



Max-Planck-Institut für Physik  
(Werner-Heisenberg-Institut)



# AWAKE Laser Propagation Meeting

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*Wigner Institute*

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# Rough Agenda

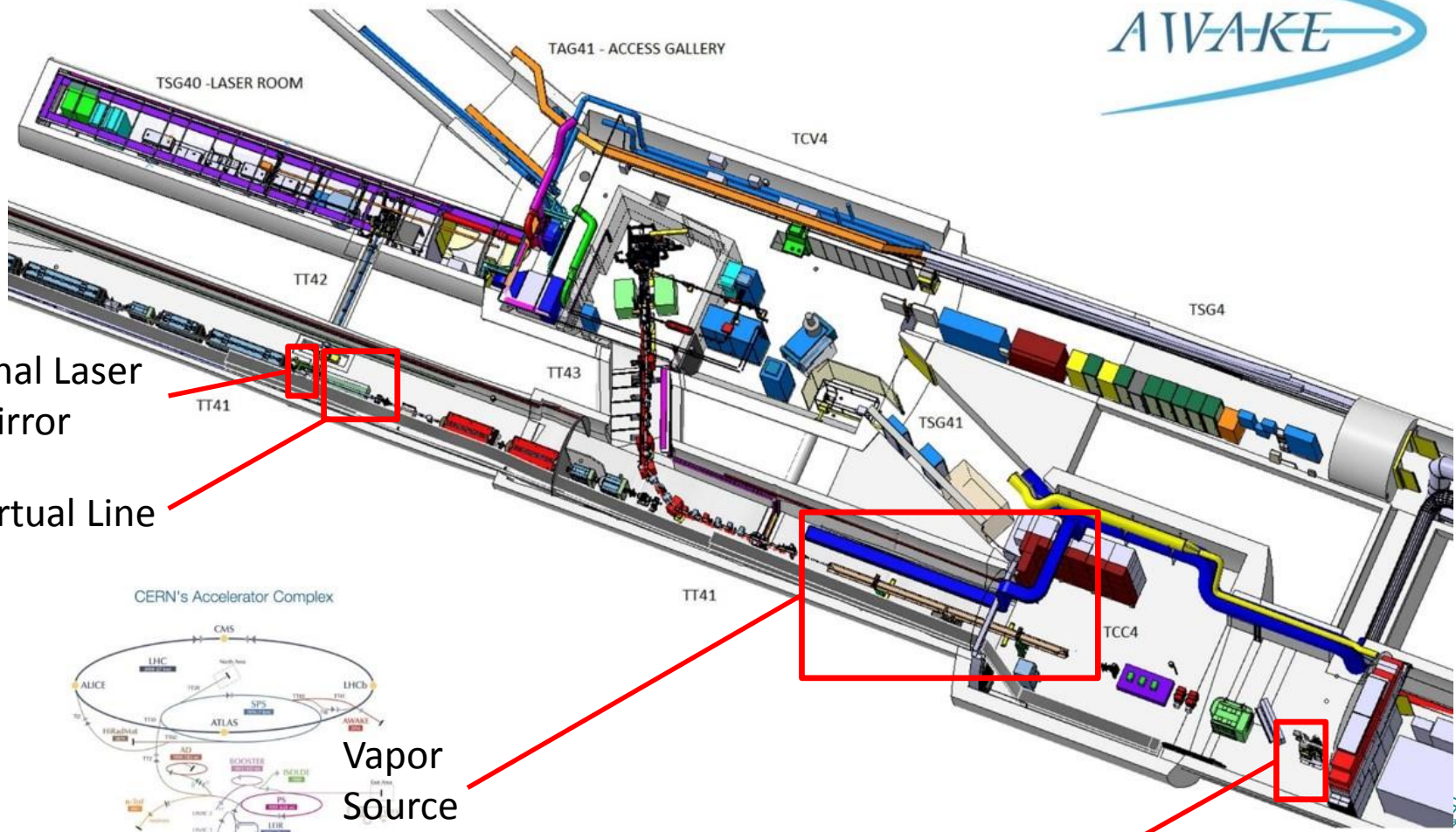


- Updates on Analysis
  - Brief Reminder
  - Gabor Report
  - Valentina
  - Anyone else
- Summer Program
  - Timetable
  - Program
  - Prerequisites
- What to show at collaboration meeting





