The Optical Dissector Bunch Length Measurements at the Metrology Light Source

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Outline

Introduction

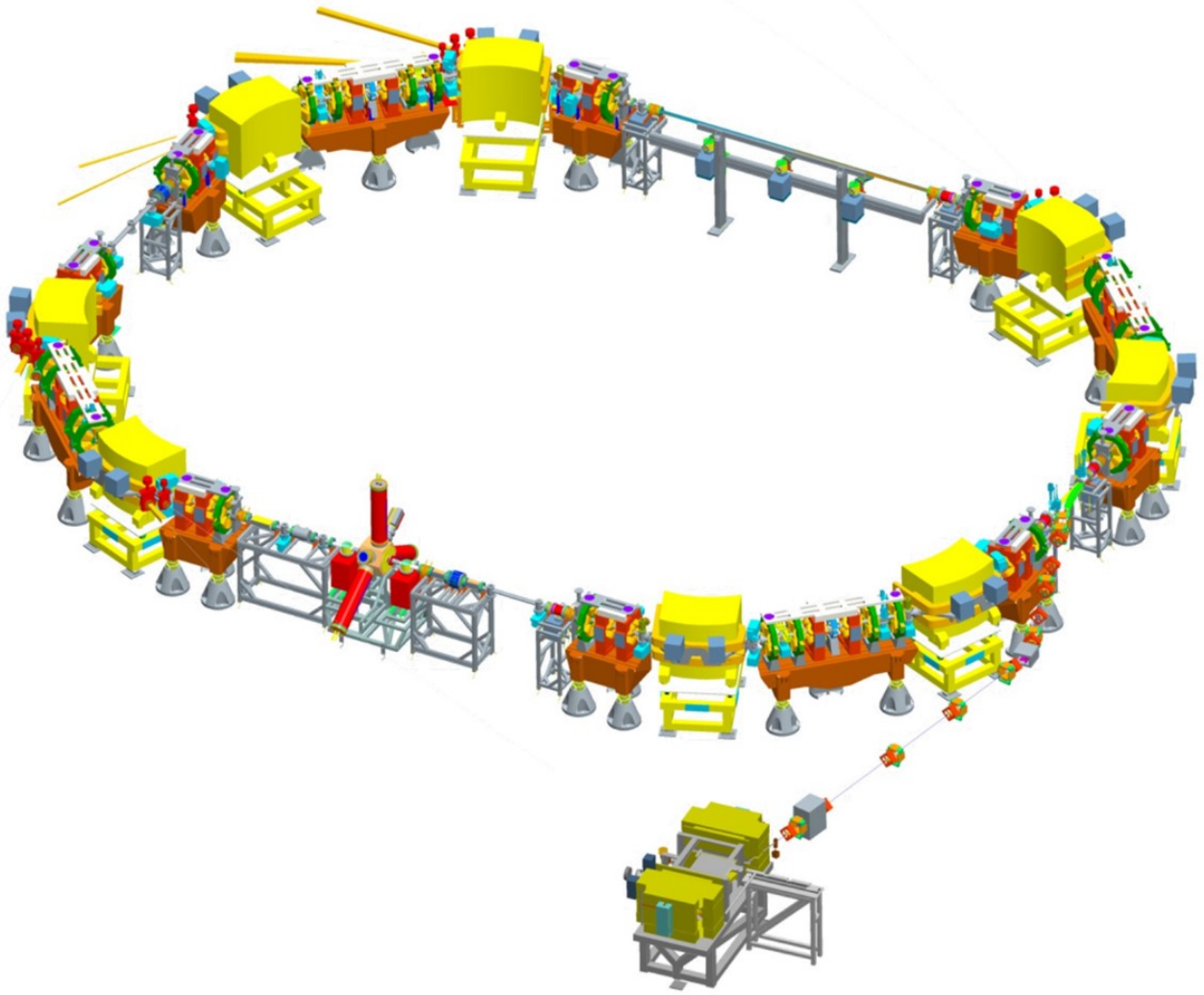
- Metrology Light Source
- Streak camera vs Dissector

Dissector installation at MLS

Measurement results

Summary and outlook

Metrology Light Source (MLS) at PTB



The Physikalisch-Technische Bundesanstalt (PTB), Germany's national metrology institute, is using synchrotron radiation for metrology and related applications for research and industry.

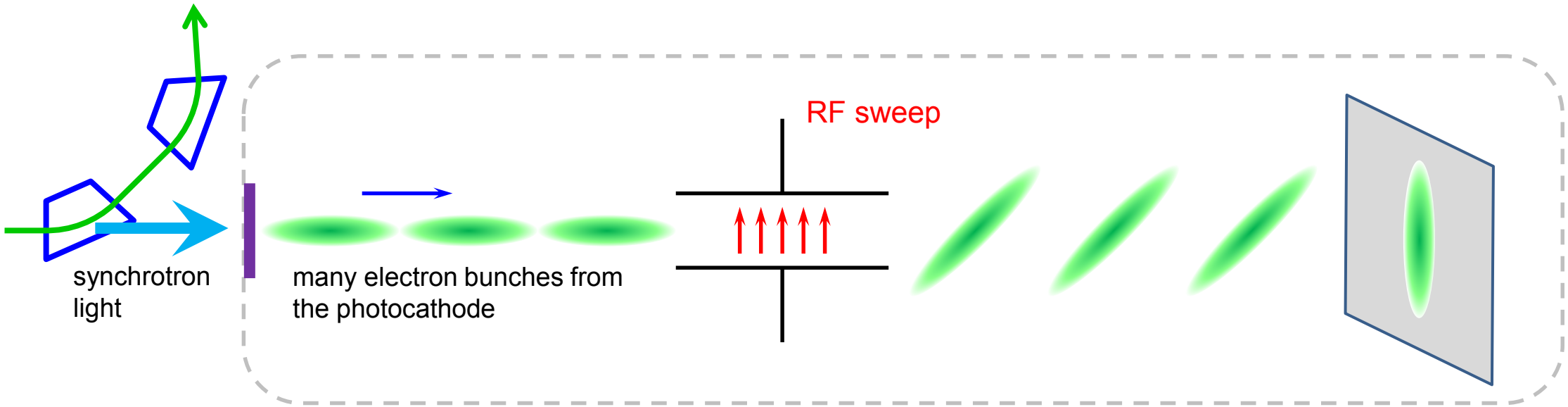
The MLS offers capabilities for accurate measurements and calibrations in the spectral ranges from the THz to the extreme ultraviolet (EUV).

