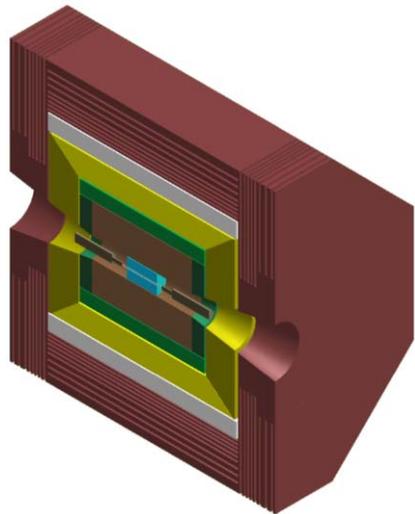


# Super $C\tau$ factory electronics and trigger concept

**Talyshev Alexey**

Kozyrev Alexey

Zhulanov Vladimir

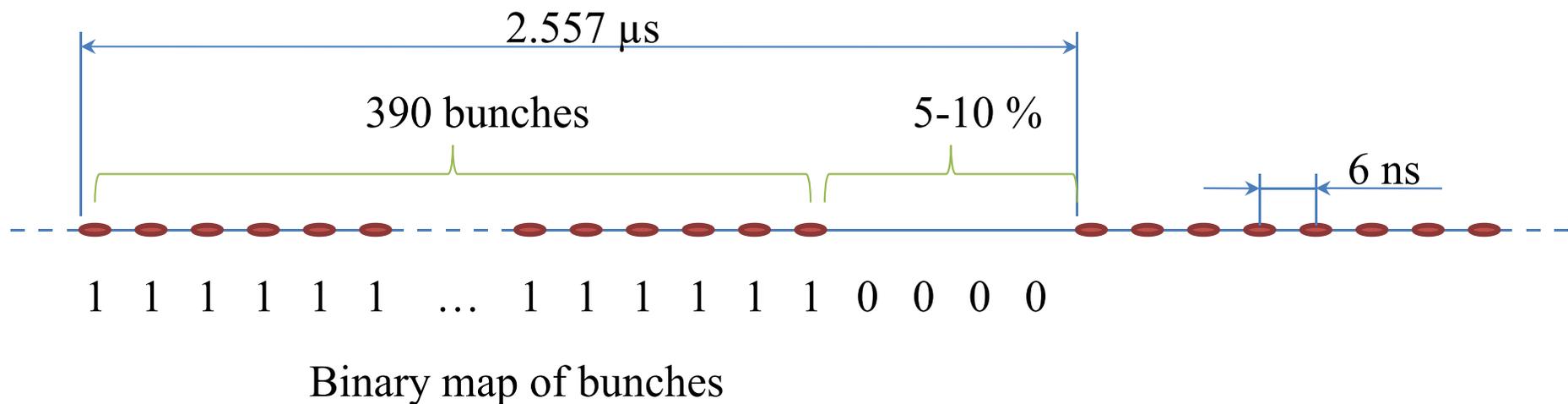


Super  $C\tau$  factory workshop

26 - 27 May 2018

# Collider important parameters

- The RF frequency is about 508 MHz.
- The period of bunch circulation is  $2.557 \mu\text{s}$ .
- The quantity of separatrices is 1300.
- The time gap between bunches is around 6 ns (filling each third separatrix).
- The mode with 8 ns gap is under discussions (filling each fourth separatrix).
- The maximum quantity of bunches in train is 390.
- The gap of 5–10% (130 separatrices) in a bunch train is necessary for suppression of the ion instability.

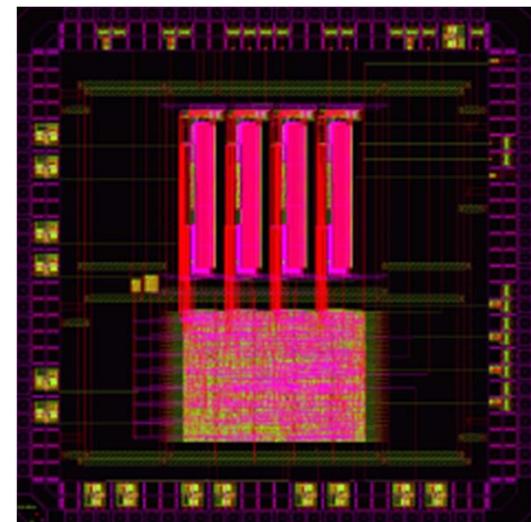


## Subdetector parameters

Detector	Channel quantity	Channel size	Power consumption	Trigger participation	Type of information
VD – GEM – Timepix	56 K 10 M	2 x 2 mm <sup>2</sup> 150 x 150 μm <sup>2</sup>	1 kW	Possibly	Amplitude (A), Time (T), Position (P)
DC	7.1 K	12 x 20 mm <sup>2</sup>	2 kW	Yes	A, T, P
FARICH	1 M	4.5 x 4.5 x 50 mm <sup>3</sup>	100 kW (21 m <sup>2</sup> )	No	T, P
Calorimeter	7.5 K	(40 -70) <sup>2</sup> mm <sup>2</sup>	2 kW	Yes	A, T, P
Mu	4 - 44 K	∅ 20 mm	1 – 9 kW	Yes	T, P

- Analog-to-digit conversions **inside** the detector
- Data transfer over the **optical links**
- Wide using of **ASIC** (application-specific integrated circuit)
- **Water** cooling of the Front-End electronics