# AWAKE Experimental Area

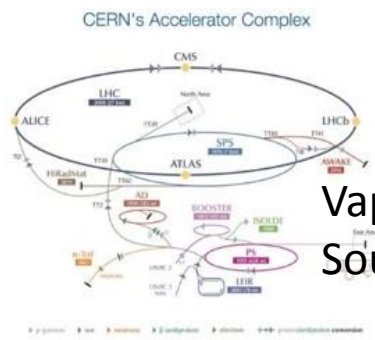


Final Laser mirror

Virtual Line

Vapor Source

Downstream Pickoff, LBDP3





# AWAKE Plasma Source

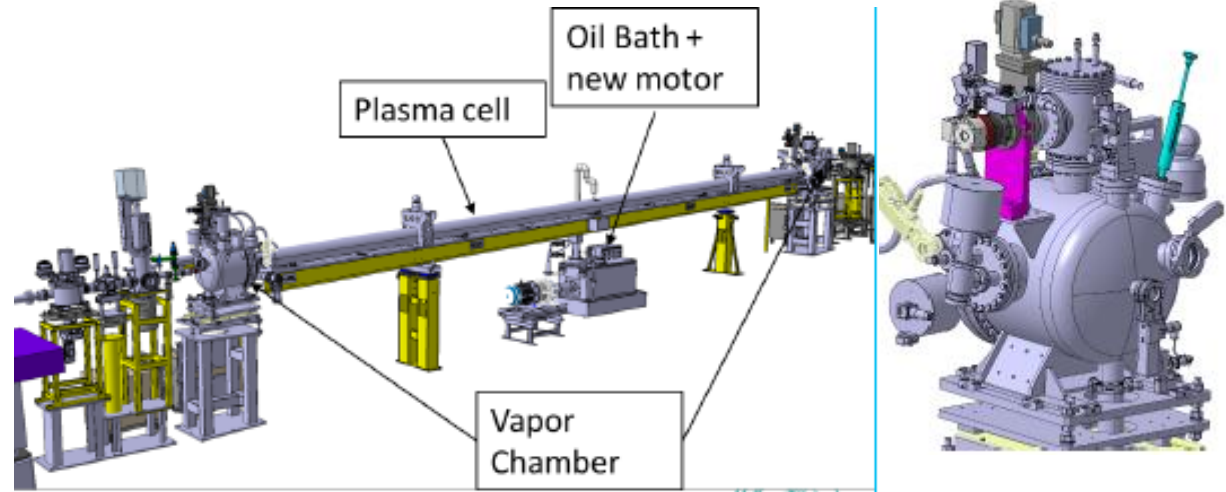
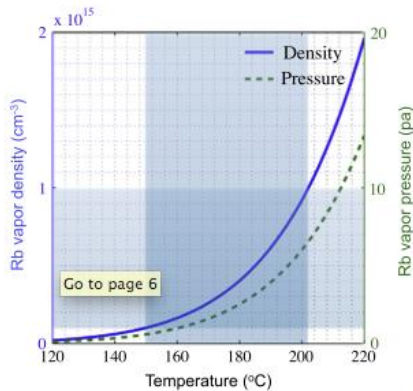
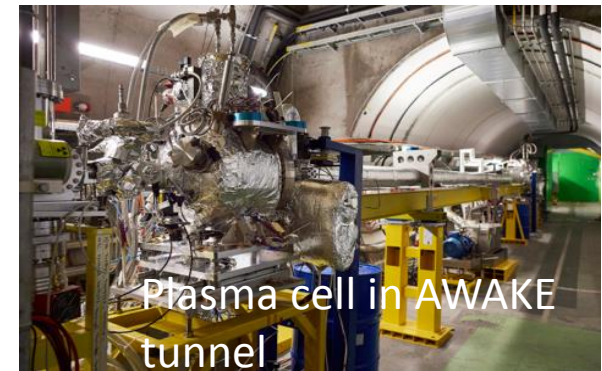
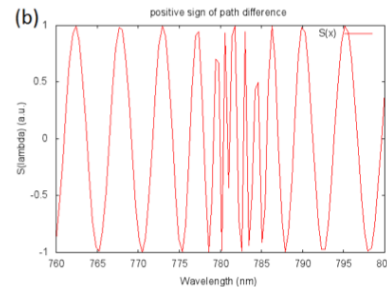
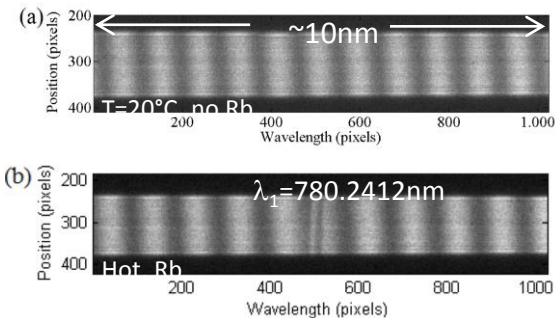


