# ACCLERATION STATION ELECTRONIC BLOCKS FOR "NUCLOTRON-NICA COMPLEX

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1 - at present from ASCI Ltd; 2 – at present from LHEP - JINR

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A small but very active group was created around the INRNE Innovation Bureau "INRNE Hi-Tech High Energy Physics Group". It was found in the middle of 90-years of the last century by Prof. Dr. Ivan Tsakov. The Group was specialized on design and mass production of specific unique scientific apparata and devices for experiments and application in the field of high energy physical experiments and acceleration physics for Dubna Joint Institute for Nuclear Research (JINR), Russia, CERN experiments in Geneva, Swiss, and in Deutsches Elektronen Synchrotron (DESY) at Zeuthen and Hamburg, Germany.

During the last decades members of this group had worked as participants of such of very known experiments as "Sphere" and "Becquerel" in JINR; CMS, ATLAS , CLOUD in CERN; PITZ, HERA-B, H1, and FLASH in DESY. Young specialists of very variety fields like electronic hard&software, mechanics, physics both theoretical and experimental were involved. Their number was around 17 -20 during of latest years.

Hi-Tech HEP Group members at DESY Hamburg and Zeuthen

A part of them is working on the data analysis of the DESY experiments HERA-B and H1, three work in JINR and two others work on ATLAS-LHC core software now. The group members are co-authors of more than 50 papers and conferences presentations. Five PhD theses were defende, 5 bachelor and two master theses were done till now.

The group had a very good international reputation - due to achieved results and group activity it was visited by many wellknown physicists as Prof. A. Malakhov, Prof. E.Krasavin, Prof. N. Rusakovich, Prof. G.Shelkov, Prof. I.Golutvin, Prof. V.Kadyshevski , Dr. O.Brovko, Dr. V.Mihajlov, Dr. V.Volkov, Dr.V.Monchinski, Dr. P. Zarubin from JINR Dubna and Dr. U.Gensch, Dr. B. Schmidt, Dr. M.Klein, Dr. D.Pitzl, Dr. M.Walter, Dr.D. Trines, Dr. R.Brinkmann, Prof. A.Wagner from DESY, Dr. P.Jenni and Dr. J.Kirkby from CERN and others.

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# R E S U L T S
# for

the period 1993 – 2014

The Group developed and finalized more than 15 very attractive devices. A lot of spin-off companies were involved into the contracts realization too. The contracts were done on the base of the signed:

Protocols for Scientific Collaboration with Dubna Laboratories as follows :

- Laboratory for Radiobiology,
- Laboratory of High Energy Physics
- Laboratory for Nuclear Problems

Photon Dragg Detector for the Dubna Nuclotron CO2 laser ion source under laboratory test at INRNE Hi-Tech Lab;
Dr.Iv.Tsakov, Dr.L.Dimitrov

Computerized precise XY target for the Dubna Nuclotron laser ion source under laboratory test at INRNE Hi-Tech laboratory

