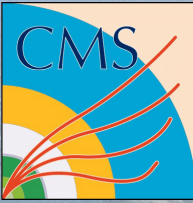




WISCONSIN
UNIVERSITY OF WISCONSIN-MADISON



USCMS PURSUE webinar

Abdollah Mohammadi
December 11th 2023

Abdollah Mohammadi



- Teaching Faculty and research scientist at UW-Madison Department of Physics
 - abdollah@hep.wisc.edu
- My research:
 - SM and Beyond SM Higgs boson
 - Tau Lepton reconstruction and Identification
 - Trigger systems and electronics

- **What are you really good at?**
 - Asking decent questions and Teaching (I hope)
- **Something you've had problems with**
 - Changing public's mind that Physics is actually beautiful and not difficult
- **I've got my eyes on:**
 - **Future Higgs Factory**
- **Things I enjoy:**
 - **Swimming in Summer and skiing in winter**
 - **Literature**

Mentee and Mentors

- Summer student: Kirstin Poppen from Gustavus Adolphus College, MN

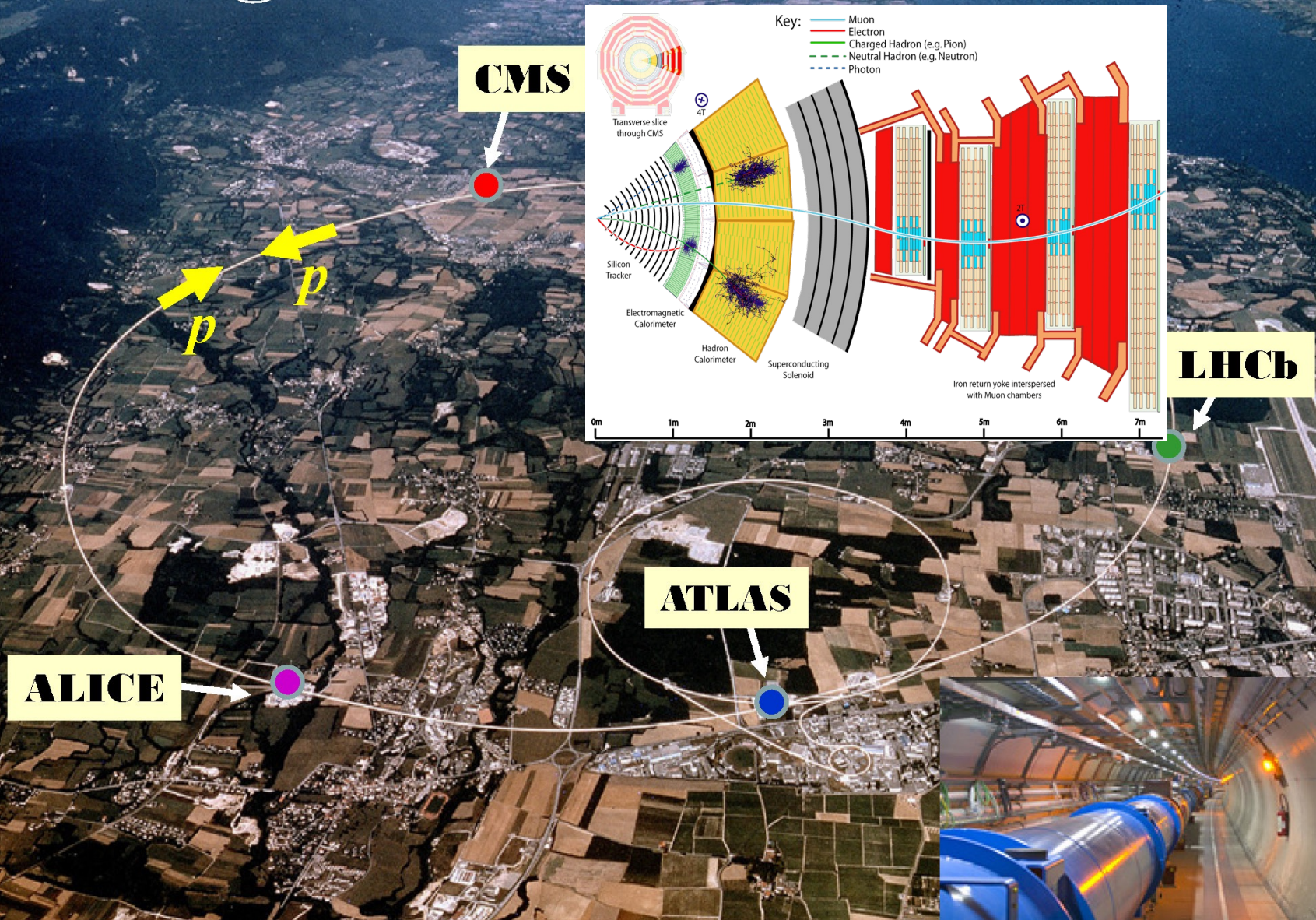


- Faculty mentor:
Abdollah Mohammadi, UW-Madison
Physics Department

Mentee Research Project

- **Title: Search for a heavy resonance decaying to a pair of boosted Higgs bosons in 4tau final state**
- Toward the end of this projects, mentee was supposed to learn the whole chain of data analysis
 - Understand the concept of the event selection and object reconstruction and identification
 - Specific focus on tau lepton and hadronic decays of the tau
 - Learn various methods of background estimation
 - Both from simulation and data
 - Incorporate advanced methods of data analysis using multivariate analysis techniques such as (Deep) Neural Network
 - Become acquainted with the concept of statistics and uncertainties and setting limit on the cross section production of the new particles

Large Hadron Collider



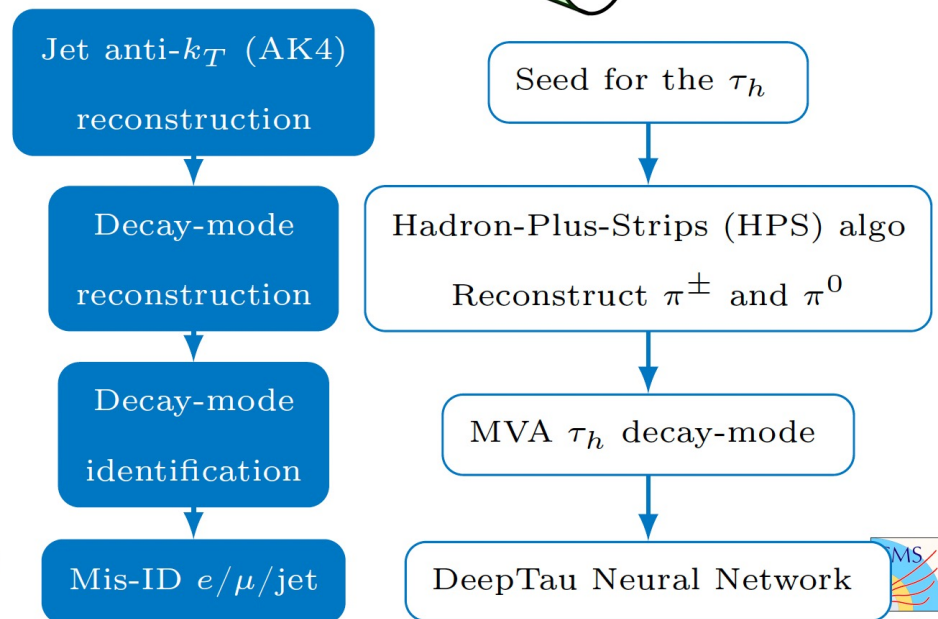
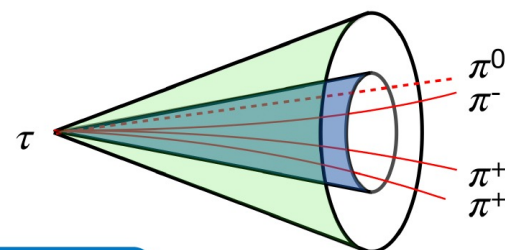
τ CMS reconstruction

