SND TP Questions/Comments (February 2021)

Executive Summary:

1. You mention that 40% of cost can be considered as pledged. What is the status of the remainder?

As discussed, we will present it at the Focus Session, with details for the different sub-detectors.

Chapter 1 (Introduction)

1. line 6: "... will observe the first neutrinos produced .." => "will first observe the neutrinos produced..." (!)
2. "inaccessible." -> "inaccessible at accelerators"

OK, thanks!

Chapter 2 (Physics Goal and Detector Concept)

1. Page 8: "HERA studied the reaction ep → nu_e X, ...". Several comments about this:

a. This refers to a 1994 paper, and much more precise measurements of the CC interaction were made later, so it's unfair to quote a 30% precision from 14 events. At the end, the CC cross section measurements at HERA relied on thousands of events, leading to precision dominated by systematics, at the level of few% (2-3%).

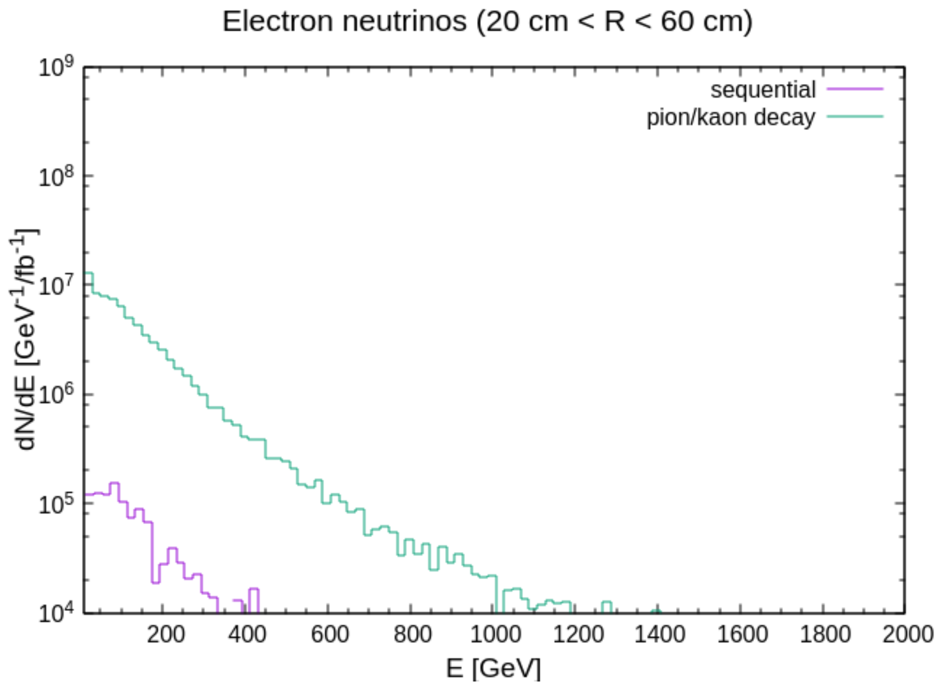
Thanks for noticing that. We will rephrase it and refer to the most recent paper.

b. Second, this measurement only constrains nu_e p -> X in the context of the SM, since we don't know that the final-state neutrino in ep-> X+invisible is actually an electron neutrino (the signal is missing energy, no nu_e was ever tagged). This also applies to the “supported by HERA” claim on page 10.

We will rephrase it as “supported by HERA results in their SM interpretation”.

2. Page 10: can you be more explicit what you mean by “electron neutrinos ... from charmed-hadron decays” - do you include only the neutrinos from the prompt D decay, or also from the sequential D->K->nu_e decay (which although smaller, is not negligible). Do you count these as from charm or K in your simulation book-keeping, and does this affect your statements about measuring the charm cross-section or (nu_e/nu_tau) flavour universality?

In the TP simulation, neutrinos from the sequential decay are counted as from K. We have now tagged these cases and it turns out that the contribution of D->K->nu_e decay amounts to about 1.5% of the kaon component we had subtracted. This is shown in the plot below, based on DPMJET-Fluka full simulation. Therefore we believe its effect is negligible.



3. Page 13: "SND@LHC plans to measure this ratio as a consistency test of the Standard Model". Given the projected precision for this measurement, to claim that it has the power to assess the "consistency" of the SM is a bit strong. To make this statement, one should indicate a potential BSM scenario, so far undetected, which could manifest itself in this measurement. Otherwise this should be rather seen as an internal test of the overall consistency of the SND measurements. Which, by itself, would already be a valuable outcome, particularly if SND measured SM deviations elsewhere, and could use the (in)consistency of the NC/CC ratio as a validation.

