

Report of the Scrutiny Group to the LHC RRB, October 2022

Membership of the Scrutiny Group

At the end of 2021 Michael Campbell (CERN), Dominik Dannheim (CERN), Renee Fatemi (Kentucky) and Pasquale Lubrano (Perugia) retired from the group. The Scrutiny Group (SG) wishes to thank them all for their dedicated service over many years.

The membership of the Scrutiny Group in 2022 was: Hans Danielsson (CERN), Ariane Frey (Göttingen), Joel Goldstein (Bristol), Edoardo Mazzucato (CEA/IRFU), Monica Pepe (INFN, Perugia), Kevin Pitts (Fermilab), Roman Pöschl (LAL), Agata Rozycka (CERN; Service Contracts), Heidi Sandaker (Oslo; chair), Burkhard Schmidt (CERN; Secretary), Christoph Schwanda (HEPHY), Jan Troska (CERN), James Yeck (BNL).

1 General remarks

The war in Ukraine has serious implications for the maintenance, operation, data taking and analysis work of the existing experiments as well as the upgrades, both for computing and detectors. Added to the already increased cost from the pandemic and the war situation, we also saw increased power costs and additional costs due to shortages of resources. The pandemic situation due to Covid-19, in 2020 and 2021, has much improved during 2022.

2022 was the first year of running (Run3) after Long Shutdown 2 (LS2) with extensive work to commission and test upgraded detectors and computing systems and prepare the existing systems in time for first beam and the start of the run. In spite of the current difficult situation most of this work has taken place. The experiments continuously work on improving infrastructure and services for a stable and safe operation of the detectors and an optimal working environment for staff and students.

The Scrutiny Group congratulates the LHC and the experimental collaborations for their extraordinary efforts and achievements in 2022.

2 Scrutiny process and general matters

Following the RRB meeting from April 25-27 the SG held its Spring meeting from May 9-10. Both in the RRB and SG meeting summary reports on 2021 expenditures and 2023 requests were presented by the collaborations. The SG met with the LHC experiments ATLAS, ALICE, CMS, LHCb, represented by their respective Resource Coordinators and other members of the senior management. The SG and experiment representatives discussed the closing of the 2021

accounts, the status of the 2022 spending, the budget request for 2023 as well as plans for the future. Additional in-depth discussions with each experiment took place in June and July. During these meetings each experiment was reviewed by a subgroup of the SG, who summarised the findings in internal reports. The Scrutiny Group met again in September 20-21 with the collaborations to discuss and resolve any outstanding matters. In addition to the scrutiny of the M&O A and B budgets, the SG also discussed the status and spending profiles of the Upgrade Common Funds (Phase-1 and Phase-2) with the experiments, following the agreement in 2015 (see RRB-2015-086).

The SG thanks the Resource Coordinators and the collaborations as a whole for the excellent cooperation and the constructive spirit of the discussions.

As a follow up of the RRB discussions in April 2022 and previous years, a few specific items were discussed in more depth with each experiment; the details are in the respective experiments' section:

- The M&O A cash balance discrepancies between the CERN Financial reports and the cumulative internal SG budget tables maintained by the collaborations were resolved in a dedicated effort in the past (RRB-2017-070). The SG is very pleased to note that for the 2022 scrutiny, the trend continues with very good agreement.
- A follow-up on long-term projections for the special online computing replacement account. These accounts are allowed to go negative, and should not accumulate excessive cash reserves.
- In RRB-2017-070 it was agreed that carry-over on subdetector M&O B accounts should aim to stay below approximately 30% of the yearly budget. The SG continues to follow these developments and reduction is progressing for all subprojects where substantial reserves are present.
- Tracking of entry fees: ALICE, ATLAS and CMS charge "entry fees" for new institutes that wish to join the collaboration, to compensate for the lack of contribution to the original detector construction. In the interest of transparency, the SG has asked the experiments to report the status of and plans for these funds. These fees are not subject to the same level of scrutiny as M&O expenditures.
- Common funds: The SG was asked to evaluate if the collection of Common Funds is proceeding according to plan or if it represents a risk.
- During LS2, the experiments, in particular ALICE and LHCb, have been installing new upgraded detector systems. This results in changes in maintenance and operation costs during LHC Run 3. Such changes have been discussed with the experiments during 2020-2022. The SG will monitor the evolution of these costs closely in the years to come.

The following specific items came up during this year's scrutiny cycle:

- As a result of the war in Ukraine, in the April RRB and the May SG meetings the experiments presented their plans and two scenarios for discussion on how to deal with this

new situation. One scenario, to continue as before, and one to continue without the contributions of Russia, Belarus and JINR. In June, the CERN Council voted to terminate the International Cooperation Agreements with Russia and Belarus at their expiration dates in 2024, and for JINR in January 2025. This decision has been the baseline for this year's SG review.

- As in 2021, the RRB continues to be concerned about the cost increase of some experiments. This applies in particular to the Phase-2 upgrades of ATLAS and CMS. This will be addressed in the individual sections for the experiments.
- During 2022 the overall increase in power cost has been significant. At present, some experiments have mechanisms in place to adjust for the change in power cost in the following years; others have a stable power cost since many years in their budget request. The increase in power cost will clearly be an important topic for next year's SG cycle.
- For some experiments risks such as shortages and delays of supplies as well as issues of inflation have been mentioned; details will be discussed in the 2023 SG cycle.
- Over the last two years the SG has noted a general development of late payment of contributions affecting several of the experiments, this trend continued in 2022.

3 Budget requests for 2023

Table 1 gives a global overview over the 2023 budget requests of the experiments. The requests are detailed in the relevant experiment subsections.

Table 1: M&O requests for 2023 in kCHF, without and with power costs.

| Experiment | without power | with power |
|-------------------|----------------------|-------------------|
| ALICE M&O A | 4,935 | 7,437 |
| ALICE M&O B | 1,385 | 1,385 |
| ALICE M&O A+B | 6,320 | 8,822 |
| ATLAS M&O A | 13,230 | 15,430 |
| ATLAS M&O B | 5,970 | 5,970 |
| ATLAS M&O A+B | 19,200 | 21,400 |
| CMS M&O A | 13,653 | 15,353 |
| CMS M&O B | 6,578 | 6,578 |
| CMS M&O A+B | 20,231 | 21,931 |
| LHCb M&O A | 3,070 | 3,670 |
| LHCb M&O B | 1,290 | 1,290 |
| LHCb M&O A+B | 4,360 | 4,960 |

4 ALICE

ALICE M&O A closing report for 2021

The ALICE M&O A closing report was submitted to the RRB meeting in April (CERN-RRB-2021-017). The 2021 budget as approved in 2020 and the closing report presented in 2022 are shown in Table 2.

