

## **‘A form of sanity check’: how people at CERN view science communication**

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### *Introduction*

This study was conducted as the main activity of a 7-month undergraduate internship at CERN (CMS Experiment communication team), from 1<sup>st</sup> of March to 29<sup>th</sup> of September 2017.

### **About CERN**

CERN (European Organisation for Nuclear Research) is the world’s largest laboratory of particle physics. Its mission is ‘to gain understanding of the most fundamental particles and laws of the Universe’<sup>[1]</sup>. Almost a half of all world’s particle physicists is in a way affiliated with CERN<sup>[2]</sup>. In addition to physicists, there are many other fields of work present at CERN, from managers to technicians. Overall, there are around 16 000 members of personnel, the vast majority of whom (ca. 12 000) are employed by other institutions<sup>[3]</sup>. In addition to strategic, ‘professionalised’ communication initiated by CERN and experiments<sup>[4]</sup>, there is a lot of communication taking place spontaneously<sup>[5]</sup> and originating from people who work at CERN. It is interesting to explore what views this communication is based on.

The distinction between CERN’s central communication team and the collaborations of individual experiments (e.g. CMS, ATLAS) was intentionally neglected in this study. This distinction matters internally or in case of official communication initiatives more than externally or informally. CERN is a unifying and more widely-known organisation, thus allowing people affiliated with it to establish a connection with the audience when they publicly communicate fundamental physics.

### **About science communication theory**

Brian Trench in the publication ‘Towards an analytical framework of science communication models’ (2008) summarises several theoretical endeavours of science communication modelling. The author proposes a unifying framework<sup>[6]</sup>, acknowledging that all models that have been developed so far share the underpinning principles and ideas. According to this framework, there are three core PCST (Public Communication of Science and Technology) models: Deficit, Dialogue and Participation. In general, the author observes that ‘communication processes become more open-ended and more open to values as well as facts in the transition from Deficit to Dialogue and Participation’.

- Deficit model describes the transmission of scientific information from experts to public that is assumed to lack awareness or understanding of the topic;
- Dialogue model refers to the situation when scientists communicate with diverse public to provide requested information or to find out how to disseminate science more effectively;
- Participation model is based on the assumption that all groups of public have equal rights to take part in discussions about science and influence science-related decisions.

Each of these models has two or three variants, which allow to analyse and plan science communication practices more accurately:

- Defence (Deficit model) focuses on ‘anti-science’ and opposition to presumably hostile public;
- Marketing (Deficit model) is used to persuade public and promote science, e.g. to increase number of students signing up for science courses;
- Context (Dialogue model) recognises the diversity of public’s backgrounds, which allows e.g. to target communication messages more effectively;
- Consultation (Dialogue model) is characterised by a search of public opinions in order to discuss potential applications with them or review communication messages;
- Engagement (Dialogue model) implies an active involvement of public in science discussions;
- Deliberation (Participation model) follows from the values of participatory democracy and thus underlines the importance of public contributions to science-related processes;
- Critique (Participation model) suggests that science is one of many other intellectual and cultural activities, which can help to rethink science implications.

These theoretical variants (submodels) and their relation to models in the context of communication of fundamental physics were investigated in this study. The overall goal of the study was to explore which models of science communication prevail in the views of people affiliated with CERN.

### *Methodology*

An anonymous survey was chosen as a method to explore the views on science communication of people affiliated with CERN. Due to the limited timeframe of the study, data were collected with the help of a short online questionnaire, which allowed for a bigger number of responses and reduction of a bias introduced by a researcher (as opposed to face-to-face interviews).

In order to set common ground for all participants, a definition of science communication was formulated: ‘Science communication is any interaction between science and public: chat with family or friends, march for science, guided tours, posts on social media, science & art exhibition, etc.’ The formulation of the definition, as well as the examples, was shaped according to the results of the testing phase and focus of the research.

Then, the theoretical models and submodels were operationalised into short statements (Table 1). These formulations were tested and reformulated according to the results of the testing phase. The participants had to choose the options that best fitted their views as continuation of the phrase ‘When you publicly communicate fundamental physics, you...’ (section 4 in Table 3).

