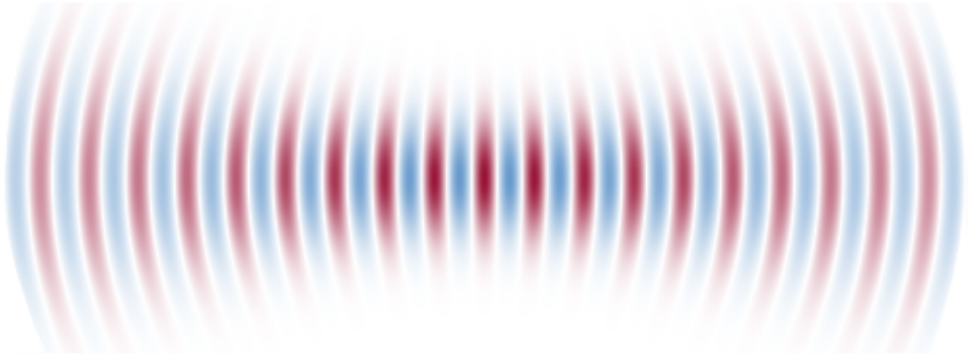
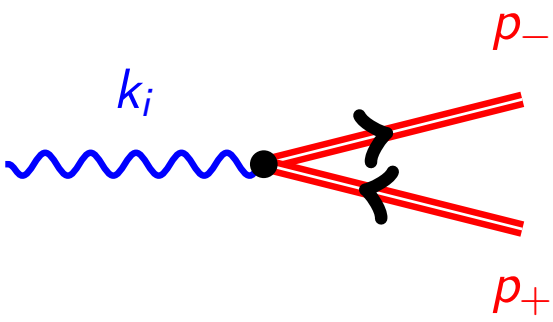
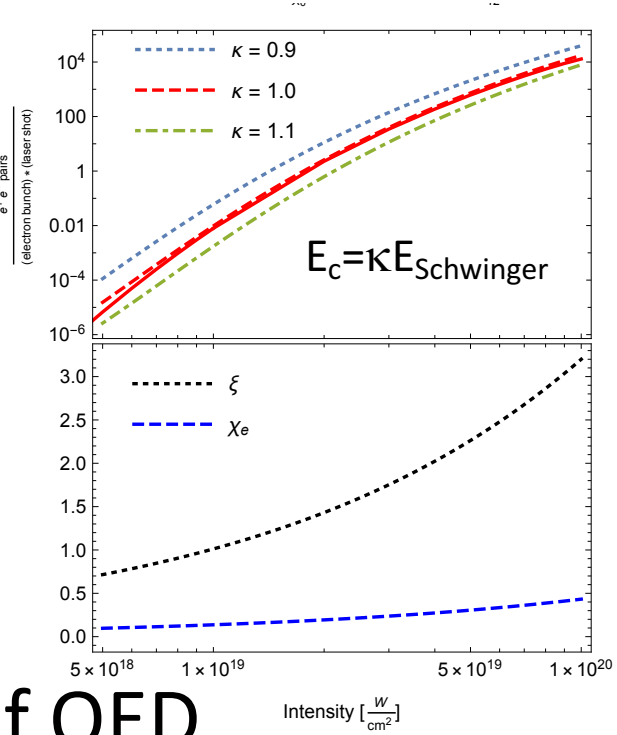
Laser Requirments LUXE

Matt Zepf



The Challenge





- Aim: Measure Critical Field of QED
  - Exact knowledge of *absolute* intensity required
  - Exact knowledge of *relative* intensity required
  - Large range of Intensity required