# Internal Target Station of Dubna JINR

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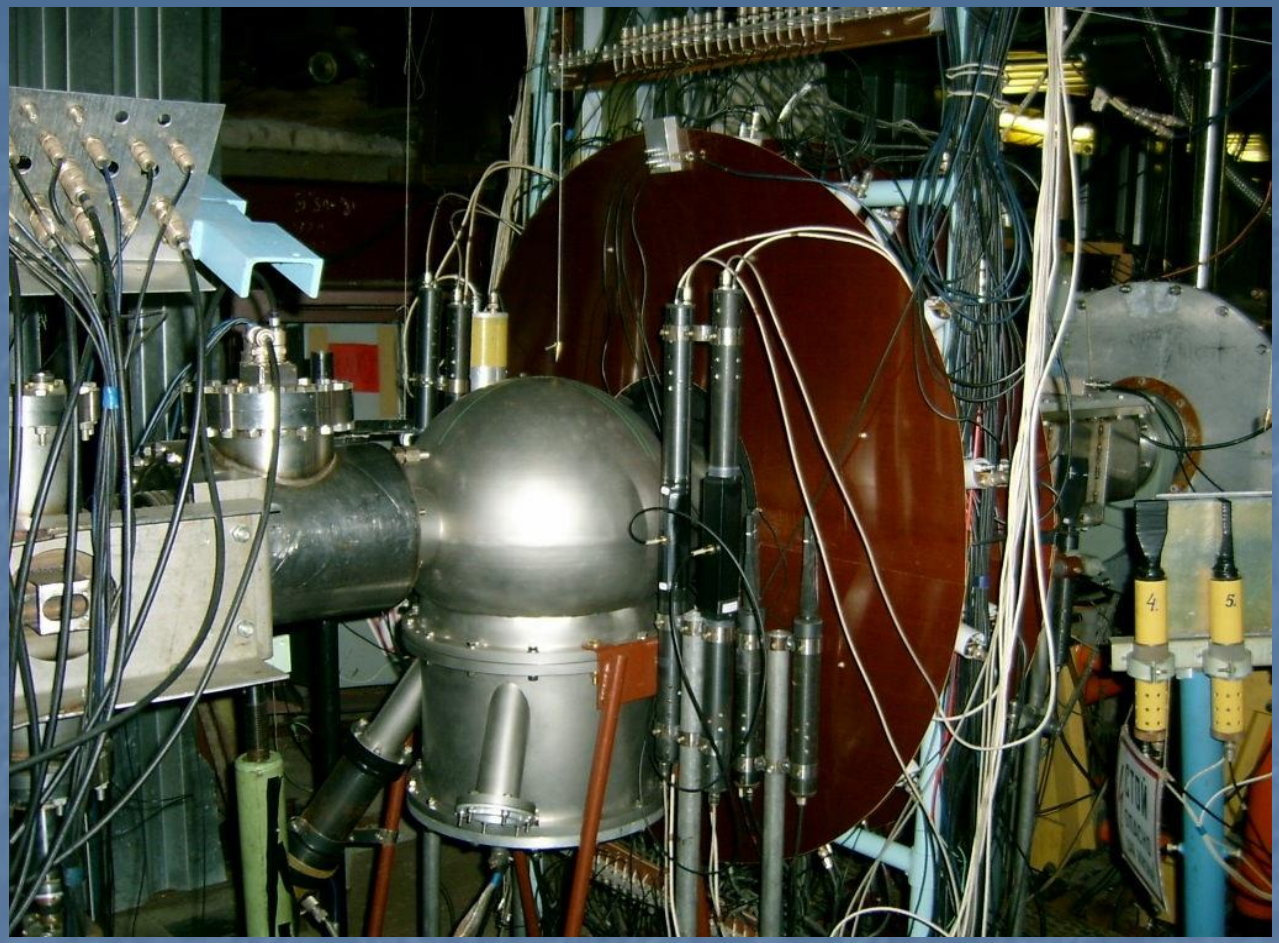
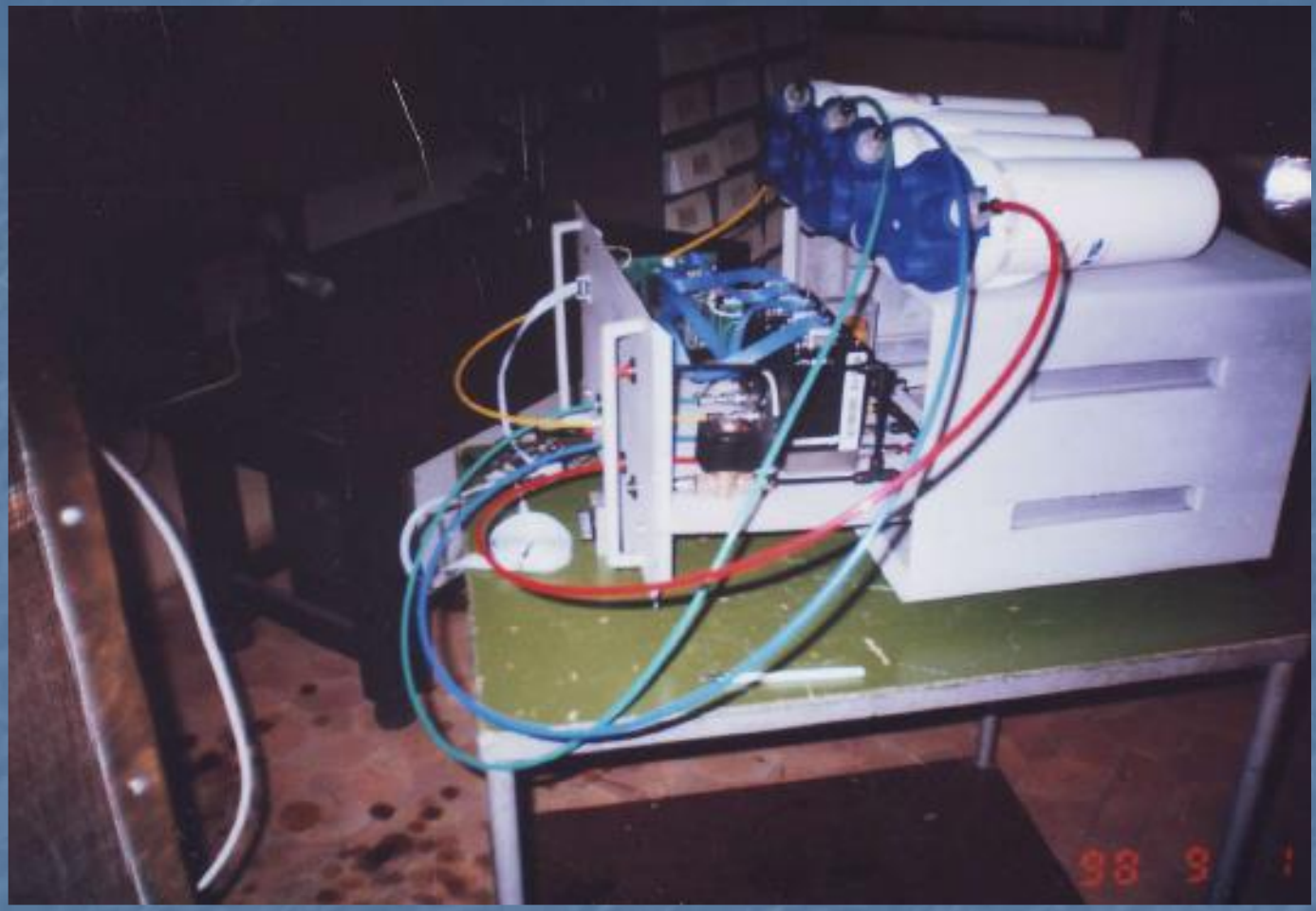


