ALICE upgrade

Common Readout Electronics Specifications

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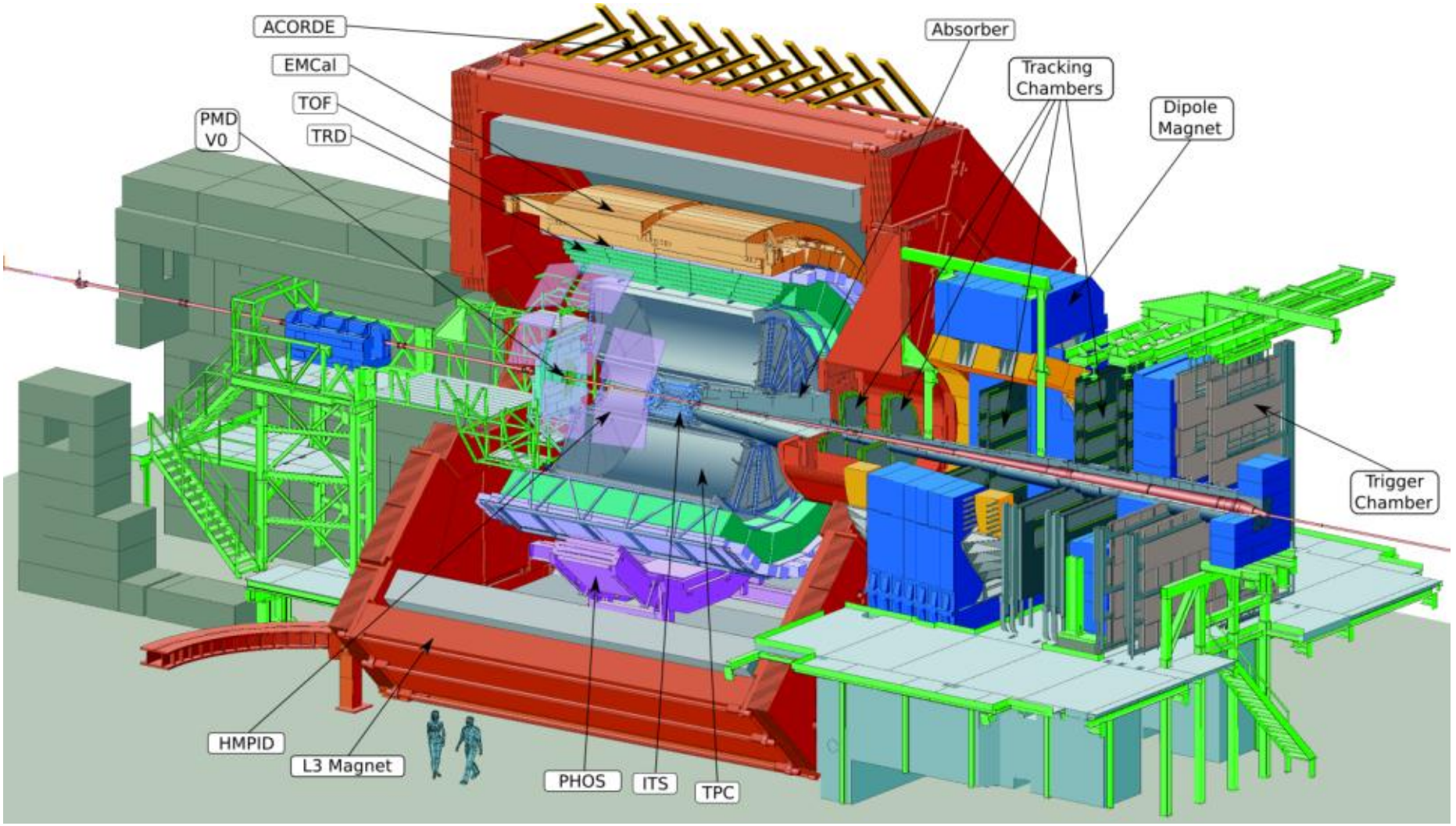
ALICE Detector



ALICE Upgrade

ALICE proposes a major upgrade on the timescale of 2018, which aims for a Pb-Pb interaction rate of 50kHz.

