A research for stochastic fluctuation of speed of Light: The REWOLF project

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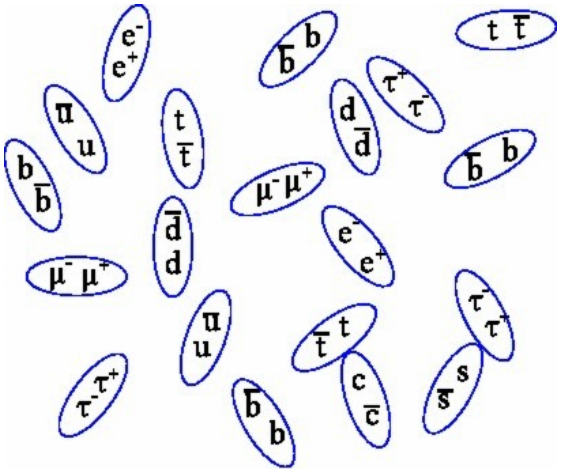
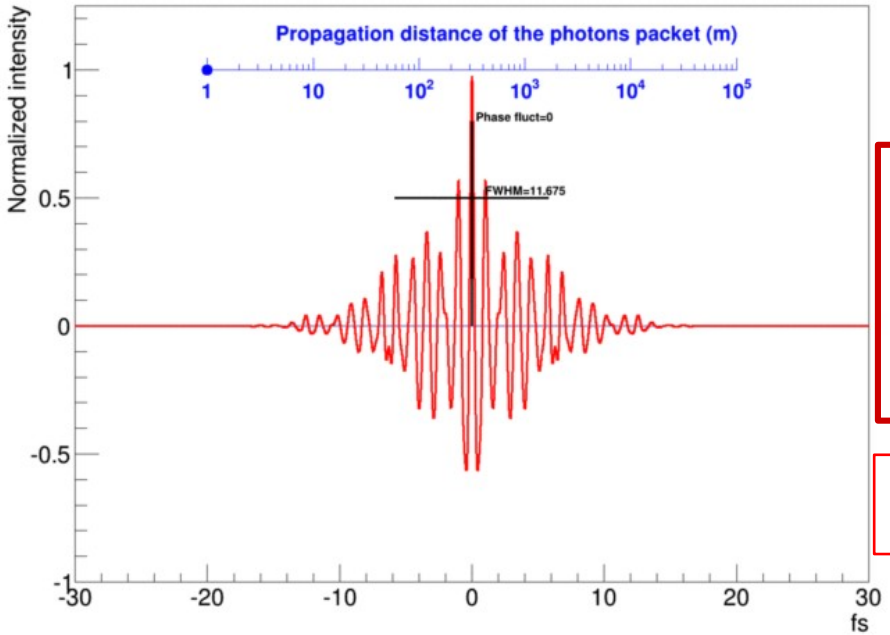
The stochastic fluctuation of the light



Pulse fluctuations



- **Stochastic fluctuation of the light's propagation:**
  - Spreading of the group velocity
  - No impact on the phase velocity (strongly constrained)
- **Theoretical origin:** EPJ 67(58)3 Appl. Phys. B 100, 9 (2010)
  - Description of the vacuum
  - Dark matter interaction (axions)