A lot of components of Dubna "Sphere" experiment at the Laboratory of High Energy "Nuclotron" accelerator were designed and manufactured by INRNE Hi-Tech High Energy Physics Group in period 1996 - 2005



A proportional chamber gas system of the LHE-JINR "SPHERE" experiment

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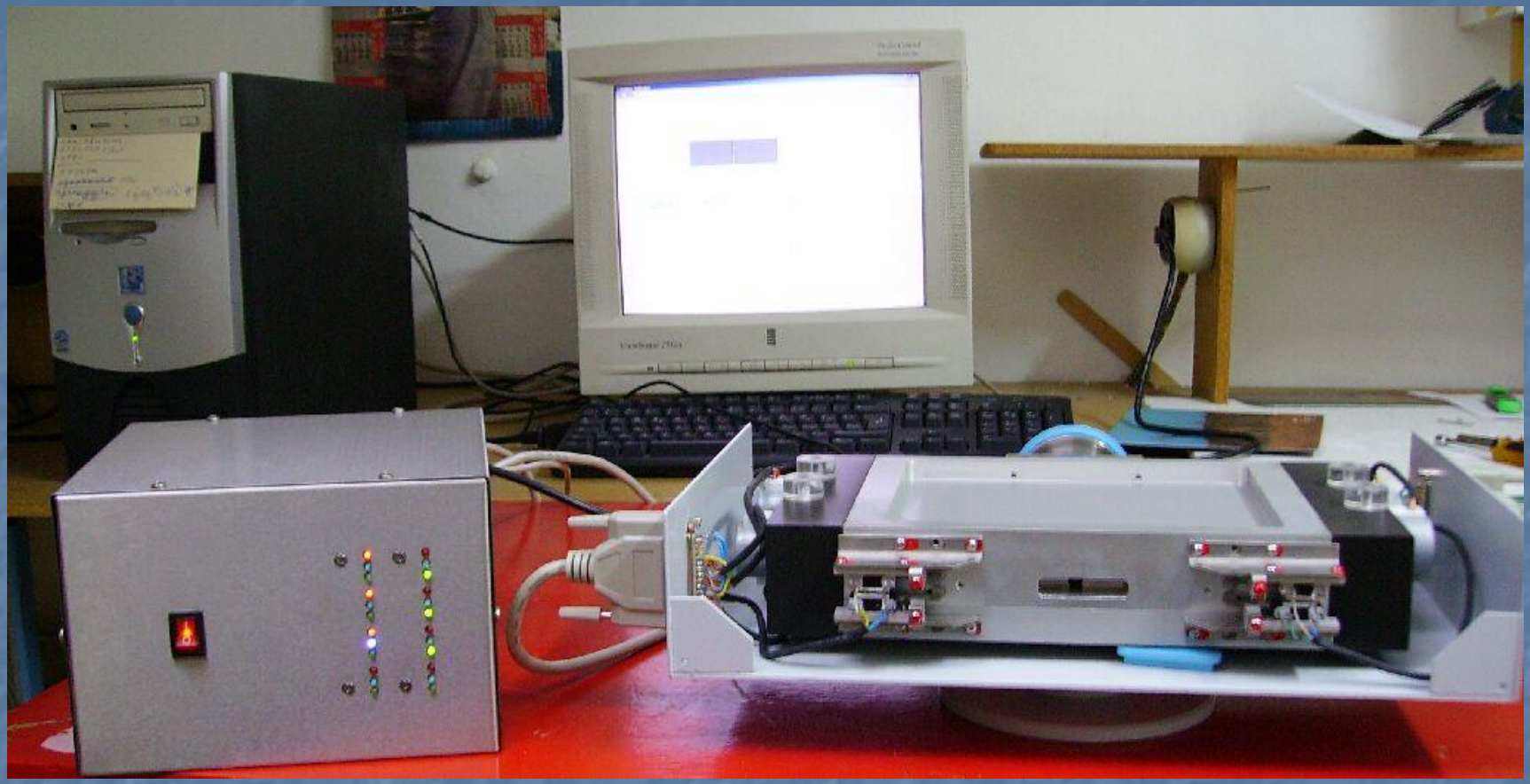


