

## CMS International Masterclasses in Mexico

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Mexico has participated in CMS masterclasses since 2014. These masterclasses have grown since then, albeit with some interruption due to the recent pandemic. The authors discuss the experience of CMS masterclasses in Mexico, the practices that enabled them to thrive, and the U.S. - Mexico collaboration that has aided their success. They also examine how students and teachers have benefited, along with lessons learned. Finally, they chart CMS masterclasses going forward.

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## 1. Introduction

A particle physics masterclass is an event sponsored by International Masterclasses (IMC) [1] under the auspices of the International Particle Physics Outreach Group (IPPOG) [2] in which high school students come with their teachers to a university or laboratory to be “particle physicists for a day”. Physicists give them an introduction to the Standard Model, a tour of facilities, and an orientation before they analyze authentic data from a contemporary particle physics experiment, in these cases, CMS. The day concludes with a videoconference with other such “masterclass institutes” in which their peers have made the same measurement that they did, discussing results with moderators at a major particle physics laboratory. International Masterclasses are in more than 50 countries with over 10,000 participating students each year, outside of the COVID-19 pandemic years [3]. There are 5 CMS masterclass institutes in Mexico. Most Mexican CMS masterclasses connect with Fermilab and the students often interact with peers from the United States [4].

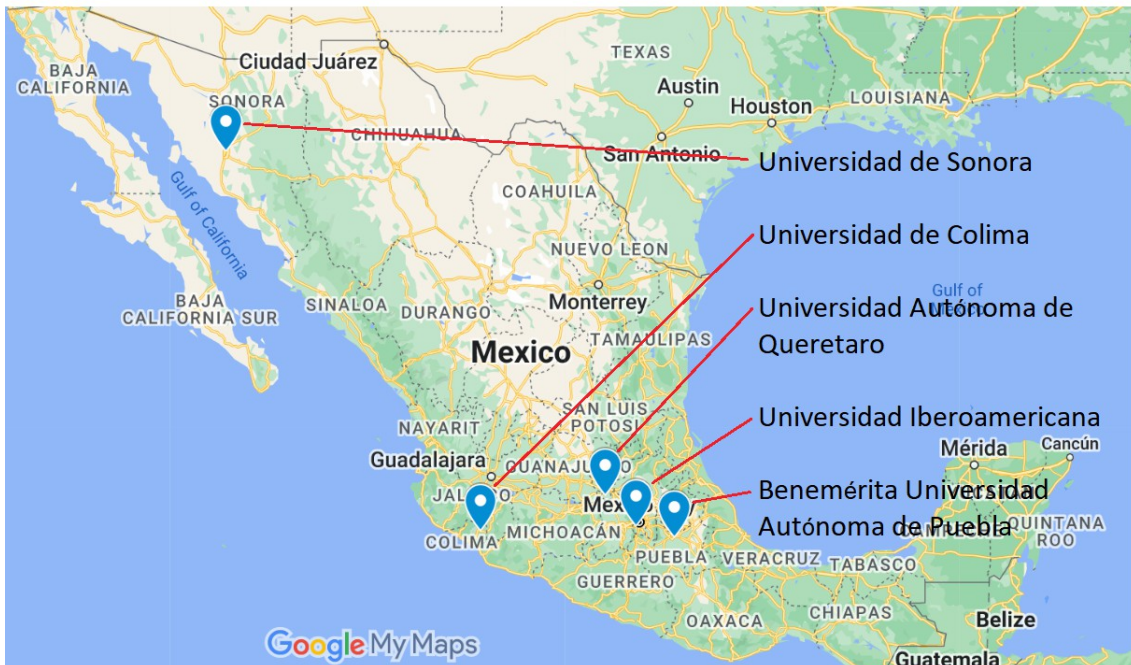


Figure 1. CMS masterclass institutes in Mexico.

## 2. International Masterclasses in Mexico

### 2.1 Context

International Masterclasses are helping to make frontier science available to high school students and teachers who otherwise would not have this opportunity. The U.S. QuarkNet program collaborates with a number of Mexican CMS scientists who participate regularly in masterclasses (contacting the teachers, planning the event, helping the students to analyze the data). In addition, a number of high school teachers in different institutions in Mexico participate annually and help advertise the events in their local areas. Thanks to these

collaborations, it was possible to continue with some events during the pandemic, which was appreciated by the students and teachers.

