

# LASER COOLING OF POSITRONIUM WITH AEGIS

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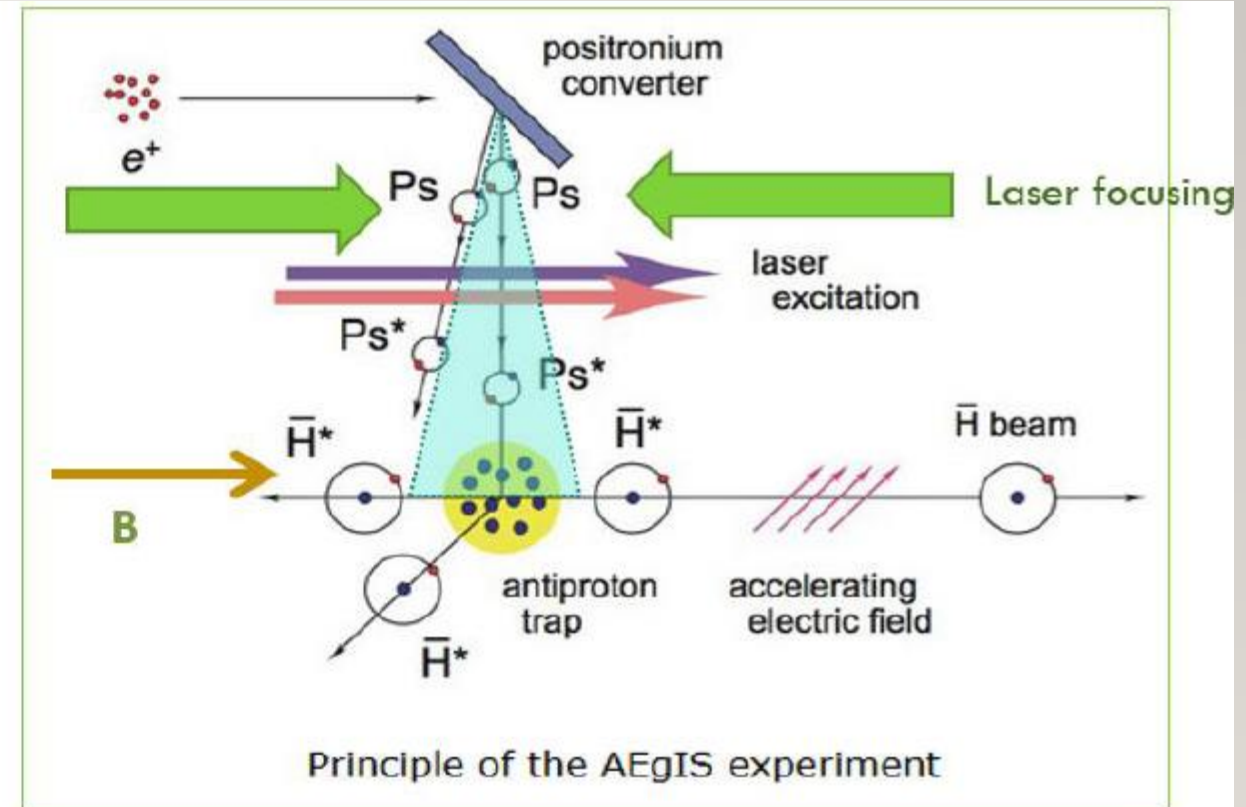
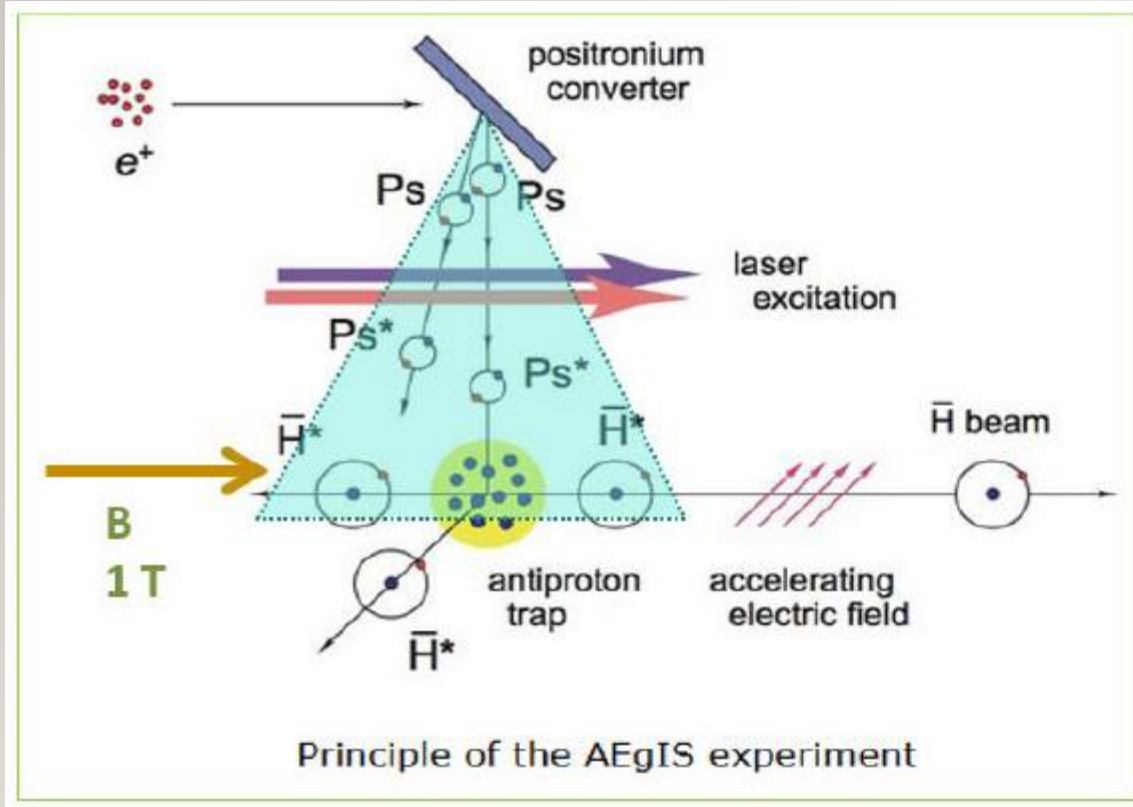
GRACE KERBER