Sixth-leafs collimator for precise cancer radiotherapy at human eyes and brain for Dubna accelerator medical beams


*15 ASCI three phases wattmeter for Dubna JINR; switched on in 2005 year for computer current consumed accounting*

The CERN ATLAS Muon chambers montage at JINR;
From Left to r ght: Dr.G.Shelkov, JINR Vice Director Prof. Ts.Vylov, Prof. Iv.Tsakov, Dr.A.Gongadze

CERN ATLAS Muon Chamberon granite montage table at JINR laboratory of Nuclear Problems; new momntage assemblingtable was done by Hi-Tech Group

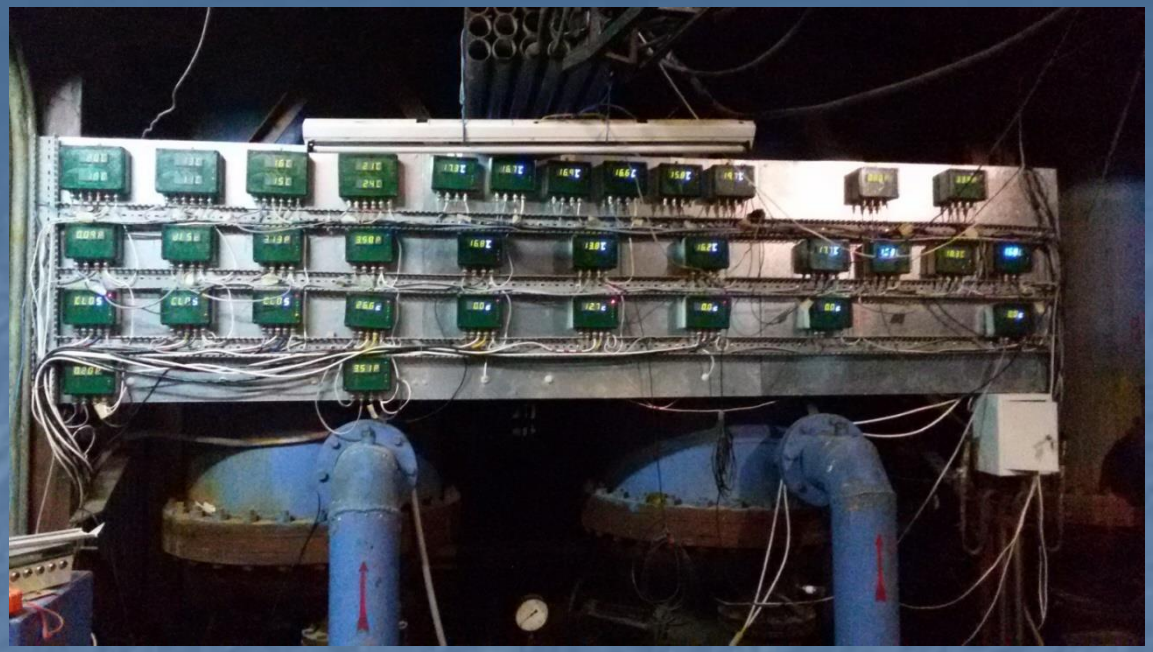

20 Joules TEA pulsed CO2 laser as a Dubna Nuclotron ion source at LADEC test laboratory; Dr.Iv.Tsakov,Dr.D.Dimitrov, Dr.V.Monchinskii


Prof. Ivan Tsakov , Dipl. Eng. Ivan Bonev and Prof.Aleksandr Malakhov around the upgraded CO2 laser for the LHEP student practicum

## THE NUCLOTRON COOLING SYSTEM „AKVON”

The system abbreviation AKVON is coming from the Russian alphabet and consists 48 modules ( fig.3) The aim of this cooling system is full automatization of the of the measurements of water flow pressure, temperature and debit in the pumping tubes with cooling water flow river Dubna to the Nuclotron first cooling loop and for processing of these pumps and their stop/start valves.( fig. 4 )

The moment values of the these parameters are under computer control by special developed hardware and via cable connection the data are processed at the Nuclotron Contro Room placed at 500 m farway from AKVON. The system is placed on the down Nuclotron floor and operated 24 hours x 365 days nonstop working regime starting 2010 year. A new “AKVON 2” project for the future NICA-Nuclotron complex is in development now.



A part of the AKVON at Nuclotron down floor and main view of its modules

In 2014 the INRNE Hi-Tech HEP group but with increased number researchers became as a part of the Bulgarian firm Advanced Solutions by Computer Implementation (ASCI Ltd) and continues the fruitful collaboration with the colleagues from of JINR Laboratory of High Energy Physics (LHEP).

The Nuclotron charged particle acceleration is realized with three RF acceletating station.Every one of them consists a ”flying tube “ electrode. Every RF station has to generate HF acceleratinig voltage with 8kV amplitude at 0,6 – 6MHz frequency diapson

The new Nuclotron –NICA project aimed at improving a great number of the exsixting Nuclotron electronic blocks.

