Streak Camera & Gated Camera Lab Primer

Jeff Corbett[a], Alan Fisher[a], Walter Mok[a], Weixing Cheng[b]
[a] - *SLAC National Accelerator Laboratory*
b - Brookhaven National Laboratory

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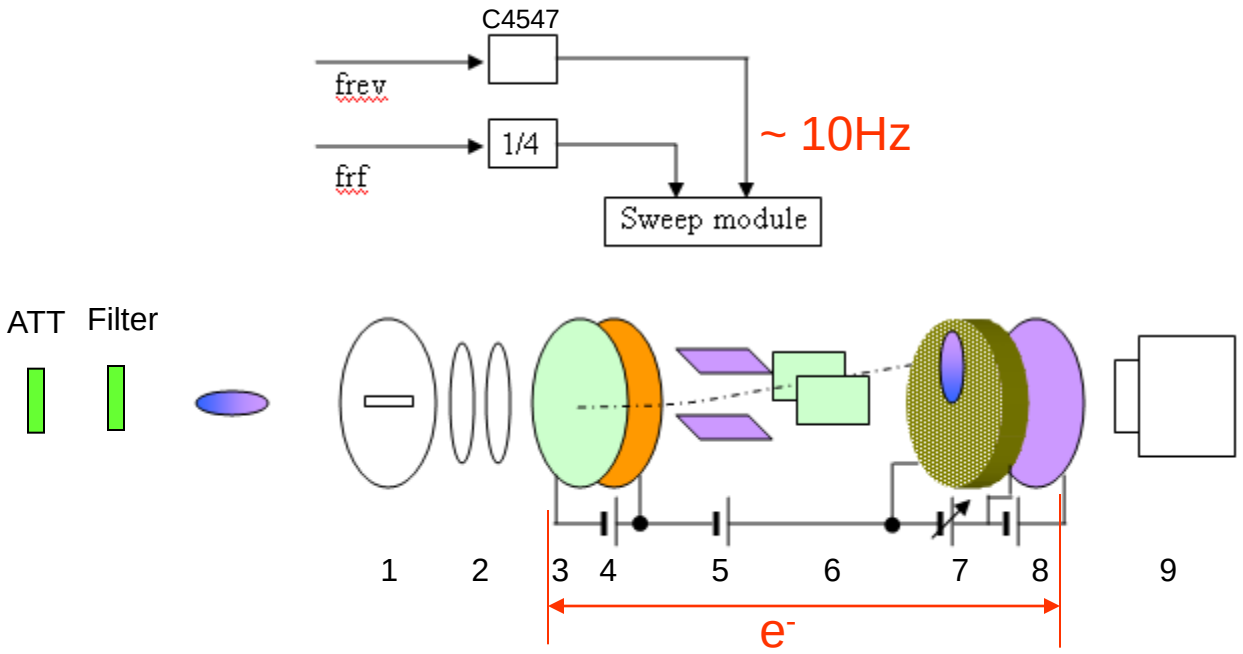
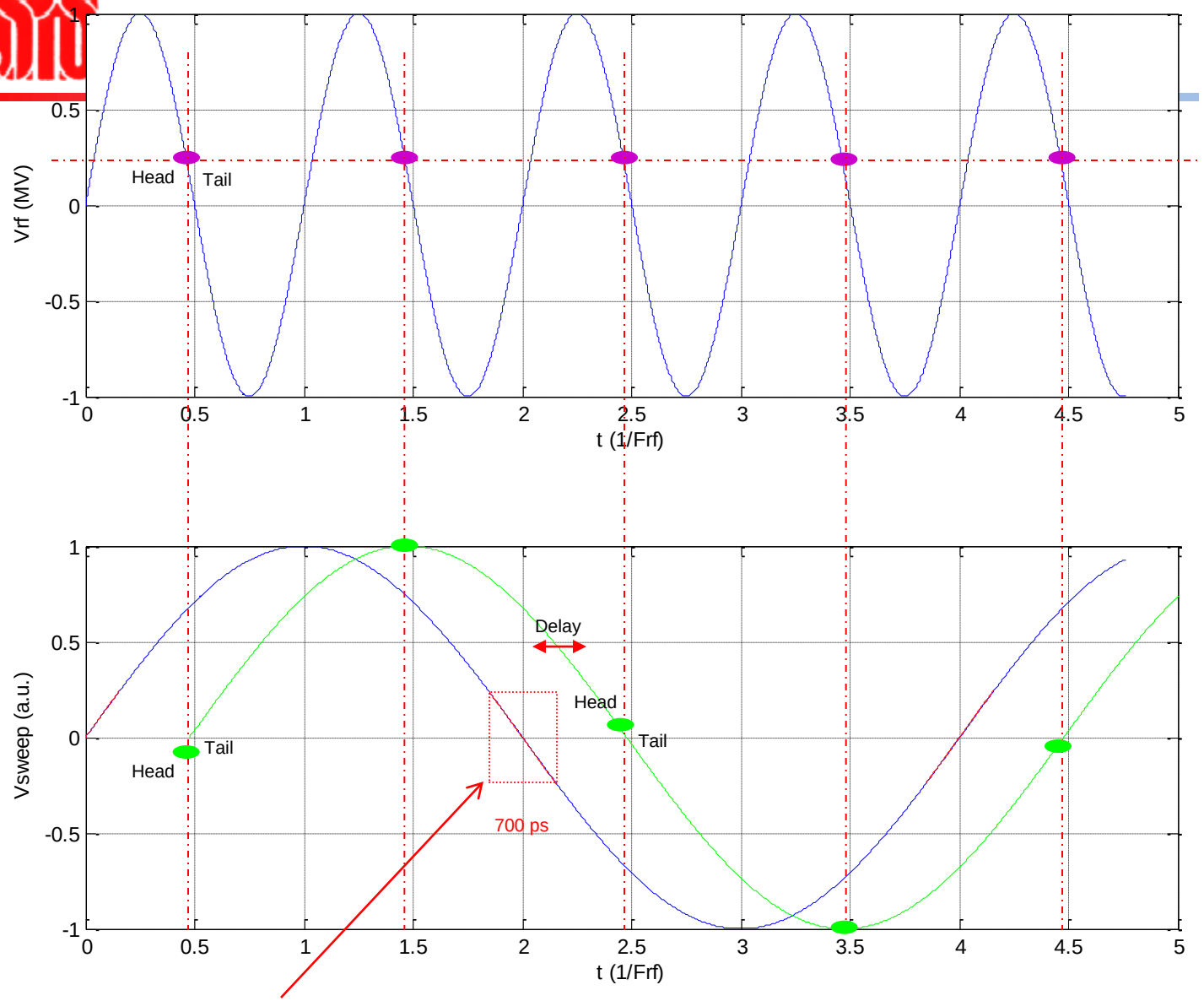
Streak Camera Principle



