# Letter of Intent:
# Exploration of heavy hadrons at thresholds (ExHAT)

**Project Leaders:** Mikhail Mikhasenko (Bochum), Ivan Polyakov (Manchester)

## 1 Research objectives

- [Meson-Meson] [Bochum]

  Measurement of relative $T_{cc}^+$ and $\chi_{c1}(3872)$ production cross-section in pp collisions in LHCb via $D^0D^0$ and $D^0\overline{D}^0$ final states. Study of the dependence on kinematics and multiplicity in the event.
  **Outcomes:** paper on Run 1&2 and/or Run 3 data.

- [Meson-Meson] [Cagliari]

  Measurement of the $\chi_{c1}(3872)$ production cross-section relative to $\psi(2S)$ in pp and heavy-nuclei collisions in LHCb via $J/\psi\pi^+\pi^-$ final states. Also, measurement of $\Upsilon$ excited to ground states vs. pp multiplicity, with more statistics than what done in Run 2. Study of the dependence on kinematics and multiplicity in the event.
  **Outcomes:** paper on Run 3 data with a measurement of $\chi_{c1}(3872)$ vs. $\psi(2S)$ and of $\Upsilon$ excited to ground states vs. multiplicity in pA (possibly also pA/AA) collisions.
  **Risk:** $\chi_{c1}(3872)$ vs. $\psi(2S)$: high, as it is difficult to control the background in high multiplicity events, and the $\psi(2S)$ is expected to be suppressed; $\Upsilon$: medium/low: the dimuon decay channel is cleaner and the luminosity should be enough to allow a precise measurement.

- [Baryon-Baryon] [Manchester]

  Search for a long-lived hexaquark state with $c$ quark in pp collisions in LHCb. Main candidates are with $[cuuddd(u)]$ and $[csuudd]$ quark content (to obtain predictions from the LatticeQCD group).
  **Outcomes:** a paper on Run 1&2 and/or Run 3 data. Either a discovery or an upper limit on cross-section times branching fraction.

- [Baryon-Baryon] [Munich+CERN]

  Study of interaction in $H_cN$ system via measurement of two-body correlation in ALICE experiment. Presumably in $\Lambda_c^+p$ or similar system. As a result will probe interaction nature in the system and possibility for a bound/resonance state.
  **Outcomes:** a paper on Run 3 data.

- [Meson-Baryon] Dropped out.

## 2 Estimated budget request

- €83k for 1 year PostDoc in Bochum [LHCb];
- €84k for 1 year PostDoc in Manchester [LHCb];
- €68k for 1.5 year PostDoc in Cagliari [LHCb];
- €45k for 1 year PhD in Munich [ALICE];

Total: €280k

Apart from the project budget we anticipate 3 mini-workshops to be funded via CERN TA with total of around €18.8k (7 experts per workshop to invite, €400 for ticket and €165 allowance/day for 3 days).

## 3 Participating and partner institutions

- The University of Manchester, United Kingdom * – **Ivan Polyakov**;
- Institute of Experimental Physics I, Ruhr-Universitaet Bochum, Germany * – **Mikhail Mikhasenko**;
- University of Cagliari, Italy * – **Giulia Manca**;
- University of Genova, Italy – **Elisabetta Stadaro Norella**;

- INFN Sezione di Bari, Bari, Italy – **Marco Pappagallo**;
- Sapienza Universita e INFN, Roma I, Italy – **Ivan Belyaev**;
- Technical University of Munich, Germany * - **Laura Fabbietti, Valentina Mantovani Sarti**;
- CERN, Switzerland - **Fabrizio Grosa**;
- University of Ljubljana, Slovenia – **Sasa Prelovsek**;
- RIKEN iTHEMS, Saitama, Japan – **Takumi Doi, Tetsuo Hatsuda**;
- University of Cambridge, United Kingdom – **Christopher Thomas, David Wilson**;

* - beneficiaries.