## 2 OVERVIEW

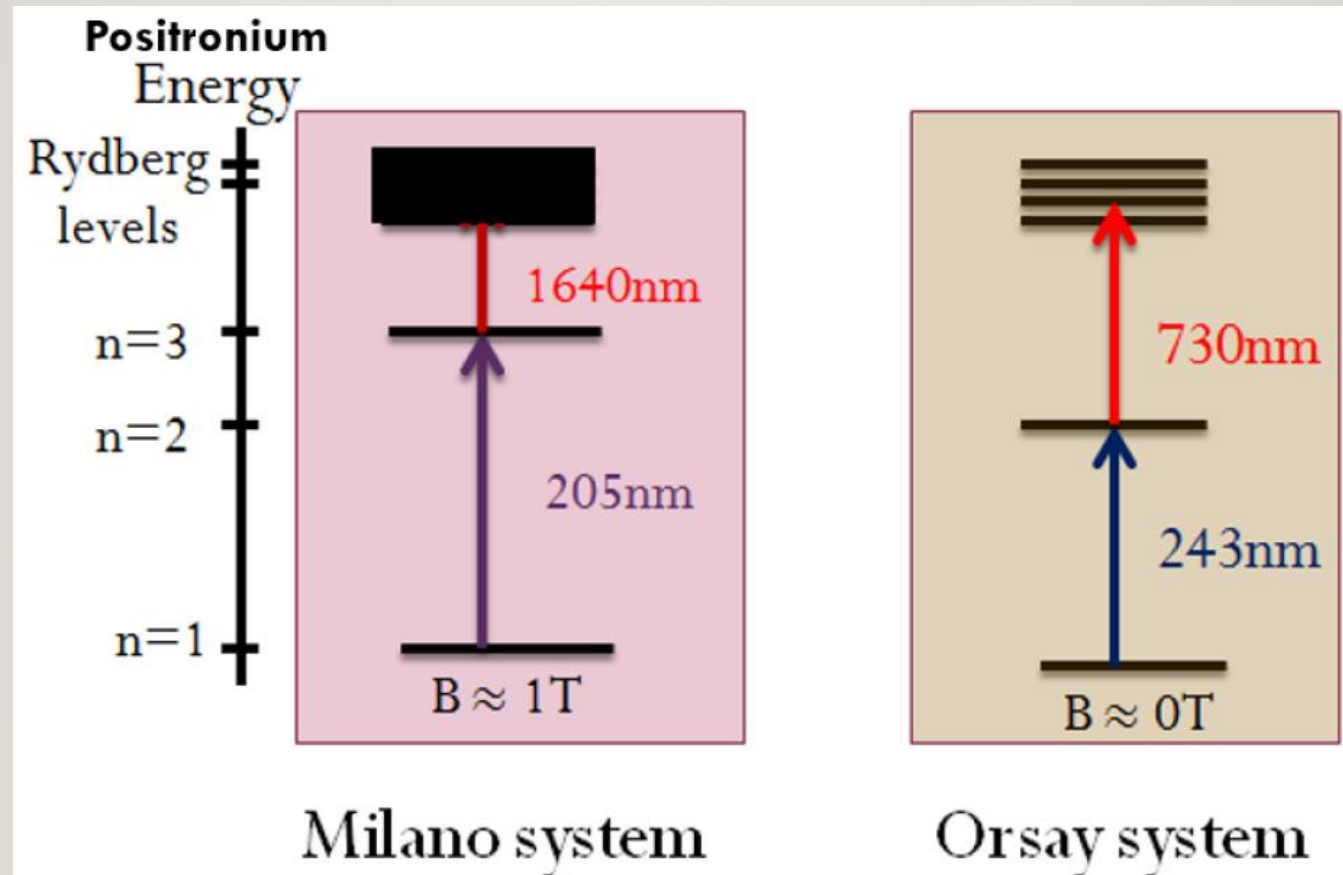
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- Goals of AEGIS (Antihydrogen Experiment: Gravity, Interferometry, Spectroscopy)
  - Measure gravitational effect on anti-matter
- Positronium (electron and positron)
  - Want to remove as much kinetic energy as possible
  - Positronium creation is at lowest energy limit
  - To then interact with anti-protons to create anti-hydrogen
- Life time on the order of  $\mu\text{s}$ 
  - Need to excite continuously to prevent decay

