



Structure and Hardware of LIA-20 Control System

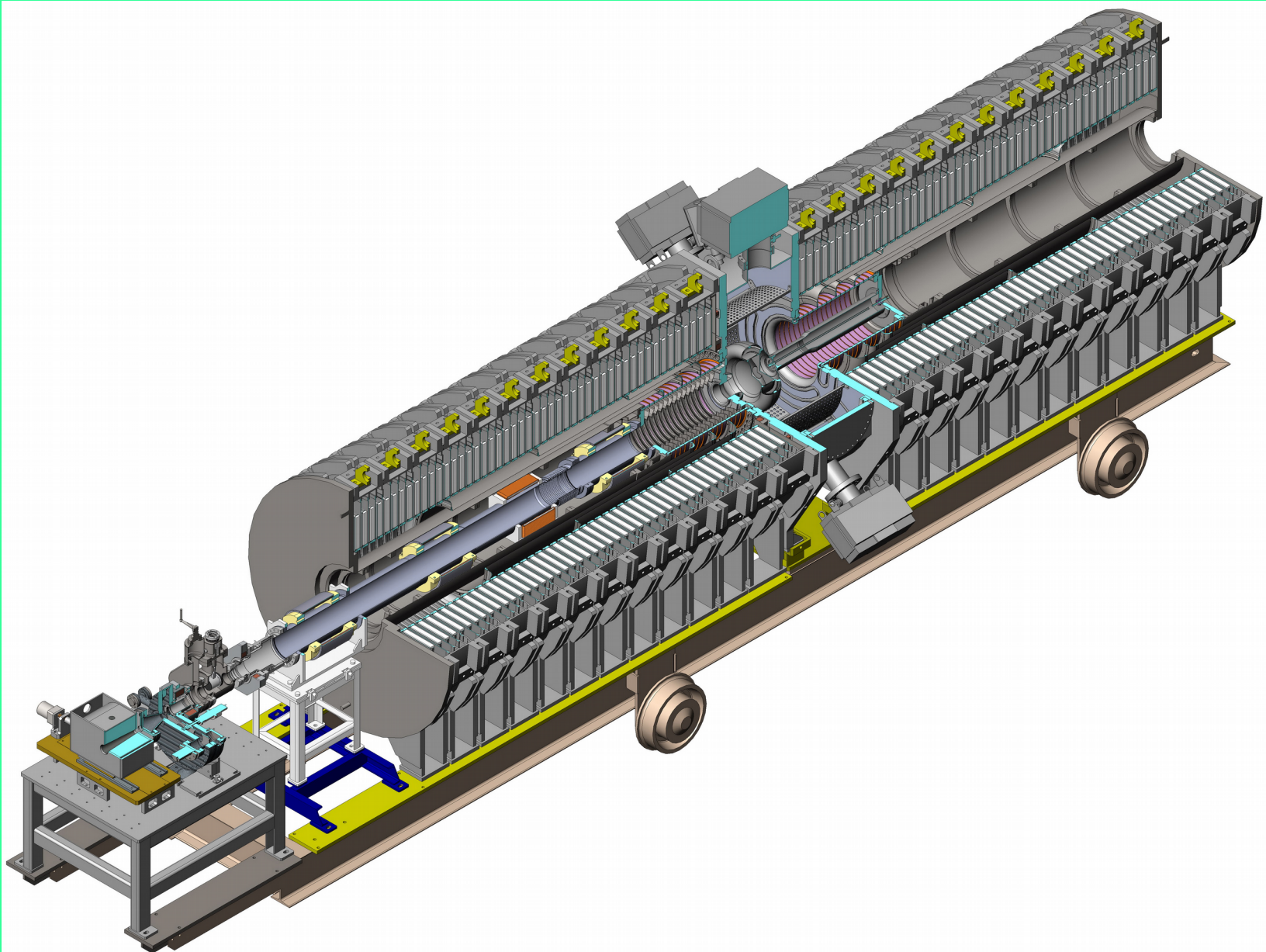
G. Fatkin, A. Baluev, A. Batrakov, E. Bekhtenev, A. Chupyra, E. Kotov,
Ya. Macheret, V. Mamkin, A. Ottmar, A. Panov, A. Pavlenko, A. Selivanov,
P. Selivanov, A. Senchenko, S. Serednyakov, K. Shtro, S. Singatulin, M. Vasilyev

THCBSh02 RuPAC 2016
XXV Russian Particle Accelerator Conference
21-25 November 2016, Saint-Petersburg, Russia