1 – slit; 2 – focus lens; 3 – photo cathode; 4 – accel. Mesh; 5 – vertical sweep; 6 – horizontal sweep; 7 – MCP; 8 – phosphor screen; 9 – CCD camera

Vertical sweep: $f_{RF}/4 = 119MHz$

Horizontal sweep trig: ~10Hz, lock to the revolution frequency



SPEAR3

RF=476MHz

h=372 (280 bunches, 2.1 ns space)

CCD camera

1344 * 1024 (H*V)

1280 * 1024

1024 * 1024

Streak camera sweeping signal, RF/4, delay adjustable

Red line is for time range 2 (0-700ps).

1. For blue sweeping signal, no bunches can be observed;
2. For green one, odd (or even) bunches can be observed on the screen.

Time range 1: 0-157.45ps

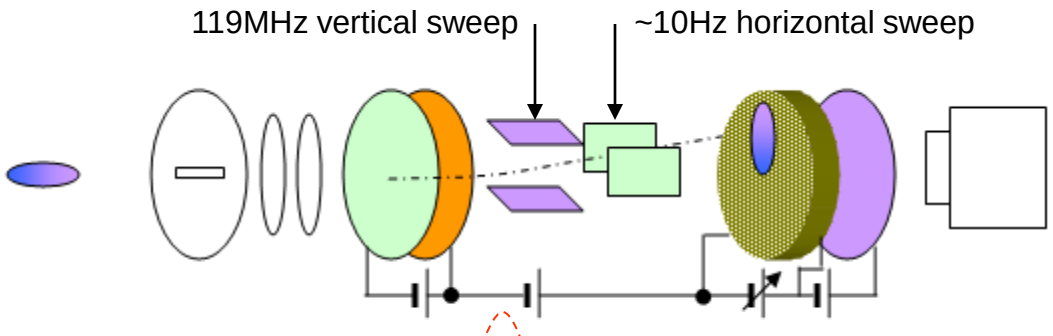
Time range 2: 0-704.41ps

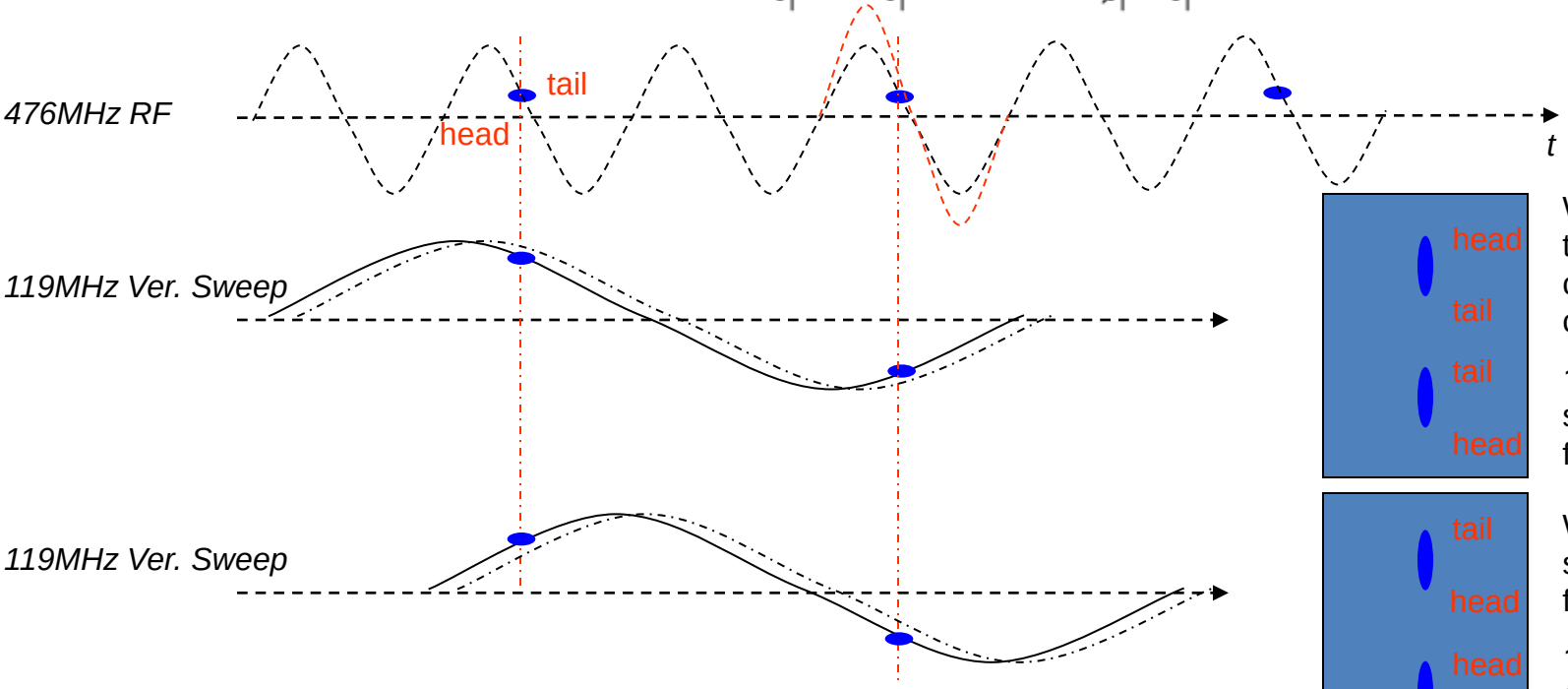
Time range 3: 0-1214.60ps

Time range 4: 0-1686.50ps

Red square shows time range 2 (~700ps full range)