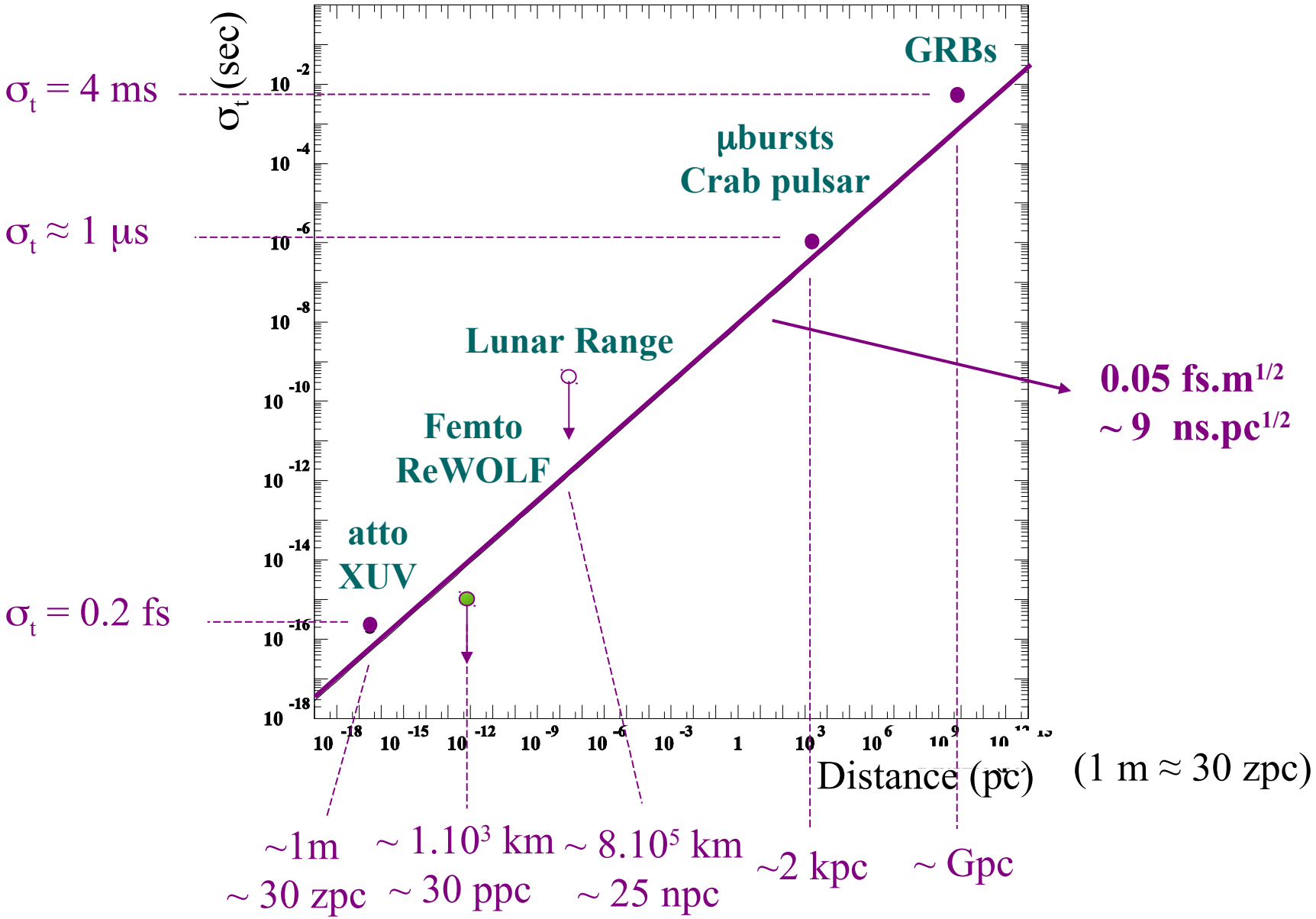
  Quantistic fluctuations Class. and Quant. Grav. 34 (2017) 17
    - Hardly or not measurable at all (coherent light state of many photons needed).

This fluctuation is measurable and can be a science breakthrough.

