EXP19 - A simple dark-matter dectector with high-end acquisition system EXP19
A Review and Scientific Target

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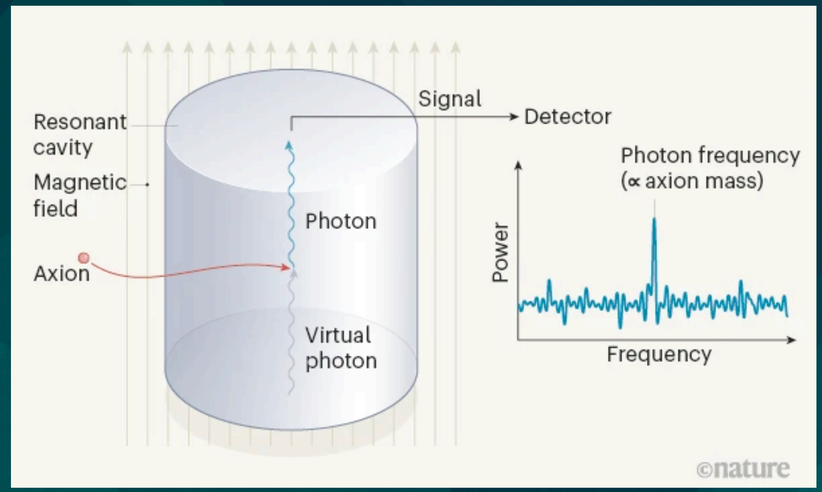
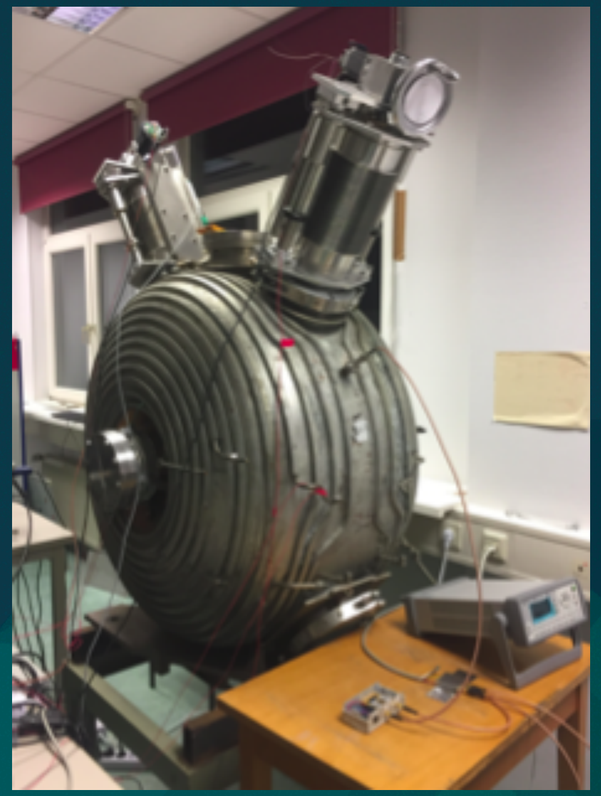
Wavelike dark matter? 🤔

- Conversion of DM to detectable photon (Primakoff, Kinetic Mixing)
- Matching the Compton wavelength of the DM to the size of apparatus
- Low T_sys detection system, T_rec dominates
- Most effective setup is resonant cavity ($\nu < 10$ GHz)