**Table 1.** Operationalisation of models (in italics) and submodels from the theory proposed by Trench (2008)

<b>Model or submodel</b>	<b>Operationalisation</b>
<i>Deficit</i>	[to] spread scientific knowledge to inform or educate public
Defence	[to] fight anti-scientific views or denial of scientific evidence
Marketing	[to] persuade public that science is important to support
<i>Dialogue</i>	[to] establish a dialogue between science and public
Consultation	[to] seek public opinions or respond to public concerns
Engagement	[to] involve public in scientific research or discussions
<i>Participation</i>	[to] empower public to have a say in science discussions
Deliberation	[to] enable public to affect decisions equally with scientists
Critique	[to] open science for public judgement or interpretations

## Testing the questionnaire

Different versions of the questionnaire were tested on 42 potential respondents. Tests included face-to-face interviews which were conducted along with filling in the online questionnaire by the respondent. The following critical points were identified and implemented:

- The Context submodel (which was initially operationalised as '[to] approach public according to their diverse backgrounds') was reported to be inconsistent with other submodels since it described a more technical rather than conceptual side of a communication process. It was therefore excluded from the final version of the questionnaire.
- An entertaining or educational element was suggested to be introduced as an incentive for the research participants. Consequently, potential participants were invited to fill in the questionnaire and receive a Feynman quote which corresponded to their views on science communication (see Annex 2).
- Number of options in general and especially in ranking questions needed to be decreased. In addition, it was hard to rank the options that acted on different levels of abstractness or encompassed one another. As a result, the Theory question (section 4 in Table 3) included only the options operationalised from the submodels; models were excluded. The Predominant question (section 6 in Table 3), however, had all the options present in Table 2; in that case, the hierarchy of the models and submodels, following from the theory, was intentionally neglected.
- During the testing phase, several points concerning science communication goals that were more specific than or different from the theory proposed by Trench were mentioned. The ones that were common and worth investigating further constituted the CERN question (Table 3).

Table 2. CERN-specific options originating from the results of the testing phase

Short name	Option
Scientism	[to] spread the idea that scientific thinking is the right one
Applications	[to] explain useful applications of fundamental research
Recruitment	[to] inspire children to study science or become scientists
Importance	[to] convey the idea that science is important and valuable
Safety	[to] assure public that research at CERN is not dangerous
Accountability	[to] inform about research since CERN is publicly funded
Education	[to] explain what particle physics is or what CERN does
Passion	[to] share the excitement of science or broaden the minds

## Final version of the questionnaire

The questionnaire was powered by SurveyGizmo platform. The formulation and number of questions was a compromise between methodological solidity and user-oriented approach. The table below shows the structure of the questionnaire.

In case participants answered 'No' or 'No, but would like to' to the Communication question (section 3 in Table 3), they still had to answer the rest of the questions. However, in that case, the formulation of Theory, CERN and Predominant questions (sections 4-6 in Table 3) was changed from 'When you publicly communicate fundamental physics, you...' to 'If you publicly communicated fundamental physics, you would...' The responses to these questions were analysed regardless of the formulation.

Table 3. The structure of the questionnaire

Section	Description	Action required from the participant
1 Informed consent	A short introduction of the research, which could be extended and display more details, followed by an informed consent form.	Here participants had to tick a box.
2 Socio-demographics	Questions about the main field of work, age group and home country. The number and formulation of options were guided by the specifics of CERN structure, data protection issues and focus of the research.	Here participants had to choose one option in each question.
3 Communication	A short definition of science communication, followed by a question 'Do you ever communicate (e.g. engage in discussions) with public about fundamental physics?'	Here participants had to choose one option: 'Yes', 'No' or 'No, but would like to'.
4 Theory	A ranking question with the options that represented the operationalised submodels from the theory (see Table 2 without Deficit, Dialogue and Participation options). It included an option Other that could be specified in the Comments section. The order in which options were displayed to participants was random.	Here participants had to continue the phrase 'When you publicly communicate fundamental physics, you...' by choosing the options that were relevant to them, dragging them to another box and then ordering them, with the 'best' being on top or receiving a ranking score of 1.
5 CERN	A ranking question with CERN-specific options originating from the results of the testing phase (see Table 3). It included an option Other that could be specified in the Comments section. The order in which options were displayed to participants was random.	As in the previous question, here participants had to continue the phrase 'When you publicly communicate fundamental physics, you...' by choosing the options that were relevant to them, dragging them to another box and then ordering them, with the 'best' being on top or receiving a ranking score of 1.
6 Predominant	A question with operationalised models and submodels from Trench theory (see Table 2). For the purposes of the study, here the hierarchy of models and submodels was neglected. The order in which options were displayed to participants was random.	Here participants had to choose only one option.
7 Open	An open question: 'In your opinion, what value does science communication add to fundamental physics?' This question was optional.	Here participants had to type their answer in the text box.
8 Result	A quote of Richard Feynman, which was triggered by a participant's response to the Predominant question (section 6 in this table). See Annex 2 for all Feynman quotes used in the study.	This section appeared after the response had been saved. Here the participants could read the quote and proceed to another ('just or fun') version of the questionnaire.

