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START DETECTOR FOR TIME-RESOLVED HIGH ENERGY IONOLUMINESCENCE EXPERIMENTS

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Outline

- Motivation
- I. Time-integrated high energy ionoluminescence
- II. Time-resolved ionoluminescence measurements (τ-IL)
- III. New approach in single ion induced τ-IL experiments
- IV. Dense excitation effects in high energy ionoluminescence of Al_2O_3
- Conclusions

Motivation

- Ion beam induced luminescence: real-time measurements of spectral composition and emission intensities during ion irradiation.

1. Time-integrated ionoluminescence;

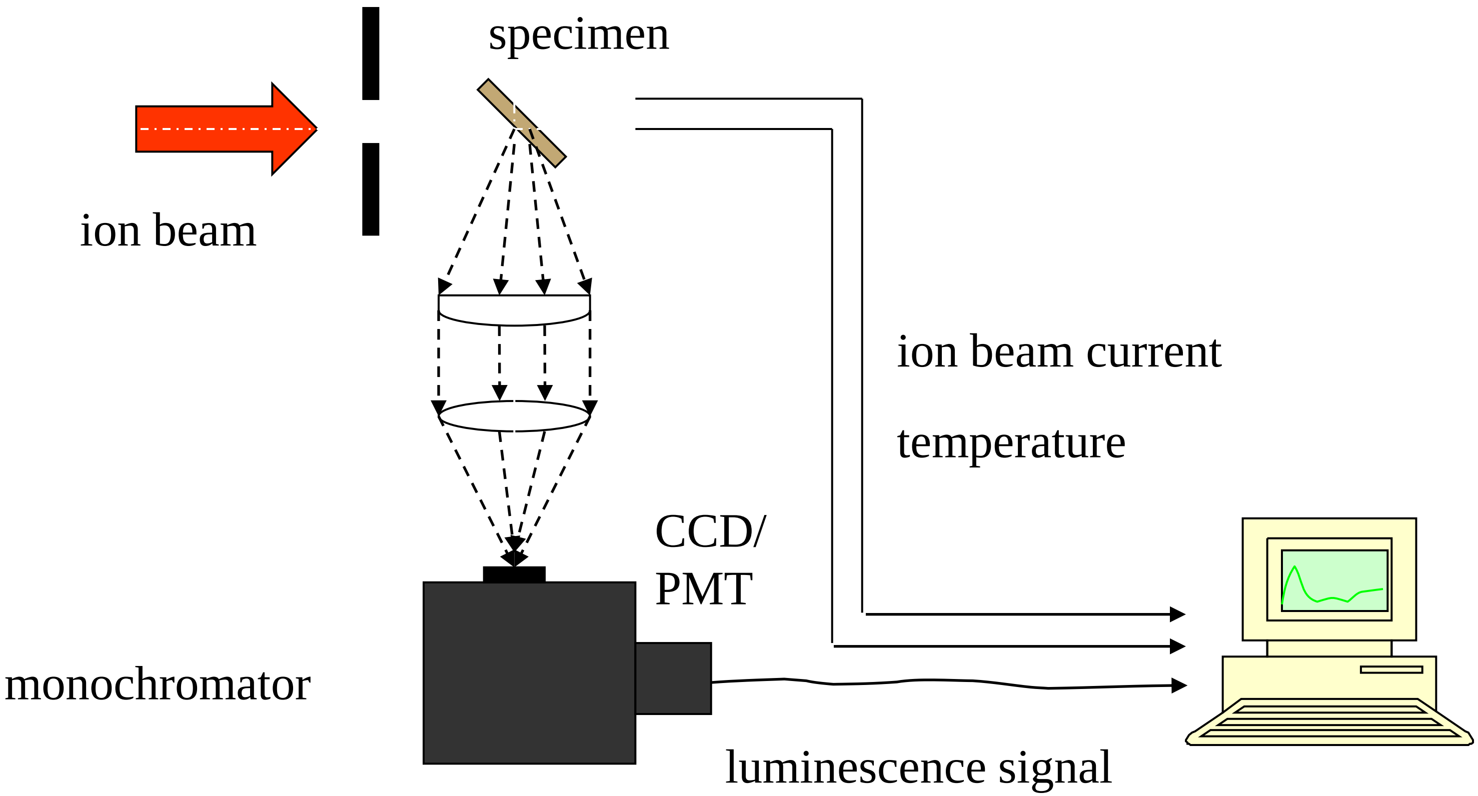
2. Single ion induced time-resolved luminescence.