ATLAS LAr FEB SCA



## Parameters of signals and FrontEnd electronics

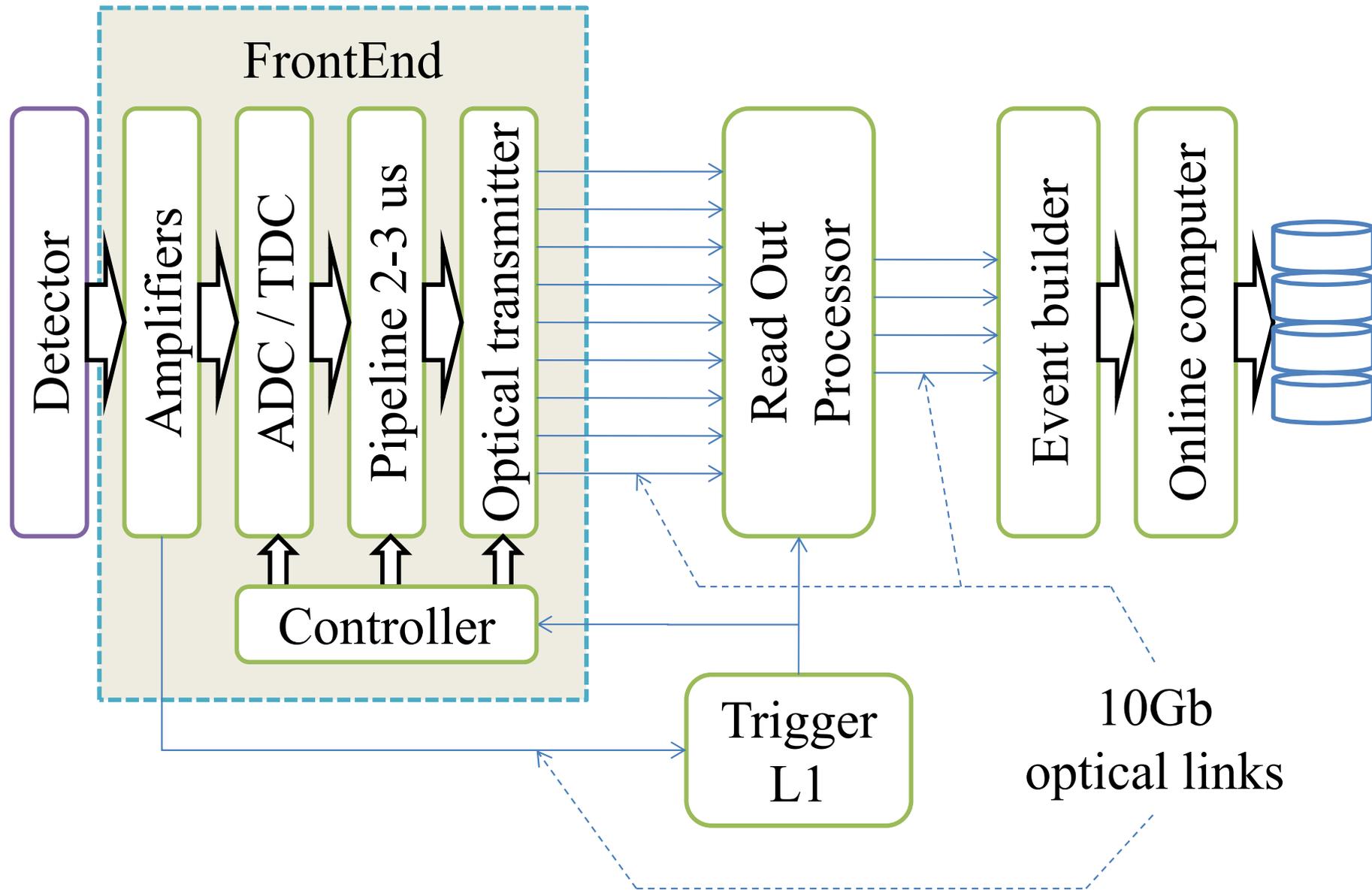
Detector	Channel load	Duration of signals	Sampling rate	Bit quantity of ADC (TDC)	Time measure precision
VD	33 kHz	Rising edge 25 ns	from 20 MHz to 80 MHz	10 -12 bit ADC	1 ns
DC	50 kHz	Rising edge 100-200 ns, Falling edge – 300 ns	50 MHz (ordinary mode) 500-1000 MHz (cluster mode)	10 bit ADC	1 ns
FARICH	1 MHz	5 – 10 ns	TDC	6 bits (for 8 ns) TDC	200 ps
Calorimeter	15 kHz	30 ns for clear CsI	40 – 50 MHz	18 bit ADC	1 ns
Mu	100 kHz	30 – 200 ns	TDC	11-12 bit TDC	60 ps

Rates in  $J/\psi$  at luminosity  $10^{35} \text{ sm}^{-2}\text{s}^{-1}$  :

- events 260 kHz
- Bhabha 90 kHz
- cosmic 2 kHz
- Background - several tens of kHz

- The maximum readout rate up to **400 kHz**
- The event size **30 KB**

# The electronics block diagram

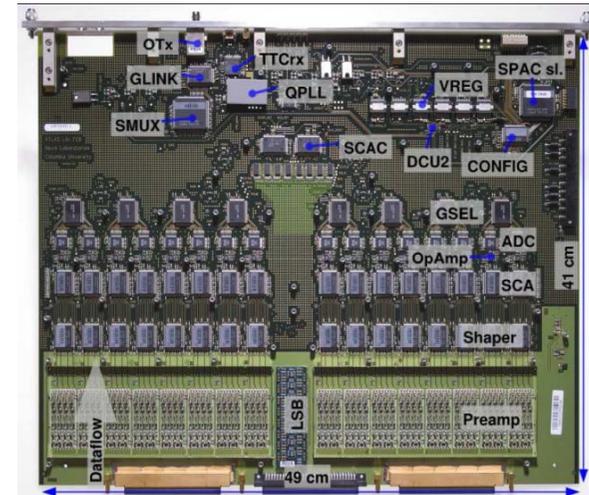


# ASICs in FrontEnd electronics

## Different ASICs in ATLAS LAr FEB

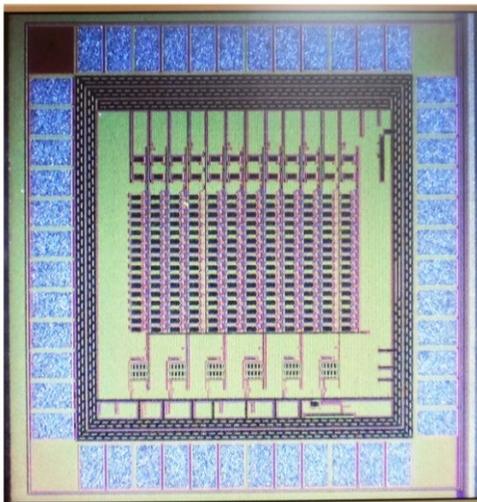
ASIC Type	Process	ASIC	Die Size (mm <sup>2</sup> )
Analog	AMS BiCMOS	Shaper	18
	DMILL	SCA	19.8
Digital	DMILL	SMUX	16
		SPAC slave	27
		CONFIG	31
	DSM	GSEL	16
		CLKFO	4
		SCAC	16

## ATLAS LAr FEB



## ASICs in BINP

### DMXS6A



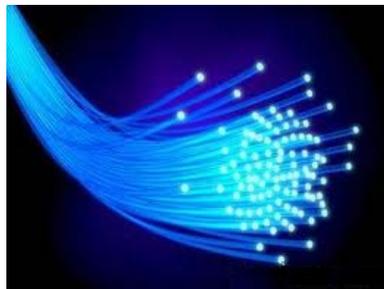
- DMXG64B - is being used in fast gaseous coordinate X-ray detector DIMEX-4
- DMXS6A - obtained first experimental results with Si coordinate X-ray detector DIMEX-4SI
- CTCALFE2A - chip prototype for CTau calorimeter Front-end electronics - under development

# Optical data transmission lines

Detector	Channel quantity	Data link quantity	Trigger link quantity
VD – GEM – pixel	56 K 10 M	56	56
DC	7.1 K	48	48
FARICH	1 M	100	0
Calorimeter	7.5 K	32	32
Mu	4 - 44 K	32	32