Table 2: Summary of the 2021 book closing of ALICE, listing the M&O A budget as approved in 2020 and the actual spending report in this year's scrutiny cycle. All numbers in kCHF.

| M&O A Categories | Budget for 2021 | Actual in 2021 |
|-------------------------------------|------------------------|-----------------------|
| Detector related | 1,271 | 1,421 |
| Secretariat | 193 | 189 |
| Communications | 0 | 0 |
| Core computing | 776 | 801 |
| Online computing | 1,773 | 1,752 |
| Test beams & calibration facilities | 50 | 49 |
| Laboratory operations | 245 | 245 |
| General services | 602 | 624 |
| TOTAL without power | 4,910 | 5,081 |
| Power (MS + NMS) | 717 | 550 |
| Grand Total | 5,627 | 5,631 |

Comments on spending: Total expenditure in 2021 excluding power was 5,081 kCHF, 171 kCHF above the budgeted sum of 4,910 kCHF. The total expenditure was 5,631 kCHF including power (550 kCHF) of which the NMS power share was 147 kCHF. There was a further 83 kCHF in open commitments. The small overspend is largely due to open commitments from before 2021 which were paid in 2021.

Carry over: The cumulative balance between the budgeted amount and the actual expenditure at the end of 2021 was 847 kCHF (without power or open commitments). Including the NMS power contributions, it reduced from 1,724 kCHF at the end of 2020 to 1,598 kCHF at the end of 2021. Taking into account received advance contributions, the cash balance at the end of 2021 was -614 kCHF.

Contributions: The invoiced total is 5,134 kCHF; of this 255 kCHF are outstanding from the funding agencies for 2021. This trend with outstanding contributions or late payments in 2019 and 2020 continues for 2021. The cumulative outstanding contributions at the end of 2021 as per finance report are 1,881 kCHF. This is a cause for concern as it threatens the experiment's financial viability.

CERN finance report: The SG confirms that the numbers reported by the experiment are in perfect agreement with the figures reported by CERN finance.

The Scrutiny Group recommends approval of the ALICE 2021 M&O A closing report.

ALICE M&O B closing report for 2021

The M&O B budget for 2021 was 1,430 kCHF, while the actual spending reached 1,388 kCHF with 24 kCHF open commitments. This corresponds to an underspend of 42 kCHF of the approved annual budget. After three years of intentional overspend in order to reduce the accumulated reserves from previous years, this is the first year that the funds see a slight accumulation again. The M&O B is a mix of in-kind and cash contributions.

Those systems which will not continue in Run3 have now spent their reserves. Other systems have reduced their cash reserves to less than 30% of their annual budget, as agreed with the Scrutiny Group.

The Scrutiny Group recommends approval of the ALICE 2021 M&O B closing report.

ALICE M&O situation in 2022

The spending of the 2022 M&O A budget proceeds according to plan. As of September 16, 49% of the budget of 4,983 is spent, 64% including commitments. The planned transfer to the online replacement account in 2022 is 878 kCHF, which (as in the last few years) will be paid at the end of the year to help with late payments and avoid cash flow problems.

Special topics 2022

War in Ukraine:

The impact of the war in Ukraine was discussed at the May and June meetings with the experiment. There is a sizeable contribution from Russia and JINR (around 8% of the total; the PHOS subdetector is to 100% under the responsibility of Russia and JINR). Following the decision of CERN Council in June, it is being assumed that these contributions will continue (including the one for the PHOS upgrade). Meanwhile, ALICE is discussing how to help its Ukrainian institutes to continue their participation during this difficult time, and it is considering that their contribution to the common fund be waived.

ALICE M&O A budget request for 2023

The budget request for 2023 is shown in Table 3 together with the previously approved budget for 2021 and the projections up to 2026.

The M&O A budget request for 2023 is 4,935 kCHF excluding power. The total power cost is 2,502 kCHF of which the NMS share is 674 kCHF. There have been no significant changes to the projections for future M&O A since the 2020 RRB. Small changes are seen for detector related costs, online computing and general services. There is an increase of 0.5 MCHF per year for Run 3 in the overall computing budget (split between offline and online), due to the new O2 data centre, as agreed in 2018.

The Scrutiny Group recommends approval of the ALICE 2023 M&O A budget request.

ALICE Online Replacement Account

During LS2 the current online system was replaced by the substantially bigger O2 system (~9 MCHF), resulting in a significant increase of replacement costs in the long term (this dif-

Table 3: ALICE M&O A budget request for 2023, shown together with the 2022 budget and the projections up to 2026. All numbers in kCHF.

| M&O A Categories | 2022 | 2023 | 2024 | 2025 | 2026 |
|-------------------------------------|--------------|--------------|--------------|--------------|--------------|
| Detector related | 1,192 | 1,207 | 1,207 | 1,207 | 1,567 |
| Secretariat | 193 | 193 | 193 | 193 | 193 |
| Communications | 0 | 0 | 0 | 0 | 0 |
| Core computing | 776 | 776 | 776 | 776 | 776 |
| Online computing | 2,022 | 1,930 | 1,930 | 1,877 | 1,338 |
| Test beams & calibration facilities | 50 | 30 | 30 | 30 | 0 |
| Laboratory operations | 245 | 245 | 245 | 245 | 255 |
| General services | 505 | 553 | 553 | 607 | 806 |
| TOTAL without power | 4,983 | 4,935 | 4,935 | 4,935 | 4,935 |
| Power (MS + NMS) | 2,546 | 2,502 | 2,502 | 2,235 | 593 |
| Grand Total | 7,528 | 7,437 | 7,437 | 7,170 | 5,528 |

fers from other experiments). These costs are partially funded through the online replacement account, consistent with direct replacements. The sum of 2,991 kCHF was spent during LS2 as planned,

In 2021, the spending was 2,517 kCHF. With a transfer of M&O A of 829 kCHF into the account, the balance reduced from 5,576 kCHF (Dec 2020) to 3,888 kCHF (Dec 2021).

From 2022 it is planned to again transfer funds to this account, 878 kCHF in 2022 (possibly towards the end of the year). After LS2, the online account accumulates funds until the O2 system will be replaced in 2028 (8 MCHF), when the balance is expected to go to 600 kCHF. It is planned for this fund to go negative after significant payments in the early 2030s.

ALICE M&O B budget request for 2023

The budget requests for 2023 is shown in Table 4 together with the 2022 budget and projections up to 2026. The M&O B budgets of each system are scrutinised internally in the collaboration and also at the national level during approval of the relevant budgets. The SG has discussed the requests with ALICE in detail.

The requested M&O B budget for 2023 is of 1,385 kCHF. This request takes also into account changes in major subsystems due to the upgrade of detectors in LS2. From 2022 onwards, these upgraded detectors will be fully in operation.

The Scrutiny Group recommends approval of the ALICE 2023 M&O B budget request.

