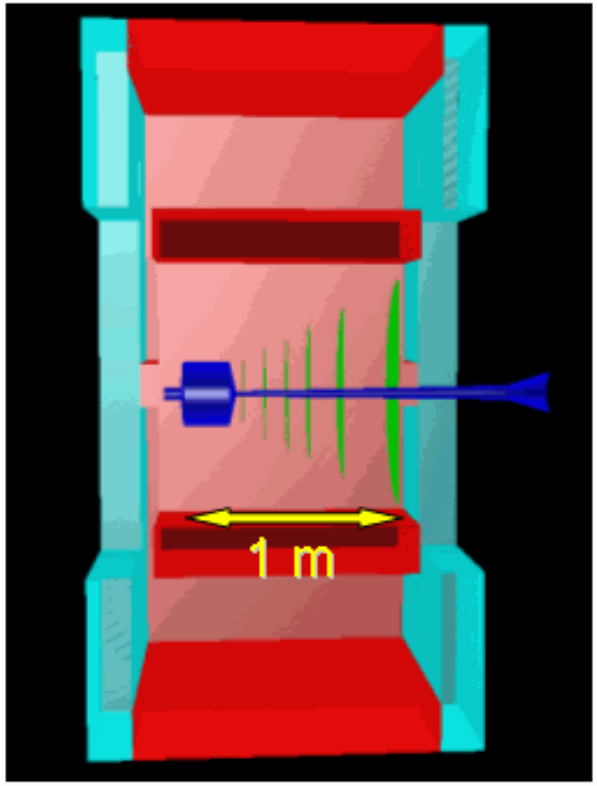
CBM Detector overview



picture from www.gsi.de

Silicon Tracking System (STS)