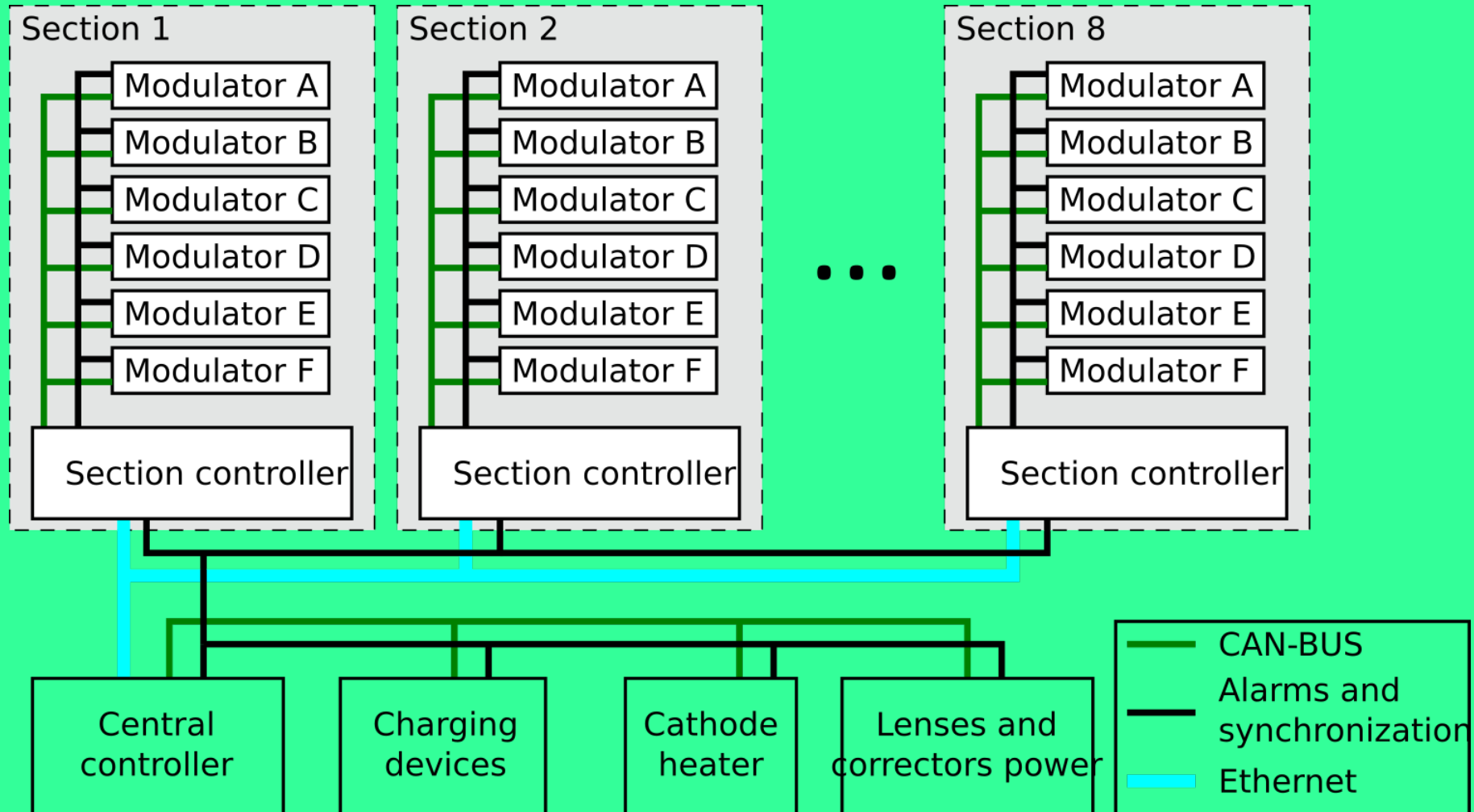
Induction accelerators for flash X-Ray radiography across the world

Country	Name	Energy (MeV)	Current (kA)	Pulse length (ns)	Beam diameter on target (mm)
USA	FXR	18	2,3-3,4	65	3,2-3,5
USA	DARHT-I	19,8	2	60	1,9-2,1
USA	DARHT-II	18,4	2	2000	1,9-2,1
France	AIRIX	19,2	1,9-3,1	60	1,6-2,0
China	DRAGON-I	19,2	2,54	70	1
Russia	ЛИУ-2	1,8	2	300	1
Russia	ЛИУ-20	~20	~2	60, 60, 360	~1