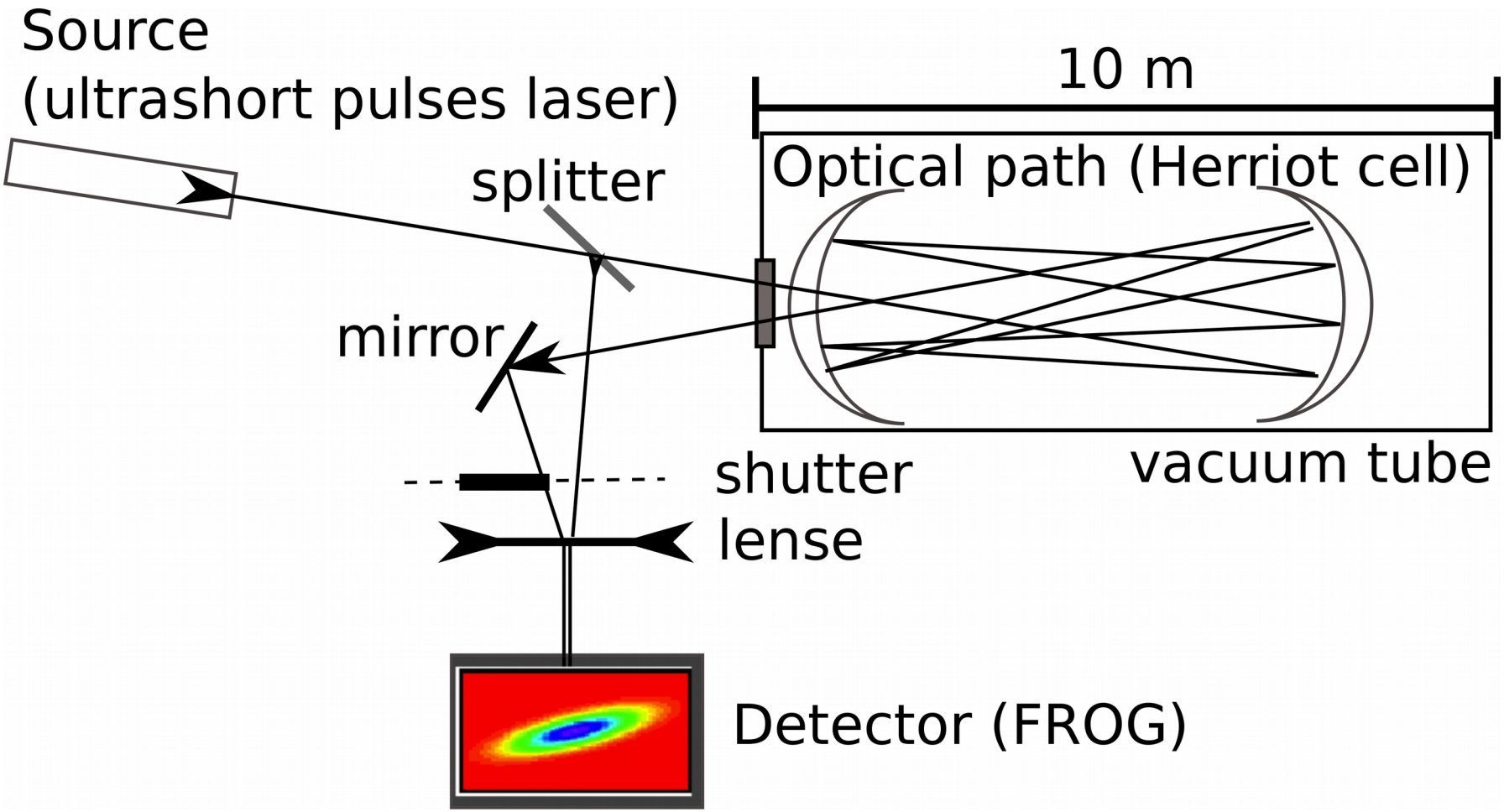
Current limit: σ(FWHM)=700 as.m$^{-1/2}$

Phys. Rev. D 69, 027504 (2004)

