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- **THE IPR-R1 TRIGA MARK I REACTOR:**

IMPROVING THE BRAZILIAN NUCLEAR TECHNOLOGY IN 45 YEARS OF OPERATION

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- TRIGA MARK I IPR-R1 REACTOR

- DEDICATED IN NOVEMBER/06/1960
- ORIGINALLY 100 kW - UPGRATED 250 kW
- FUEL: ENRICHED URANIUM
- MODERATOR: ZIRCONIUM HYDRIDE
- REFLECTOR: GRAPHITE
- COOLING SYSTEM: DEMINERALIZED WATER

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- **TRIGA MARK I IPR-R1 REACTOR USES**

- **Production of radioisotopes for different educational and scientific institutions uses;**
- **Scientific experiments;**
- **Training of nuclear engineers for research and power plant reactor operation;**
- **Experiments with materials and minerals;**
- **Neutron activation analysis**

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YEAR	ENERGY RELEASED (kW)	SAMPLES IRRADIATED AT IPR-R1	
		Neutron Activation Analysis	Experiments, Tests, Other Applications
1960 - 1964	152,989	217	1,577
1965 – 1969	85,601	14,184	3,405
1970 - 1974	247,480	50,026	3,562
1975 – 1979	505,162	137,943	2,631
1980 - 1984	384,036	167,477	1,024
1985 – 1989	131,295	36,430	650
1990 - 1994	69,666	10,399	214
1995 – 1999	154,639	13,063	468
2000 – 2004	167,029	17,006	455
TOTAL	1,897,897	446,745	13,986

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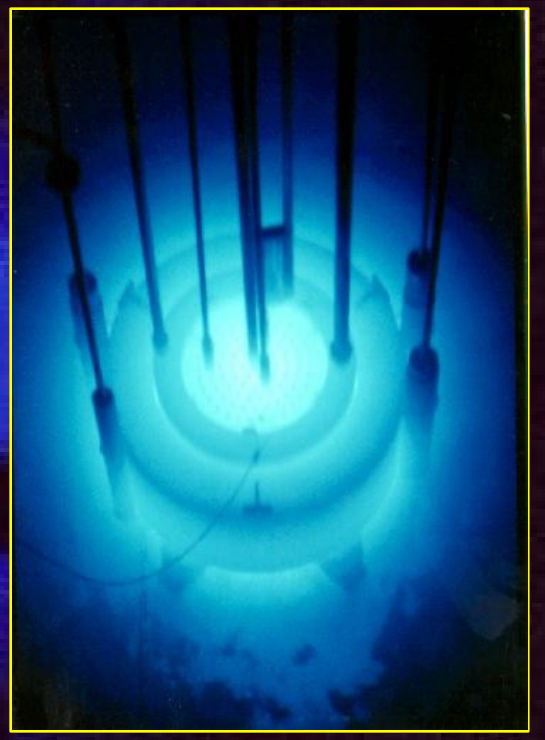
IMPROVEMENTS AT THE IPR-R1 REACTOR



- The Pneumatic System
- The Water-Water Cooling System
- The Reactor Aluminum Tank
- The Control Rod Drive Mechanisms Replacement
- The Neutrongraphy Facility
- The New Reactor Control Console

- THE NEW IPR-R1 REACTOR CONTROL CONSOLE

THE USE OF COMPUTER SYSTEMS AT THE IMPROVEMENTS OF THE REACTOR

- Use of software to improve data acquisition and signal processing system
- Use of calculations codes to calculate the physics and engineering parameter
- Use of software as a tool to improve burnup and decay calculations

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Data Acquisition and Signal Processing System

Five screens compose the program:

Navigation Screen

Reactor Power Level Instrumentation

Cooling and Water Parameters System

Radiation Level Monitoring Channels

Extra Instrumentation Measurements Parameters

Data Acquisition Cards :

Two Cards Model PCLD-789

- Accuracy: 0.0244% of the range ± 1 LSB;
- Input: 16 differential channels;
- Over voltage protection: ± 30 V continuous;
- Input range: ± 10 V maximum, varies with gain selection;
- Gain: 1, 2, 10, 50, 100, 200, 500 and 1000;
- Cold junction compensation: +24.4 mV/°C (0.0 V at 0.0 °C);