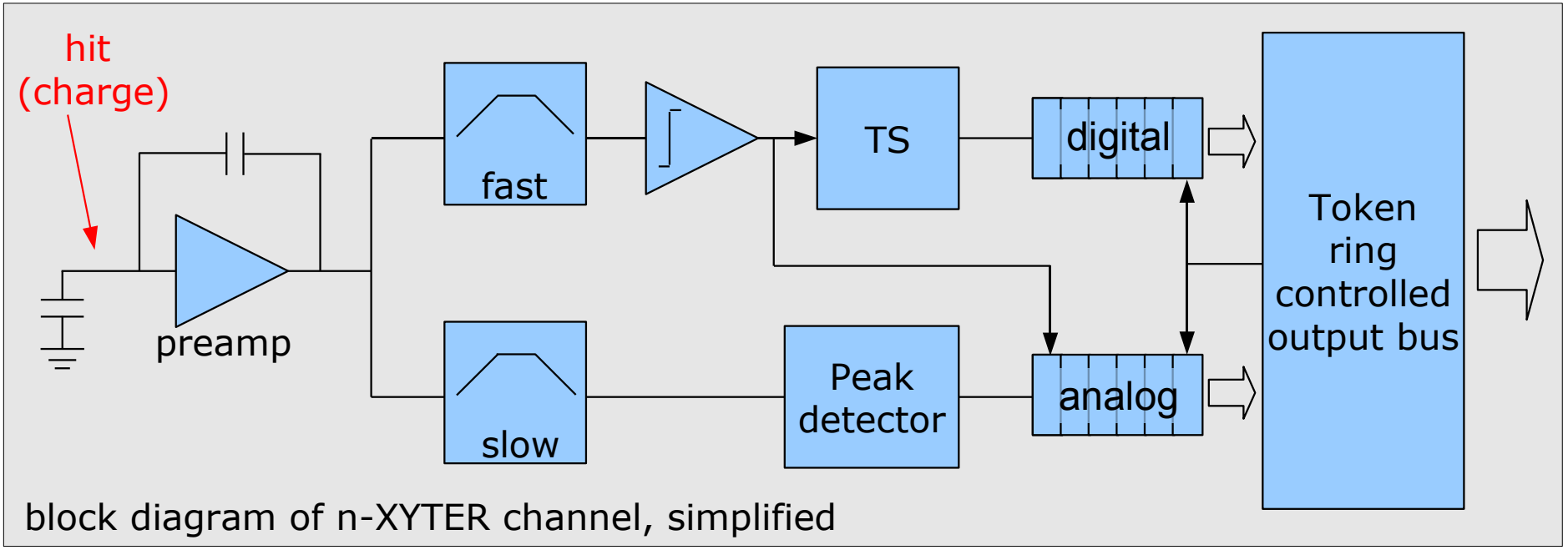




picture from www.gsi.de

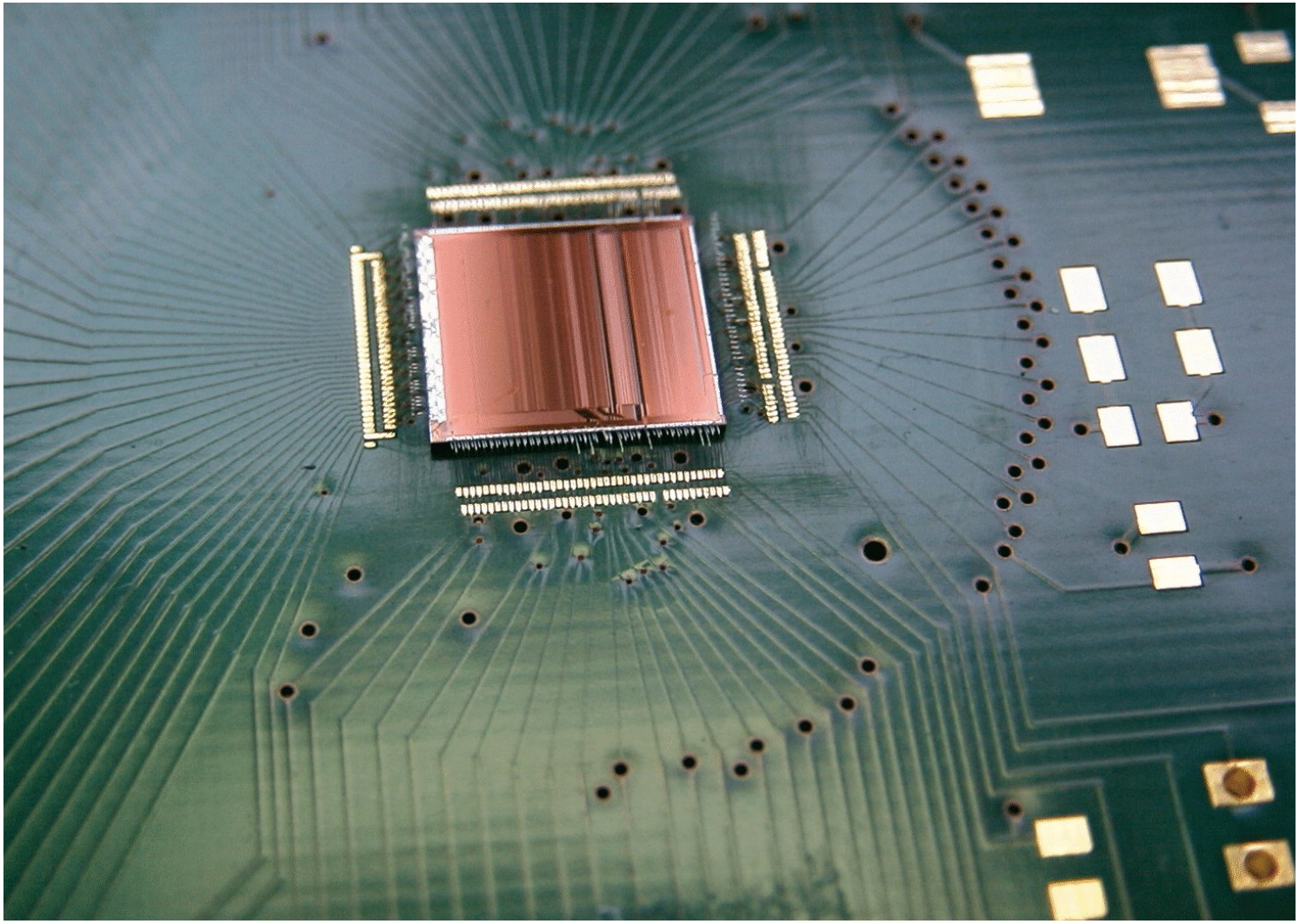
n-XYTER

- n-XYTER: **n**eutron **XY** (coordinates) **T**ime **E**nergy **R**eadout
- 128 channels in AMS 0.35µm
- Digital time-stamp generation, analog energy readout
- Design finished and under test today



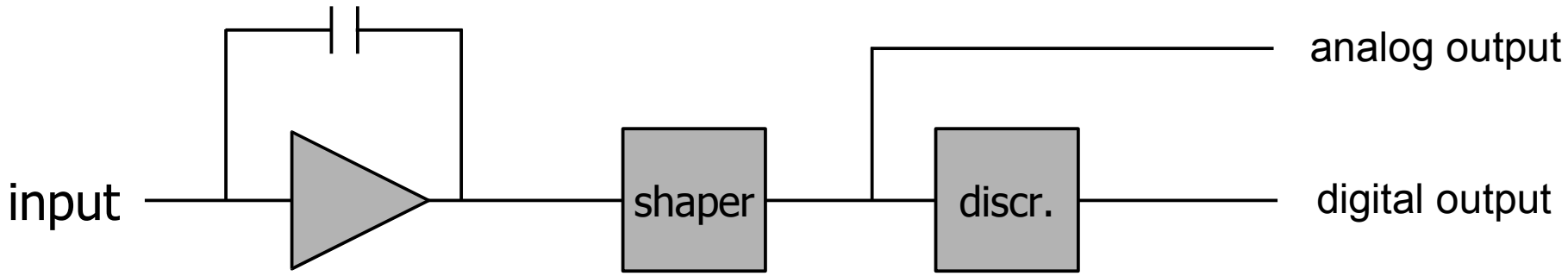
block diagram of n-XYTER channel, simplified

n-XYTER bonded on PCB



picture from GSI

Design study: Test CSA in UMC 0.18 µm (TC-UM7)



