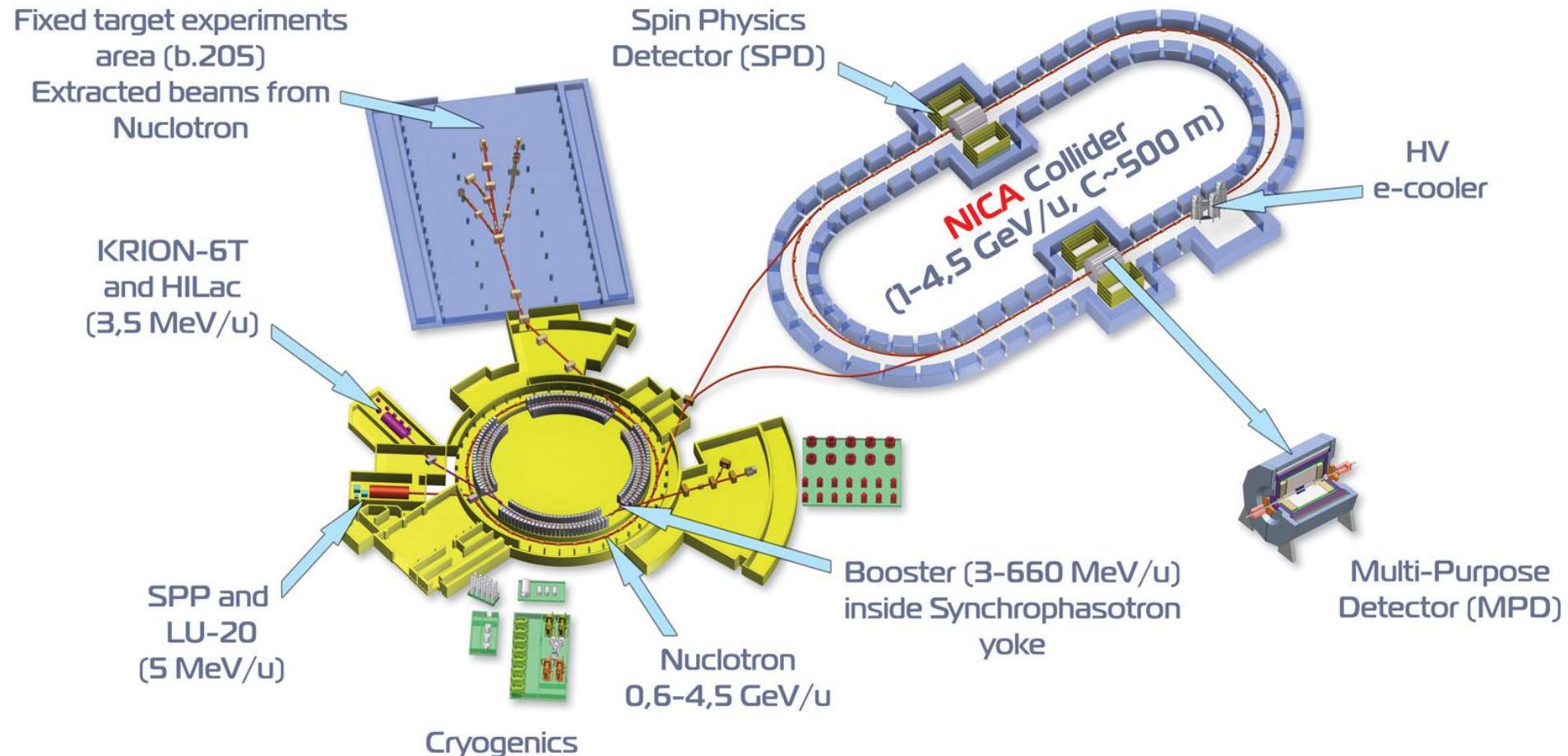


The Signal synchronization system of the NICA injector. Development of Timer module

author: Shirikov Ilia V.
co-authors: Donets Denis E.

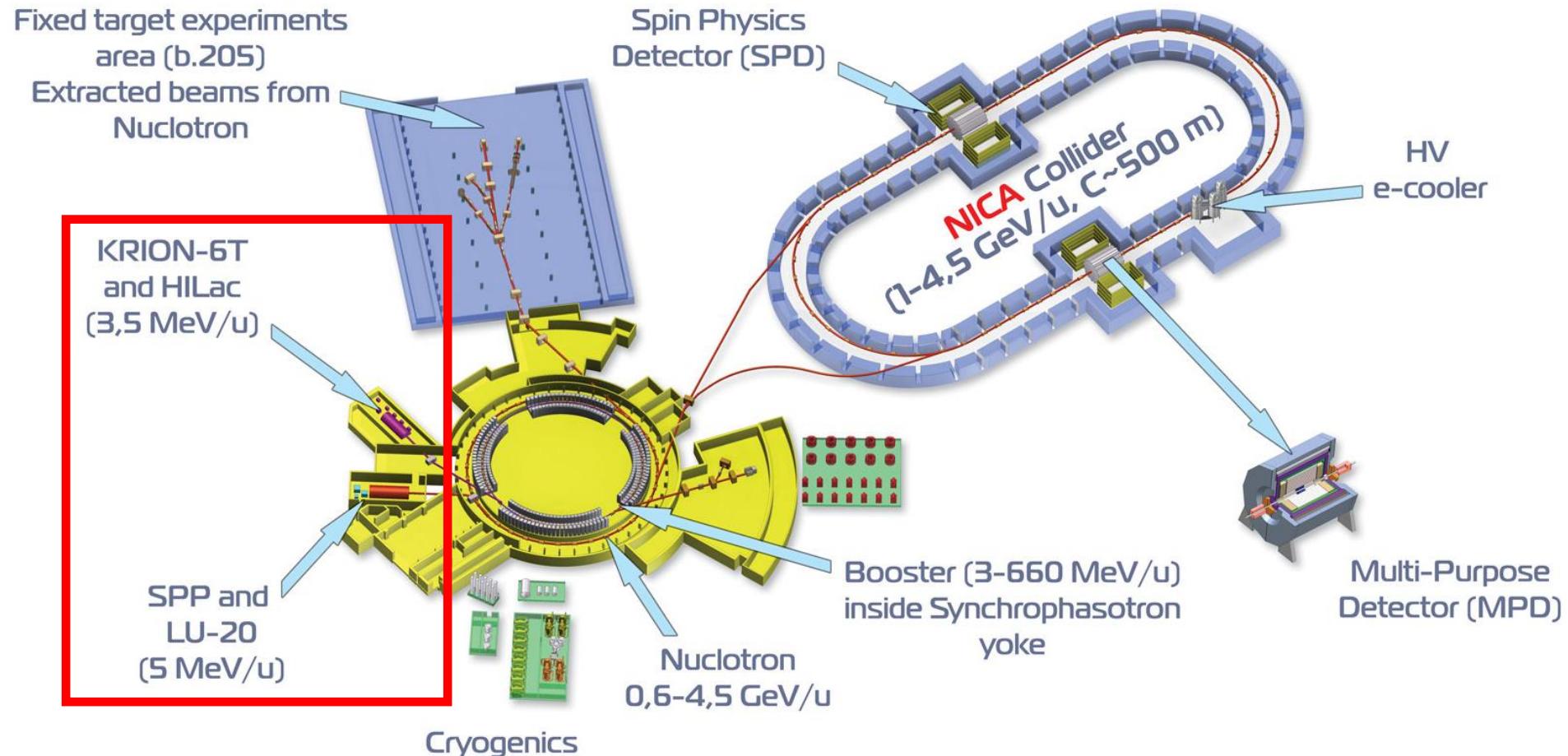
Signal synchronization system concept

Superconducting accelerator complex NICA (Nuclotron based Ion Collider fAcility)



Signal synchronization system concept

Superconducting accelerator complex NICA (Nuclotron based Ion Collider fAcility)



Signal synchronization system concept

Superconducting accelerator complex NICA

(Nuclotron based Ion Collider fAcility)

Fixed target exper
area (b.20)
Extracted beam
Nuclotron

KRION-61
and HILac
(3,5 MeV/u)

SPP an
LU-2
(5 MeV)

