Martian Advanced Radiation Acquisition (MARA)

Paul Delaune

MARA Purpose

Overview:

- **History**
  - **Radiation instruments at JSC involve the efforts by Dr. Gautam Badhwar in the late 80's to develop new radiation instruments.**
  - **Contracts to design instruments for the Shuttle and a Russian Mars mission to be launched in 1992.**
  - **A radiation instrument system was developed by Battelle Northwest Laboratories under Dr. Badhwar's direction.**
    - custom Battelle bus,
    - using an Intel 80188 CPU (PC XT type technology)
    - Software was developed using Turbo Pascal running on ROM DOS.
- **To keep costs down, as new instruments were bid by Dr. Badhwar, only small modifications were made to the existing designs.**
  - Over the years, this resulted in technology erosion.
  - Station TEPC, IV/EVCPDS and the MARIE instrument are all designed using the same technology used in the late 80's.
- **Recent bids to produce new higher performance instruments with more advanced technology were unsuccessful due to high cost and high perceived risk.**
  - **The MARA project was started to proactively address the risk areas and thereby reducing the bid costs for new instruments.**

MARA Objectives

- **Advance the state of the art in radiation particle data acquisition.**
  - **Eliminate the short comings of the ISS/MARIE suite of radiation instruments. <u>This will produce the largest gain in data collection at the lowest cost.</u>**
    - Radiation tolerant parts.
    - Data acquisition is deterministic.
    - Distributed rather than centralized data acquisition. Decision to take data or not is at the sensor level rather than the instrument level.
    - Near real time data display.
  - **Design a radiation instrument using an industry standard bus system.**
    - **Allows several vendors to supply components. No proprietary interfaces.**
    - **Allows for upgrade of system components using commercially available sources.**
      - Less expensive.
      - Quick turn around.
      - Commercial components are normally more mature designs which allow for good reliability and more available support.
  - **Design a radiation instrument using a real time operating system with applications written in C or C++.**
    - **Improves the reaction time of the instrument**
    - **Allows multi-tasking.**
    - **Portable to state of the art compilers.**
      - Eases upgrades and configuration management.
  - **Design a radiation instrument using a modular data acquisition system.**
    - **Allows for simpler reconfiguration for different sensor needs.**
    - **Allows for quicker software reconfiguration.**
    - **Gives a common hardware and software interface.**
  - **<u>Prove the design through testing.</u>**

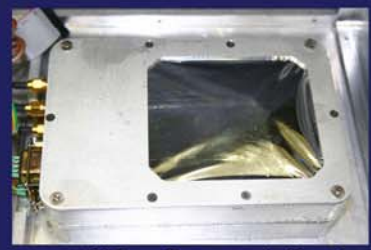
MARA Prototype with Silicon Detectors

Mars Advanced Radiation Acquisition (MARA)

