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Title: Fact Sheet for KM200 Front-end Electronics

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KM200 Fact Sheet

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1. Introduction

The KM200 device is a versatile, configurable front-end electronics boards that can be used as a functional replacement for Canberra's JAB-01 boards based on the Amptek A-111 hybrid chip, which continues to be the preferred choice of electronics for large number of the boards in junction boxes of multiplicity counters that process the signal from an array of ^{3}He detectors. Unlike the A-111 chip's fixed time constants and sensitivity range, the shaping time and sensitivity of the new KM200 can be optimized for demanding applications such as spent fuel, and thus could improve the safeguards measurements of existing systems where the A-111 or PDT electronics does not perform well.

2. Electronics Description

The basic KM200 electronics is a reconfigurable board stack, which includes a HV filtering and decoupling, a preamplifier, a bipolar shaper, and a discriminator. The preamp/shaper board can be reconfigured as a buffer amplifier during the manufacturing process (no switches) for applications where the preamplifier has to be separated from the shaper and discriminator. The top (discriminator) board implements the standard functionality of PDT and Canberra JAB-01 designs: discriminator, threshold and digital pulse width control, rail-to-rail output driver, LED indicator, and TTL OR circuitry (daisy chain). The discriminator board has a header connector with the same functional pin configuration as the connector of the JAB-01 boards, thus it can be a fully functional replacement. Built-in parameters such as shaping time, gain, etc., can be customized during manufacturing by modifying certain component values. The KM200 includes the following features:

- Analog front-end (HV decoupling, charge sensitive preamplifier, and bipolar shaper).
- Sophisticated discriminator, which includes a comparator with threshold adjustment, double pulsing suppression circuit, output logic pulse width adjustment, OR logic input for daisy-chaining of devices, and an output logic pulse buffer capable of driving a 50Ω cable close to both the positive and negative supply rails.
- The KM200-Dual Channel Architecture design option expands the measurement capabilities of existing front-end-electronics and detectors by increasing the counting rate range and providing real time diagnostics (see below).
- Possible reconfiguring of the analog front-end as a stand-alone charge sensitive preamplifier with a linear buffer capable of driving coax cable load.
- The design is based on modern bipolar (no CMOS technology) off the shelf components in standard footprints used in the communications industry. This mitigates the risk of components becoming obsolete or scarce, and allows for easier upgrades with more modern components over the life span of the product.

The basic KM200 board stack, as well as the locations of the output connector and adjustment controls, is shown in Fig. 1a and Fig 1.b

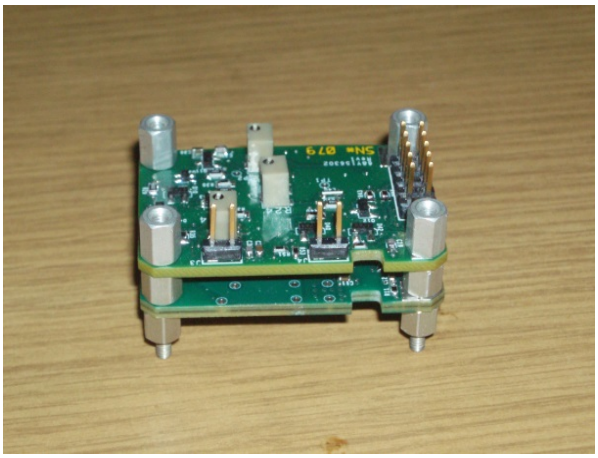

Fig. 1a. KM200 basic board stack.

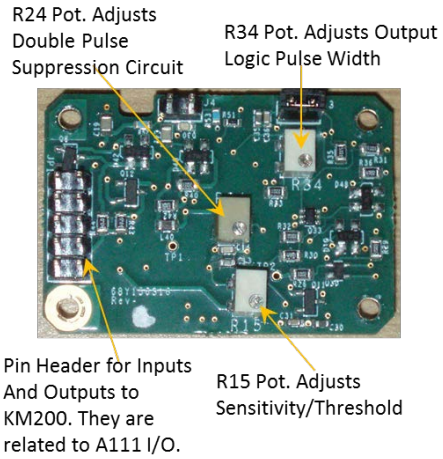

Fig. 1b. Location of adjustment controls and output connector

3. Configuration Options:

3.1. *A-111 functional replacement for installation in junction boxes.*

The KM200 basic board stack has a smaller footprint than the JAB-01 board, which allows for a higher installation density for new applications. For a drop-in replacement of the JAB-01 electronics in existing designs and installations, a KM200 to A111 adapter board can be used. Fig. 2a, shows the basic KM 200 board stack, and Fig 2b and Fig.2c shows the KM200 as a replacement for the JAB-01 connected to an A111 adaptor board.