B - timer

t of injection

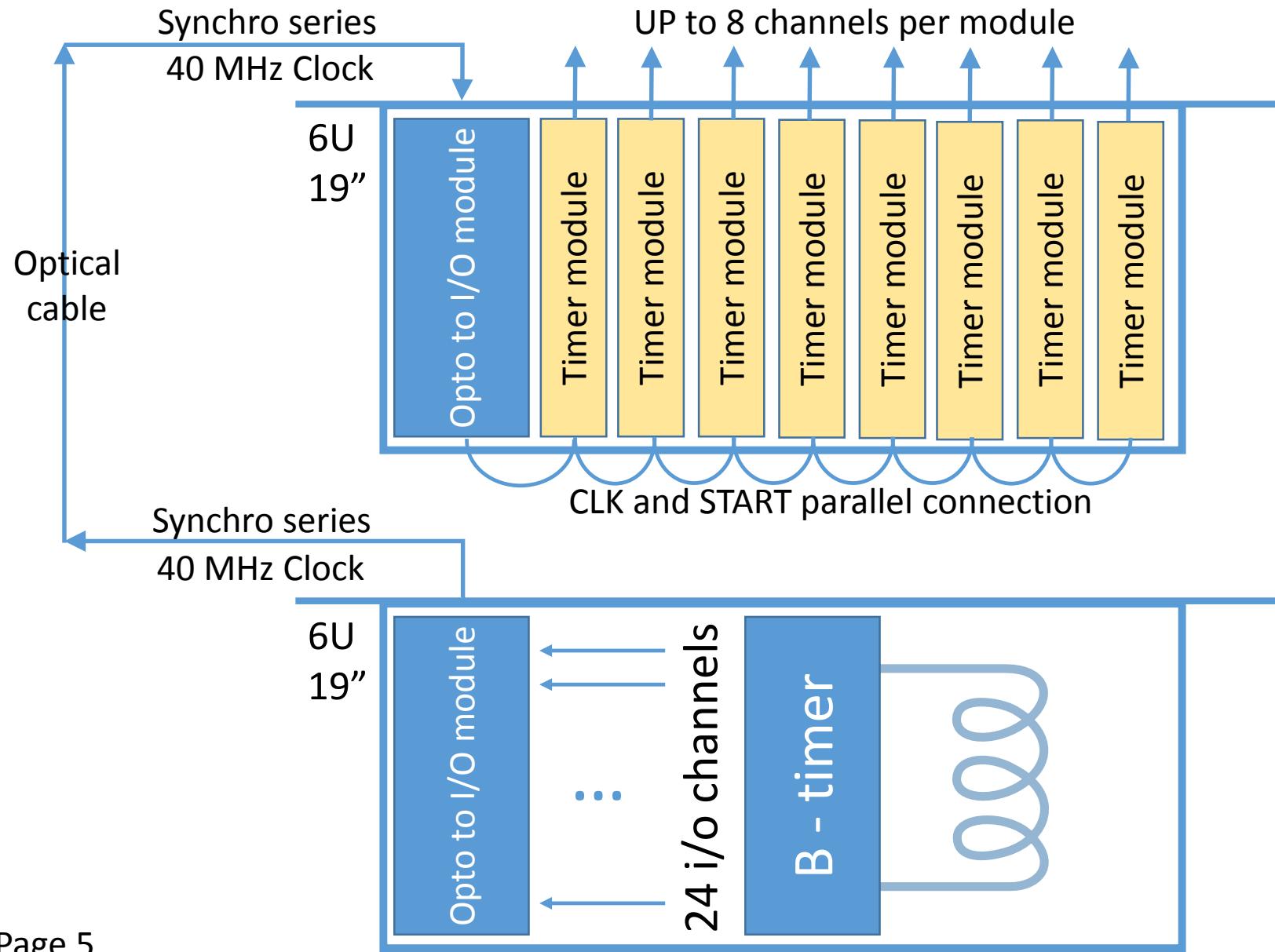
t of injection

HV
e-cooler

Multi-Purpose
Detector (MPD)

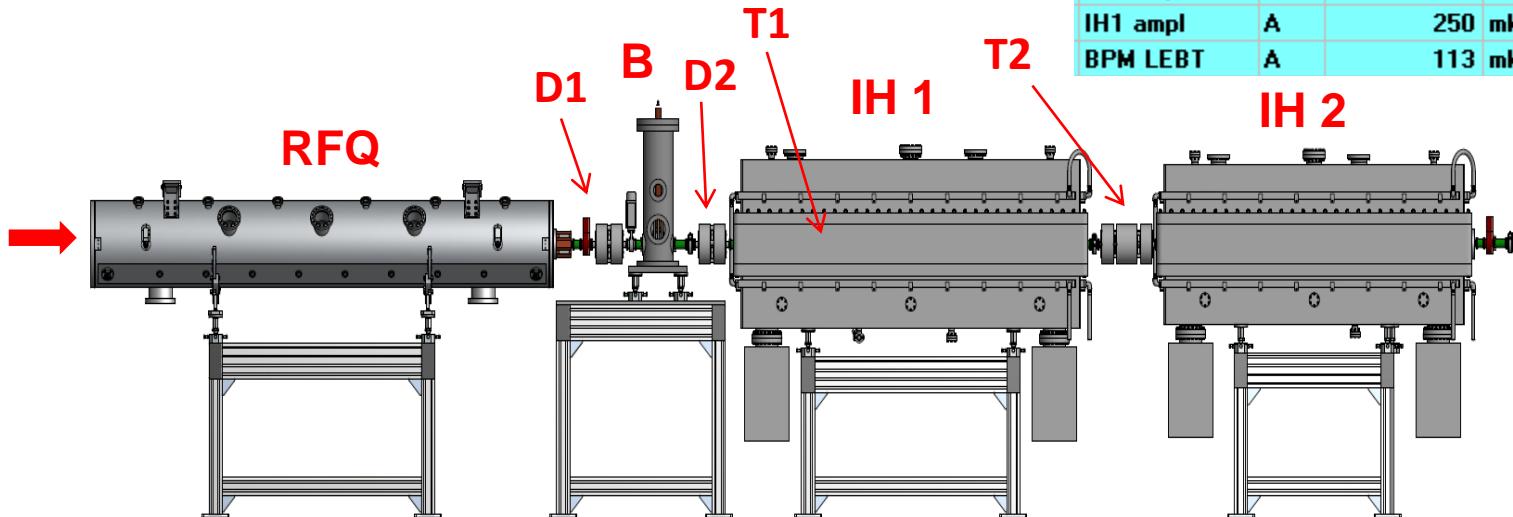
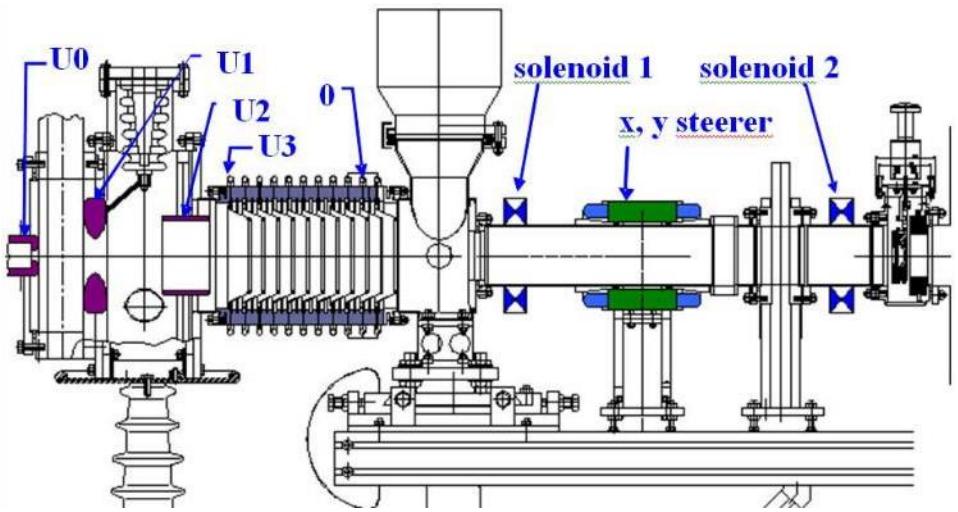
Nuclotron