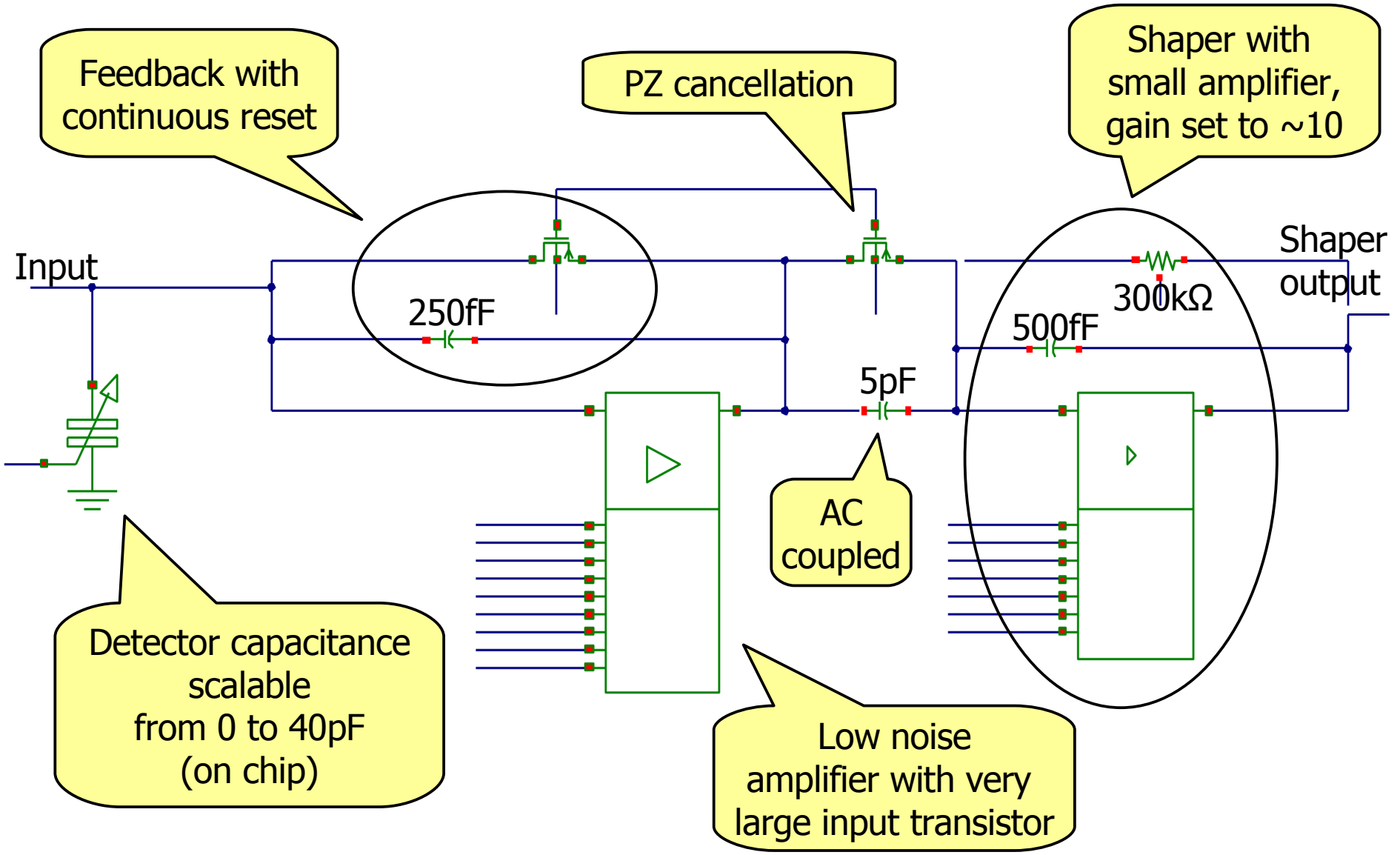
Test ASIC TC-UM7 (submitted 19th February):