The ASCI Hi-Tech HEP Group's good reputation was the "collaboration kick off" for the colleagues from the Radio-electronic systems department of JINR Laboratory of High Energy Physics (LHEP).

During the last 4 years , the ASCI Hi-Tech HEP group jointly with this department and in the frame of the JINR LHEP Nuclotron-NICA project realized a lot of electronic apparata for its accleration stations.

**A 500 Amper Generator designed and manufactured jointly with Sofia Techn.Uni, Lab "BELA"**

The generator is in exploitation at LHEP now

Fig.1 500 Amper generator with Industrial PC

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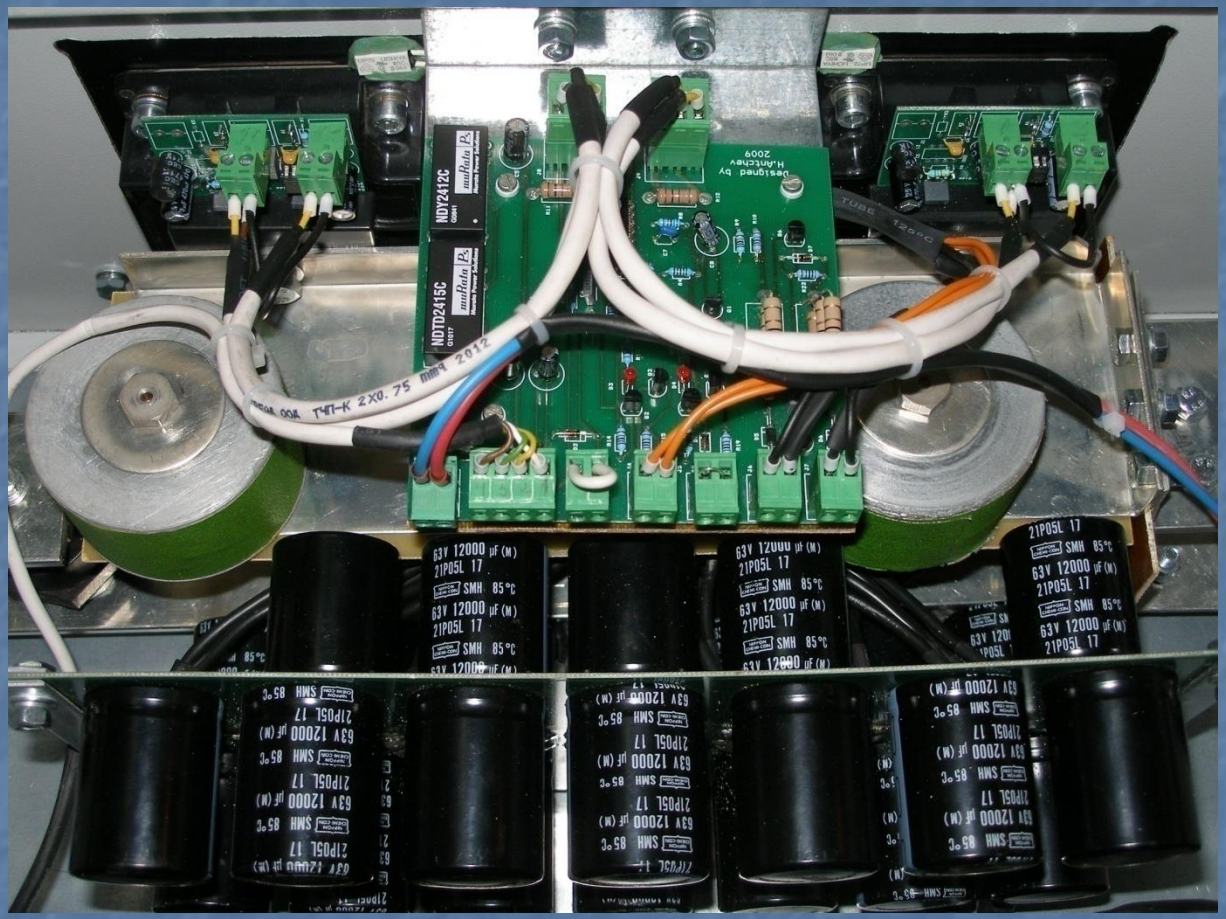


Fig. 2 Inner view of 500 A generator

## A RESONATOR THERMOSTABILESED COOLING SYSTEM

The resonator cooling system is based on the water mixing from the destillate water tank with the used hot water from the resonator corpuses so that the regulated diapason of the water temperature has to be in the frame of 35+/-degrees centigrade at +/- 5 Celsius accuracy. The system is computerized by using of the Baumer firm electronic pressure, valves and thermometer components which guaranteed 100 l/min debit at 3 Bars pressure in the inlet destillating pipe and 0,5 Bars at the outlet one (fig.3 ).