Fig 2a. KM200 board stack.

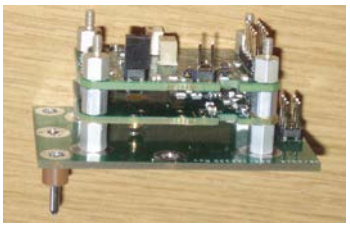

Fig 2b. KM200 as a replacement to the JAB-01 board (side view)

Fig 2c. KM200 as a replacement to the JAB-01 board (top view)

3.2. *Stand-alone KM200 installation options.*

The installation options are shown in Fig 3a and b. HN or SHV connectors could be used in both options which would extend the installation flexibility.

Fig 3a. KM200 Standalone configuration with connector board for direct connection to detector cables. Built-in regulator allows use of 5V to 15V power voltage

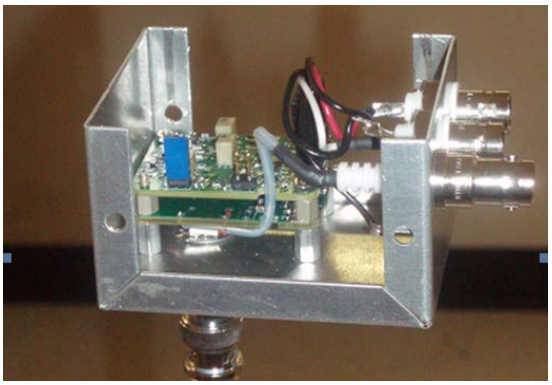

Fig 3b. KM200 Standalone configuration installed in 2.8" by 2.2" by 1.6" aluminum box. (Box lid removed).

3.3. *KM200-Dual Channel architecture.*

The KM200's dual channel design is shown in Fig.4. This is where the preamplifier signal is processed in two (slow and fast) parallel shaper discriminator channels. This design could be used for:

- Expanding the operational range of gamma and neutron fluxes for demanding applications such as spent fuel or vitrified waste measurements.
- Expanding the application versatility to tolerate long cables between the detector and electronics, or send an analog signal through a coaxial cable.
- Incorporating two fixed time constants to cover a broad range of neutron detectors used in safeguards: A fast channel for fast ^{3}He tubes, ^{10}B tubes and ^{235}U Fission Chambers, and a slow channel for slow ^{3}He tubes and NaI(Tl) scintillation detectors.