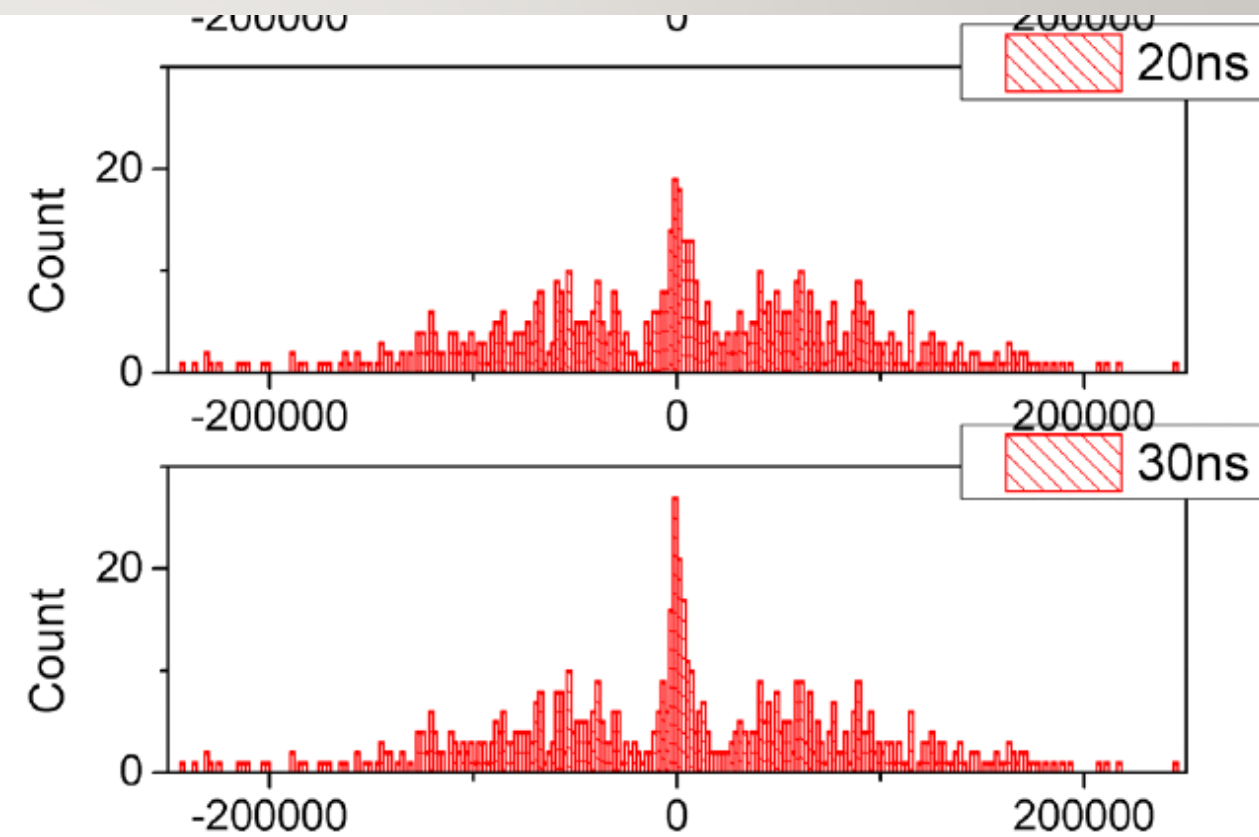
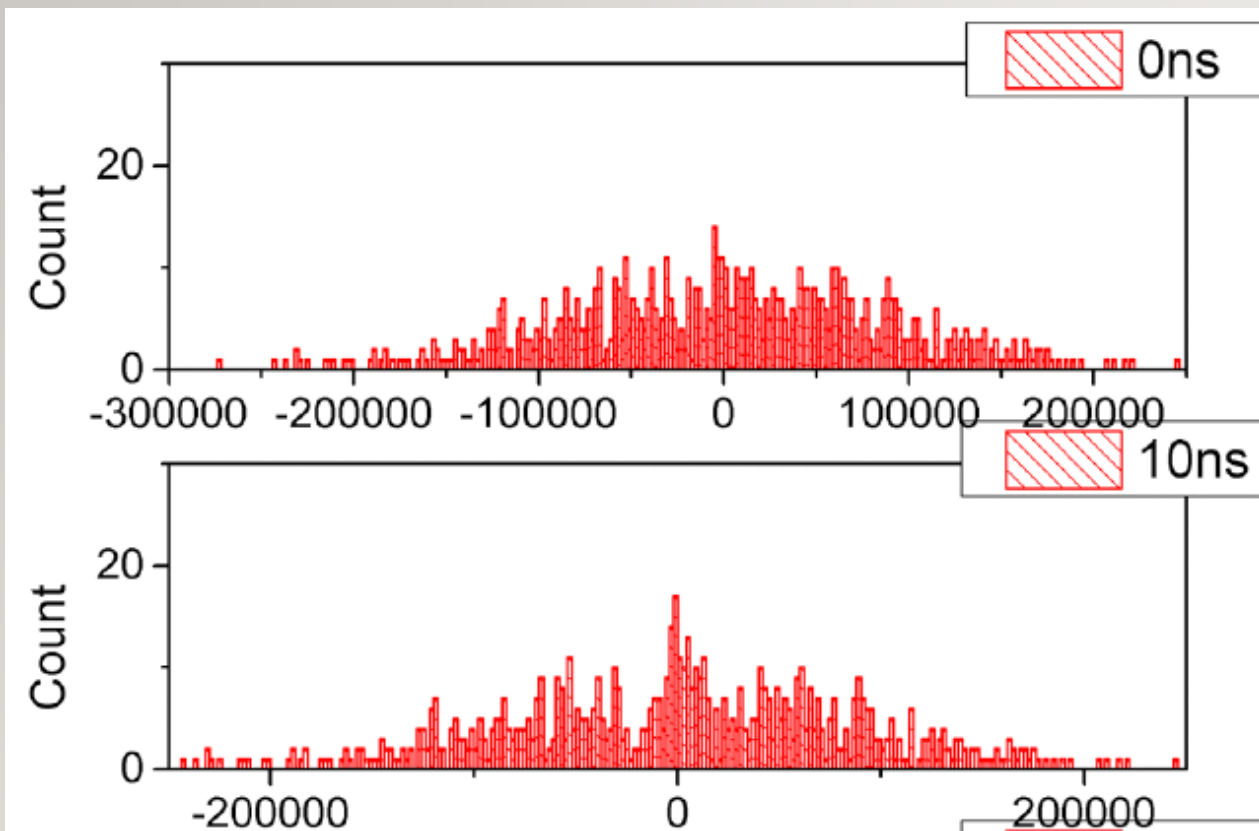
### 3 EXPERIMENTAL SET UP