Different optics schemes allows the bunch length manipulations.

MLS main parameters:

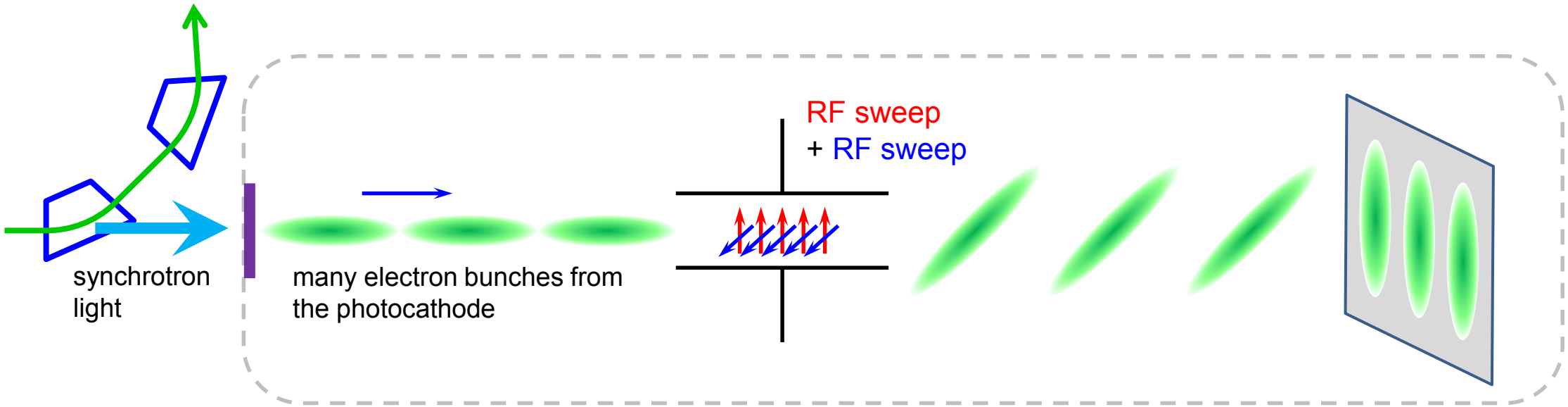
Electron energy	105 → 630 MeV
Revolution frequency	6.25 MHz
RF frequency	500 MHz
Number of bunches	80
Current (charge/bunch)	~200 mA (0.4 nC) down to a single e^-

Streak camera: How does it work?

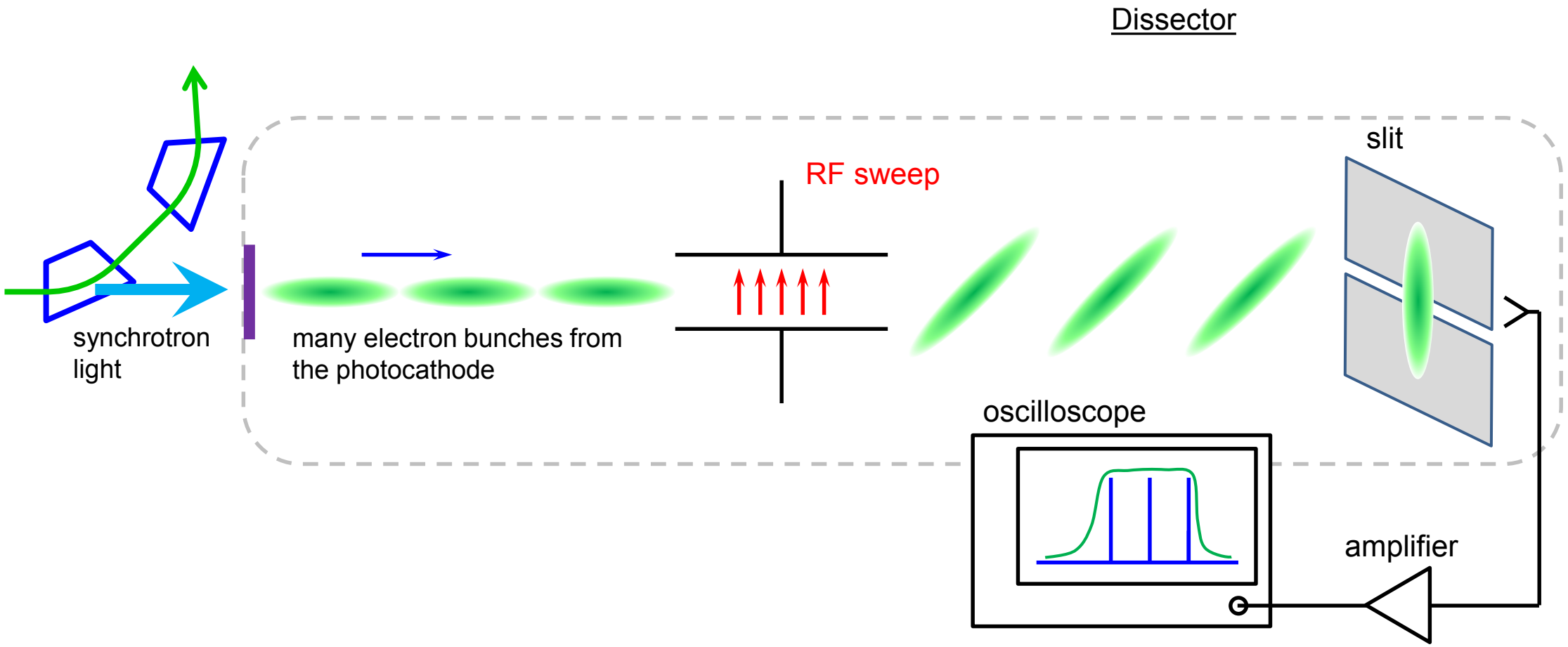


Streak camera: How does it work?