- Explore UMC 0.18 µm
- Main focus on noise and power
- Get practical experience

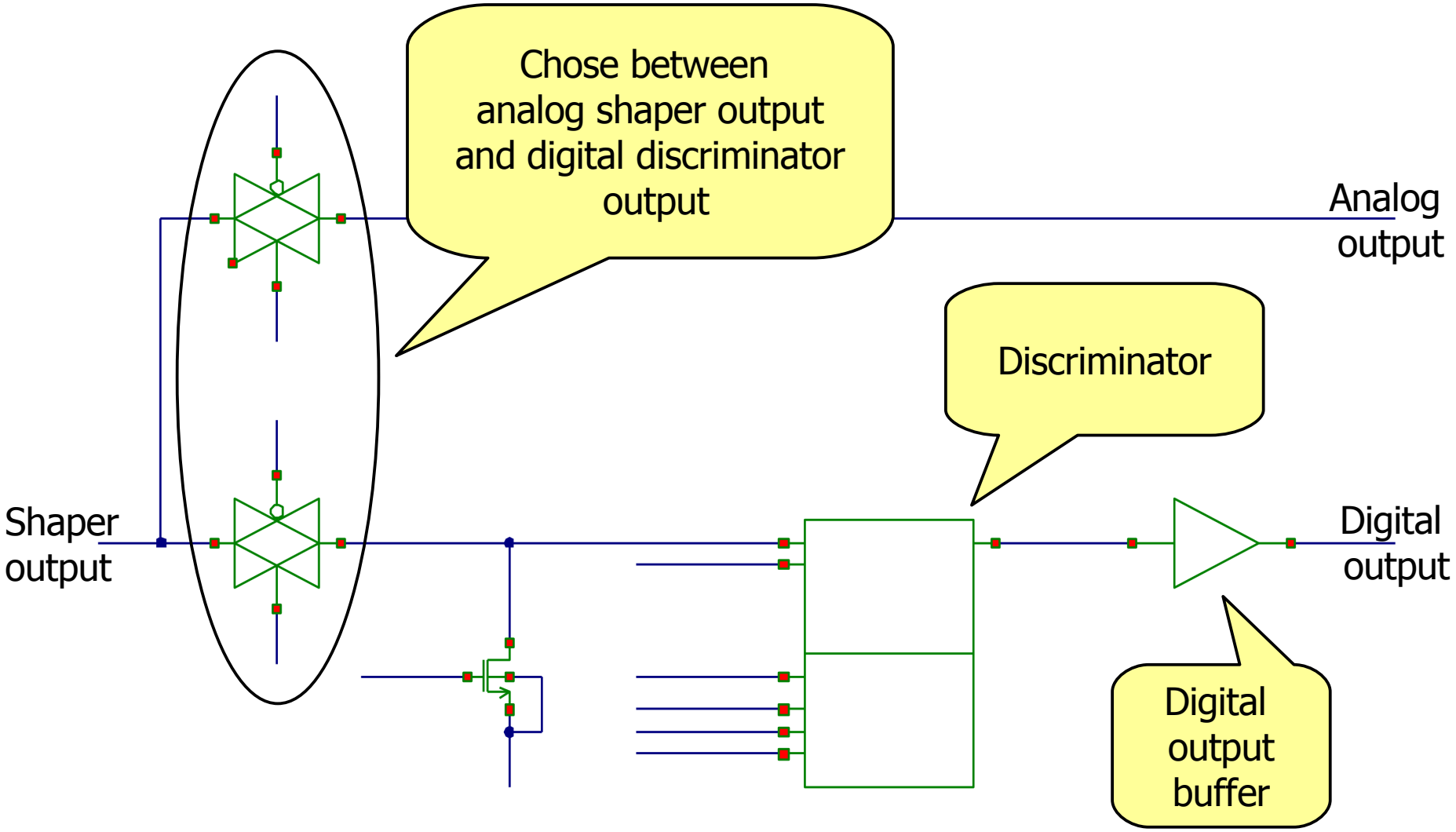
Main parameter:

- Size of Cf: 250fF
- Detector capacitance: variable
- DC-Feedback: O'Connor
- Shaper type: simple 1st order
- Digital and analog outputs
- Size of input MOS: variable