Experience from LIA-2



Experience from LIA-2

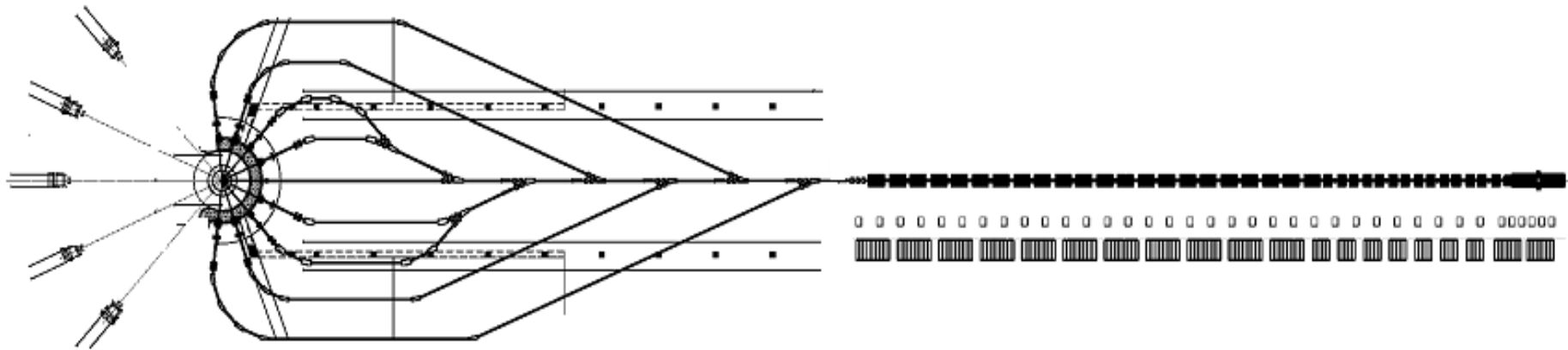


Experience from LIA-2

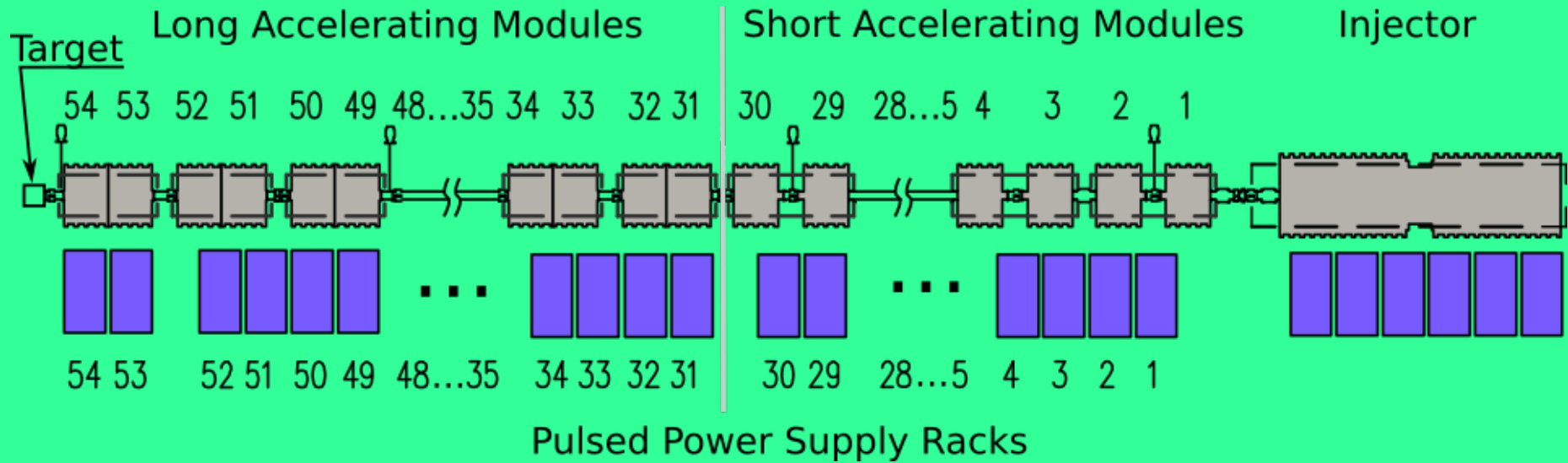


LIA-20: problems of scale

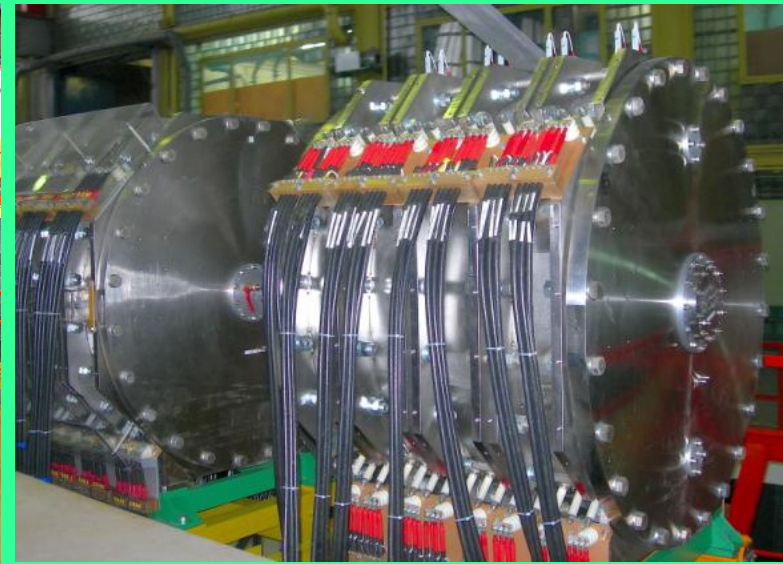
- 480 modulators (10xLIA-2, or DARHT)
- Accelerator length ~70 m
- Several stages of commissioning: LIA-5
LIA-20 (1 pulse, 3 pulses, 9 angles)
- >6000 control channels for full system
- Reliability is crucial