Data links – 268

Trigger links – 168



10Gb/s SFP+ Transceiver



Size 56\*14\*12 mm

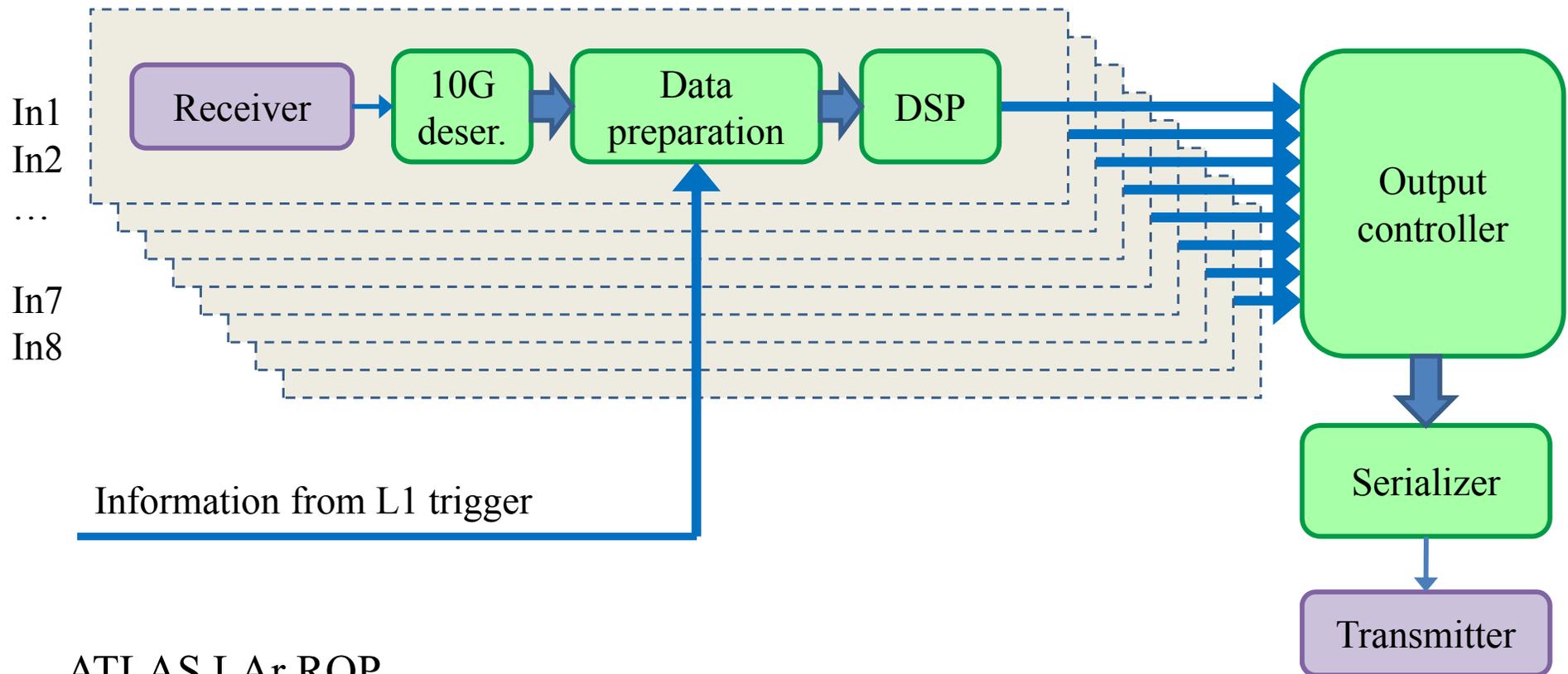
Power 3.3 V

Consumption < 1 W

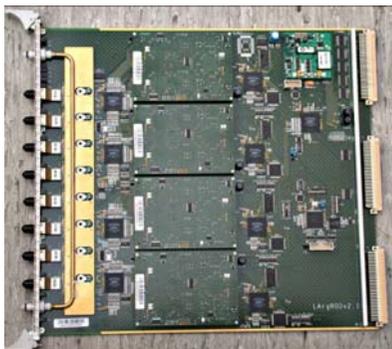
Price in 2010 - \$550

in 2018 - \$80

# ReadOut Processor (ROP)



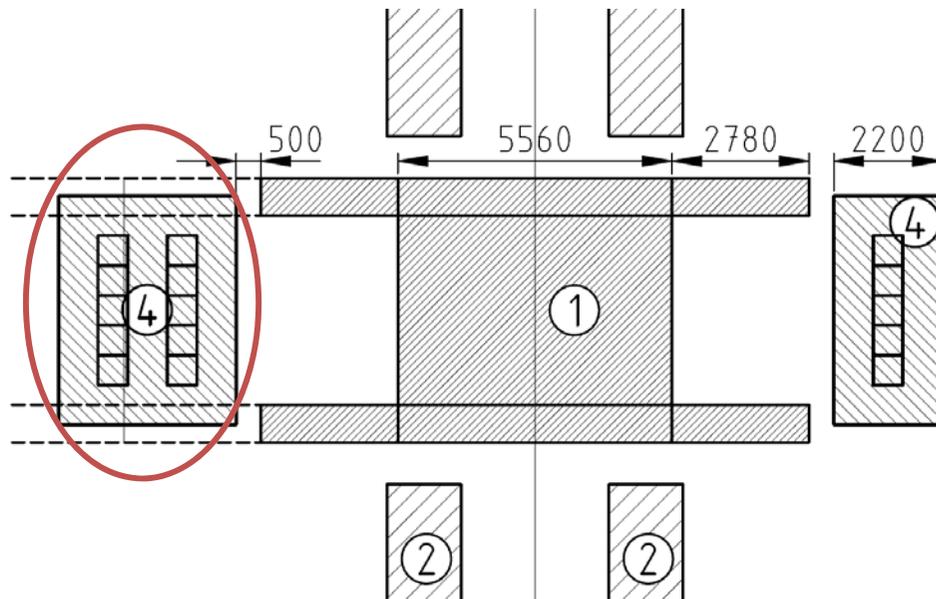
ATLAS LAr ROP



- The ROP can be equipped from 2 to 8 optical inputs
- 134 ROPs are necessary for 268 optical links