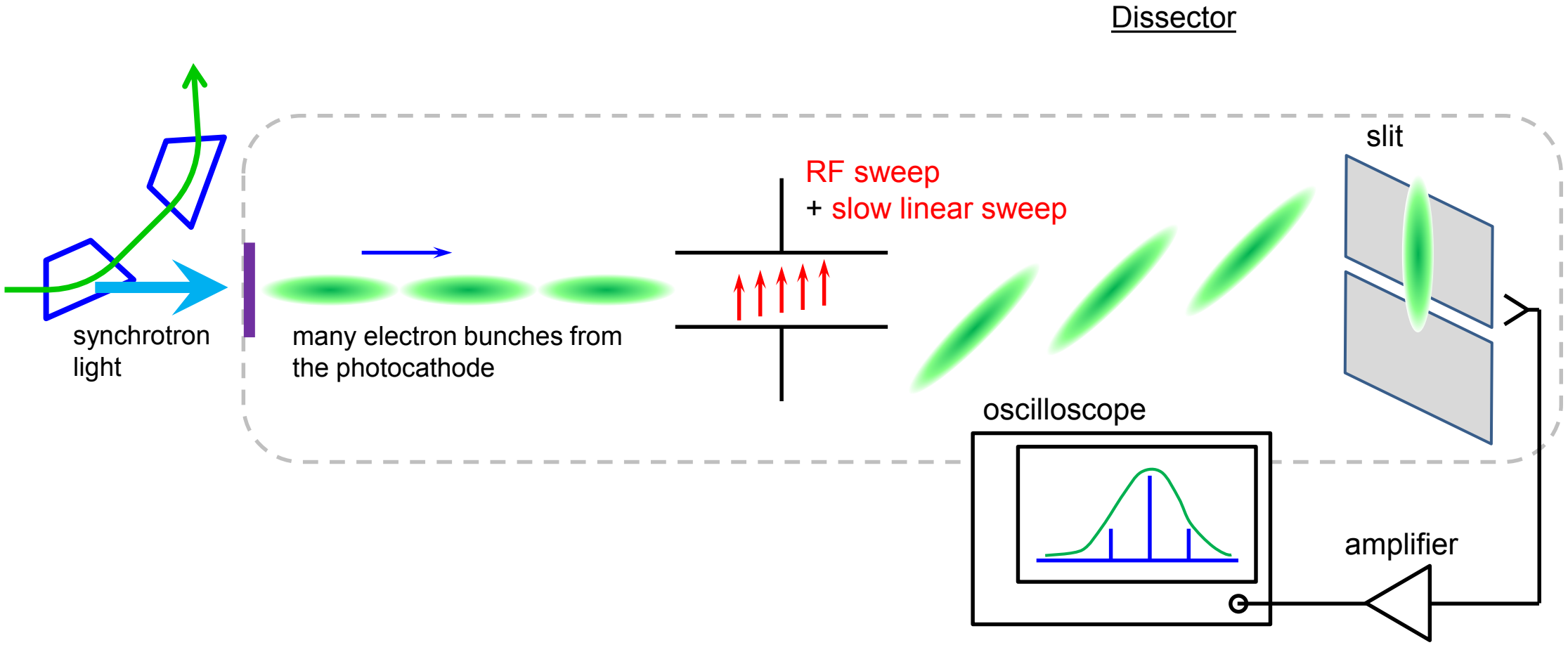
Streak camera, dual sweep



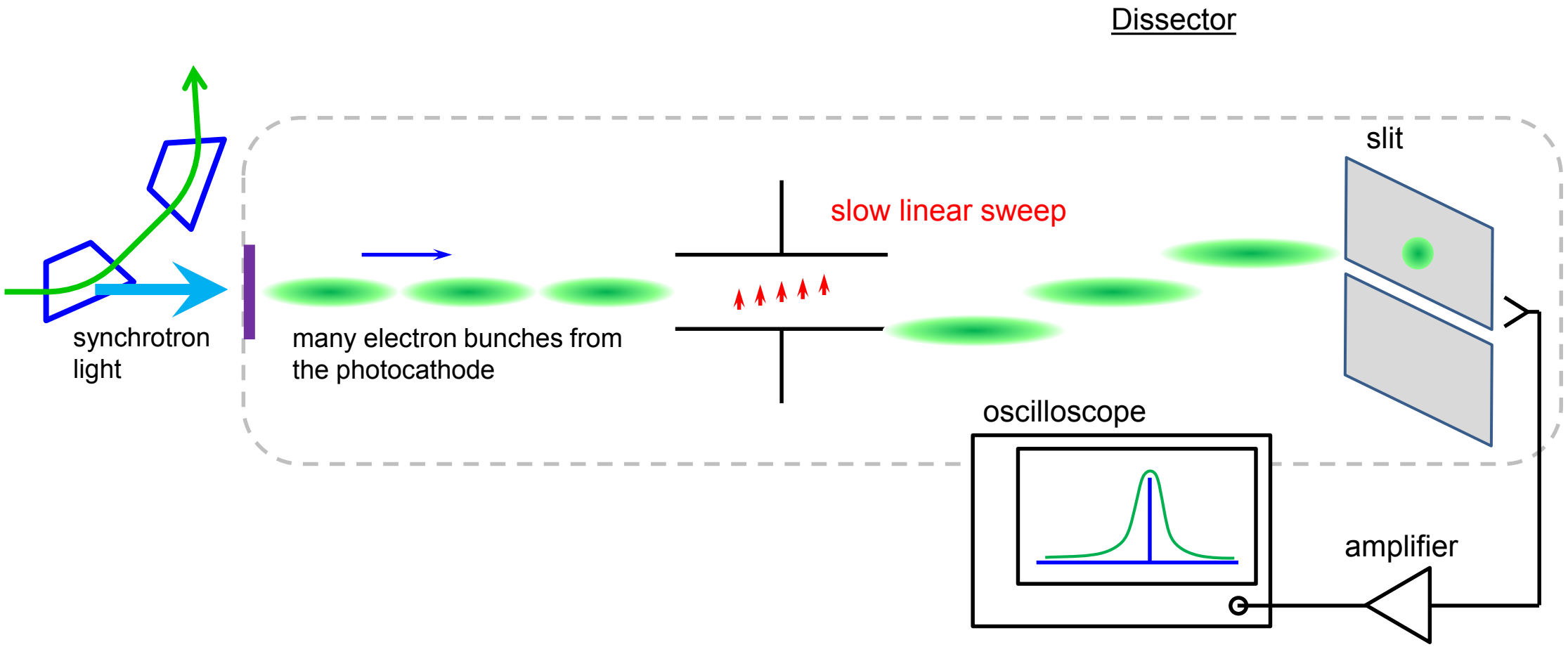
Dissector: How does it work?