## Language

Since French is the second official language at CERN, the questionnaire was translated into French with the help of 3 volunteers. Both English and French versions of the questionnaire were available for research participants. However, Feynman quotes displayed in the end of the questionnaire (section 8 in Table 3) were kept original (i.e. English).

## Sample and dissemination

Originally, the plan was to obtain a list of all CERN members of personnel, make a random sample out of it and then forward the request to fill in the questionnaire to the people in the random sample. However, due to some organisational and technical constraints, it was not possible to access the list of all CERN personnel. As a result, the invitation to participate in the questionnaire was disseminated through various digital and analog channels across CERN, including:

- webpage of the Announcements section of CERN Bulletin, which is an internal biweekly newspaper for the CERN community;
- Young@CERN group in Facebook, which is a closed group with ca. 8700 members;
- CERN Summer Students 2017 group in Facebook, which is a closed group with ca. 600 members;
- CERN Technical Students group in Facebook, which is a public group with ca. 3200 members;
- personal messages to CERN scientists on Twitter;
- personal messages to people who helped in the testing phase, with a request to fill in the questionnaire and invite their colleagues;
- 30 paper posters distributed around the main CERN site (site Meyrin).

## Limitations of the study

- Non-random sample and thus bias introduced by the dissemination channels.
- Different interpretations of statements and wording by the participants and thus bias introduced by the operationalisation of the theoretical concepts.
- Ignored distances between the chosen and ordered options in ranking questions (e.g. for some respondents, some options were equally important while some were distinctly far).
- Some information (e.g. gender) was not collected due to data privacy issues.

## Results

Due to the bias introduced by a non-random sample, it is not legitimate to extrapolate any results to the whole CERN population. However, it is still possible to say something about the 418 participants of the research who are affiliated with CERN.

## Who participated in the research

In total, there were 418 completed responses, out of which 3 were in French. 74% of all people who started to answer the questionnaire completed it. Due to the limitations introduced by the dissemination methods, it is not possible to determine how many people were aware of the questionnaire and had access to it. Neither it is possible to determine the exact number of CERN population. However, based on the official records from 2016<sup>[3]</sup>, it is legitimate to assume that there were around 16 000 members of personnel, making the response rate approximately 2.5%.

The results described in this section correspond to section 2 in Table 3. The majority of the research participants worked in physics, or came from a European country, or were younger than or exactly 30 years old. 31% (131 out of 418) participants combined all three of these properties.

Field of work. 64% of the participants worked in physics, 14% in IT, 11% in engineering, 9% in administration, communication or education. 2% of participants chose Other as their field of work and specified it as e.g. biology, data science.

Home country. Research participants came from 60 different countries. With regard to the global regions, 73% of the participants came from Europe, 14% from North America, 9% from Asia, 3% from South America, 1% from Africa and less than 1% from Australia and Oceania. With regard to

the individual countries associated with 10 or more participants, 10% of participants came from Italy, 10% from the United States, 8% from Germany, 8% from the United Kingdom, 8% from France, 5% from Spain, 4% from Russia, 3% from Poland, 3% from Greece, 3% from Belgium, 3% from India, 3% from Canada, 2% from Portugal.

Age group. 63% of the participants were below or 30 years old, 37% were above 30 years old.

