Studies related to gender and geographic diversity in the ATLAS Collaboration

The ATLAS Collaboration

Abstract

The ATLAS Collaboration consists of about 5,300 members, with nationalities from 94 countries. There are about 2,800 scientific authors from 182 member institutions in 38 countries. This note presents data showing aspects of the demographics and diversity of the collaboration, and how the various regions of the world are represented in ATLAS. In particular the relative fraction of women is discussed, both from various demographic perspectives as well as their share of contributions to, and recognition by the ATLAS experiment.
1 Introduction

The ATLAS Collaboration was founded in 1992 for the purpose of constructing and operating the ATLAS detector at the Large Hadron Collider (LHC). It consists of about 5,300 members from almost 100 countries, of which 2,800 are scientific authors of the ATLAS physics publications.

The collaboration’s membership is diverse, with a large variety of people with different age, gender, sexual orientation, gender identity, culture, physical ability, ethnicity, appearance, education or religious background. The collaboration established a Study Group on Diversity in 2015, with the goal of assessing the diversity of the membership of the collaboration and making recommendations on how that diversity is best supported. As part of the Study Group’s work, it collected and synthesized a significant amount of information related to the demographics of the collaboration, how people participate within the collaboration, how leadership roles are filled and how collaborators are recognized for their contributions.

This note presents the data collected regarding the composition of the ATLAS Collaboration in terms of world region and gender from Spring 2016, and the correlations of world region and gender with contributions to the collaboration, leadership and recognition. The role of women in physics has been studied extensively (see, for example [1, 2]); this report provides a summary of data that we hope will contribute to these studies.

2 Composition of the Collaboration

The ATLAS Collaboration maintains an administrative database that records basic demographic information, most of which is provided by the member when they join the collaboration. Besides identifying the institution that the member is affiliated with, it contains self-declared information about the person’s gender (available choices: male or female), date of birth, profession and nationality. These data are augmented by other databases that track the contributions of each member, the various technical and leadership roles that they play and the recognitions that they receive. These data were explored for various correlations with gender and regional distribution.

The ATLAS Collaboration as of May 2016 has 5,300 members. The database has complete information for 5,060 members and so that subset of members is used in the study described below. Among these there are 4,102 men and 958 women, so that the fraction of women is 19%. This overall fraction is shown in the figures below as a reference to facilitate comparisons.

Table 1 lists the number of collaborators divided into the professional categories with which they are identified in the collaboration’s administrative database. Each member has to select one of these categories. The fraction of women for each of the professional categories is also shown. The single largest category is physicists who hold a doctorate or equivalent qualification representing 44% of the membership (we refer to this category as “physicists” in what follows). The second largest group are doctoral and masters students in physics (collectively referred to as “students”), who represent 36% of the collaboration.

The fraction of women varies significantly across these groups, with the largest fraction among the administrative support staff. It is between 22 and 27% for the students, with the exception of the engineering students where the fraction of women is $(12\pm4)\%$. The fraction of women physicists is 17%. The fraction of women is about 10% among the engineers and technicians.
Table 1: Number of ATLAS members in various categories. The fraction of people is given with respect to the total number of ATLAS members for which all data are available. The fraction of female members within that category is listed in the right column. The uncertainties are statistical.

<table>
<thead>
<tr>
<th>Profession</th>
<th>Number of people (fraction)</th>
<th>Fraction of women (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physicist</td>
<td>2,237 (44%)</td>
<td>17±1</td>
</tr>
<tr>
<td>Physics PhD student</td>
<td>1,080 (21%)</td>
<td>24±1</td>
</tr>
<tr>
<td>Physics master/diploma student</td>
<td>443 (9%)</td>
<td>22±2</td>
</tr>
<tr>
<td>Summer/undergraduate student</td>
<td>234 (5%)</td>
<td>27±3</td>
</tr>
<tr>
<td>Engineering student</td>
<td>67 (1.3%)</td>
<td>12±4</td>
</tr>
<tr>
<td>Engineer</td>
<td>711 (14%)</td>
<td>10±1</td>
</tr>
<tr>
<td>Technician</td>
<td>210 (4%)</td>
<td>7±2</td>
</tr>
<tr>
<td>Administrative support</td>
<td>78 (1.5%)</td>
<td>62±5</td>
</tr>
</tbody>
</table>