ReWOLF among the other experiments



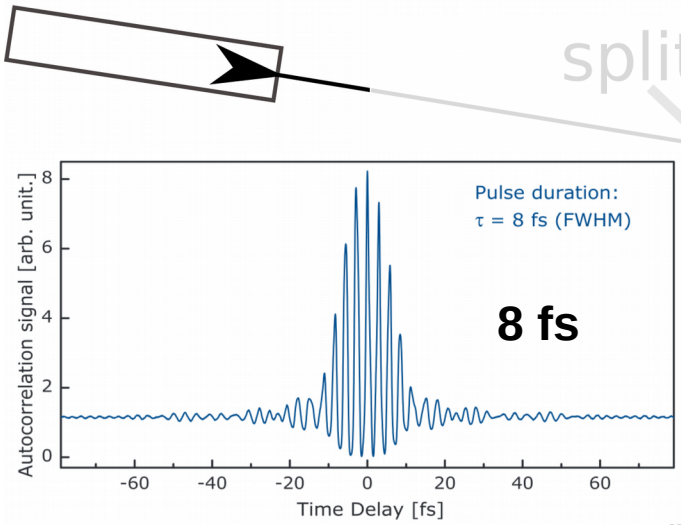
The setup summary
General view

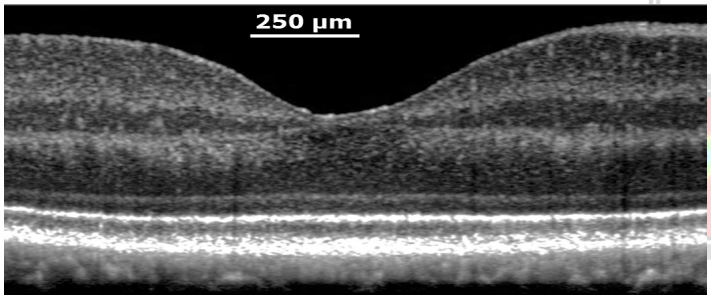


The setup summary
General view

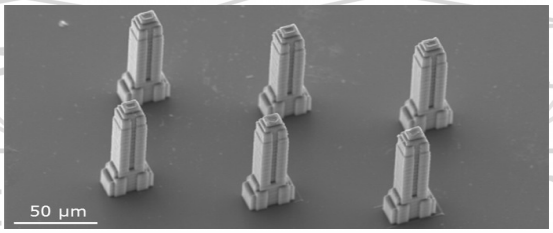
Source
(ultrashort pulses laser)

splitter

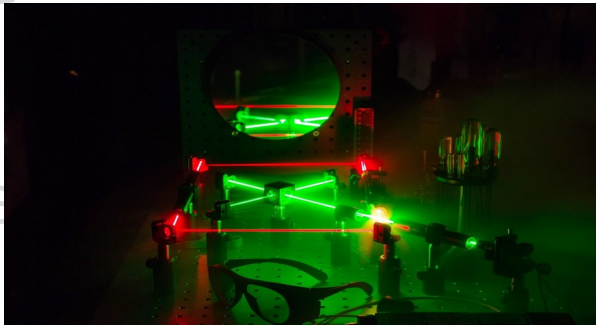




Health (eyes, tomography, microscopy)