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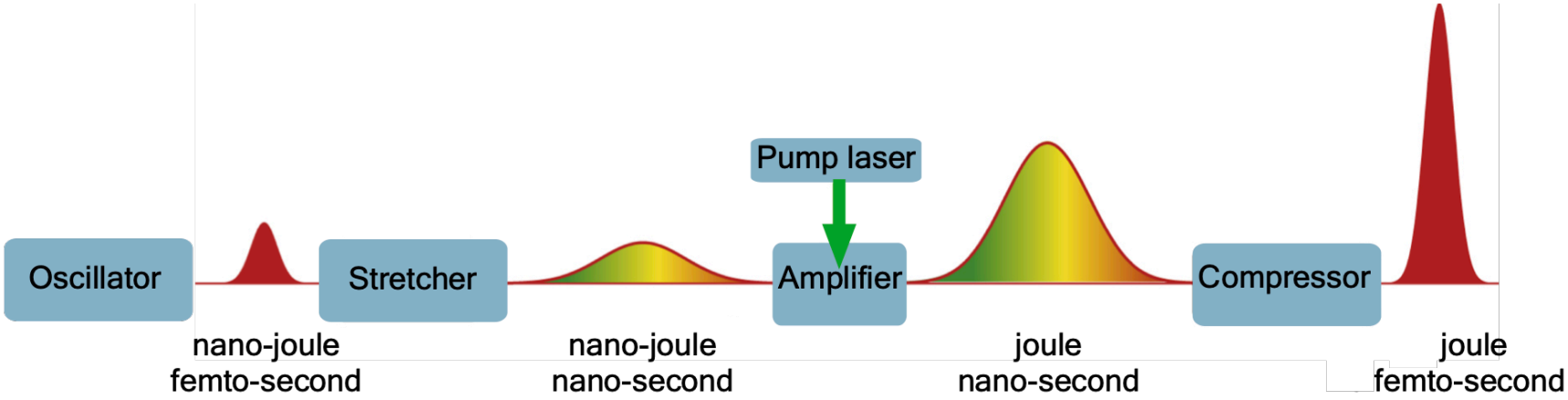
What laser do we need?



Standard CPA laser – commercial architecture.

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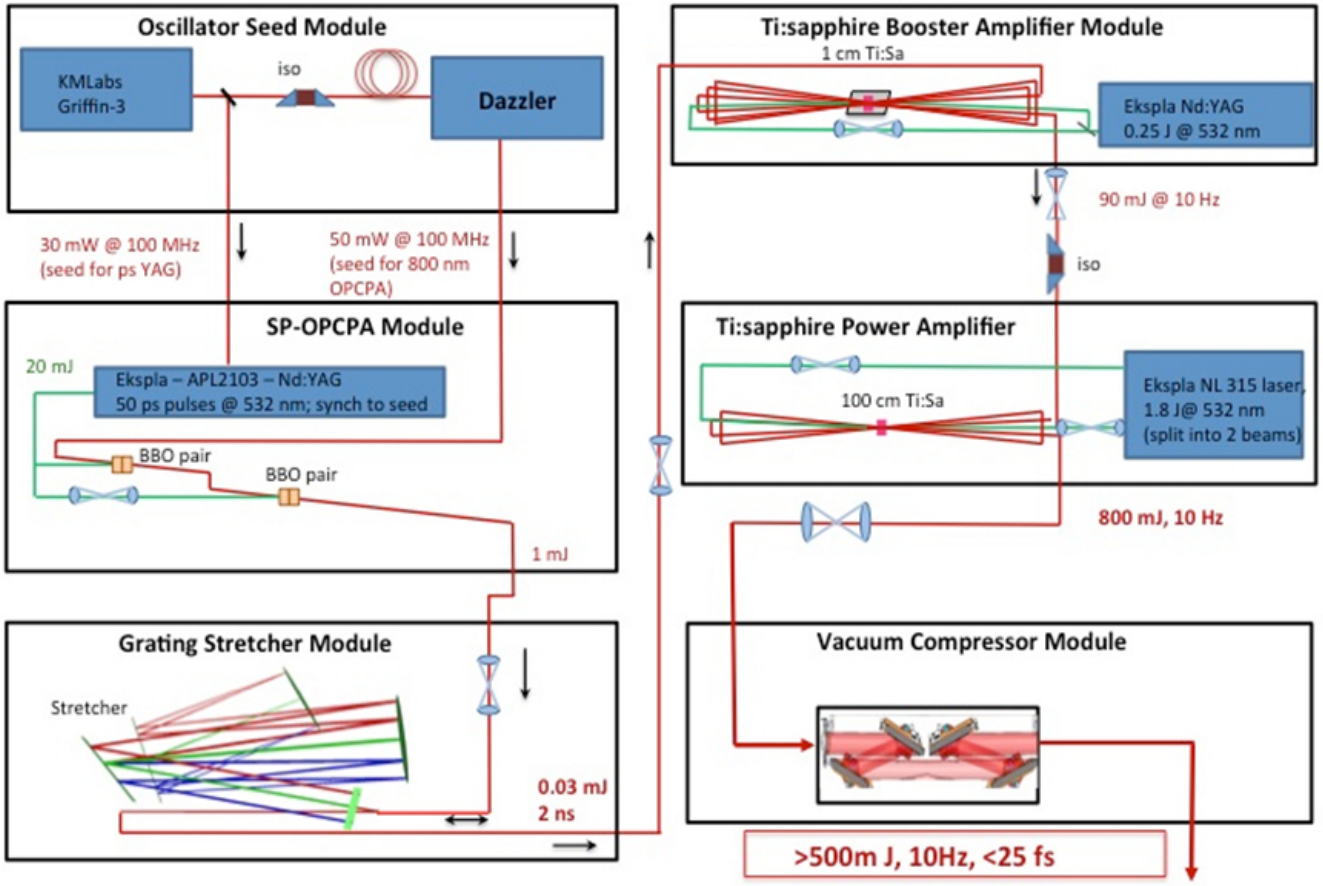
Standard Layout