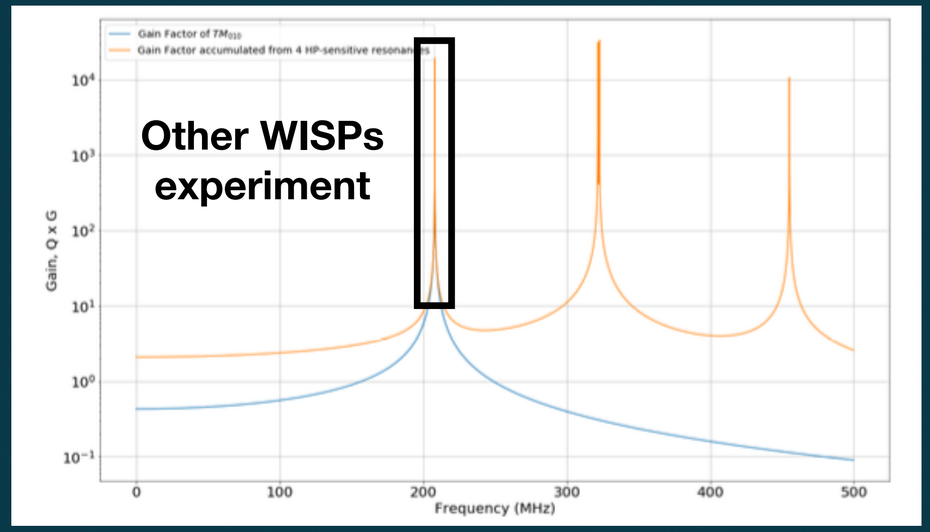


@Irastorza

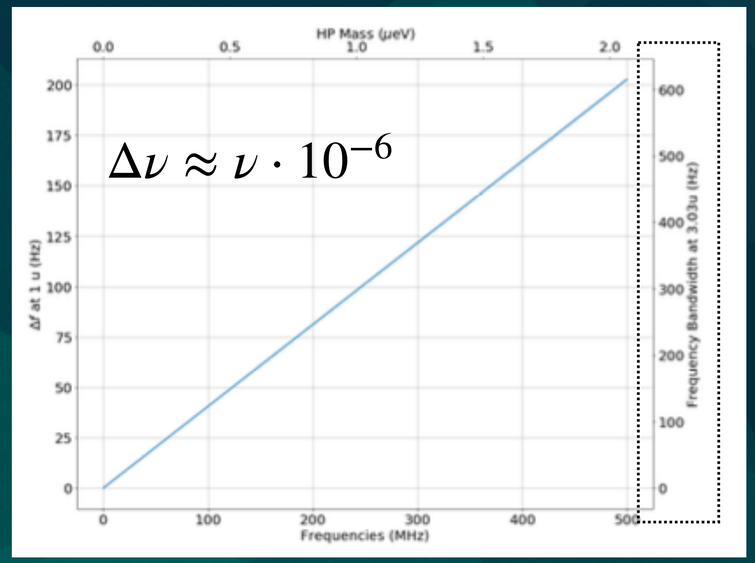
EXP19: WISPDMX



$$\chi = 2.9 \cdot 10^{-15} \sqrt{\mathrm{SNR}} \left(\frac{t}{1\mathrm{s}}\right)^{-1/4} \left(\frac{T}{100\mathrm{K}}\right)^{1/2} \left(\frac{\kappa}{0.1} \frac{Q}{50000} \frac{V}{447\ \mathrm{liter}} \frac{\mathcal{G}_{\gamma'}}{0.3} \frac{m_{\gamma'}}{\mu eV} \frac{\rho_0}{\mathrm{GeV/cm}^3}\right)^{-1/2}.$$



The power gain from the 208 MHz Hera Cavity

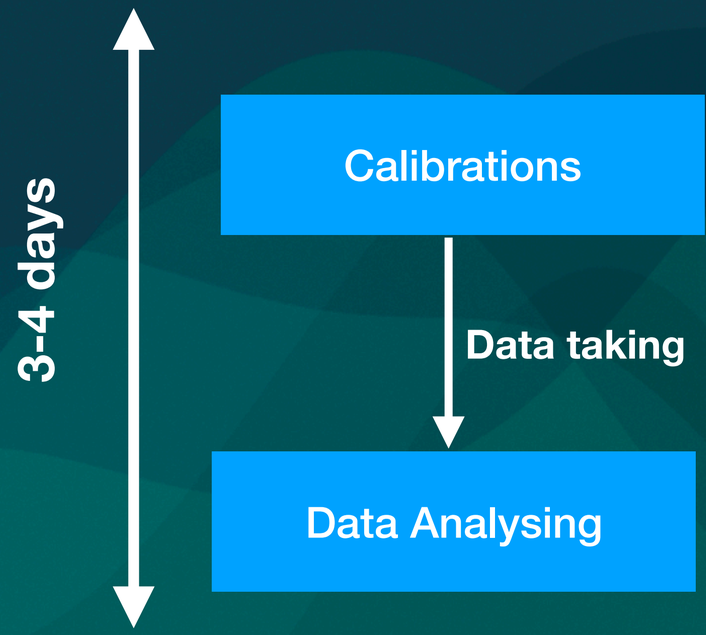


Signal width

Physics motivates the acquisition system development

EXP19: Agenda

1. Physics define the experiment design.
2. Experimental practice.
3. Technology advancement influences to experiment.



DM, WISPs, and fundamental of the components, dBm units

- Student's 1st day presentation
- Discussion (up to 2 hours)
- Aspect in experiment design

- Resonant frequency calibration (23 positions)
- Amplifier calibration
- ADC cablibration

- Taking calibrating data
- Analysis (simple and trivial)
- Systematic error estimation

- Working with high res data set
- Obtain baseline results
- Basic method to search for new physics