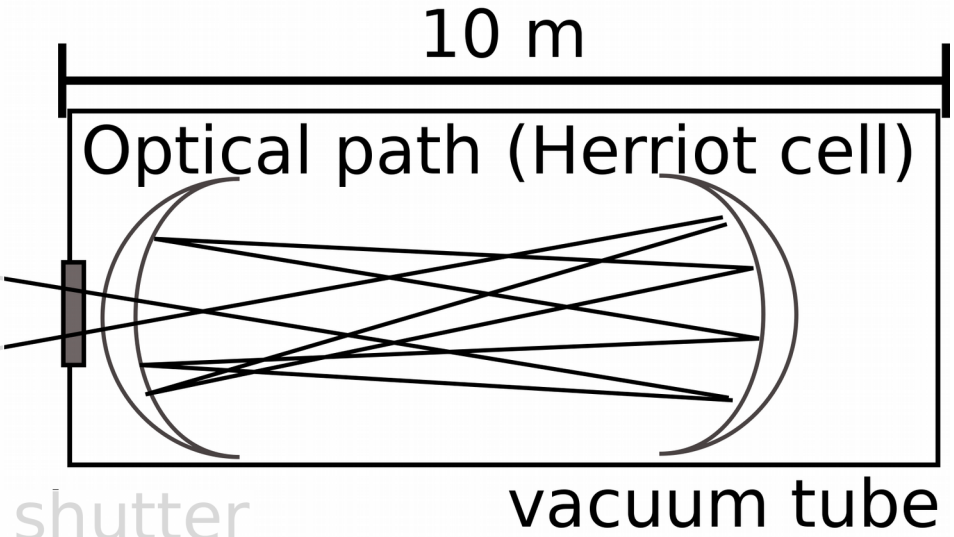
Micro etching, polymerization

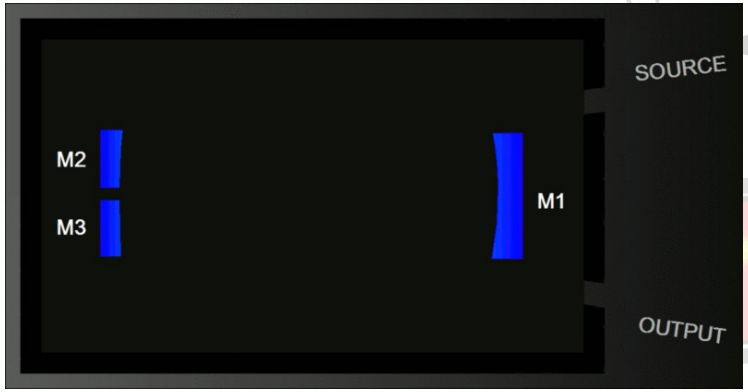


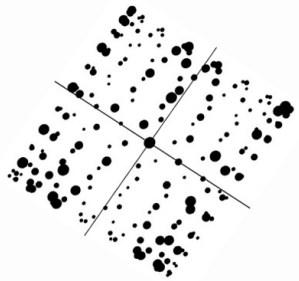
Laboratory research

The setup summary
General view

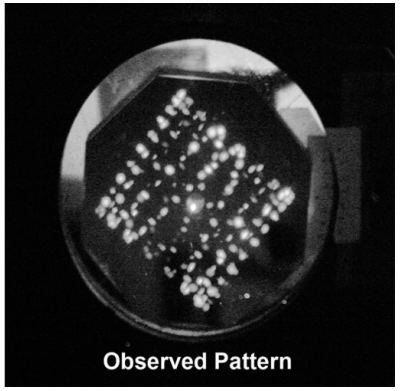
- **Commonly used for study of the light propagation in the fluids/gas**
  - **Attenuation**
  - **Chromatic dispersion**
  - **Etc.**
- **Very well known setup:**
  - **Extremely stable**
  - **Tens of km already done**