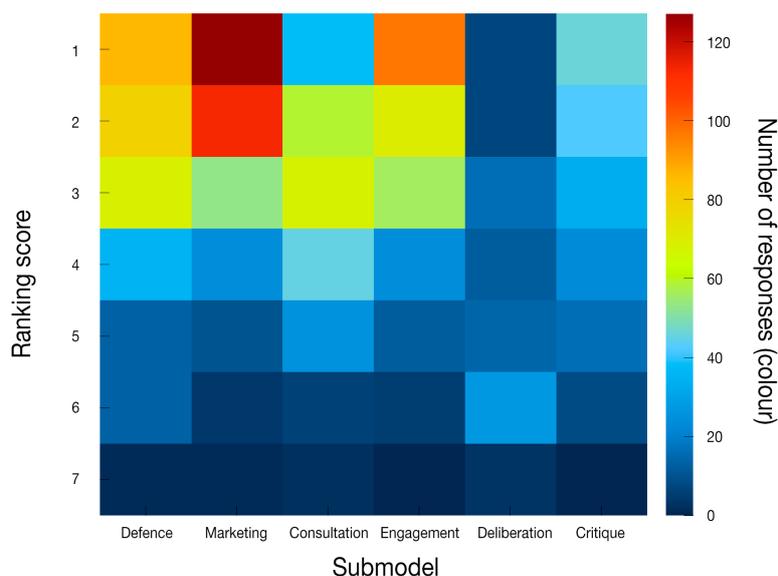
### How many of them communicated about fundamental physics

The results described in this section correspond to section 3 in Table 3. 86% of the research participants said that they communicated about fundamental physics; 14% said they did not communicate about it, with 6% who said that they did not communicate but would like to.

### What was important to them in communication (Theory)

The results described in this section correspond to section 4 in Table 3. As noted above, this question included only the options operationalised from the submodels (models were excluded). In general, the prevailing submodel was Marketing (chosen by and thus presumably considered to be relevant for 79% of the participants), followed by Defence (71%), Engagement (63%), Consultation (58%), Critique (40%) and Deliberation (21%).

As can be seen in Figure 1, the participants assigned the highest ranking scores to Marketing (which was operationalised as '[to] persuade public that science is important to support'), Defence and Engagement, presumably considering these options to be not only relevant, but also the most important to them.



**Figure 1.** Distribution of ranking scores (y-axes) obtained by theoretical submodels (x-axes) with regard to the number of responses (colour coding)

Among the 35 comments accompanying the option Other (that was chosen and ranked in the same way as the options which were operationalised from the submodels):

- 1 comment ('Open science for the public's own judgement, to encourage discussion and curiosity amongst communities with a basis in scientific evidence'; given the ranking score of 5) was classified as Critique;
- 1 comment ('None of the above. If I speak about physics it's mostly to try to explain to a friend a theory that seems interesting to me, in a (usually failed) attempt to have their view about it'; given the ranking score of 1) was classified as Consultation and as None;

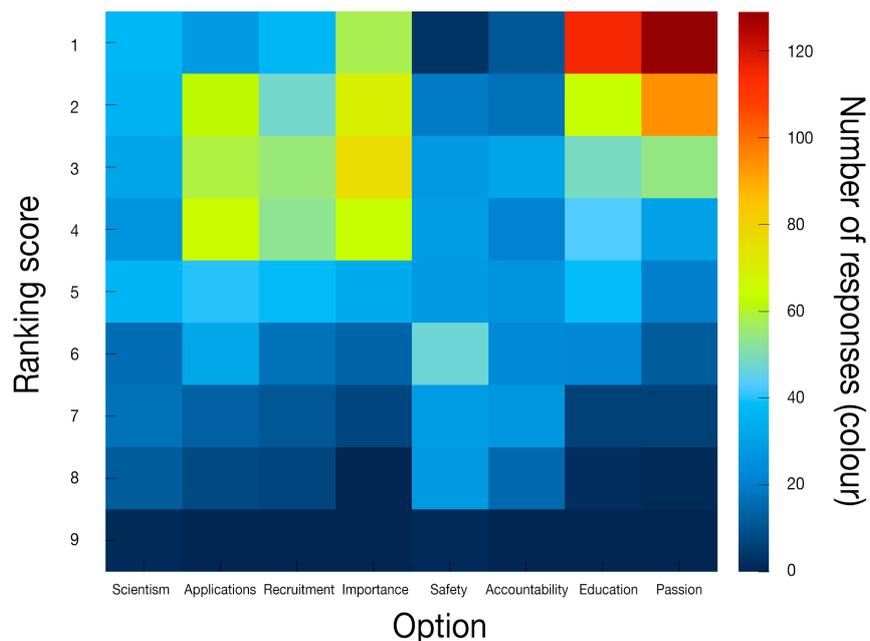
- 1 comment ('Persuade scientists to move away from pseudoscience they have been indoctrinated with by the media'; given the ranking score of 3) could not be classified;
- the rest of the comments (given the whole spectrum of ranking scores) could be classified as CERN-specific options (see Table 3), where the options Education and Passion were the prevailing ones (each gained 11 out of 33 responses), followed by the option Recruitment (5 out of 33 responses).