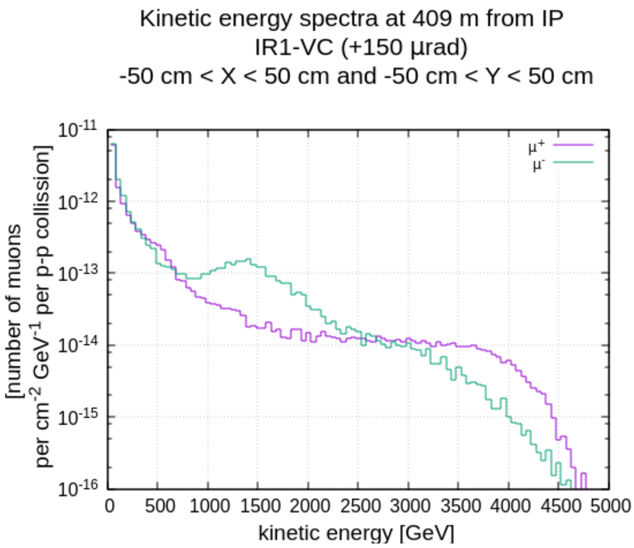
Indeed, this is intended as an internal test rather than a SM consistency test. We will modify the sentence accordingly.

4. Page 20: Can you make a bit clearer how you take into account the crossing angle in the simulations and physics studies? Do you simulate and combine both configurations with equal weight assuming a 50/50 split?

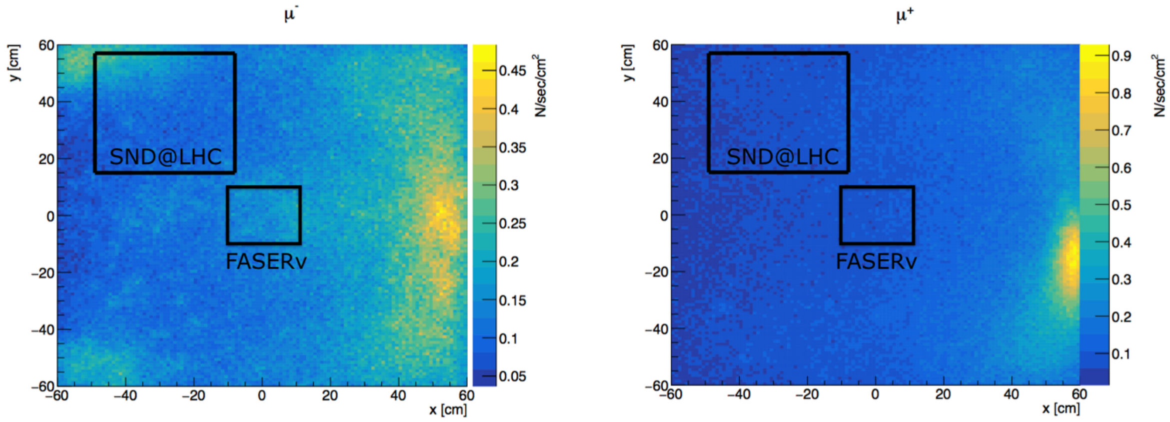
The neutrino flux used to perform neutrino physics studies accounts for the crossing angle upwards. So all the performances were given in that configuration. We have estimated that, in the opposite configuration, the expected number of interactions will be reduced by about 40%: overall a 20% reduction is thus expected if they are run with equal weights. A Monte Carlo production with the opposite crossing angle has been launched. Nevertheless, we don't expect any relevant modification of the conclusions because the statistical uncertainty is significantly lower than the systematic one in most of the studies.

5. Page 21: We did not see the final explanation for the structure of Figure 10 and the difference between positive and negative muons - can you expand on that?

The difference between positive and negative muons is related to the effect of the magnetic field of the accelerator elements on their own and their parents' trajectories. The low energy component of the spectrum (up to about 600 GeV) is dominated by secondaries: this results in an equal amount of positively and negatively charged muons. At higher energies, the drop of the positive muon spectrum shows the effect of the quadrupoles and, mostly, of the dipole at around 60-70m from the IP which produces a large depletion of events in the quarter where the detector is located. This is clearly seen in the comparison between Figure 10 and the plot below (all quarters).



6. Page 22 (Figure 11): It would be nice to indicate the acceptance of the FASERnu reference background measurement on these plots, for comparison.



The expected rates are 0.20 Hz/cm2 and 0.26 Hz/cm2 within the SND@LHC and the FASERnu acceptance, respectively.

7. Page 23: Regarding the thermal neutron flux, it would be helpful to cast this into an integrated flux per fb^-1, to be able to compare this to the exchange cycle of the emulsions. These numbers should also be shown with the shielding that has been adopted (if it has).
The estimated thermal neutron flux originates from beam-gas interactions and therefore it does not scale with the integrated luminosity, but it rather depends on the beam intensity and the operation time. Their combined annual value (expressed as the product between the number of protons and seconds) used in that figure was done for a HL-LHC year. It should be divided by 2.5 for a Run 3 year. Therefore, one could tentatively express it per fb^-1 by dividing by 250 fb-1, a typical Run 4.