# BackEnd electronics location

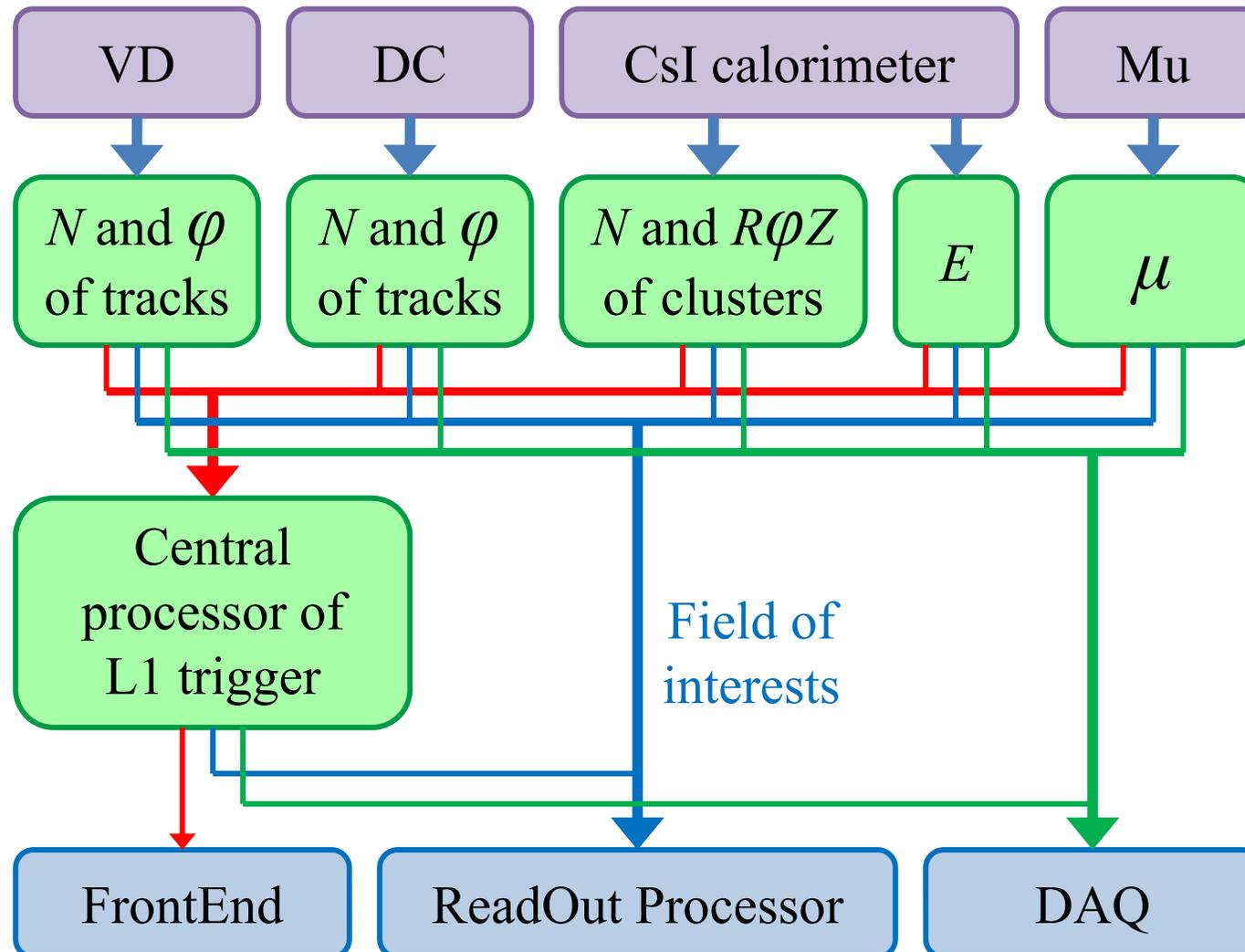
- 134 ROPs occupy 10 VME crates
- 10 crates => 4-5 racks
- Power consumption of crate  $\sim 1$  kW
- rack 2 – 3 kW



## ATLAS BackEnd electronics



# L1 Trigger



# L1 Trigger

## Requirements

- Maximal rate of L1 is 500 kHz
- Dead time < 100 ns
- Decision time (latency) – 2-3  $\mu$ s

## Information

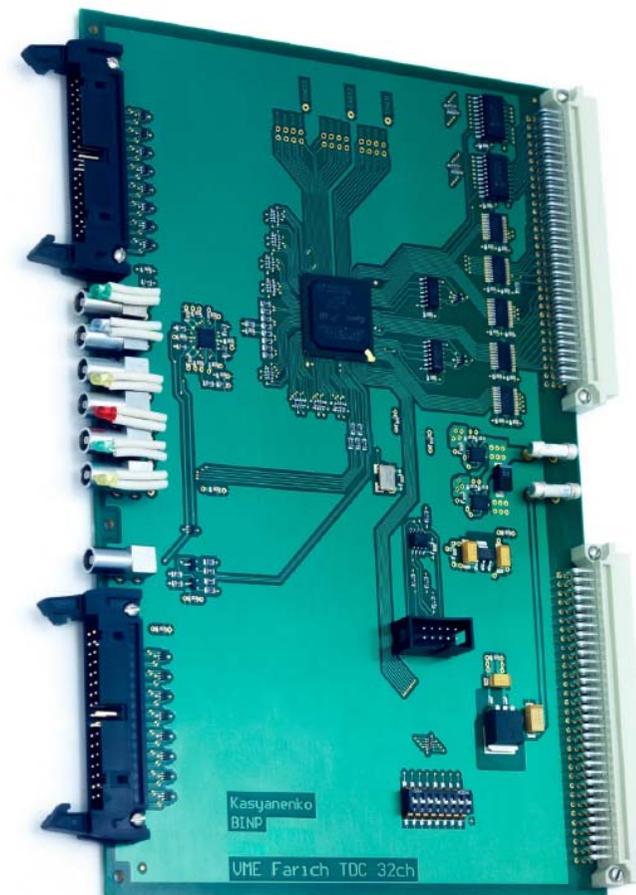
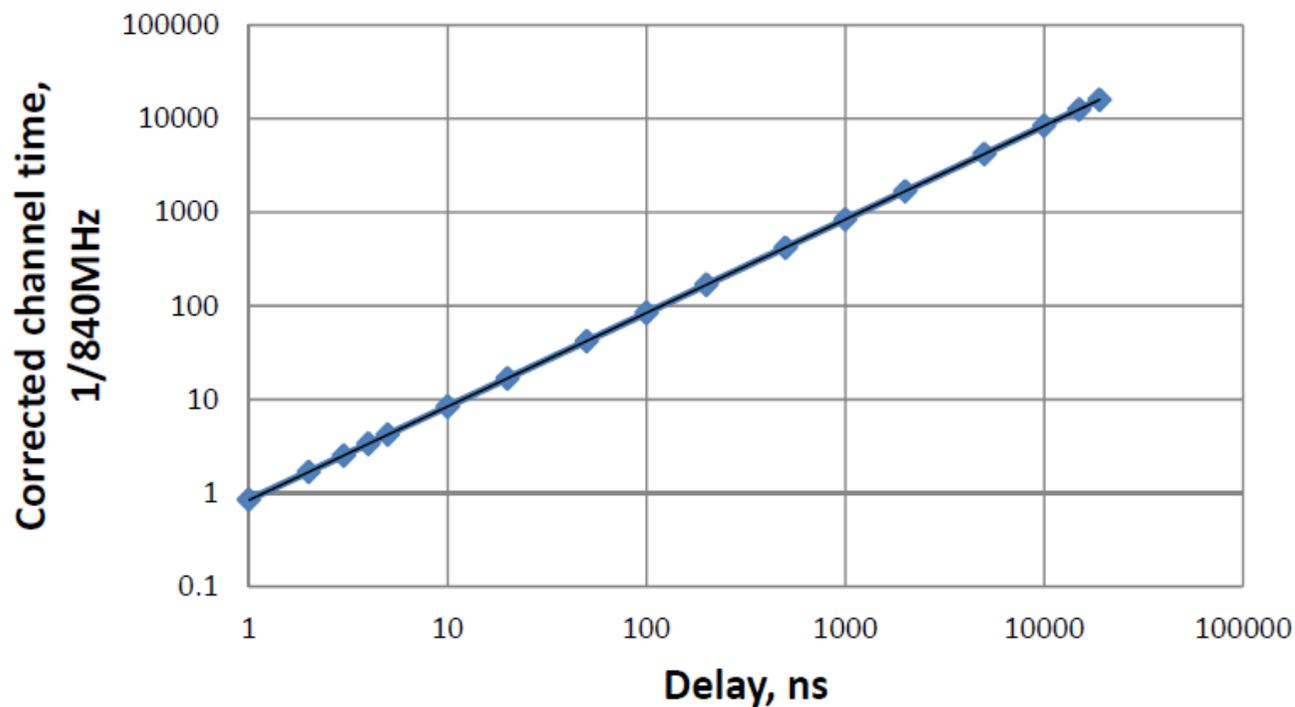
- Quantity of tracks in tracking systems
- Positions of tracks
- Energy deposition in calorimeter
- Quantity of clusters
- Position of clusters
- Muon system information