Time-integrated ionoluminescence:

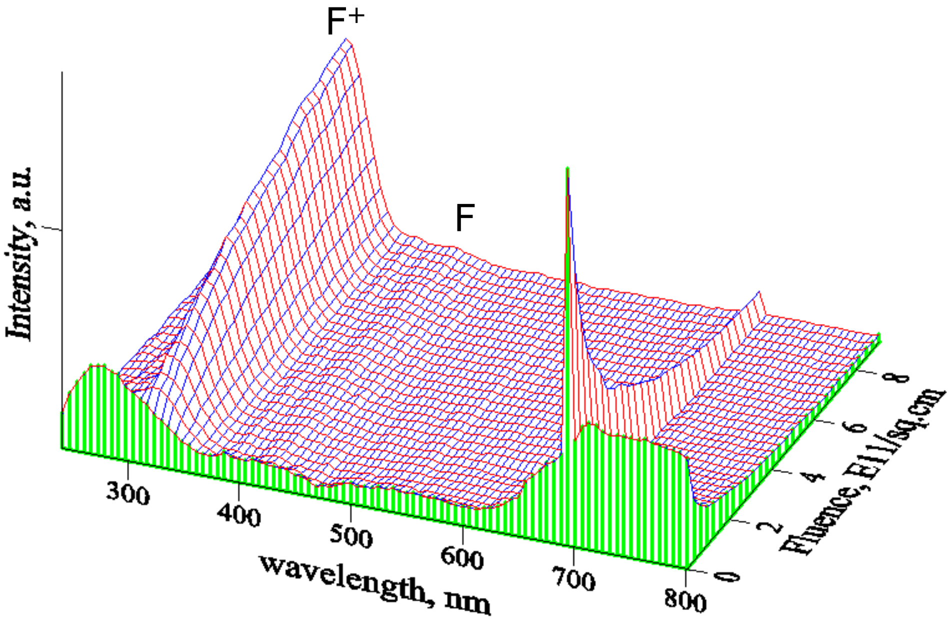
- Real-time data on accumulation of radiation damage and associated mechanical stresses vs irradiation parameters (ion type and energy, ion fluence, irradiation temperature).

- **I. Time-integrated high energy ionoluminescence**

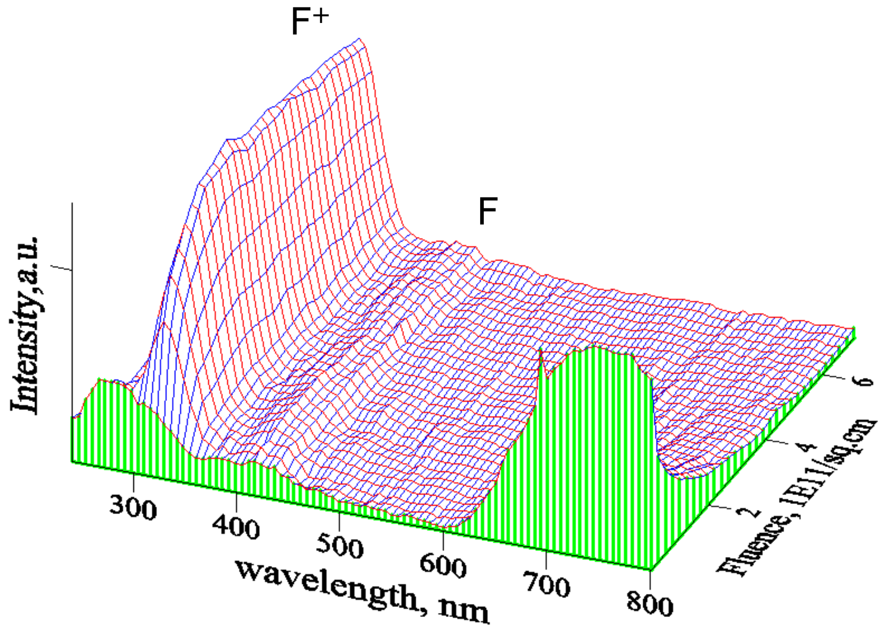
Block diagram for time integrated ionoluminescence measurements