## 4 LASER SYSTEMS



# 5 DOPPLER COOLING



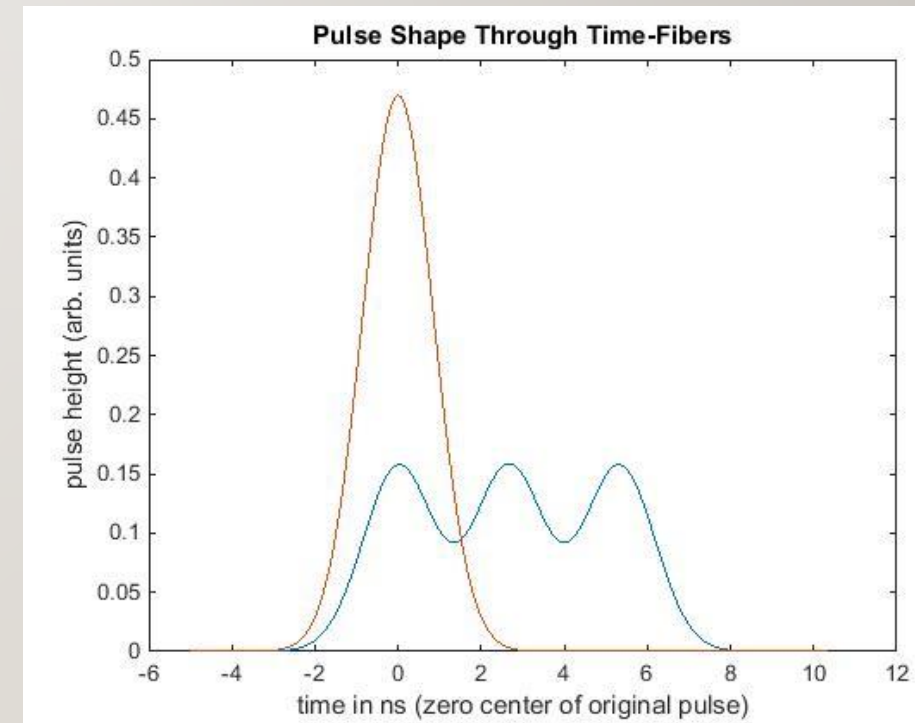
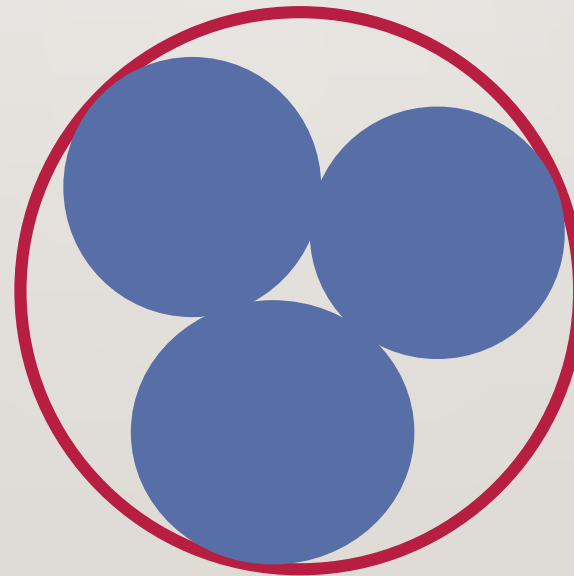
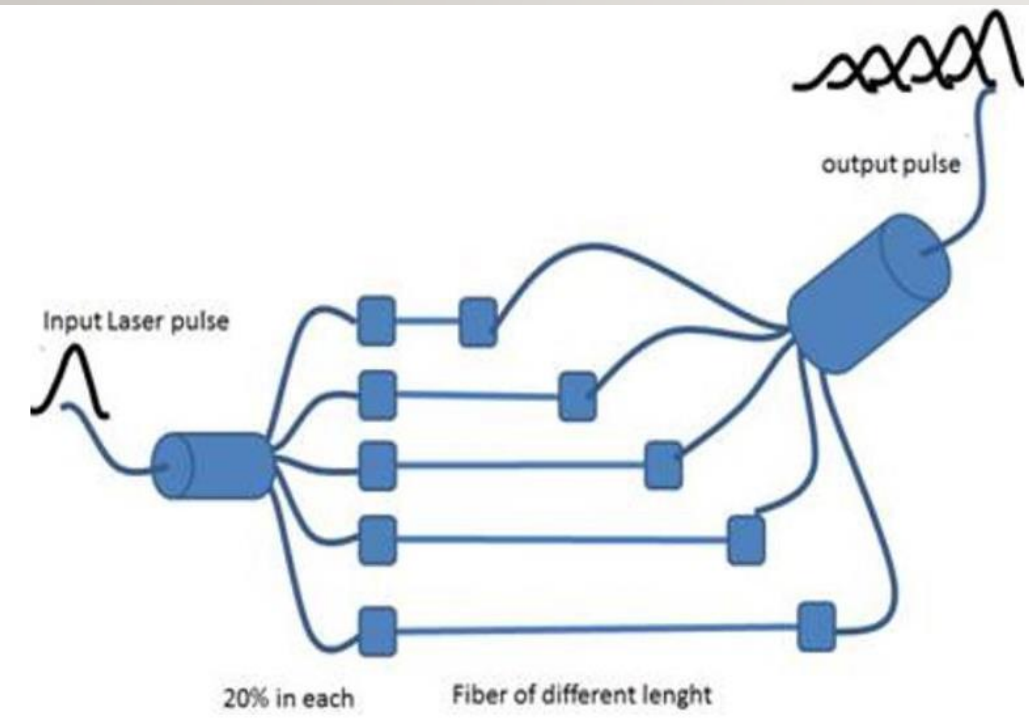
## 6 MY WORK