Upgrade Common Fund and Entry Fees

Phase-1 Upgrade Common Fund: The ALICE Phase-1 upgrade Common Fund budget is of 5.8 MCHF. By September 2022, contributions of the order of 5,730 kCHF was invoiced and 5,660 kCHF collected, 70 kCHF outstanding. The total spending has been 5,947 kCHF, consisting of 5,545 kCHF from the fund and an additional 400 kCHF from entry fees. A cash balance of 681 kCHF remains. Any funds remaining once the upgrade spending is complete is proposed

Table 4: ALICE M&O B budget planning for the years 2022 - 2026. All numbers except the last rows in kCHF. The last row is in staff-months.

| M&O B Categories | 2022 | 2023 | 2024 | 2025 | 2026 |
|---|--------------|--------------|--------------|--------------|--------------|
| Mechanics | 39 | 37 | 87 | 87 | 56 |
| Gas Systems | 28 | 23 | 23 | 23 | 11 |
| Cooling Systems | 52 | 50 | 50 | 54 | 45 |
| FEE Spares | 94 | 76 | 73 | 70 | 66 |
| Standard Electronics LV/HV PS | 146 | 142 | 154 | 154 | 130 |
| Standard Electronics Crates | 38 | 38 | 38 | 38 | 39 |
| Standard Electronics R/O modules | 74 | 72 | 72 | 72 | 68 |
| Controls (DCS & DSS) | 29 | 29 | 29 | 29 | 29 |
| Sub-Detector Spares | 13 | 38 | 38 | 38 | 39 |
| Areas | 56 | 51 | 51 | 51 | 56 |
| Communications | 105 | 106 | 106 | 106 | 99 |
| Store Items | 85 | 76 | 76 | 76 | 81 |
| Technical Manpower@CERN: Industrial Support | 8 | 9 | 9 | 19 | 32 |
| Techn. Manp.@CERN from Collaborating Institutes | 652 | 639 | 639 | 639 | 707 |
| Grand Total | 1,418 | 1,385 | 1,444 | 1,455 | 1,453 |
| Techn. Manp.@CERN from Col. Instit.(man months) | 221 | 213 | 213 | 213 | 223 |

to be moved to a common fund for the next upgrade (ALICE3). The scrutiny group agrees with this proposal.

Entry fees: ALICE collects entry fees from new members. These fees are accumulated in the Common Fund account and thus discussed with the SG. The entry fees are normally used for upgrade-related projects or other projects not covered, or going beyond, the Common Fund. In 2021, 198 kCHF of entry funds were received, giving a cash balance of 565 kCHF remaining with a further 41 kCHF still owed at the end of 2021.

5 ATLAS

ATLAS M&O A closing report for 2021

The ATLAS M&O A closing report was submitted to the RRB meeting in April (CERN-RRB-2022-026). The 2021 budget as approved in 2020 and the closing report presented in 2022 are shown in Table 5.

Spending: The 2021 M&O-A budget without power costs amounted to 13,759 kCHF. The total power costs were budgeted at 2,200 kCHF including a NMS share of 723 kCHF. The total budget was thus 15,959 kCHF. The actual expenditure in 2021 excluding power was 13,311 kCHF, 15,511 kCHF including power costs. This corresponds to an underspending of 448 kCHF, which is well balanced by the open commitments of 499 kCHF.

Table 5: Summary of the 2021 book closing of ATLAS, listing the M&O A budget as approved in 2020 and the actual spending report in this year's scrutiny cycle. All numbers in kCHF.

| M&O A Categories | Budget for 2021 | Actual in 2021 |
|-------------------------------------|------------------------|-----------------------|
| Detector related | 4,991 | 4,724 |
| Secretariat | 464 | 509 |
| Communications | 210 | 233 |
| Core computing | 2,354 | 2,249 |
| Online computing | 3,704 | 3,316 |
| Test beams & calibration facilities | 295 | 171 |
| Laboratory operations | 90 | 63 |
| General services | 1,651 | 2,047 |
| TOTAL without power | 13,759 | 13,311 |
| Power (MS + NMS) | 2,200 | 2,200 |
| Grand Total | 15,959 | 15,511 |

While in some areas, e.g. detector related costs, core and online computing and test beam and calibration facilities, there was underspending, general services had actually overspending of around 400 kCHF (compared to a similar underspend in that category in 2020). Additional expenditures of 1,486 kCHF were covered by the TDAQ online account for the scheduled replacement of the HLT servers. In fact, the cost of the servers was significantly lower than projected, resulting in a smaller transfer from the Online Replacement account of only 1,486 kCHF, compared to the 3,380 kCHF estimated at last year's meeting.

Carry over: The cash balance went from 708 kCHF to 3,327 kCHF, which corresponds to 20% of the 2021 total budget (including power). This large increase is mainly due to an increase in the advanced membership payments (2,638 kCHF by end of 2021, compared to 805 kCHF by end of 2020) and a reduction in outstanding contributions.

Online account: In 2021, 1,486 kCHF were withdrawn from the online account, no funds were deposited. The cumulative cash balance amounted to 1,962 kCHF at the end of 2021.

Contributions: The contributions received from Funding Agencies for 2021 were 14,816 kCHF, 102% of the due contributions of 14,482 kCHF. The cumulative outstanding contributions from 2021 went down to 1,189 kCHF from 1,523 kCHF end of 2020. This is a positive development.

CERN financial report: There is very good agreement between the Finance Department report (CERN-RRB-2022-023) and the numbers from the experiment. Note that a correction in the expenditure 2020 in computing had to be applied, resulting in a difference of 687 kCHF that was only reflected in the 2021 financial report. This results in a cash balance of 22 kCHF at the beginning of 2021 instead of 708 kCHF and a larger amount of 2,174 kCHF transferred from the online account shown in the Finance department report.

The Scrutiny Group recommends approval of the ATLAS 2021 M&O A closing report.

ATLAS M&O B closing report for 2021

The M&O B budget was 5,501 kCHF including 40 kCHF from provisions (stemming from the LAr subdetector budget), with an actual spending of 5,012 kCHF including 3,628 kCHF for hired manpower at CERN. At the end of 2021 the open commitments were 362 kCHF. With a net underspend of 489 kCHF in 2021, the carry-over, summed over all sub-systems at the end of the year, continues to increase from 2,149 kCHF in 2020 to 2,638 kCHF in 2021 (2,276 kCHF when subtracting the 362 kCHF open commitments). Globally, the M&O B carry-over is 41% of the annual budget and thus above the target limit of 30%. The large carry-over stems from the Inner Detector. Here, open commitments of the Pixel Optoboards of 345 kCHF have not been taken into account, which would reduce the carry-over to 35%. ATLAS plans to return the carry-over above the 30% limit to the respective Funding Agencies during the years 2023-26. The SG is pleased to see this return of funds.

The Scrutiny Group recommends approval of the ATLAS 2021 M&O B closing report.