- **I. Time-integrated high energy ionoluminescence of Al_2O_3**



Kr (245 MeV), 300 K



Bi (710 MeV), 300 K

F^+ center – oxygen vacancy + e^-

F center – oxygen vacancy + $2e^-$

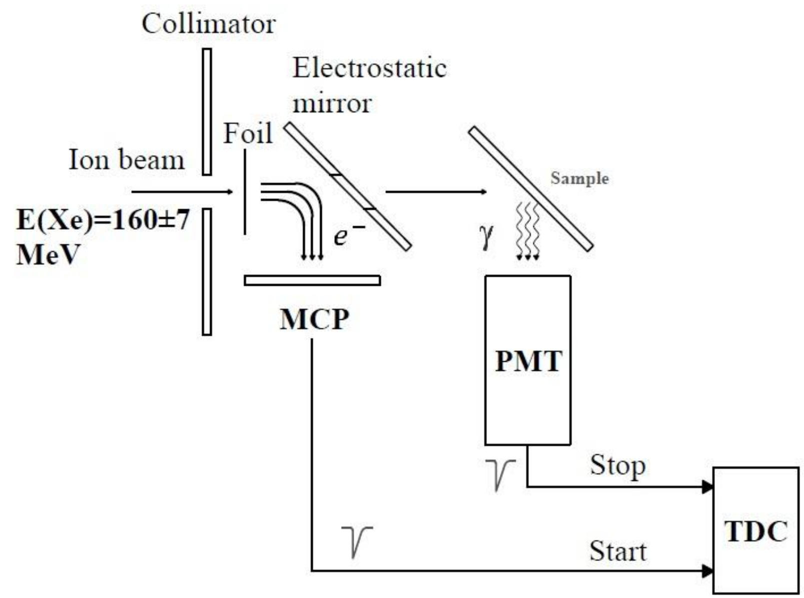
V.A. Skuratov et al. / Nucl. Instr. and Meth. in Phys. Res. B 245 (2006) 194–200

Single ion induced time-resolved luminescence:

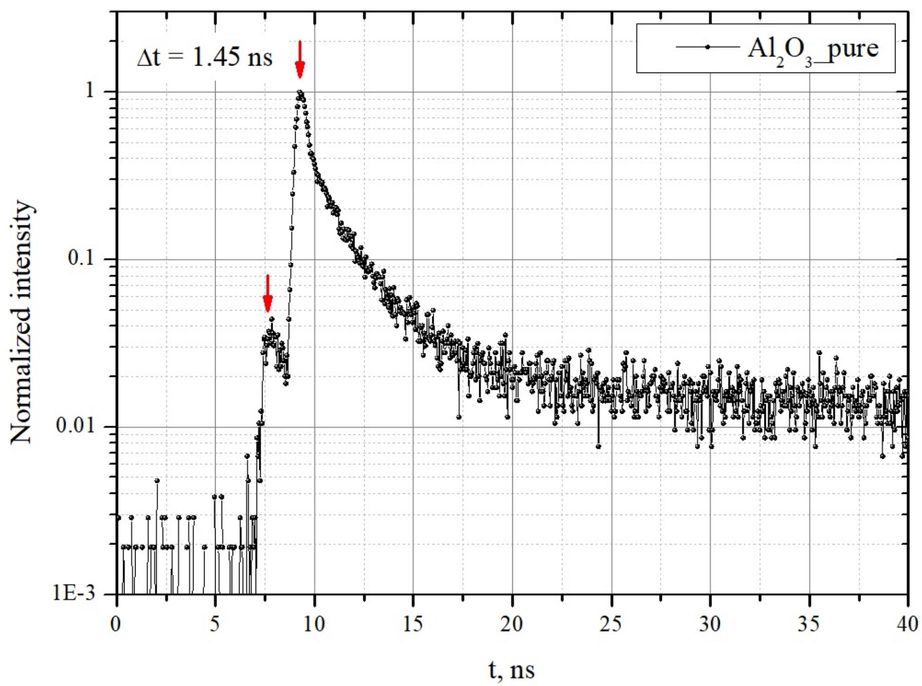
- dynamics of dense electronic excitations in vicinity of swift ion trajectory