Signal synchronization system concept



Development of Timer module. HILAc timing

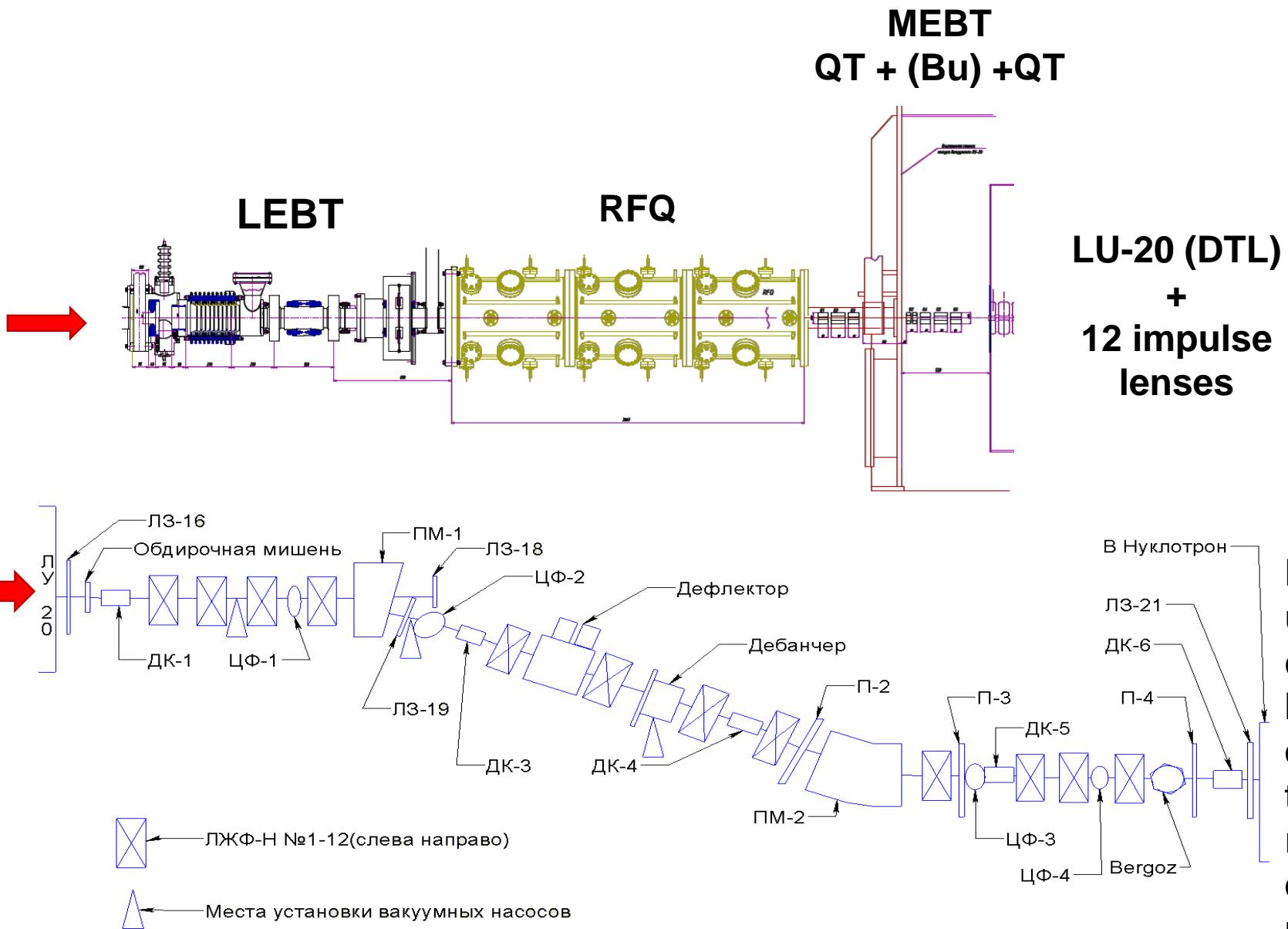
Beam from
KRON-6T



Имя канала	A/П	Задержка	Длительность
L1	А	1 ms	10 mks
L2	А	1 ms	10 mks
D1.D2	А	3.67 ms	10 mks
T1.1 T2.1	А	3.67 ms	10 mks
T1.2 T2.2	А	3.67 ms	10 mks
mod	П	1 ms	10 mks
mod	П	1 ms	10 mks
mod	П	1 ms	10 mks
mod	П	1 ms	10 mks
mod	П	1 ms	10 mks
mod	П	1 ms	10 mks
Лазер	П	100 mks	10 mks
ИТ-150М	А	180 mks	10 mks
LLRF	А	150 mks	100 mks
RFQ ampl	А	250 mks	150 mks
Buncher ampl	П	250 mks	150 mks
ИH2 ampl	А	250 mks	150 mks
ИH1 ampl	А	250 mks	150 mks
BPM LEBT	А	113 mks	120 mks
			10 mks
			10 mks
			10 mks
			100 mks

Development of Timer module. LU-20 timing

S
o
u
r
c
e



Development of Timer module. LU-20 timing

Имя канала	А/П	Задержка		Длительность	
ЛФИ	А	9.51	ms	20	mks
mod	П	100	ns	100	ns
mod	П	100	ns	100	ns
mod	П	100	ns	100	ns
mod	П	100	ns	100	ns
mod	П	100	ns	100	ns
mod	П	100	ns	100	ns
ВЧ	А	415	mks	20	mks
mod	П	100	ns	100	ns
ИСТОЧНИК	А	400	mks	20	mks
ИТ-800	А	20	mks	20	mks
ДФ1	А	730	mks	20	mks
ДФ2	А	740	mks	20	mks
mod	П	100	ns	100	ns
ОСЦ	А	300	mks	20	mks
mod	П	100	ns	100	ns
mod	П	100	ns	100	ns
ИНФЛЕКТОР	А	451	mks	1	mks
АЦП	А	355	mks	20	mks

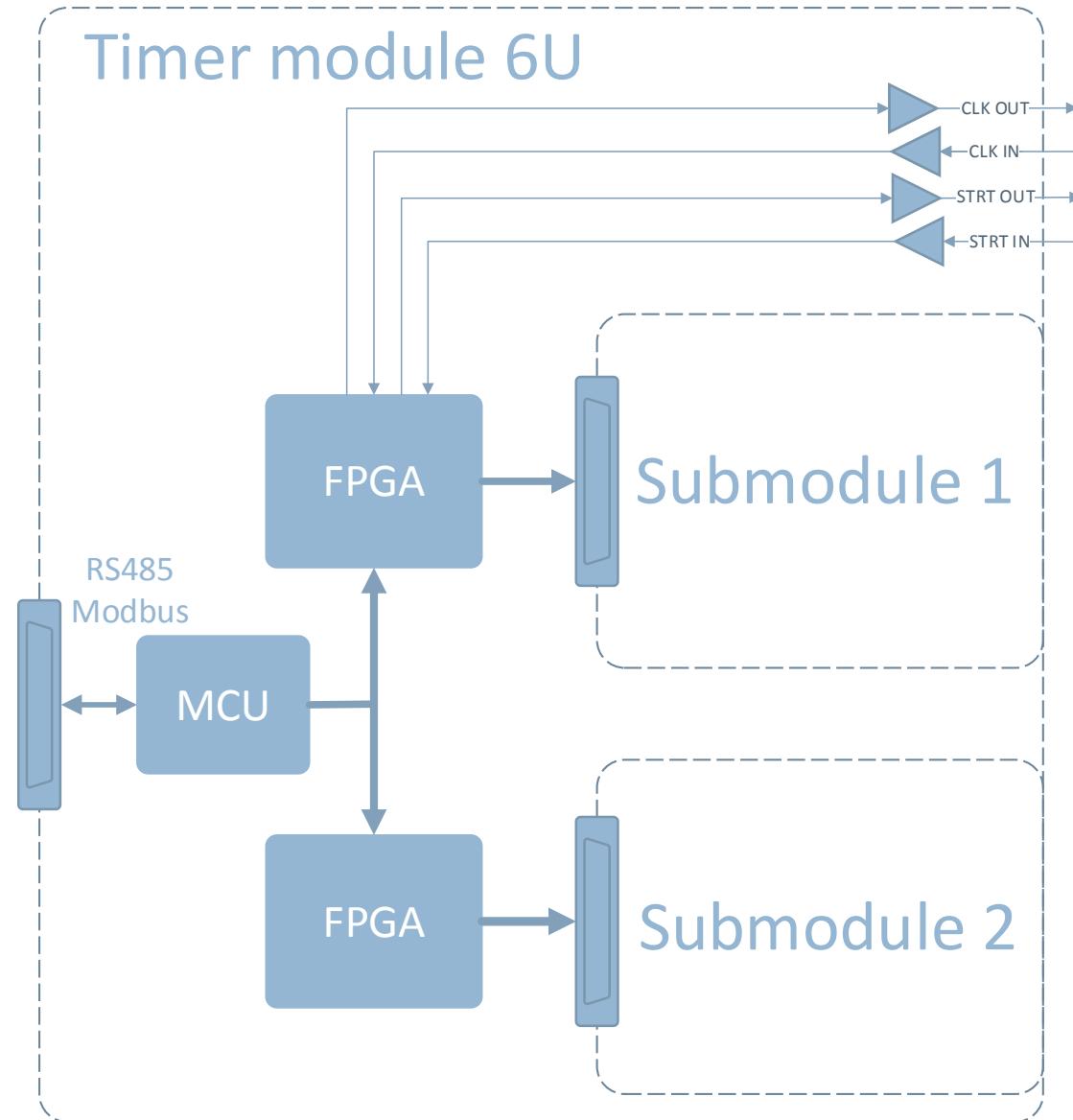
Имя канала	А/П	Задержка		Длительность	
ЛЖФ-ЛУ0	А	11.11	ms	20	mks
ЛЖФ-ЛУ1	А	10.01	ms	20	mks
ЛЖФ-ЛУ2	А	10.01	ms	20	mks
ЛЖФ-ЛУ3	А	9.81	ms	20	mks
ЛЖФ-ЛУ4	А	10.11	ms	20	mks
ЛЖФ-ЛУ5	А	9.81	ms	20	mks
ЛЖФ-ЛУ6	А	9.61	ms	20	mks
ЛЖФ-ЛУ7	А	9.41	ms	20	mks
mod	П	100	ns	100	ns
mod	П	100	ns	100	ns
mod	П	100	ns	100	ns
mod	П	100	ns	100	ns
ЛЖФ-ЛУ8	А	9.81	ms	20	mks
ЛЖФ-ЛУ9	А	9.81	ms	20	mks
ЛЖФ-ЛУ10	А	8.91	ms	20	mks
ЛЖФ-ЛУ11/1	А	10.31	ms	20	mks
ЛЖФ-ЛУ11/2	А	10.51	ms	20	mks
mod	П	100	ns	100	ns
ЛЖФ-Н1	А	10.2	ms	20	mks
ЛЖФ-Н2	А	10.2	ms	20	mks

