Strategic program and “high impact” activities on the MdM application

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(on behalf of all MdM contributors … and more)

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PREMISES & OBJECTIVES

PREMISES

- (Once successful) the MdM should strengthen ***ALL*** research lines of the institute but should also aim to pursue a number of ***COMMON, EVEN MORE AMBITIOUS goals***.
- The 2021 MdM proposal should be understood as a way to pave the road to achieve these ambitious Scientific (SSGs) and Transversal (TSGs) Strategic Goals (how these will involve/benefit every single researcher within IPARCOS? *That is, detective, the right question*).
- We would not get the MdM to simply extend what the different UCM groups are already doing (and already financed by other means).

OBJECTIVES

- Put together a competitive 2021 MdM proposal in a relatively short amount of time.
- Try to embark on as many as possible of the (multiple and not necessarily connected) scientific and technological/transversal objectives of the institute.
- Prepare the ground for (possible) future MdM proposals.

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MdM structure

IPARCOS director

MdM scientific director

Strategic Scientific Council

IPARCOS Council

SECTION A: ASTROPHYSICS & COSMOLOGY

SECTION B: PARTICLE & NUCL. PHYSICS

SECTION C: INSTRUMENTATION

MdM management and recruitment committee

IPARCOS director

MdM scientific director

Strategic Scientific Council

Sections A, B, C representatives

Gender issues representative

Industry *liaison*

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STRATEGIC GOALS

- Scientific Strategic Goals
  - SSG1: The history and fate of the Universe: dark matter and dark energy
  - SSG2: The birth of gravitational-wave and multi-messenger astronomy
  - SSG3: Effective field theories: from high precision hadronic observables to new physics
- Transversal Strategic Goals
  - TSG1: Instrumentation development
  - TSG2: Extreme computing

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SCIENTIFIC STRATEGIC GOALS

- SSG1: The history and fate of the Universe: dark matter and dark energy
  - Objective 1: Dark matter searches (SSG1.O1)
    - Task 1: Astrophysical searches
    - Task 2: Collider searches
    - Task 3: Indirect searches

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SCIENTIFIC STRATEGIC GOALS

- **SSG1: The history and fate of the Universe: dark matter and dark energy**
  - Objective 2: DM candidates (SSG1.O2)
    - Task 1: Ultra-light candidates
    - Task 2: BH & sterile neutrinos

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SCIENTIFIC STRATEGIC GOALS

- SSG1: The history and fate of the Universe: dark matter and dark energy
  - Objective 3: Dark Energy (SSG1.O3)
    - Task 1: Galaxy experiments
    - Task 2: Galaxy clusters
    - Task 3: Beyond General Relativity
    - Task 4: Effective theories for Dark Energy
    - Task 5: SNIa vs. CMB tension

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SCIENTIFIC STRATEGIC GOALS

- SSG2: The birth of gravitational-wave and multi-messenger astronomy
  - Objective 1: Gravitational Wave production and detectability (SSG2.O1)
    - Task 1: Binarity and stellar evolution
    - Task 2: BW physics & GW generation
    - Task 3: Quantum gravity & BH
    - Task 4: GW propagation
    - Task 5: BH shadows
    - Task 6: EW counterparts of GW
    - Task 7: EM emission in binary NS

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SCIENTIFIC STRATEGIC GOALS

- SSG2: The birth of gravitational-wave and multi-messenger astronomy
  - Objective 2: Multi-messenger astronomy beyond GW (SSG2.O2)
    - Task 1: Extragalactic transients

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SCIENTIFIC STRATEGIC GOALS

- SSG3: Effective field theories: from high precision hadronic observables to new physics
  - Objective 1: Hadronic structure (SSG3.O1)
    - Task 1: Hadronic distributions and jets
    - Task 2: Jet physics
    - Task 3: Gravitational & Dark Matter effects on spin physics

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SCIENTIFIC STRATEGIC GOALS

- SSG3: Effective field theories: from high precision hadronic observables to new physics
  - Objective 2: EFTs at high energy (SSG3.O2)
  - Objective 3: EFTs at low energy (SSG3.O3)

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TRANSVERSAL STRATEGIC GOALS

- TSG1: Instrumentation development
  - Objective 1: Astronomical instruments (TSG1.O1)
    - Task 1: MOSAIC@ELT
    - Task 2: TARSIS@CAHA
  - Objective 2: IACTs (TSG1.O2)
    - MAGIC support activities, including its integration with CTA LST-1
  - Objective 3: Colliders (TSG1.O3)
    - Theoretical support to LHC@CERN and EIC. To extend our participation in ISOLDE/CERN, GSI-FAIR, NUSTAR (FATIMA).
  - Objective 4: GW detectors (TSG1.O4)
    - To join the ET project.