## Hardware

- 168 optical links, 2 – 4 links per preprocessor
- => 84 – 42 preprocessors
- => 6 – 3 crates
- => 2 – 1 racks
- VME or ATCA

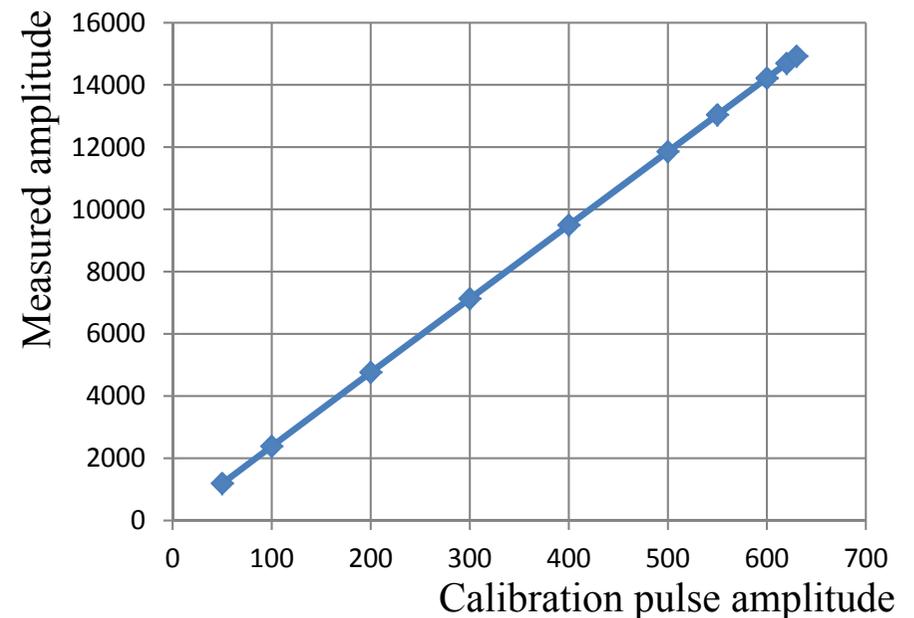
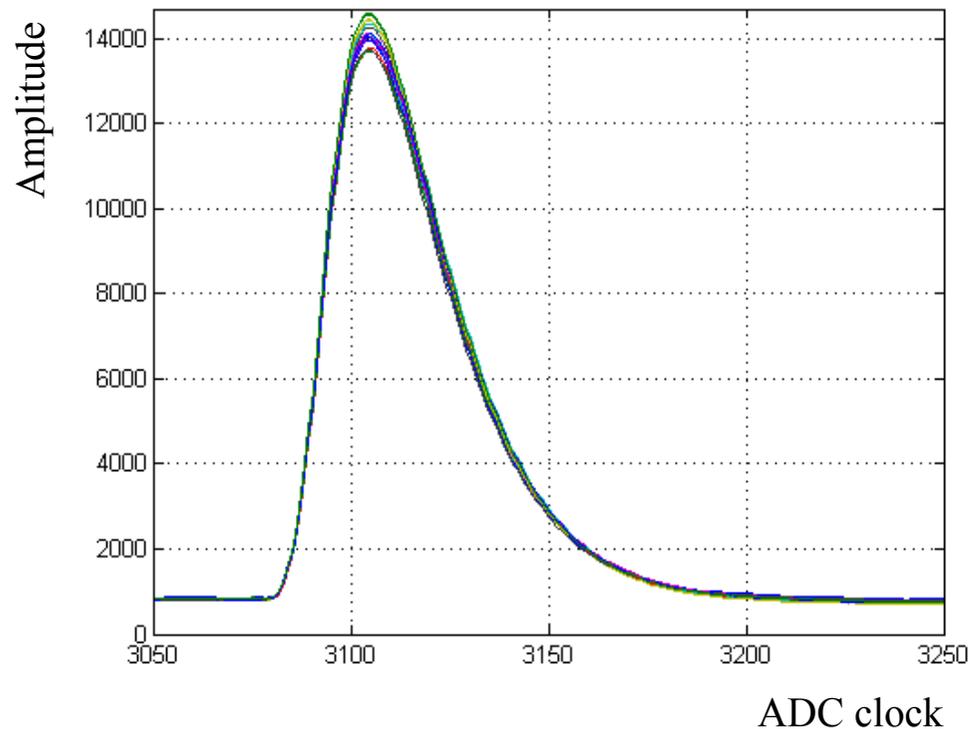
# Prototypes of electronics for FARICH

Parameter	Value	Comment
Resolution	1.19 ns	1/840 MHz sample rate
Dead time	4.76 ns	4 samples = 4/840 MHz
Maximal time interval	19504 ns	14 bit
Number of input channels	32	
Channel FIFO buffer size	256 events	
Shared memory size	4096 events	
Input signal level	LVDS	

