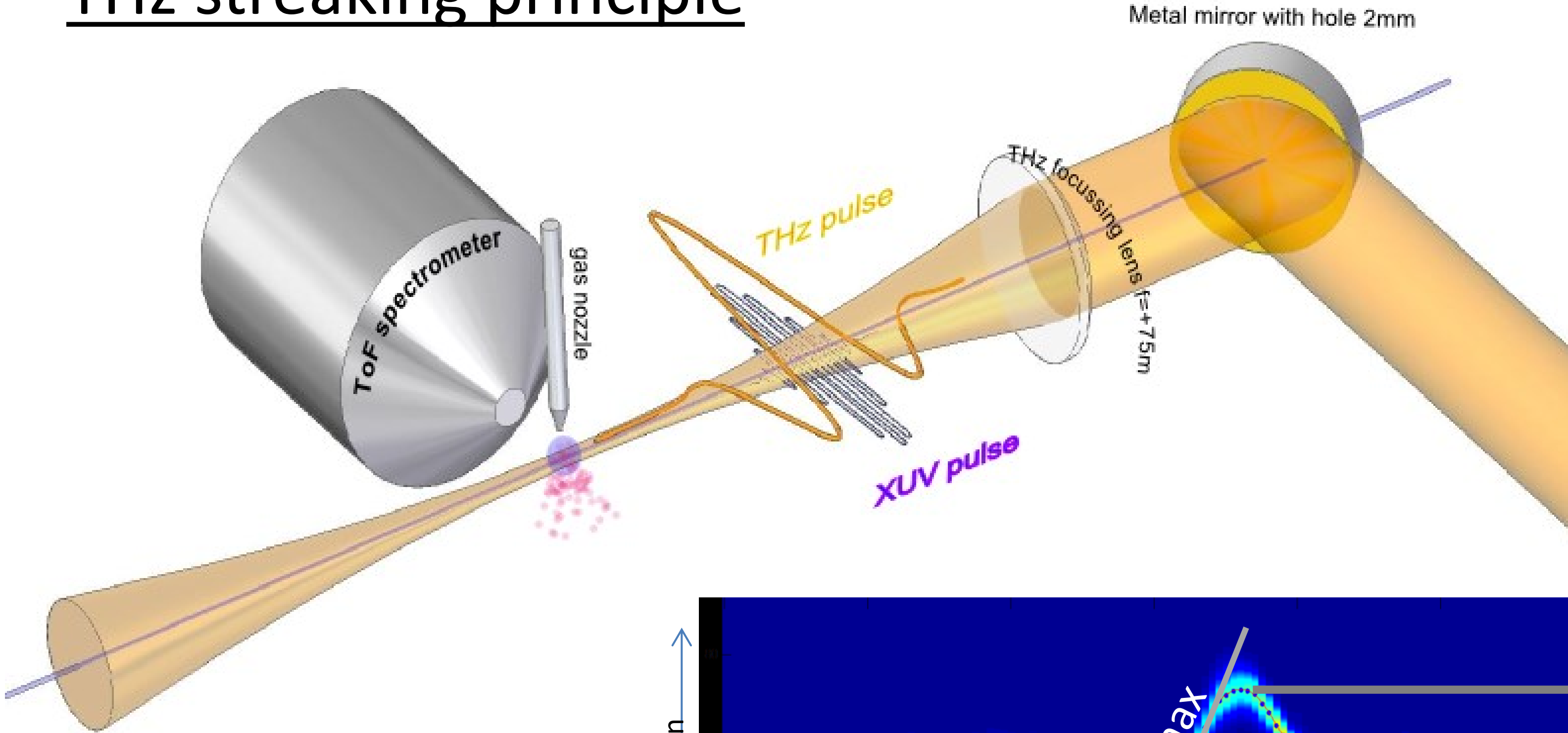
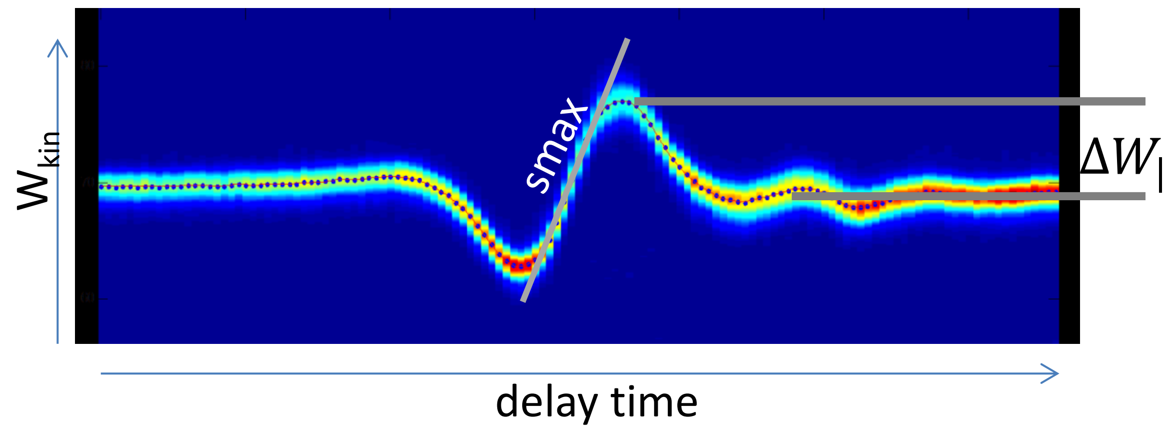
THz streaking principle