## 2.2 Survey

At the conclusion of International Masterclasses 2022, a small number of teachers in Mexico were surveyed about the results of International Masterclasses for their students and themselves [5]. Of the eight teachers, all gave the highest rating of agreement (5 on a scale of 1-5) the statement “My students liked the Masterclass.” For the statement, “My students increased interest in physics due to the Masterclass,” six gave a 5 and two rated it a 4. The statement “The Masterclasses helped my professional development in pedagogy or physics,” again, six gave a 5 and two rated it a 4. Asked what the best parts of the Masterclass were, five selected the measurement of data and three chose the interactions of students with scientists. Asked which parts could be improved, three suggested the lectures and three picked the videoconferences. One teacher suggested that the interactions with scientists needed improvement and one other suggested availability of equipment [6].

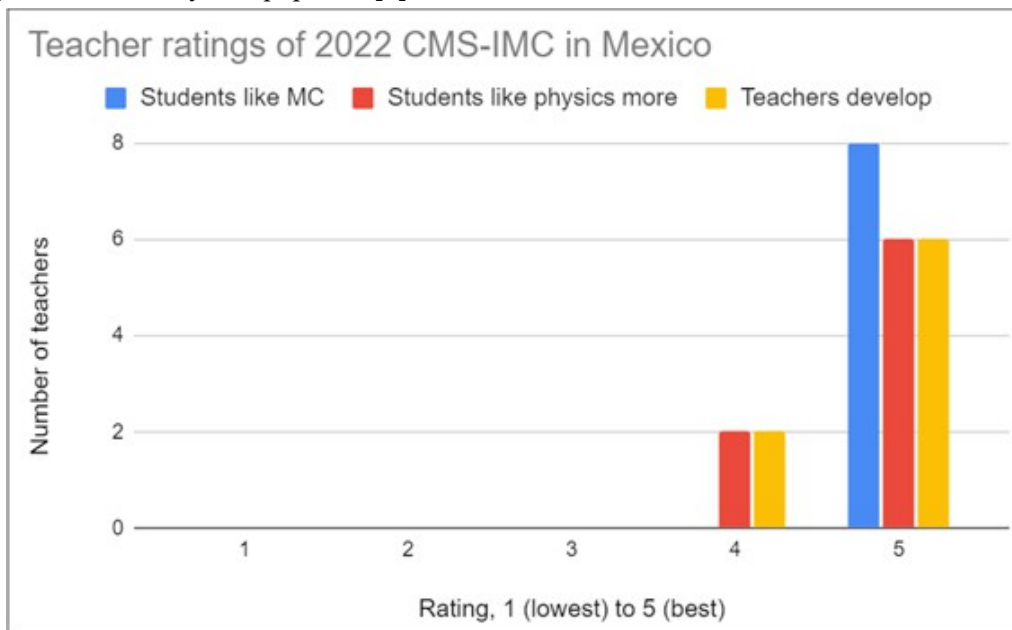


Figure 2. Teacher ratings of masterclasses.

## 2.3 Conclusions

CMS collaborators in Mexico are making important contributions to outreach and education through International Masterclasses among other initiatives. Our initial inquiries with teachers indicate that high school students and teachers benefited from and appreciated the masterclasses. This development is owed to the efforts of physicists in Mexico and fruitful collaborations with International Masterclasses and QuarkNet. Further development should be encouraged and expected.

### 3. In Memoriam

Salvador Carillo was a Professor of Physics of Universidad Iberoamericana and a leader in both particle physics education and in developing production of RPCs for CMS in Mexico. By virtue of his knowledge, enthusiasm, and availability to help, Dr. Carillo was most responsible for growing CMS International Masterclasses in Mexico. Sadly, he passed away suddenly in March 2021. He is missed and his colleagues remain grateful for his work and his friendship.



Figure 3. Salvador Carillo works with students on the CMS masterclass measurement.

### References

- [1] *International Masterclasses*, <https://www.physicsmasterclasses.org/>
- [2] *International Particle Physics Outreach Group*, <https://ippog.web.cern.ch/>
- [3] U. Bilow and K. Cecire, Developments in International Masterclasses, in proceedings of the *European Physical Society Conference on High Energy Physics - EPS-HEP2019 - 10–17 July 2019*, <https://pos.sissa.it/364/459/pdf>
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