Decay mode	Resonance	$\mathcal{B}(\%)$
Leptonic decays		35.2
$\tau^- \rightarrow e^- \bar{\nu}_e \nu_\tau$		17.8
$\tau^- \rightarrow \mu^- \bar{\nu}_\mu \nu_\tau$		17.4
Hadronic decays		64.8
$\tau^- \rightarrow h^- \nu_\tau$		11.5
$\tau^- \rightarrow h^- \pi^0 \nu_\tau$	$\rho(770)$	25.9
$\tau^- \rightarrow h^- \pi^0 \pi^0 \nu_\tau$	$a_1(1260)$	9.5
$\tau^- \rightarrow h^- h^+ h^- \nu_\tau$	$a_1(1260)$	9.8
$\tau^- \rightarrow h^- h^+ h^- \pi^0 \nu_\tau$		4.8
Other		3.3

τ_h appear in the detector with :

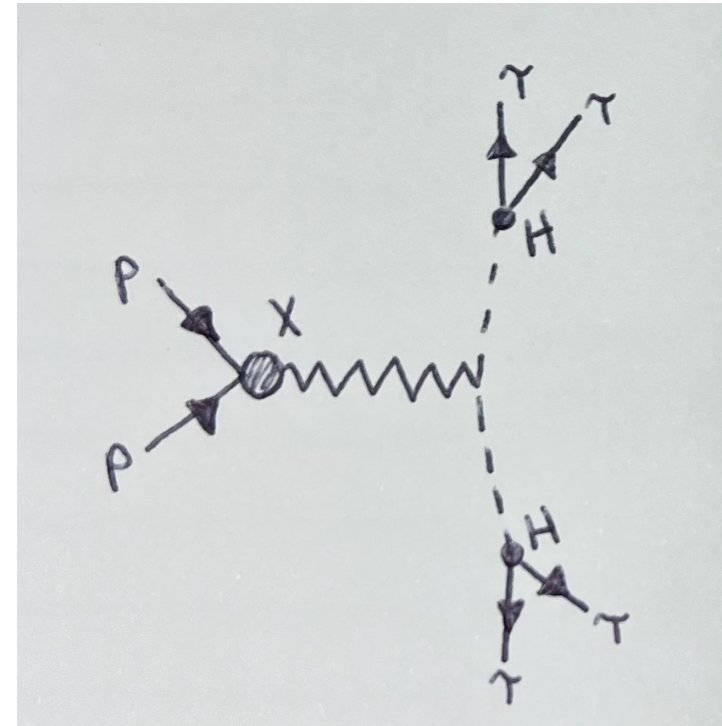
- 1 or 3 charged hadrons (mainly π^\pm, K^\pm , CMS does not distinguish them)
- 1 or more neutral pions that undergo the decay $\pi^0 \rightarrow \gamma\gamma$
- intermediate resonances in the decay

Many decay modes \rightarrow different signatures to be captured by the same algorithm



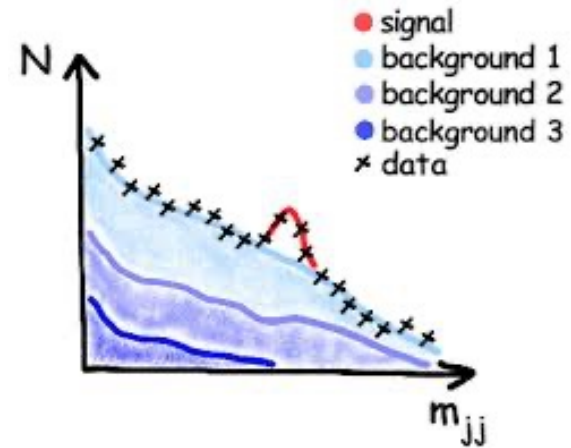
Physics Motivation

- Graviton/Radion (\sim TeV scale) are hypothetical particles that arise many Beyond standard model theories and might decay to SM Higgs bosons
- Higgs boson has an approximate mass of 125 GeV, this they will be Lorentz-boosted
- Each Higgs decay to pair of collimated taus
- Previous research in CMS only looked for resonant particle with mass up to 1 TeV in 4 tau final state
- This research will look in the range of 1-3 TeV [*NEW STUDY*]