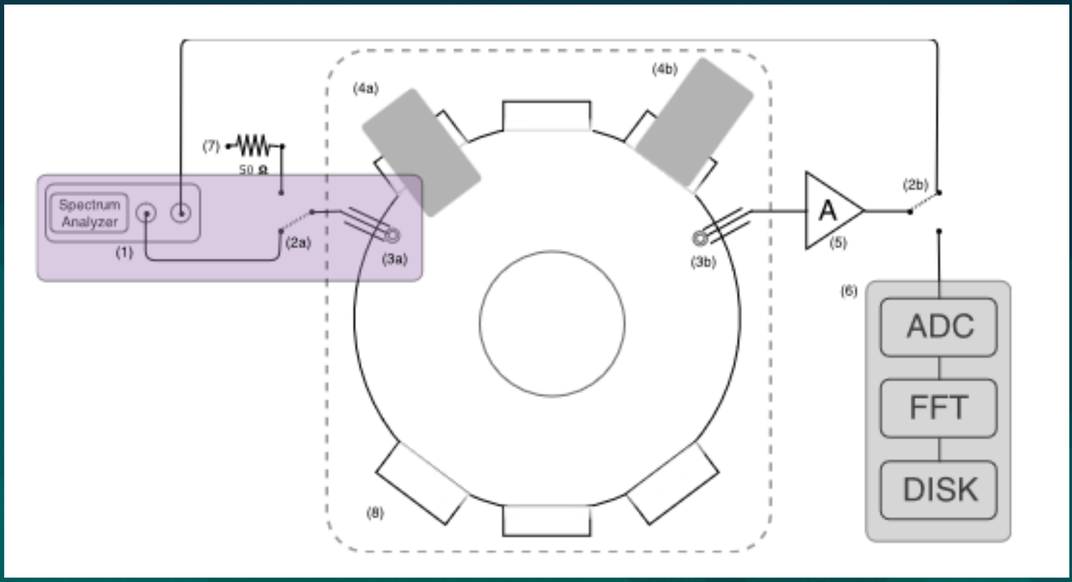
- Taking science data
- Analysis (advance array manipulation)
- Increase the complexity depends on the student.
- Recall knowledge from day 1.

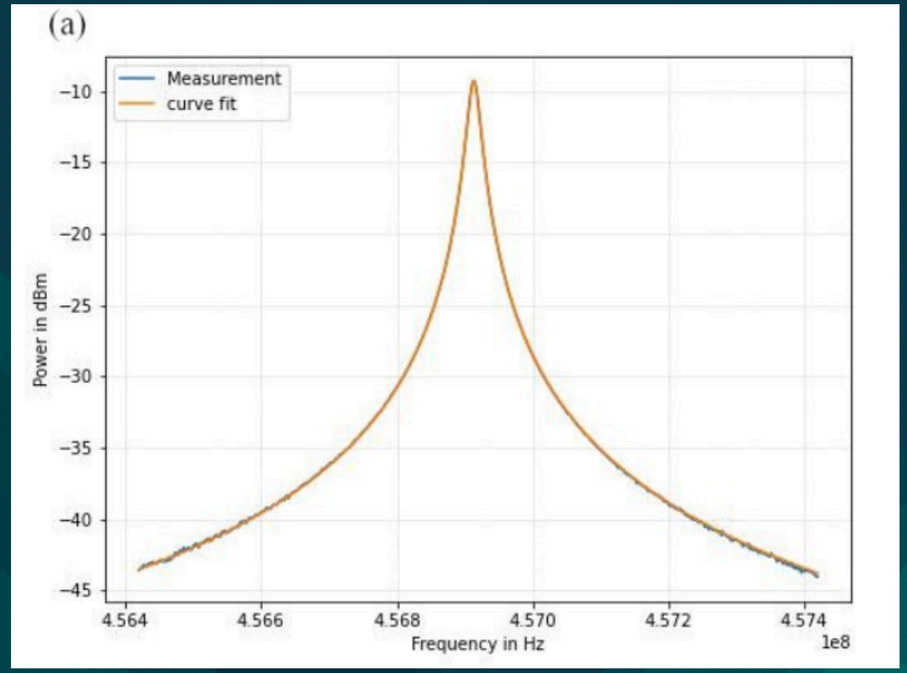
Calibrations

- Resonant frequency calibration (23 positions)
- Amplifier calibration
- ADC cablibration

- Taking calibrating data
- Analysis (simple and trivial)
- Systematic error estimation

- **Working with standard devices in RF measurement.**
- **Terminology/jardon of the field.**
- **Calibration routine for each components (with explaination)**