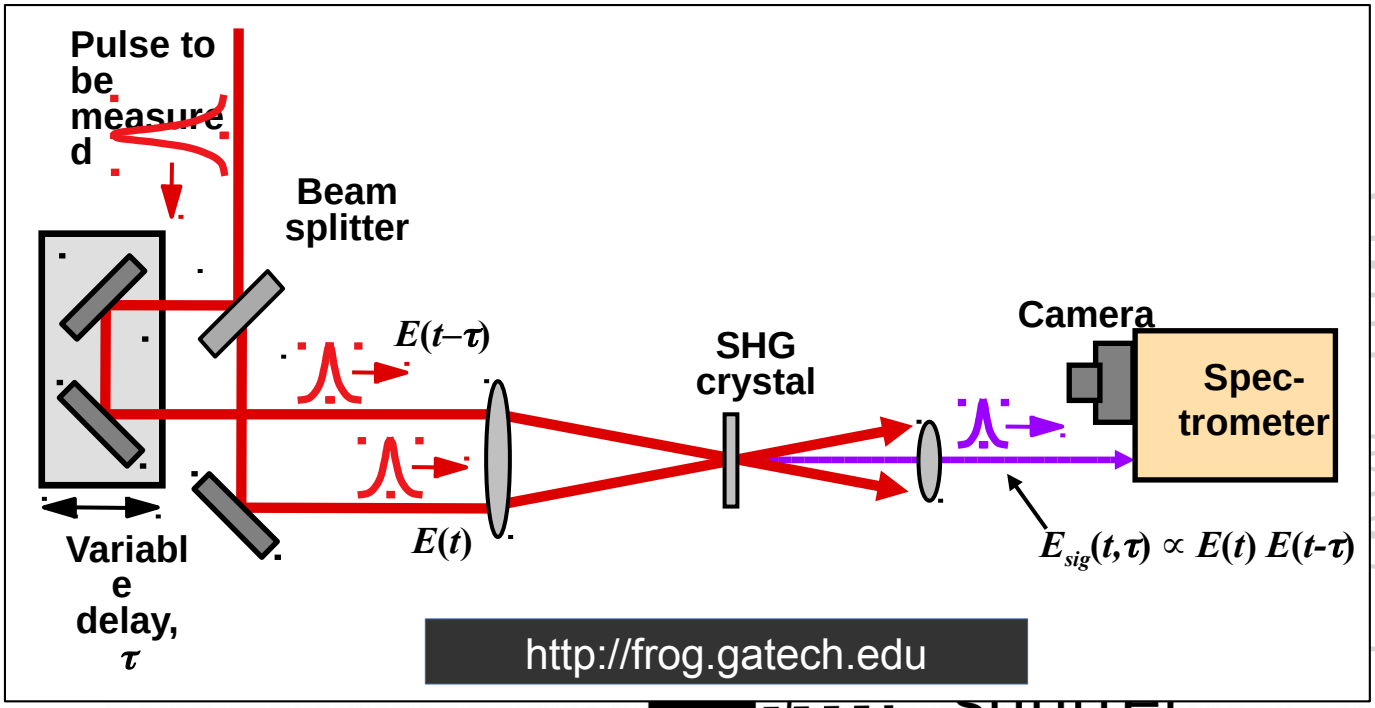
Calculated Pattern, 422 pass



Observed Pattern

Appl. Opt., 46, 22 5408-5418 (2007)

The setup summary
General view



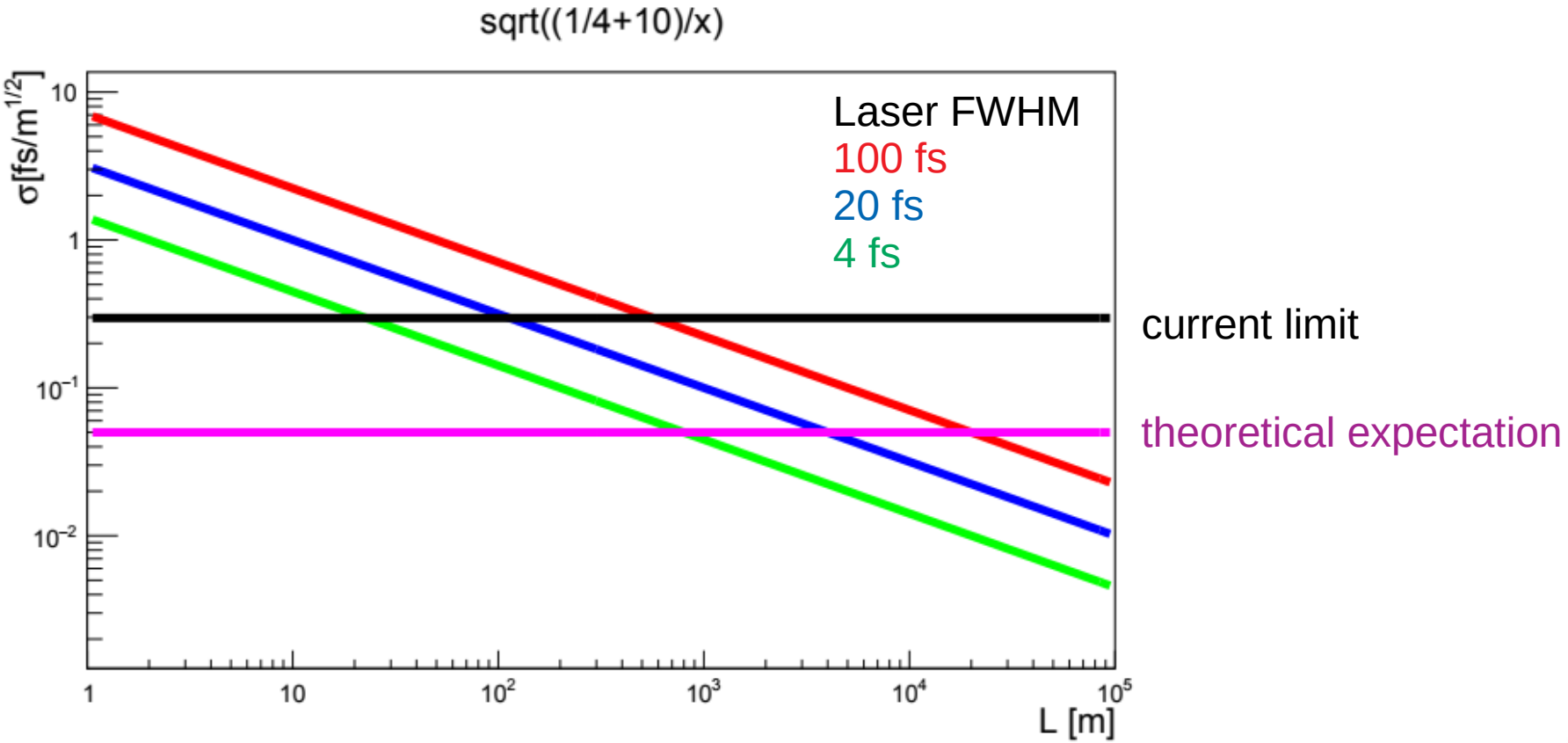
- Autocorrelation system:
  - Sensible to the packet intensity
  - Strong reduction of systematics errors
- The fastest existing measurements
  - Resolution : 0.1 fs
  - Min pulse length: 2 fs