### What was important to them in communication (CERN)

The results described in this section correspond to section 5 in Table 3. Overall, CERN-specific options obtained more responses than the options operationalised from the theory. In addition, in this question the option Other was chosen and specified in less cases than in the Theory question (4 times versus 35 times, respectively).

In general, the prevailing options were Passion (chosen by and thus presumably considered to be relevant for 83% of the participants) and Education (81%), followed by Importance (77%), Applications (74%), Recruitment (64%), Safety (51%), Scientism (50%) and Accountability (41%).

As can be seen in Figure 2, the participants assigned the highest ranking scores to the options Passion and Education, presumably considering these options to be not only relevant, but also the most important to them. The options Importance and Applications were also important to the participants, but as the 2-4 place.



**Figure 2.** Distribution of ranking scores (y-axes) obtained by testing-based options (x-axes) with regard to the number of responses (colour coding)

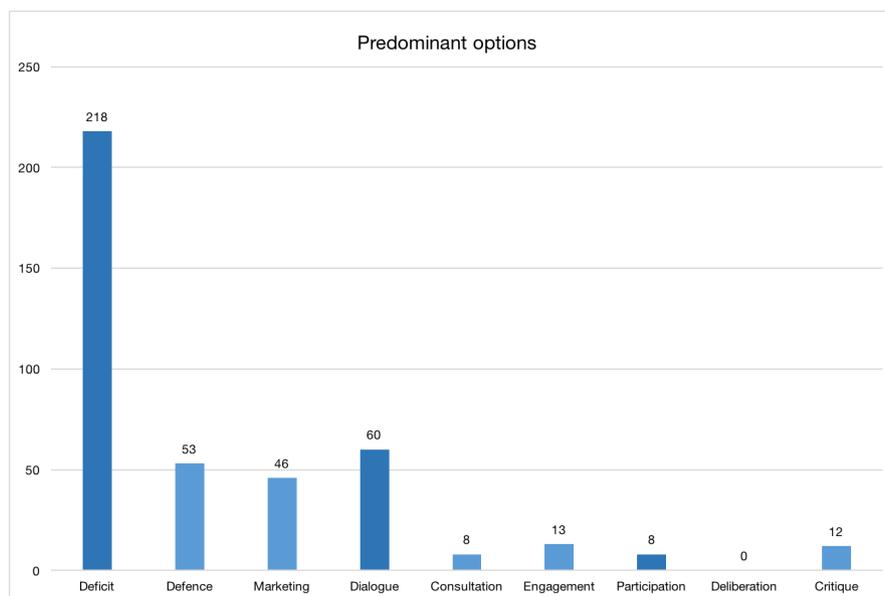
### What was predominant for them in communication

The results described in this section correspond to section 6 in Table 3. As noted above, this question included the options operationalised from both models and submodels (Table 2). The hierarchy of the models and submodels, following from the theory, was intentionally neglected.

As can be seen in Figure 3, Deficit was the main option for the majority (52%) of the participants, followed by Dialogue (14%), Defence (13%), Marketing (11%), Engagement (3%), Critique (3%), Participation (2%) and Consultation (2%). Deliberation was not chosen by anyone.