Fig. 1. Rubidium vapor density (blue line) and vapor pressure (green dashed line) as a function of temperature. Region between  $1 \times 10^{14} \text{ cm}^{-3}$  and  $1 \times 10^{15} \text{ cm}^{-3}$ , and the corresponding temperature show the parameter range of interest for the PDPWFA. (For interpretation of the references to color in this figure caption, the reader is referred to the web version of this article.)



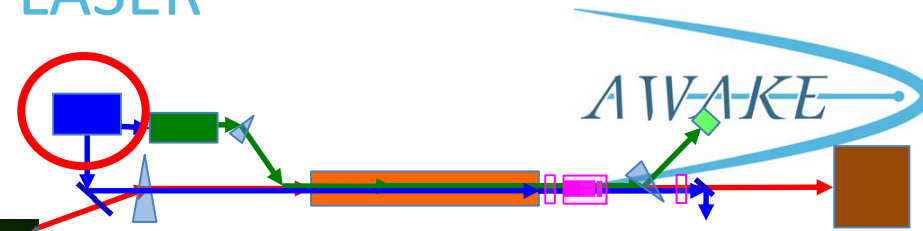
- 10 meter rubidium vapor source
- Rubidium is controlled to within .2% neutral density, gradients can be controlled  $(1-10) \times 10^{14} \text{ cm}^{-3}$
- Rubidium neutral density is measured by white light interferometry
- Vapor is photo-ionized by peak power 4.5 TW Ti:Sa laser





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# TW LASER



Laser System

Laser type	Er:Fiber/ OscillatorTi:Sapphire
Pulse wavelength	$\lambda_0 = 780 \text{ nm}$
Pulse length	120 fs FWHM
Maximum Pulse energy (after compressor)	<b>450 mJ</b>
Maximum Laser power	<b>4.5 TW</b>
Focused laser size	$\sigma_{x,y} = 1 \text{ mm}$
Rayleigh length $Z_R$	$\sim 3.5 \text{ m}$
Energy stability	$\pm 1.5\% \text{ r.m.s.}$
Repetition rate	10 Hz