The collaboration members’ ages span seven decades, though 2,483 members—nearly half the collaboration—are younger than 35 years of age. One of the most striking relationships is how the fraction of women varies with age. The age distributions of the ATLAS members and separately the male and female members are shown in Fig. 1. The fraction of women is largest for collaborators younger than 25 years of age where it is about 25% and falls to below 10% for the members 65 years of age and older. Among the group of collaborators younger than 35 years of age, the fraction of women is \((23 \pm 1)\)%\(^1\), and among the collaborators who are 35 years old or older it is \((15 \pm 1)\)%.

In what follows, we have used 35 years of age as the dividing line between the younger and older members of the collaboration. This divides the collaboration approximately in half, with the younger portion being dominated by members in training or holding term-limited contract positions and the older being composed largely of members having continuing or long-term appointments.

Figure 1 also shows the age distribution of the 2,777 scientific authors of ATLAS publications. These are primarily physicists and doctoral students. There are fewer people younger than 25 years old as undergraduate students and masters students are normally not scientific authors. The fraction of women is 20% and its decrease with age follows the same trend as for all ATLAS members.

Figure 2 shows (in blue) the 38 countries with member institutions of the ATLAS Collaboration, and in addition (in green) countries where at least one ATLAS Collaboration member holds that nationality. In total, 94 nationalities are represented.

This global distribution allows us to look at the correlation of gender distribution with region. Each ATLAS collaborator is assigned to a regional group according to the location of their home institution rather than their nationality, and independently of whether they are based at CERN. For this purpose the following ad hoc regions are defined, based on grouping countries in proximity and creating groups with sufficiently large memberships to discern any regional correlations:

1. **Asia:** Armenia, Azerbaijan, China, Georgia, Japan, Taiwan

2. **Eastern Europe:** Belarus, Czech Republic, Poland, Romania, Russia (including JINR Dubna), Serbia, Slovakia, Slovenia

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\(^1\) Binomial statistical uncertainties are associated with fractions. These are provided to facilitate comparisons of fractional populations selected with various criteria and do not reflect measurement uncertainties in the data themselves.
Figure 1: Age distribution of ATLAS members (left) and ATLAS scientific authors (right). The bottom panel shows the fraction of women as a function of age. The dotted line shows the average fraction of female ATLAS members of 19%.

![Age distribution of ATLAS members and authors](image-url)

Figure 2: Map of the world showing in blue countries that have ATLAS member institutions. In green are countries that contain no ATLAS institutions but have ATLAS members that are citizens of the country.

![Map of the world](image-url)

3. **Mediterranean**: France, Greece, Israel, Italy, Portugal, Spain, Turkey, Morocco
4. **North America**: Canada, USA
5. **Northern Europe**: Austria, Denmark, Germany, the Netherlands, Norway, Sweden, Switzerland (including CERN), UK
6. **Southern Hemisphere**: Argentina, Australia, Brazil, Chile, Colombia, South Africa
Figure 3 shows the number of ATLAS members per region for 2015. It also shows the fraction of women by region and its statistical uncertainty. These fractions vary from 12% to 23%, with the lowest representation of women appearing in the Asian region and the highest in the Mediterranean, North American and Northern Europe regions. The fraction of women is larger amongst the younger half of the collaboration in all regions, as seen in Fig. 4.

Figure 3: Region of affiliation of ATLAS members. The bottom panel shows the fraction of women as function of region. The dotted line shows the average fraction of female ATLAS members of 19%.

3 Leadership Positions

There are many leadership positions within the ATLAS Collaboration, at senior and junior levels, to provide scientific direction and organize the work needed to design, construct and operate the detector, as well as analyse and interpret the data collected by ATLAS. This section reports on the degree to which gender and regional differences play a role in the makeup of the collaboration’s leadership team.