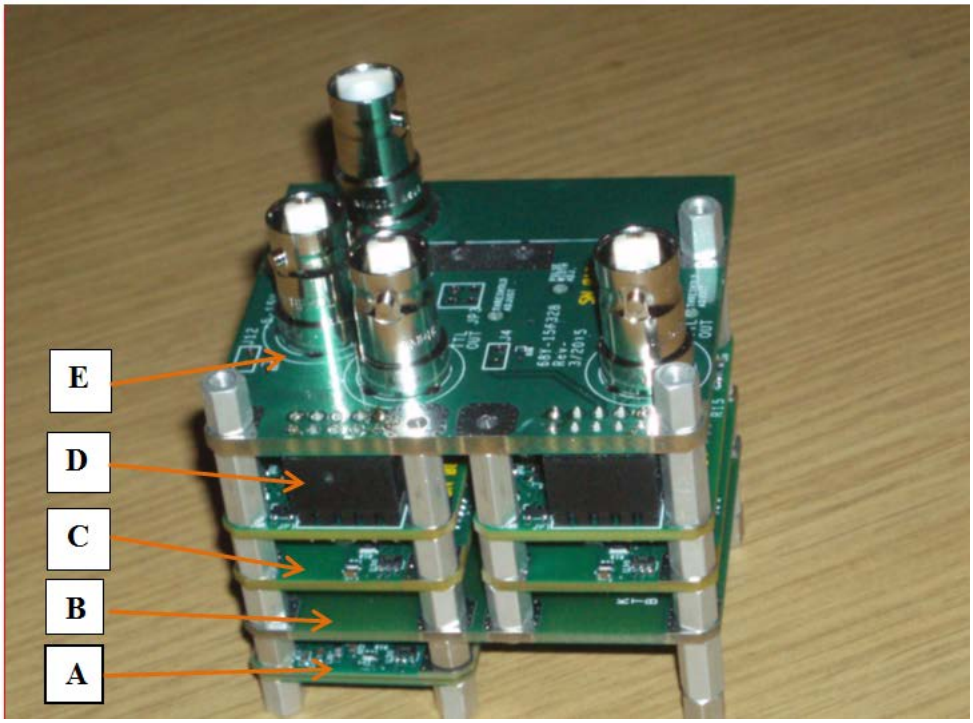

Fig. 4. KM200–Dual Channel Architecture. Bottom to top: (A) Charge sensitive preamplifier board with a buffer amplifier; (B) Signal interconnection board; (C,D) Two, fast and slow independent shaper/discriminators boards stacks; (E) Output connectors board with built-in voltage regulator

4. Technical Specifications

4.1. Sensitivity: 10fC to 100 fC measured with a charge pulse with 1 µs rise time.

4.2. The following parameters are controlled by potentiometers installed on the discriminator board:

- Threshold adjustment
- TTL Pulse width
- Double pulsing rejection filter (width/delay?)

4.3. Output logic pulse

- Pins 8 and 7 on header connector JP1 or BNC connector on output connectors board
- Amplitude >4.5 V unterminated and >2.V terminated with 50 ohm.
- Pulse width; 50 ns to 500 ns

4.4. Power requirements: 5V, 20mA with no output pulses and no LED activated

4.5. Dimensions/footprint including 0.25” standoffs to the mounting plate:

- KM200 Boards Stack as shown in Fig. 2a: 1.6” long by 1.2” wide by 1” high.
- KM200 for JAB-01 drop-in replacement: 2.2” long by 1.5” wide by 1.25” high.
- KM200 Standalone stack for tube mounting as shown in Fig. 3a: 1.6” long by 1.2” wide by 1.4” high.
- KM200 Dual Channel Architecture package: as shown in Fig. 4: 2.2” long by 2.2” wide by 1.7” high.

4.6. Operating environment:

- Operating temperatures: -25C to +75C,
- Temperature drifts of the detection threshold: less than 5% for entire temperature range.
- Humidity: less than 80% relative
- All current prototypes require a sealed junction box

4.7. Inputs and Outputs

- *Detector Inputs:*
  - KM200 Boards Stack as shown in Fig. 2a: MILLMAX receptacle Mod# 0364-0-15-15-13-27-10-0 mounted on bottom side of preamplifier board
  - KM200 for JAB-01 drop-in replacement as shown on Fig.2b: jack connector mounted on the bottom of KM200 to A111 adapter board
  - KM200 standalone options as shown on Fig 3a and Fig 3b: HN or SHV connector mounter on the metal plate

- *Output connectors:*
  - 2 x 5 pin header connector JP1 on the discriminator board. Pin numbers and signal descriptions are listed in Table 1.
  - BNC and SHV output connectors for configurations are shown in Fig.3a and Fig. 4.

Table 1. Signals Description for JP1 Connector

Pin Number	Name	Description
10	VCC	This is where the 5V power connects.
9	GND	Ground return for VCC
8	TTL Out	Logic pulse produced by bipolar transistor driver capable of driving 50 Ohm Impedance.
7	GND	Ground return for TTL Out
6	LED Out	Port for external pulse signaling LED.
5	GND	Ground return for LED Out
4	Shaper Out	Analog output signal for monitoring the bipolar shaped detector pulses. Alternatively it can be configured as a remote threshold control input.

3	GND	Ground return for Shaper Out
2	TTL In	Input for daisy-chaining of multiple detectors. The received pulses go through an OR circuit with the pulses from the current detector and the resulting pulse stream is passed on to the next link in the chain.
1	GND	Ground return for TTL In

5. Performance Capabilities

5.1. *KM200 and A111 plateaus with tubes used in standard multiplicity counters.*

Comparison plateau characteristics of HLNCC and ENMC tubes taken with KM200 and JAB-01 board based on Amptek A-111 are shown in Fig. 5 and Fig. 6.