Typical time delay = 0,1 – 100 ms

Typical time impulse width = 0,1 – 100 us

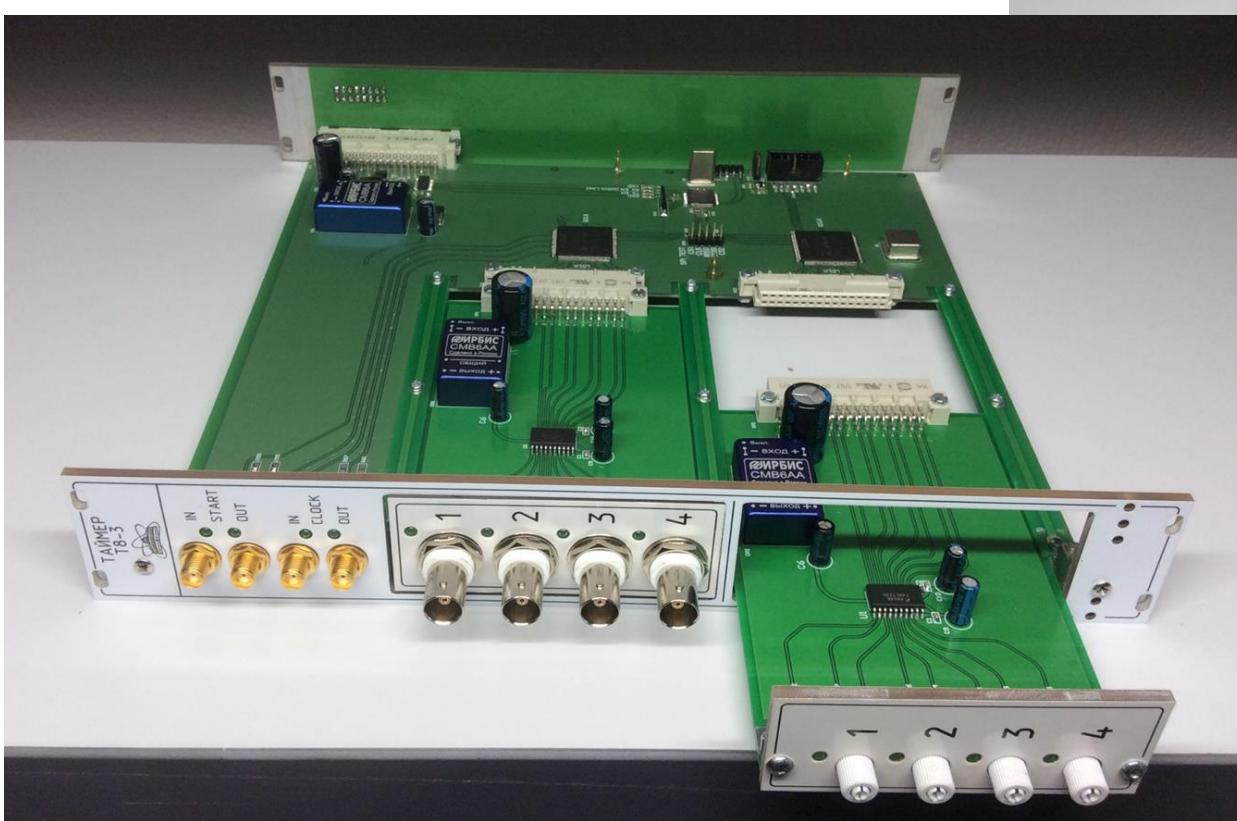
Development of Timer module 6U

Timer module 6U



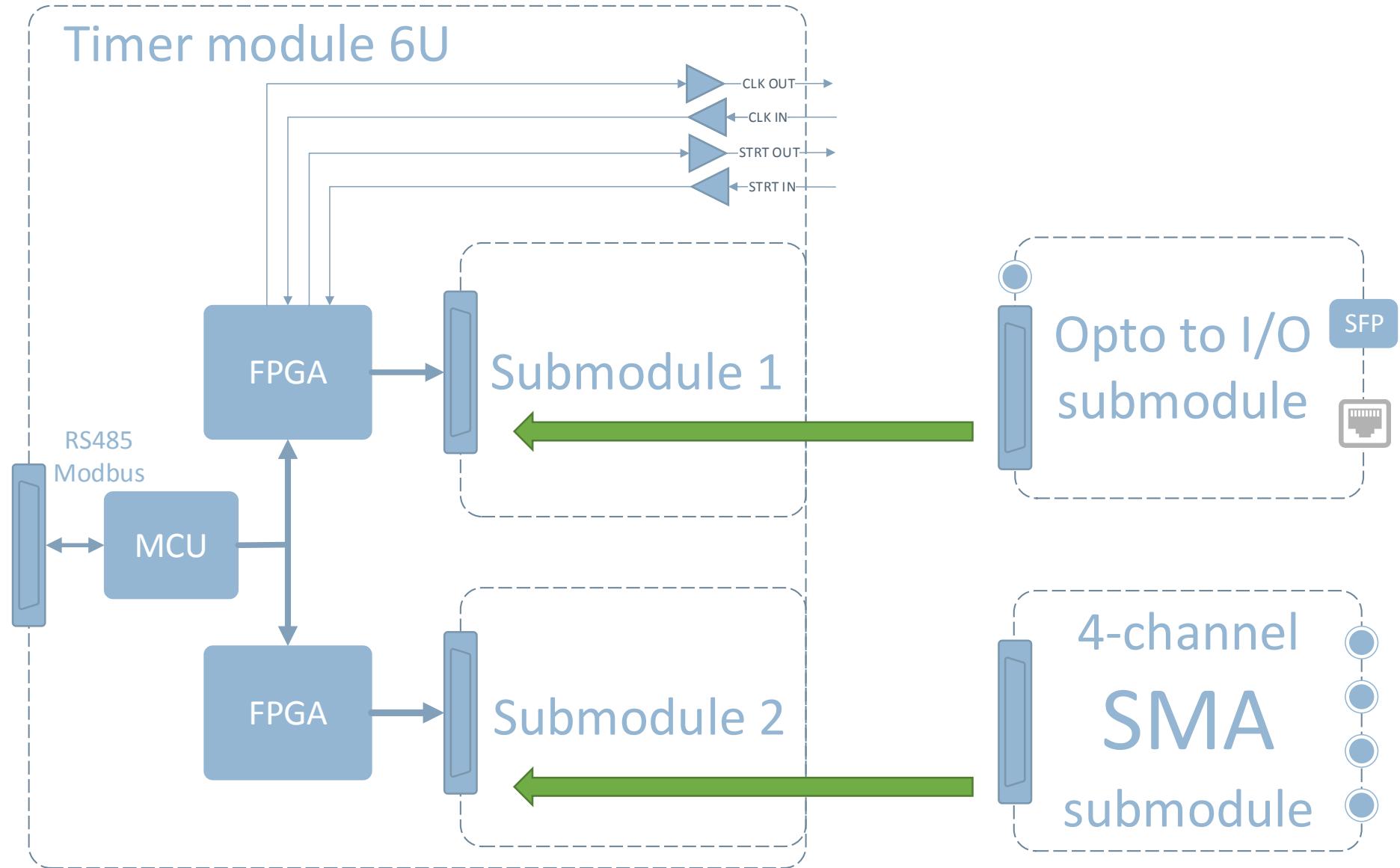
- External Clock input 40 MHz
- 40 MHz Clock output (Master mode)
- External trigger Start input
- Start output (Master mode)
- 8 output channels
- Inverse output mode
- 32-bit timer for delay
- 32-bit timer for impulse width
- 50Ω SMA, SMB, Lemo, BNC , Optical standarts support.
- Operating by RS-485 Modbus

Timer module 6U layout

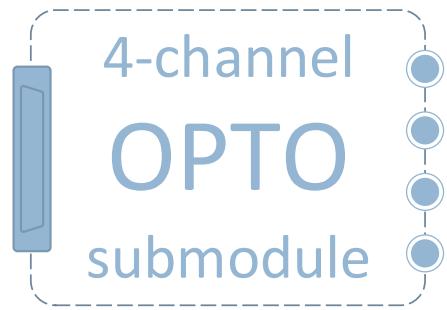
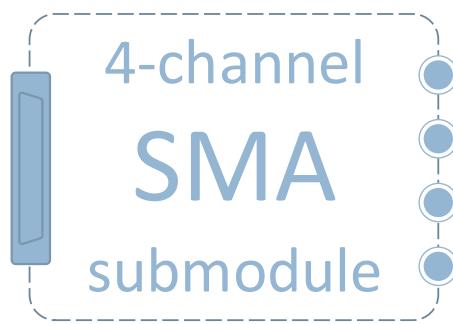
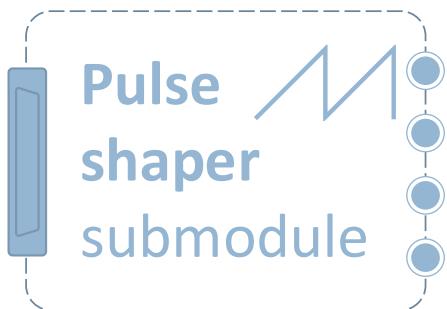
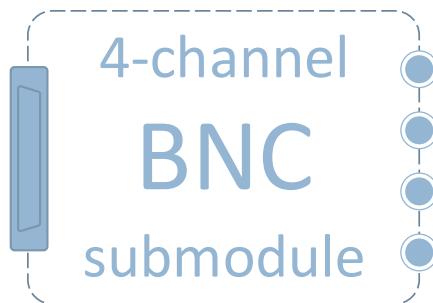
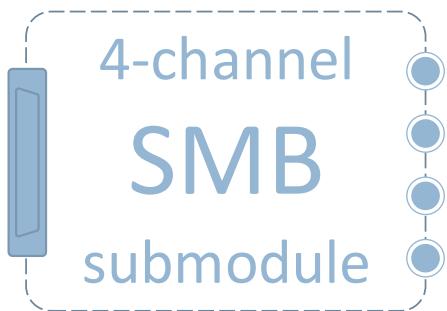