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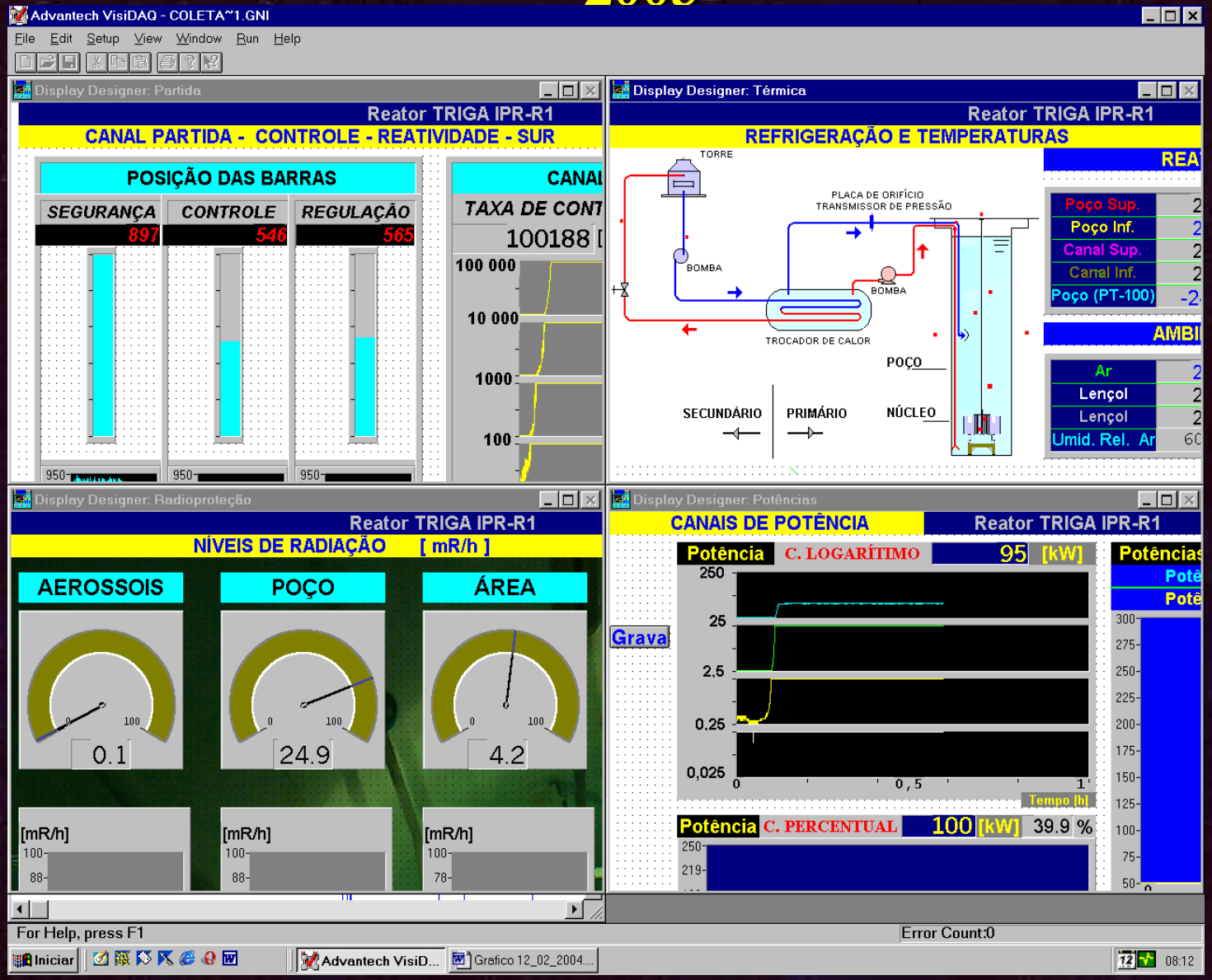