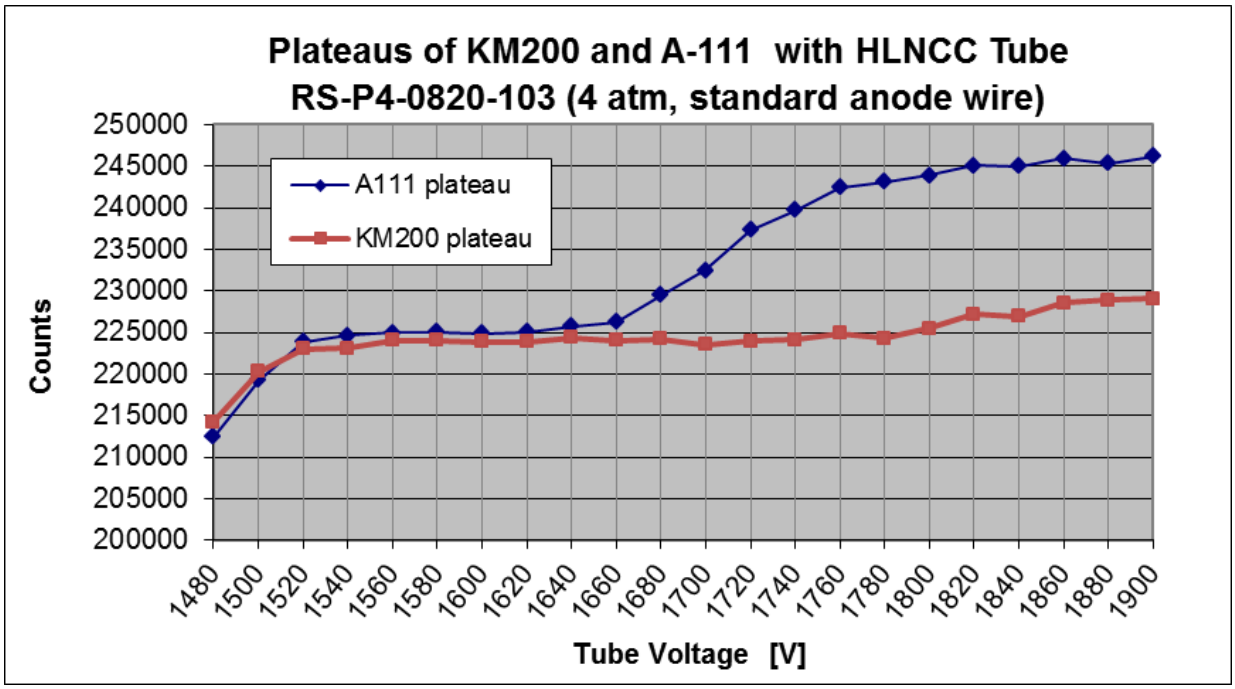

Fig. 5 Plateau characteristics of KM200 and JAB-01 boards for RS-P4-0820-103 tube. The thresholds of both preamplifiers are set to maximal sensitivity.