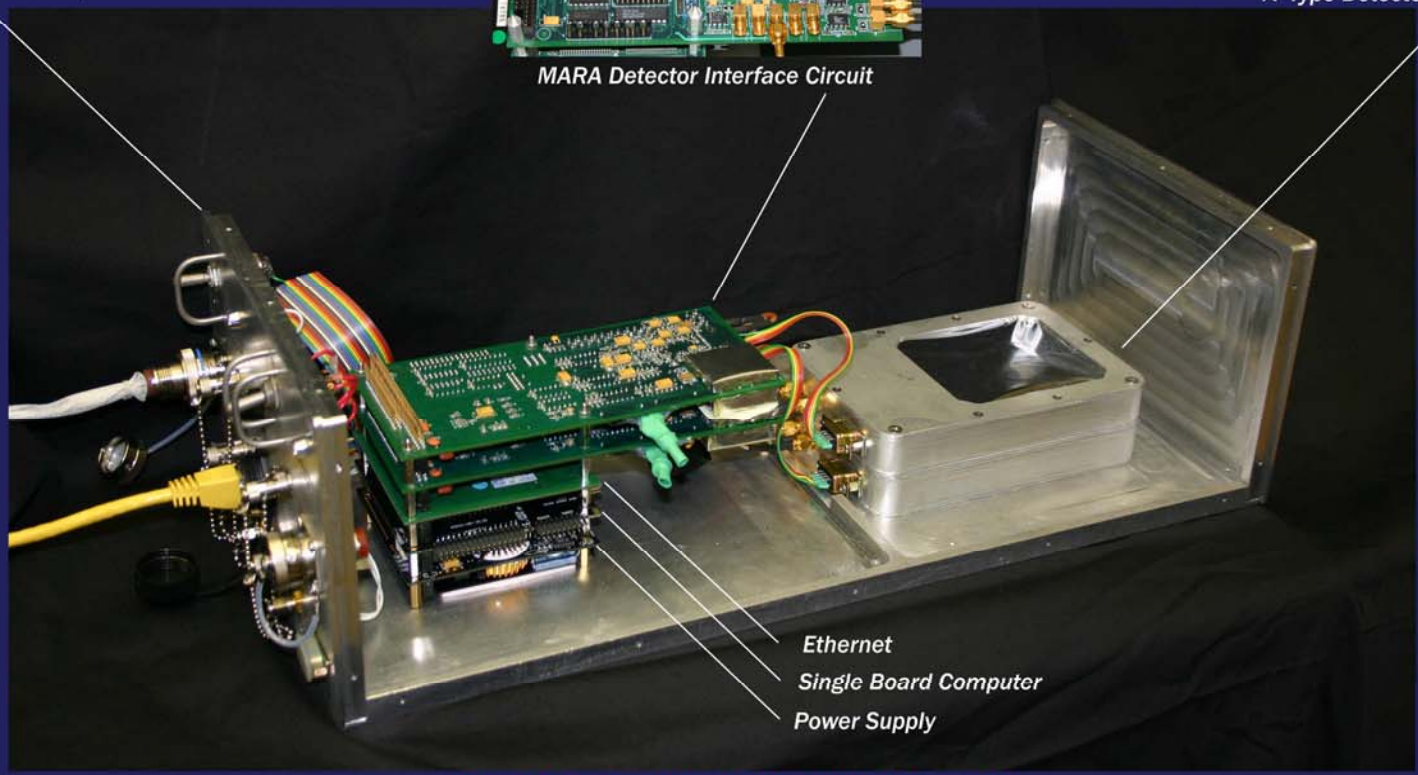
Space Radiation Detection and Measurement for:
CEV, Moon, Mars, Shuttle & Station

Front Panel Future Spacecraft Interfaces

MARA Detector Interface Circuit



'A' Type Detector in Housing



Phase I Prototype (shown in 2 detector configuration)

MARA Software Components

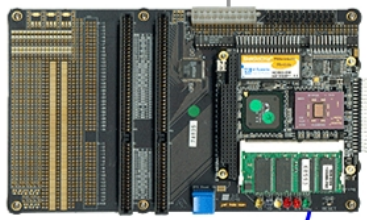
Control Console

Purpose: **Simulates GSE (Ground Support Equip) or Spacecraft**
Hardware:
Dell Latitude D600 Laptop
Software:
Windows XP
Visual Basic 6.0

Serial Comm
(RS-232)
9600 Baud

Purpose: **Data Acquisition from detector board**
Hardware:
Tri-M Engineering TMZ-104
PC-104 Computer (Pentium)
Software:
Wind River VxWorks 5.5
(Real Time Operating System)
C/C++ Application software

MARA Instrument



System Boundary

Ethernet
10/100 Base

Software Development

Purpose: **Develop instrument software. Debug & profile.**
Hardware:
Dell Desktop Computer
Software:
Wind River Tornado 2.2
(Integrated Development Env)

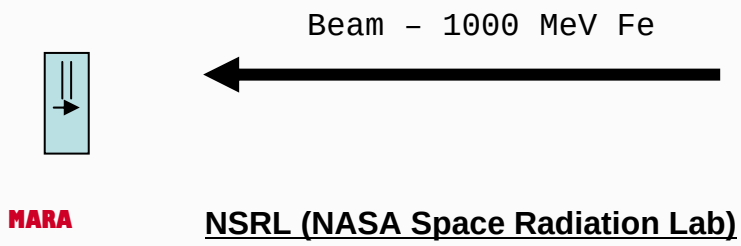
MARA At Brookhaven

Test Parameters

- This testing was conducted in cooperation with Johns Hopkins University's APL and LBL at the NASA Space Radiation Lab (NSRL) at Brookhaven National Laboratory.
- A beam of iron ions energized to 1000 MeV was aimed directly at the sensor stack and 30 degrees off center.