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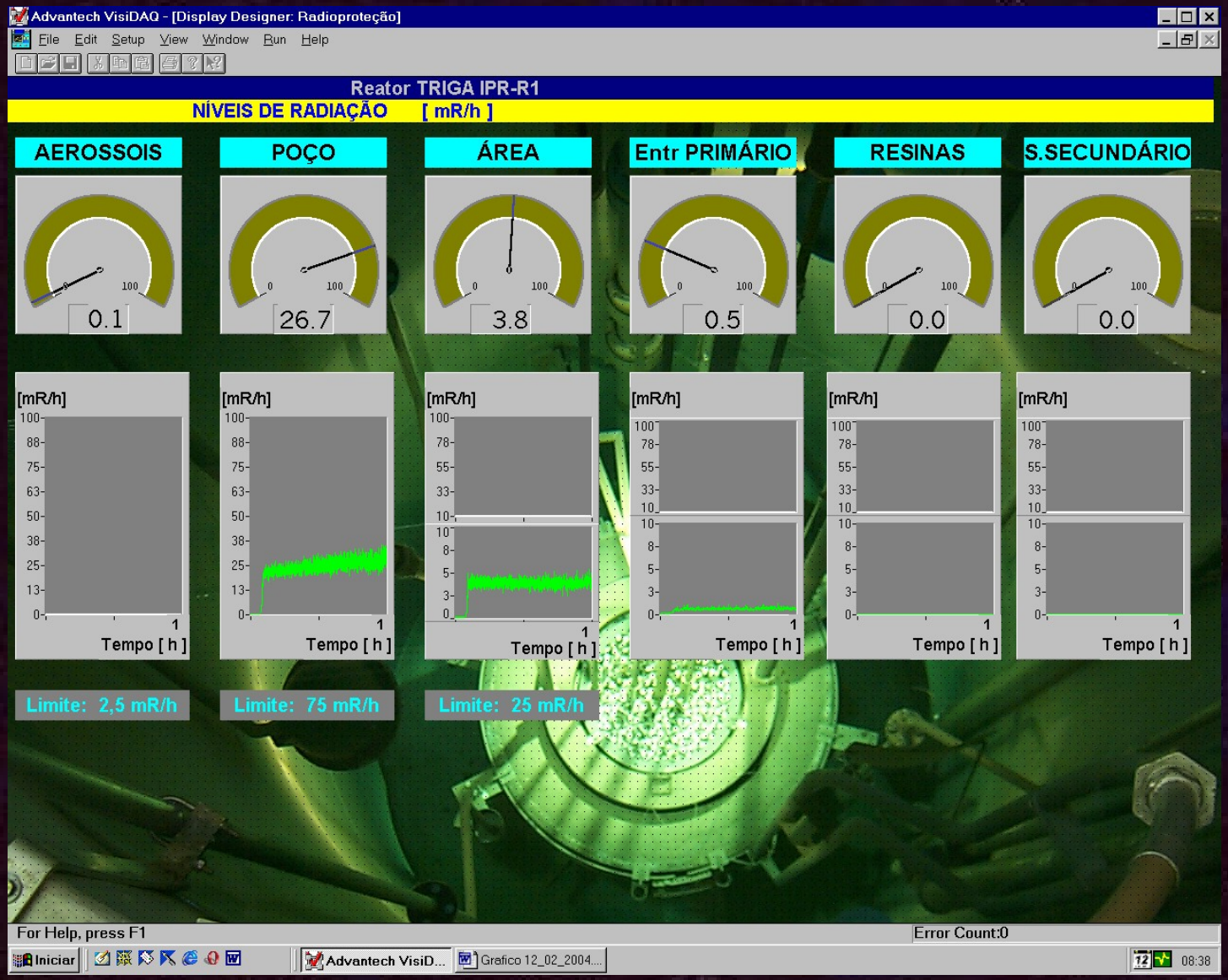

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Neutronic Calculation to the TRIGA IPR-R1 Reactor Using the WIMSD4 and CITATION Codes

- Integral curves of the control and safety rods

Burnup Calculations of Nuclear Fuel Using Monte Carlo Transport Methods

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The use of the WIMSD4 and CITATION codes

- The Reactivity Excess,
- The Temperature Reactivity Coefficients
- The Control, Safety And Regulation Rods Reactivity Worth
- The Integral Curves Of The Control And Safety Rods