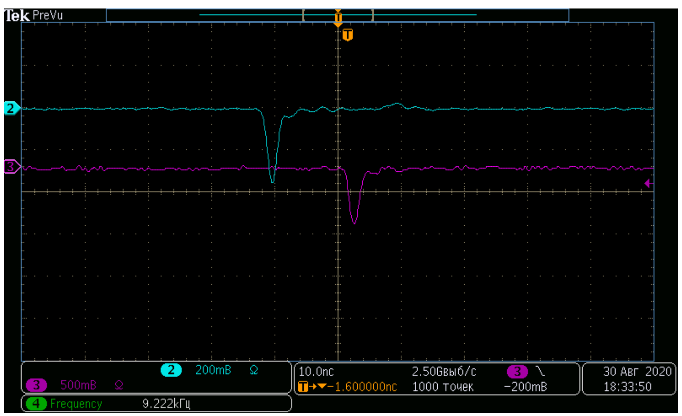
• II. Time-resolved ionoluminescence measurements (τ-IL)

The sources of an inaccuracy in the τ-IL measurements:
- the distance between START and STOP detectors positions;
- the beam should be very stable and aligned;
- the dispersion in the ion beam energy after passing of foil;
- the main contribution in Δt measurement gives dispersion in energy of ion beam, typical for all cyclic accelerators, like cyclotron.