8. Neutron shielding. This does not seem to be completely settled yet. Can you give an update on the neutron shielding studies and plans?

We have done a full simulation accounting for the neutron spectrum (figure 12) and the 2 options for the absorber. Boron carbide is more effective in the absorption of the thermal component due to the (one order of magnitude) larger boron content, so 5mm boron carbide is equivalent to about 6cm of borated polyethylene. The higher energy component (about half of the distribution) would not be absorbed but it could be thermalised by adding an hydrogenated material surrounding the shield. Given that boron carbide is more expensive, the plan is the following: we will use a thin (5 mm) layer of boron carbide underneath and on the downstream side, while borated polyethylene will be used on the other sides and on the top.

Chapter 4 (Veto system)

1. What efficiency is assumed for the VETO detector for the rejection of charged particles? Would it make sense to add a second double-layer of scintillator bars?

The efficiency of the bars+SiPMs is assumed to be 99.8%, a measurement will be performed to validate this value. The veto system helps to classify correctly the events before the analysis of the emulsion is carried out. The inefficiency increases the number of muon neutrino candidates that will later be rejected in the emulsion analysis.

2. Since the experience with SHiP-charm is important to show the feasibility of combining emulsion data and data from electronic detectors in a harsh environment, please provide more information. Ref [111] (for which the information in the references is incomplete) contains only an analysis of the emulsion data, no combination.

The matching between the emulsion detector and the downstream Pixel tracker was successfully tested in the SHiP-charm experiment, as reported in the following analysis note: http://cds.cern.ch/record/2746408

Chapter 5 (Target and Vertex Detector)

1. Table 4 : What are the tungsten transport costs indicated in the table?

They refer to the shipment cost from China to CERN.

Chapter 6 (Target Trackers and Electromagnetic Calorimeter)

1. Sec 6.1. (also for Sec 9.3) How is the tracker aligned with respect to the emulsion walls in the analysis? (How far) can the precision be improved over the mechanical alignment precision?

A nominal alignment accuracy of about 100 microns between SciFi and the emulsion mechanical frame is achieved by the mechanical alignment. The accuracy of the alignment between the emulsion film (inside the mechanical frame) and SciFi is estimated to be about 300 microns. Given the low density of neutrino interactions in the target, this accuracy is certainly sufficient to unambiguously associate SciFi hits and emulsion tracks with a pattern matching procedure.

2. Page 39: How do the dead zones between fibre mats affect the overall detector performance? Do they have a significant impact in terms of reduced acceptance, or are they negligible?

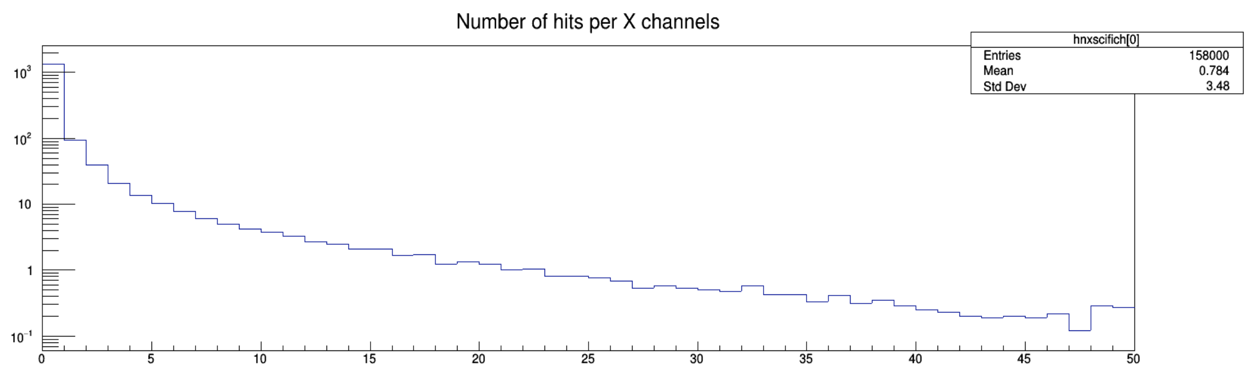
It is 500 micron per fibre mat which corresponds to 0.4%. Therefore, its impact on the shower energy resolution is expected to be negligible.