$$U_p = \frac{e^2 E_0^2}{4 m_e \omega_{IR}^2} \sim I(t) * \lambda_{THz}^2$$ "ponderomotive potential"

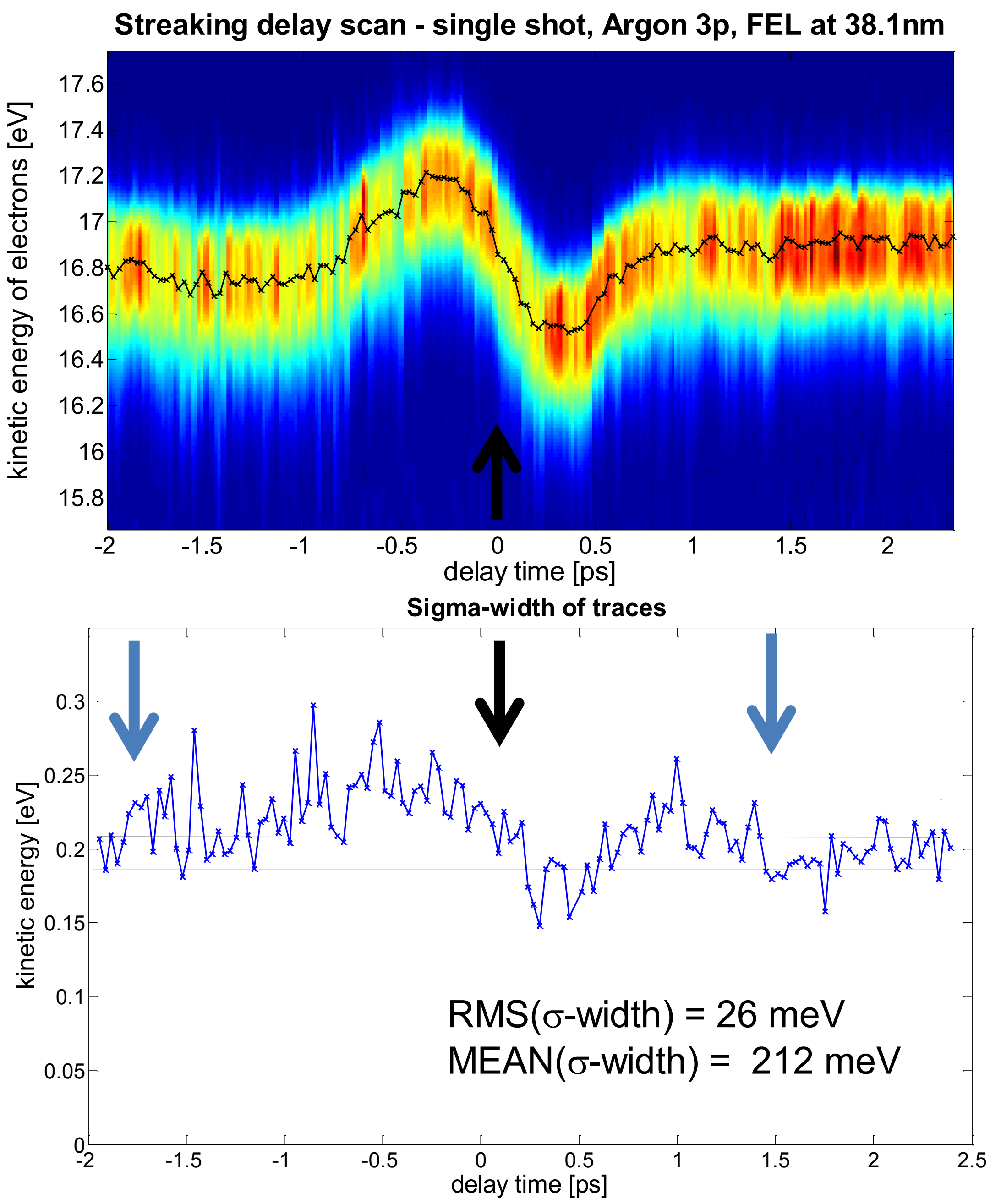
$$\Delta W_{||}(t) = W(t) - W_0$$ "streaking amplitude"