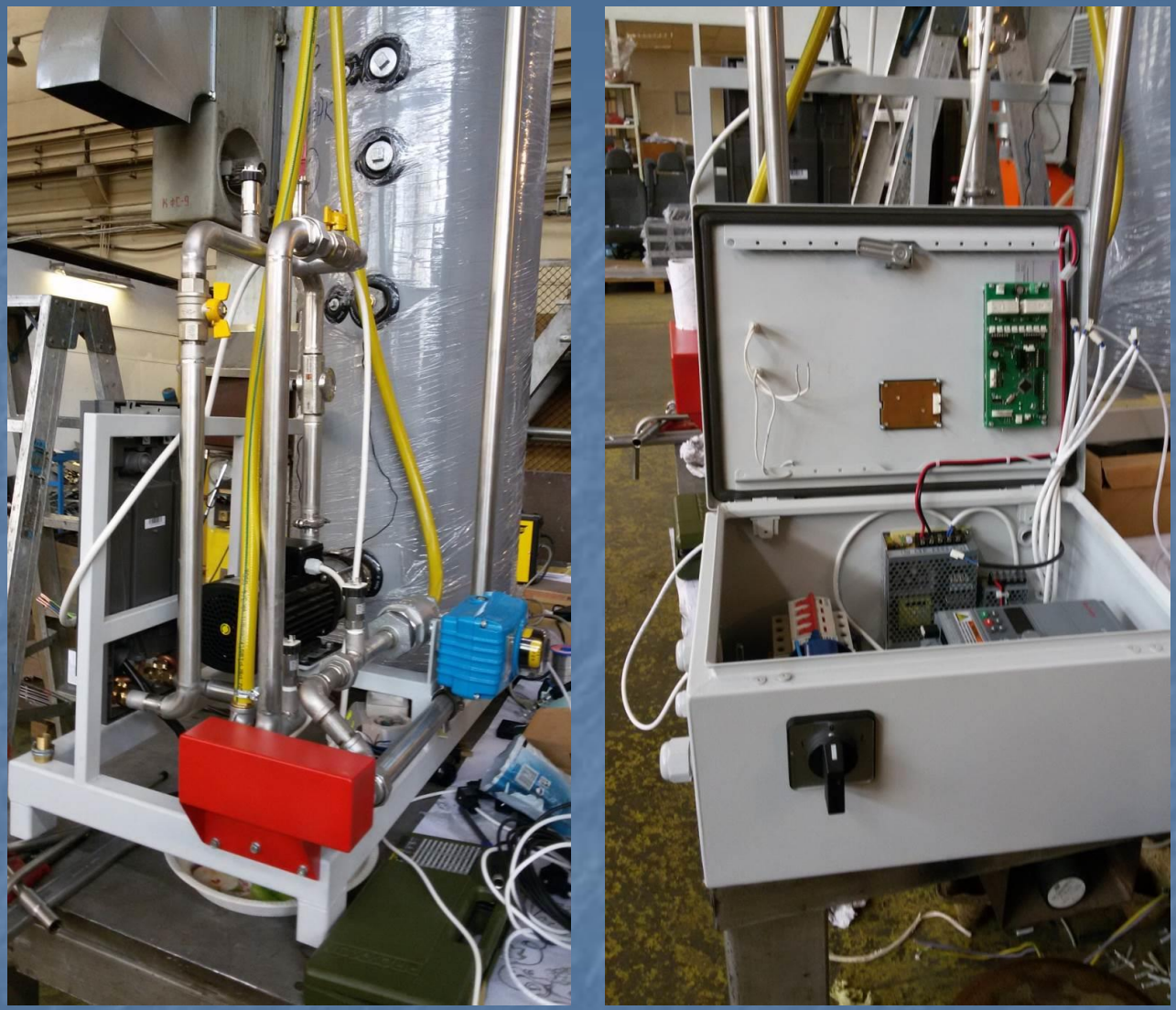

Fig. 3 Mechanic, gas and PC processing blocks of Thermo system

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## A 6,5 kv/ 30 A RECTIFIER

This apparatus were designed and manufactured jointly with the Sofia Technical Universe Laboratory “ BELA” as power supply of the Nuclotron output generators ( fig. 4 ).The block generarates 30 Ampere direct current at 50 Hz 3x4,5 phases applied voltage.The apparatus is realized at two blocks ( fig. 5)