3. Page 39: The heat dissipation into the closed volume is not quite clear. Here it would be

helpful to clearly specify the number of components for a SciFi station: How many mats, how many boards per mat, which power per board, which part of this needs to be cooled away in the volume / which is taken out by water cooling of the boards?
The power dissipation is dominated by the FE chip, water cooling is provided to evacuate this heat. The remaining power of 250W is dissipated by the FPGA board and the DAQ boards power supply (8W/board with 31 boards inside the neutron shielded volume)

4. Sec 6.4: Some more details on the TOFPET2 ASIC and the expected performance should be given here, since all test results are with the STiC: Time resolution, dynamic range (in particular in view of the use of the same chip for the veto and muon systems, which have very different pixel numbers in the SiPMs)
The time resolution of the SciFi together with the TOFPET2 evaluation system was measured and found to be consistent with the expectations for a single plane hit time resolution over 128channels of 250ps. With the same electronics, the direct injection into the SiPM with a pulsed laser showed a time resolution of 80ps, demonstrating that the electronics is suitable for the SciFi but also for the Muon timing detector. The dynamic range of the FE electronics required to read the small area SiPMs of the SciFi is 50pC. For the Muon system, SiPMs with reduced area (3x3mm^2) and pixel size (10um) will ensure that the 1600pC linear range of the TOFPET2 chip covers a dynamic range up to 12kMIPs.

5. Page 41: Here you mention significant saturation for a shower track density of 2 tracks per channel. Which densities are actually expected?
With a total of 104 pixels per channel and 25pe per MIP, for a shower with an average energy deposit of 2 MIPs/channel about 50% of the pixels of the photodetector are occupied. Beyond this point, the detector response has a deterministic, strongly non-linear response. We have clarified that in the TP. The number of hits per channel in the SciFi plane downstream of the interaction vertex is reported in the plot below, as estimated with the Geant4 simulation of νe CC interactions.



6. Table 5: How are existing detectors accounted for here? Is their cost included (and then budgeted as an in-kind contribution)?
- Yes, existing parts are budgeted as in-kind contribution, for example the SciFi fibre planes

<u>Chapter 7 (Muon System & Hadronic Calorimeter)</u>

1. Section 7.1:
a. Which spatial resolution is required for the downstream layers of the muon system? A bar width of 1 cm should yield 3 mm for each plane.
The requirement on the spatial resolution is driven by the extrapolation error from the target to match a track reconstructed in the emulsion with the muon candidate track. Given the resolution of about 3 mrad in the emulsion films, the extrapolation error is about 5mm.

b. Does the smaller coverage by SiPMs on the bar ends in terms of fraction of area for the small strips compared to the wide strips of the upstream layers result in lower signal amplitudes? If yes, does this have an impact?
Yes, the fractional coverage of the SiPMs per bar end for the upstream stations is 48%, while for the downstream stations it is 36%, leading to a roughly 25% reduction in signal. This should not impact the reconstruction of tracks because the signal per bar is expected to be about 50 p.e. (as measured in a testbeam with 2.5 GeV/c^2 muons), which is much higher than the noise due to dark counts.

c. Do the strips with one-sided readout have mirrored ends? How are corrections based on the longitudinal position along the strip applied to account for non-uniform response, and travel time of the signal? (Presumably using the other projections, but it would be good to see a concrete strategy).
Yes, the bottom end of the vertical bars will be wrapped with aluminum mylar foil. A correlation between the arrival time and amplitude is corrected for by fitting a polynomial function to the time vs. amplitude and time and applying a correction on an event per event basis. By using the track projection, the position of the signal along the bar can be used with the arrival time to determine the correction based on the effective velocity along the bar. This can be performed with background muons in the cavern and applied to the data offline.

d. On the rhomboidal bars: Would it make sense to push this further, with larger overlap? Signal sharing could then possibly further improve spatial resolution. However, in the same context: At what point does this run into a limit by Landau fluctuations?
The exact angle of rhomboidal bars is being optimised with the aim of recovering tracking inefficiencies between bars rather than improving on the position resolution, which is adequate (see above).

2. Section 7.2:
a. The lateral shift of 22 cm of the last layer is not quite clear. Is the value indeed 22 cm (which is significant with respect to the overall dimensions of the detector)? Is the absorber also shifted, or just the scintillator plane? What is the analysis impact of that shift?
Thanks for spotting, it’s a typo, should be 22 mm

b. Are there test beam measurements that show response as a function along the bar, comparing left/right/sum signals?
Yes, for the bars with 6 x 1 cm^2 cross-section:
DOI: 10.1088/1748-0221/12/11/P11023
DOI: 10.1016/j.nima.2020.164398

Chapter 8 (DAQ)

1. The plan to harmonise the readout of the scifi and the veto and muon stations by using the same readout ASIC makes a lot of sense from the DAQ point of view, but on the other hand the SiPMs used in the two systems are very different (104 pixels in the scifi vs. 14331 in the veto and muon stations). According to the TOFPET2 documentation, the dynamic range of the ASIC ends at 2500 pC, which seems too small for the veto/muon SiPM - can you comment on this?
In the first 5 upstream Muon planes, the Collaboration intends to use SiPMs of a different type with a reduced area (3x3mm^2) and reduced pixel size (10um). This will ensure that the 1600pC linear range of the TOFPET2 would cover a dynamic range equivalent to up to 12kMIPs.