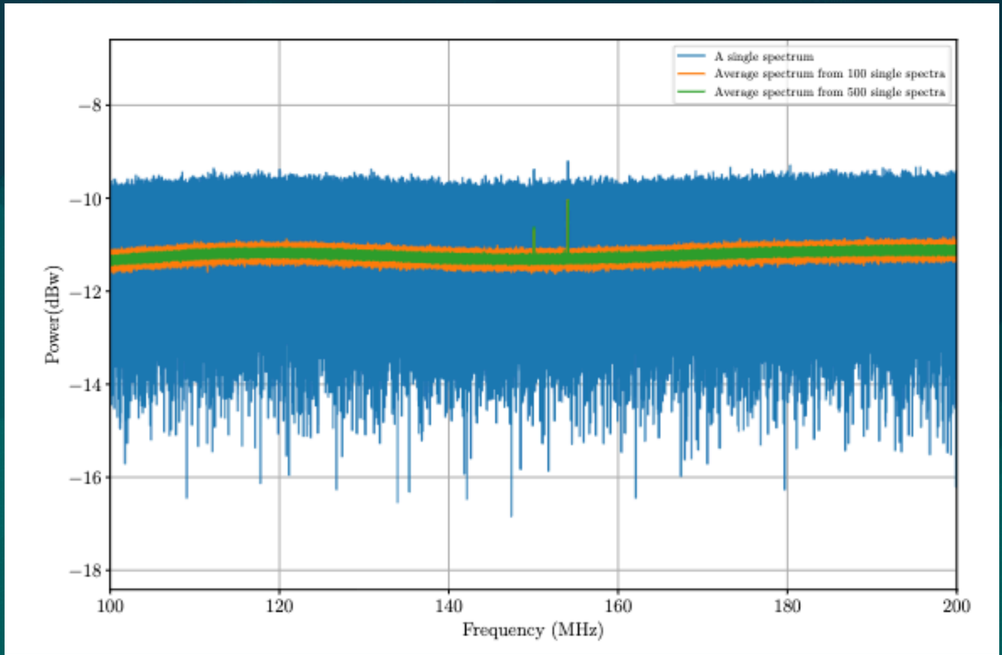
Spectrum near resonant and Fit

Data Analysing

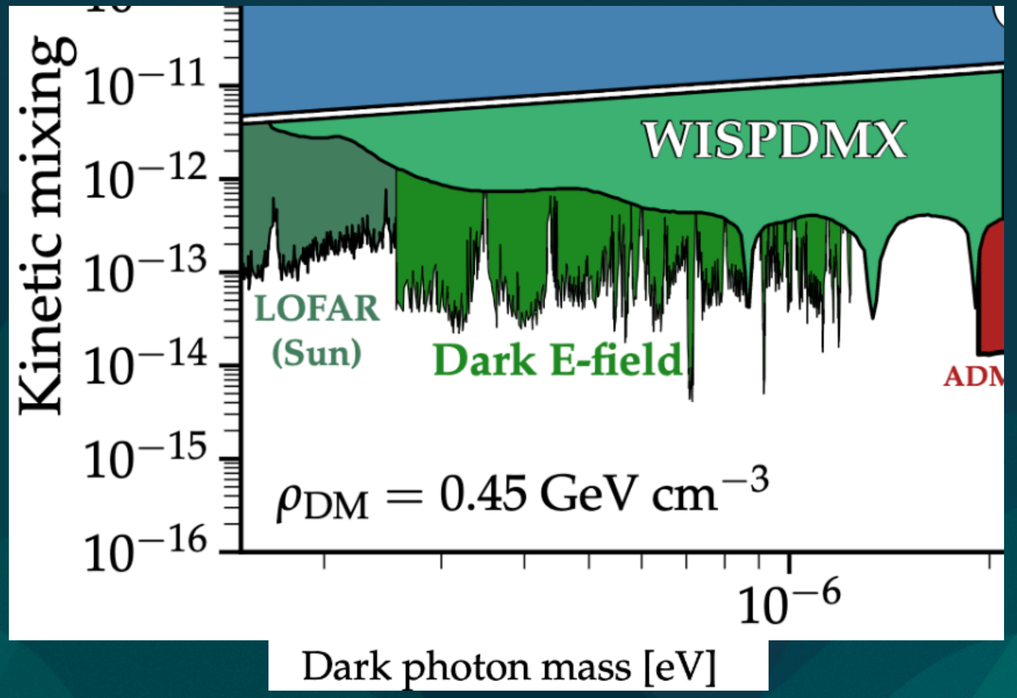
- Working with high res data set
- Obtain baseline results
- Basic method to search for new physics

- Taking science data
- Analysis (> baseline level)
- Increase the complexity depends on the student (secretly injecting signal)
- Recall knowledge from day 1.