ATLAS M&O situation in 2022

The amount spent so far on September 22nd, 2022 on M&O A budget, including open commitments, is 12,738 kCHF, i.e. 91% of the 2022 approved budget of 13,982 kCHF (without power). A moderate withdrawal from the TDAQ account of 680 kCHF is foreseen.

Special topics 2022

War in Ukraine:

ATLAS has a strong participation of Russian institutes, JINR and Belarus with 374 members and might thus be heavily exposed to the consequences of the war in Ukraine. This concerns both, person power and financial contributions. Russian experts are critical for the operation of the Inner Detector, the Tile Calorimeter, TDAQ and Technical Coordination. They have contributed to the NSWs and Muon systems (in particular a leak repair expert team) as well as the LAr calorimeter. While the Council decision to maintain the ICAs until the end of 2024 may prevent immediate consequences, the M&O budget sharing 2023 has been presented to the SG with and without contributions from Russia, JINR and Belarus. These contributions amount to 3.8% of the total M&O A+B that would have to be shared by the remaining countries' FAs.

The contribution of Russia, JINR and Belarus to the Phase II upgrade CORE amounts to 7.91 MCHF (844 kCHF expected in kind) which is about 3% of the total CORE. In addition, contributions of 1.08 MCHF are expected to the Phase II Common Fund up to 2026, corresponding to 4%. The timeline of the expected contributions peaks in 2023 and 2024. The loss of the Russian experts would hurt in particular during LS3.

Other items:

The SG commends the ATLAS collaboration for keeping the flat budget profile of 21.4 MCHF despite the large increase in cost of gases and coolants. This is possible at the moment due to underspending in previous years caused in large parts to the prolonged LS2. Some uncertainty arises concerning additional person power needed to cover for Russian experts that may potentially no longer be available. Considering also the large inflation, it seems unavoidable that

eventually the budget will have to be adjusted.

ATLAS M&O A budget request for 2023

The budget request for 2023 is shown in Table 6 together with the approved budget for 2022 and the projections up to 2026.

Table 6: ATLAS M&O A budget request for 2023, shown together with the 2022 budget and the projections up to 2026. All numbers in kCHF.

| M&O A Categories | 2022 | 2023 | 2024 | 2025 | 2026 |
|-------------------------------------|---------------|---------------|---------------|---------------|---------------|
| Detector related | 4,806 | 4,897 | 4,867 | 6,252 | 5,661 |
| Secretariat | 410 | 440 | 440 | 440 | 440 |
| Communications | 173 | 173 | 173 | 173 | 173 |
| Core computing | 2,354 | 2,354 | 2,354 | 2,354 | 2,354 |
| Online computing | 4,681 | 4,000 | 3,670 | 1,865 | 2,244 |
| Test beams & calibration facilities | 220 | 145 | 145 | 520 | 1,020 |
| Laboratory operations | 90 | 90 | 90 | 140 | 140 |
| General services | 1,248 | 1,131 | 1,131 | 1,161 | 1,695 |
| TOTAL without power | 13,982 | 13,230 | 12,869 | 12,905 | 13,727 |
| Power (MS + NMS) | 2,200 | 2,200 | 2,200 | 2,200 | 2,200 |
| Grand Total | 16,182 | 15,430 | 15,069 | 15,105 | 15,927 |

The ATLAS M&O A budget request without power for 2023 is 13,230 kCHF, down by 752 kCHF compared to the corresponding budget approved for 2022. The power cost is 2,200 kCHF of which the NMS share is 742 kCHF. This total request for 2023 has decreased slightly, by 339 kCHF, from the 2023 budget anticipated in autumn 2021. Some changes in the distribution between different items have been done following the re-evaluation of the long term experience. The projections for the M&O A budgets for the years 2024-2026 show a slightly decreased budget for 2024 and 2025 with a rise in budget in 2026 due to LS3.

In 2023, a deposit of 2,465 kCHF to the online replacement account is planned.

The Scrutiny Group recommends approval of the ATLAS 2023 M&O A budget request.

ATLAS Online Replacement Account Projections

At the end of 2021, the online replacement account had a positive balance of 1,962 kCHF. In 2022 a withdrawal of 680 kCHF is planned to finish the scheduled HLT server replacement. Due to the large savings in cost for these server replacements, the balance is about 1.9 MCHF higher than projected last year. In the years 2023 to 2025 the online replacement account will accumulate funds up to around 5.95 MCHF (with large deposits foreseen in 2023 and 2024 of 2,465 kCHF and 2,205 kCHF, respectively). In 2026 a withdrawal of 2 MCHF is planned. The accumulated funds are expected to cover significant purchases in 2028, still the size of the funds remain large until then.

ATLAS M&O B budget request for 2023

The actual and planned budgets from 2022 to 2026 are given in Table 7. The M&O B budgets of each subsystem have been scrutinised internally by the ATLAS collaboration and discussed with the SG during the June meetings.

The M&O B budget request for 2023 is 5,970 kCHF, compared to 5,631 kCHF presented last year. It includes 3,302 kCHF for hired manpower at CERN. The budget invoiced to the funding agencies for 2023 is slightly lower: it amounts to 5,754 kCHF due to the return of funds from carry-over mainly from ID over the period from 2023 to 2026. The budget increase since last year's meeting is due to a first request from ITk, a budget request from ID identical to 2022 and a small increase in the FD budget.

An ITk budget is now foreseen already for 2023 with 200 kCHF, the ITk budget projections for the following years remain unchanged. The SG noted during the 2022 cycle minor items which may be better included in core costs than in M&O, these items will be scrutinised in more depth in 2023. The cost overlap of ID and ITk from 2023 to 2026 will result in an increased budget peaking in 2025 at 2,850 kCHF and expected to fall below the level of the current ID budget from 2027 on.

Table 7: ATLAS M&O B budget planning for the years 2022 - 2026. All numbers except last row in kCHF.

| M&O B Categories | 2022 | 2023 | 2024 | 2025 | 2026 |
|--|--------------|--------------|--------------|--------------|--------------|
| Mechanics | 43 | 50 | 55 | 65 | 135 |
| Gas Systems | 58 | 58 | 58 | 63 | 15 |
| Cryo System | 0 | 0 | 0 | 0 | 0 |
| Cooling System | 18 | 18 | 38 | 38 | 38 |
| FE Electronics | 124 | 102 | 104 | 87 | 87 |
| Std Electronics LV/HV PS | 603 | 948 | 1,058 | 1,127 | 1,165 |
| Std Electronics Crates | 413 | 403 | 429 | 441 | 220 |
| Std Electronics R/O modules | 324 | 168 | 238 | 238 | 110 |
| Controls (DCS & DSS) | 115 | 115 | 125 | 130 | 94 |
| Sub-Detector Spares | 92 | 58 | 133 | 100 | 105 |
| Areas | 408 | 439 | 419 | 361 | 474 |
| Communications | 43 | 44 | 48 | 48 | 45 |
| Store Items | 243 | 215 | 263 | 280 | 241 |
| Hired Manpower @ CERN | 2,773 | 3,352 | 3,363 | 3,318 | 2,744 |
| Hired Institute Manpower @ 90 kCHF/FTE | 0 | 0 | 0 | 0 | 0 |
| Total expenditure | 5,258 | 5,970 | 6,331 | 6,295 | 5,473 |
| Return to FAs | -60 | -216 | -216 | -216 | -182 |
| Total to be invoiced to FAs | 5,198 | 5,754 | 6,115 | 6,079 | 5,291 |
| Technical Manpower OTP (FTE) | 242 | 239 | 239 | 237 | 211 |

The Scrutiny Group recommends approval of the ATLAS 2023 M&O B budget request.