2. Has the readout been tested with both SiPMs?
Not yet. The SiPM for the Veto/Muon system will arrive at the end of March. First tests are foreseen in May. The readout has been tested with SciFi SiPMs.

3. Are the effects of the SiPM non-linearity and of the electronics taken into account in the expected detector performance (e.g. figure 55)?
These effects are included in some of the detector performance plots. For example, they are included in the studies reported in Figure 56 and 57 but not yet in that of Fig. 55. The improvements in the simulation will be propagated to all performance plots.

4. How important is a stable temperature for the operation of the SiPMs in the muon stations? Is there a temperature monitoring foreseen close to the SiPMs? Do you plan to adjust the SiPM bias voltage?
The breakdown voltage variation is < 100 mV/K. A PT-1000 can be read by each TOFPET board. The temperature is measured below the SiPM in good thermal contact with it: this system was developed for the LHCb SciFi that has a very demanding constraint on the temperature monitoring. All the SiPMs for a given DAQ board are biased to the same voltage. SiPMs connected to a single DAQ board will be selected to have the same breakdown voltage, so a SiPM-by-SiPM adjustment is not required.

5. If we understand correctly, the BST-TTC is a custom board that does not yet exist. Is there no (already existing) alternative? What is the status of the board?
The BST-TTC board is identical to a DAQ board, with the addition of a mezzanine card, providing two ECL outputs to be used for the recovered clock and orbit signals to be delivered to the TTC system. The firmware for this card will be based on the DAQ boards one, with small modifications, like routing the deskewd 40 MHz clock and the L1A (which is the orbit pulse in the BST system) to the ECL outputs. The final production of all the cards (DAQ V3, mezzanine V0 and TOFPET V1) was launched in the week of February 8.

6. How much of the DAQ firm- and software does already exist? How many people are working on it?
Firmware: the most important parts are completed and debugged, namely:

- Configuration and calibration of TOFPET ASICs can be correctly performed;
- Data for TOFPETs is correctly received, decoded and packetized;
- Communication between CPU and FPGA works correctly, for configuration, monitoring and data acquisition;

- The TTCrx-related part, i.e. configuration and monitoring of the chip and reception of clock and L1A, is implemented and debugged;
- The SiPM temperature is correctly read;

A few features are implemented and will be debugged next:

- Reception of long and short B-channel commends from the TTCrx

A few minor features will be implemented soon (they require the updated versions of the DAQ [V3] and TOFPET [V1] boards to be tested):

- Reading of unique ID of each DAQ and TOFPET board from an EEPROM
- Monitoring of TOFPET board temperature

Software: the low-level software corresponding to the “completed and debugged” features listed above is available and debugged. The communication protocol between the various components for command and data is defined and debugged. Regarding the higher-level software components, the main focus has been on the software for the DAQ boards because it is the most complex. The other components are comparatively simpler and will be based on the base classes written for the DAQ part. In more details:

- DAQ data server: early stage, data communication from multiple boards at once has been tested. Monitoring, commands reception and event building will be added soon.
- DAQ data client: early stage, data communication to DAQ data server tested. Needs to be integrated in the DAQ board server to be easily started, stopped and monitored.
- DAQ board server: advanced stage, most commands it can receive are implemented and correctly working (e.g. to check the board status, configure board, perform calibration of TOFPETs, etc.)
- BST-TTC software: not written yet, but will be based on the DAQ board one. Requires V3 of the DAQ boards.
- VME server: written, needs to be tested.
- DCS server: not written yet, will investigate if JCOP can be easily integrated with the rest of the software. The base classes will be the same as for the other servers.
- “control room” clients: the DAQ board client base classes are written and tested with a basic command line tool. The other clients will follow

2 people are working on this item.

7. Do you foresee any online monitoring of data? If there is a problem in the data (e.g. wrong bias voltage applied to SiPMs, or incorrect synchronisation between the layers), on which time scale would you be able to spot it?

Yes, the details will be defined with the software group. With the monitoring foreseen, a problem in the data can be detected within minutes. Apart from daily shifter monitoring, automatic data quality controls will raise alarms by SMS.

An incorrect synchronization can be spotted automatically by the DAQ data server because periodic triggers will be sent to all the boards with the TTC system and verified on the server, which then requests a resynchronization (i.e. a sync reset is sent with the TTC system). This can be spotted within a few seconds (depending on the sync trigger rate, that can be chosen to be even ~1Hz if needed).