Determine the head and tail





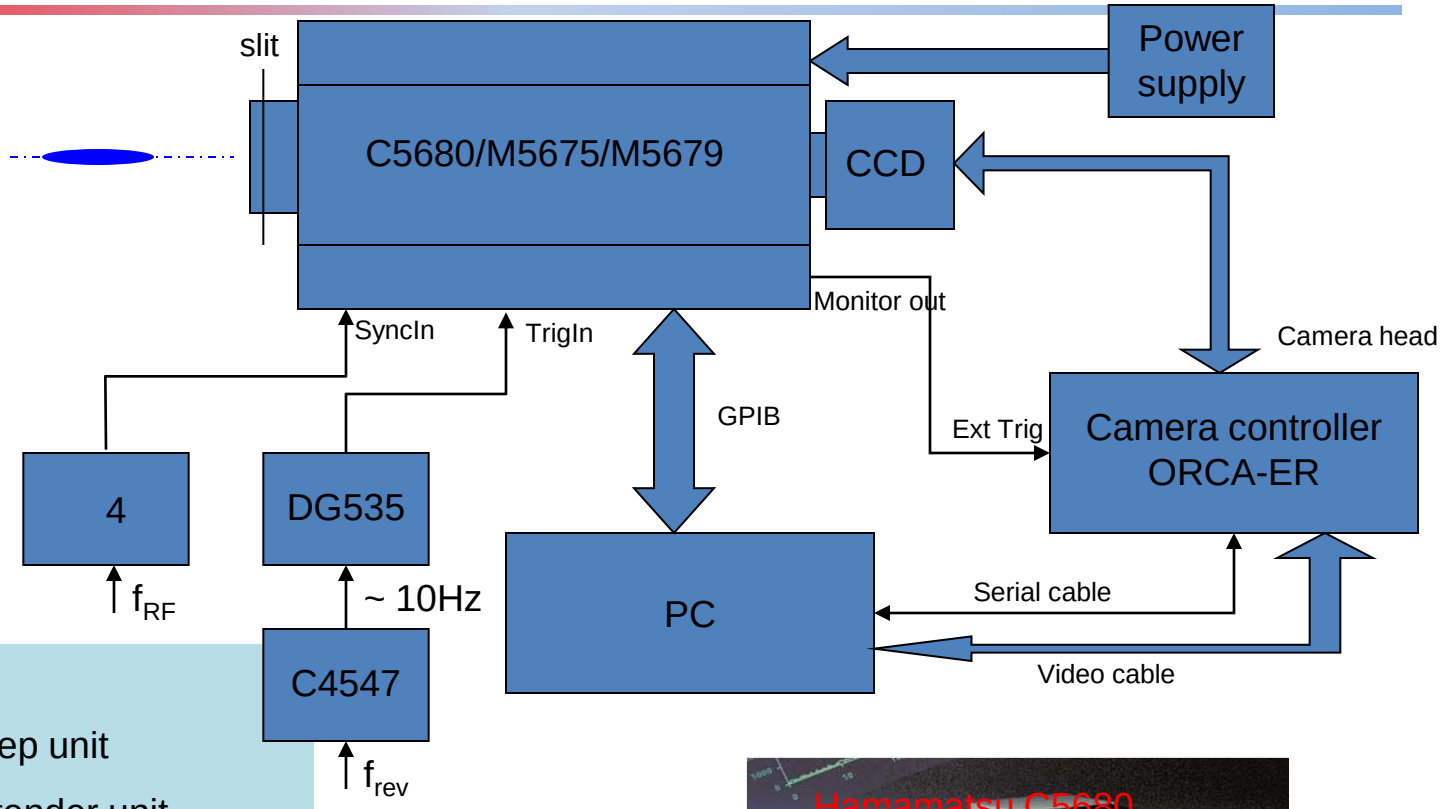
While $V_{rf}\uparrow$, $\varphi_s\uparrow$, two spot getting closer to the center;

119MHz delay↑, spots getting away from center

While $V_{rf}\uparrow$, $\varphi_s\uparrow$, two spot getting away from the center;