Timer module with submodules

Timer module 6U

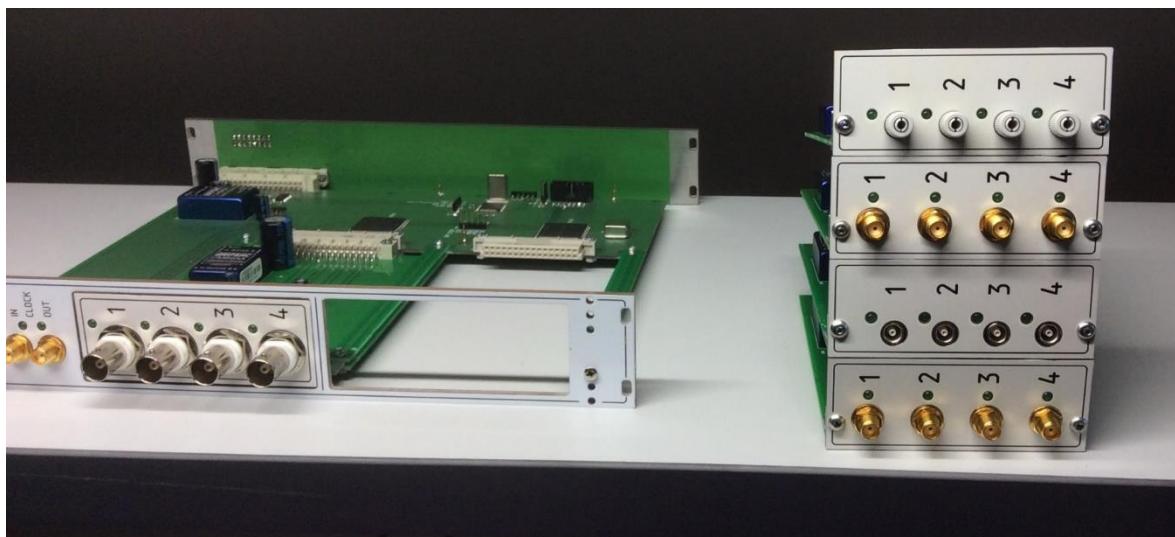
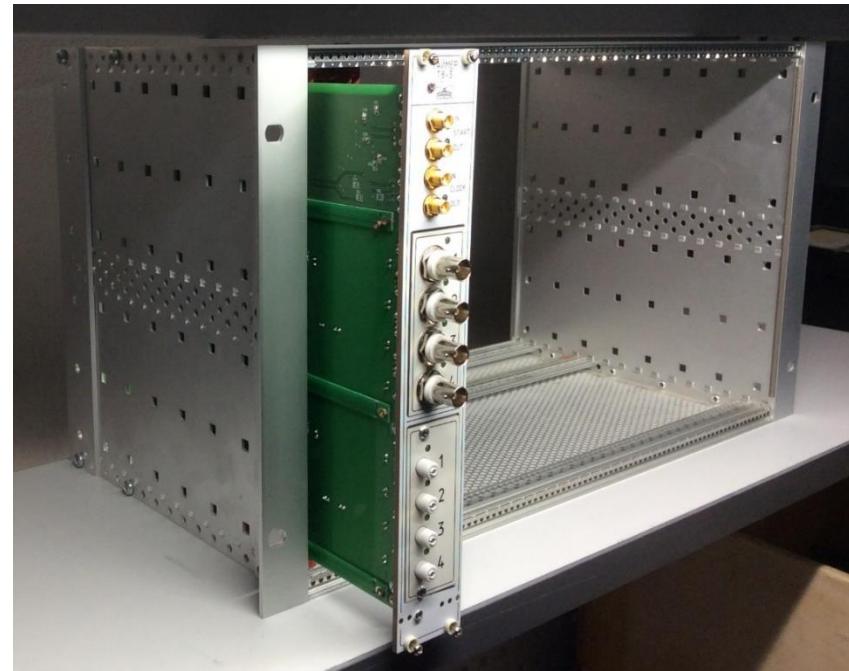


Timer's submodules



- Derived from impulse
- Up to 50V amplitude
- Up to 5 (SMB) channels
- Photocoupler isolation

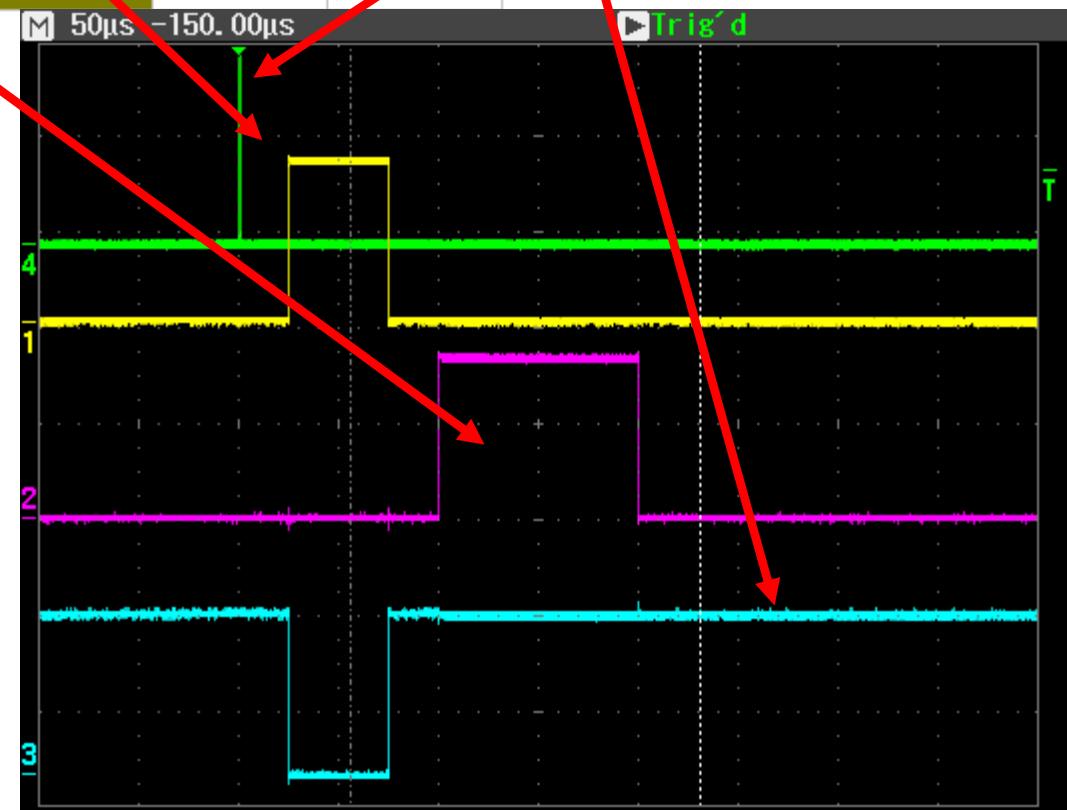
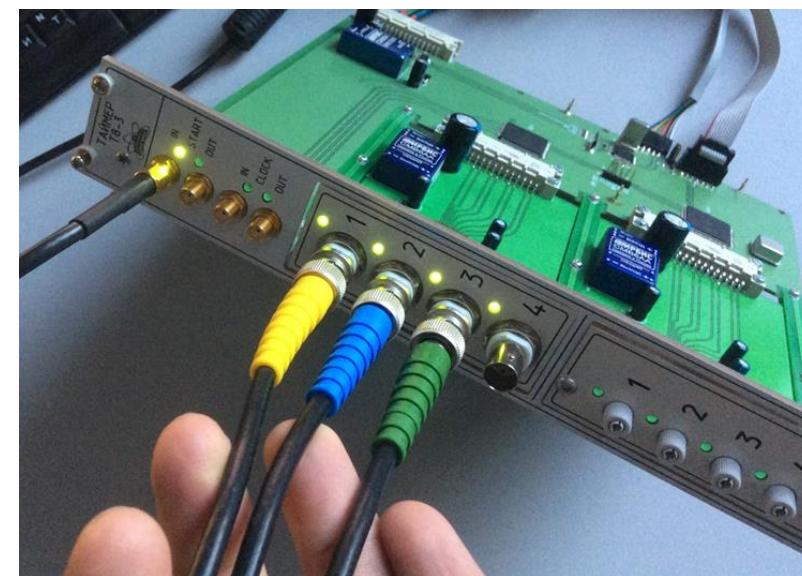
Timer module 6U with submodules layout



