The first results obtained with array of 16 electron-neutron detectors in INR RAS

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1. Scientific goals

2. Array layout and location

3. Detector and Electronics

4. Simultaneous recording of EAS and background variations

5. Pulse shape separation of signals

6. EAS size spectrum

7. Conclusion
Scientific goals

1. Test of our EAS and background recording technique

2. Detector and electronics stability test in outdoor conditions

3. Comparison of the results obtained with electron-neutron detectors at the sea level (Moscow) and mountain level (Tibet)
Array layout and location

Figure 1: Array layout

Figure 2: Array location
Detector and electronics

Figure 3: Detector design

Figure 4: FADC CAEN DT5740

Figure 5: HV power supply

Figure 6: DIU

Figure 7: IU
Recording of EAS and background variations

**Figure 8: Electronics design**

- HV
- LV
- Detector #1
- Dynode #8
- DIU
- IU
- Detector #16
- Dynode #5
- DIU
- IU

- 32-channel CAEN FADC DT5740
- PC

**Figure 9: Recording algorithm**

- Signal from dynode #8
- Is there a coincidence between pulses from 8 dynodes of >=2 detectors inside 1 us?
- Yes
- Record EAS front pulse and open time gate of 20ms for delayed neutrons
- If the current pulse inside 20 ms after last coincidence?
- Yes
- Record it as delayed neutron in EAS
- No
- Record it as background pulse
- No
Pulse shape selection

Figure 10: Rising front width distribution of pulses. Pulses to the right from red line are mostly neutrons, while pulses to the left are mostly produced by simultaneous transition of several relativistic light charged particles

\[ {}^{10}B + n \rightarrow ^{4}He + ^{7}Li + 2.3(2.7)MeV \] - excite slow components of ZnS
Test of pulse shape separation technique using radioactive sources

Counting rate of neutrons (blue) and "short" (orange).

Figure 11: Effect of adding $^{252}$Cf

Figure 12: Effect of adding $^{232}$Th
Test of pulse shape selection technique with $^{252}\text{Cf}$

Figure 13: Time front distribution with and without neutron source $^{252}\text{Cf}$
Figure 14: Example of background variations from first 4 detectors of the array. Blue - neutrons, orange - "short". Red lines - adjacent average.
Example of recorded big event

Figure 15: Recorded event with 36 neutrons, 05/07/2020
Temporal distribution of delayed pulses in EAS, time window is 20 ms

Figure 16: neutrons

Figure 17: "short"
EAS energy deposit spectrum

Figure 18: EAS distribution on sum of detectors amplitudes
Conclusions

1. Array of 16 en-detector was installed in INR RAS in Moscow

2. Technique of simultaneous recording of EAS and background variations was successfully realized

3. Technique of pulse shape selection was realized and tested

4. Temporal distribution of delayed neutrons in EAS was obtained
Thank you for attention!