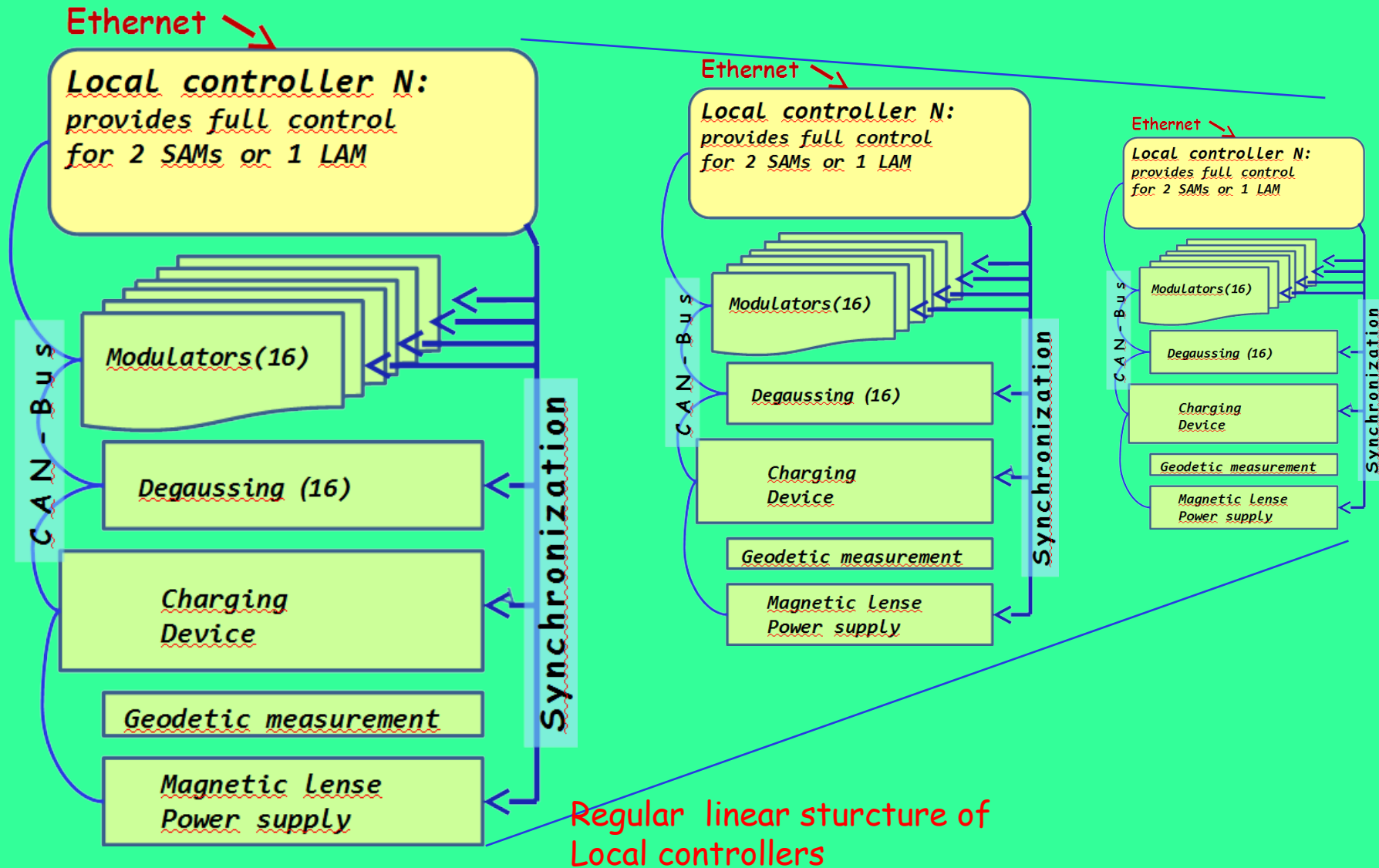
LIA-20: components



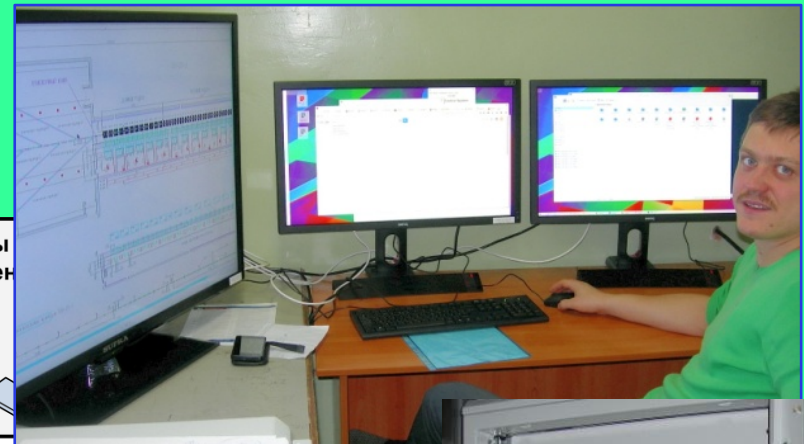
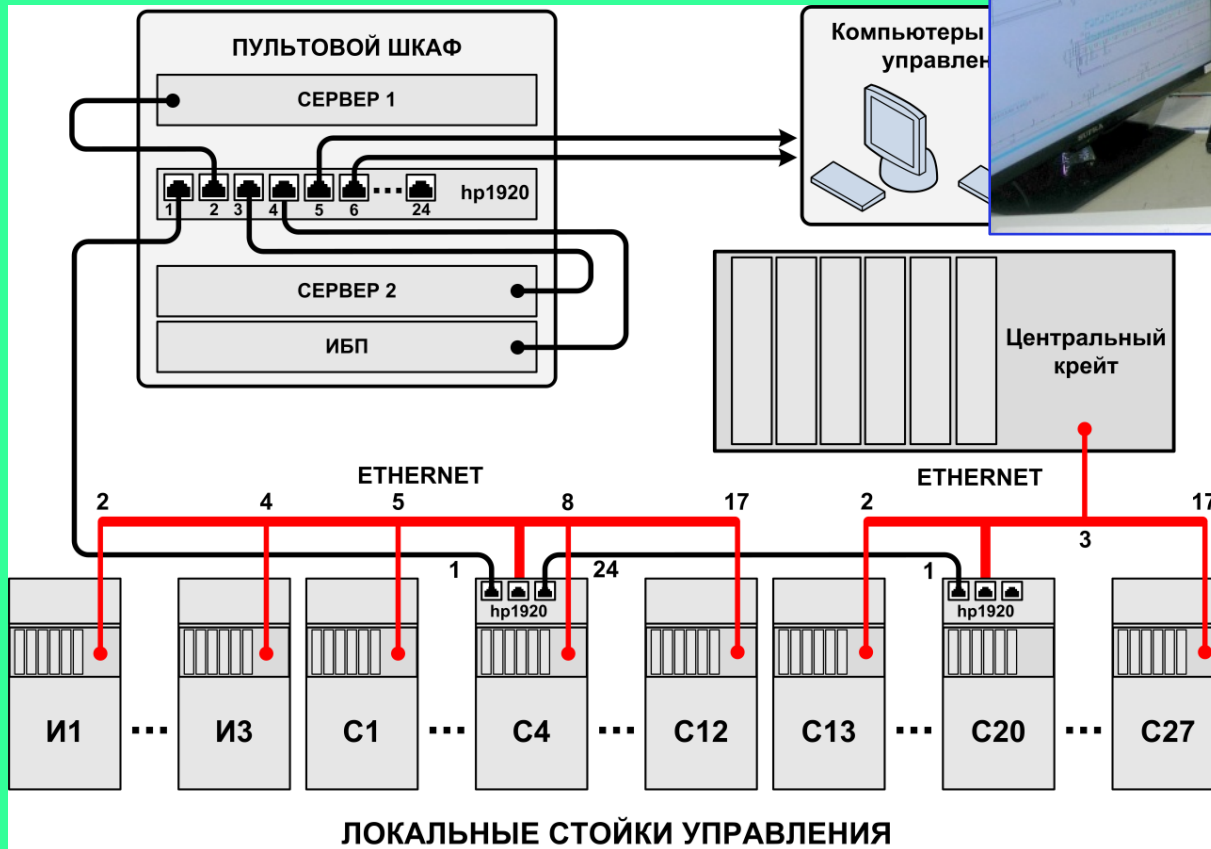
- Pulsed power supply rack
 - 8 modulators
 - Demagnetizing device
- Charging devices
- Beam position monitors
- Lenses and power supplies
- Cathode power supply
- Vacuum pumps, etc...



LIA-20: Control system structure



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LIA-20: Control system structure

- Timing subsystem (~2000 channels):
 - timers
 - delay lines
- Measurement subsystem
 - «fast» (<10 us) ~ 600 channels
 - «slow» (>10 us) ~ 2000 channels
- Fast interlock subsystem
- Slow controls subsystem
 - Geodetic measurements (water-based and wire-based)
 - Vacuum, power supplies, etc.
- System infrastructure:
 - crates
 - controllers
 - interfaces

Posters

E. Kotov et al.

«VME Based Digitizers for Waveform Monitoring System of Linear Induction Accelerator (LIA-20)»

THPSC081

A. Chupyra E. Bekhtenev

«System of Geodetic Measurements for LIA-20»