Leadership roles in ATLAS are structured into roughly seven categories:

- The "Top Level Management" includes the Spokesperson, two deputy Spokespersons, the Technical Coordinator and the Resource Coordinator of the experiment. The terms for these positions are two years or longer. For the Spokesperson the term can only be renewed once. The Spokesperson is elected by the ATLAS Collaboration Board (CB), which has one representative from each member...
Figure 4: The fraction of women by region for members aged < 35 years and ≥ 35 years. The dotted line shows the average fraction of female ATLAS members of 19%.

institution. The deputies are appointed by the Spokesperson and endorsed by the CB. The Technical and Resource Coordinators are recommended by search committees and endorsed by the CB.

- The "Major Area Coordinators" are responsible for either a detector or an activity and are members of the Executive Board of ATLAS. This includes the coordinators for each detector sub-system (Trigger and DAQ, Pixel, Semi Conductor Tracker, Transition Radiation Tracker, Inner Detector, Liquid Argon Calorimeter, Tile Calorimeter, Muon Spectrometer and Forward Detectors), and the coordinators of the following activities: Computing & Software, Data Preparation, Physics Analysis, Run Coordination, Trigger, Upgrade. The terms for the detector project leaders and the upgrade coordinator are two years (and can be renewed) while the terms for the other coordinators are one year. They typically coordinate tens to hundreds of people, and in many cases have responsibilities for resources. All the activity coordinators are elected by the CB from a short list prepared by a search committee. The detector sub-system project leaders are elected within the respective sub-system by representatives of the member institutions responsible for that detector sub-system. In all cases nominations from either all of ATLAS or the relevant sub-system are solicited.

- Institution Team Leaders provide leadership of the 182 ATLAS member institutions. There can be more than one team leader per institution, and their terms vary from one institution to the next. The data shown here represent a snapshot of the situation in July 2016. There are 225 team leaders and 44 of them are women. The team leaders are selected within their institution and there is no coherent scheme across all ATLAS member institutions.

- The Physics Coordination area includes nine Physics Analysis groups (B physics and Light States, Exotics, Heavy Ions, Higgs, Physics Modeling, Standard Model, SUSY, Top and Upgrade Physics) and six Combined Performance groups (E/\gamma, Flavour tagging, Jet/E_{T}^{miss}, Muon Combined, Tau, Tracking). Each is convened by two people, who serve a staggered two-year term, and in many cases there are hundreds of people contributing to each of these groups. The conveners are selected by the Physics Coordinator with help of a search committee. Nominations from the entire collaboration are solicited.

- There are numerous leadership positions in the Trigger, Data Preparation and Computing & Software areas. Since 2009, 223 people have held such leadership positions in the Trigger area, 101
in the Data Preparation area and 113 people in the Computing & Software area. These coordinate the work of between five and 100 people, typically, and they serve terms of one to two years. They are selected by the relevant activity coordinator, usually following a call for nominations to the full ATLAS Collaboration.

- Each of the Physics Analysis and Combined Performance groups typically are divided into about five subgroups. These are normally convened by two people serving one-year terms, and they convene between tens and hundreds of people. These appointments are made by the relevant group conveners, following a call for nominations in the relevant group, and in consultation with the Physics Analysis Coordinator.

- There are two large committees on ATLAS that serve the whole collaboration and require significant work: the Publications Committee and the Speakers Committee. The Publications Committee oversees the process of publishing scientific results in journals: it consists of 12 members, each serving a two-year term. The Speakers Committee is responsible for allocating talks to ATLAS members to show results at conferences and workshops. There are typically 800 such talks each year. This committee consists of 15 members, each serving a three-year term. The committee members are selected by a search committee following a general call for nominations, and then are either elected or endorsed by the CB.

Figure 5 shows the number of people who have held or currently hold such leadership roles within the ATLAS Collaboration, with the roles ordered approximately by level of responsibility. The data shown here contain positions held since the start of data taking in 2009 and up to May 2016. Overall the number of leadership positions considered in this time period was 1284; 235 of these positions were held by women, corresponding to 18%.

The only significant deviation from the average occurs in the Speakers Committee where the fraction of women is larger than the average.