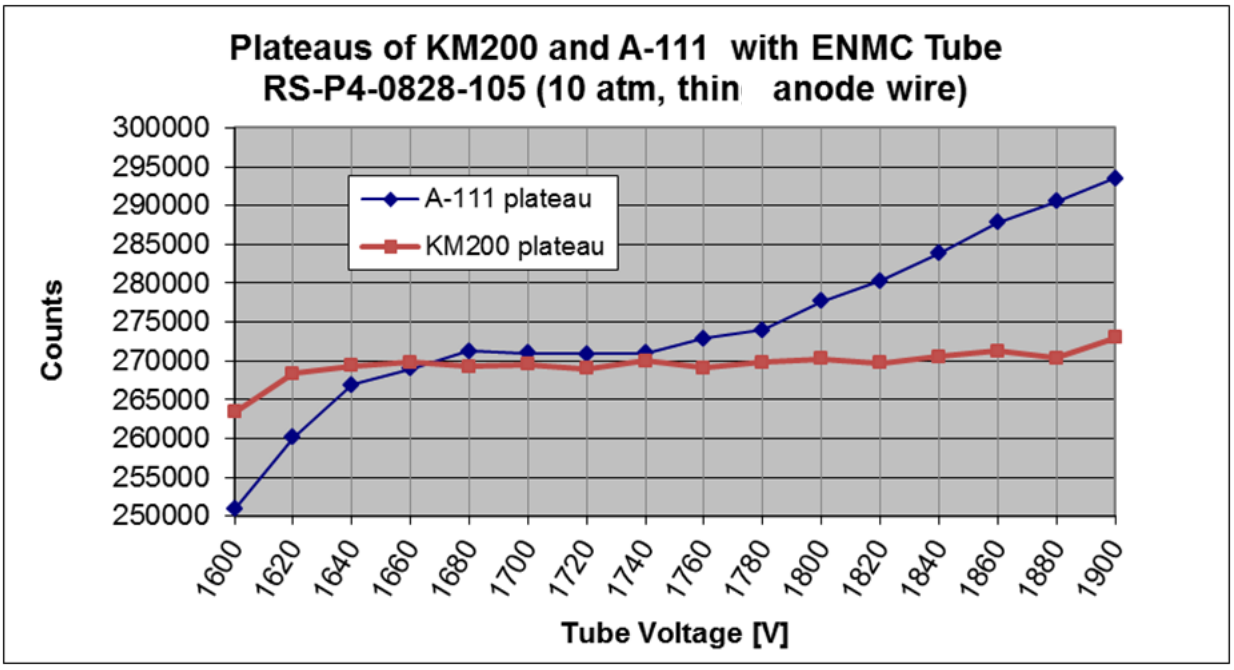

Fig. 6 Plateau characteristics of KM200 and JAB-01 boards for RS-P4-0828-105 tube. The thresholds of both preamplifiers are set to maximal sensitivity.

5.2. *Operational data for fast KM200 electronics with time constants customized for ^{10}B-lined proportional counter with inorganic gas admix and redesigned electrodes for operation in high gamma and neutron fluxes.*

Fig. 7a,b show the integral counting characteristics and Time Interval Histograms taken with this set of detector and electronics

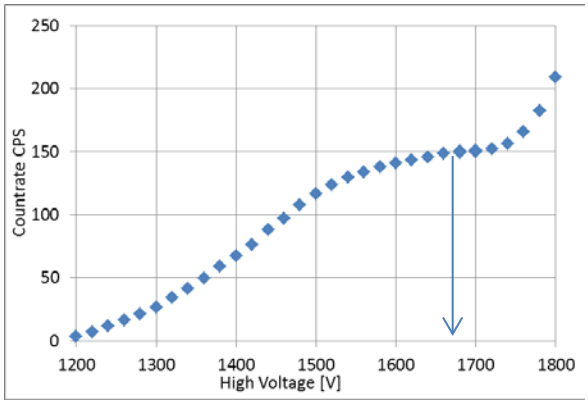

Fig.7a Integral counting characteristics of gamma resistant ^{10}B lined proportional counter and fast KM200 shaper discriminator for ^{10}B detectors.

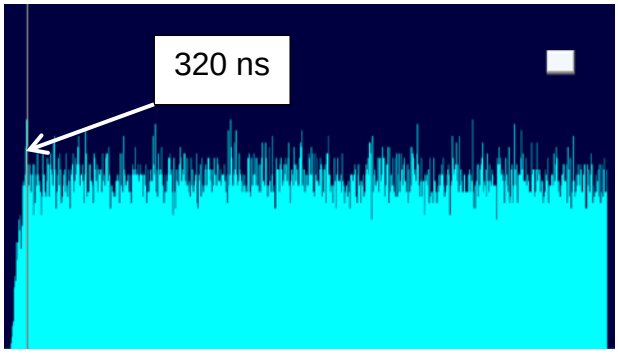

Fig.7b Time interval histograms taken at the selected operating voltage of 1660V. Using a short shaping time is essential to reduce gamma pile-up.

5.2 TTL driver performances.

The timing diagrams in Fig. 8a and b show the TTL driver's performance when driving a 70 meter long RG223 terminated coaxial cable. The amplitude at the cable end is between 1.8 and 1.9 volts depending on the pulse duration. The slow rise to maximum amplitude and the slow tail following the pulse are due to cable losses.