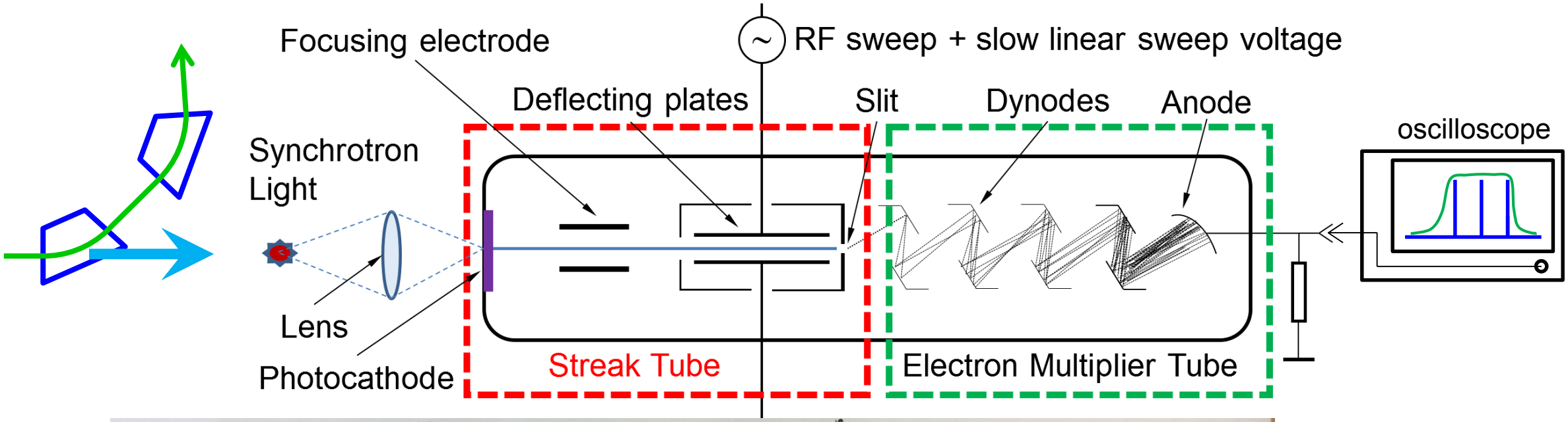
Dissector: How does it work?

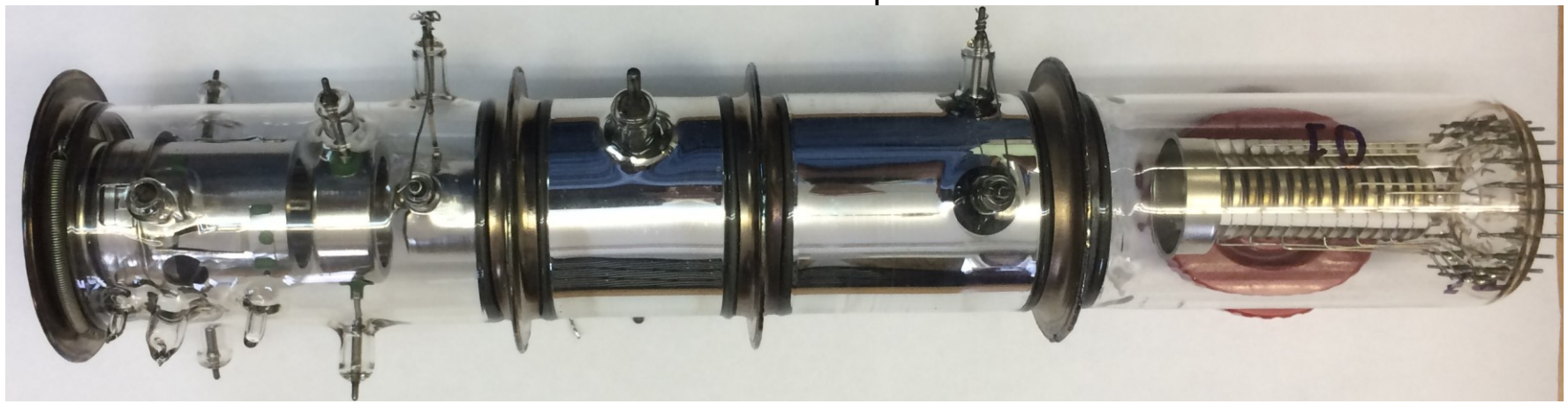


Dissector: How does it work?