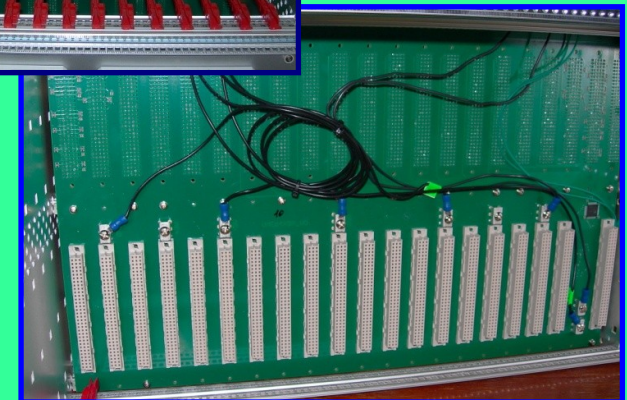
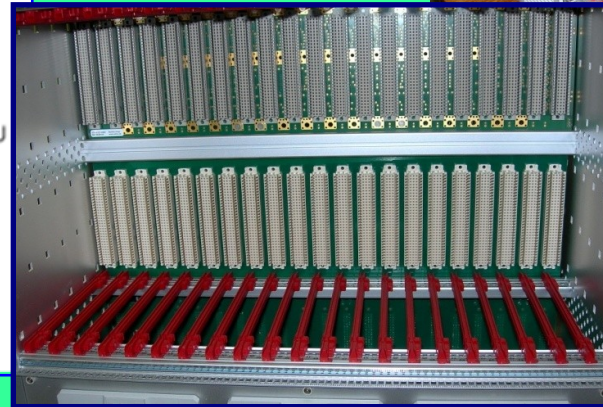
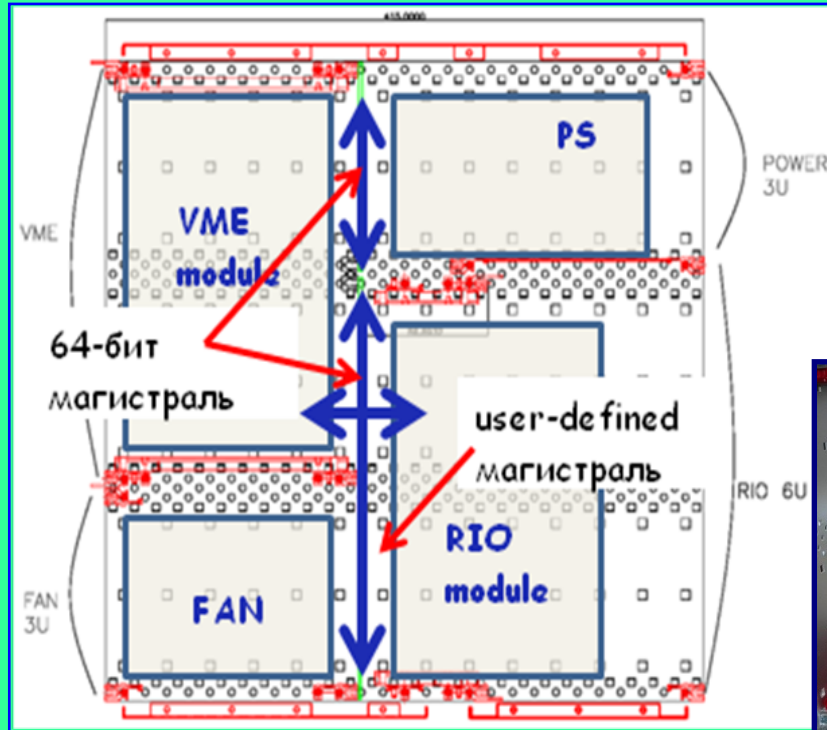
THPSC083

A. Senchenko et al.

«Software and Computational Infrastructure of LIA-20 Control System»