The Executive Board is the main body steering the ATLAS Collaboration and is chaired by the Spokesperson. The deputy chair is the Technical Coordinator of the collaboration. The members are the Top Level Management and the Major Area Coordinators, as defined above. In addition the chair of the Publications Committee and three members-at-large of the collaboration are members of the Executive Board. Figure 6 shows the fraction of members of the Executive Board relative to the number of Ph.D. physicists on the author list of the collaboration. It is shown by world region, defined in the same way as described in Section 2 but excluding members affiliated with CERN. The fraction is about 1% for each region. For the Southern Hemisphere there has not yet been a member but the upper limit (defined as a 95% confidence interval) is also consistent with the average value.

The fraction of Executive Board members affiliated with CERN is about 5%, and is therefore larger than for any region. This is largely explained by the special role CERN has in the operation of the experiment as the host laboratory: CERN staff are resident in the area and have typically fewer personal and professional constraints that may prevent the senior members from other institutions from taking on leadership positions that require residency at CERN. It should also be noted that the Technical and Resource Coordinators are requested formally by CERN to be CERN staff members during their terms, which also contributes to this fraction being larger for CERN.
Figure 5: Number of people in leadership positions and on selected committees for all ATLAS members and for women (top). The vertical dashed line indicates a separation between leadership positions (left) and committee memberships (right). In the bottom plot the fraction of women is shown for each category, and the horizontal dotted line shows the average fraction of women in ATLAS of 19%. The data are shown per term, i.e. if the same person held the responsibility for two terms there are two entries. For Institution Team Leaders the data shown are for July 2016.

4 Contributions to the Experiment and Allocation of Talks

These data also allow us to examine how ATLAS collaborators contribute to the experiment, and how members are recognized by being given the opportunity to represent the collaboration at a scientific conference. Talks given on behalf of the ATLAS Collaboration are allocated by the Speakers Committee. Given the size of the collaboration, there are generally a significant number of speaker candidates with the necessary expertise to give any particular talk; the procedures used to select the appropriate candidate have been designed to be equitable.

A person’s suitability to give a talk is quantified by the number and “priority” of talk nominations from the team leaders of the institutes and the ATLAS Major Area coordinators. In addition, the committee takes into account the amount of time the candidate has contributed to tasks related to the successful operation of the experiment, their current need for professional advancement, and how long it has been since they last gave a talk representing the collaboration.

In the following paragraphs we examine some of these criteria, and the resulting allocation of physics
Figure 6: Fractional membership of the ATLAS Executive Board by region normalized to the number of physicists, integrated from January 2009 until December 2015. For the Southern Hemisphere an upper limit on the number at the 95% confidence level is shown.

talks, with an eye to gender equality. Only physicists and physics PhD students are considered since the present study only concerns public ATLAS talks on physics topics.

Figure 7 shows the number of nominations per person for giving talks based on the work done on the experiment, and the “priority” of the nominations given by the Physics Coordination team. A nomination priority of 1 indicates the highest weight, 5 is lowest, and 0 indicates that the person did not receive a nomination from this source.

The overall number of nominations for women and men are roughly equal. However a significant difference is seen in the nominations from the Physics Coordination team: the relative fraction of men with a value of 0 (meaning no nomination) is larger. Also, among those people nominated, women receive on average stronger nominations.

The amount of time each ATLAS member spends on control room shifts, data quality checks, and similar operational tasks is recorded in a central database; Fig. 8 shows this contribution expressed in full-time equivalents (FTEs) averaged over the past four years, separately for men and women. No significant difference is observed between the genders.

Table 2 shows the fraction of men and women who have given at least one talk at an international conference or workshop on a topic related to physics results in ATLAS since 2010. The fractions are shown separately for physicists and students, and only people who have contributed to the operational aspects of the experiments are included. The physicists are subdivided depending upon how long they have been an author on ATLAS papers. The authorship qualification is a milestone that all collaborators must complete before being considered for recognition. As it usually takes about a year to complete, it is a good measure of how long a person has been an active collaborator on ATLAS.