Data Results

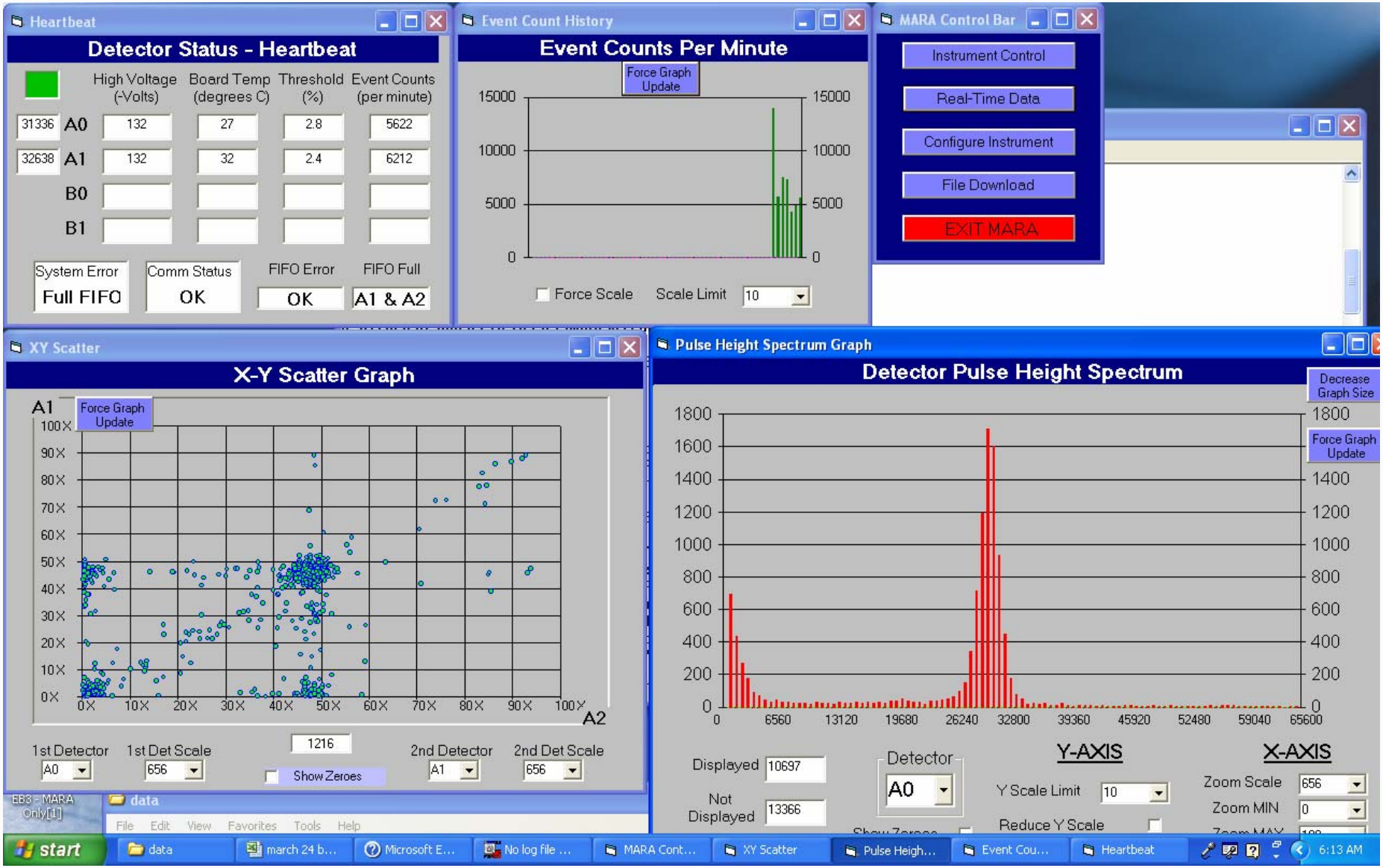
- Pulse Height Spectrum shows the relative number of events at each energy level for each detector
- XY-Scatter plot shows the relative energies deposited in each detector by the same particle
- Timeline is used to characterize the particle rate.