Streak Camera → Dissector





~40 cm

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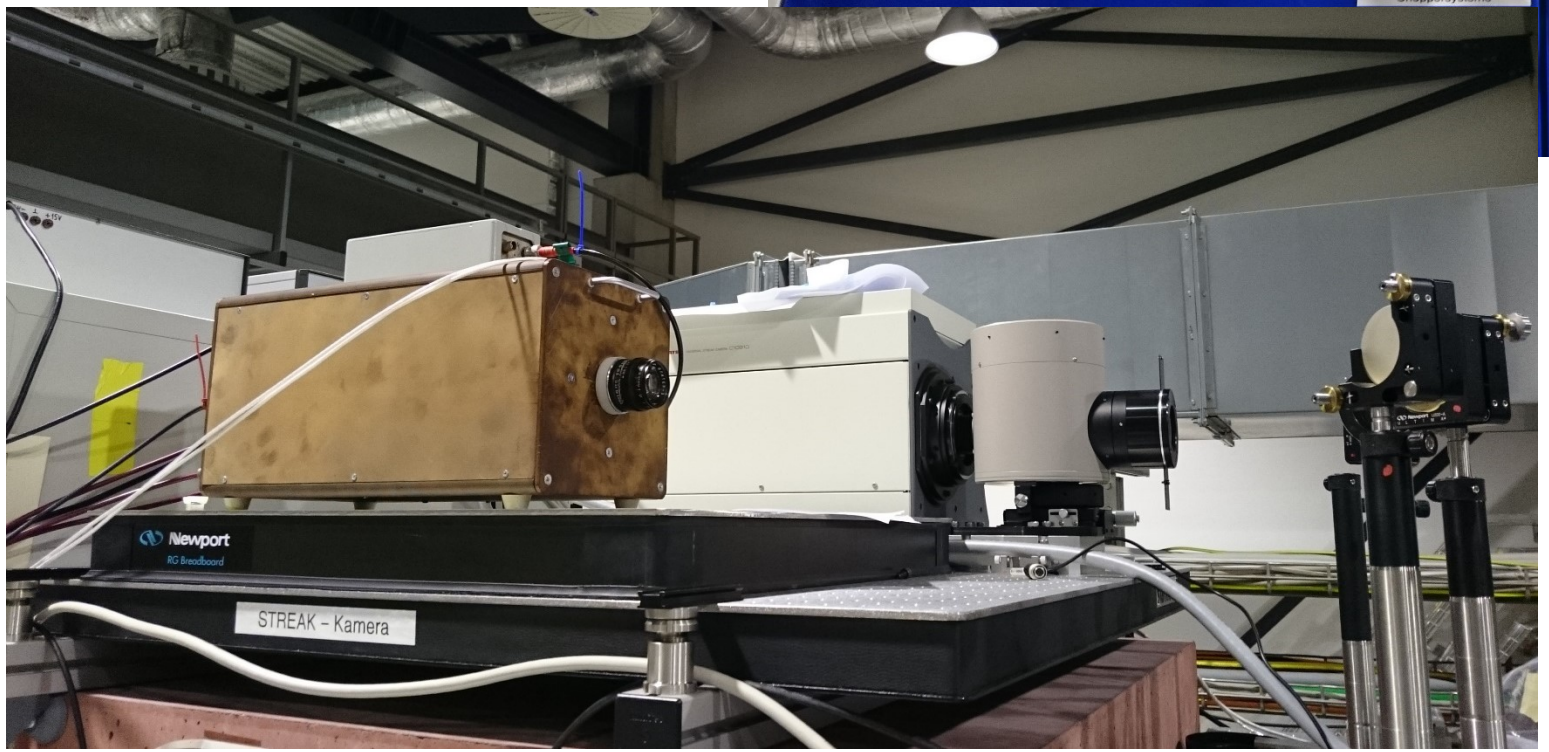
Installation at MLS

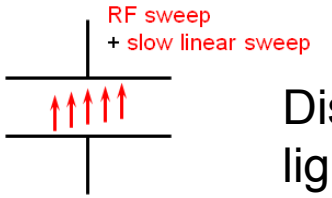
Dissector electronics:
- RF power supply,
- high voltage power supply



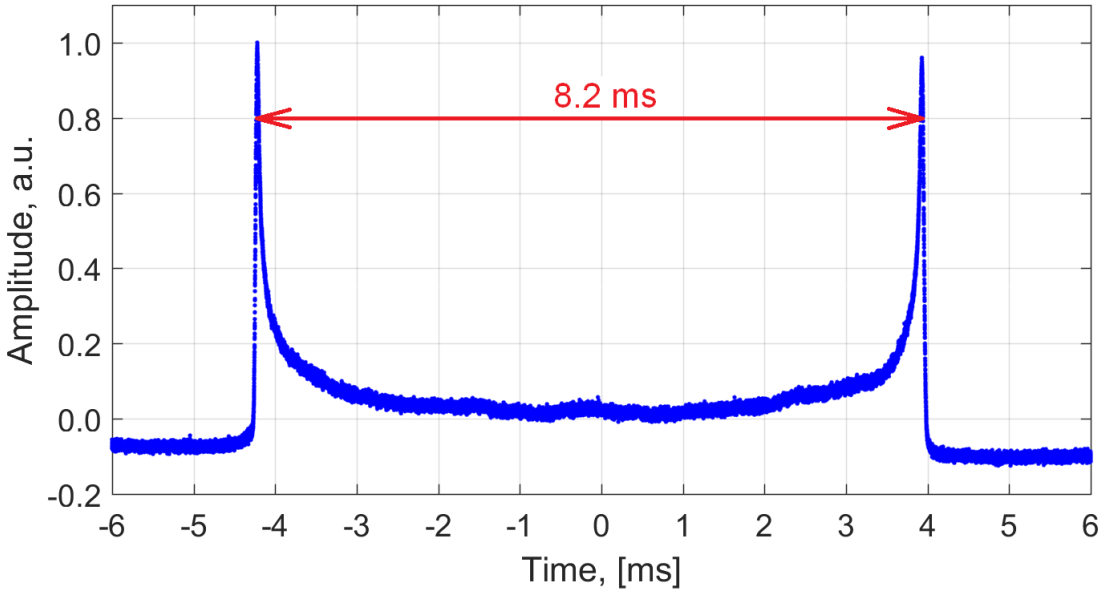
Dissector and streak camera at the MLS:

Synchrotron light is shared between both devices by a mirror edge.