Among the 6 comments accompanying the option Other (that was chosen in the same way as the options which were operationalised from the theory):

- 3 comments (e.g. ‘Try to convey what science is about’) were classified as Deficit;
- 1 comment (‘Science is interesting and exciting and key to the progression of society. Anti-intellectualism is bad for society’) was classified as Defence;
- 1 comment (‘The idea is just to discuss it as an interesting topic’) was classified as Dialogue;
- 1 comment (‘Empower public to participate and demystify science’) was classified as Participation.



**Figure 3.** Distribution of the predominant options with regard to the number of responses (columns in darker blue represent options that correspond to models, in lighter blue — options that correspond to submodels)

### Discrepancies between the main options

This section describes the comparison between the options that were given the ranking score of 1 in the Theory question (section 4 in Table 3) and the options that were chosen in the Predominant question (section 6 in Table 3). As already mentioned above, the ranking question included only the submodels, while the predominant question included both models and submodels.

25% of the participants provided identical answers in both cases. 27% changed from a submodel to a corresponding model (e.g. from Defence to Deficit, from Engagement to Dialogue). The rest of the responses (200, 48%) did not coincide with the logical assumptions inferred from the theory.

These 200 responses can be investigated from two different sides. On the one hand, Engagement was prevailing (45% of the responses) among the submodels that were changed to something else. On the other hand, among the options to which something was changed, the prevailing one was Deficit (54%), followed by Dialogue (35%).

### Open question

The results described in this section correspond to section 7 in Table 3. This question was formulated as ‘In your opinion, what value does science communication add to fundamental physics?’ and was optional. In total, 161 of the participants (39%) answered this question. In case a participant mentioned several aspects, a response was broken into individual pieces, with each of these pieces (188 identified) being classified separately. The table below shows the topics that were identified in the analysis phase.

Table 4. The topics identified in the responses to the open question

Topic	Description	Examples
Resources	'Communication brings to fundamental physics public and political support in a form of funding and workforce'	'By cultivating fascination in the minds of tomorrow's researchers, science communication ensures that particle physics will have a future.'  'Funding. Science needs the appropriate funding. Without science communication therefore science could not afford itself.'
Public input	'Communication brings to fundamental physics fresh ideas and perspectives from non-scientific public'	'Explaining our science to people makes them asking question to us that we probably would not have asked ourselves.'
Self-reflection	'Communication brings to fundamental physics an opportunity to reflect on scientists' work or knowledge or develop communication skills'	'Science communication provides understanding of science and its goals not only for the public, but also for the scientists. It is essential.'  '[Science communication] is a form of sanity check to make sure that we can still explain what we are doing and that we keep in touch with public interests and thinking.'
Part of science	'Communication brings to fundamental physics a sense of completion or meaningfulness'	'It is not physics without communication. What is the point of having an experiment if the world does not know it happened?'  'What other than science communication is the ultimate goal of any fundamental science — especially in physics!?'
Public inclusion	'Communication brings to fundamental physics an opportunity to involve public into science processes or integrate science into culture'	'I believe [science communication] adds more human value. It's something worth sharing with humanity, just as the fine arts.'  '[Science communication] integrates fundamental [physics] into popular culture and prevents it from becoming an exclusive piece of knowledge, of little value to the broader community.'
PUS (public understanding of science)	'Communication brings [to the public] education, understanding, knowledge, appreciation of or inspiration by physics or scientific processes'	'[Science communication] removes the cloak of misconception from the public's idea of what physics really involves.'  'Everyone should love and appreciate the science behind how it all works.'
None	'Communication does not add any value to fundamental physics'	'None. I also do not question biology results nor contribute to them (unless there is an obvious mistake).'

34% of the respondents identified Resources as the main value added to fundamental physics by science communication. It is followed by Public Understanding of Science (33%), Self-reflection (12%), Part of science (9%), Public input (6%), Public inclusion (6%). 1 respondent said that there was no value added to fundamental physics by science communication.

## Discussion

### Socio-demographics

As already noted above, there was a bias introduced by a non-random sample and the dissemination channels, preventing any extrapolation of the results to the whole population. In case of two of the socio-demographic factors, however, it is possible to suggest the potential relation between dissemination channels and effects they had on the sample.