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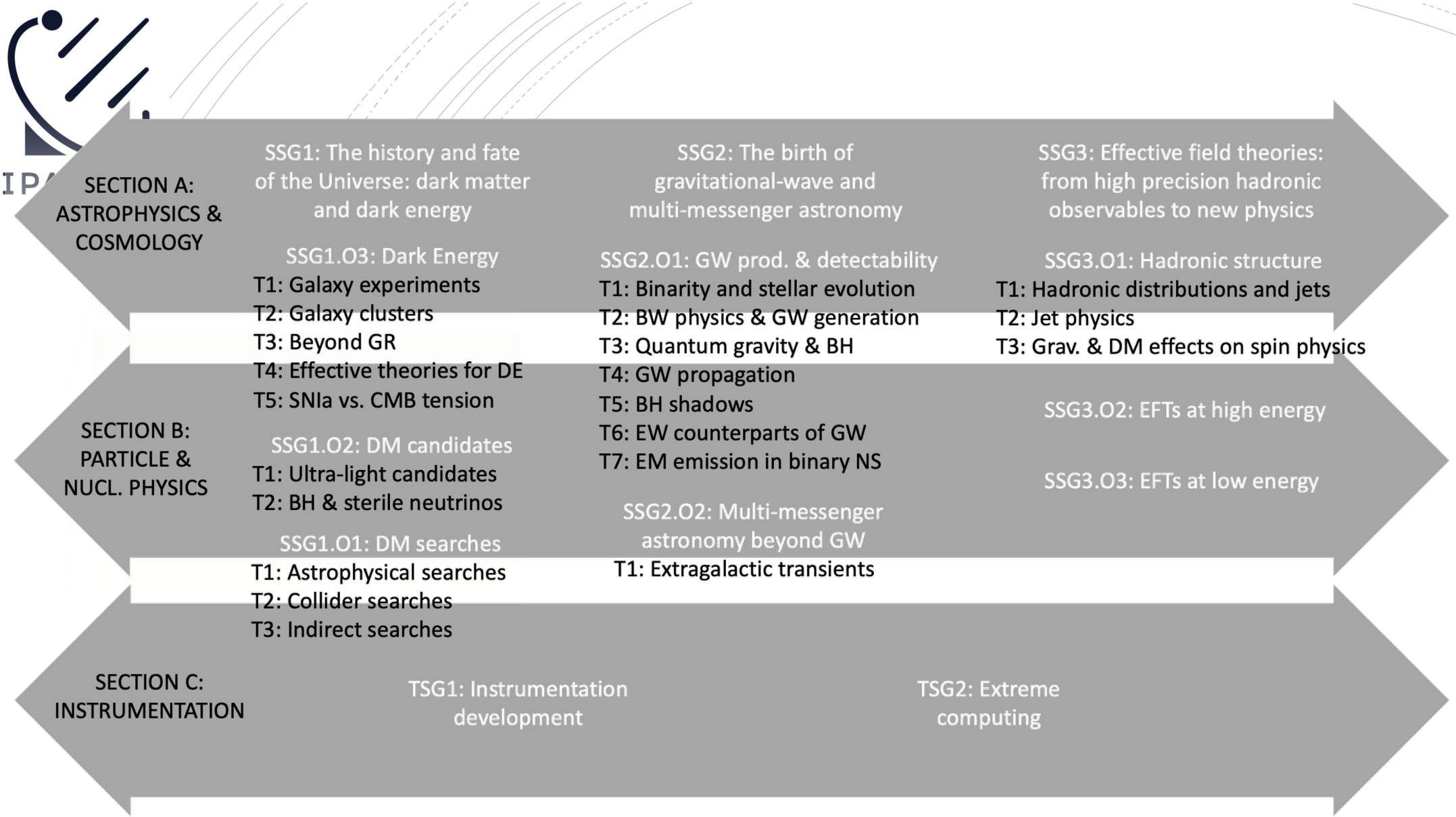
TRANSVERSAL STRATEGIC GOALS

- TSG2: Extreme computing
  - Objective 1: Image processing (TSG2.O1)
    - Task 1: Data Reduction Pipelines for astronomical instruments
    - Task 2: Nuclear-physics & medical-image processing
  - Objective 2: Statistical and programing tools (TSG2.O2)
    - Task 1: *ShowerModel*
    - Task 2: AI/ML algorithms
    - Task 3: GPU/FPGA programming


SECTION A: ASTROPHYSICS & COSMOLOGY
SSG1: The history and fate of the Universe: dark matter and dark energy
SSG1.O3: Dark Energy
T1: Galaxy experiments
T2: Galaxy clusters
T3: Beyond GR
T4: Effective theories for DE
T5: SNIa vs. CMB tension
SSG2: The birth of gravitational-wave and multi-messenger astronomy
SSG2.O1: GW prod. & detectability
T1: Binarity and stellar evolution
T2: BW physics & GW generation
T3: Quantum gravity & BH
T4: GW propagation
T5: BH shadows
T6: EW counterparts of GW
T7: EM emission in binary NS
SSG3: Effective field theories: from high precision hadronic observables to new physics
SSG3.O1: Hadronic structure
T1: Hadronic distributions and jets
T2: Jet physics
T3: Grav. & DM effects on spin physics
SECTION B: PARTICLE & NUCL. PHYSICS
SSG1.O2: DM candidates
T1: Ultra-light candidates
T2: BH & sterile neutrinos
SSG1.O1: DM searches
T1: Astrophysical searches
T2: Collider searches
T3: Indirect searches
SSG2.O2: Multi-messenger astronomy beyond GW
T1: Extragalactic transients
SSG3.O2: EFTs at high energy
SSG3.O3: EFTs at low energy
SECTION C: INSTRUMENTATION
TSG1: Instrumentation development
TSG2: Extreme computing