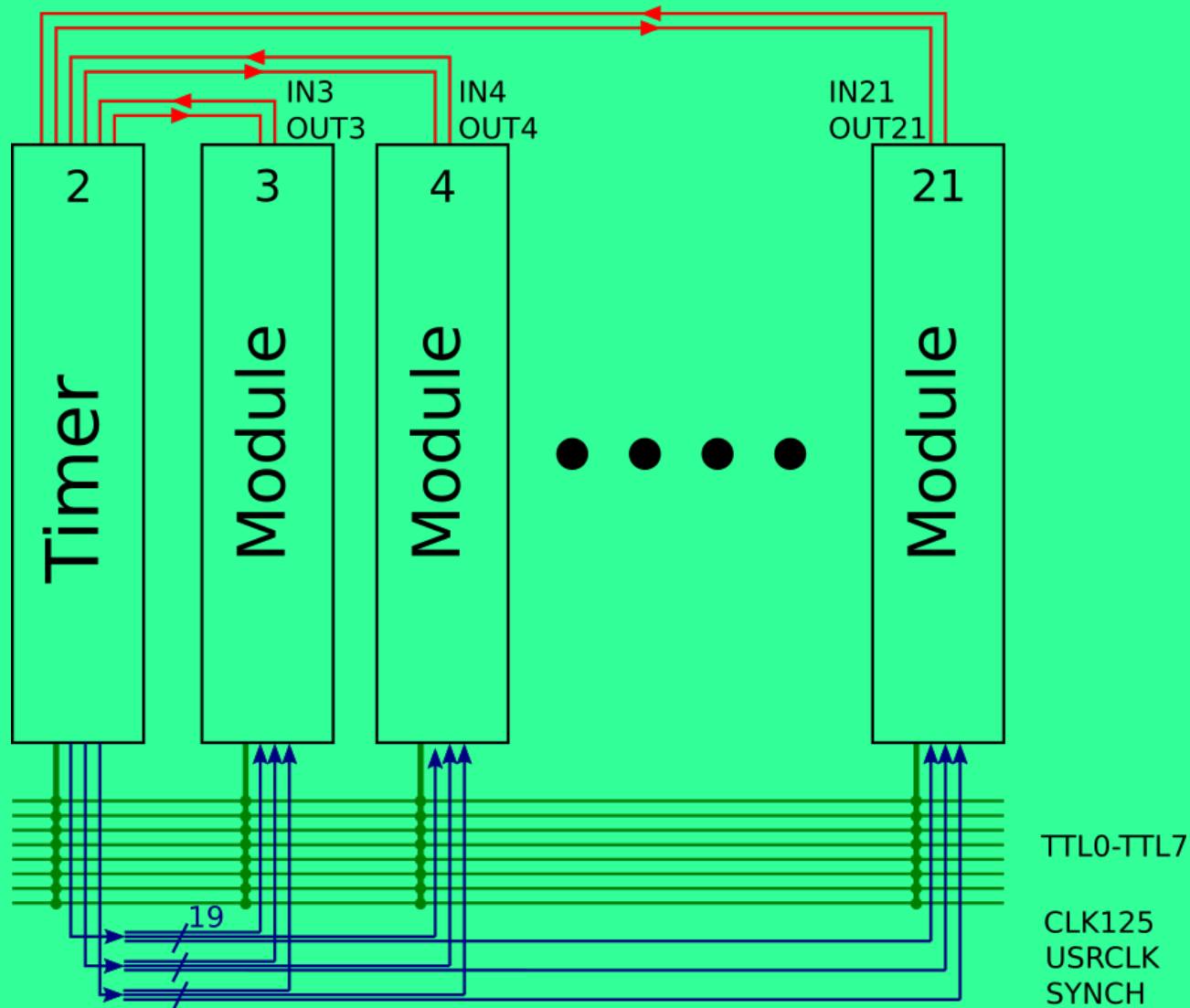
THPSC088

System infrastructure: VME-BINP

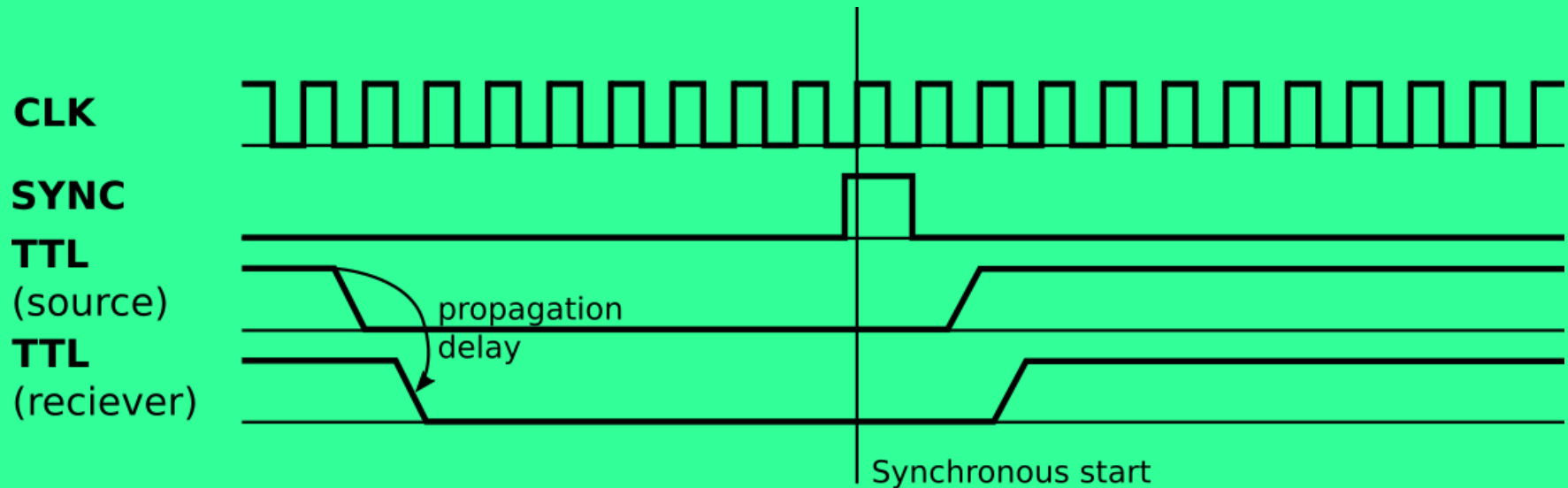


- 21 Slots (1 controller + 1 Timer)
- VME-64x compatible
- 6U Backplane RIO-module
- Built-in synchronization
- Remote CAN-BUS power control