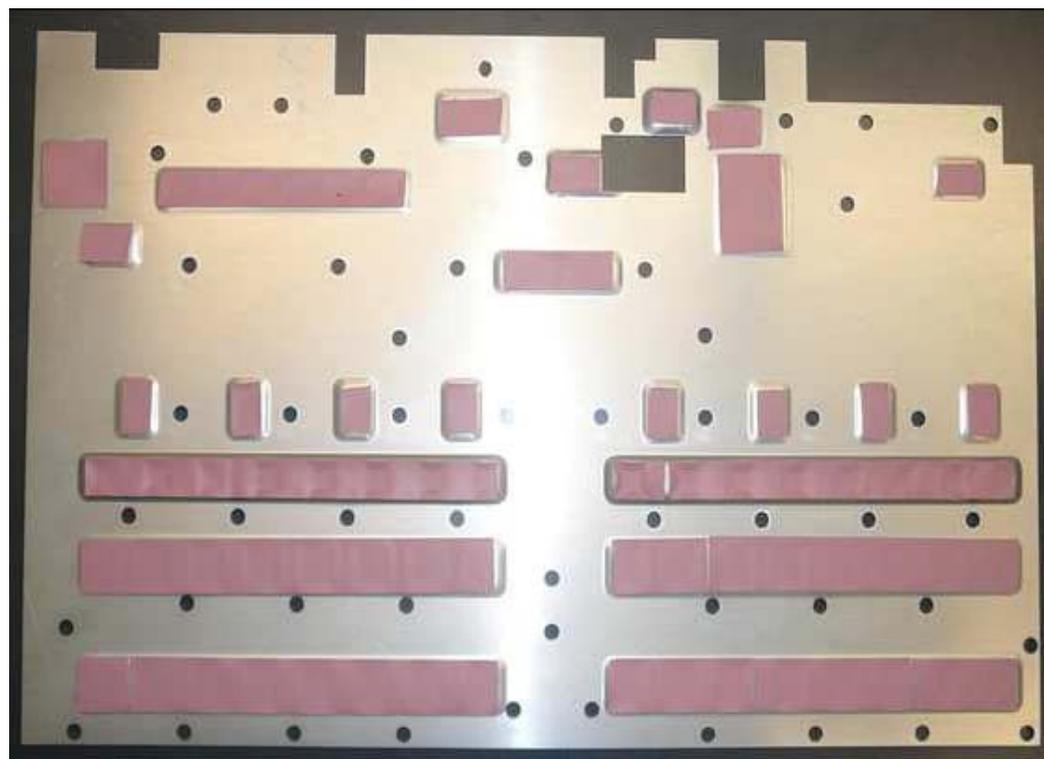


# Prototypes of electronics for CTau calorimeter

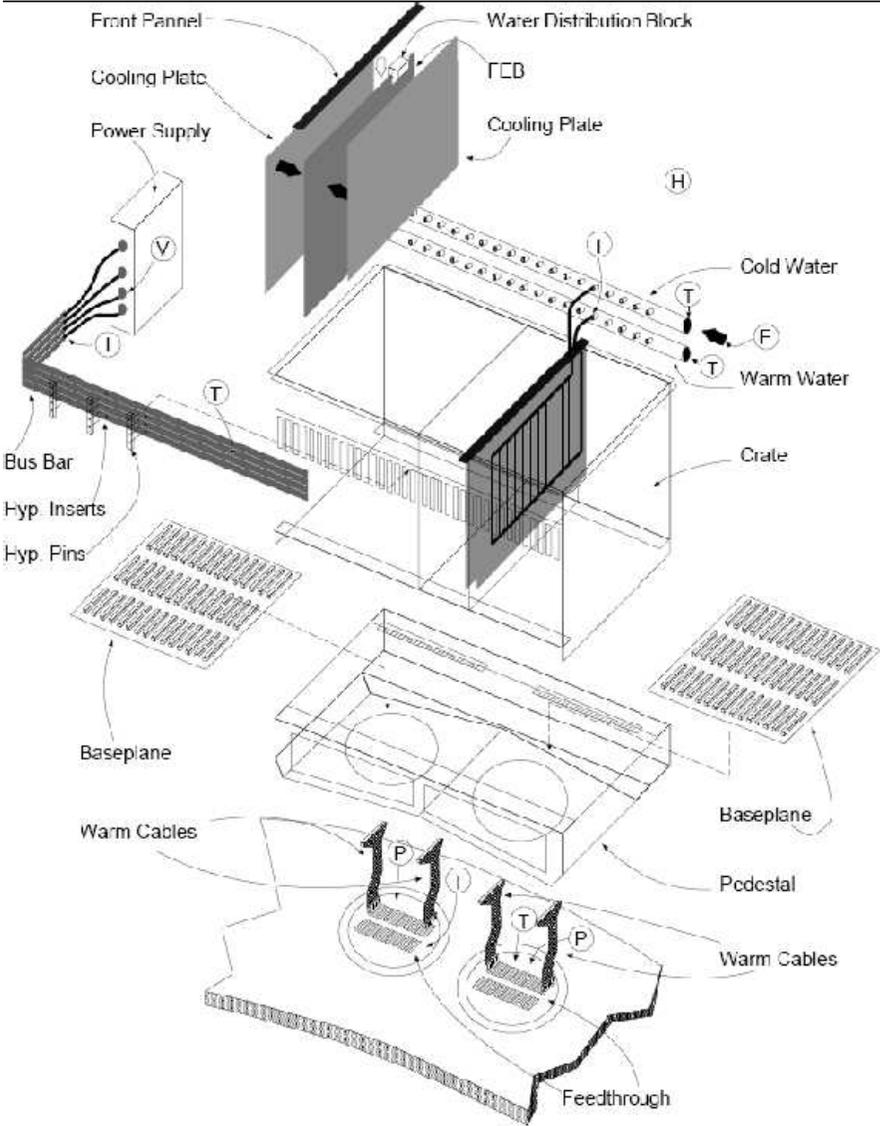
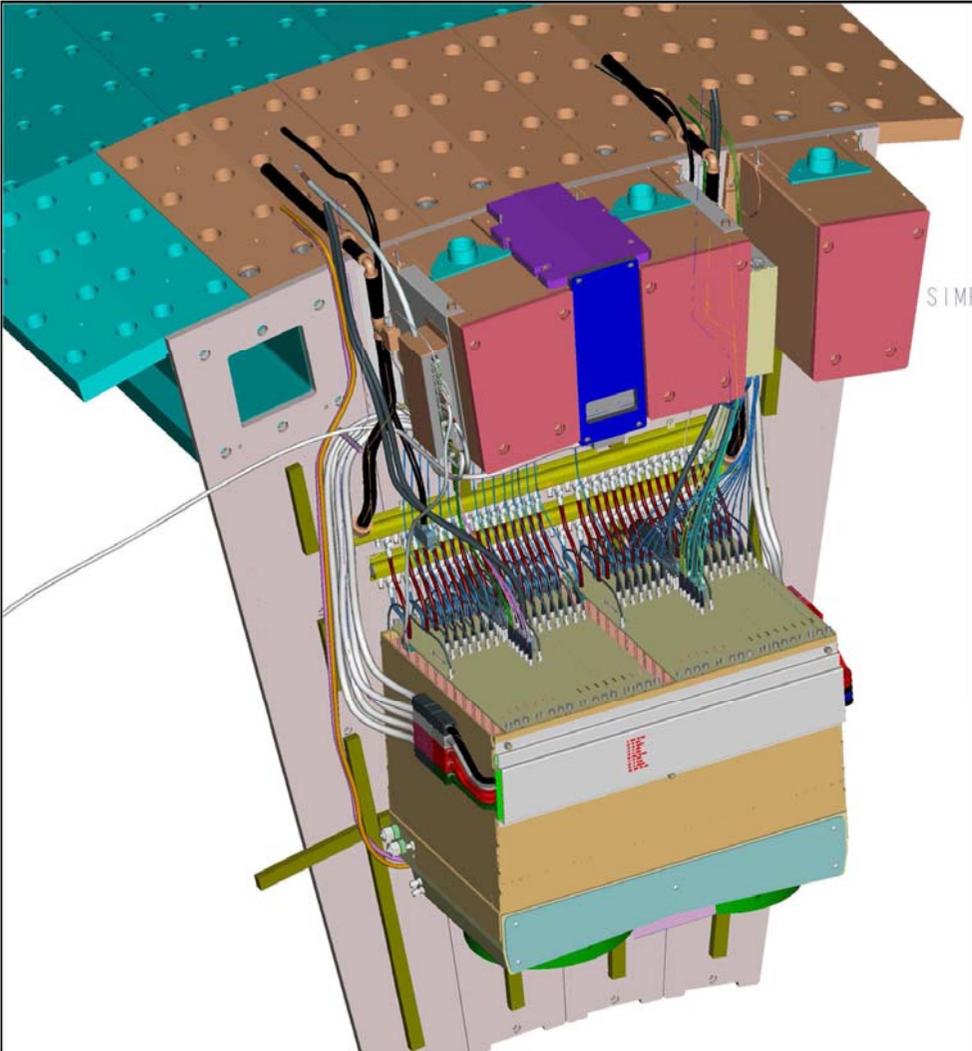
- Quantity of channels – 32
- 8 channel ADC
- ADC sampling rate – 50 MHz
- ADC resolution – 14 bits
- Variable gain amplifiers
- Total dynamical range – 17 bits
- Linearity -  $< 0.2\%$
- CTCALFE2A – ASIC (under development)