Fig.4

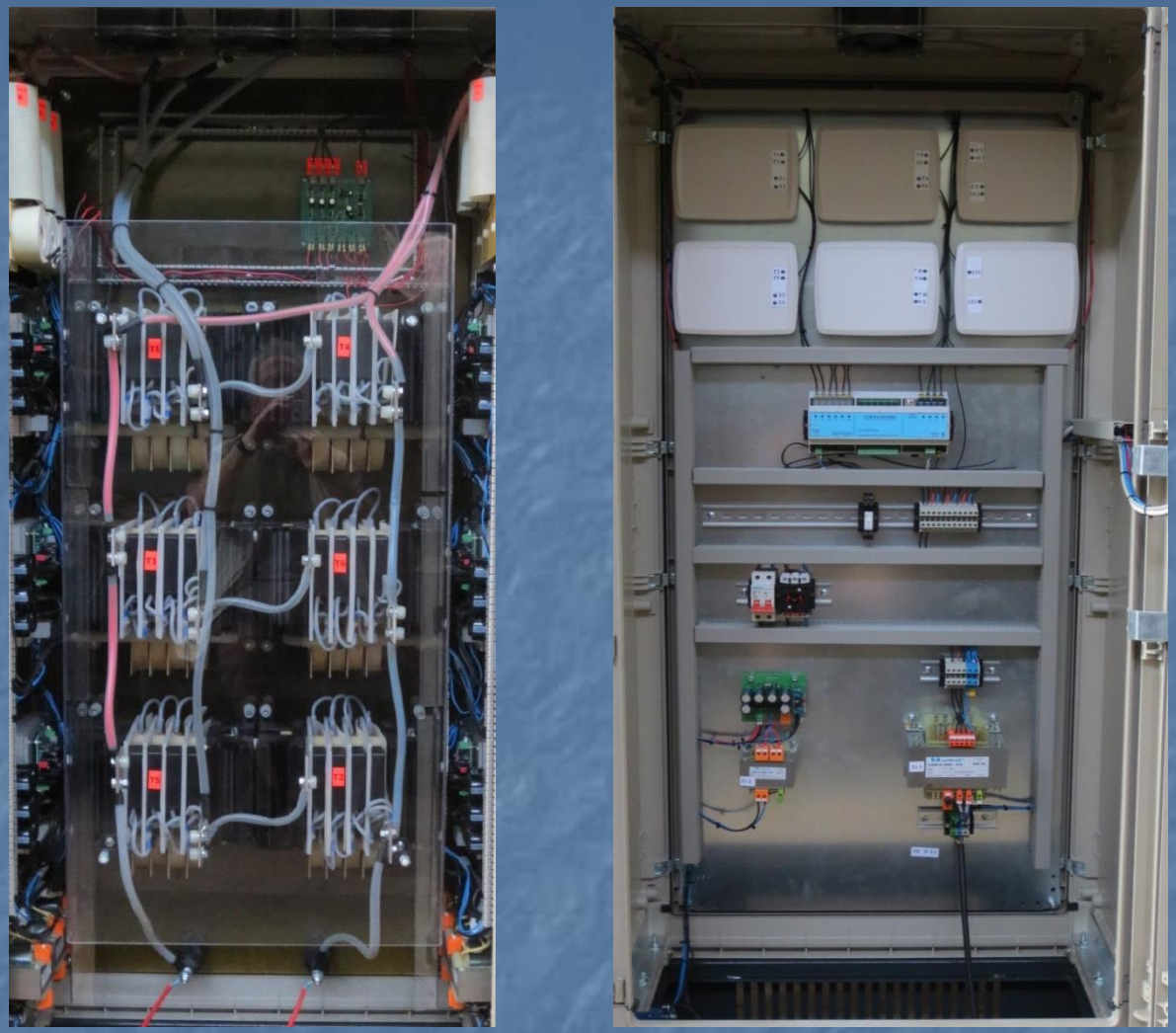

Fig. 5 A high voltage and low voltage blocks of 6,5/30A rectifier

## A PHASE DETECTOR

Phase Detector – it is a central processing element of the acceleration station resonator retuning system. The apparatus design is based on the classical principle of the own phase overlap on the exciting voltage phase. The block generates an electrical signal which magnitude and polarity are proportional to the magnitude and phase shift of the two incoming sinewave voltage (fig. 6).

The detector main advantage is the possibility of the large diapason of output voltage amplitude – from 0,1 to 10 Volts with no more that 25 % amplitude change at every phase shift.