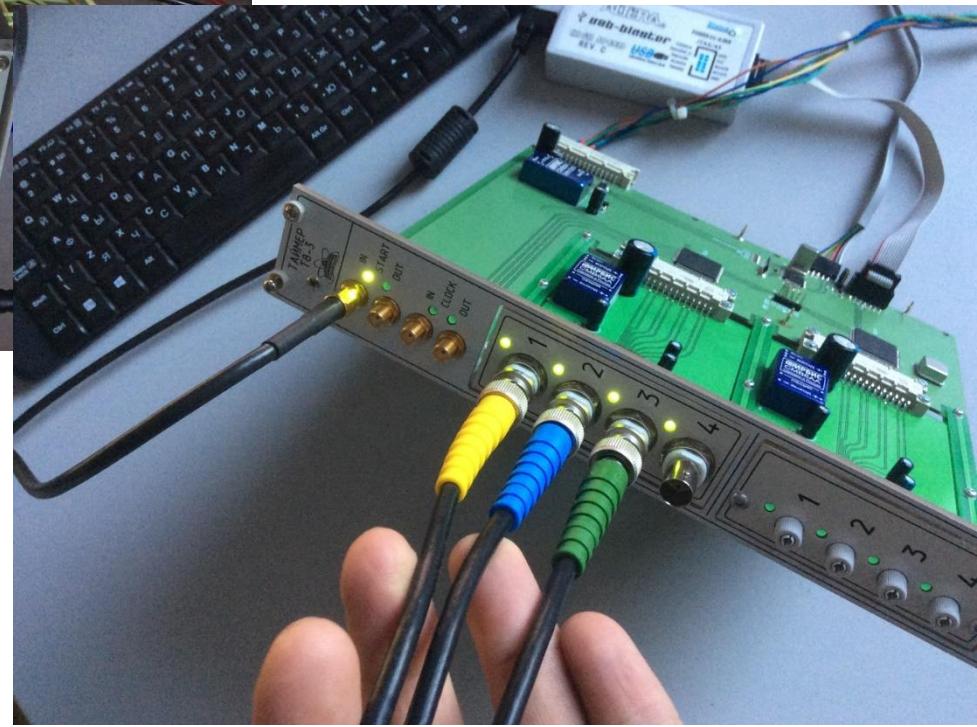
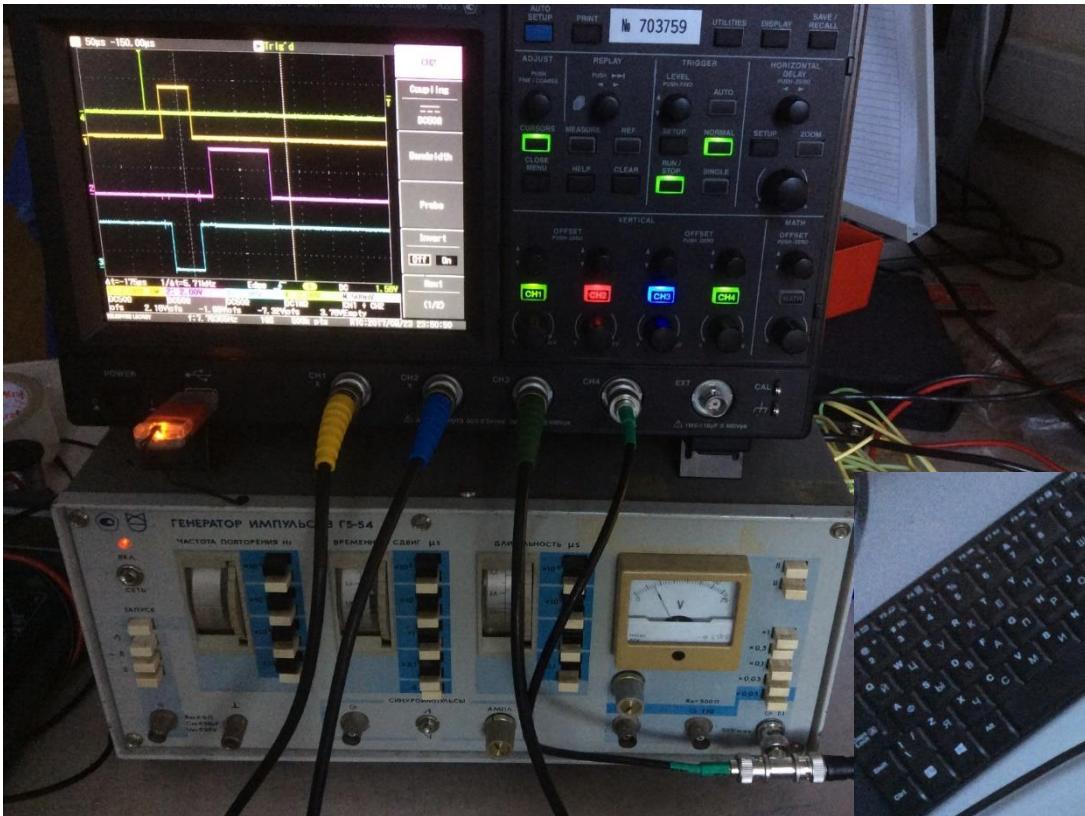
Modbus poll operating

	Alias	01000		Alias	01010		Alias	01020
0	CH1_del_LSB	1000		CH3_width_LSB	2000		EN_chanel_3	1
1	CH1_del_MSB	0		CH3_width_MSB	0		INV_chanel_3	1
2	CH1_width_LSB	2000		CH4_del_LSB	1000		EN_chanel_4	1
3	CH1_width_MSB	0		CH4_del_MSB	0		INV_chanel_4	0
4	CH2_del_LSB	4000		CH4_width_LSB	2000		CONTROL	117
5	CH2_del_MSB	0		CH4_width_MSB	0			
6	CH2_width_LSB	4000		EN_chanel_1	1			
7	CH2_width_MSB	0		INV_chanel_1	0			
8	CH3_del_LSB	1000		EN_chanel_2	1			
9	CH3_del_MSB	0		INV_chanel_2	0			

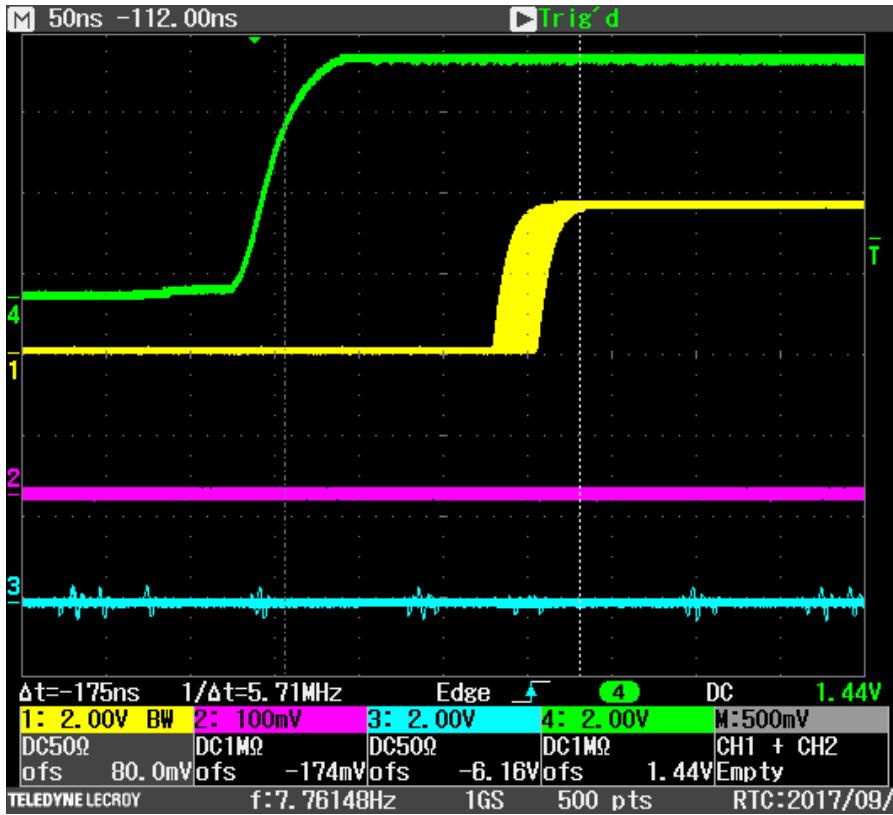
Start strobe



Timer module 6U debugging



Conclusions



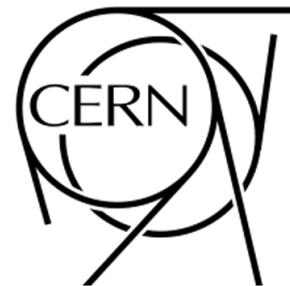
- Developed 8 channel Timer module with plug-in interface submodules

For each of 8 channels:

- 40 MHz input clock
- 100 ns – Min time setting
- 107,37 s – Max time setting
- Time step – 25 ns
- Maximum jitter - 25 ns

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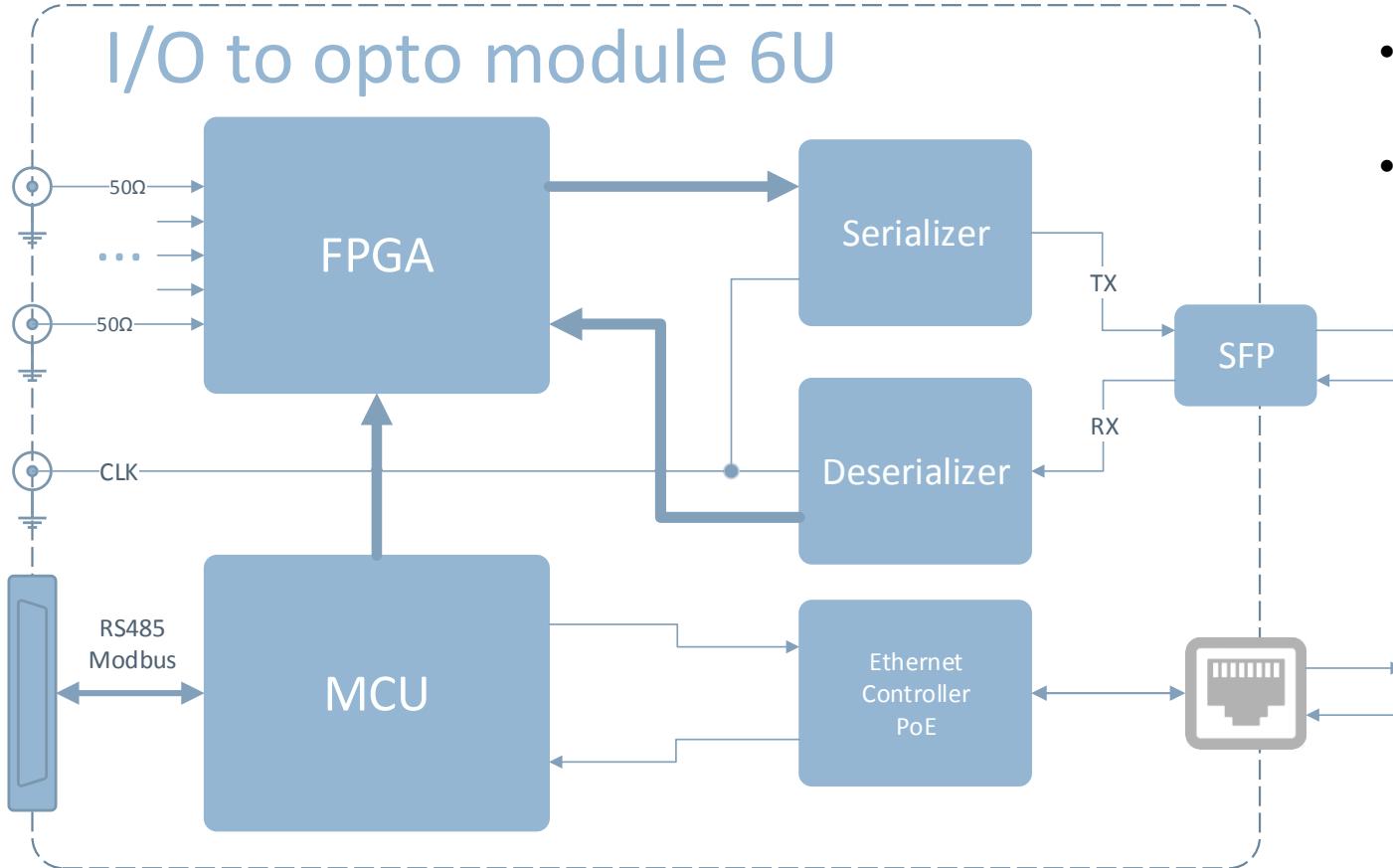
26'th International Symposium on Nuclear Electronics & Computing