8. Do you foresee an external control of the power supplies (except the switching on/off in the DCS)?

The power supplies and the main frame will be controlled via Ethernet, giving full access to all settings and switches via DCS. We are investigating if also the Ethernet interface has special hard-turn off/on with special packets. Alternatively a remote controllable power strip may be used.

9. You should foresee spare components for equipment in TI18 as much as possible, such that it can be exchanged in a short stop in case of problems. For example, a spare for the control PC (fully installed as the real one!), or for the TTC equipment. Can you comment on your plans in this regard?
Yes, spare components are foreseen, namely:
- TTC system: a full TTC system is available at the EPFL LPHE lab. To avoid using our own, the purchase of a couple of TTCvi/TTcex is foreseen for late 2021, when they will become available.
- Control PC: a “mirror” spare PC is considered
- Power supplies: a few spare modules and 1 spare crate are foreseen
- TOFPET, DAQ and BST-TTC boards: several spares are foreseen

Chapter 9 (Installation)
1. It is concerning that there is no clear procedure yet how to exchange the target tracker bricks in one 8-hour shift - this can be one of the possible show-stoppers for the success of the whole experiment. The smaller target bricks address the size of the emulsions, but it seems this change is not used to make the installation of the target easier, since the bricks will be assembled into walls in the dark room and transported as whole units - is that correct?
The current scheme of replacing emulsion in Technical Stops does not require the procedure to take less than a single shift of 8 h. Nevertheless, we have aimed at guaranteeing this in order to have the possibility to replace the films in other unforeseen stops of the LHC, should it be needed. The missing part of the procedure only concerns the practical aspects of requesting the access, impact handling, RP etc.

The wall preparation and the piling up of the emulsion films can be performed in advance with respect to the installation underground, as also discussed in the context of the sharing of the dark room facility with FASERnu: a storage room underground will be needed. This makes the actual replacement much faster.

We describe here the typical length of the different processes. Each wall (composed by 4 piles) is assembled in a dark room in about 1h using an assembly set up with a 45 degree tilted pile position, directly on the transport trolley. 5 walls = 5 hours. Each wall will be then rotated to horizontal position and stay on his transport trolley. 5 walls = 5 trolleys to be transported (by truck) from Meyrin dark room lab to LHC tunnel access site, or to the storage room if done in advance. All the operations described here do not count in the operation time needed, if they are done in advance. They will then be manually towed to the SND site. The transport will take place while a first crew opens the cold box and prepares the extraction of the exposed walls. The trolley is designed to let the wall rotate to a full horizontal position to let it slide under the LHC magnets. In the SND site there will be a 6th empty trolley to be used to remove the wall n.1 from exposure set up and free the wall slot n.1 in the set up, to be filled with one of the brand new 5 walls transported there. This action will liberate one trolley to be used to download the wall n.2 from exposed set up. This operation will be repeated five times.

The 5 trolleys with the removed walls will be transported to Meyrin dark room lab to open them and process emulsion films. The entire wall replacement action is estimated to take less than 5 h (time from access to exit of LHC tunnel not including the truck upload/transport/download steps).

2. Please clarify how the trolley for the target walls (fig. 43 right) is supposed to fit into the 37 cm height underneath the QRL (is the handle hinged ?)
Yes, the trolley design is such that the handle and the load volume stay well within 35 cm max height. Yes, the handle is hinged.

3. How crucial is the time between the preparation and the installation of new emulsion bricks? How long can they sit and wait until being installed?
If the emulsion is to be stored in the emulsion lab on the surface, the chambers should be prepared within one week before the installation.For this reason we are requesting a storage site underground at controlled temperature. This solution is preferred and have two advantages: (i) assemble the wall in advance, (ii) be ready for installation as soon as we have green light for the access to TI18.

4. Do you expect problems in the installation of the chiller and the rack due to the slope of the tunnel in TI18?
The slope has been taken into account in the transport study by the EN-HE. A manual winch to pull the “heavy” parts, such as the chiller and the cooling platform, will be installed. The cooling platform is designed to compensate for the slope.

5. Page 57: you write "The available space below the hoist for the transport channel is H:0.2 x W:0.1 x L:3m^3" That doesn't seem to fit to the size of the pieces you need to transport.
Thanks for spotting the typo, the transport path allows a volume up to H:200 cm x W:100 cm x L:300 cm while the item with the biggest volume to be passed above the LHC machine is 75 cm x 90 cm x 150 cm.

6. Page 58: On the temperature for the emulsions, here it is stated that the temperature must be below 15 C, while the cooling is specified to keep the temperature at 15 +- 1 C, which can be above 15 C. What exactly are the specs, and what are the consequences of temperatures 1 C above 15 C?
“below” → “about” as stated elsewhere. Within a few degrees and a few days, the emulsion will not degrade. The rise in temperature will raise an alarm that gives ample time to either correct the problem remotely or turn off until the earliest possibility to access.