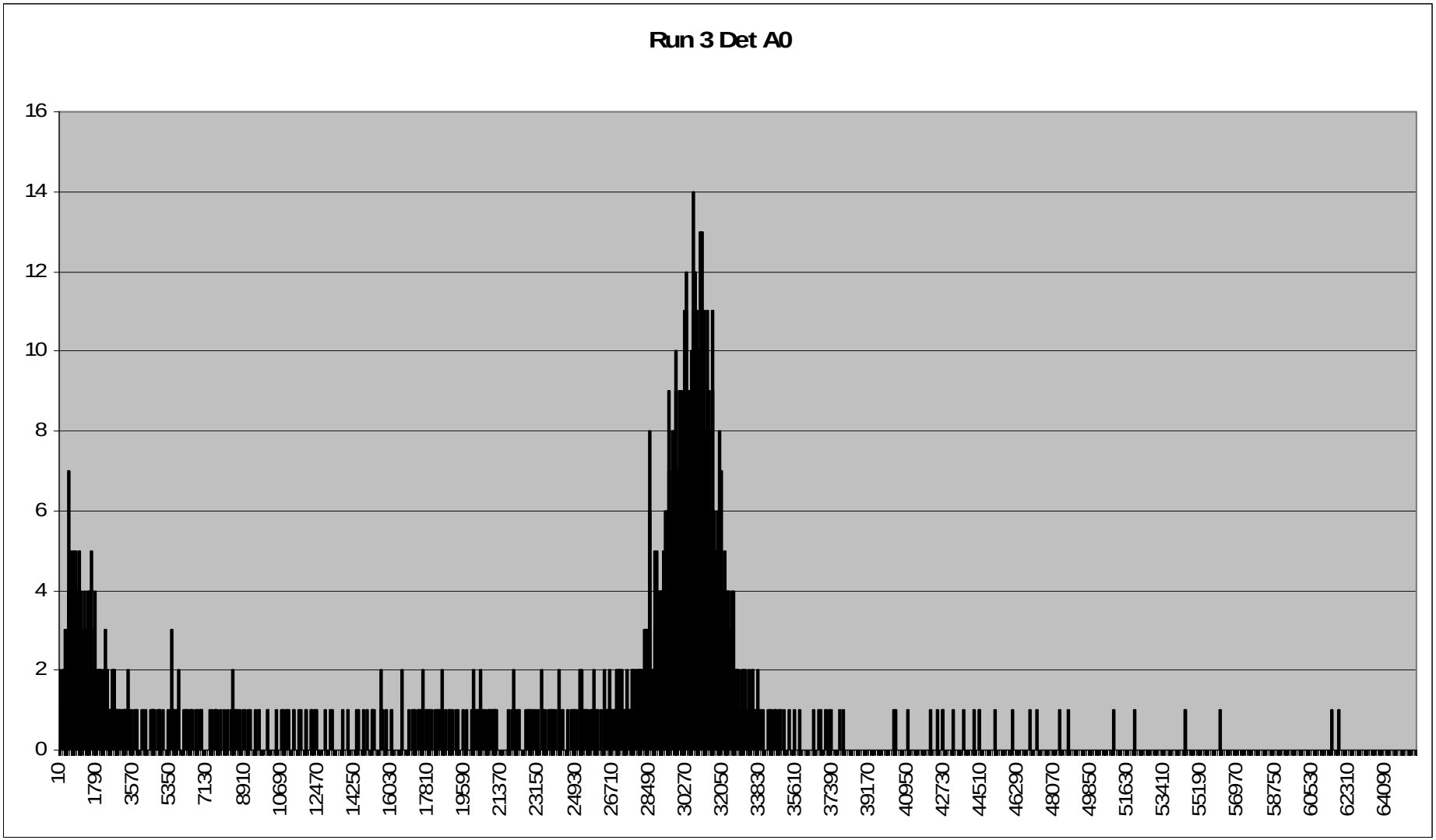
MARA Specs

- 2 - 1 mm Silicon Detectors (MARIE heritage)
- Maximum event rate – 1000 events/sec.
- Maximum energy deposition measurement – 500 MeV (can be reconfigured in hardware)
- 65K channels per detector
- Asynchronous event counter for each channel
- GUI displays
  - detector voltage, temp, event count
  - Graph of event count
  - Graph of pulse height spectrum
  - X-y scatter plot of coincidence.