Laser Room at AWAKE

Amplitude  
Technologies  
Centarus X

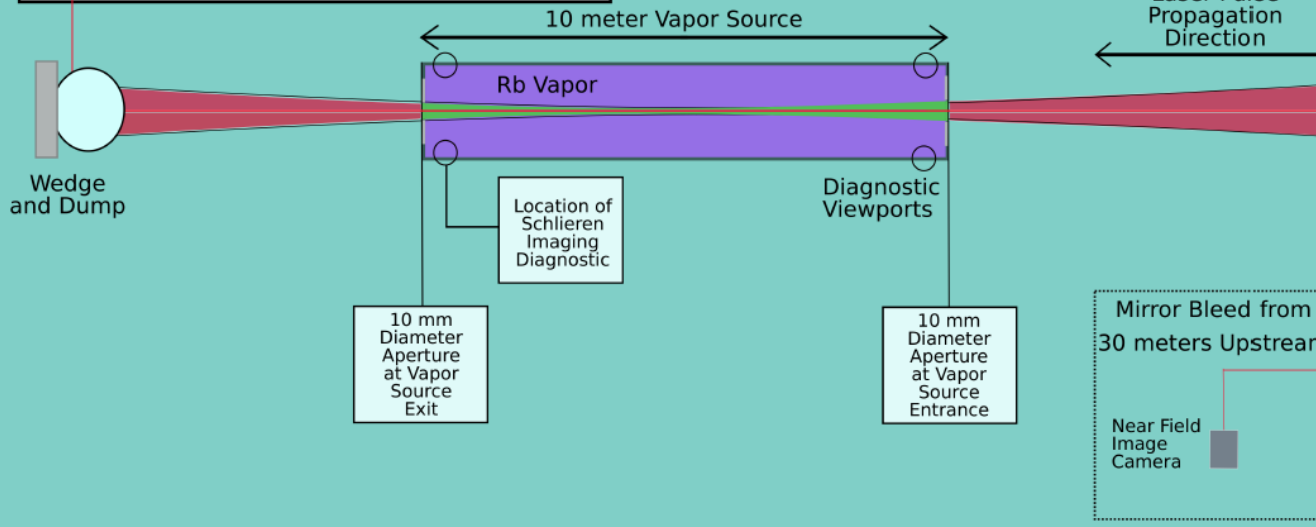
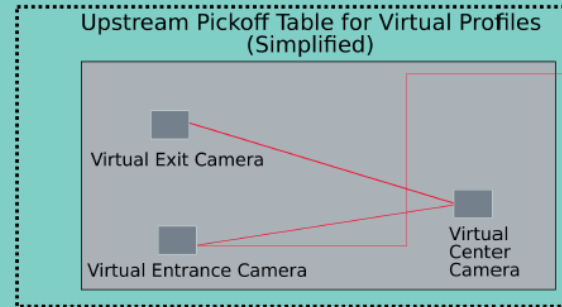
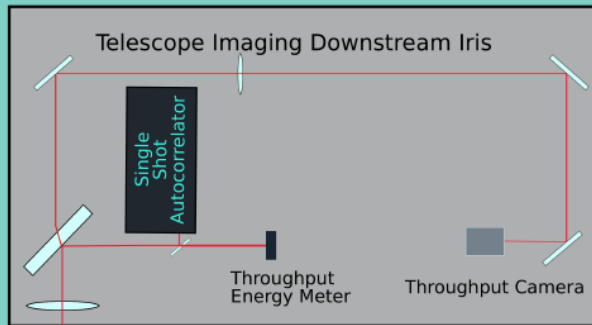
- Fiber laser chosen for stability on long runs
- Laser BW is only 15nm with peak spectrum at 780nm
- Several Rb lines within spectrum