119MHz delay↑, spots getting closer to the center

Streak camera setup



C5680-21S Main unit

M5675 Synchroscan sweep unit

M5679 Dual timebase extender unit

C4742-95-12ER digital camera

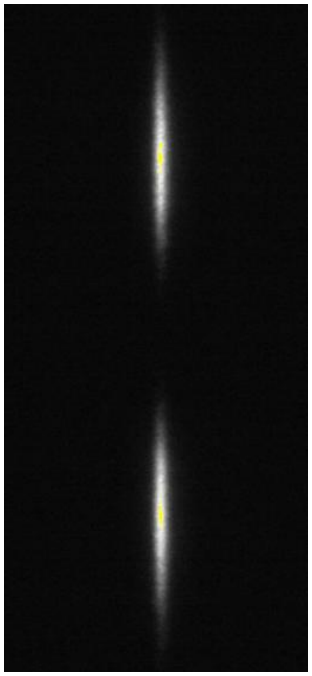
C4547 Streak trigger unit

ORCA-ER camera controller

Power supply unit

DG535 Digital delay/pulse generator

Streak camera examples

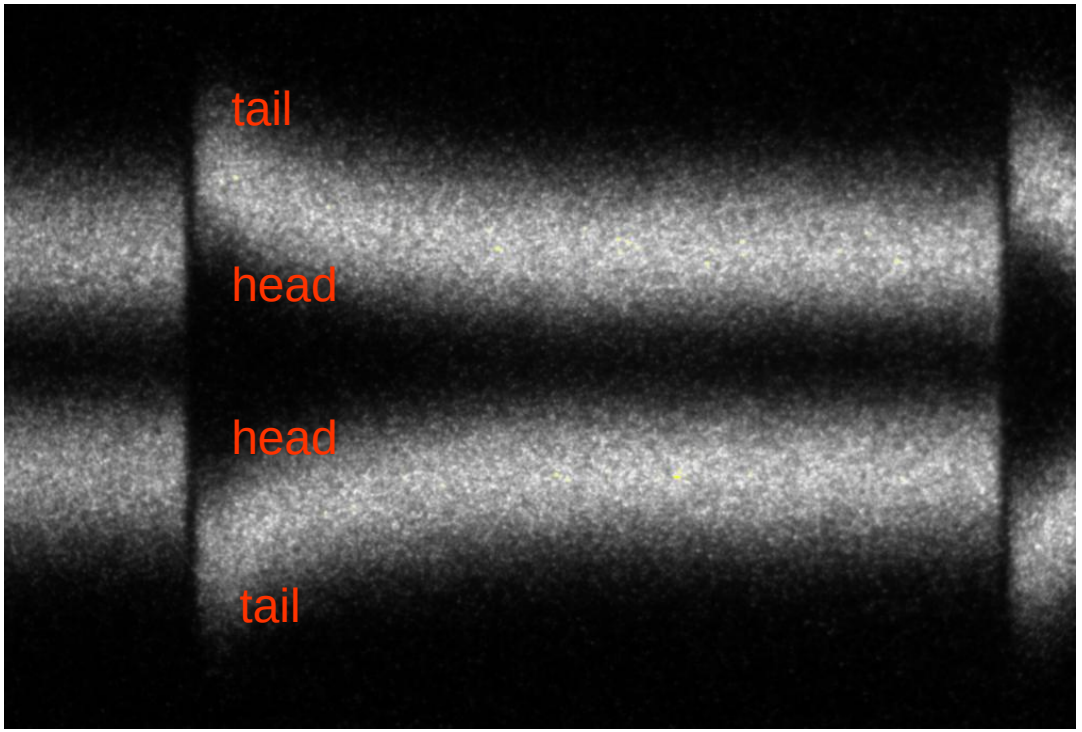


Synchroscan

Trev = **7.336 us**;

CCD exposure time = **120ms**;

About **16358 turns** sweeping for one frame of picture



DualSweep

Horizontal scale 10us

Streak camera applications

- Bunch length vs. single bunch current Ib; => Im{Z//}, imaginary part of ring broadband impedance
- Synchronous phase vs. single bunch current Ib; => Re{Z//}, real part of ring broadband impedance
- Microwave instability threshold (together with CCD measure sigma_x at dispersion);
- Bunch length and synchronous phase with harmonic cavities;
- Longitudinal instability measurement; (coupled bunch instabilities)
- Synchronous phase transient in the bunch train due to RF cavities beam loading; (with external GATE or dual sweep)
- Injection transient measurement, help to optimize the injecting beam phase and energy => important for top-off; (to see the injecting beam only with not so many stored beam, need to kick the beam out after ~50ms after injection using bunch purification system)
- Transverse motion using cylindrical lens setup;
- Other measurement during machine study, especially RF cavity related.
- Booster measurements

Streak camera Lab

- Don’t have the $200,000 camera here
- Hamamatsu HPDP-TA 8.1.0 software
- Stored streak camera images
- “Focus mode”, “Synchroscan mode”, “Dual sweep mode”
- Gaussian fit using Matlab
- Streak camera calibration using Etalon
- Resolution
- Bunch length vs. current => impedance