$$E + \Delta E \Rightarrow \tau + \Delta\tau$$

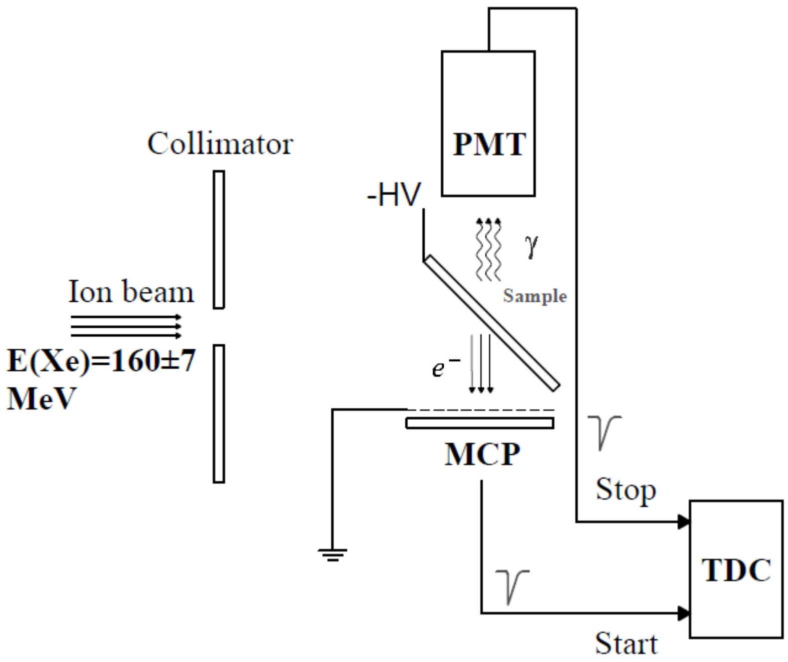


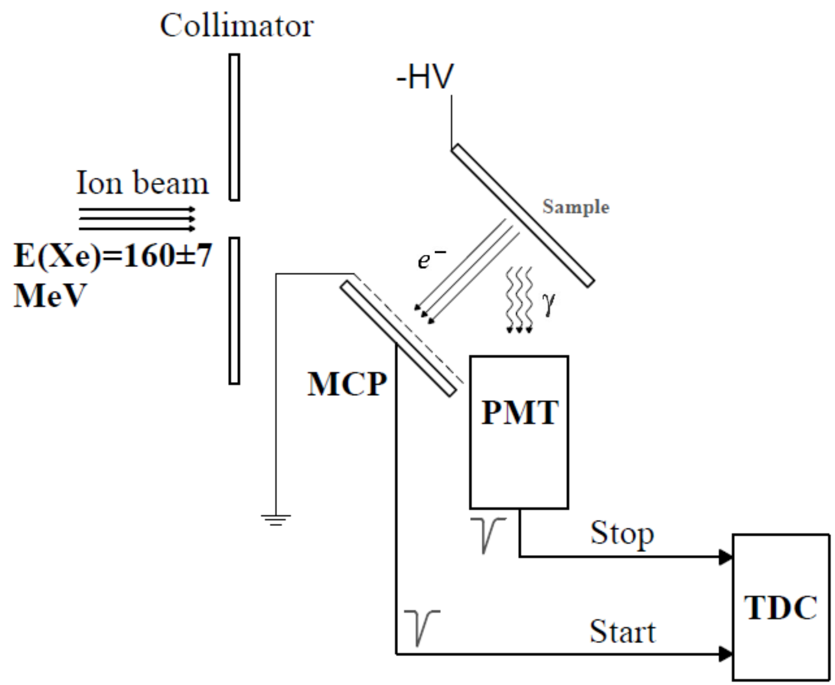


III. New approach in single ion induced τ-IL experiments

-The PMT measurements are provided from back side of the sample.
-Au foil is used to generate (attached to the sample surface) START signal.

The sample is covered (by sputtering) by semitransparent metal layer.





$E + \Delta E \Rightarrow \tau$

What does such approach give?

~~- Dispersion in ion energy~~

~~- The sample position~~

~~- Alignment of the ion beam position~~

Dispersion in energy $E + \Delta E$ has no significant effect on luminescence generation.

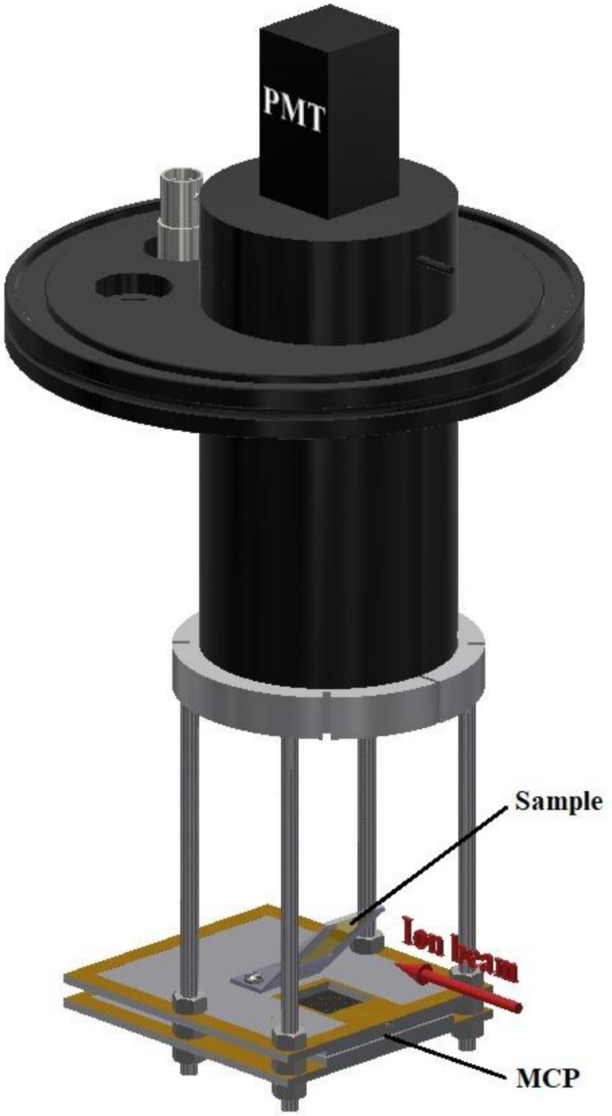
The advantages of this approach:

-Detectors and the sample are installed at the one standard DN-100 flange;

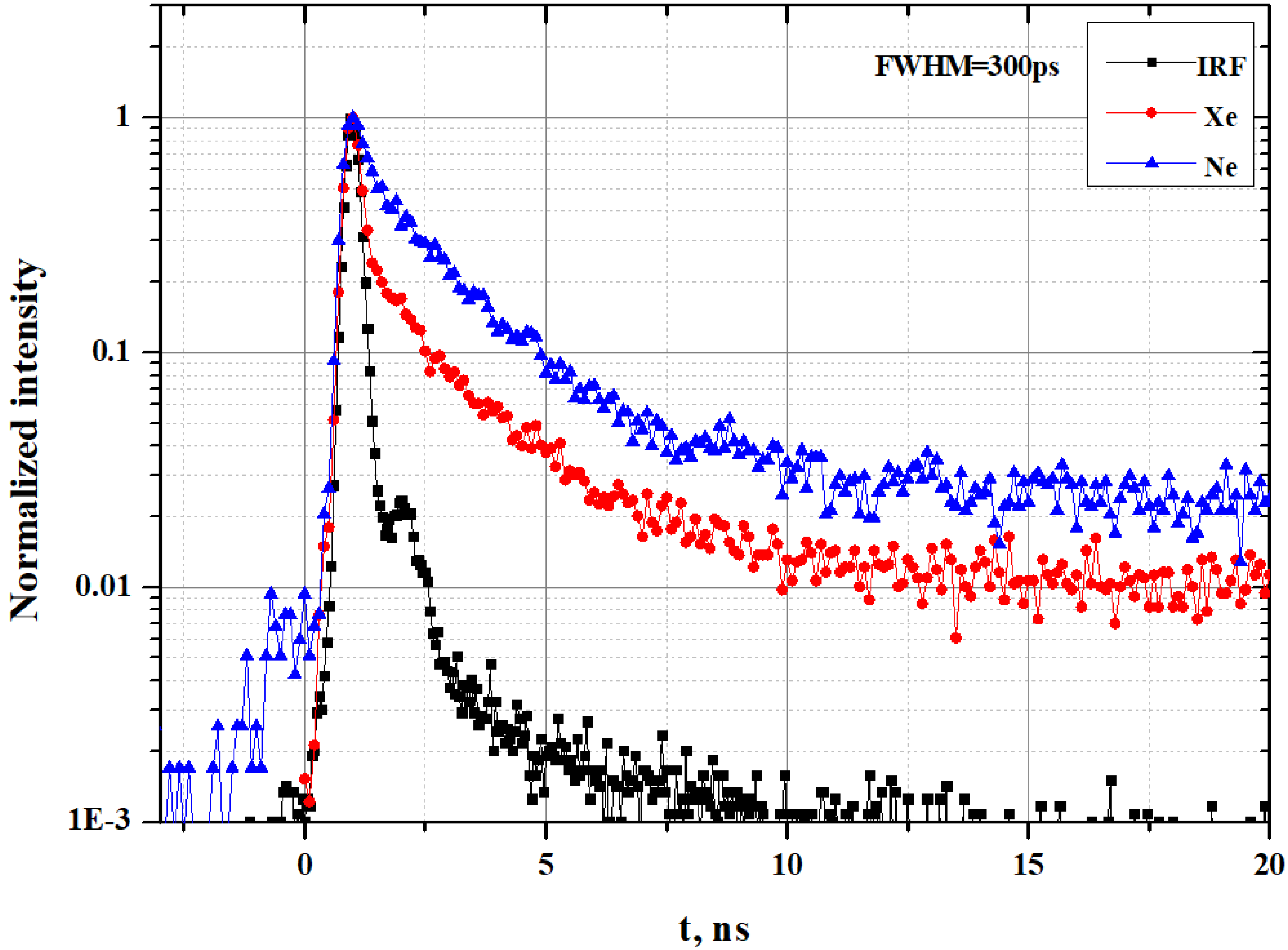
-It's very compact and doesn't require a special vacuum chamber;

-It can be installed to all standard diagnostic blocks (chambers) with DN-100 flange;

-An option to adjust the distance to the center of the beam is also available.