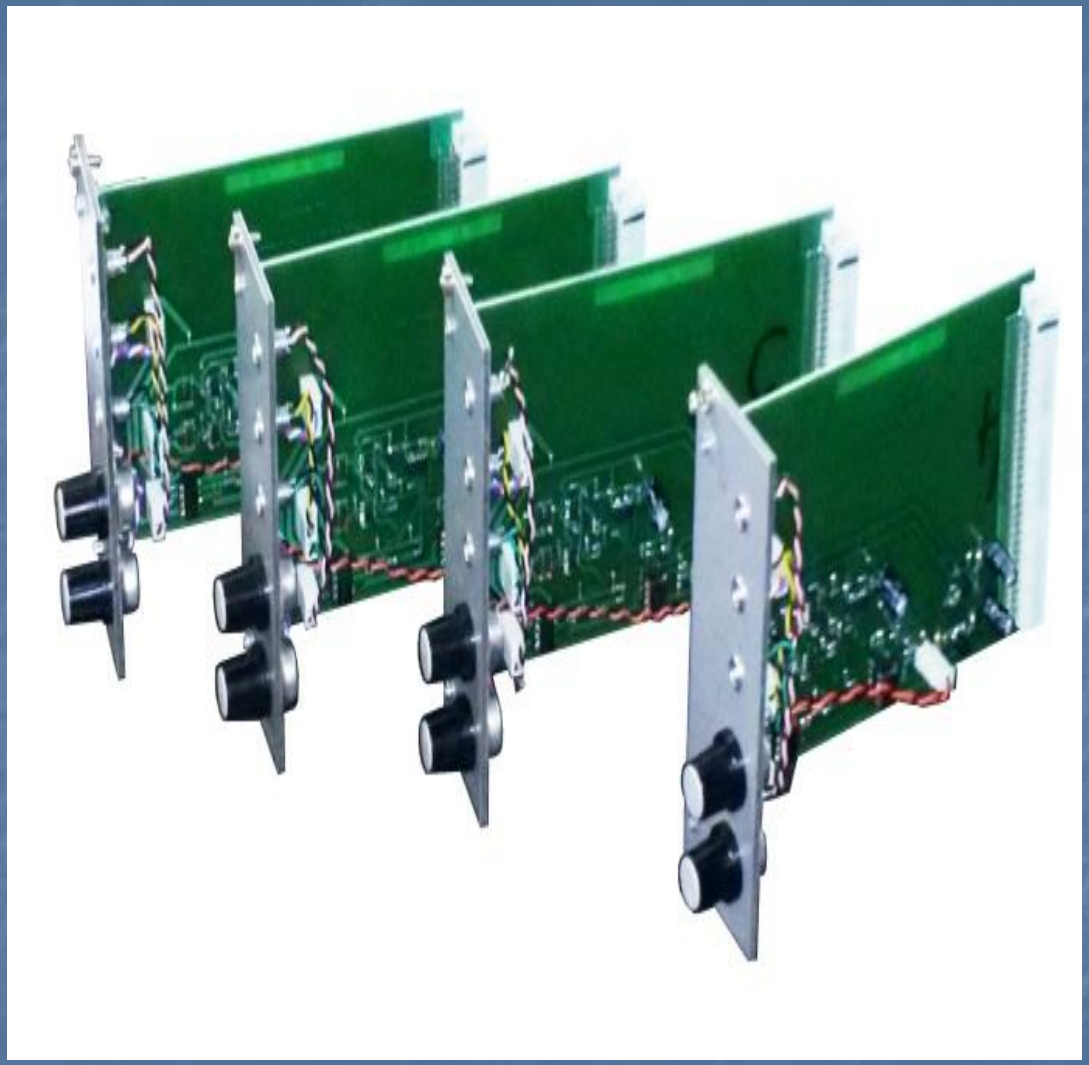

Fig. 6 Four pcs phase detectors

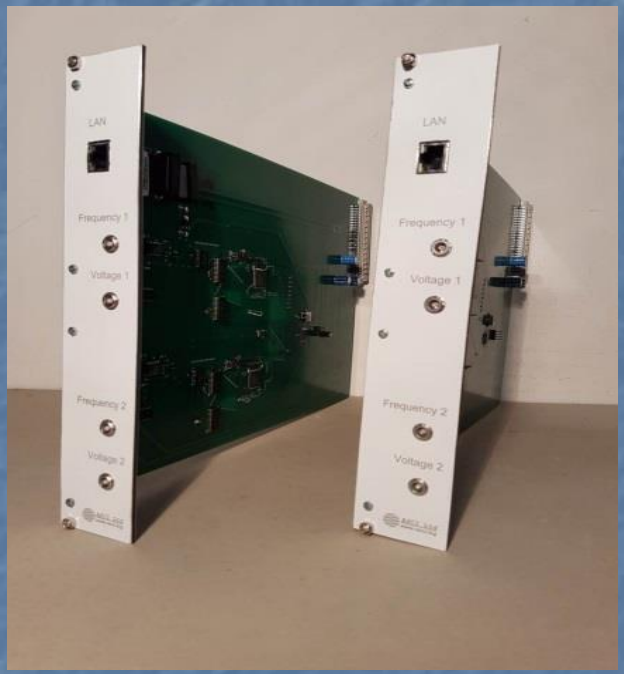


Fig.7

**Processing of frequency dependended parameters of Nuclotron Acceleration station**

A multi chanel device for the input sinusoid voltage ferquensy conversion to analog software signals. The block frequency diapason is 0,5-6.0 Mhz which at 0,5-1 V input signal amplitude guaranteed frequency resolution is no less that 10 kHz at 100 kHz Frequency velocity alternation ( Fig. 7 )


Fig. 8 An apparatus for precise controls the amplitude of accelerating voltage and regimes of supporting (auxiliary) systems by the adiabatic capture of particles.

A 24 multichanel device for synchronization of accele-ration systems and physical plants; at 4+/1 V and 0,5/2 mks input pulses block generates 5+/- 1 V and 0,5/2 mks out-put pulses (Fig 10).

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# VERBA VOLANT - SCRIPTA MANENT!

The spoken words fly away,
but
the written - remain!

**THANK YOU FOR ATTENTION!**