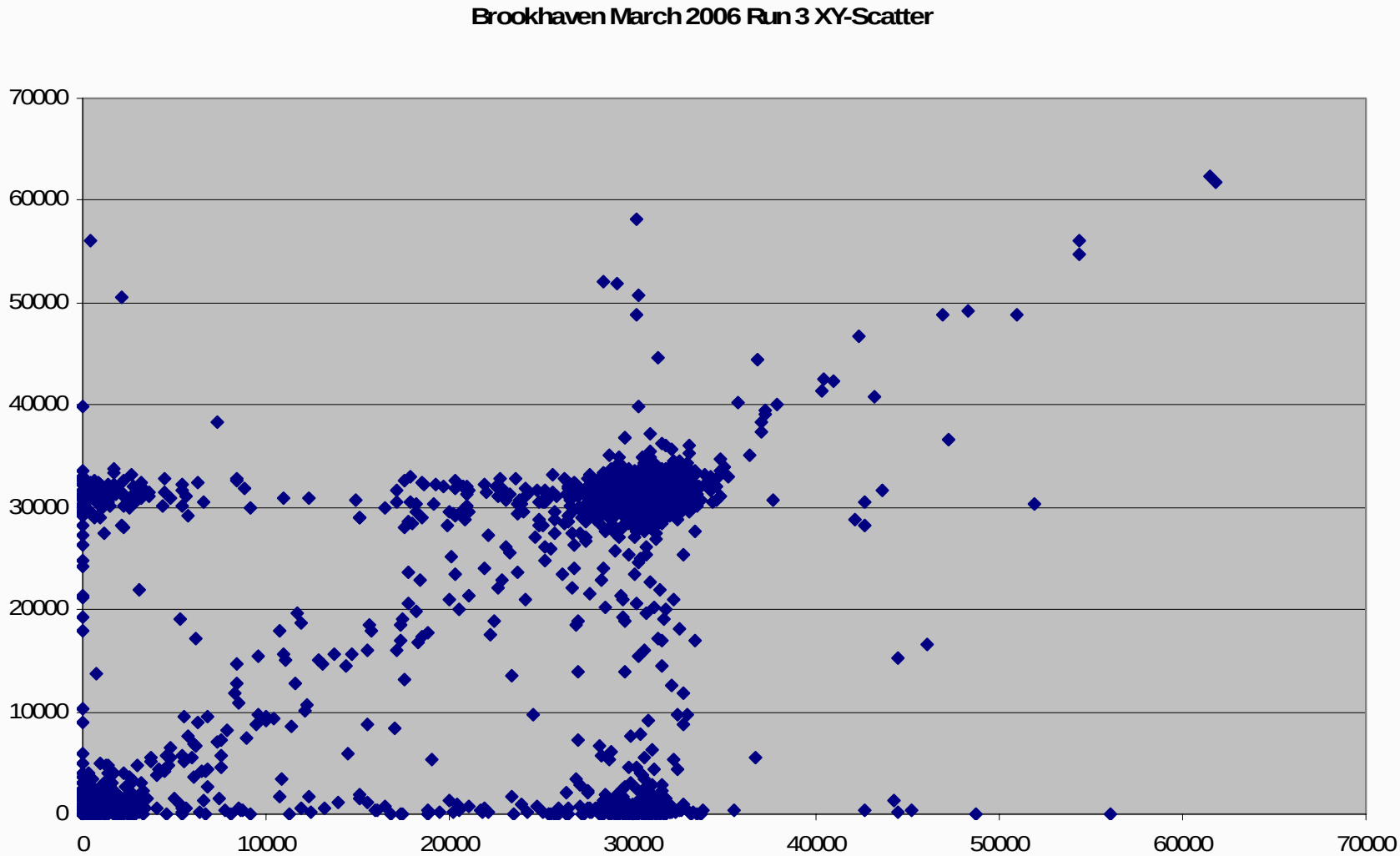
MARA Screen shot at Brookhaven



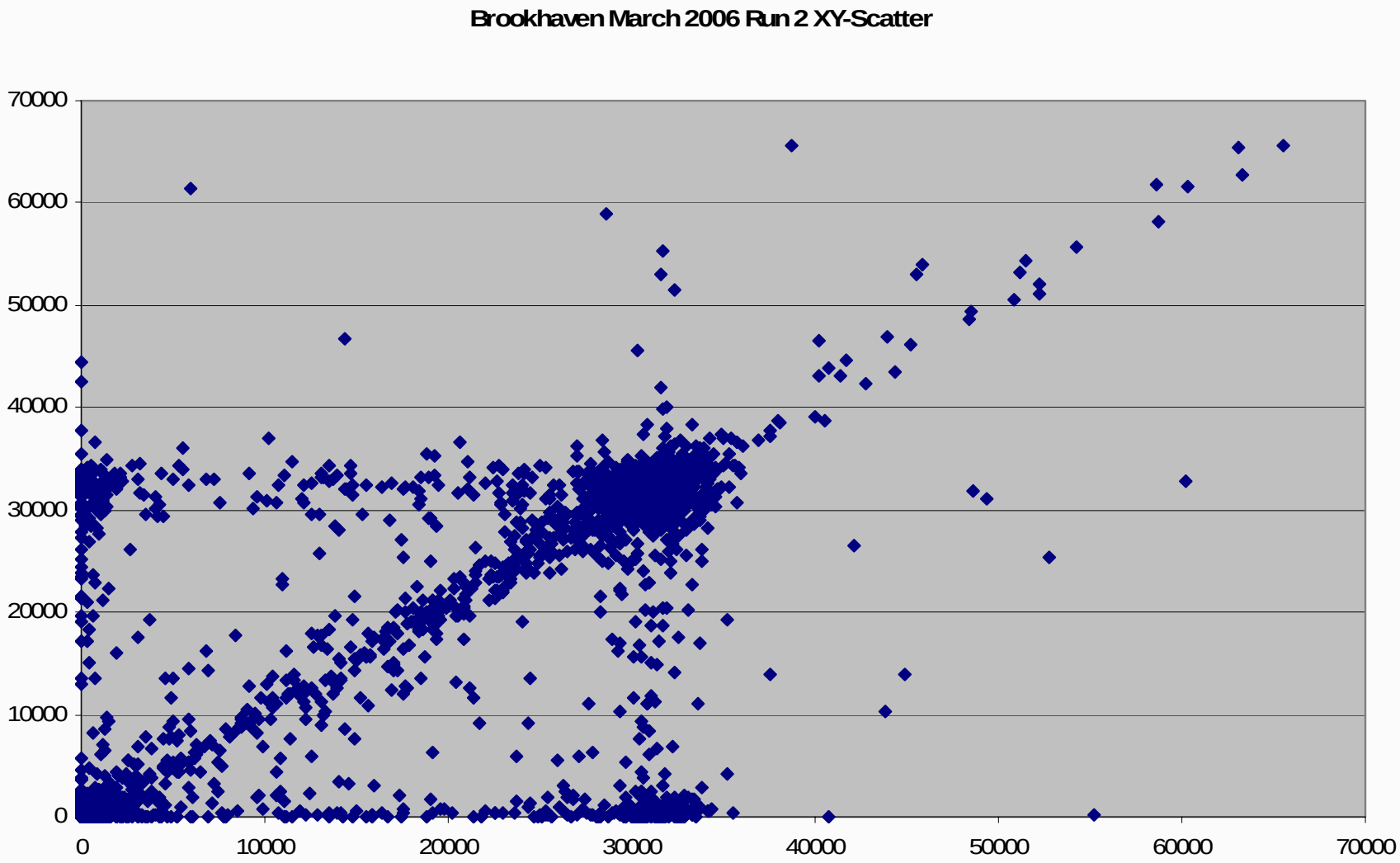
Brookhaven 1000 MeV Fe



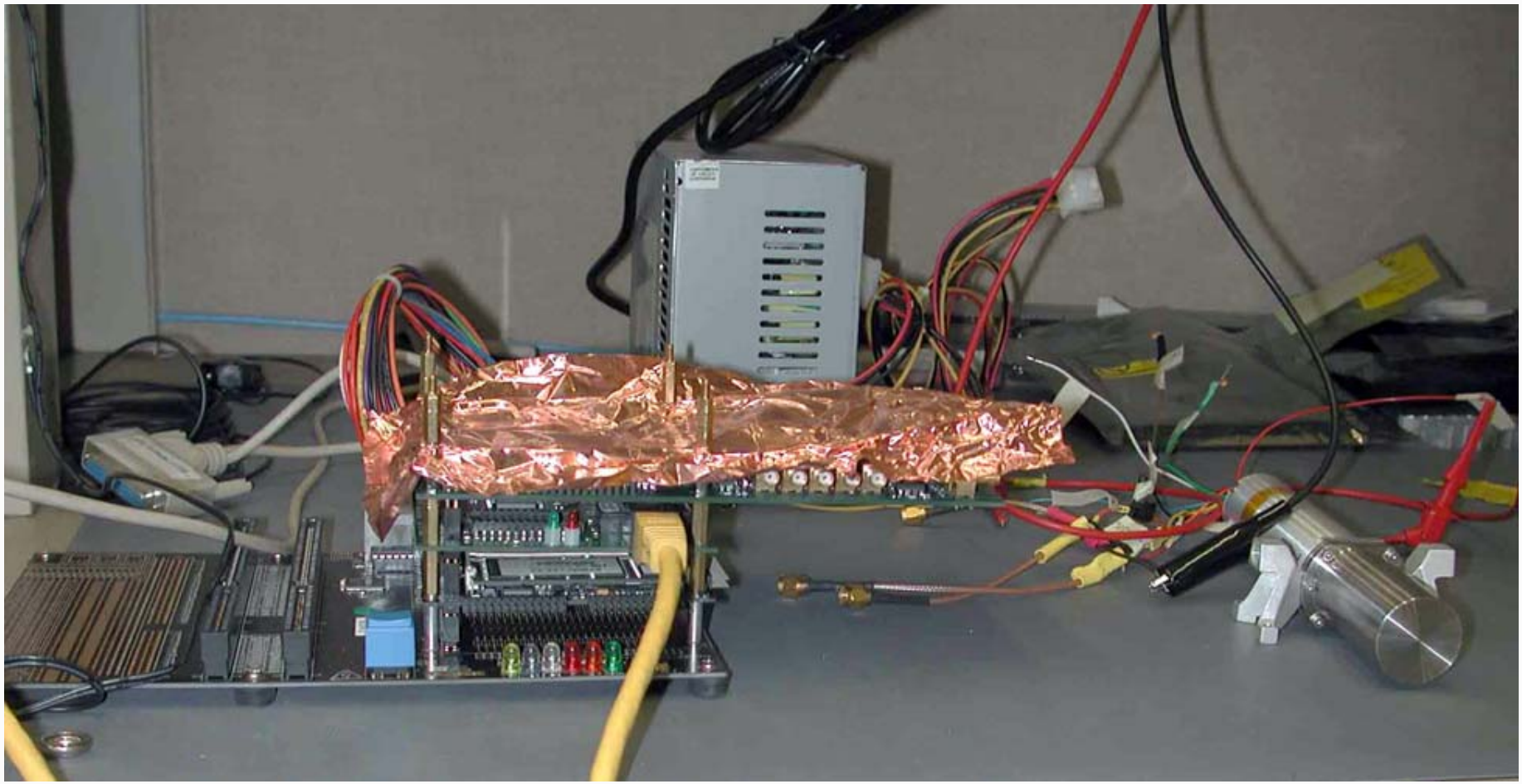
Fe beam no shielding



Fe beam with plastic shield



MARA with TEPC Detector



MARA Conclusion

- Phase I for initial design and testing has been completed.
- Phase II to incorporate the lessons learned and expand the sensor capabilities has been initiated.
  - Options to utilize TEPC or Silicon detectors on the same DAQ board design.
  - Hardware noise reduction.
  - Software improvements.
  - As the design is improved continued testing is required for verification.
- The MARA System design and DAC design goals are realistic and within the capabilities of current electronics and software. There are no obstacles in the technologies being used.

- **A modular data acquisition system coupled with real-time software built around modern industry standards can fulfill the radiation monitoring needs within the limited budget and schedule of a flight project.**