First, the majority of the research participants (63%) were 30 years old or younger. One potential explanation for this is the fact that one of the most significant dissemination channels was Facebook. The other is that data collection period took place in July and August when there are typically a lot of summer students coming to CERN. Second, only one respondent chose 'technical support' as their field of work (it was added to Other option in the analysis). This can be potentially explained by the fact that the non-digital dissemination channel (paper posters) was targeted primarily at English speakers (although it had links to both English and French versions of the questionnaire), while many of CERN personnel responsible for the technical support speak French and have limited or none English proficiency. More importantly, posters were not distributed in the sites of the experiments (e.g. P5 – CMS Experiment), where personnel responsible for the technical support is mainly present, and online tools are less effective in reaching technical staff than scientists or administrative staff<sup>[6]</sup>.

No significant differences in results were identified with regard to different socio-demographic groups. In addition, when broken into different groups, the low number of the responses in each group (e.g. there were only 28 people who work in communication, outreach or education) makes any generalisations meaningless.

### CERN

According to CERN's Communications Strategy 2017, the overall communication goal of CERN's Education, Communications and Outreach group is 'to help ensure the long-term future of CERN's mission and share it with society'<sup>[1]</sup>. This goal can be broken down in 6 objectives (in the original document, it is the overarching 'objective' which is broken down into more specific 'goals'). In order to compare the CERN's strategy with the results of the study, these objectives and the goal can be classified according to the theory proposed by Trench, as well as the topics raised in the responses to the open question (Table 4). For the purposes of the comparison, the hierarchy of goals and objectives, following from communication strategy, is neglected.

As can be seen in Table 5, Marketing, along with Engagement and Deficit (provided the theoretical hierarchy is neglected), prevail in CERN's strategic communication as the basic (sub)models. In addition, education and outreach, which have a significant share in CERN communication priorities<sup>[1]</sup>, are by definition closer to or a part of Deficit model of science communication. At the same time, results show that the research participants considered Marketing, Engagement and Deficit (sub)models to be highly important to them in science communication.

Table 5. CERN ECO group strategic goals and objectives according to the classifications used in the study

CERN's strategic goal or objective	Theoretical model or submodel	Open question topic
to help ensure the long-term future of CERN's mission and share it with society	Marketing	Resources, PUS
to contribute to maintaining and increasing support from current Member States	Marketing	Resources
to contribute to attracting new Member [...] States	Marketing	Resources

to maintain high public awareness and engagement with CERN's activities	Marketing, Engagement	PUS, Public inclusion
to foster community-building efforts within both CERN and the international particle physics community	<i>this objective is related to scientific rather than public science communication</i>	
to raise awareness of and provide information about CERN's societal impact	Deficit, Marketing	PUS
enable CERN to serve as an effective voice for fundamental research in relevant multilateral debates and with the public	Deficit, Dialogue (debatable)	PUS

Resources and PUS (Public Understanding of Science) were the dominant topics both for CERN's communication strategy and for the participants who discussed the value added to fundamental physics by science communication. It can therefore be suggested that the views of the research participants were to a high extent in line with the CERN's strategic communication priorities.

## Theory

As discussed above, the participants had to choose and rank the submodels that corresponded to their views on science communication (section 4 in Table 3). The assumption was that these submodels exhaustively represented the 3 basic models. However, several points identified in the data analysis suggest that this might not be the case, namely:

- 22 comments accompanying the chosen option Other in the Theory question, raising the topics similar to Education and Passion options in the CERN question;
- the fact that, overall, Education and Passion options were chosen (and thus identified as relevant) by a bigger number of participants than any option in the Theory question;
- the absolute majority gained by the option Deficit in the Predominant question;
- the number of participants who chose the option Deficit in the Predominant question, despite the fact that they had chosen something conceptually different before in the Theory question.

It can therefore be suggested that, in order to represent Deficit model more accurately, Defence and Marketing submodels should be complemented by at least one other submodel. This submodel should seemingly be closer to education, and be related to spreading knowledge or sharing passion of science, while being less strategic than Marketing and more inclusive than Defence. It might not be applicable at the organisational level (as institutions cannot afford to 'just share science') but might describe something which is more relevant for individuals. In addition, data suggest a coexistence of different models of science communication. In spite of the fact that the views of the participants tend towards the Deficit model, Engagement was also identified as being important. However, this result could have been distorted by the limitations of operationalisation or by different understandings of concepts like 'dialogue'.