High Contrast Front End eliminates intensity uncertainty due to Spontaneous Emission



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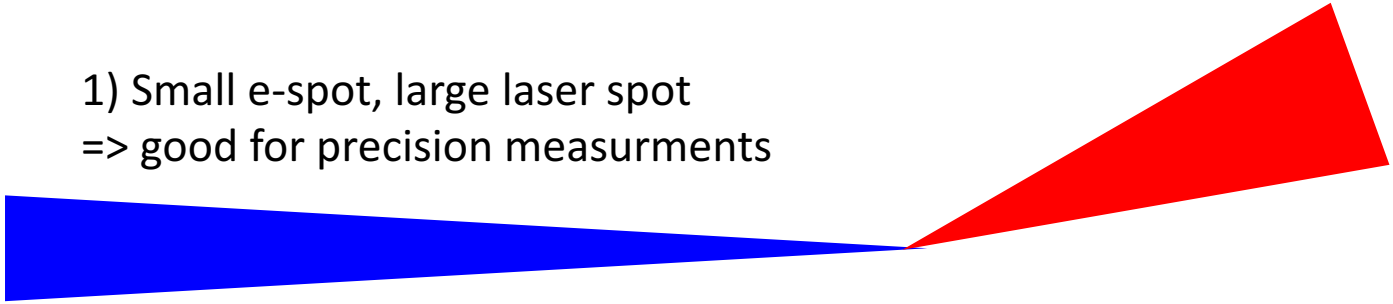
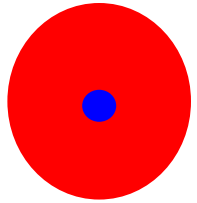
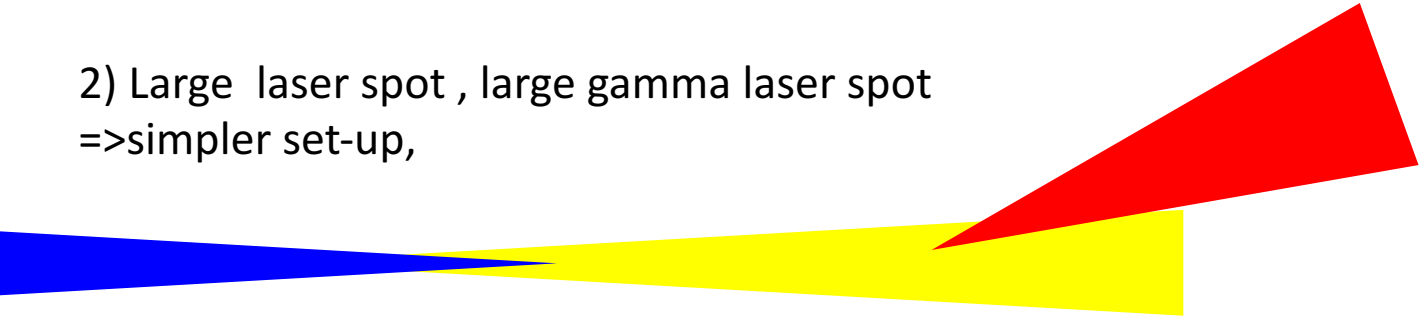
Different interaction geometries