ATLAS Upgrade Common Funds and Entry Fees

Construction Common Fund: This Common Fund is used to cover Phase-1 Upgrade spend-

ings and also to deposit the entry fees of new institutions. At the end of 2020 this account had 3,270 kCHF in cash balance. 287 kCHF were spent during 2021, leaving 2,983 kCHF at the end of 2021. In the past, the ATLAS Collaboration wished to finish the Phase-1 upgrades before closing this account, now the work has been concluded. This account will be kept for entry fees in the future. In May 2022, the balance of this account was 688 kCHF. New entry fees amounted to 114 kCHF and expenses for the NSW were covered.

Phase-2 Upgrade Common Funds: For Phase-2 upgrades, a dedicated Common Fund account is used with a total budget of 24.4 MCHF, to be collected over 9 years from 2018 to 2026 with a flat profile of 2.7 MCHF per year. The spending profile peaks in the years 2025 to 2027. As of end of the year 2021, 9,513 kCHF of contributions have been received (1,340 kCHF outstanding contributions) and 524 kCHF spent (227 kCHF in 2021).

Entry fees: ATLAS collects entry fees from new collaborating institutes. The funds are accumulated in the Construction Common Fund account (see above). The entry fees are used for detector and upgrade-related projects that extend beyond the original scope of the Common Fund.

6 CMS

CMS M&O A closing report for 2021

The CMS M&O A closing report was submitted to the RRB meeting in April (CERN-RRB-2021-035). The 2021 budget as approved in 2020 and the closing report presented in 2022 are shown in Table 8.

Table 8: Summary of the 2021 book closing of CMS, listing the M&O A budget as approved in 2020 and the actual spending report in this year's scrutiny cycle. All numbers in kCHF.

| M&O A Categories | Budget for 2021 | Actual in 2021 |
|-------------------------------------|-----------------|----------------|
| Detector related | 4,398 | 4,914 |
| Secretariat | 312 | 314 |
| Communications | 130 | 134 |
| Core computing | 1,964 | 1,840 |
| Online computing | 3,665 | 3,641 |
| Test beams & calibration facilities | 96 | 99 |
| Laboratory operations | 533 | 529 |
| General services | 1,853 | 1,791 |
| TOTAL without power | 12,951 | 13,262 |
| Power (MS + NMS) | 1,700 | 1,700 |
| Grand Total | 14,651 | 14,962 |

Spending: The 2021 M&O-A budget without power costs was 12,951 kCHF. The total power costs were budgeted at 1,700 kCHF with the non-member share (NMS) of 724 kCHF. The total

budget was thus 14,651 kCHF. The actual expenditure in 2021 amounted to 13,262 kCHF without power costs, and 14,962 with power. The total amount of open commitments at the end of 2021 was 497 kCHF of which 55% is related to industrial support contracts and 45% is related to consumables and goods to be delivered in 2022.

CMS reports a general overspending in the year 2021 of 312 kCHF (excluding open commitments) corresponding to a bit more than 2% of the budget for 2021. The main increase are for detector related costs, mainly manpower, due to the extension of LS2 to include 2021. Saving in other areas made it possible to limit the overspending.

Carry over: There is no significant accumulation of funds, the carry over stays well below 10%. Taking the open commitments into account the carry over from 2021 to 2022 is of a negative 809 kCHF. The accumulated carry over at the end of 2021 is of 615 kCHF without open commitments and taking into account the income through the NMS share on power. Note for completeness, that the cash balance at the end of 2021 was 828 kCHF not taking into account open commitments of 494 kCHF.

Online account: In 2021, the total DAQ expenditures amounted to 5,588 kCHF of which 2,888 kCHF was taken from the online account. The budget for 2021 was 2,700 kCHF. The resulting accumulated cash balance for this account is then a negative 158 kCHF at the end of 2021, in line with the account policy.

Contributions: As of June 2022, about 12% of the contributions received from the Funding Agencies were still outstanding for 2021 (1% remaining for 2020). We see a development of late payment of contributions to CMS the last three years. In the interest of CMS the SG would like to raise awareness to the trend of late payment of contributions.

CERN finance report: After a minor difference in reporting was found and resolved, there is perfect agreement between the Finance Department report and the numbers from the experiment.

The Scrutiny Group recommends approval of the CMS 2021 M&O A closing report.

CMS M&O B closing report for 2021

M&O B in CMS is organised around detector subsystem groups with varying practices. Certain systems operate completely on an in-kind basis. The M&O B budget for 2021, as approved in 2020, was 5,715 kCHF, of this 5,506 kCHF was spent in 2021.

Some systems overspend, but this is largely compensated by others underspending. The main reason for overspending as for example in BRIL and the Trigger is hired manpower at CERN. The Tracker is collecting funds for a 2nd spare of the Phase-2 Barrel Pixel Detector (BPIX L1). The estimated cost is 500 kCHF. So far 456 kCHF have been collected. A decision whether this spare will be built will be taken at the end of 2022. Some systems put aside money for decommissioning during LS3. An example are the current ECAL endcaps that will be replaced by the HGCal. For each sub-systems, the SG is pleased to note that the spend down of past accumulated funds to below the agreed limit of 30% is proceeding.

The SG recommends approval of the CMS 2021 M&O B closing report.

CMS M&O situation in 2022

M&O A for 2022 is of 13,366 kCHF without power. As of June 2022 about 48% of the funds are spent as is to be expected. However, CMS informed the Scrutiny Group that some overspending is likely to happen in 2022. This concerns items such as the water mist system, the forward shielding (around 15% increase), the relocation of the ECAL laser system and the relocation of the laboratory for the storage of the muon chambers under controlled conditions (Stasis Lab, 60 kCHF).