Dissector calibration and point spread function



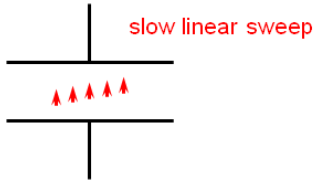
Dissector response to a permanent light source like a flashlight:

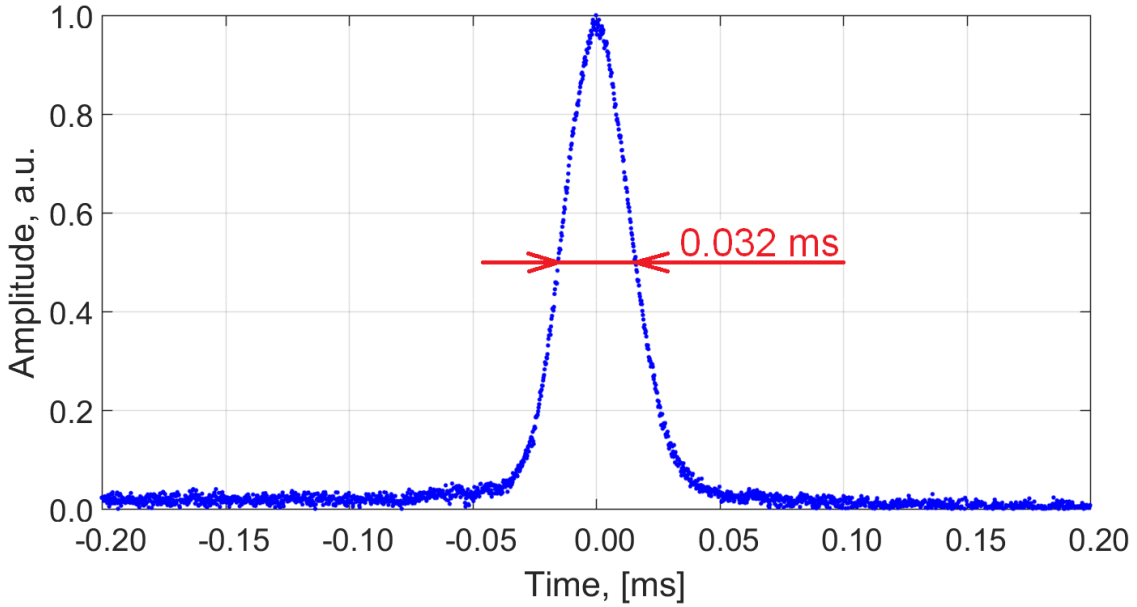


8.2 ms corresponds to the time distance for the photo electrons of about 5.3 ns (a half of a period of the dissector RF sweep).

$$\text{scale} = 10^3 \frac{2 \cdot 5.3}{\pi \cdot 8.2} = 416 \frac{ps}{ms}$$

Switching off the RF sweep one can get a point spread function of the device (now with syn. light):