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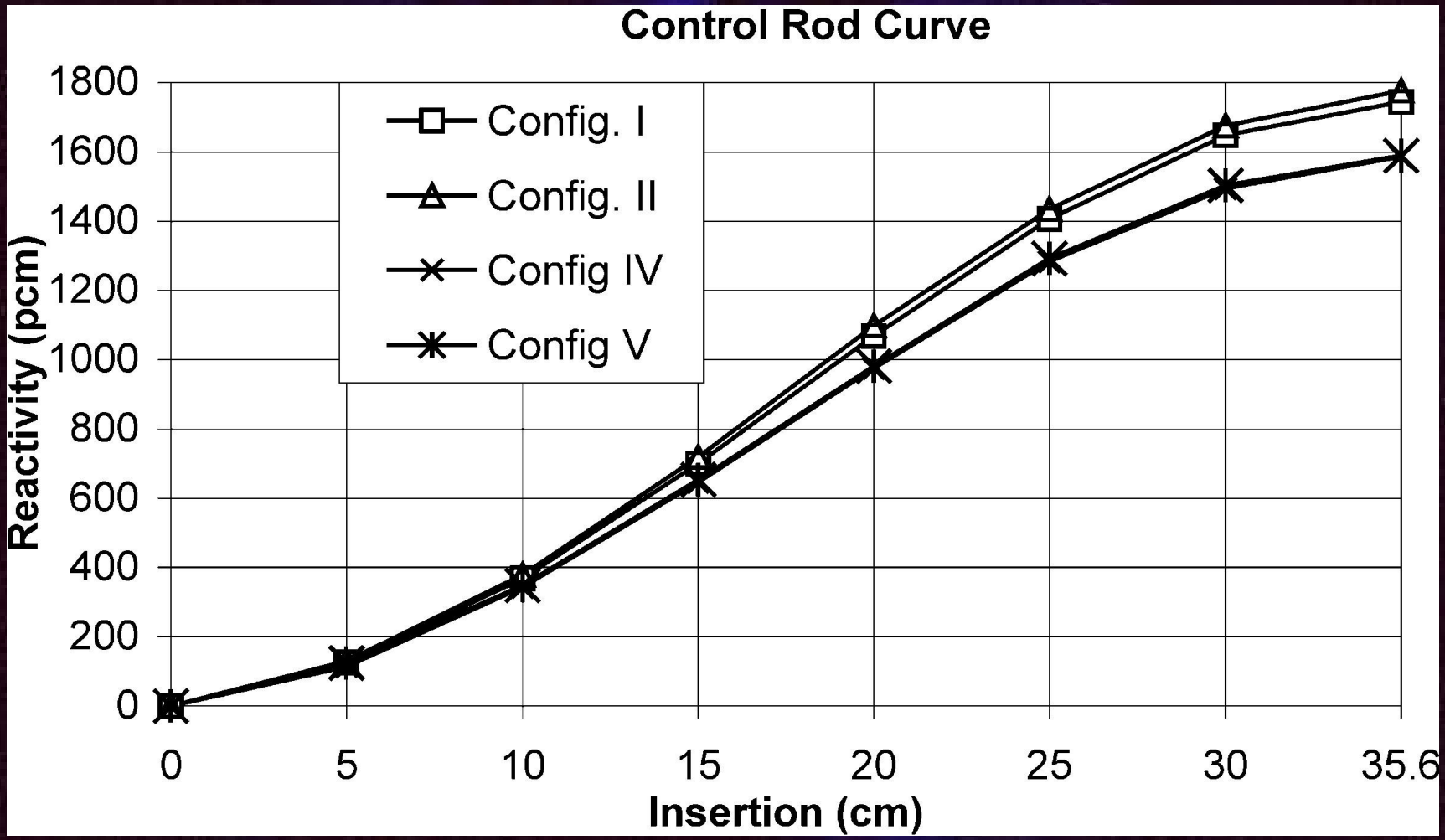

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Burnup Calculations of Nuclear Fuel Using Monte Carlo Transport Methods

- Monteburns
- MCNP4B
- Origen 2.1

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USES OF THE COMPUTER CODES IN NEUTRON ACTIVATION ANALYSIS

- ACQUIREMENT OF GAMMA SPECTRA
  - Maestro (ORTEC)
  - Genie 2000 (CANBERRA)
- EVALUATION OF GAMMA SPECTRA
  - Hyperlab-PC (Hungary)
- ELEMENTAL CONCENTRATIONS
  - Kayzero/Solcoi (Belgium)

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CONCLUSIONS

- The developed data acquisition system has been operated during normal operation and during all experiments realized with the reactor since July 2003
- Some codes used along the years have been changed and new ones has been introduced to study the reactor parameters.
- In general, the results of the methodology using the codes WIMSD4 and CITATION to simulate the TRIGA IPR-R1 reactor are very close to the experimental values

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CONCLUSIONS

- The Monteburns system code has also been used in simulations of the IPR – R1 TRIGA Reactor at CDTN, Belo Horizonte, Brazil.
- Criticality calculations are well within the expected accuracy of the calculation methodology and MCNP model
- The Monteburns codes system is able to supply neutronic parameters like neutron fluxes, keff, power distribution, control rods reactivity worth, core excess reactivity, fission products poisoning

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THANK YOU SO MUCH

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