- **Extracting ROI from Raw Data**
- **Data cleaning**
- **How to search for signal (background, noise power, and signal scan)**



Proving the Dicke Radiometry equation

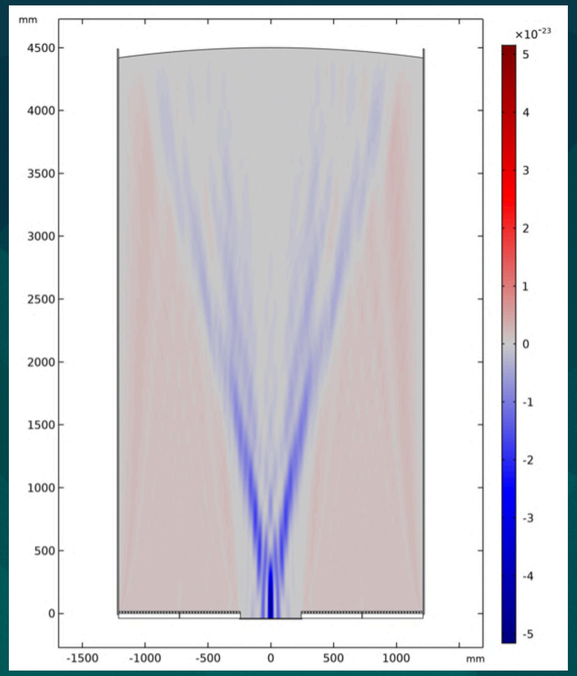


- **Baseline analysis: signal scan in a single resonant.**
- **Advance analysis: broadband search, signal fit.**

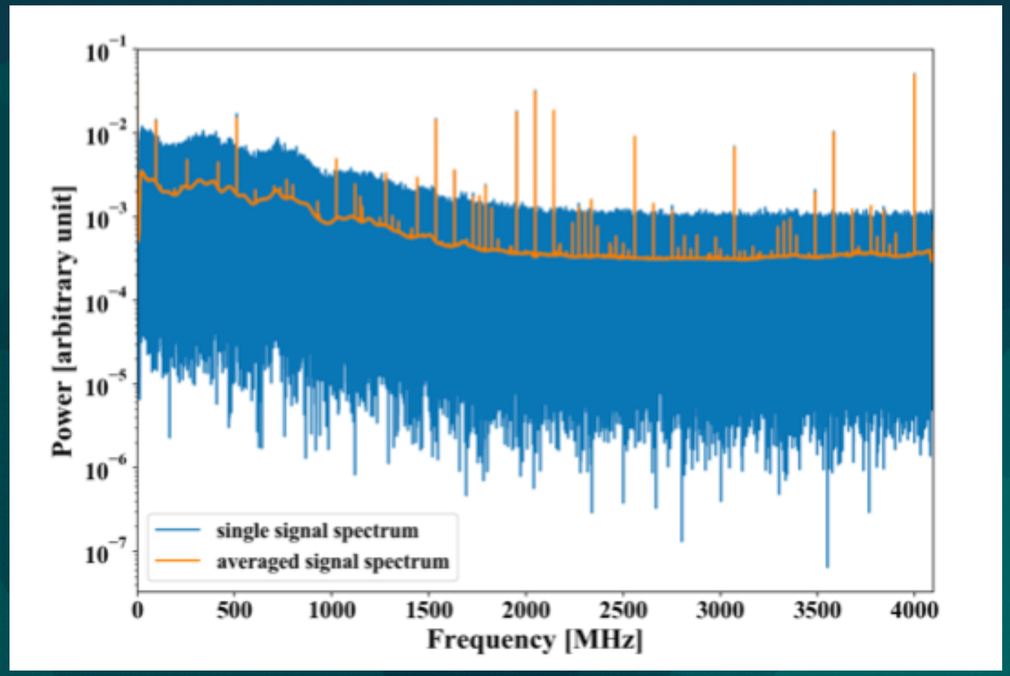
- EXP19 is usually their 1st or 2nd experiment.
- Consistent of 4 groups every semester (last sem, 5)
- Analysing part put their programming knowledge to practice
- Their data is not going to waste → HP modulation search, more data = lower noise

Theory / preparation	Setup / experimental	Data taking	Analysis	Protokol
3	3	2	4	3

Following BA/MA works by EXP19 students



BRASS-p Simulation



4000 MHz bandwidth @ 625 Hz for BRASS-p