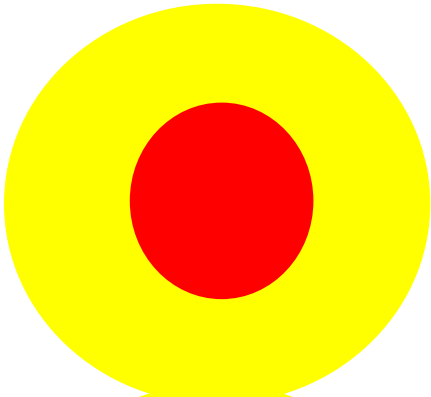
1) Small e-spot, large laser spot
=> good for precision measurments



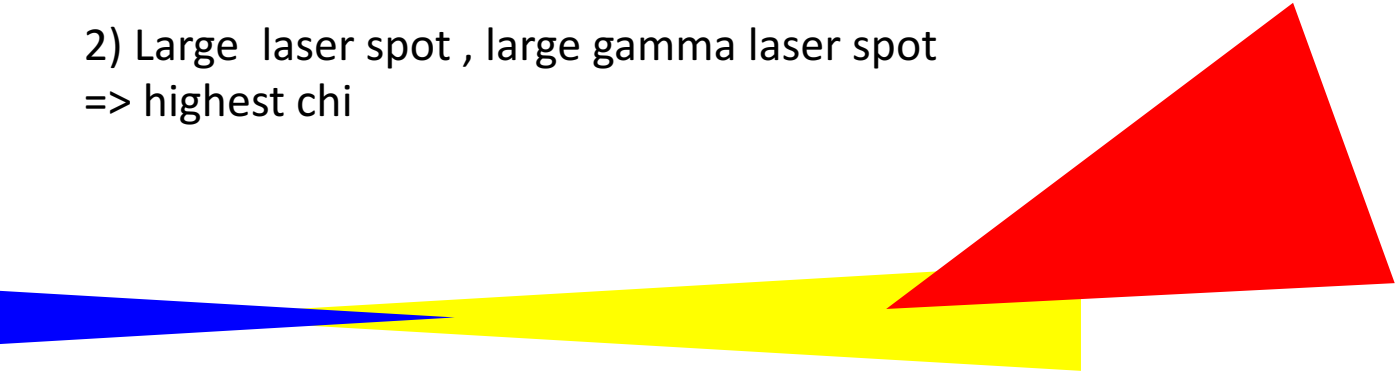


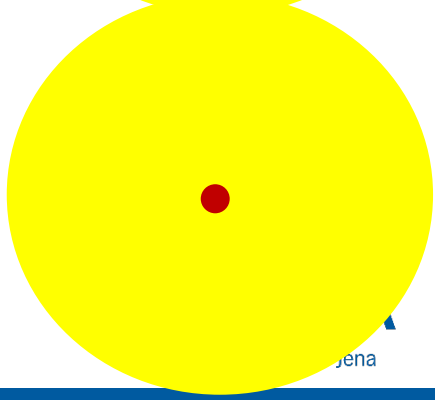
2) Large laser spot , large gamma laser spot
=>simpler set-up,