# Investigation Setup

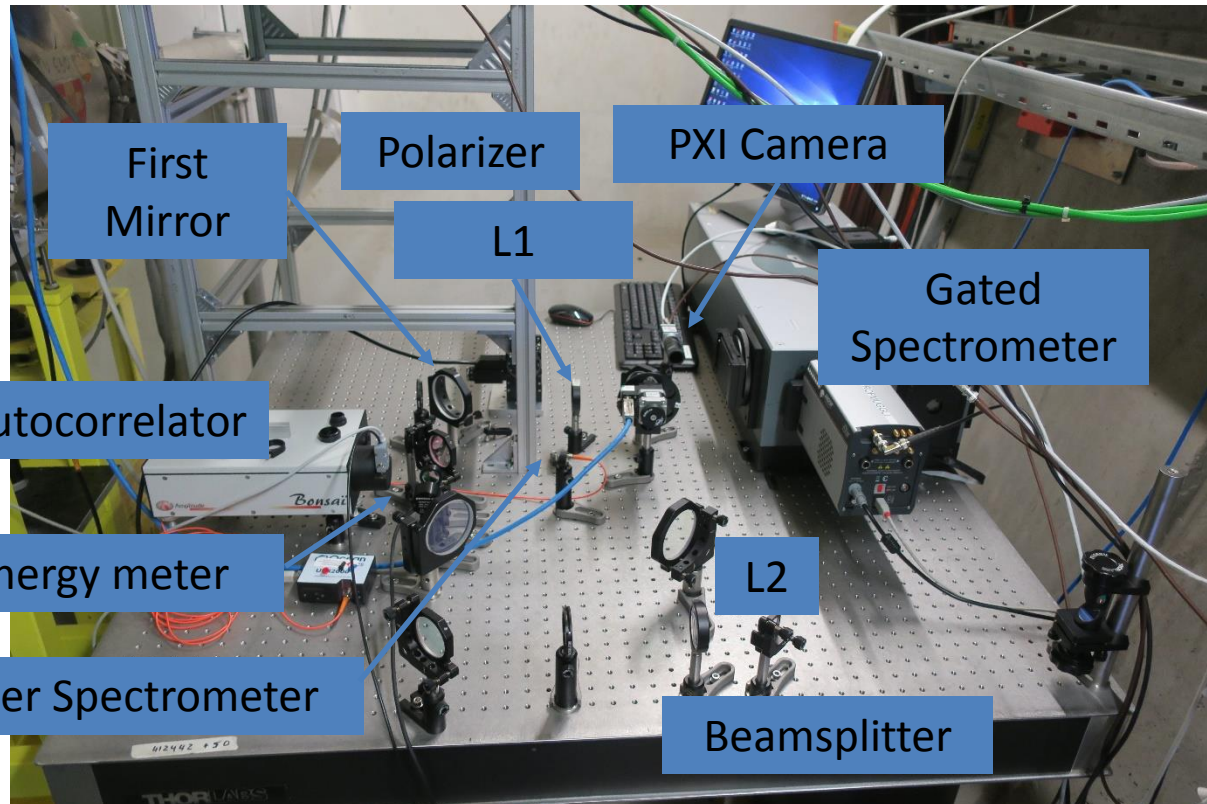
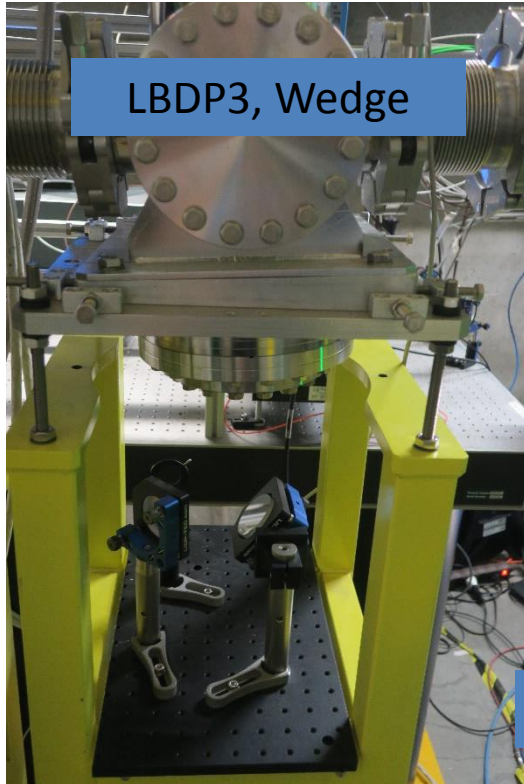
**Needs update**

## AWAKE Plasma Source (top view)





# Latest Setup Pictures





# Most Recent Laser Propagation Data



- Data sets from Laser Propagation
  - Three data file types:
    - .hd5 files including:
      - 6 transverse profile images at known distances
        - » 5 virtual line images to reconstruct the laser field at entrance of vapor source
        - » One image
      - Input and output energy of pulses into and out of vapor source
      - Autocorrelator data
      - Neutral Rb Data
      - Timestamps for data verification
    - Ocean optics “long timescale” spectrum
      - Simple files, ASCII two column - wavelength and signal
    - Andor gated camera spectrum ‘.sif’ files

- datasetVacPolmin\_100mJ.h5
  - Emeter03
  - Emeter04
  - IRCam
  - PickOff
  - autoCorrAmp
  - autoCorrDel
  - autoCorrFit
  - autoCorrImg
  - autoCorrWid
  - autoTimeStamps
  - camTimeStamps
  - rbDens\_value
  - rbSpecAmp
  - rbSpecDel
  - rbTimeStamps
  - vCam1
  - vCam3
  - vCam4
  - vCam5