- **IV. Dense excitation effects in high energy ionoluminescence of Al_2O_3**



Luminescence decay curves measured from pure Al_2O_3 during 1.2 MeV/amu Xe and Ne ion irradiation and instrumental response function of measuring system.

Conclusions:

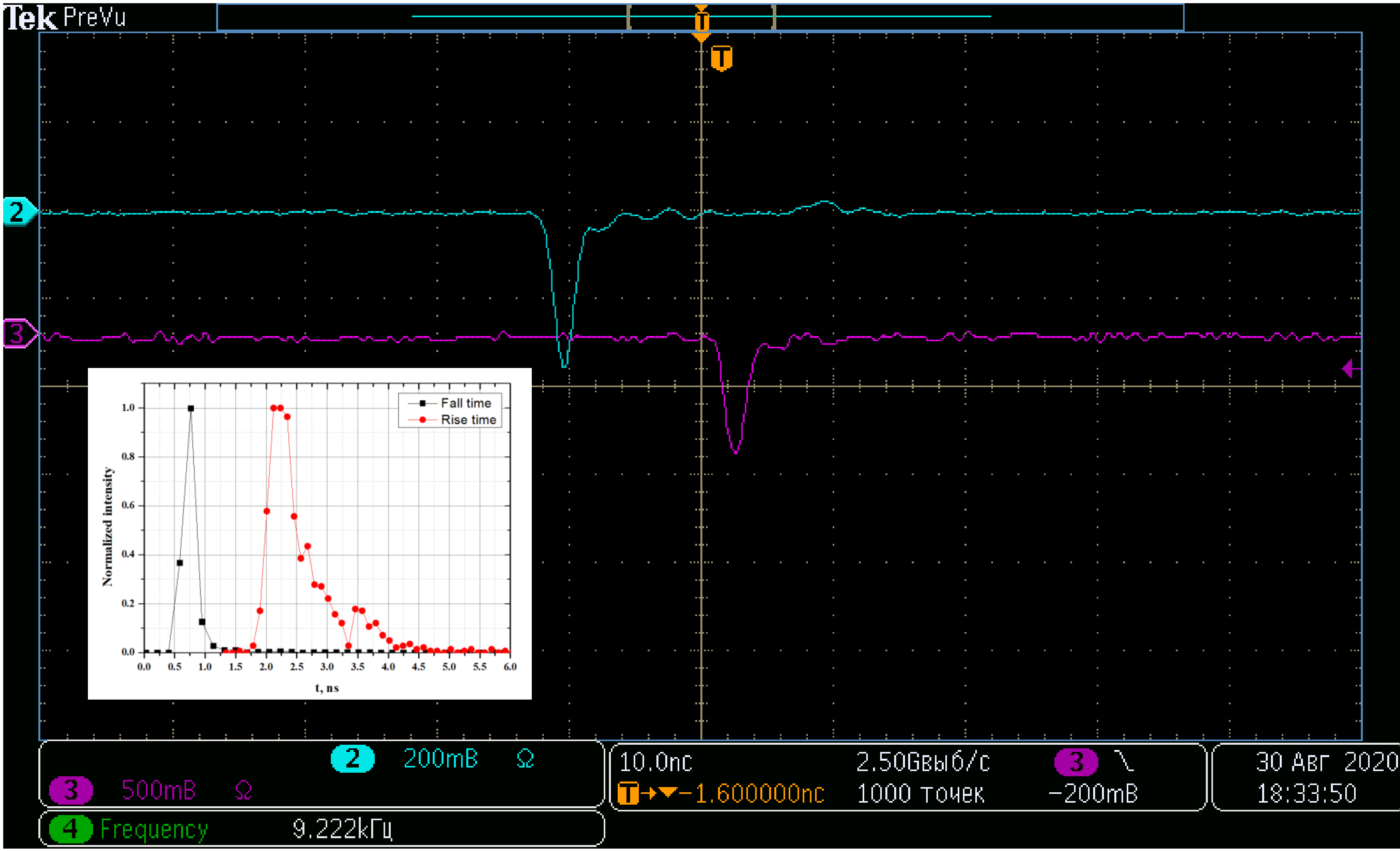
- Secondary electron emission from the target surface has been used to trigger the single ion induced time-resolved ionoluminescence measurements.