$$\Delta W_{\|} = \sqrt{8 W_0 U_p} \sin\phi_i = e\sqrt{\frac{2W_0}{m_e}} \frac{E_0(t_i)}{\omega_{Ir}} \sin\phi_i = e\sqrt{\frac{2W_0}{m_e}} A_{Ir}(t_i)$$

Streaking speed

$$s_{max} = \omega_{IR} \Delta W_{max}$$

Approximation of seeded FLASH XUV pulse duration



Because of a small streaking strength, the spectral width of a streaked FEL spectrum at time zero was not larger than the width of any unstreaked spectrum at delay times far off the temporal overlap region.

*Hence, we can only calculate an **upper limit** for the temporal width of the seeded FEL pulse by **comparing the RMS value of the jitter of the spectral width** with the **broadening due to the streaking strength**.*

Approximation of seeded FLASH XUV pulse duration

$$\sqrt{\sigma_{XUV}^2 + (\boldsymbol{\tau_{XUV} \cdot s})^2} \leq \sqrt{\sigma_{XUV}^2 + \left(\mathbf{2} \cdot \boldsymbol{RMS}(\boldsymbol{\sigma\text{−}width})\right)^2}$$

$$\tau_{XUV} \cdot s \leq \mathbf{2} \cdot RMS(\sigma\text{−}width) \leq 52meV$$

$$\tau_{XUV,RMS} \leq \frac{52meV}{1.6\,\frac{meV}{fs}} = 32.5fs\ RMS \leftrightarrow \boldsymbol{76fs\ FWHM}$$

Assuming **95%-significance (⇔ streaking broadening is at least two times larger than the RMS value of the jitter of the spectral width)**, one finds that the temporal duration of the measured XUV pulse should be **smaller than 76fs FWHM**.

For any larger XUV pulse duration, the measurement would have shown **with 95% probability** a measurable spectral broadening at time zero !

(In this consideration any effect of a temporal chirp of the FEL pulse is disregarded!)