# Summer Program: Timetable

Physics and Studies for Summer 2019

File Edit View Insert Format Data Tools Add-ons Help Last edit was made 4 days ago by Spencer Gessner

100% Arial 10

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
1		Late March	Early April	Late April	Early May	Late May	Early June	Late June	Early July	Late July	Early August	Late August	Early September	Late September	Early October	Late October
2	Access and interlocks	Non-functional	Non-functional	Non-functional	Non-functional	Non-functional	Non-functional	Non-functional	Non-functional	DSO tests					Availability unknown	Availability unknown
3	Controls	Non-functional	Non-functional	Non-functional	Spencer et al: Testing	Spencer et al: Testing	Spencer et al: Testing	Spencer et al: Testing	Spencer et al: Testing						Availability unknown	Availability unknown
4	RF	Non-functional	Non-functional	Non-functional	Non-functional	Non-functional	Non-functional	Non-functional	Non-functional	Conditioning?					Availability unknown	Availability unknown
5	High power laser	Non-functional	Non-functional	Non-functional	Non-functional	Non-functional	Non-functional	Non-functional	Non-functional	Realignment?	Laser-plasma studies	Laser-plasma studies	Laser-plasma studies	Laser-plasma studies	Availability unknown	Availability unknown
6	UV Laser	Non-functional	Non-functional	Non-functional	Non-functional	Non-functional	Non-functional	Non-functional	Non-functional						Availability unknown	Availability unknown
7	Electron source										Source studies		Source studies		Availability unknown	Availability unknown
8	Electron Beamline										Beamline studies		Beamline studies		Availability unknown	Availability unknown
9	Rb plasma cell				Rb Recycling??							Laser-plasma studies		Laser-plasma studies	Availability unknown	Availability unknown
10	Away dates		Spencer at LOA April-May	Spencer at LOA April-May	Spencer at LOA April-May	Spencer at LOA April-May			Steffen away 5th-21st	Steffen away 5th-21st		Spencer@LANL 19.08-23.08	Spencer contract ends, PJAS TBD	Spencer contract ends, PJAS TBD	Spencer contract ends, PJAS TBD	Spencer contract ends, PJAS T
11																
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From Spencer's planning table

- Access system is a part of safety, it is a **hard constraint** at the CERN level
- Main laser shutter is tied to access system **No access system, no laser through vapor source**
- Window is now late July-Sept
- Window is shared with other experiments





# Summer Program: Program



- Original Program:

1. Stable trigger gating of transmitted laser profile, spectrum, and transverse schlieren at ns+ timescales
2. Streak camera profile, spectrum, schlieren
3. Longitudinal interferometry





# Summer Program: PreRequisites



1. Nanosecond scale time resolved profile and spectrum:
  - Working laser system
  - Working vapor source
  - Move equipment from streak room to LBDP3 and Schlieren station
  - Pull cables from streak room to LBDP3 for triggers
2. Same as 1.
3. Access system, laser, vapor, triggers to laser room MP1 diagnostic table
  1. ~100m single mode fiber cable pull from LBDP3 to laser room
  2. Demonstrate isolation/protection and propagation of diode laser
    1. Faraday isolator?
    2. Crossed polarizers?
    3. Telescope to have small spot transversely through channel and pickup at grating?
  3. Build interferometer
  4. Demonstrate ability to make fringes on interferometer with 0 order bounce





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# What are our capabilities for interferometry?



- Big question for interferometry:
  - Do we have enough resources to do interferometry?



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# What To Show at Collaboration Meeting?



- Only a 10 minute update scheduled during the analysis section
- Analysis:
  - What conclusions can we draw, how can we prove them?
  - Main points of interest:
    - Transverse size of plasma versus laser profile for different neutral Rb densities
    - How certain are we of the spot size?
    - Can we do parameter sensitivity scans?
- Plan for Summer:
  - Do we continue with the interferometry plans?