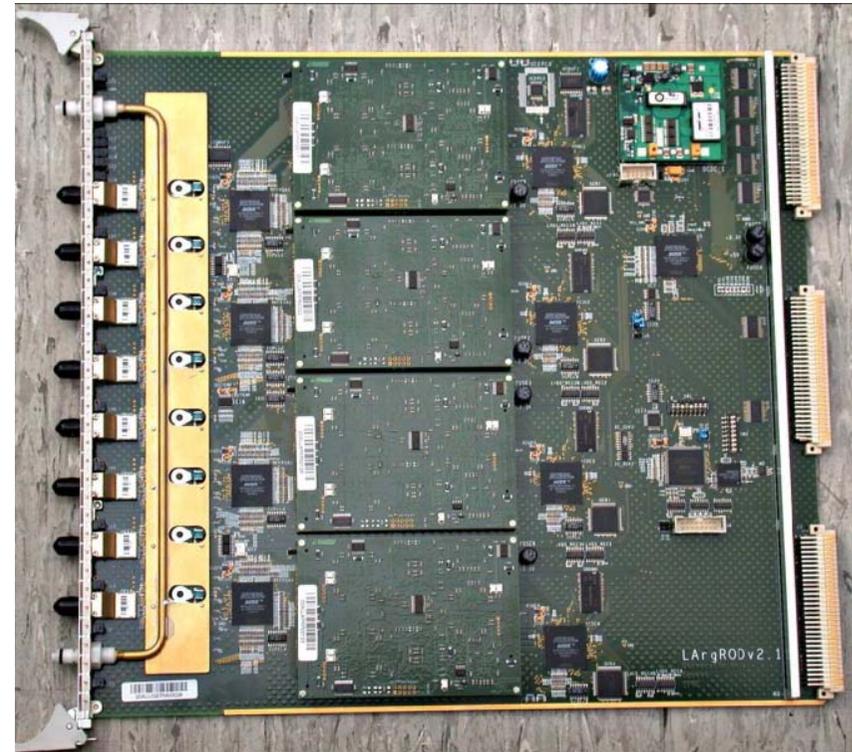
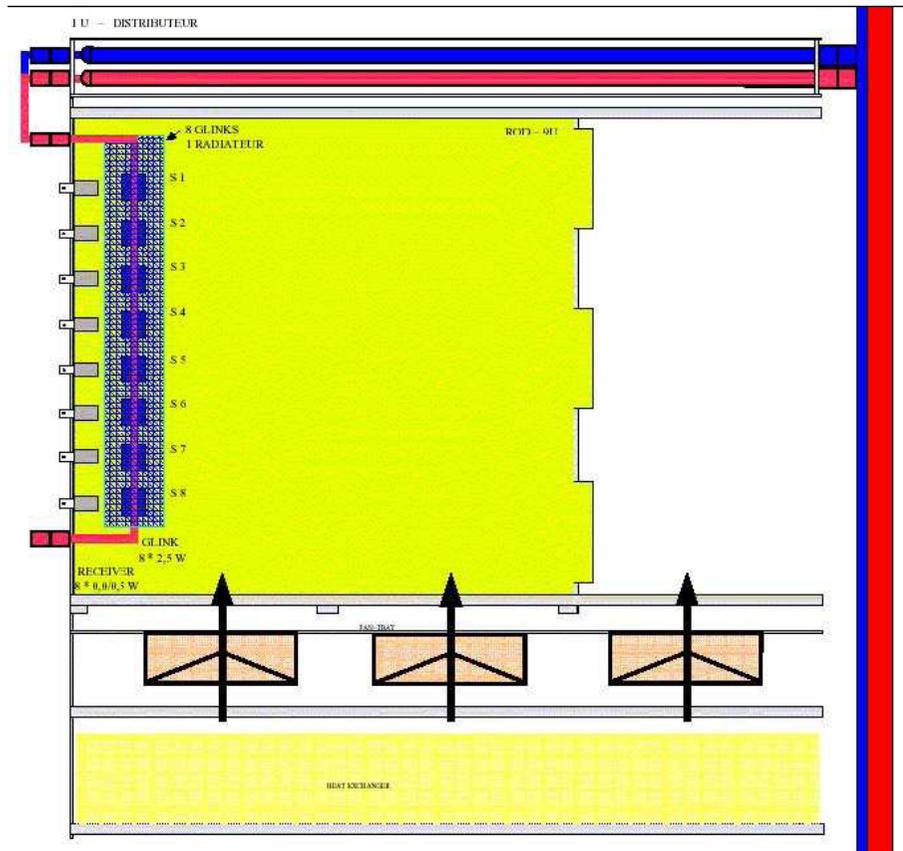
# Cooling of ATLAS LAr FEB