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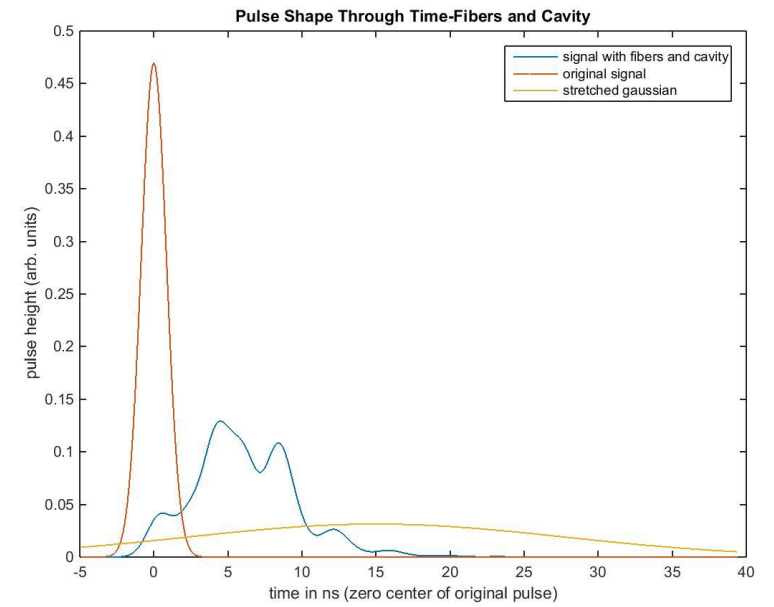
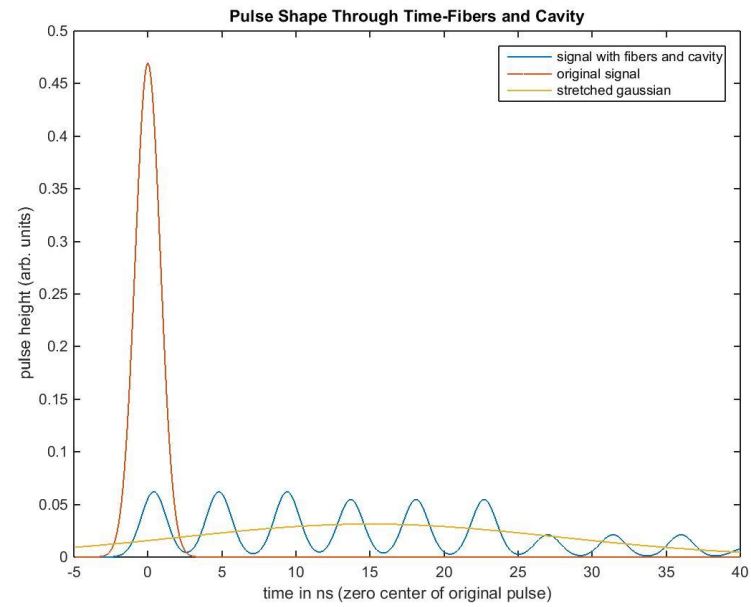
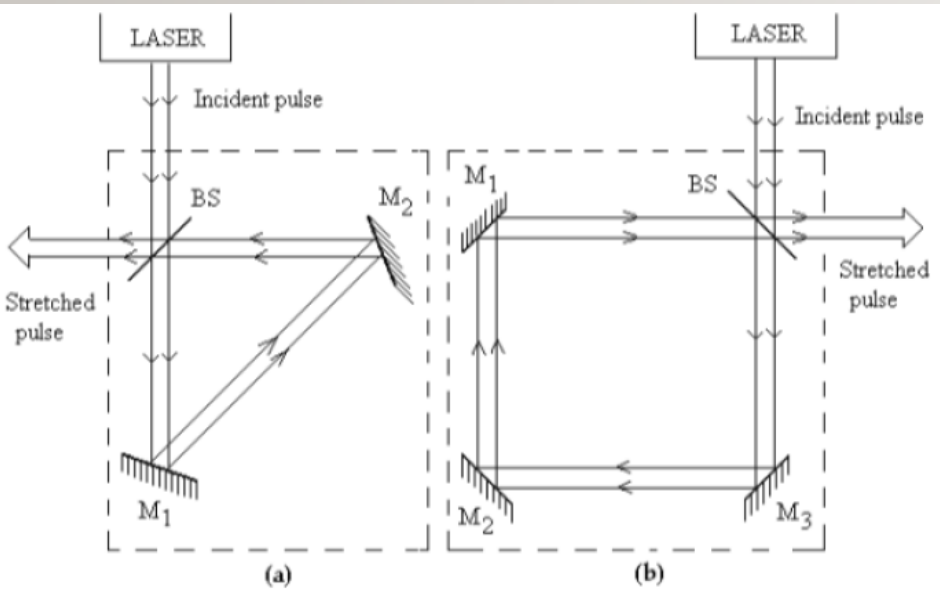
- Design an optical system that stretches laser pulse from  $\sim 2$  ns to longer
- Simulate these designs
- In UV range
  - High absorption
  - Special optics required