7. Page 61: 12 optical fibers should be installed, but the need for 6 is described (including 2 spares). What is the role of the other six fibers?
A standard optical fibre cable has 4, 6, 8, 12, 24 or 48 optical fibres. A 12 optical-fibre cable was chosen as the difference in cost between the first four alternatives is limited, leaving spare fibres already installed for future upgrades. Following EN-EL-FC policy, a pro rata cost per used fibre is charged for its maintenance. Therefore, only the pro-rata cost of 6 fibres has been

included in the present infrastructure budget following the detector needs described in the Technical Proposal.

Chapter 13 (Physics Performance)

1. Page 87: Although the analysis you cite involved different energies in the numerator and denominator (14 TeV and 7 TeV), can it be done with a common energy (14 TeV) in both? Might this, in fact, reduce further the scale and mass systematics, and therefore enhance the PDF dependence?

Taking a common energy in the cross section ratio would indeed reduce the scale and mass uncertainties. However, at the same time, it also considerably reduces the pdf uncertainty. This is shown in the plot below and it can be traced to the fact that the *x* values probed in the numerator and in the denominator are closer in the second case, thus enhancing the correlation.

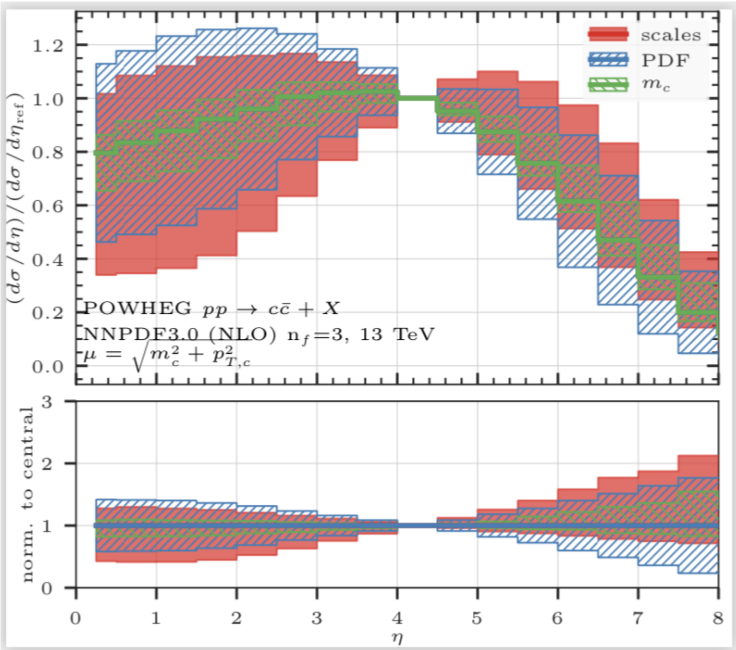


Figure 1: Ratio normalized with the bin at 4 < η < 4.5 at 13 TeV.

Another option consists of building the ratio with respect to a central bin. In Figures 2 and 3 we show the two cases when we normalize with respect to the central bin at 7 TeV and at 13 TeV respectively. Also in these two cases the pdf uncertainty is larger than the other two, although the scale uncertainty is sizable.

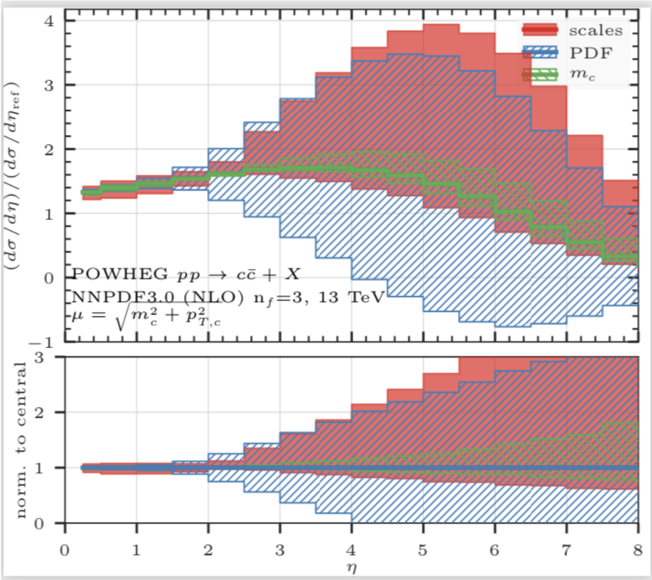


Fig. 2 Ratio normalized with the bin at 0 < η < 0.5 at 7 TeV.

Furthermore, a subdivision of the collected data in pseudorapidity bins could offer the possibility to build other ratios. This subject is currently under investigation by the theorists. We don't exclude that other theoretical procedures could produce an even better exploitation of the data compared to the TP.