Gated camera

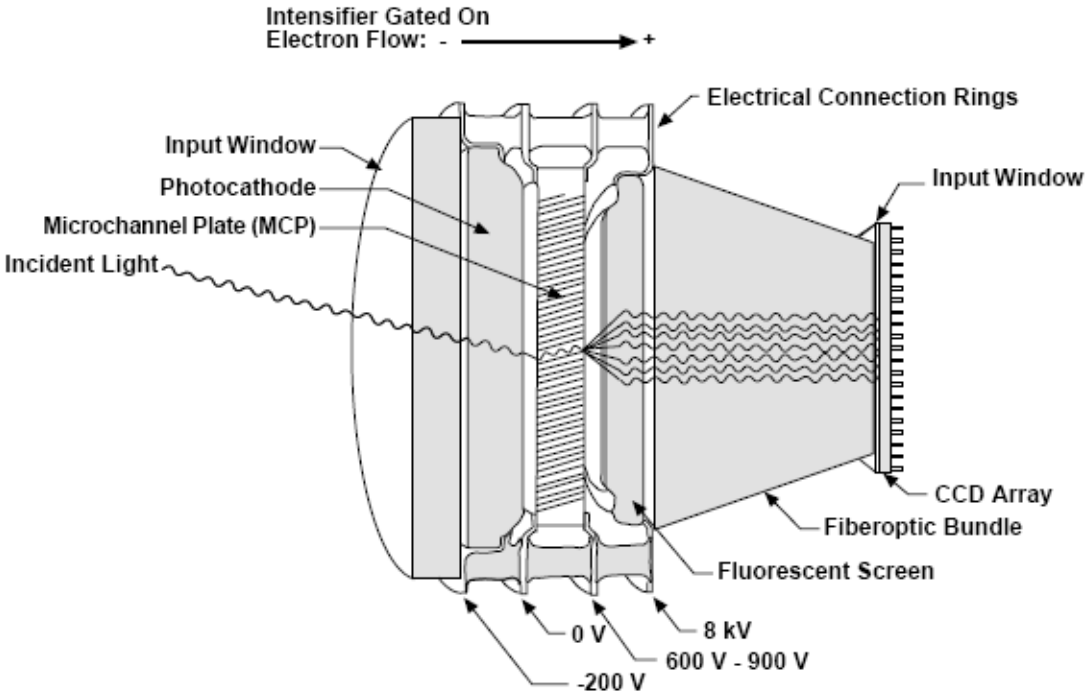
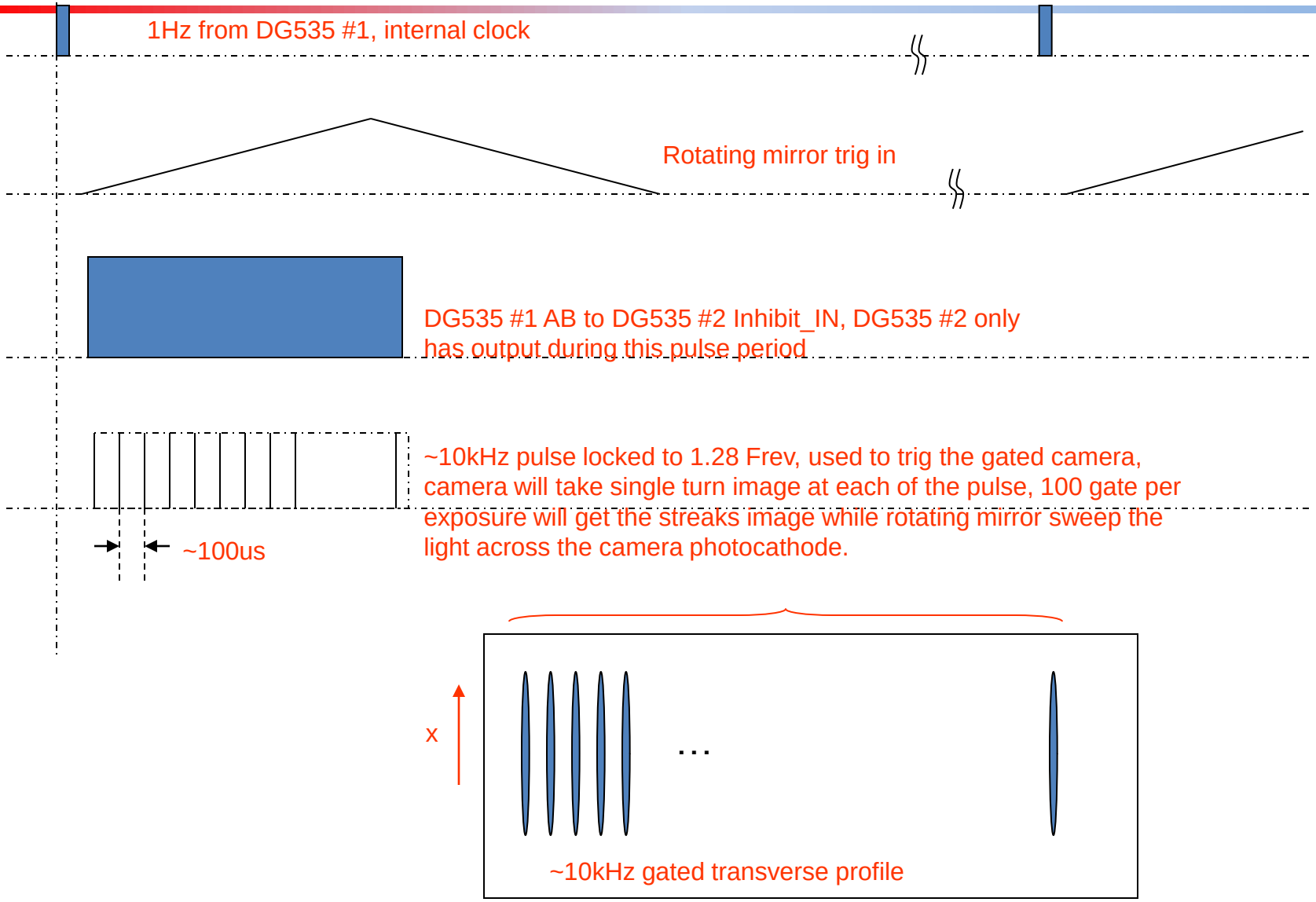