Special topics 2022

War in Ukraine: CMS is heavily exposed to the consequences of the military conflict in Ukraine. This concerns both, person power and financial contributions. The intention of CERN Council to terminate the International Cooperation Agreements with the Russian Federation and Belarus by the end of 2024 aims at preventing immediate consequences, in particular for the Technical Coordination. A drop out of the Russian and Belarusian institutes would especially affect the Phase 2 Upgrade. The core contributions by Russia and Belarus to the Phase 2 Upgrade are 10,7 MCHF in total for Phase-2 Upgrade CORE funding. On top, the replacement of expertise and setting up the necessary infrastructure to cover the deliverables is estimated to cost another 4 MCHF. The most critical system is the HGCal. Major impact is also expected in parts of the muon system, the BRIL and the hadron calorimeter. CMS is working actively to alleviate the impact. The provisioning of the missing funds and expertise has to be shared in a fair way within the collaboration.

Other items: Thanks to policies and procedures put in place in 2021, the effect of Covid continues to have limited impact. Increased power costs, delivery problems and shortages of supplies are areas of increasing concern. A special discussion about cost increase for the Phase-2 Upgrade Common Fund took place (see also below) and needs to be pursued next year.

CMS M&O A budget request for 2023

The budget request for 2023 is shown in Table 9 together with the approved budget for 2022 and the projections up to 2026.

The CMS M&O A budget request for 2023 is 13,653 kCHF without power and 15,353 kCHF with power. The total power cost is 1,700 kCHF of which the NMS share is 705 kCHF as of June 2022. This is a budget increase for 2023 of 437 kCHF compared with what was presented in 2021 for 2023. After 2023 the budget numbers show a slight decrease towards 2026, but remain at a higher level than what was presented for this period in 2021. The numbers are around between 1,000 kCHF and 1,500 kCHF higher compared to the running years before LS2. Although some adjustments are expected in the transition to upgraded systems, the SG is concerned that these increases now seem to happen every year.

The cost increase for 2023 and beyond is mainly explained by the need of infrastructure to store current equipment that will be taken out during LS3 and replaced by new detector components, for example the endcap calorimeters. This infrastructure will be temporary. However, it needs to be built on a concrete slab (“west-slab”) that will be permanent. CERN will carry 500 kCHF of the construction cost of the west-slab. The remaining cost will have to be funded

Table 9: CMS M&O A budget request for 2023, shown together with the 2022 budget and the projections up to 2026. All numbers in kCHF.

| M&O A Categories | 2022 | 2023 | 2024 | 2025 | 2026 |
|-------------------------------------|---------------|---------------|---------------|---------------|---------------|
| Detector related | 4,663 | 4,633 | 4,248 | 4,248 | 4,248 |
| Secretariat | 312 | 312 | 312 | 312 | 312 |
| Communications | 130 | 130 | 130 | 130 | 130 |
| Core computing | 1,964 | 1,964 | 1,964 | 1,964 | 1,964 |
| Online computing | 3,665 | 3,665 | 3,665 | 3,665 | 3,665 |
| Test beams & calibration facilities | 96 | 96 | 96 | 96 | 96 |
| Laboratory operations | 533 | 700 | 866 | 653 | 533 |
| General services | 2,003 | 2,153 | 2,130 | 2,130 | 2,130 |
| TOTAL without power | 13,366 | 13,653 | 13,410 | 13,197 | 13,077 |
| Power (MS + NMS) | 1,700 | 1,700 | 1,700 | 1,700 | 1,700 |
| Grand Total | 15,066 | 15,353 | 15,110 | 14,897 | 14,777 |

by CMS. This cost will budgeted by CMS after the completion of the tendering process. A second major item is a new CO₂ cooling plant that will serve now for the assembly of upgrade projects and after LS3 as a spare for the actual CO₂ cooling system. As it is recognised that the CO₂ pump and new buildings will be used both for upgrades and M&O, a more detailed review was made of these items during the 2022 SG cycle. A compromise was found where part of the costs will be moved to the Upgrade Common Fund ("west-slab"), while the temporary buildings and an extra CO₂ pump will be paid by M&O funds.

In addition, increased costs caused by the extension of TOTEM operation into 2023 is needed to keep expertise and people for operation. CMS is asked to cover part of the cost in 2023, 50% of the total of 180 kCHF, which is not taken into account in the presented budget and will, if executed, lead to an overspending in 2023.

The insurance policy as suggested by CMS is still being discussed.

The construction of the new control room is imminent, and the first indication is that the costs will be very close to the number presented in 2021 (6,012 kCHF), where 58% (3,512 kCHF) is to be paid by CERN and the remaining 42% (2,500 kCHF) paid out of CMS funds.

The Scrutiny Group recommends approval of the CMS 2023 M&O A budget request.

CMS Online Replacement Account Projections

After withdrawal of 2,888 kCHF in 2021, resulting in a negative balance, the plan is to deposit funds to the online replacement account equivalent of 600 kCHF in 2022 and 700 kCHF in 2023. The next withdrawal from the account will take place in 2024 (300 kCHF). This plan has shifted by one year w.r.t. the 2021 cycle. Most of the outdated online computing/DAQ equipment has been replaced at the end of LS2 (total cost is about 10 MCHF). Parts of the funds will also be used to fund the new control room (1,000 kCHF). Additionally, CMS proposes to use 1 MCHF/year from the online funds in the M&O A budgets, starting in 2021 and extending through the years to come, and depositing these funds into a separate account to partially fund

the DAQ/HLT Phase 2 upgrade (RRB autumn 2020).

CMS M&O B budget request for 2023

The actual and planned budgets from 2022 to 2026 are given in Table 10. The M&O B budget request for 2023 is 6,578 kCHF, down by 147 kCHF from what was presented for 2023 in the October 2021 RRB (6,725 kCHF). This saving is mainly explained by a smaller overall budget request of the HGCal project. Beyond minor increases of the budget request for some sub-systems (around +5% for Muon and MTD, respectively) are compensated by savings in others (-6% and -12% for Tracker and Trigger, respectively). The savings of the Trigger became possible since some spare parts for the Phase-2 Upgrade were already paid out of the 2021 budget. During the June and September SG meetings CMS presented in detail the transition between old and new sub-detectors. There is an steady increase of the M&O B requests until 2026 that can be attributed to the Phase-2 Upgrade Projects. It should be noted that systems put aside money for decommissioning during LS3. An example are the current ECAL endcaps that will be replaced by the HGCal.

The Scrutiny Group recommends approval of the CMS 2023 M&O B budget request.