lense

Detector (FROG)

The ReWOLF expected sensitivity

- Expected REWOLF sensitivity assuming FROG resolution of 1 fs.
- Naive calculation assuming that pulse enlargement is comparable with FROG resolution $\mathrm{sqrt}(\sigma^2_{laser+}\sigma^2_{effect})-\sigma_{laser}=\sigma_{FROG}$



Budget REWOLF

- Laser ~80 kEuro
- FROG 15-50 kEuro.
- Heriott cell a vuoto 10-30 KEuro + produzione a casa (prezzo varia se l'aggiustamento degli specchi si po fare senza vuoto o con il vuoto, diametro di specchi, altri "unknowns")
- Banco ottico.
- Laboratorio separato con il percorso di 10-100 m.
- Ottimo progetto per ERC/PRIN!

Ma cosa si puo fare con 20 KEuro?

Budget Rewolf Cub

- Laser – in prestito da DIFI/IIT:
  - Tsunami 80 fs. Presente al 3 piano, Riparazione necessaria.
  - IIT – laser da 60 fs.
  - Grant di eccellenza di DIFI
- Herriott cell nell'aria: due specchi da 2x300 Euro, mount (200-1000 Euro).
- FROG – 20 kEuro (NewPort). Prestito di autocorrelatore APE da IIT + upgrade a FROG (7 kEuro).
- Banco ottico. Prestito da DIFI/INFN/IIT (guidato da quale laser sara usato).
- Ottimo setup per:
  - Verifica della fattibilita di REWOLF e preparazione per PRIN/ERC.
  - Avvicinarsi al limit esistente.
  - Aprire la fisica sperimentale di laser corti alla sezione e DIFI.
    - Strumentazione per tuning e caratterizzazione dei laser corti.
    - Setup fisso per la prattica per gli studenti?

Avanzamento

- Idea e proposta per l'ERC con C. Hugon e A. Orzelli in 2015 (diversamente accettata, da "molto interessante, approvato" a "non avete esperienza per farlo").
- Continuo contatto con FLOWER/Atto XUV, gli autori della teoria e (Urban et al). Approvazione della nostra iniziativa per REWOLF.
- Supporto non formale da
  - G. Gemme, F. Sorrentino
  - IIT (M. Scotto, A. Diaspro)
  - DIFI (M. Canepa)
- Associazione con IIT. Prima visita 2 mesi fa e ricomincio della preparazione dalla settimana prossima con M. Scotto.