## Open question

The topics mentioned in the responses to the question 'What value does science communication add to fundamental physics?' relate differently to the question itself. Resources, Public input and Self-reflection (see Table 4) describe the values that can be obtained by fundamental physics. PUS and Public inclusion, on the other hand, are more directed at public than science itself, thus leaving the exact value obtained by fundamental physics unclear. However, the fact that many participants mentioned an increase of public support as a logical or desired consequence of sharing knowledge or passion (e.g. '[Science communication] allows for greater public understanding of fundamental physics, which is necessary for continued public support of the sciences') suggests that PUS can be closely related to Resources. In this case, public inclusion or education can serve as a means to obtain acceptance and support.

Apart from acquiring funding, workforce and creative ideas, an opportunity for science to reflect on its own processes and knowledge was also identified as a value added to fundamental physics by science communication. It varied from more practical aspects, such as improving communication skills or formulations (e.g. 'Explaining difficult concepts to outsiders of the field shows us what we don't really understand'), to more philosophical discussions (e.g. '[Science communication] reminds us of the point of our research').

The topic Part of science introduces an idea that science communication is an important or even inseparable part of fundamental physics. The responses mentioning this topic varied from the opinion that science simply has a responsibility of 'giving back to society' (e.g. 'People outside the scientific community have the right to knowledge and we as scientist[s] should make it our obligation to provide that knowledge') to the opinion that communication is integral to science (e.g. 'It's not enough that we scientist[s] discover the fundamental processes that govern our universe. We should share our findings with anyone willing to listen').

### *Conclusion*

The study provided an insight on the views on communication in the field of fundamental physics, as reported by 418 people affiliated with CERN. The channels used to disseminate an invitation to participate in this research project introduced a bias to the sample. Nevertheless, the research participants were represented by a variety of fields of work, age groups and home countries. The views of participants were investigated with a help of the theoretical framework of science communication models proposed by Trench (2008), as well as the results of the testing phase.

Data suggest that the framework taken as the theoretical basis of the study needs a revision. First of all, the two variants of Deficit model—Defence and Marketing — might not fully capture the specifics of communication that is characterised by spreading knowledge or information. A complementing variant of Deficit model should seemingly encompass the desire to share scientific results or passion for science with public. This type of communication is not motivated by a need to acquire or maintain resources (both financial and human), as in Marketing, and is more applicable on personal than on organisational level (e.g. in a conversation with a friend). Secondly, Context variant seem not to fit in the list of other variants of the models as it refers to a more technical rather than conceptual side of communication processes. It was also noted during the testing phase by some of the participants that the described variants become more abstract and more philosophical on the way from Deficit to Participation. Thirdly, there is a need to explore further how different models of science communication coexist in the minds of communicators, and what values and views these models might be connected to.

In responses to the question about the value added to fundamental physics by science communication, several interesting points were raised. One of them is the idea that science communication gives an opportunity for scientific community to reflect on their knowledge and goals and to 'synchronise the watches' with public. Another can be described as following: the fact that public is less knowledgeable in fundamental physics than scientists does not prevent them from contributing to it. On the contrary, it enables them to have a fresh, unbiased, creative perspective, which might become a valuable input for the common pursue of knowledge. Finally, some participants hold an opinion that science communication is integral to fundamental physics and that 'science is not finished unless it is communicated'.

The results were also analysed with regard to CERN communication strategy. Speaking generally, views of the participants to a high extent coincided with CERN current strategic communication priorities. Still, the results of this study provide CERN communication teams with a more detailed understanding of how people at CERN view science communication, thus helping to establish common ground with them or adjust the activities accordingly.

Overall, the study served as a starting point of identifying the specifics of communication in the field of fundamental physics and provided ideas for further research on this topic.

## *References*

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## *Acknowledgments*

The author would like to thank Marzena Lapka (CERN, CMS Communications team) and Ana Godinho (CERN, ECO group) for their help and support with the study.