# 7 OPTICAL FIBERS

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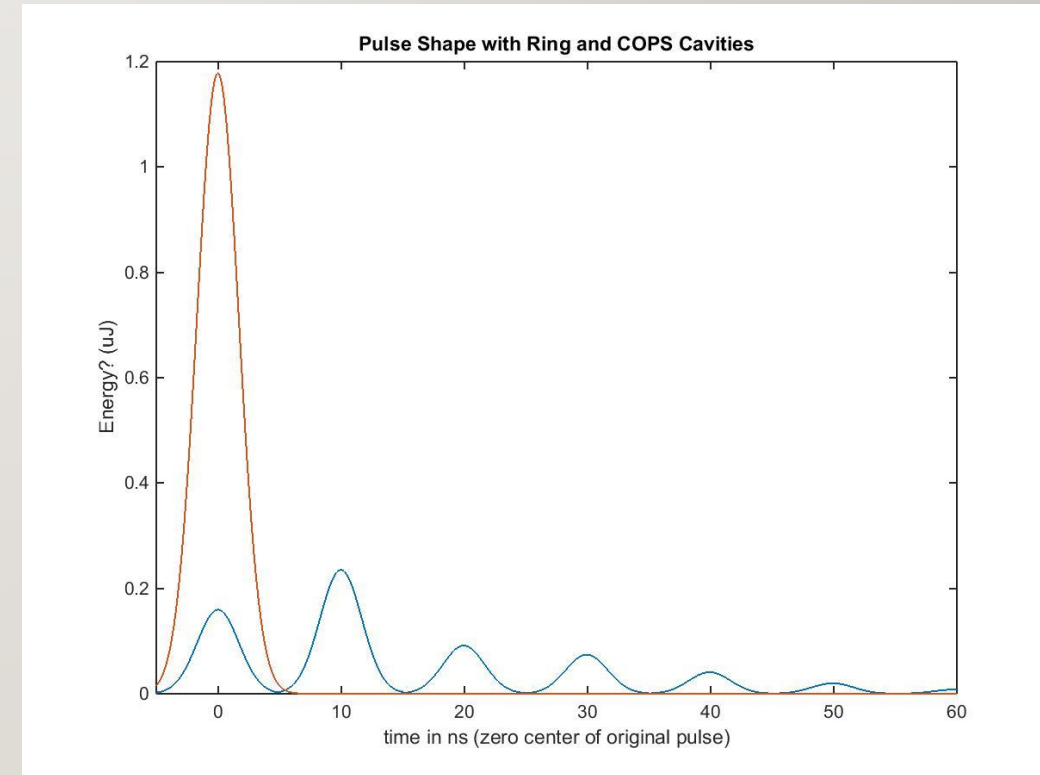
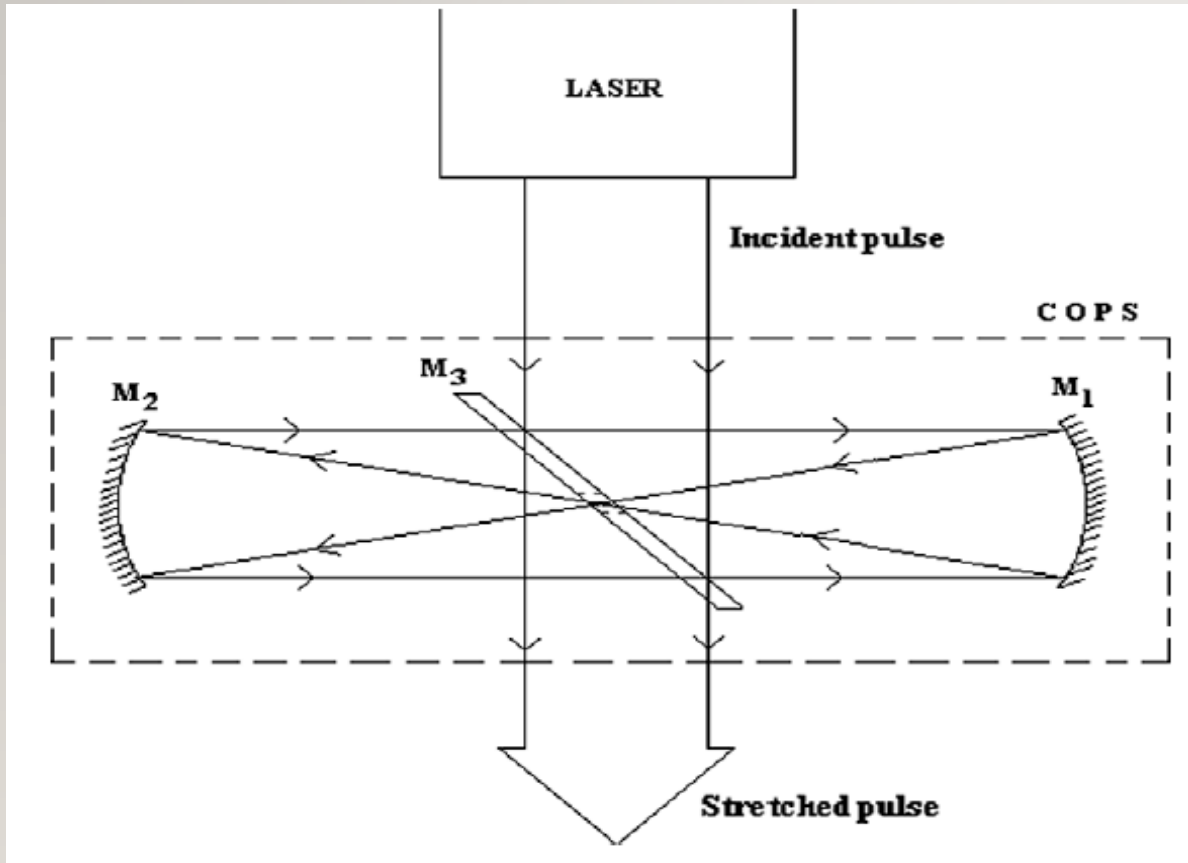