2) Large laser spot , large gamma laser spot
=> highest chi





System requirments

Geometry	f/3, 17°	f/10, 17°
FWHM (μm)	2.4	8
Laser Power (TW)	250	250
Repetion Rate [Hz]	≥ 5	≥ 5
Peak Intensity $Wcm^{-}2$	1.8×10^{21}	1.6×10^{20}
χ_{MAX} at 17 GeV	7	2

- Initial system requirements for f/10 set-up
  - 50TW (reaches χ~1) (Similar to facet)
  - 250 TW for full parameter range

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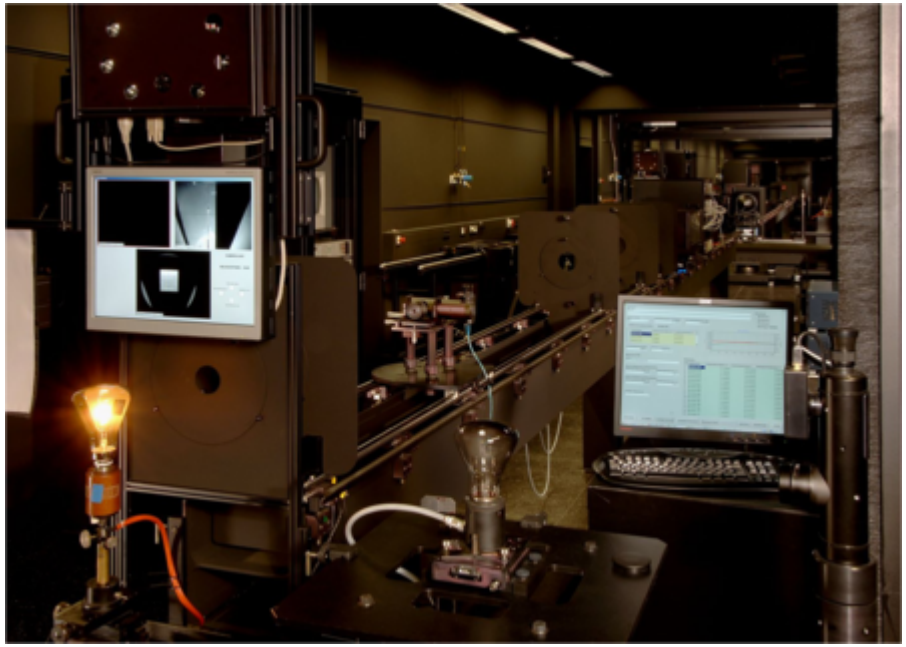
Measuring Intensity



- PTB/NIST: Candela traceable to 10^{-4}
  - 1cd: radiant intensity of (1/683) W/sr @ 550nm (540×10^{12} Hz)
  - At other frequencies 10^{-3}

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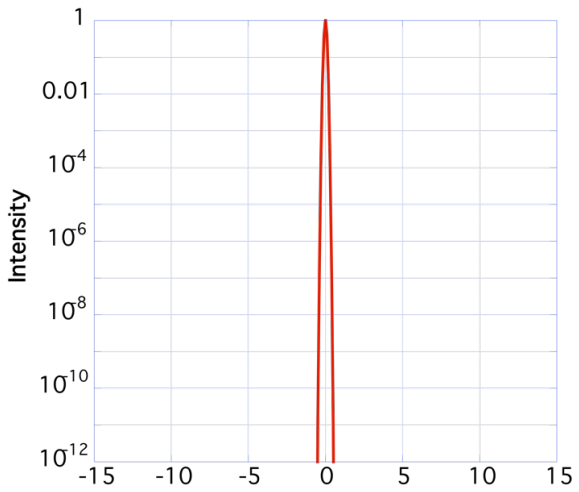
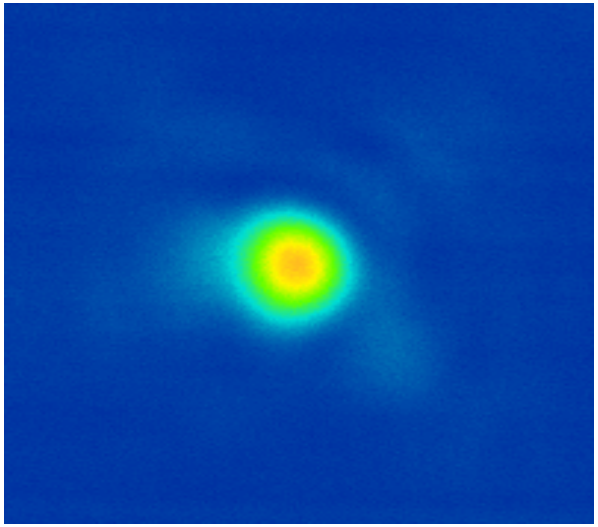
High Quality Diagnostic System