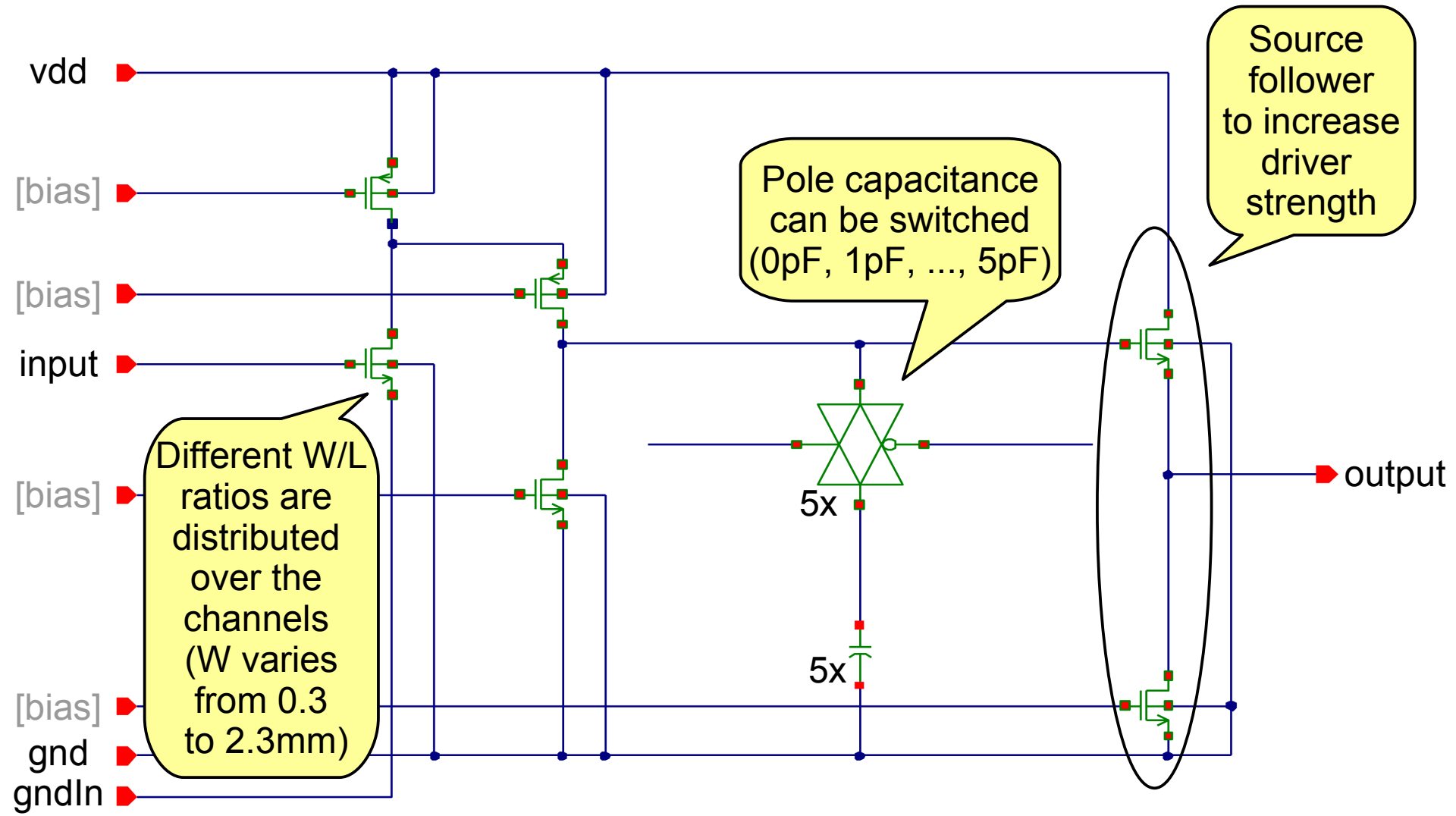
TC-UM7: Single channel schematic (1/2)



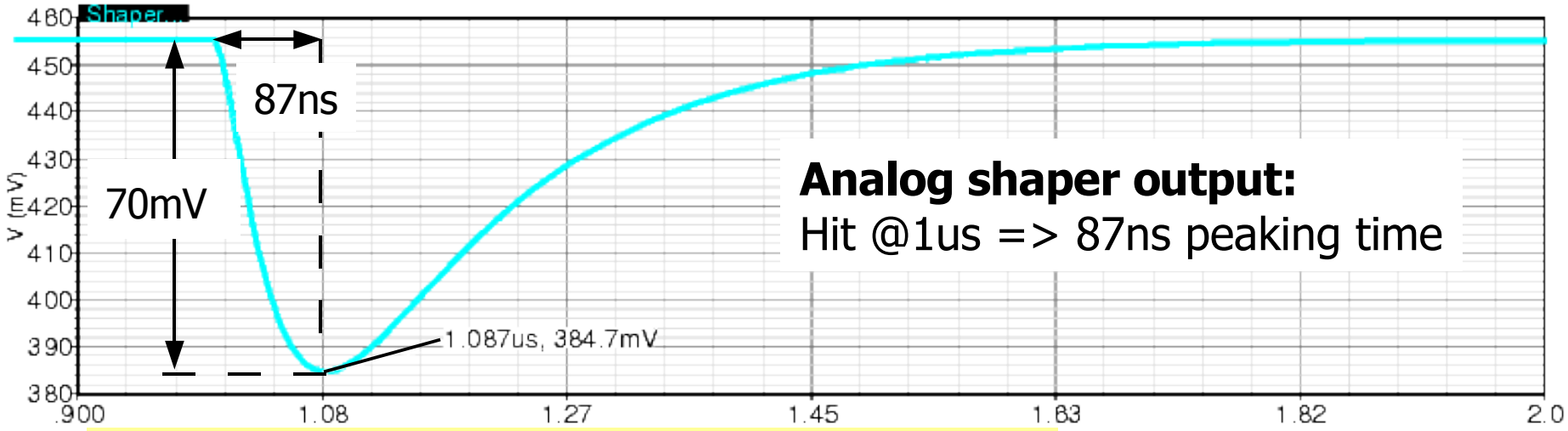
TC-UM7: Single channel schematic (2/2)