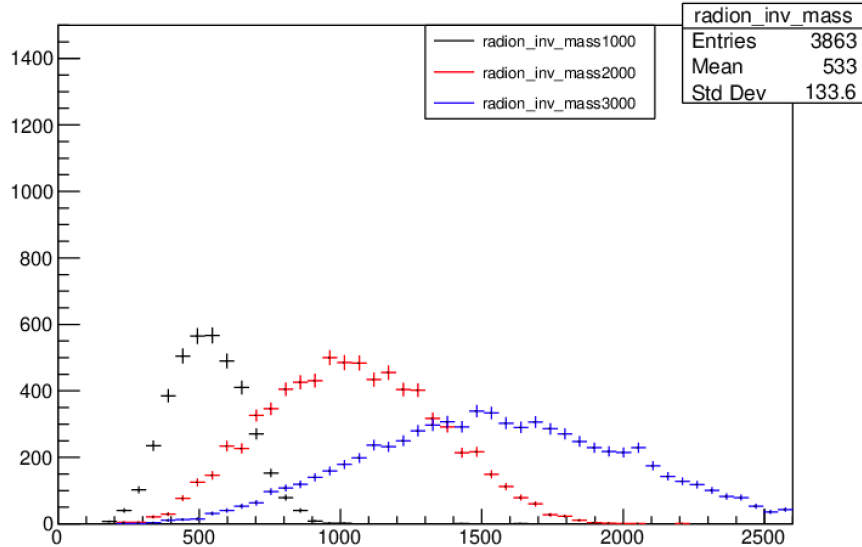


Mass is the finger print

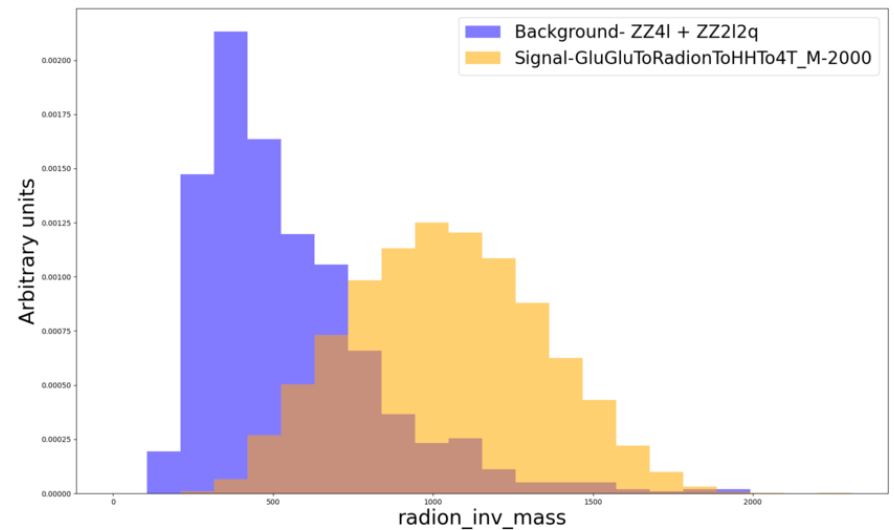
Mass is the
particle's
fingerprint



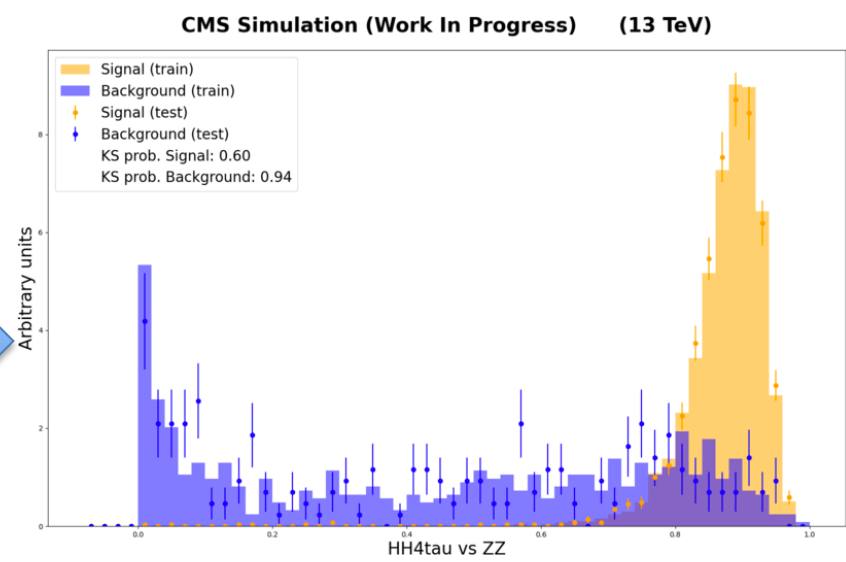
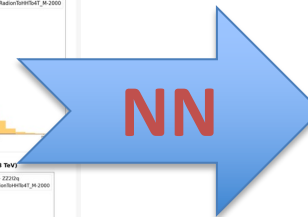
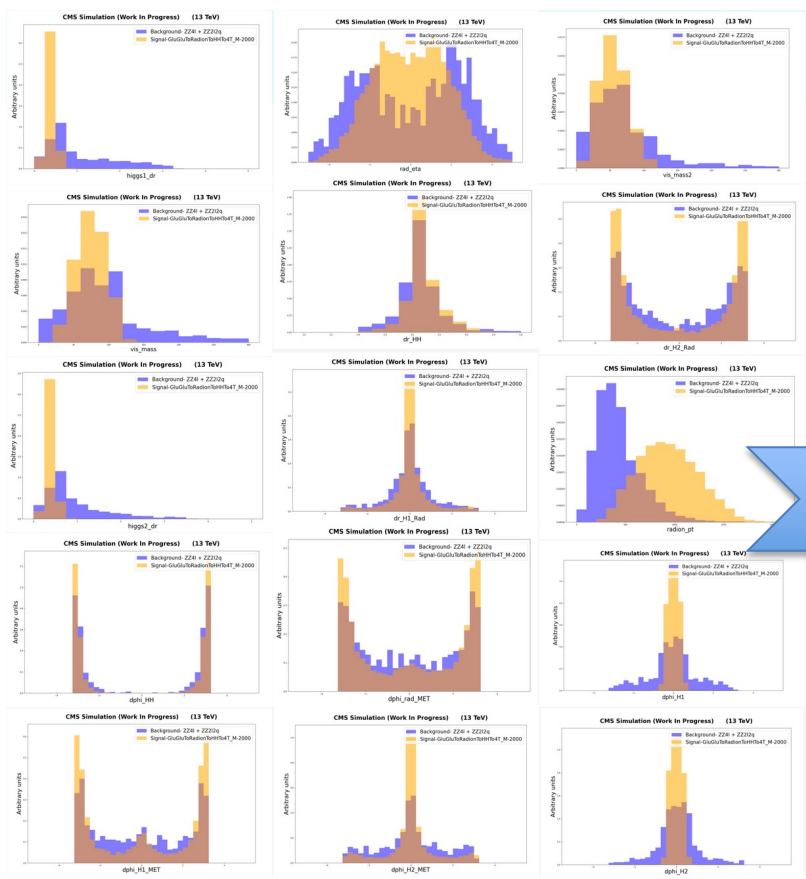
radion_inv_mass



CMS Simulation (Work In Progress) (13 TeV)



Neural Network (Inputs v.s. output)



Overall Experience with Program

- The USCMS workshops and tutorials held at Fermilab were very helpful for the student, so it was a smooth process to get started on the research project
- Kirstin then moved to Madison and closely worked with me and other undergraduate students during the summer. Lots of discussions and a couple of weekly meetings
- Kirstin learned a lot and found the project very interesting. She is now continuing on finishing remainder parts of the analysis
- Kirstin got a chance to present her work at the US-Madison HEP Physics meeting and will present her work in [Conferences for Undergraduate Women in Physics \(CUWiP\)](#)
- She will apply for graduate school next year! Great resume so far!