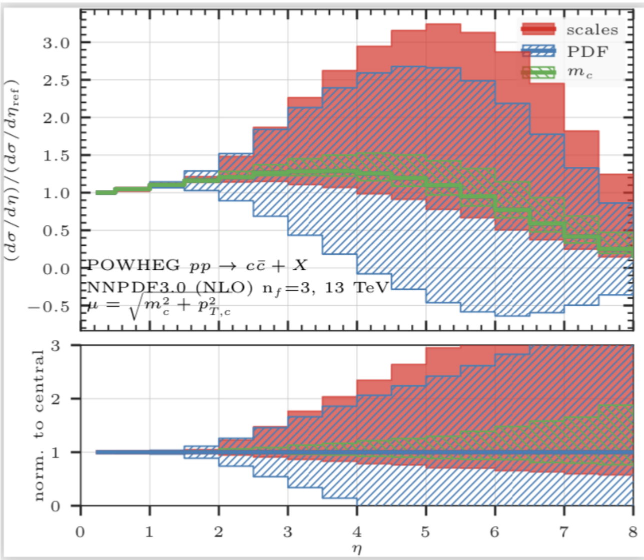


Fig. 3 Ratio normalized with the bin at 0 < η < 0.5 at 13 TeV.

2. Page 87 (bottom): Figure 68 is referred to before 67 (figure references are not in order).
OK, thanks. We will fix this.

3. Page 89: right under eq (3): "Notice that Br(Ds → τν) includes also the contribution from the subsequent tau decay". It would be inaccurate to absorb the contribution of tau->nu_tau in a rescaling of the branching ratio. The reason is that the spectrum of the prompt nu_tau is

much harder than the spectrum of the tau-decay nu_tau, and its interaction cross section is therefore smaller. Can you comment on this?
We did not mean a simple rescaling of the branching ratio, but rather the full simulation of the decay chain which accounts for the different spectra (the prompt is softer). We have modified the sentence accordingly.

Chapter 14 (Cost & Schedule)
1. Page 103 (Table 22): What is the explanation for the extra 500kCHF in the cost of the emulsions? The text says "The cost of the emulsion films in the LoI was based on the raw material cost from Nagoya. The current cost is based on an offer from the Slavich Company (Russia) for the complete production." If the Russian offer is more costly than Nagoya's, why not stick with nagoya?
Nagoya so far has committed manpower and local machine time for the production of about 40% of the films. The remaining material cost would reduce to less than half the net cost of the corresponding emulsion films. However, due to uncertainties in Nagoya's resources and funding for 2021, we conservatively assumed that emulsion is ordered through the Slavich company.

2. The installation assumes 11 weeks of access at the end of 2021. Is this realistic? Is there any float contained in these 11 weeks?
We are currently in the process of reviewing the timeline for the detector construction and installation, Collaboration meeting on Friday 19/2. Currently, the work time for each detector component has been rounded up to a week and no parallel activities are assumed.

In order to gain confidence and train on the installation we are aiming at setting up a large fraction of the detector on the surface and perform detector commissioning and calibration. **We have submitted a request to the SPS coordinator to have the area outside of the H8 test beam zone during the month of September and October. This will also allow to parasitically take data with muons. We would appreciate your support in this request.**

3. In general, is the proposed schedule consistent with the latest modifications to the LHC cooling schedule? Is there flexibility to absorb further changes to the LHC plan?
Yes, we have had another iteration with the LHC coordination and LHC beam commissioning in the week of February 10. Our current schedule and assumptions are compatible with the machine status during the second half of 2021, the latest updates on the magnet training, and the beam test in w.39-40. We also have flexibility which seems compatible with the possible changes of the schedule as long as machine closure is not moved to an earlier date.

Chapter 15 (Organisation)
1. How many people are dedicated to the project (i.e. it takes the majority of their research time)?
We have about 180 signatures equivalent to 50 to 60 FTEs.

2. Is there a risk of manpower being drained from the project if SHiP is approved?
SHiP is not on the same time scale. Moreover, the SHiP Collaboration will profit from this experiment in many respects.

3. How do you plan to ensure that there is a responsible person who can be reached 24/7 without on-site shifts?

After the initial commissioning period, operation will turn to a routine of automated data taking with one trained person acting as general "shifter" and expert-on-call. The shifter should be available at CERN to perform daily routine checks of detector operation and data processing from the control room (dedicated office on Meyrin site), and be available 24/7 for interventions, if necessary, remotely supported by the corresponding detector experts. Similar to the scheme in for instance LHCb, the shifters will be volunteer experts from around the participating institutes that typically take two-week shift periods.

By construction, immediate interventions will be limited to control operations via software and on the equipment that is in the experiment rack in SR1. Interventions on the detector will have to be scheduled through the LPCs.