VME-BINP synchronization features

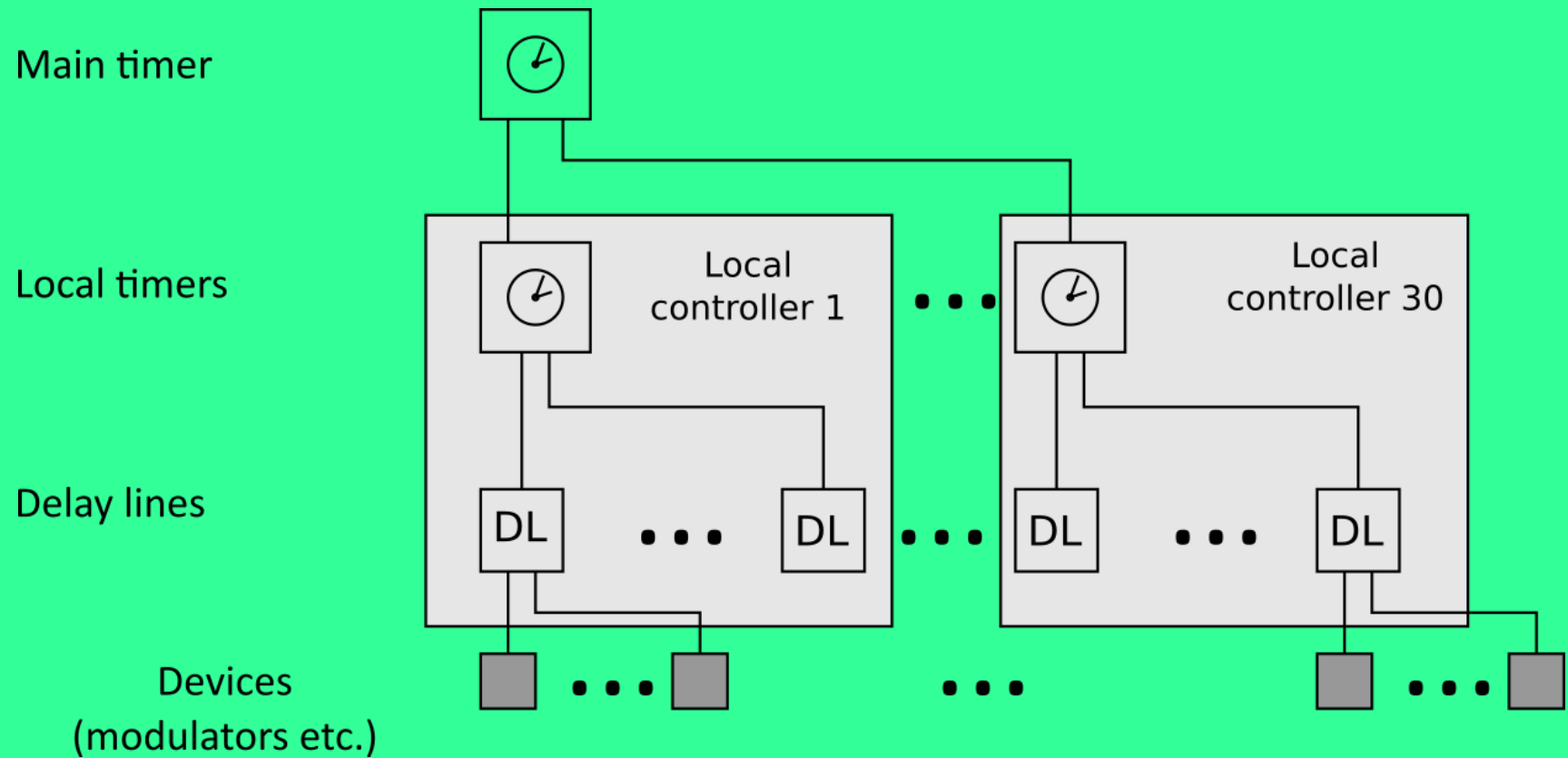


VME-BINP synchronization features



First 8 lines (positions 2-9) propagation delays are aligned up to 100 ps accuracy

Timing Subsystem



Timing Subsystem: Timer



System timer variant

1 optical input

9 optical outputs

Propagation delay accounting

Local timer clock accuracy 2 ns

Local timer variant

1 optical input

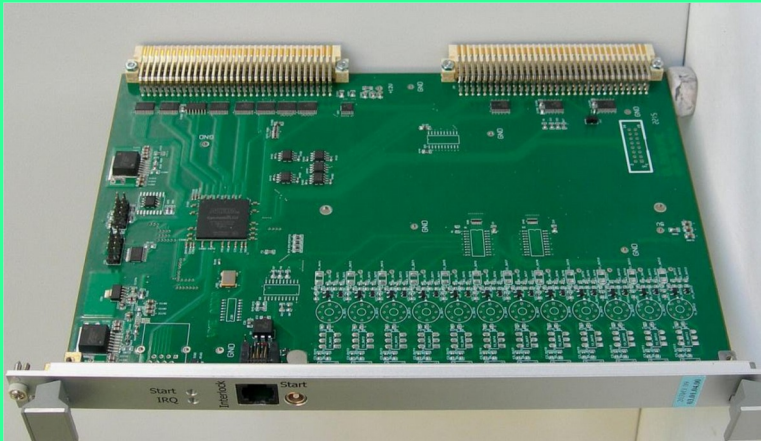
Output clock 125 MHz

Output user clock

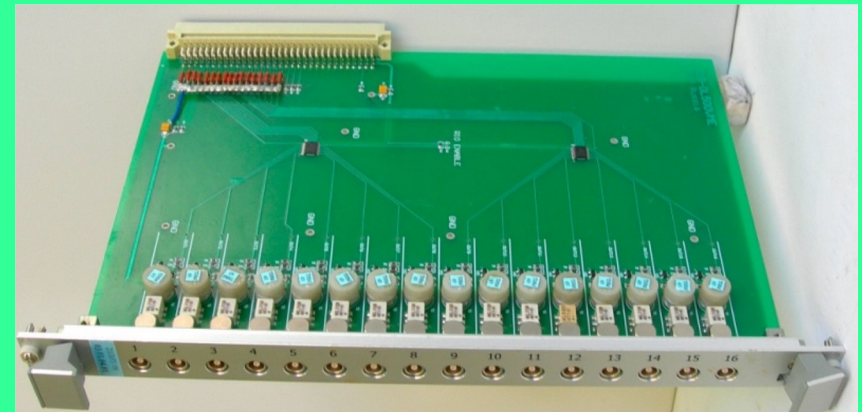
8 Trigger lines

In/Out cross-commutation

Timing Subsystem: Delay line



Digital delay line
16 RIO + 8 front channels
Discrete 4 ns
Range 17 s
VME-BINP synchronization



RIO module
16 channels
 $I_{out} = 200 \text{ mA}$
Pulse length 0.5 μs
Front 5 ns
Short-circuit defence

Measurement Subsystem

«Fast signals»

< 10 us, 4 ns per point

16* inductor voltages

4* beam position monitor signals

Kicker voltages

1 ns per point

Total > 480 channels

«Slow signals»

>10 us, 8-32 us per point

1* charging voltage

16* forming line voltage

2* degauss currents

1-3* lense currents

Total > 1860 channels

*Per local controller

E. Kotov et al. «VME Based Digitizers for Waveform Monitoring System of Linear Induction Accelerator (LIA-20)» THPSC081

Measurement Subsystem: «Fast» Oscilloscopes



Base module

Base module
 4 ADC channels
 250 MHz generator
 VME-BINP synchr.
 Ext/Backplane trigger



4—channel version

ADC 4x250
 4 channels @ 250 MS/s
 $\pm 0,5$; $\pm 1,0$; $\pm 2,0$; $\pm 4,0$ V
 Bandwidth 80 MHz
 0,75 MWords/channel



1—channel version

ADC 4x250
 1 channel @ 1 GS/s
 $\pm 0,5$; $\pm 1,0$; $\pm 2,0$; $\pm 4,0$ V
 Bandwidth 300 MHz
 3 MWords/channel