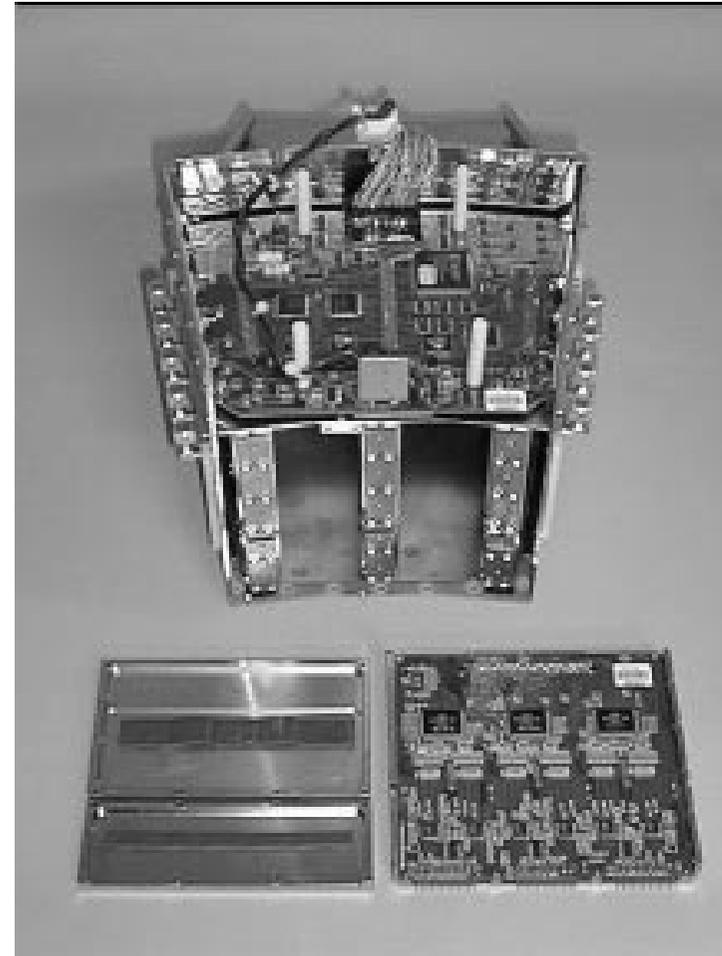
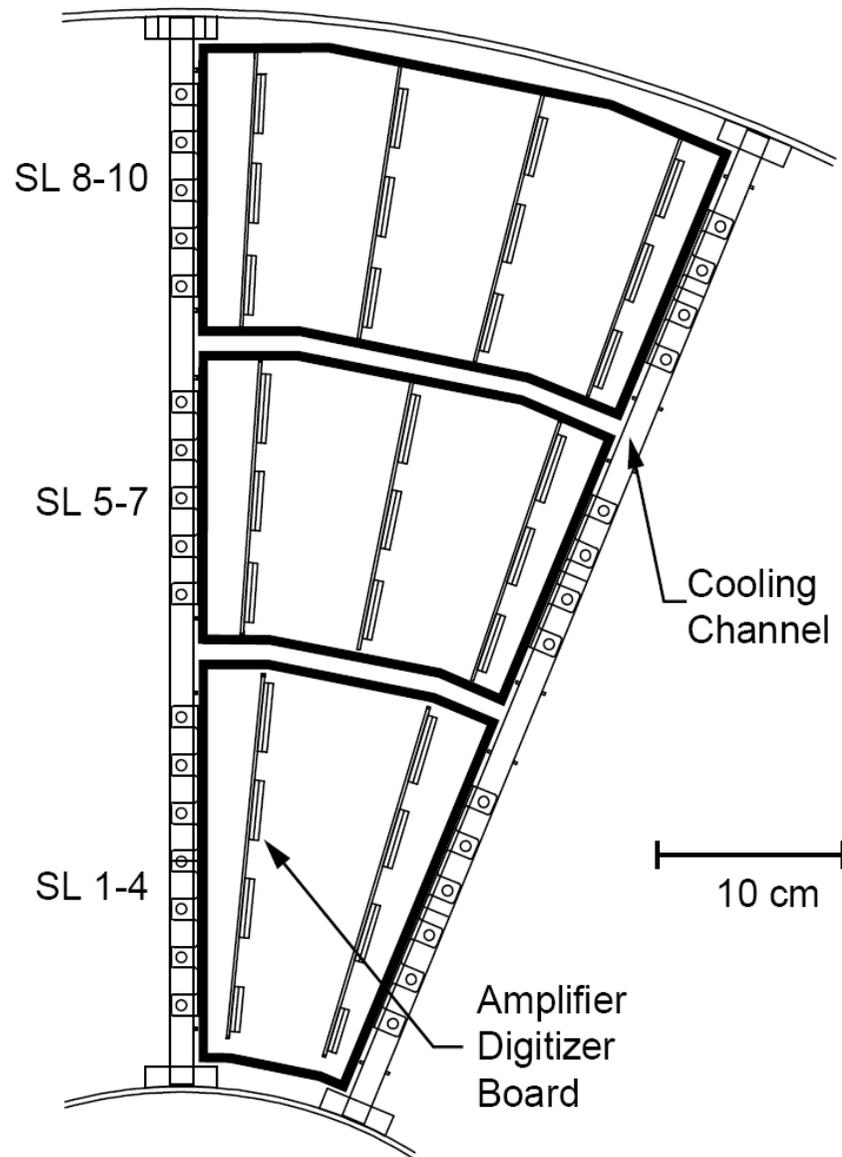
# ATLAS LAr FEC structure

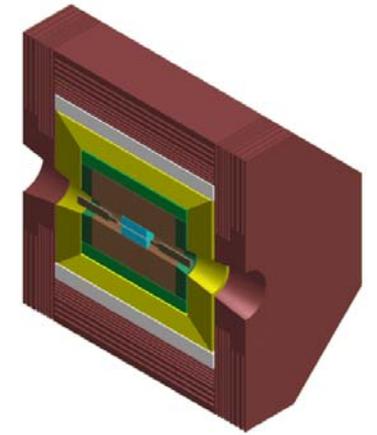


# Cooling of ATLAS LAr BackEnd electronics



# Cooling of Babar DC FrontEnd electronics





Thank you for attention