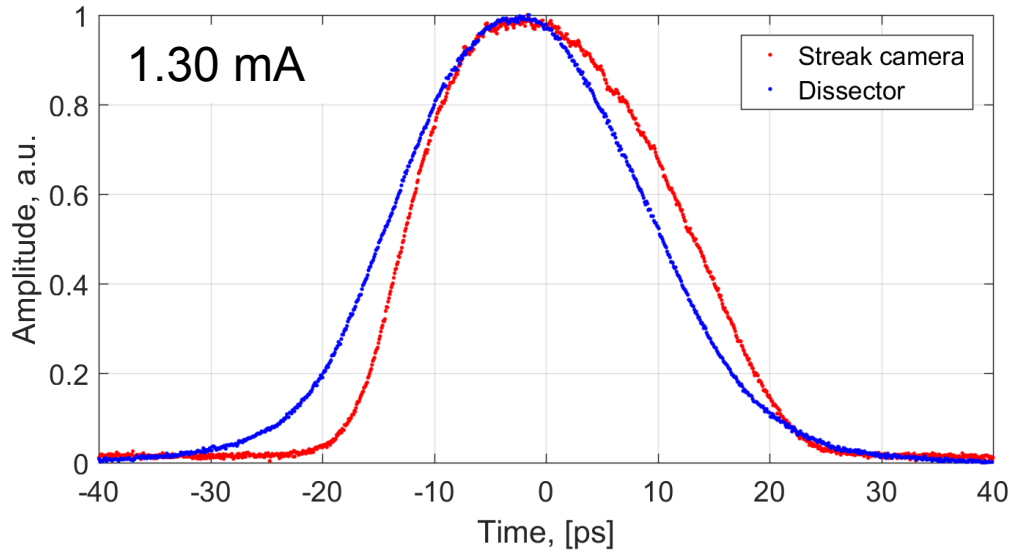


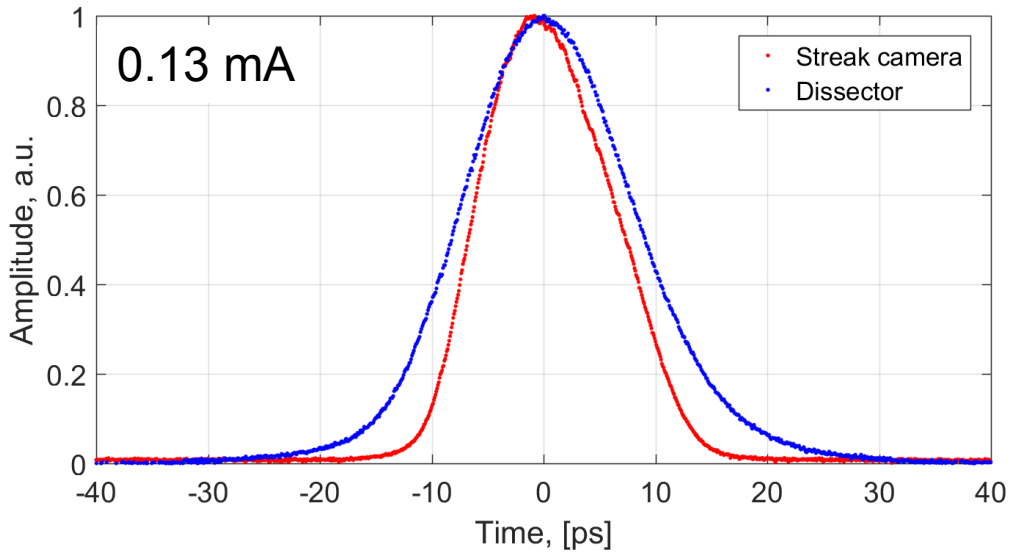


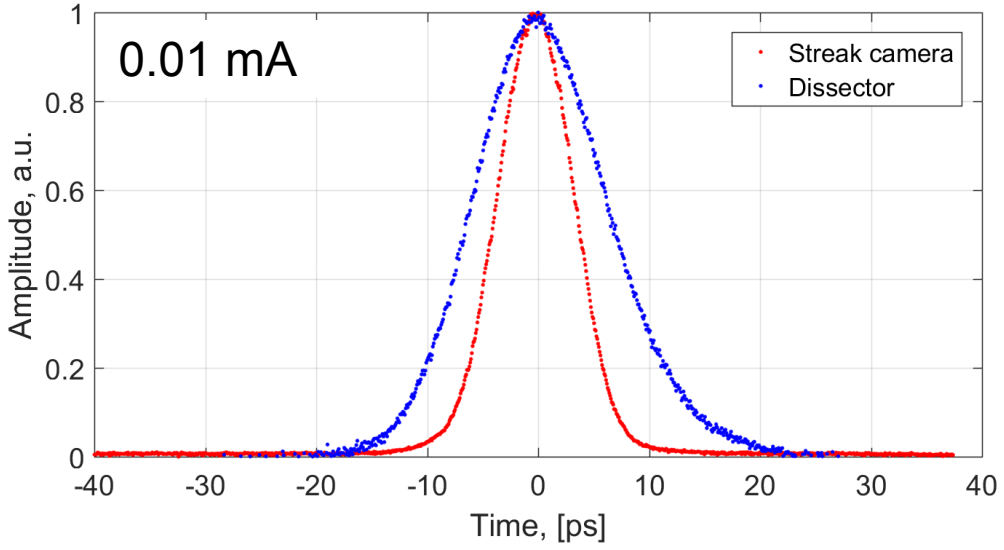
0.032 ms → 13.4 ps – dissector “zero” bunch length

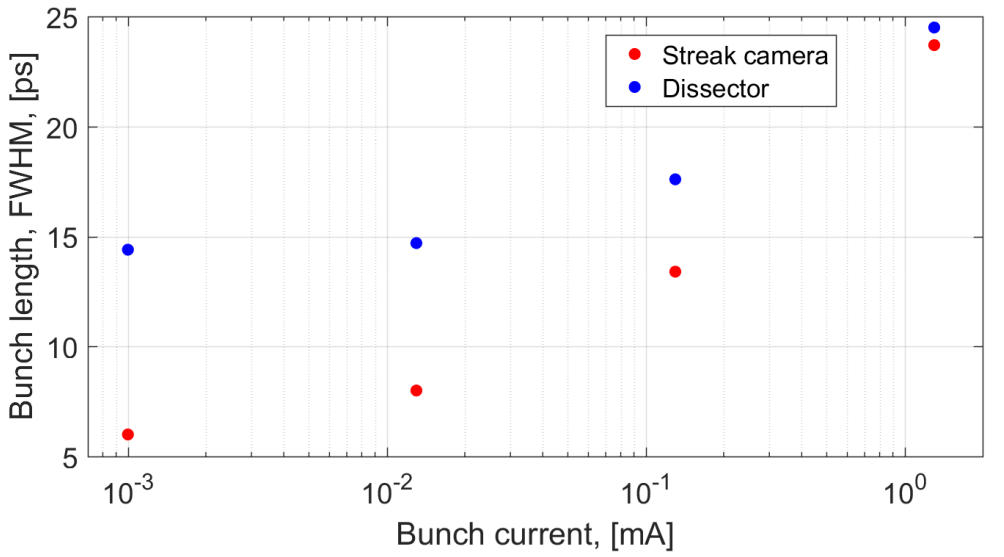
Streak camera vs Dissector, bunch current profiles