# 8 OPTICAL CAVITY

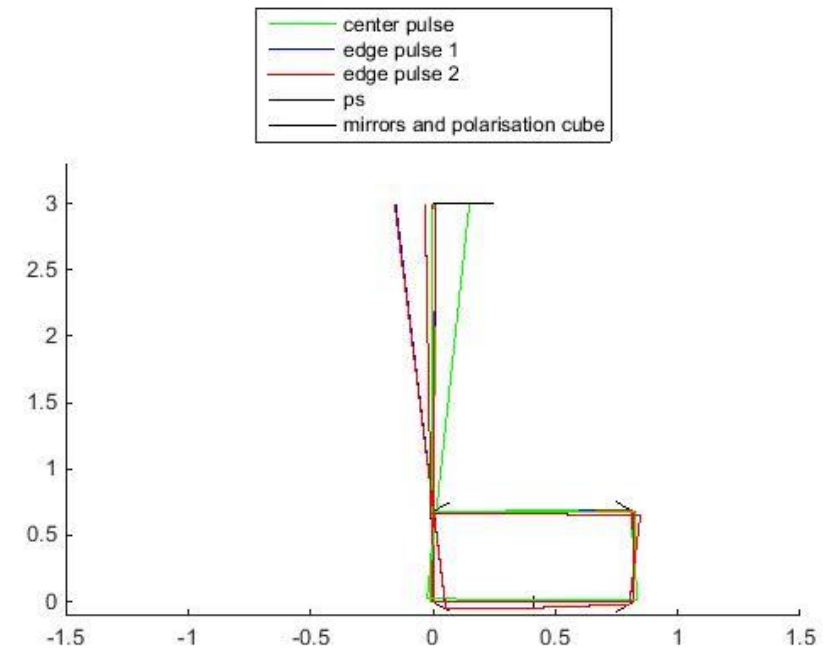
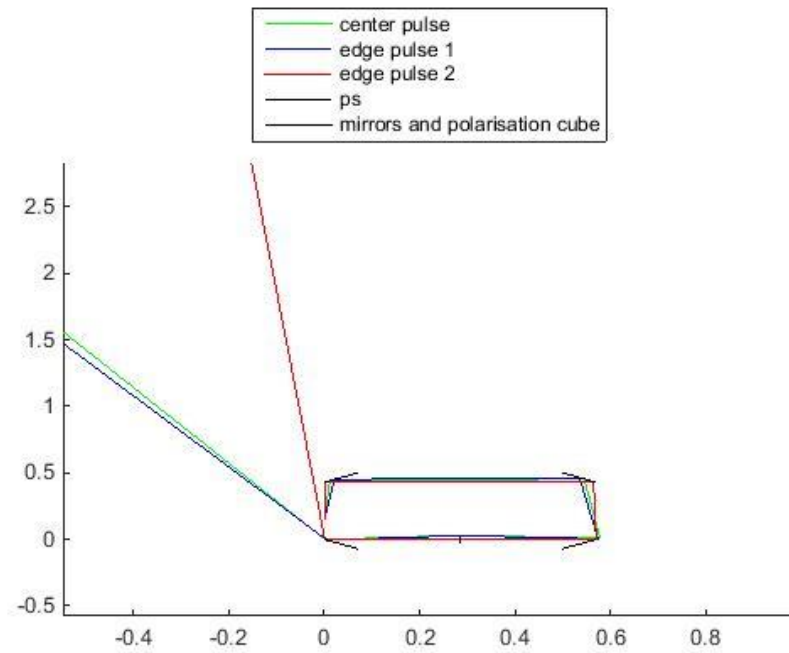
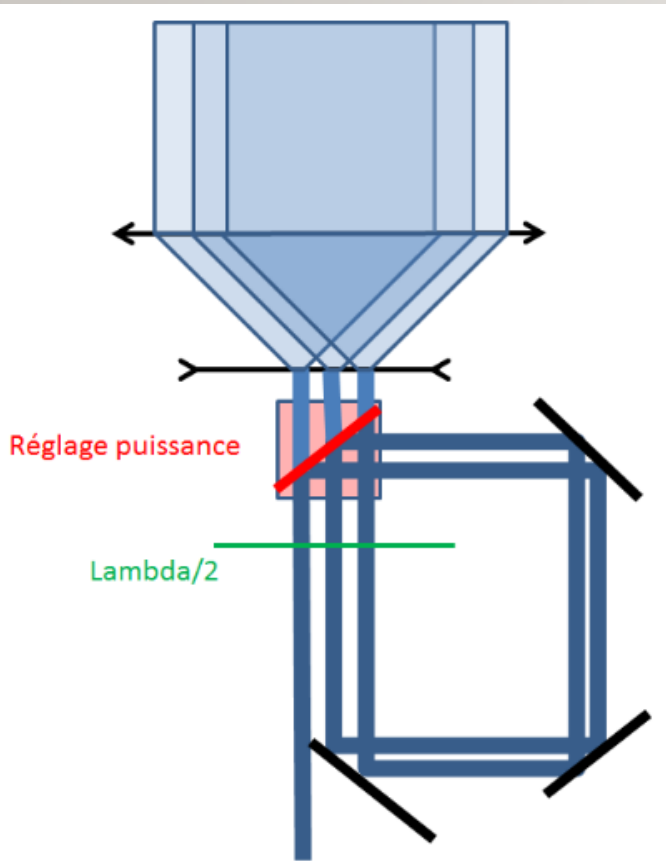