It is seen that female physicists tend to be given relatively more talks than their male colleagues, particularly among those who have been collaboration members for more than 15 years. For students the fractions are consistent between male and female ATLAS members. It was also studied whether the same
Figure 7: The total number of talk nominations per person (left) and the priority of the Physics Coordination team’s nomination (right). The bottom plot shows the fractions received by women. The uncertainties displayed on the ratio are calculated as binomial errors as described in Sec. 2. Also shown is the average fraction of women in ATLAS of 19% as horizontal dotted line in the bottom panels.

<table>
<thead>
<tr>
<th>Selection</th>
<th>time as ATLAS author</th>
<th>Fraction of men (%)</th>
<th>Fraction of women (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physicist</td>
<td>2–7 years</td>
<td>83 ± 3</td>
<td>91 ± 4</td>
</tr>
<tr>
<td>Physicist</td>
<td>7–15 years</td>
<td>81 ± 2</td>
<td>94 ± 3</td>
</tr>
<tr>
<td>Physicist</td>
<td>&gt; 15 years</td>
<td>55 ± 4</td>
<td>77 ± 8</td>
</tr>
<tr>
<td>Student</td>
<td>&gt; 2 years</td>
<td>62 ± 5</td>
<td>57 ± 8</td>
</tr>
</tbody>
</table>

Table 2: Fraction of men and women who have given a talk in the past six years for various selections, as a function of their role in the experiment and the time that has passed since their qualification as an ATLAS author (a good indication of how long a person has been a member of the collaboration). Only people who have contributed time to operational tasks (at least 0.1 FTE in the past 4 years) are considered.

Figure 9 shows the dependence of the fraction of people who have given a recent talk upon the region of the world in which they work; the fraction is consistent with being independent of world region.

Based on this analysis we conclude that at least part of the reason that women give more talks on average is that they receive relatively stronger nominations from the ATLAS Physics Coordination team.

Figure 10 shows the time evolution of the plenary talks given at these so-called “ATLAS Overview Weeks”. The upper plot simply shows the number of talks as function of time, in total and for female speakers separately; the lower plot shows the fraction of the total number that were given by women, indicating an increasing fraction of women speakers with time. In recent years the fraction is consistent with the current average fraction of women in ATLAS of 19%.
Figure 8: Operational contributions to the ATLAS experiment, averaged over the past four years, expressed as FTEs per person. The bottom plot shows the fraction performed by women. The uncertainties displayed on the ratio are calculated as binomial errors as described in Sec. 2. Also shown is the average fraction of women in ATLAS of 19% as horizontal dotted line in the bottom panels.

5 Discussion and Conclusions

This note presented data on the demographics of the ATLAS Collaboration in 2016 related to gender and geographic distribution. ATLAS has collaborators with more than 90 different nationalities, and about 20% of the collaborators are female. The fraction of women is largest among the youngest members, and then declines with increasing age.

The data on leadership and recognition indicate that the ATLAS Collaboration, at this level of scrutiny, appears to be engaging female members in leadership roles and recognizing their contributions in a manner proportional to the male members. This is seen most clearly in the fraction of women in both senior and mid-level leadership roles. This level of equity is also seen in the manner in which recognition is made of scientific contributions through the allocation of conference talks across the collaboration.

Studies of regional correlations are performed based on using the institutional affiliations to identify ATLAS members with a given region. The various world regions are represented in a manner roughly proportional to the number of ATLAS members from these regions in both leadership positions and recognition.

A decrease of the fraction of women with age is observed. The reason for this could not be determined with the information available. In particular, the question of how much this reflects a slow and steady increase of women’s participation in physics and engineering, or a "leaky pipeline" (a metaphor for the continuous loss of women as they climb the career ladder), or a combination of both effects could not be addressed with the data available.

There are other aspects of diversity within the ATLAS Collaboration that are not addressed in this document, largely due to limitations in the data available.
Figure 9: The fraction of physicists who have given at least one talk on behalf of the ATLAS Collaboration since 2009 versus the world region.
Figure 10: Plenary talks given during the ATLAS Overview Weeks. The top plot shows the total number of talks given by all ATLAS members and by women as function of time, and the bottom plot shows the fraction of talks given by women.
References