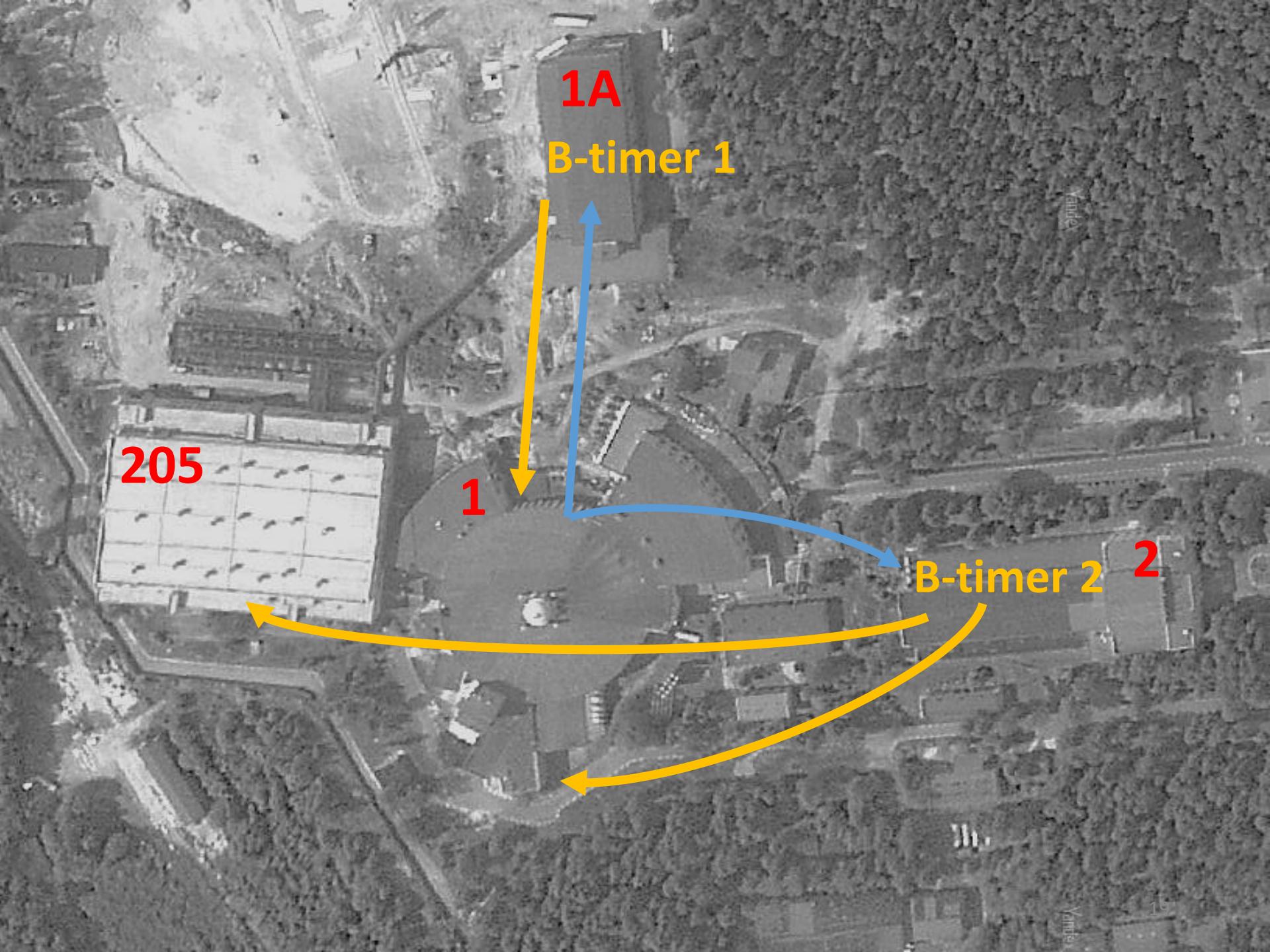
Thank for your attention!

I/O to opto module 6U

I/O to opto module 6U



- SFP optical interface
- 40 Msps
- Up to 40 MHz clock output
- PoE power supply



205

1A
B-timer 1

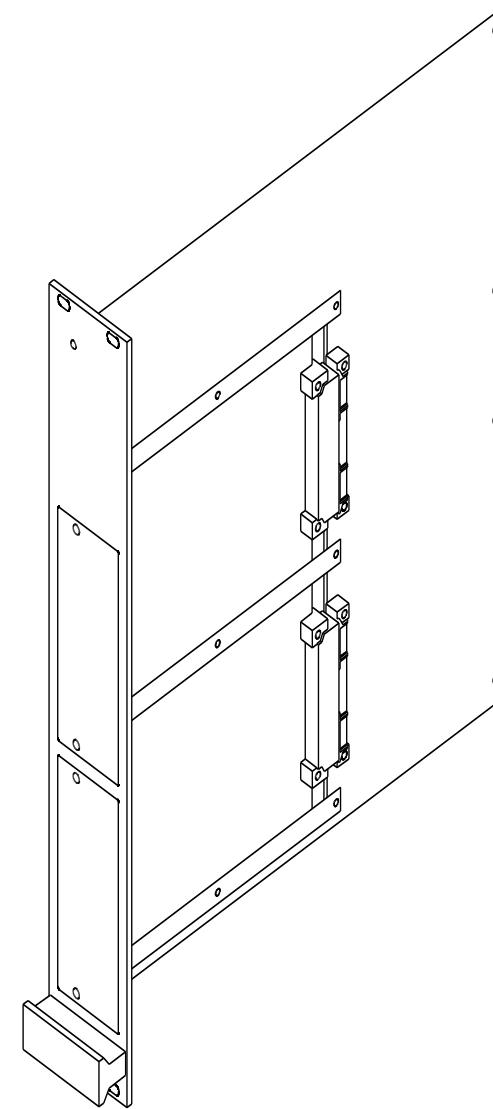
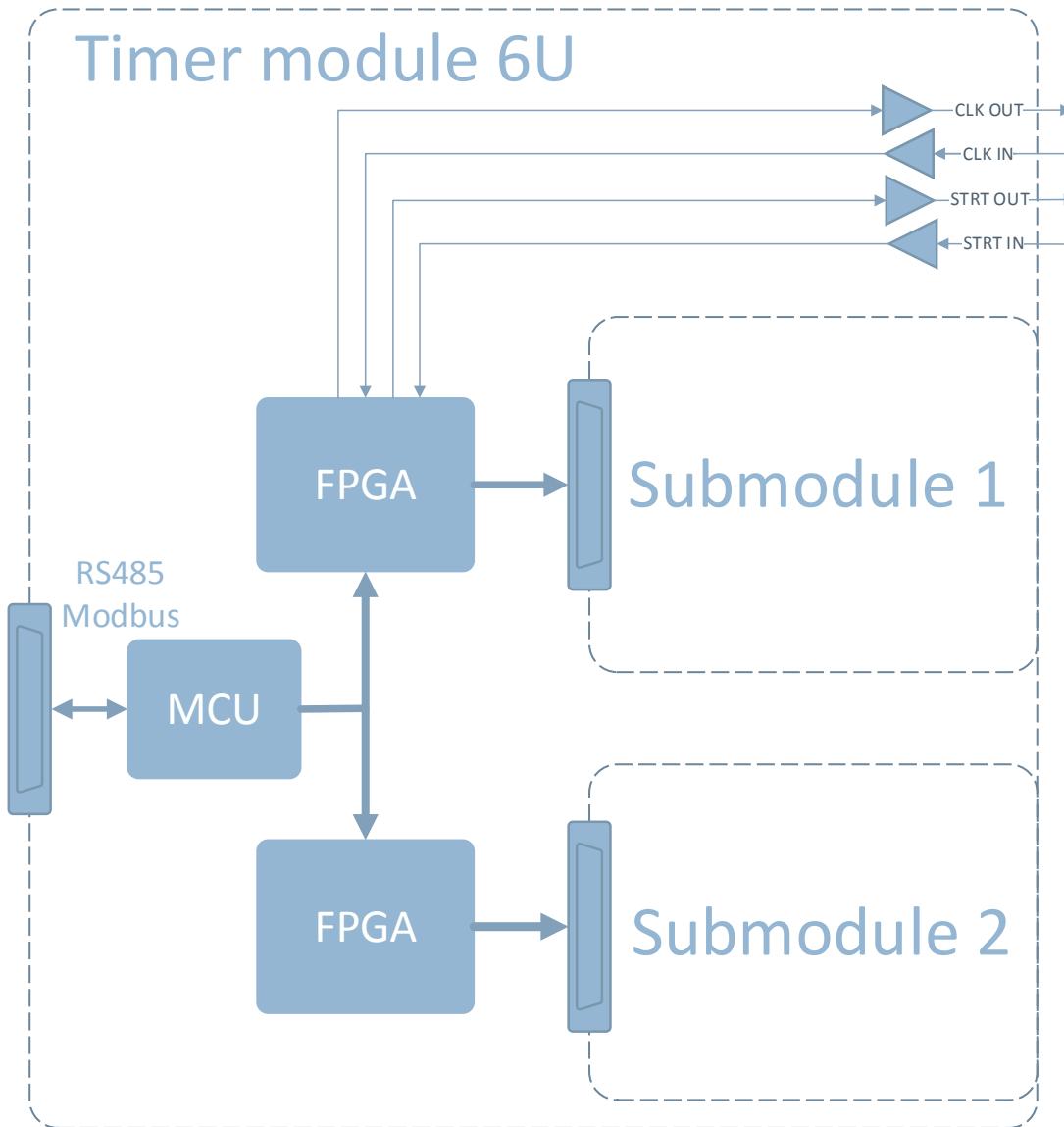
1