# 9 CONFOCAL OPTICAL PULSE STRETCHER (COPS)

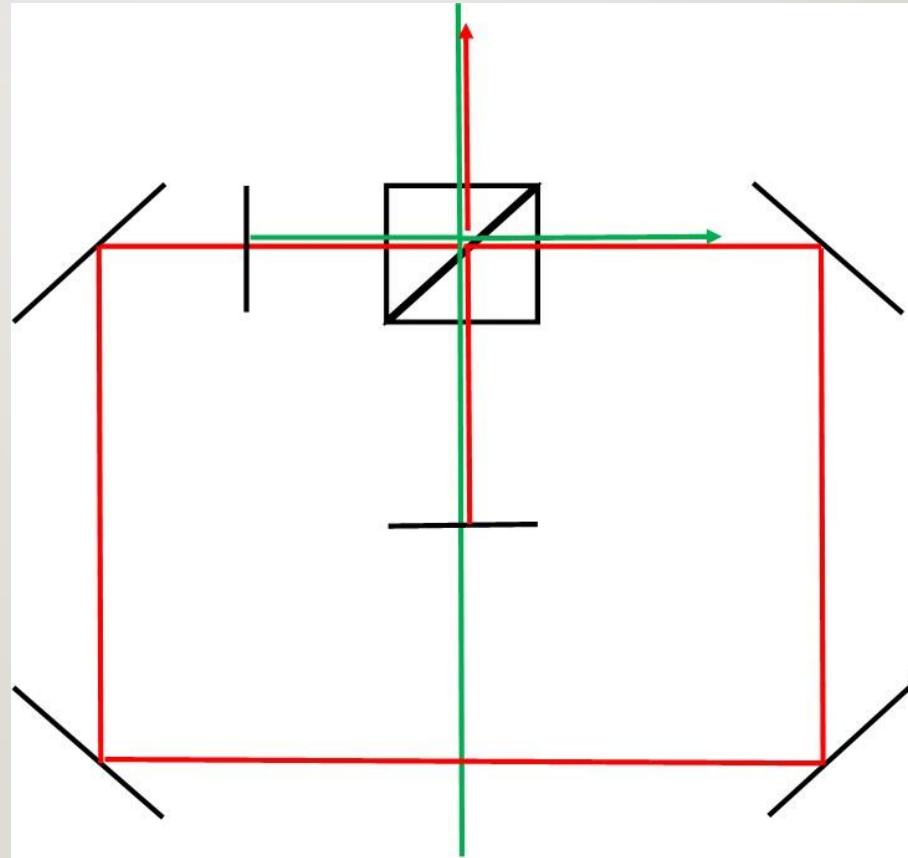


# 10 POLARIZATION CUBE

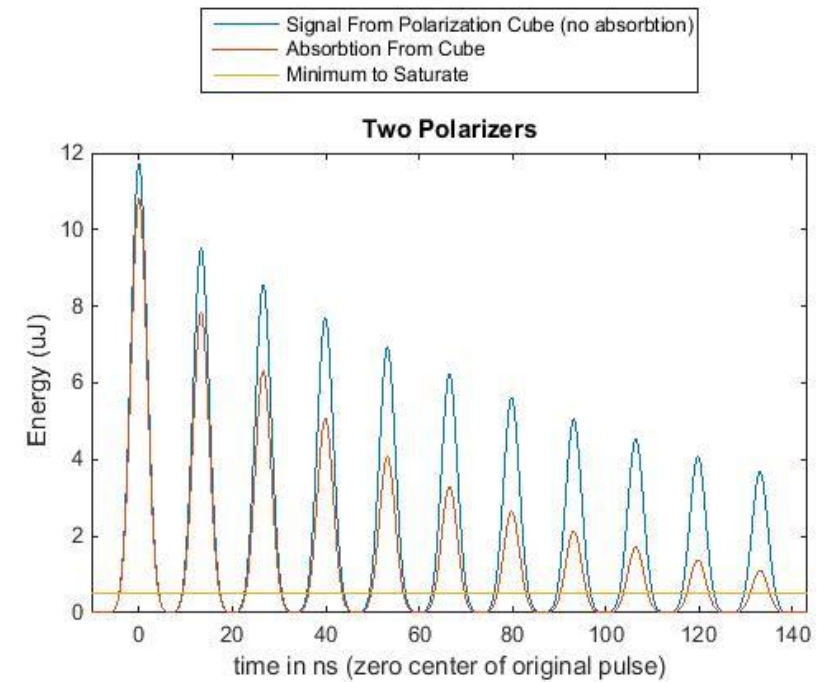
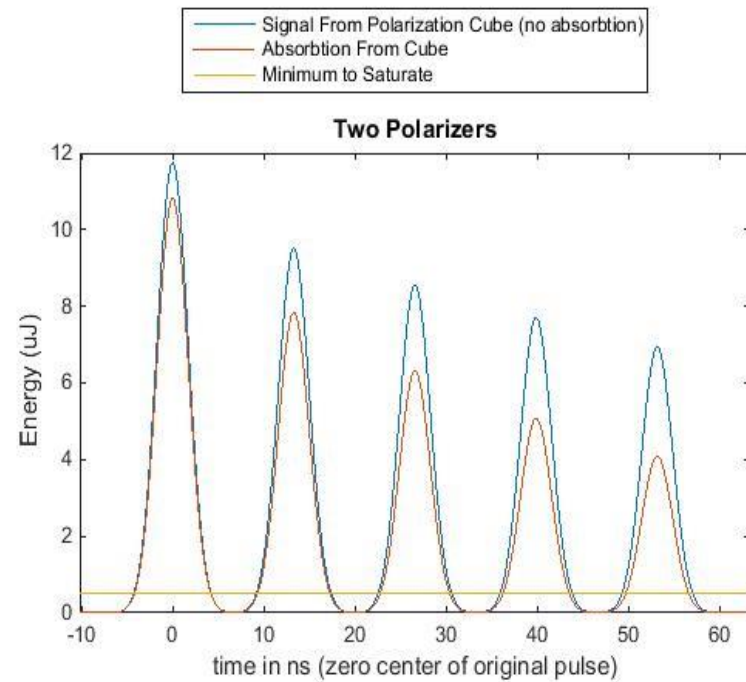
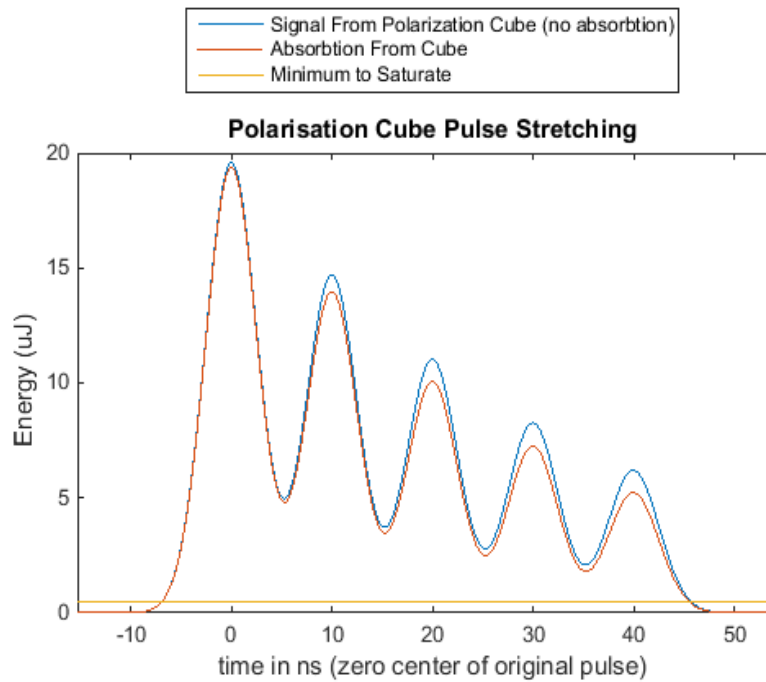


# || ORTHOGONAL POLARIZATION CUBE

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# 12 PULSE SHAPE



# I3 SATURATION FLUENCE

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- $I_{sat} = \frac{1}{6} hbar c k^3 \frac{\Gamma_{total}}{2\pi}$
- $\Gamma_{total} = \Gamma_{spont} + \gamma_{coll} + \Gamma_e + \Gamma_f + \Gamma_L \cong \Gamma_{spont}$
- $I_{sat} = 4544 \frac{W}{m^2}$ 
  - For 500  $\mu m$  radius (smallest possible) = 0.00357 W
  - For 4 ns =  $1.43 \times 10^{-5} \mu J$
  - For 100 ns =  $3.56 \times 10^{-4} \mu J$

# 14 STILL LEFT TO DO

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- Finish simulations
  - Determine best design
- Will be built this summer and implemented into experiment this year

# 15 QUESTIONS?

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