- Measure Laser Paramters to infer Intensity

$$I = \frac{E}{A\tau}$$

- Eliminate Shot to Shot variations

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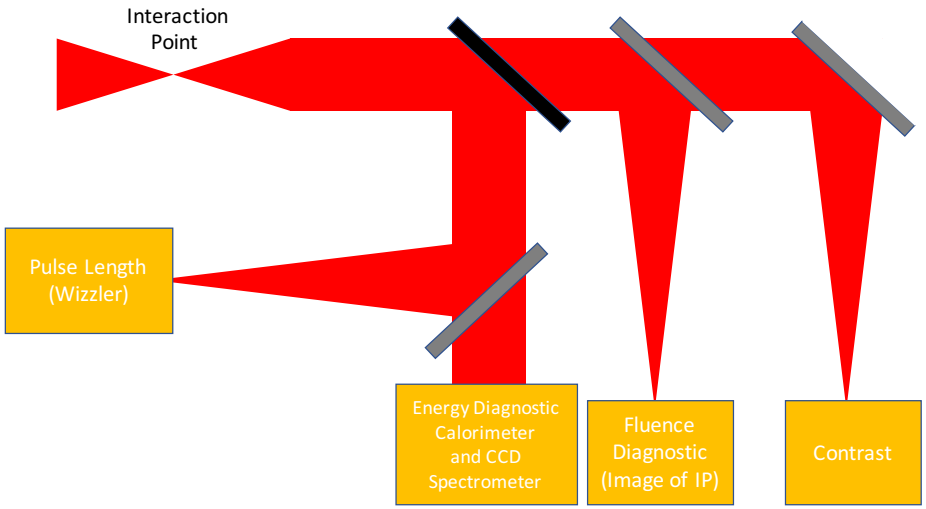
Diagnostic System



- Diagnostic system
  - Maintain Vacuum Propgation for best precision
  - Careful attenuation to avoid non-linearity