Table 10: CMS M&O B budget planning for the years 2022 - 2026. All numbers except for the last two rows are in kCHF.

| M&O B Categories | 2022 | 2023 | 2024 | 2025 | 2026 |
|---------------------------------|--------------|--------------|--------------|--------------|--------------|
| Mechanics | 145 | 168 | 140 | 120 | 140 |
| Gas Systems | 58 | 101 | 81 | 64 | 69 |
| Cryo System | n/a | n/a | n/a | n/a | n/a |
| Cooling System | 246 | 353 | 384 | 428 | 492 |
| FE Electronics | 47 | 57 | 49 | 54 | 90 |
| Std Electronics LV/HV PS | 251 | 241 | 345 | 358 | 428 |
| Std Electronics Crates | 101 | 79 | 79 | 89 | 118 |
| Std Electronics R/O modules | 166 | 428 | 568 | 618 | 519 |
| Controls (DCS & DSS) | 90 | 87 | 90 | 90 | 128 |
| Sub-Detector Spares | 153 | 53 | 23 | 53 | 68 |
| Areas | 181 | 204 | 219 | 219 | 266 |
| Communications | 153 | 154 | 163 | 163 | 177 |
| Store Items | 130 | 146 | 156 | 156 | 197 |
| Hired Manpower @ CERN | 4,368 | 4,508 | 4,668 | 4,898 | 5,117 |
| Material Resources Total | 6,089 | 6,578 | 6,965 | 7,310 | 7,809 |
| Technical Manpower OTP (FTE) | 0 | 0 | 0 | 0 | 0 |
| Core Computing (FTE) | 8 | 8 | 8 | 8 | 8 |

CMS Upgrade Common Funds and Entry Fees

Phase-1 Upgrade Common Fund: The Phase-1 Upgrade has been completed during LS2 and the payments for the common facilities have been finalised. CMS has received all contributions

except one. An in-kind payment is under discussion in order to settle the last remaining contribution before closing the account.

Phase-2 Upgrade Common Fund: The total budget of the Phase-2 Upgrades Common Fund is currently of 25 MCHF and was planned to be collected over 9 years from 2018 to 2026 with a profile dependent on individual agreements with Funding Agencies. At the end of 2021 contributions amounting to 9,917 MCHF have been collected and the spending of the common funds is reported to be 6,484 kCHF. Outstanding contributions amount to 580 kCHF.

The size of this fund, around 10% of the earlier estimated total upgrade costs, is no longer tenable according to CMS, as indicated already in 2021. Therefore, CMS has, during the last two years, carried out a revision of their needs for the Phase 2 Upgrade that has been completed during Summer 2022. According to this revision the Phase 2 Common Fund will have to be increased by about 20%. In parallel, also sizeable increases on M&O A have to be taken into account. The SG took note of these estimations and thanks CMS for having shared the result of the revision. The updated numbers will be scrutinised during the 2023 cycle. The advice of the SG would be to organise a review which take into account all aspects of the CMS Phase 2 Upgrade.

Entry fees: CMS collects entry fees from new members. The funds are accumulated in a general account of the CMS management, with no dedicated accounting for the entry fees alone. They are used to cover items for which no alternative source of funding is available and that are considered urgent by the management. To a large extent, the entry fees are used to facilitate the integration of the new institute in CMS **but also for underfunded common items**. In May 2022 the balance was approximately 353 kCHF.

7 LHCb

LHCb M&O A closing report for 2021

The LHCb M&O A closing report was submitted to the RRB meeting in April (CERN-RRB-2021-045). The 2021 M&O A budget as approved in 2020 and the closing figures presented for 2021 are shown in Table 11. The strategy of LHCb, as presented to the SG and agreed, is to keep an as constant budget as possible and not to add extra resources for shutdown operations.

Spending: The budget for 2021 was 3,070 kCHF and the total spending excluding power was 2,794 kCHF. With power the spending was 3,094 kCHF, the power amounting to 300 kCHF of which the budgeted NMS share was 60 kCHF. The total expenditure without open commitments corresponds to an underspending of 276 kCHF. LHCb had 483 kCHF of open commitments by the end of 2021, mainly due to increased delivery times and expenditures on Online storage (265kCHF), Data Center Maintenance, Cooling Fluids, Gas and Safety. The largest underspending was for detector related costs and online computing; general services saw some overspending. Including open commitments and the transfer to the online account there is an M&O A overspending (excluding power) of 207 kCHF. Adding the overspending for NMS power (166 kCHF) brings the entire overspending to 373 kCHF.

Table 11: Summary of the 2021 book closing of LHCb, listing the M&O A budget as approved in 2020 and the actual spending report in this year's scrutiny cycle. All numbers in kCHF.

| M&O A Categories | Requested budget 2021 | Actual in 2021 |
|-------------------------------------|------------------------------|-----------------------|
| Detector related | 1,015 | 920 |
| Secretariat | 190 | 174 |
| Communications | 10 | 6 |
| Core computing | 220 | 236 |
| Online computing | 1150 | 953 |
| Test beams & calibration facilities | 30 | 24 |
| Laboratory operations | 50 | 41 |
| General services | 405 | 440 |
| TOTAL without power | 3,070 | 2,794 |
| Power (MS + NMS) | 300 | 300 |
| Grand Total | 3,370 | 3,094 |

Carry-over: The cumulative cash balance by the end of 2021 was 806 kCHF, almost unchanged compared to 2020 (807 kCHF). However, considering the large open commitments (483 kCHF), the SG finds that the carry-over of previous years is duly reduced.

Online account: In 2021, 350 kCHF were transferred to the special online account and nothing was spent. The balance of this fund, which allows to purchase online computing power “just in time”, has been brought up to 578 kCHF by the end of 2021 (compared to 228 kCHF at the end of 2020).

Contributions: Requests for contributions to the 2021 M&O A were 3,070 kCHF of which LHCb has invoiced 3,134 kCHF including power. 3,220 kCHF have been received in 2021, including advance payments. Cumulative outstanding contributions are 930 kCHF for 2021 as of June 2022.

CERN finance report: The numbers reported by the experiment are in very good agreement with the figures reported by CERN finance (CERN-RRB-2022-042/43).

The Scrutiny Group recommends approval of the LHCb 2021 M&O A closing report.

LHCb M&O B closing report for 2021

M&O B in LHCb is under the responsibility and control of the subsystems within existing agreements. Spending is constant to the 10% level between years with fluctuations mainly driven by exchange rate fluctuations. The 2021 budget including in-kind contributions was 1,080 kCHF, 80 kCHF more than in 2020. In this round of scrutiny, LHCb presented details on how the spending at the subsystem level followed the 2021 M&O B budget: 1,052 kCHF were received and 1,161 kCHF were spent at CERN. In addition, 251 kCHF were spent at the collaborating institutes.

The transition to post-LS2 levels of M&O B due to the addition of new sub-detectors started in 2021 and will continue until 2023 where the level of M&O B will reach its new level of 1,290 kCHF which is expected to remain stable in the following years. This is an increase of 140 kCHF from what was the plan last year, corresponding to the cost (manpower) of the new Real Time Analysis (RTA) project, as was discussed during the 2021 SG cycle.

The Scrutiny Group recommends approval of the LHCb 2021 M&O B closing report.

LHCb M&O situation in 2022

The LHCb sub-detectors are now fully upgraded; commissioning and operation are in full swing. The approved M&O Category A budget for 2022 totals to 3,070 kCHF, together with estimated power costs of 300 kCHF. The spending as of August 2022 is 2,473 kCHF including open commitments and the online transfer, indicating that the 2022 spending will be in line with forecasts and requests in spite of the current difficult situation.