The upgrade plans are building on the specific strengths of ALICE, namely low momentum tracking and Particle Identification.

The core detector projects of the upgrade consist in

- **New, very low mass tracker**
- **Replacement of the TPC readout wire chambers with GEMs**
- **Replacement of readout electronics of TPC, TRD and Calorimeters (EMCAL, PHOS)**
- **Increased readout rates for TOF and Muon system (without changing frontends)**

In order to have the possibility to investigate rare and complex decay patterns, which cannot efficiently be triggered by simple hardware based algorithms, the scheme foresees just an interaction trigger (L0) which ships all the data into an HLT farm for further data reduction.

For the TPC (100us drift-time, 50kHz = 20us event spacing) this translates into a continuous readout of the detector.

Common Frontend for ALICE

TPC , TRD, EMCAL, PHOS are currently using individual frontends and the ALTRO chip for sampling the signal at 10MHz with 10bit resolution.

For EMCAL and PHOS, the signal is split and fed into two ALTRO channels with different gains in order to realize a 14bit ADC.

→ Clearly, the goal is to have a common frontend chip

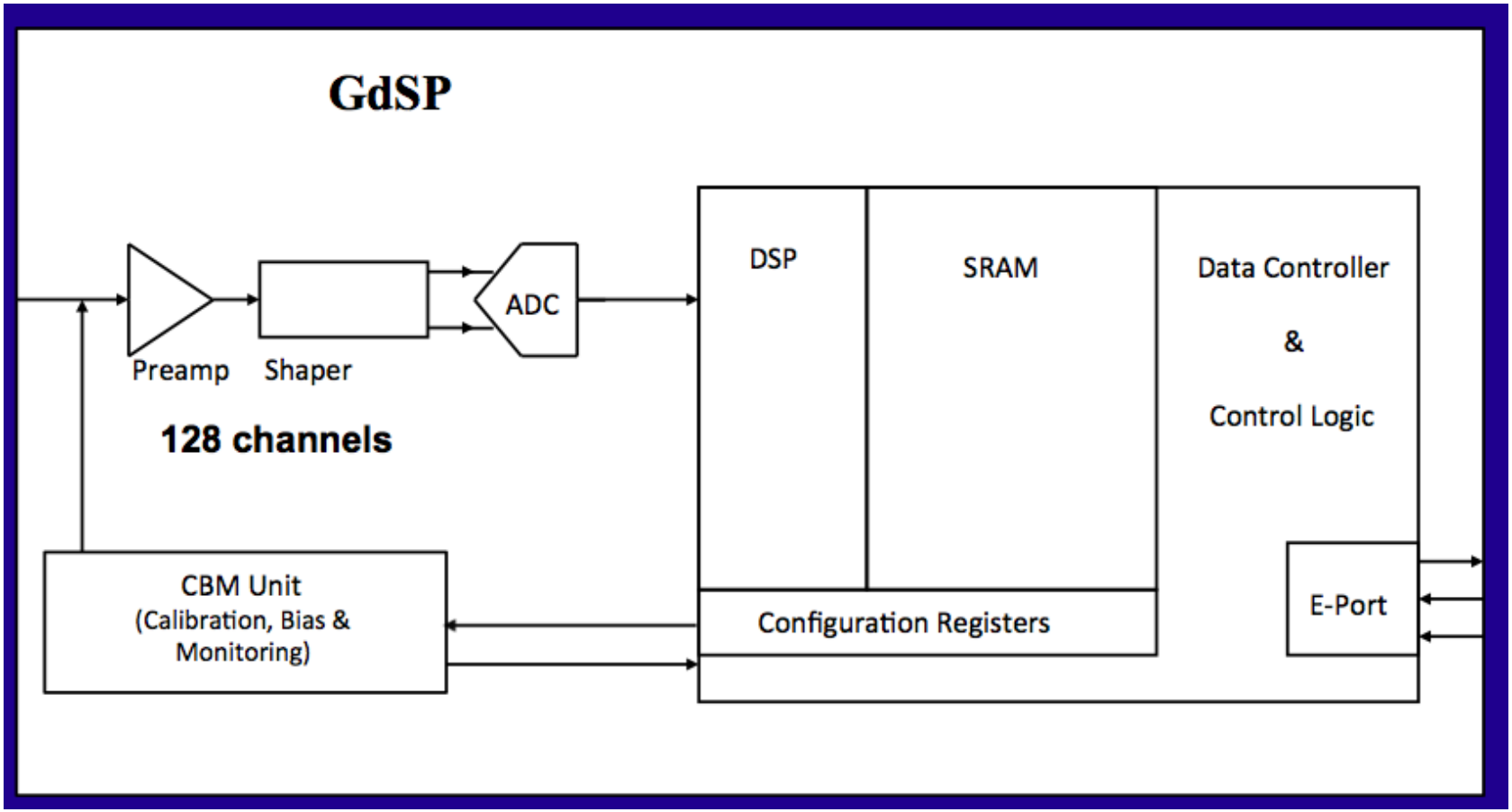
To set the scale of the problem for the TPC readout:

Continuous sampling of the TPC requires a large number of optical links between the detector and the counting room:

500k channels * 10MHz * 10 bit = 50 000 Gbit/s

= 5000 links with 10 GBit/s
= 15000 links with 3.3 GBit/s

GdSP project looks attractive



Programmable polarities and frontend peaking times,
Signal processing etc.

Frontend Numbers of Current Detector

	TPC	TRD	PHOS1	PHOS2	EMCAL1	EMCAL2
Polarity	Pos	Pos	Neg	Neg	Neg	Neg
Peaking time	160ns	160ns	1000ns	1000ns	200ns	200ns
Sensitivity (mV/fC)	12	12	15	0.94	6.24	0.39
Noise (electrons)	700e- @25pF	850e- @25pF	450e- @100pF		2000e- @100pF	
Linear Range (V)	2V (ALTRO)	2V (Trap)	2V (ALTRO)	2V (ALTRO)	2V (ALTRO)	2V(ALTRO)
Linear Range (fC)	170fC	170fC	133fC	2130fC	320fC	5128fC

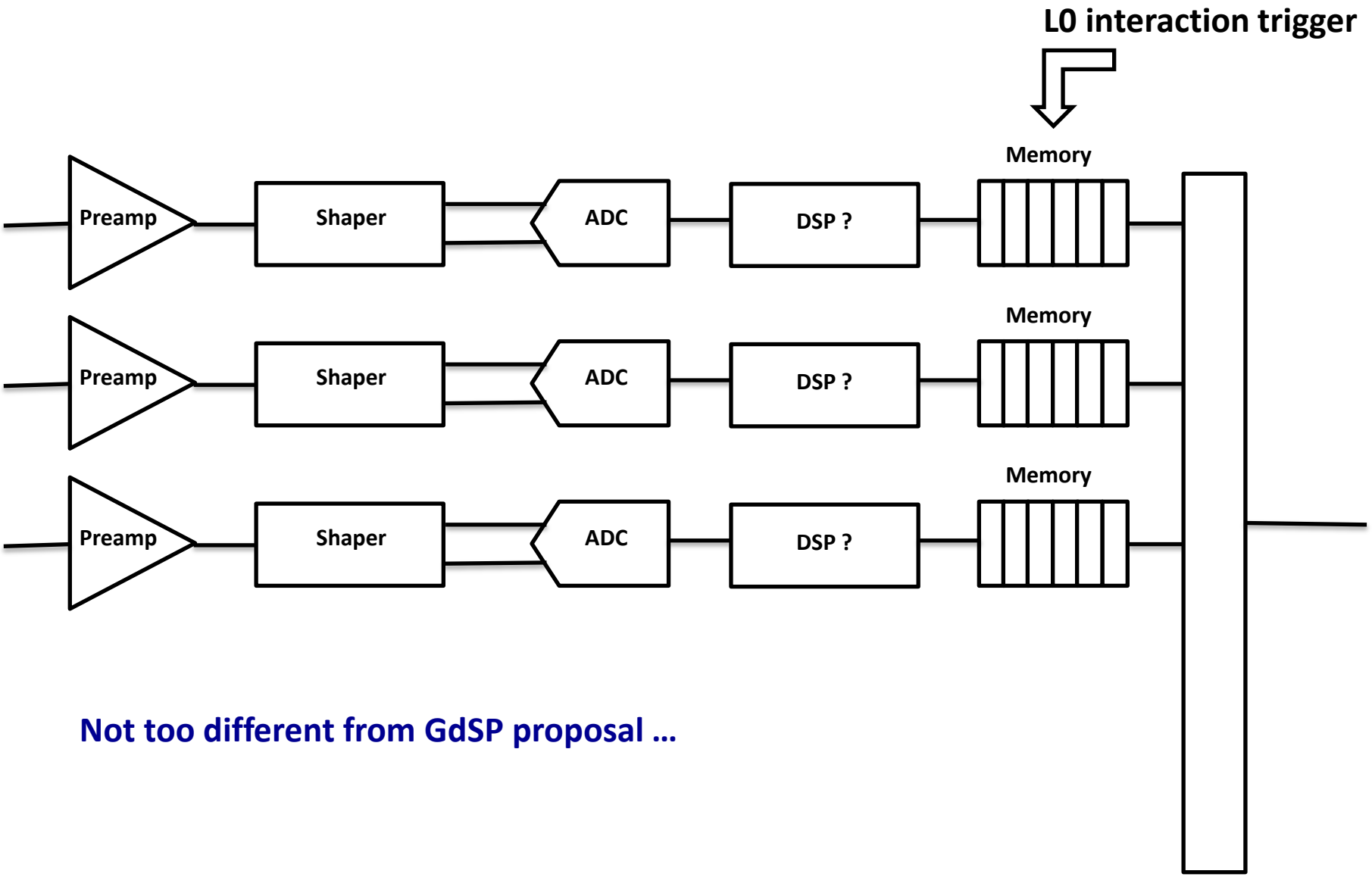
Frontend Specs for Upgraded Detector

	TPC	TRD	PHOS1	PHOS2	EMCAL1	EMCAL2
Polarity	Neg	Pos	Neg	Neg	Neg	Neg
Peaking time	160ns	160ns	1000ns	1000ns	200ns	200ns
Sensitivity (mV/fC)	t.b.d.	t.b.d.	t.b.d.	t.b.d.	t.b.d.	t.b.d.
Noise (electrons)	<700e- @25pF	<850e- @25pF	<450e- @100pF		<2000e- @100pF	
Linear Range (V)	t.b.d.	t.b.d.	t.b.d.	t.b.d.	t.b.d.	t.b.d.
Linear Range (fC)	170fC	170fC	133fC	2130fC	320fC	5128fC

The replacement of the wire chambers with GEMs results in a negative signal.

For all other number we want to AT LEAST reproduce the current performance in terms of noise etc.

The Basic Architecture



Not too different from GdSP proposal …

TPC rate per channel

TPC event rate for continuous readout i.e. no DSP and ZS:

10MHz * 10 bit = 100 Mbit/s
→ 3 channels = 300Mbit/s = 1 E-link

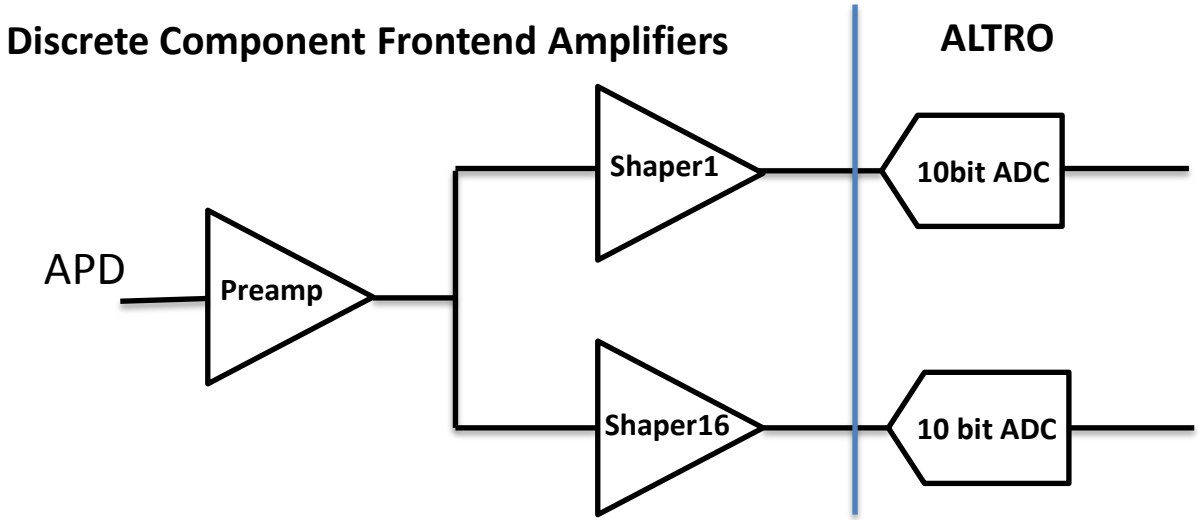
TPC event rate with zero suppression at 20% occupancy:

10MHz * 10bit * 0.2 = 20 Mbit/s
→ 16 channels = 320Mbit/s = 1 E-link

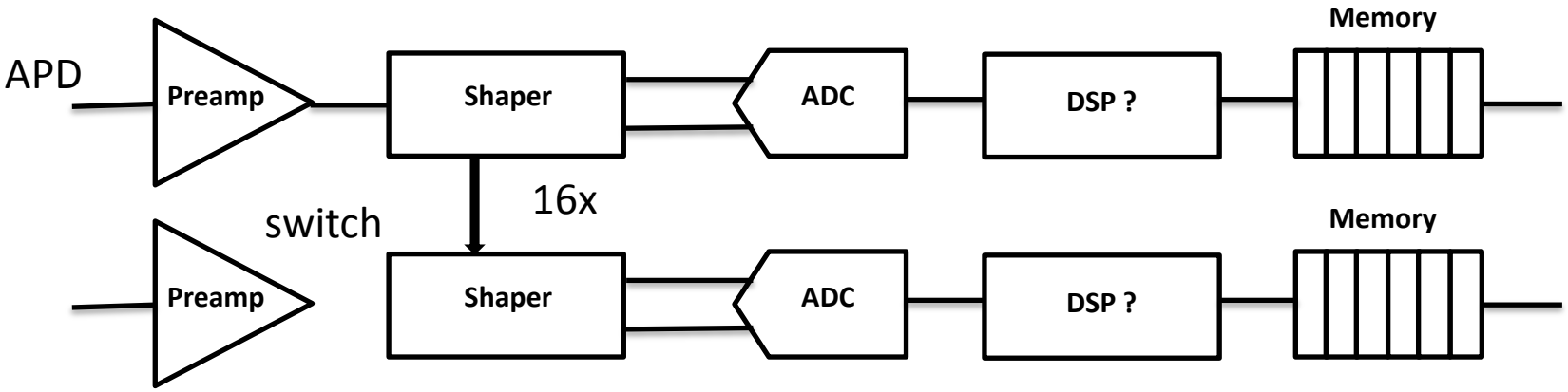
This data rate is significantly higher what is foreseen for CMS, where 128 channels are fed into 1 E-link

Calorimeter Readout 14 bits

Present readout:



Possible solution in the new chip:



ALICE interest in GdSP development

ALICE is compiling the specifications and possible architecture of a common frontend chip that will serve the upgrade plan for TPC, TRD, EMCAL, PHOS.

The specification of the chip has many similarities with the proposed GdSP chip.

The expected rates per channel ask for very large output bandwidth.

The possible realization of a 14 bit dynamic range for the calorimeter readout requires a possibility to connect one input channel into two ADCs with a factor 16 difference in gain.

Even if a common GdSP chip that satisfies the ALICE requirements will be difficult to achieve, there are certainly many building blocks in common !

We would like to stay in close contact with the GdSP development while we are working out the detailed specifications for the ALICE upgrade electronics.