Low alpha user optics at MLS



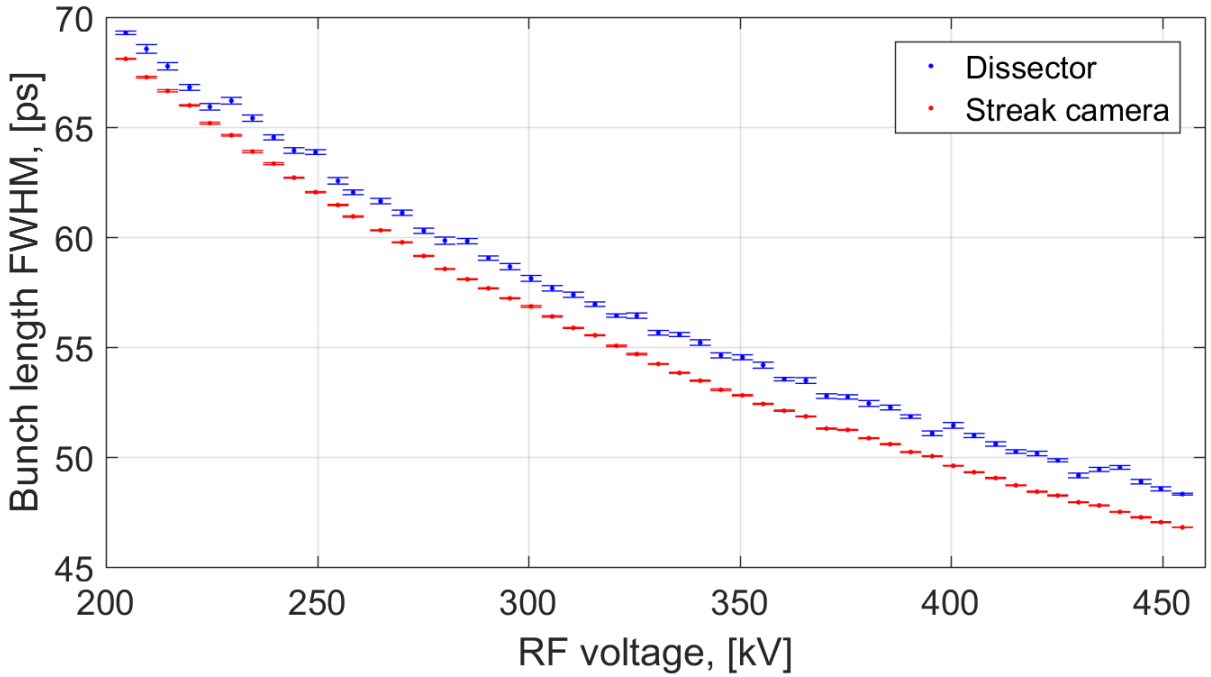




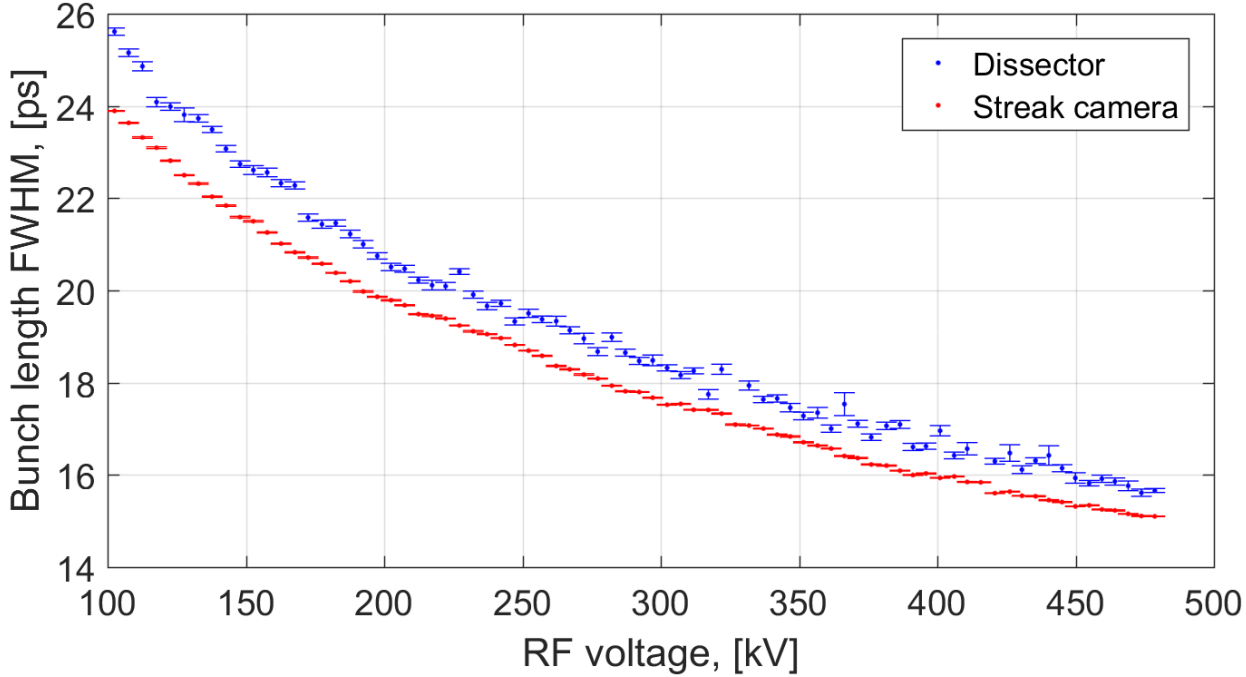


Streak camera vs Dissector, bunch length

Standard user optics of MLS, 0.9 mA (144 pC)



Low alpha user optics of MLS, 0.3 mA (48 pC)



Point spread function of the streak camera ~2.4 ps and for dissector ~13 ps FWHM.

Summary and Outlook

- Results of the dissector measurements are comparable with the streak camera measurements, but the resolution is worse.
- The measured bunch lengths are in good agreement for the range from 70 ps down to 15 ps (point spread function needs to be taken into account).
- Simple and radiation hard device in contrast to the streak camera.
- One of the possible applications: installation at the BESSY II booster to control the bunch length during the energy ramp (see poster today TUPCC06).
- Can be use as a permanent running device for the bunch length monitoring.
- Next steps will be to perform a comparison of the devices to even shorter bunches down to 1 ps.

Thank you!!!