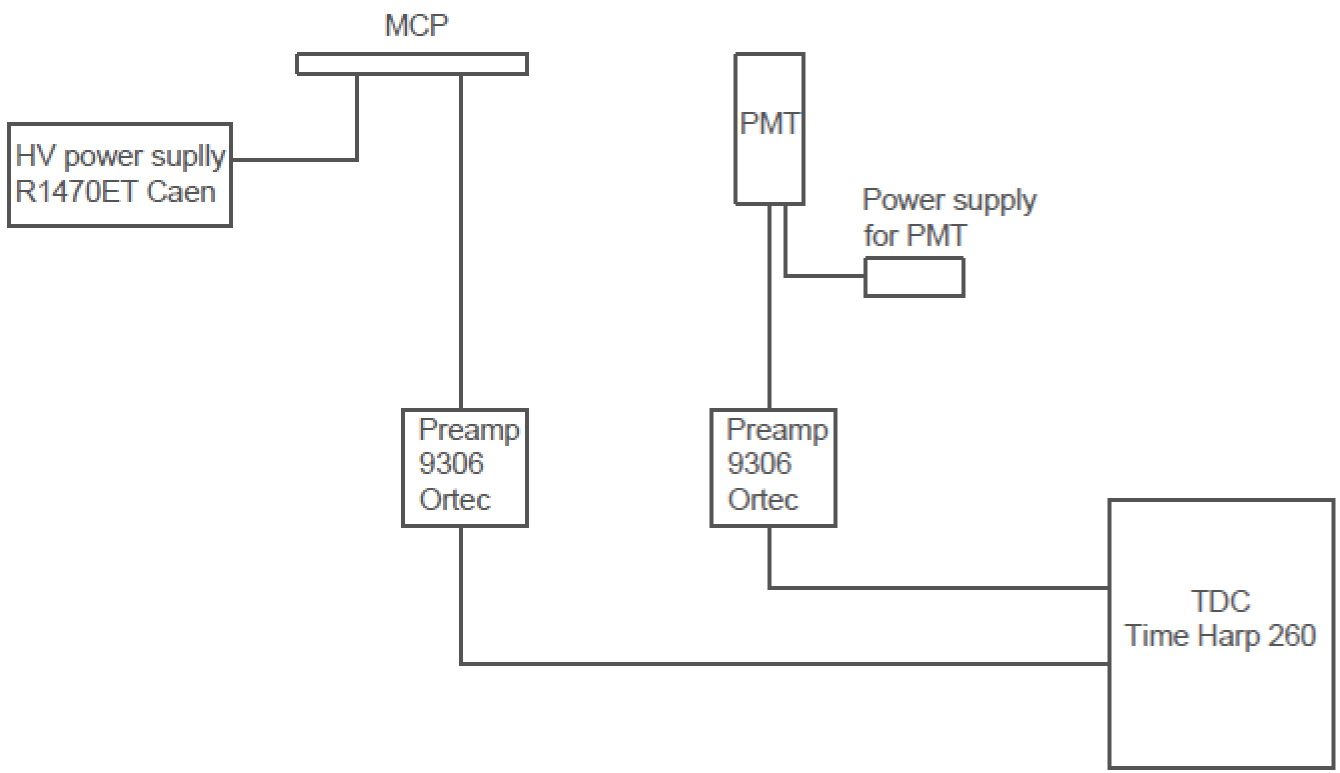
- Temporal resolution about 300 ps was achieved for registration of luminescence decay curves.

- The increase of luminescence decay rate with increasing ionizing energy loss was observed in single crystalline Al_2O_3 in the near ultraviolet region.

THANK YOU FOR YOUR ATTENTION

Backup slides




MCP
HV power suplly
R1470ET Caen
PMT
Power supply
for PMT
Preamp
9306
Ortec
Preamp
9306
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TDC
Time Harp 260