TC-UM7: Schematic of the low noise amplifier stage

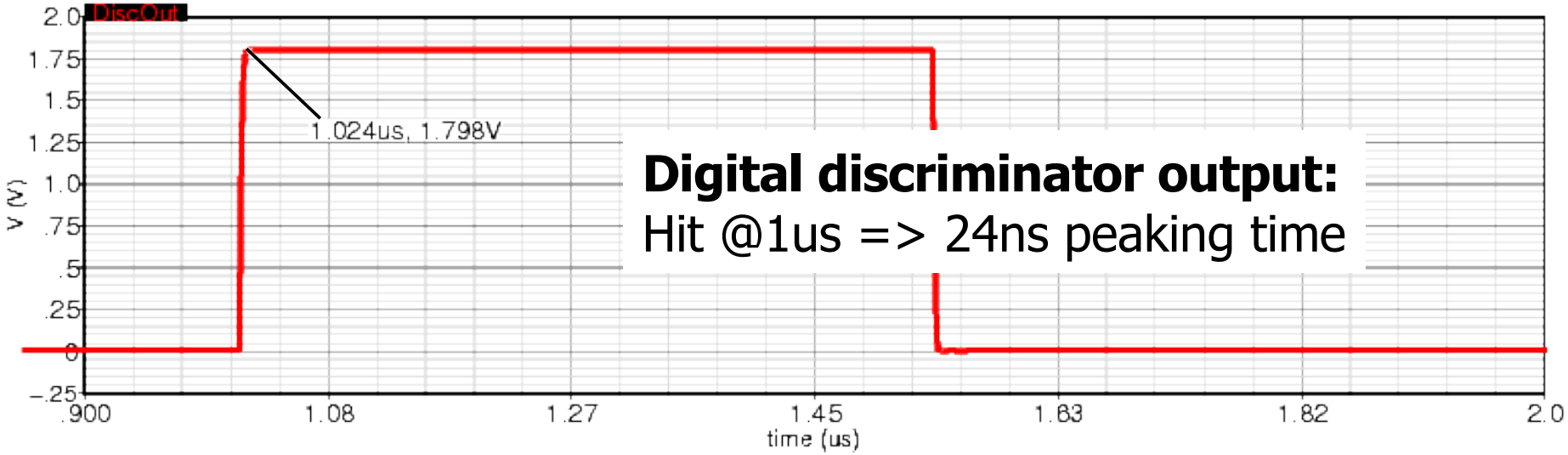


TC-UM7: Transient simulation



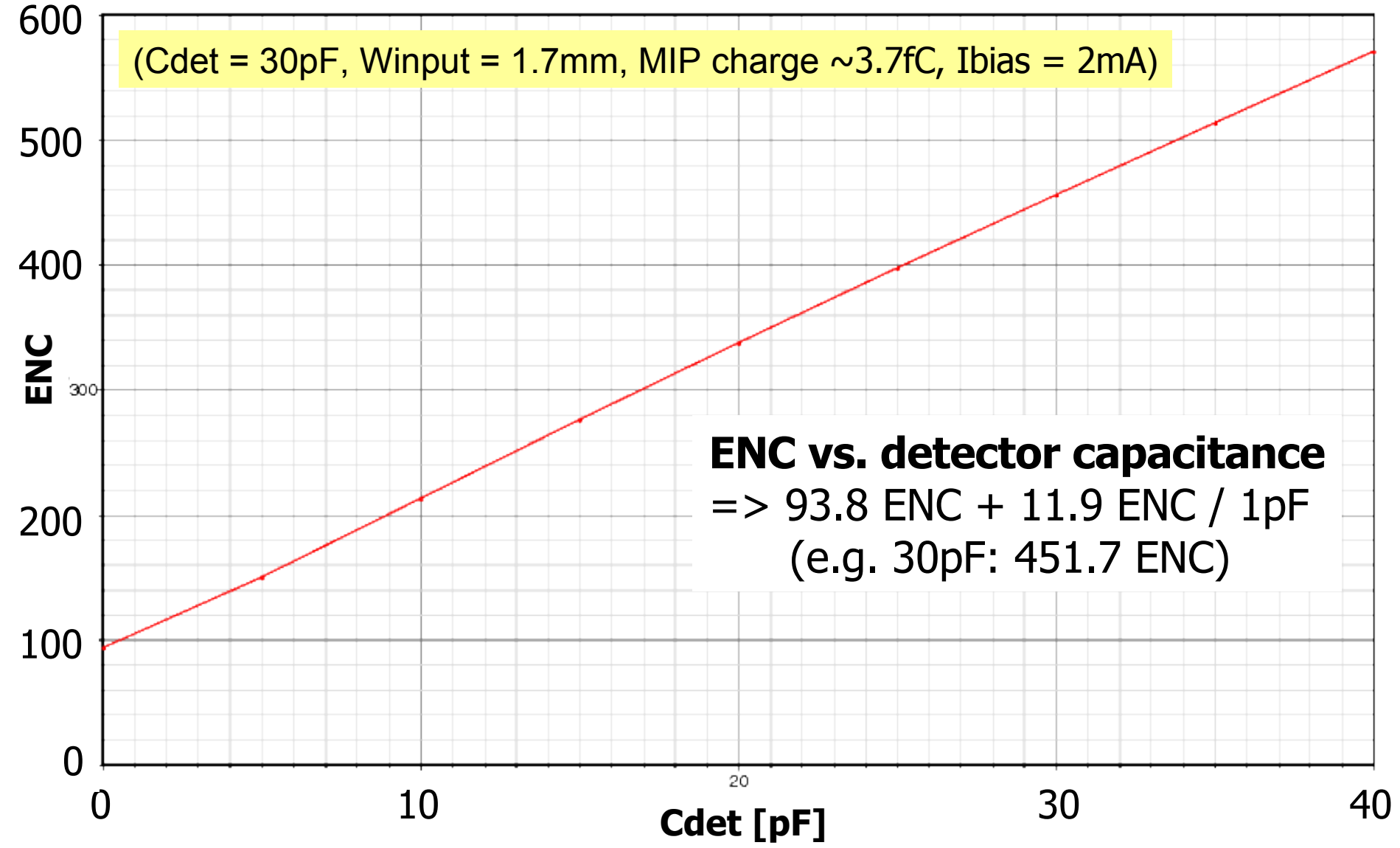
Analog shaper output:
Hit @1us => 87ns peaking time