Measurement Subsystem: «Slow» oscilloscope

ADC-32

32 channels

Input voltages: $\pm 1,0$; $\pm 2,0$; $\pm 4,0$; $\pm 8,0$ V

Resolution: 12 bit

Speed: 8 us/32 channels

Accuracy: 0,1%

Bandwidth: 300 kHz

VME-BINP Synchronization



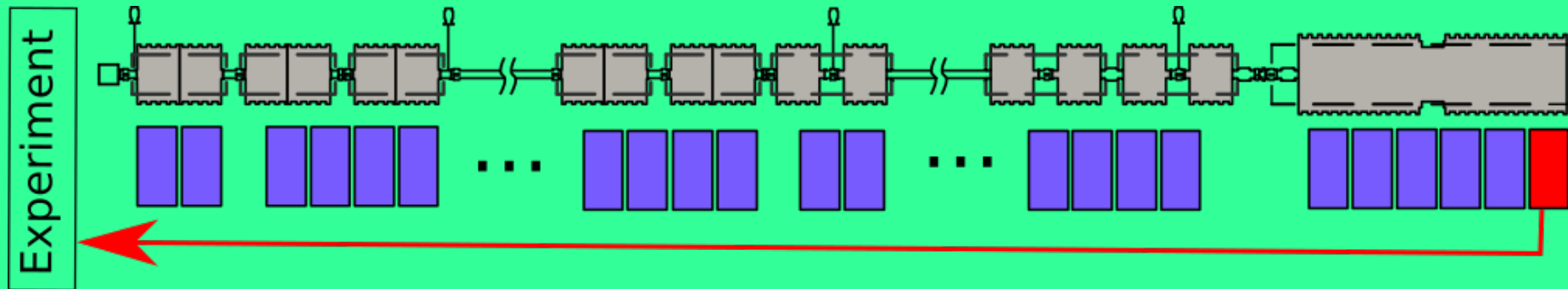
Fast interlock subsystem

Main task: Inhibit the experiment start!

Total length ~ 200 m

Reaction time < 20 μ s

Subsystem is in development



Slow controls subsystem

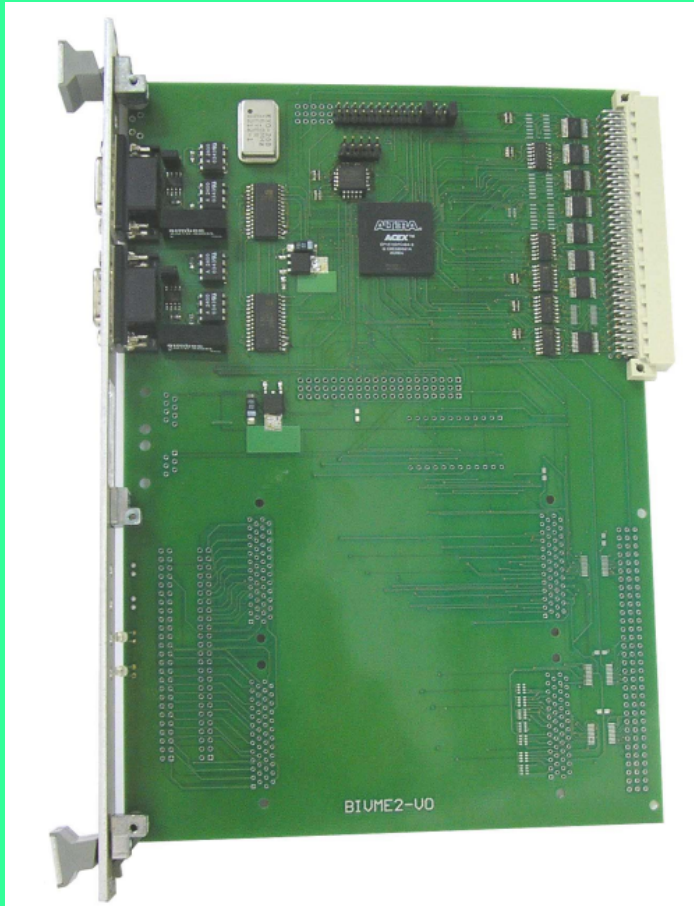
1. Beamline elements positioning (geodetic):
 - Angle positioning (water)
 - X-Y positioning (wire)
2. Pulsed power control
 - Modulators (Thyratron parameters)
 - Degaussing
 - Lense power supplies
3. Cathode heater control
4. Vacuum and vacuum pumps control
5. Crate power control



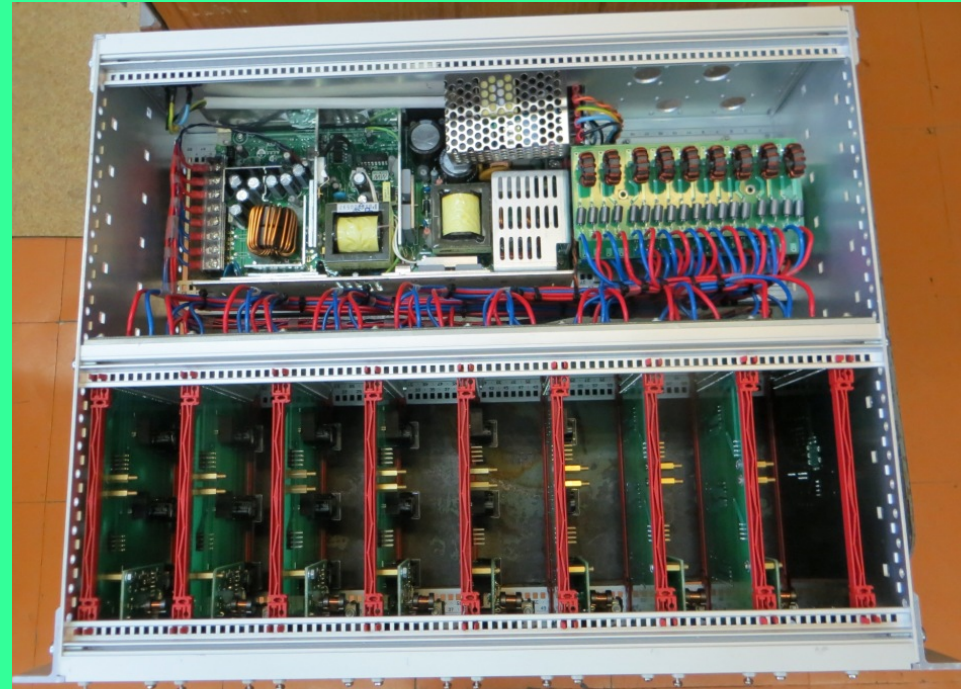
CAN-BUS

A. Chupyra E. Bekhtenev «System of Geodetic Measurements for LIA-20» THPSC083

Slow controls



VME-CAN module



Status and nearest plans

Inductor stand is commissioned

VME-BINP crates are developed

Electronics is developed

Software and algorithms are in development

LIA-5 to be commissioned in 2017

LIA-20 to be constructed in 2018



Гидродинамические испытания боеголовки W76 на установке DARHT в Los Alamos National Laboratory, 2005 г.



Материал со страницы:
<http://allthingsnuclear.org/fy12ssmppost3/>