Special topics 2022

War in Ukraine: LHCb proposed during the 2022 SG cycle to cancel the debt of Ukraine. Ukraine has been a member of LHCb from the start and very active in the construction of the TIs, currently contributing to the PLUME and providing the Radiation Monitoring System for Upgrade I. This proposal is supported by the SG.

For Russia, the total outstanding contributions are 503 kCHF for M&O A and 270 kCHF for M&O B as of 2022. Russian institutes contribute about 300 kCHF/year to M&O A (9.5% of the total) and about 135 kCHF/year to M&O B. The Russian contribution to the Upgrade CF has essentially been paid. LHCb proposes in the case of non-payment that these costs will be shared among its members.

LHCb M&O A budget request for 2023 and beyond

2023 will be the second operation year of Run3 with the LHCb sub-detectors all operational. The budget request for 2023 is shown in Table 12 together with the approved budget for 2022 and the projections up to 2026. The requested budget takes into account the transition to the new sub-detectors; the foreseen plateau is reached already from 2021 onwards. The power costs increase for operational years.

The budget request for 2023 is of 3,070 kCHF without power and is unchanged from previous forecasts. The power cost is 600 kCHF of which the NMS share is estimated to 129 kCHF. From 2021 M&O A has reached the plateau which corresponds to 1.23 times the pre-LS2 budget. This level is stable for the later years.

The Scrutiny Group recommends approval of the LHCb 2023 M&O A budget request.

LHCb Online Replacement Account Projections

LHCb is currently accumulating funds on the online replacement account in 2021 and 2022, 350 kCHF each year. The plan is to spend 1,000 kCHF in 2023 to replace old nodes and to consolidate the farm with a new slice corresponding to 300 nodes. In 2024 the account will again accumulate funds, resulting in a longer period from 2018 to 2025, where the online replacement account does not go negative. The cash balance is planned to reach 278 kCHF in 2023.

Table 12: LHCb M&O A budget request for 2023, shown together with the 2022 budget and the projections up to 2026. All numbers in kCHF.

| M&O A Categories | 2022 | 2023 | 2024 | 2025 | 2026 |
|-------------------------------------|--------------|--------------|--------------|--------------|--------------|
| Detector related | 1,015 | 1,015 | 1,015 | 1,015 | 1,015 |
| Secretariat | 190 | 190 | 190 | 190 | 190 |
| Communications | 10 | 10 | 10 | 10 | 10 |
| Core computing | 220 | 220 | 220 | 220 | 220 |
| Online computing | 1,150 | 1,150 | 1,150 | 1,150 | 1,150 |
| Test beams & calibration facilities | 30 | 30 | 30 | 30 | 30 |
| Laboratory operations | 50 | 50 | 50 | 50 | 50 |
| General services | 405 | 405 | 405 | 405 | 405 |
| TOTAL without power | 3,070 | 3,070 | 3,070 | 3,070 | 3,070 |
| Power (MS + NMS) | 300 | 600 | 900 | 900 | 900 |
| Grand Total | 3,370 | 3,670 | 3,970 | 3,970 | 3,970 |

LHCb M&O B budget request for 2023

The request for 2023 and the projections beyond are shown in Table 13. For 2023 the budget request is of 1,290 kCHF, 20 kCHF more than the projection presented in 2021. 2023 is the second year of operation after LS2 and will be affected by this. New sub-detectors have come into operation and the budget is adjusted to the new level of operation costs. The new systems are PCI-E40, On Line, Scint Fibre Tracker (SciFi), Upstream Tracker (UT) and VELO. All the new systems represent an increase in costs, SciFi being the largest with 120 kCHF extra costs. Moreover, the newly established RTA Project results in a budget increase of 120 kCHF from 2022 and onwards. The costs are shared between almost all participating institutes and will be used for short-term on-site experts during maintenance and operation.

The Scrutiny Group recommends approval of the LHCb 2023 M&O B budget request.

LHCb Upgrade Common Funds and Entry Fees

Phase-1 Upgrade Common Fund: The LHCb Phase-1 Upgrade Common Fund amounts to 15,710 kCHF. 13,7 MCHF (April 2022) have been received. LHCb reports that nearly 90% of the funding for common projects are either fully committed or available, outstanding contributions amounts to 1,260 kCHF, taking the adjustment for exchange rate fluctuations into account. This figure is unchanged from the previous round of scrutiny. By the end of 2021 10.5 MCHF of the upgrade common fund have been spent or committed, which corresponds roughly to the expected level (CERN-RRB-2016-039,115). The remaining expenditures are expected in 2022-2023 for “just in time” purchases of computing.

Entry fees: LHCb currently does not collect cash entry fees from new institutes, there has been no change to this practice since last year. In-kind contributions for the general benefit of the collaboration are considered but currently not collected.

Table 13: LHCb M&O B budget planning for the years 2022 - 2026. All numbers in kCHF.

| M&O B Categories | 2022 | 2023 | 2024 | 2025 | 2026 |
|---|--------------|--------------|--------------|--------------|--------------|
| Mechanics | 100 | 100 | 100 | 100 | 100 |
| Gas Systems | 10 | 10 | 10 | 10 | 10 |
| Cooling Systems | 30 | 30 | 30 | 30 | 30 |
| FEE Spares | 120 | 120 | 120 | 120 | 120 |
| Standard Electronics (all) | 220 | 220 | 220 | 220 | 220 |
| Controls (DCS & DSS) | 60 | 60 | 60 | 60 | 60 |
| Sub-Detector Spares | 200 | 200 | 200 | 200 | 200 |
| Areas | 50 | 50 | 50 | 50 | 50 |
| Communications | 30 | 30 | 30 | 30 | 30 |
| Store Items | 30 | 30 | 30 | 30 | 30 |
| Manpower @ CERN: Collaborating Institutions | 420 | 440 | 440 | 440 | 440 |
| Grand Total | 1,270 | 1,290 | 1,290 | 1,290 | 1,290 |

8 SUMMARY

The LHC Resources Scrutiny Group has examined the closing reports of the four LHC experiments ALICE, ATLAS, CMS and LHCb for 2021. The LHC Resources Scrutiny Group recommends to the RRBs the approval of the 2021 M&O closing reports of ALICE, ATLAS, CMS, LHCb. The Scrutiny Group has scrutinised the requested budgets for 2023 for ALICE, ATLAS, CMS and LHCb. The LHC Resources Scrutiny Group recommends to the RRBs the approval of the 2023 M&O budget request of ALICE, ATLAS, CMS and LHCb.

The Scrutiny Group acknowledges the central role of the Resource Coordinators of the collaborations in carrying out the annual scrutiny process and wishes to thank them for their time and effort and for their positive and collegial approach.