Figure 2. Major Components of the Intensifier-CCD

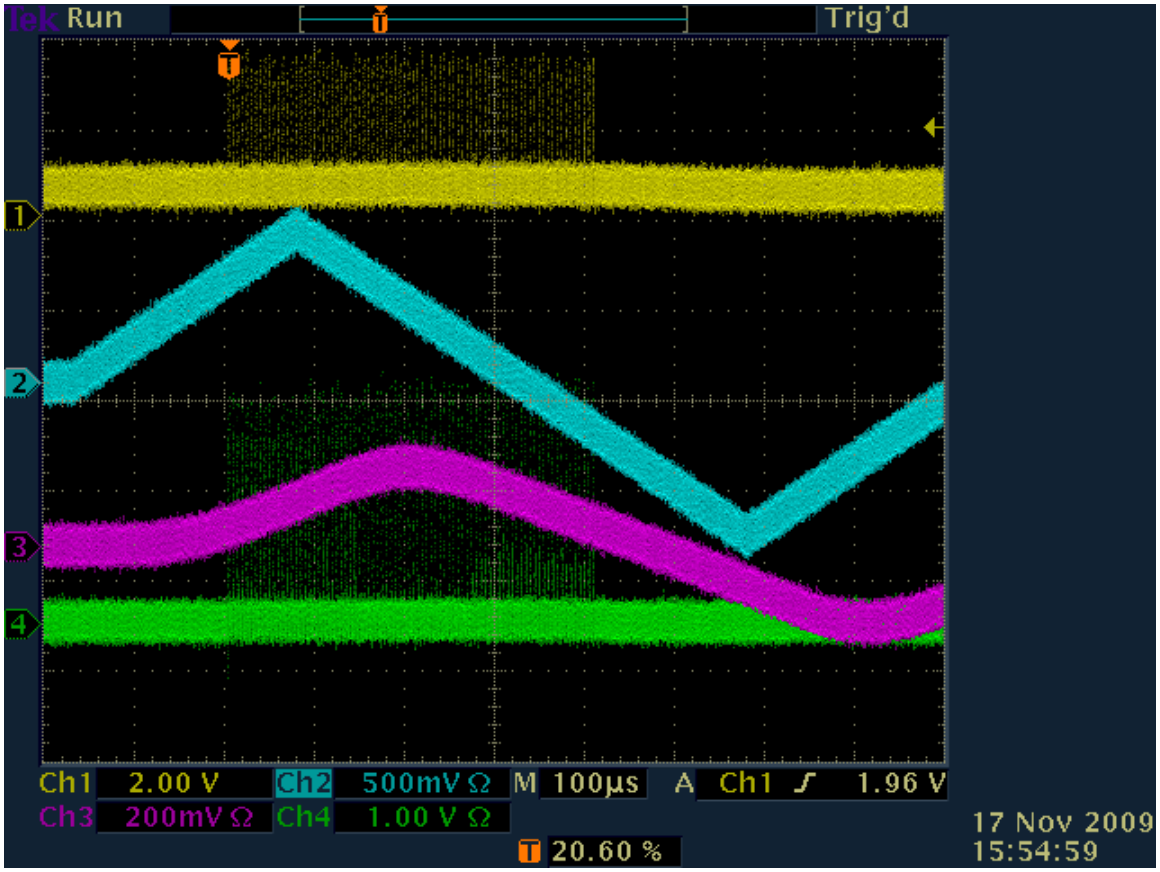
Photo Cathode + accelerate mesh + MCP + phosphor screen + CCD (1024*1024)