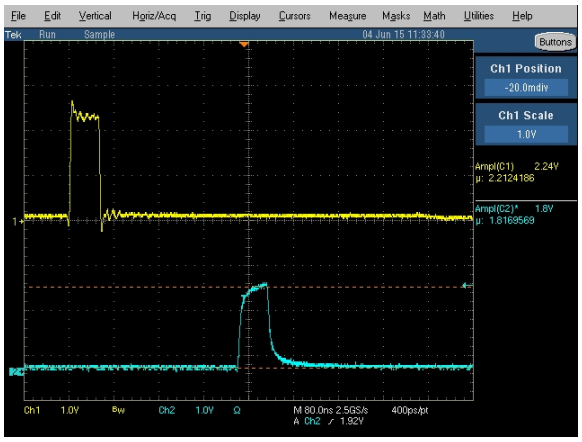

Fig. 8a KM200 TTL driver performance for 60 ns pulse width. Top trace: 1meter cable length. Bottom trace: 70 meter cable length.

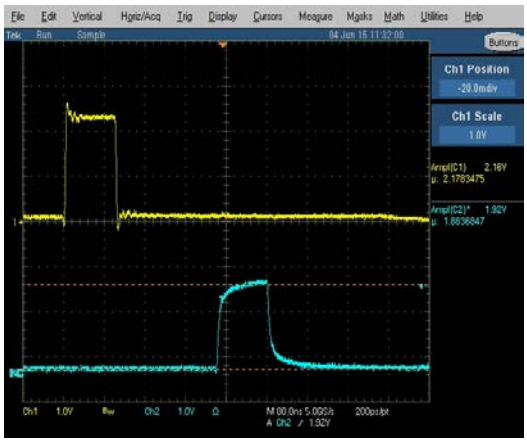

Fig. 8b KM200 TTL driver performance for 100 ns pulse width. Top trace: 1meter cable length. Bottom trace: 70 meter cable length.

5.3. *Reproducibility*.

The standard manufacturing techniques used in KM200 production ensure high reproducibility and repeatability of the gain and threshold values between different devices. This is demonstrated by a collection of plateau counting characteristics taken at maximum sensitivity from a number of KM-200 devices shown in Fig. 9.

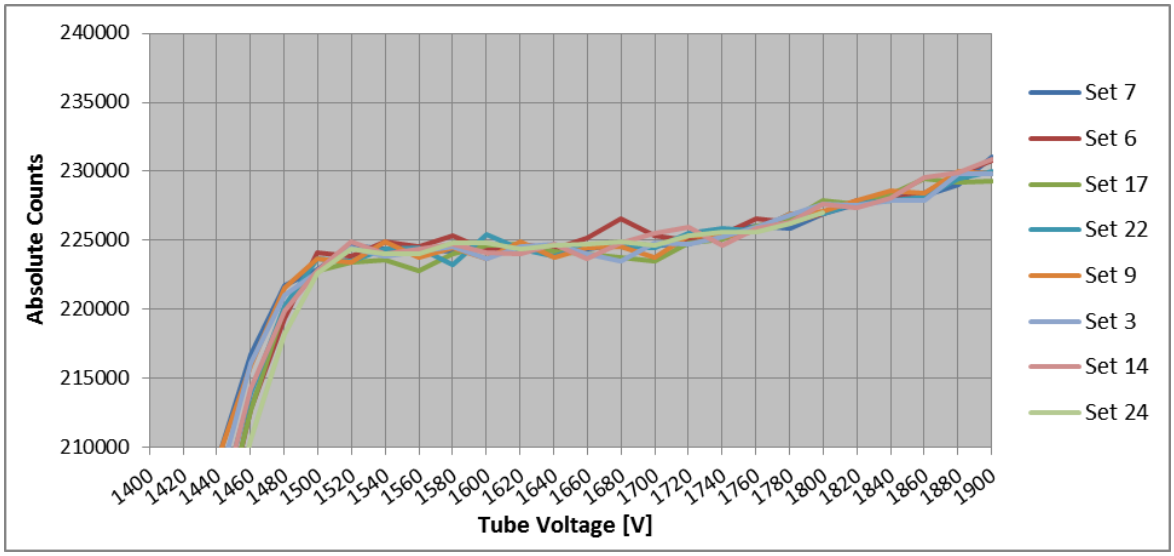

Fig. 9. Plateau counting characteristics of separate KM200 devices set at maximum sensitivity. The variation of less than 30 volts in the 1500 V plateau knee indicates high reproducibility of the KM200 characteristics.

The combination of a wide plateau and small variation in the plateau knee voltage can allow operation at 100V above the plateau knee and threshold setting with charge calibrator without the need for tedious gain matching using neutron sources.