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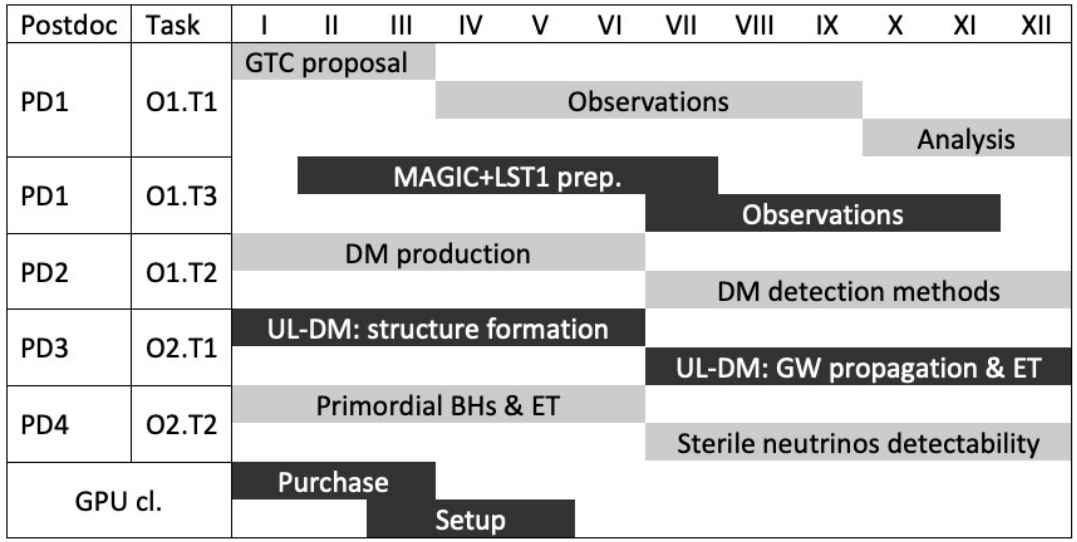
HIGH-IMPACT ACTIVITIES

- Within "**SSG1: The history and fate of the Universe: dark matter and dark energy**" we focused on SSG.O1 (Dark matter searches) and SSG1.O2 (Dark matter candidates). The criterion was to be able to emphasize the capabilities associated to the IPARCOS interdisciplinary nature.

  - **SSG.O1: Dark matter (DM) searches:** Astrophysical searches, Collider searches, Indirect searches.
  - **SSG.O2: Dark matter candidates:** Ultra-light candidates, Other candidates (Black Holes & Sterile neutrinos).



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- **SSG.O1: Dark matter (DM) searches:**
  - SSG1.O1.T1: Astrophysical searches: To measure DM distribution and content estimates in the Local Group. From this analysis, the best candidate galaxies for identifying emission from annihilation and decay products will be identified.
  - SSG1.O1.T2: Collider searches: To detect signals from DM produced when colliding SM particles in controlled laboratory conditions. Its production would be inferred using energy or transverse momentum conservation.
  - SSG1.O1.T3: Indirect searches: To identify WIMPs through secondary products of their annihilation or their decay into SM particles, notably gamma rays. We proposed to search for these signals using MAGIC & FERMI but also taking advantage of CTA-North.
- **SSG.O2: Dark matter candidates:**
  - SSG1.O2.T1: Ultra-light candidates: To evaluate the impact of ultralight DM (UL-DM) on structure formation and GW propagation, that would help us predicting possible signals from LISA, Einstein Telescope, and CMB B-mode detectors such as LiteBIRD.
  - SSG1.O2.T2: Other candidates: Black Holes (BH): To explore the generation and detection of primordial BHs in inflationary models as part of our involvement on the ET. Sterile neutrinos: To analyze the feasibility of carrying out possible future measurements by studying the role of first-forbidden transitions in key lead isotopes.

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CONCLUSIONS & QUESTIONS FOR THE FUTURE

CONCLUSIONS

- An effort was made to encompass most scientific and technical / transversal objectives of the UCM groups within IPARCOS.
- Several Strategic Goals were identified and elaborated in the MdM 2021 proposal.
- The 1-yr-long 'High Impact'' activities were focused on SSG1.O1 (Dark matter searches) & SSG1.O2 (Dark matter candidates).

QUESTIONS for all of us

- Are we happy with the result? Is this what we want for MdM 2022?
- Should IPARCOS adopt a Group- / Section- / or SG-based structure to (1) make future MdM proposals more competitive and (2) strengthen collaboration?
- How should the current resources and capabilities be used to achieve (1) and (2) above?
- How to succeed in making all researchers in IPARCOS to benefit from the MdM (once successful)?