KATANA Data Analysis

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KATANA – Kraków Array for Triggering with Amplitude discrimination

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• A bit of history

• Charge calibration and resolution

• Stability and correlations
KATANA main requirements
(more than just a trigger...)

- High trigger efficiency for central and semi-central collisions
  - GEANT4 + UrQMD simulations to test various options and setups

- Fast VETO signal for fragments with Z>20 to close the Gating Grid
  - Fast plastics (BC404)
  - Fast preamps
  - Trigger Box with FPGA logic

- Insensitivity to magnetic field
  - MPPCs (HAMAMATSU)

- Possibly low position dependence of the signal amplitudes
  - Wave Length Shifters (BCF-92) for VETO paddles

- Stability and beam time respect
  - Remote control of discriminator thresholds, bias voltages and temperatures

- Provide data, handle Active Collimator signals
  - Include trigger detector in DAQ
In order to make TPC blind for $Z>20$ heavily ionizing fragments we should device a trigger with 0-efficiency for $b>6$ fm
3 veto bars 10x40x0.1 cm$^3$ with 5mm overlap +
10 multiplicity bars 10x40x1 cm$^3$

veto bars read out from both sides
multiplicity bars read out from one side → 16 channels

\[ Z : de (nhit > 0 && Z > 0) \]

Max forward charge

\[ \Delta E \text{ [MeV]} \]

amplitude threshold

\[ \text{maxZ \{nhit > 0\}} \]

trigger efficiency [%] vs b [fm]
Top view

- Target
- VETO1
- VETO2
- BC404, 1 mm thick, 10×40 cm²
- KRATTA
- PID
- Xe @ 300 AMeV beam

Dimensions:
- ~3 m
- ~60 cm

HIMAC beam-test
Heavy Ion Medical Accelerator in Chiba
**VETO prototype**

**MPPC:** HAMAMATSU, 1×1 mm², 10000 pixels  
**WLS:** BCF92  
**PA:** current preamplifier, \(\tau<2\) ns (P. Lasko)

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MPPC + PA

WLS

Sum+Split+Inv

BC404

~6-7 ns

V1730C FADC 500 MHz

~40 ns

TAPE & monitoring

10 chan L.E. DISCR+ FPGA

~40 ns

(LVPECL)

VETO

VME-RIO4-MBS

MPPC + PA

Sum+Split+Inv

MPPC + PA
```

- **MPPC:** HAMAMATSU, 1×1 mm², 10000 pixels
- **WLS:** BCF92
- **PA:** current preamplifier, \(\tau<2\) ns (P. Lasko)
KRATTA (triggering) and VETO1 in coincidence: Xe pulses

Plastic, 500 Ms/s FADC

KRATTA, 100 Ms/s FADC

TOP

PD0

BOTTOM

PD1

Plastic:
~6-7 ns rise time
8-11 ns FWHM
VETO vs KRATTA
(projectile fragmentation)

\[
\Delta E_{\text{KRA}} \cdot \Delta E_{\text{VETO}} = (\text{am}[0]+\text{am}[1]) \cdot (\text{run}>483) + (4 \cdot (\text{am}[0]+\text{am}[1])) \cdot (\text{run}\leq483) \cdot \text{am}[4]+\text{am}[5]
\]
VETO vs KRATTA

(projectile fragmentation $\rightarrow \Delta E \sim AZ^2/E$)
KRATTA Z-resolution (1 mm Si+Csl)

\[ Z \sim \sqrt{\text{amplitude}} \]

Charge resolution at \( Z=54 \): FWHM=0.6
Prototype VETO Z-resolution
(1 mm BC404)

$Z \sim \sqrt{\text{amplitude}}$

charge resolution at $Z=54$: FWHM=1.3
KATANA 1.0
7+5 Multiplicity plastic bars (BC408, 10x40x1 cm³) with 2 3x3 mm² MPPCs (S12572-025P)

Power supply and 110/230V transformer for Trigger Box

Trigger Box with 20 discriminator channels and FPGA logic

3 Veto paddles (2 on the other side of the frame, BC404, 10x40x0.1 cm³) with 4 1x1 mm² MPPCs (S12571-010P) read out by BCF-92 WLS on top and bottom sides

24 DAC channels for remote control of the discriminator thresholds

Analogue adders, splitters and inverters

40-channel power supply (50-75 V with 10 mV precision) and 40 DAC channels for remote control of the MPPC bias
Middle VETO charge resolution

Run 2350: charge resolution $\sim \pm 1.6$ charge units
30 mV threshold corresponds to $Z \approx 22$
Stability

~ 1% drop / day
First 25 evts with $0 < \text{VETO ampl} < 5 \text{ mV}$
First 25 evts with $10 < \text{VETO ampl} < 15$ mV
First 25 evts with $25 < \text{VETO ampl} < 30 \text{ mV}$
Summary

- Charge resolution of the VETO paddle: about 2.9-3.9 charge units FWHM
- Amplitude drop of the central VETO: about 1% per day of the beam time
- Visible sensitivity of the VETO amplitude to the track multiplicity and, supposedly, to the centrality
KRATTA module
active elements

PD0, PD1, PD2 – HAMAMATSU PIN photodiodes for direct detection, 500 μm thickness
Opening: 3×3 cm²

Ions of beam velocity and Z~<15 punch through CsI1 (2.5 cm)
Sweep runs

The graph shows the relationship between sweep events and beam amplitude. The x-axis represents the event number, while the y-axis represents the average beam amplitude in mV. The graph is divided into sections labeled as "right," "middle," and "left." The graph also includes data points for sweep runs at 0 T and 0.5 T magnetic fields, with distances marked as 0 cm, ~5 cm, ~15 cm, and 22 cm.