(Cdet = 30pF, Winput = 1.7mm, MIP charge ~3.7fC)

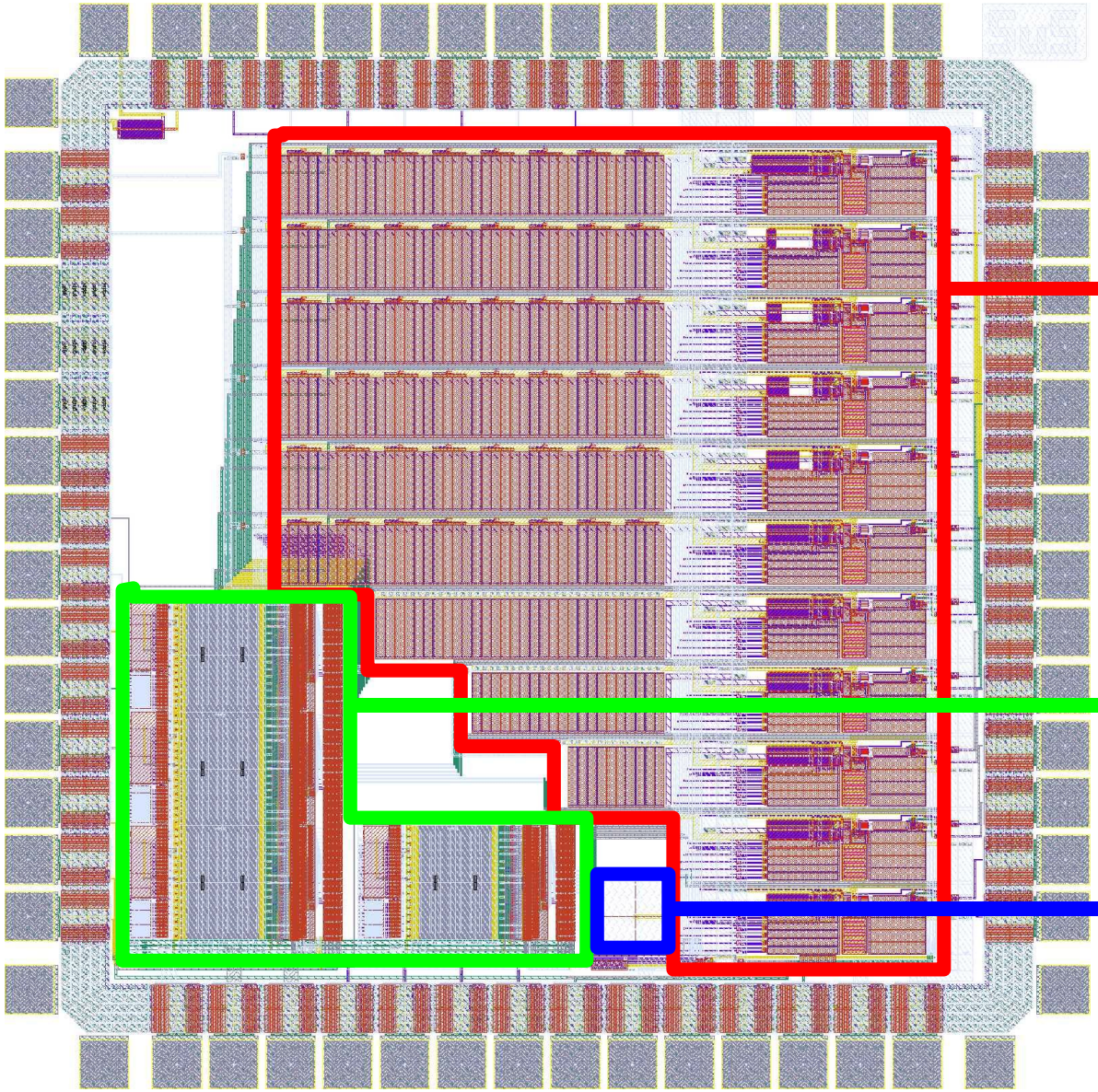


Digital discriminator output:
Hit @1us => 24ns peaking time

TC-UM7: Equivalent noise charge (ENC) simulation



TC-UM7 layout

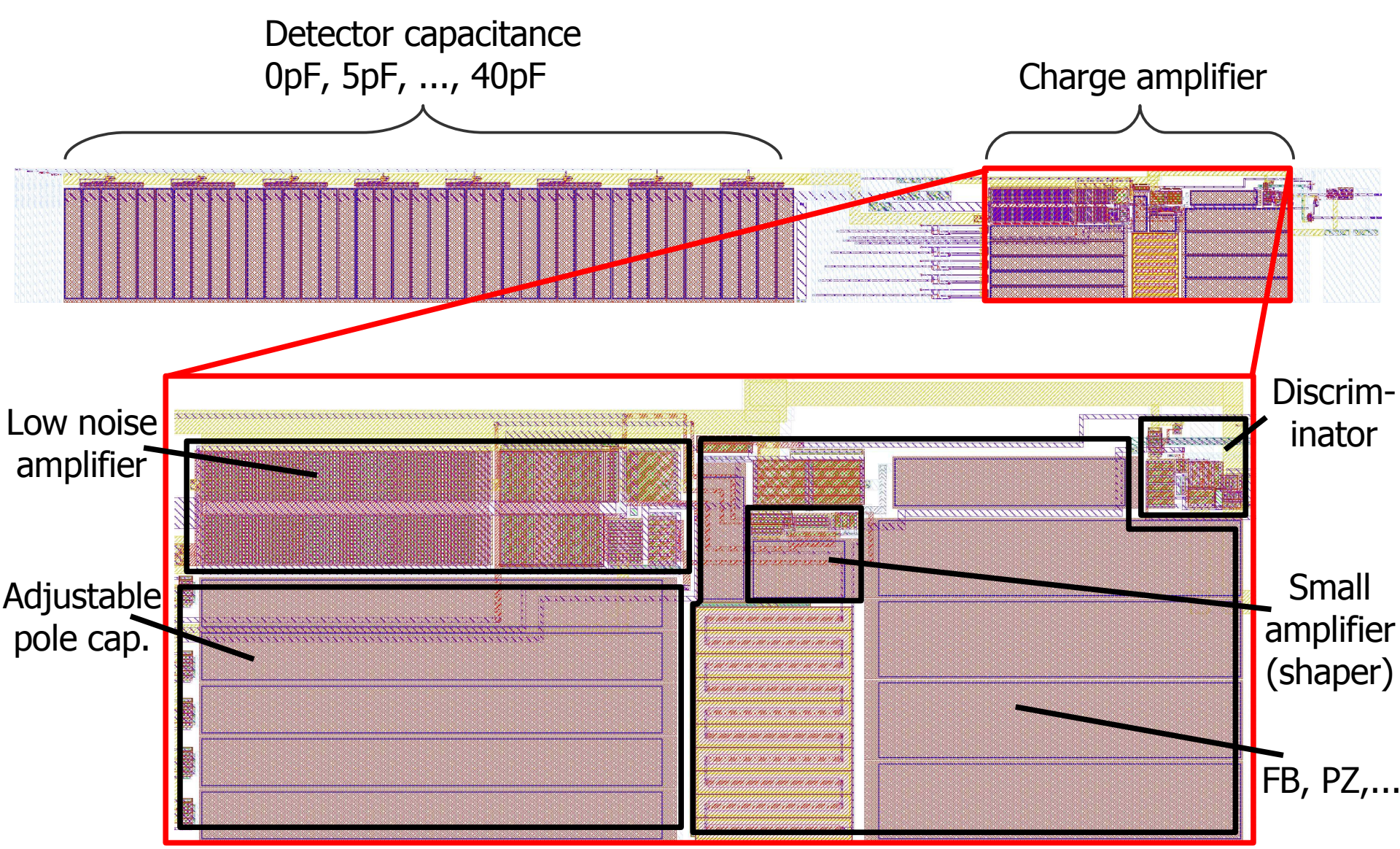


11 channels
- Various sized input transistors
- Fixed and scalable detector capacitances
- Digital and analog outputs

4 Bias DACs
- Internal bias voltage generation
- Configuration register

N-well detector diode
- To measure real particle hits

TC-UM7 layout one channel



Towards the next generation: CBM-XYTER

Challenges:

- In general: Redesign n-XYTER architecture, identify and improve weak parts
- Think about radiation hardness
  - Radiation dose
  - Leakage currents, threshold shifts, SEU, etc. in UMC018
  - Radiate some test chips (e.g. Matthias)
- ADC for energy quantification on chip
  - One ADC per channel versus one ADC per chip
- Synchronisation between chips
  - Timestamp needs precisely defined global reset
  - Find a simple and solid method
- Definition of working packages
  - How to combine different building blocks?
  - Who handles which working package?