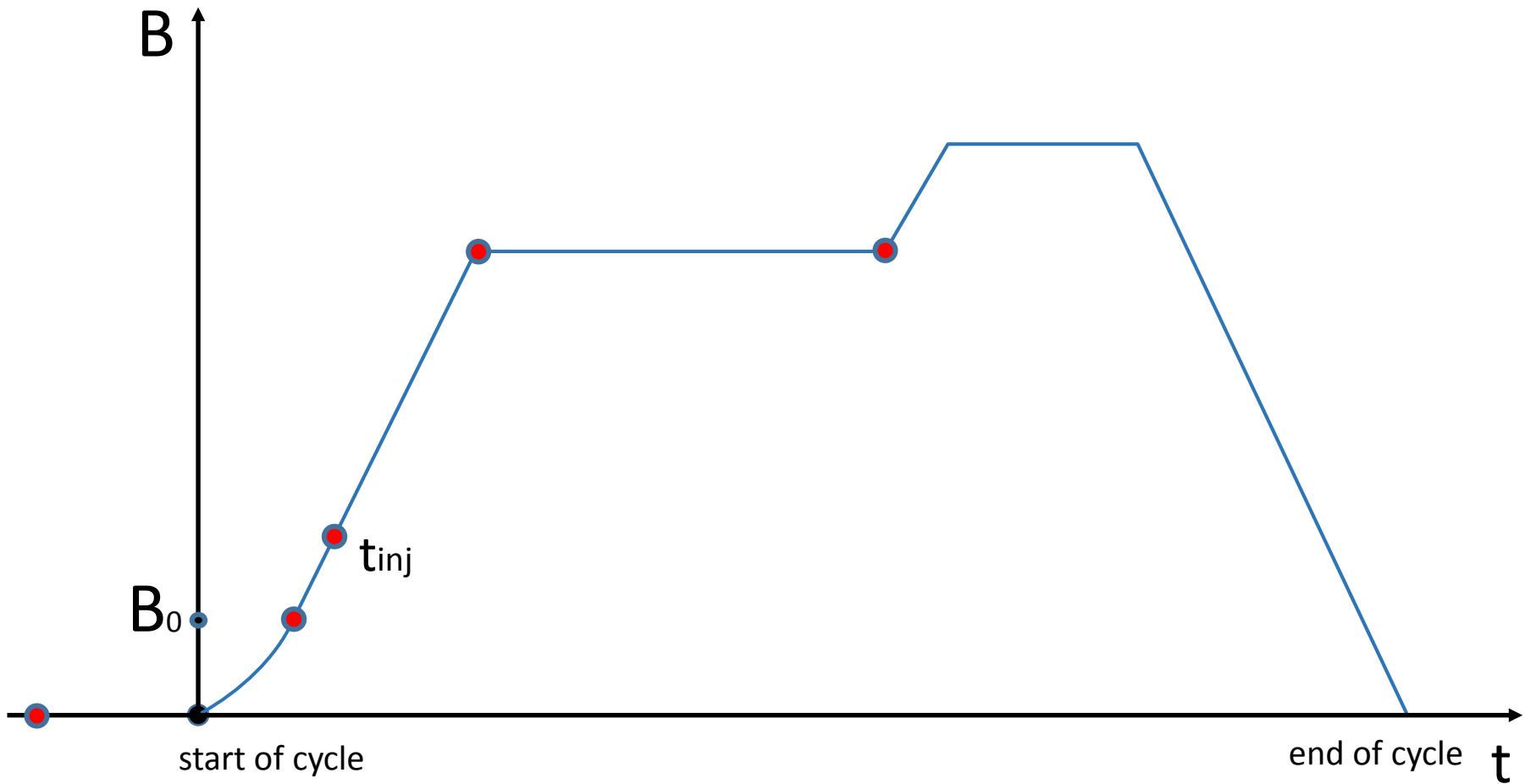
B-timer 2 **2**



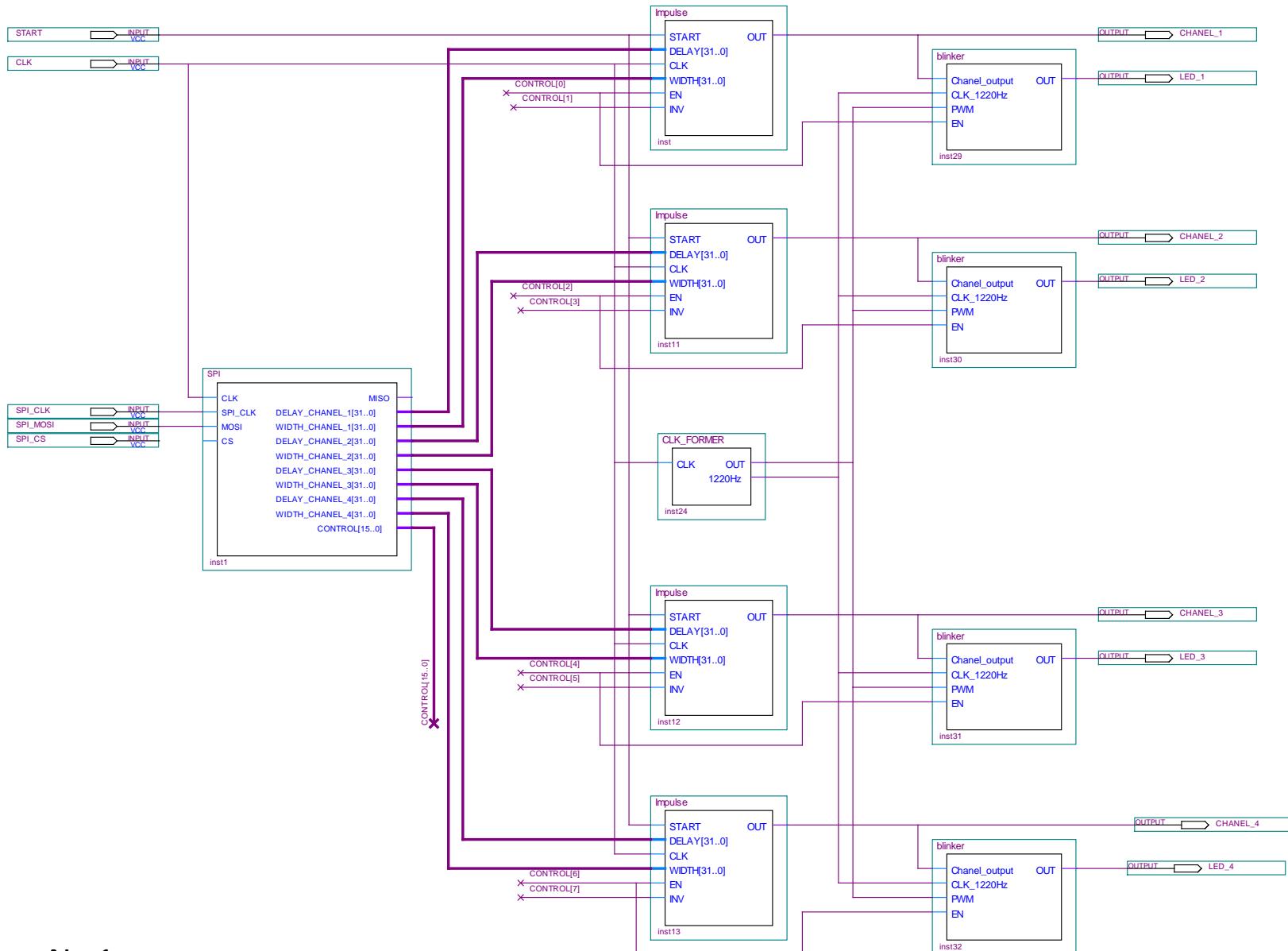
Timer module 6U



Signal synchronization system of the Nuclotron



Quartus level top design file



Quartus level top design file