Roper/PiMax

Gated Camera Timing



Gated Camera Timing



CH1 LED drive signal, 200kHz repetition rate, 15ns minimum

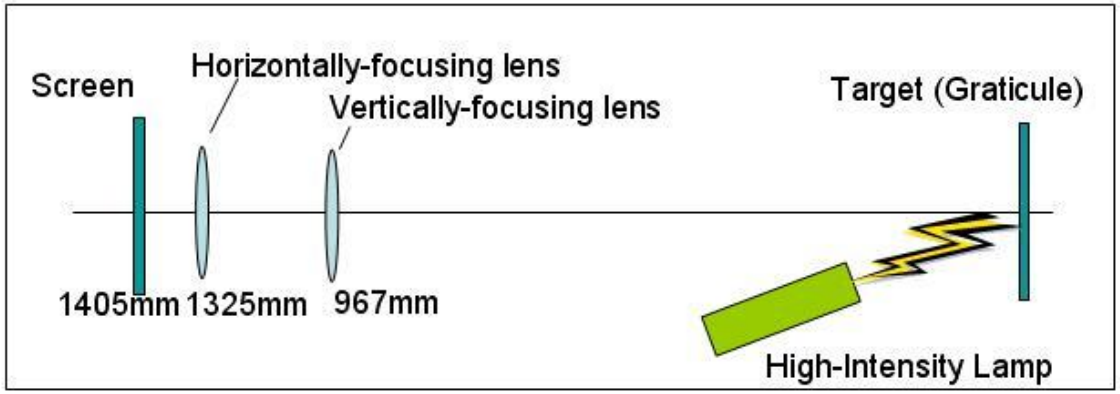
CH2 Rotating mirror drive signal from DS345, triangle waveform/burst once/Phase 270 deg

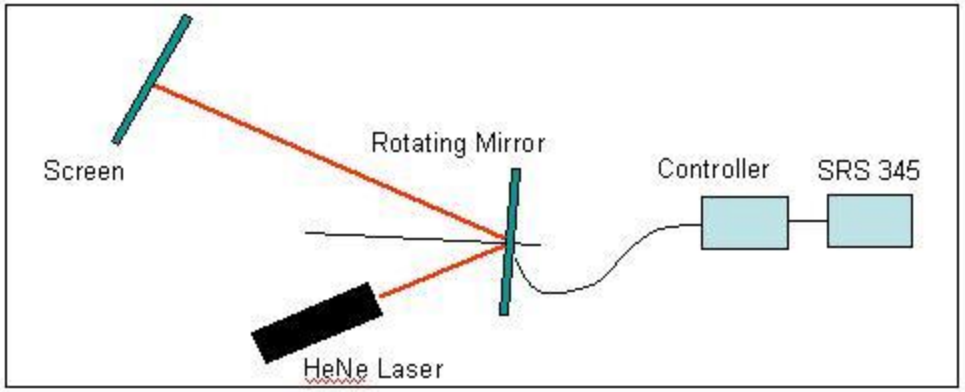
CH3 Read back from the rotating mirror controller, that's the real rotating signal

CH4 Gate to PiMax camera

Gated camera lab

- Group 1
  - Cylindrical lens, make a tall image
  - Rotating mirror





Gated camera lab

- Group 2
  - Timing for the Gated camera, rotating mirror and LED