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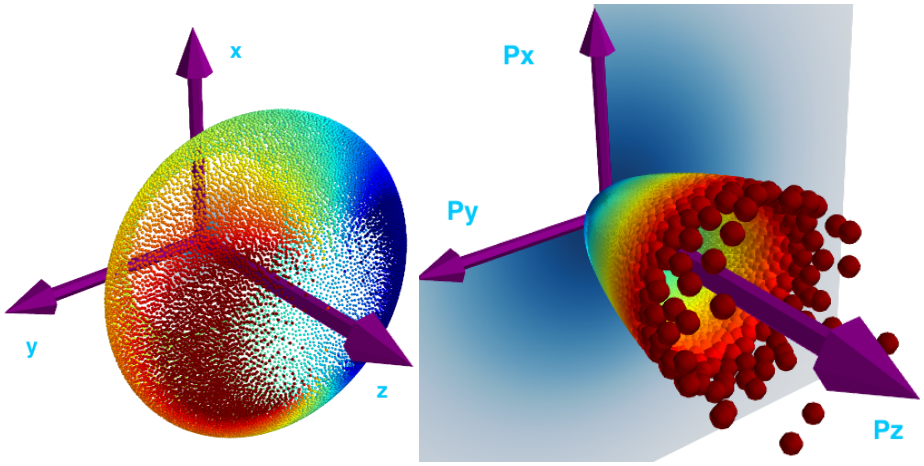
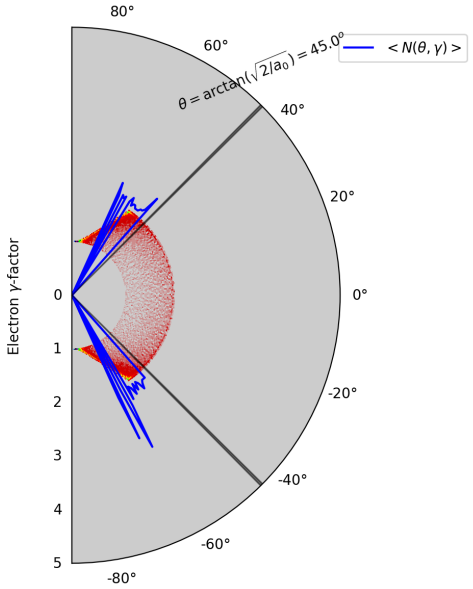
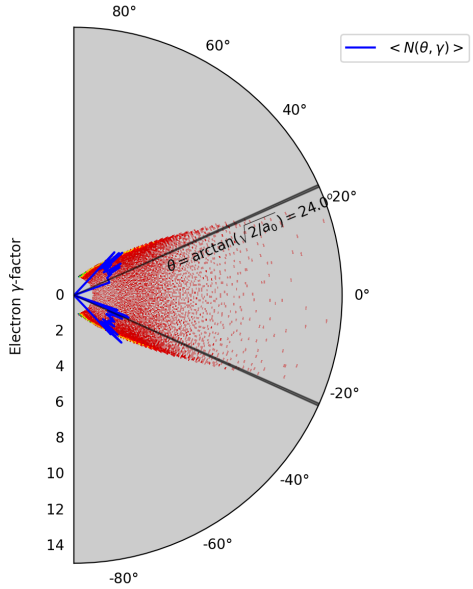
Independent Chi Measurement

Ponderomotive Scattering



Scattering angle depends a0





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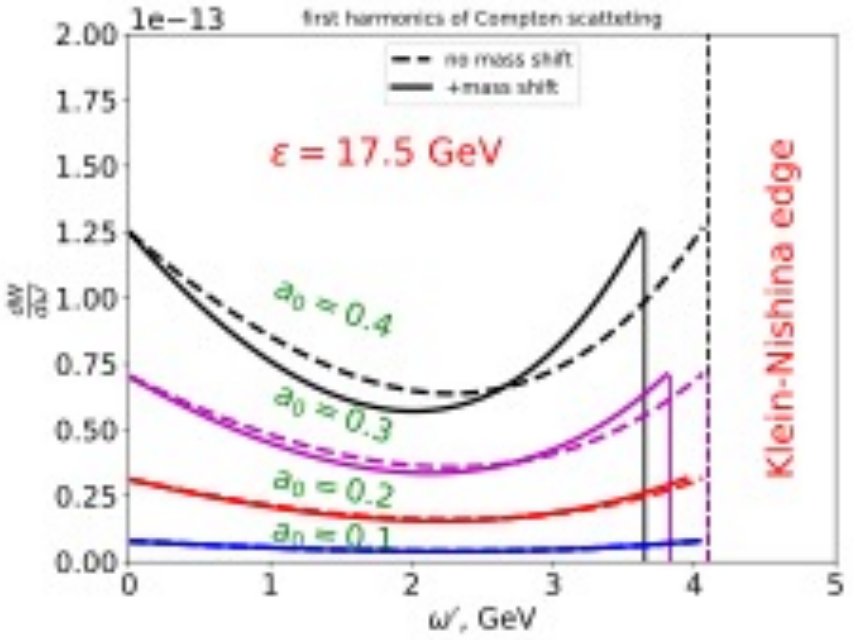
Compton Edge Shift



- More difficult measurement for peak a0
- May get washed out by averaging

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Costs

- Ballpark 3M for system + transport.
- Need enough space
  - Small existing labs do not look sufficient.