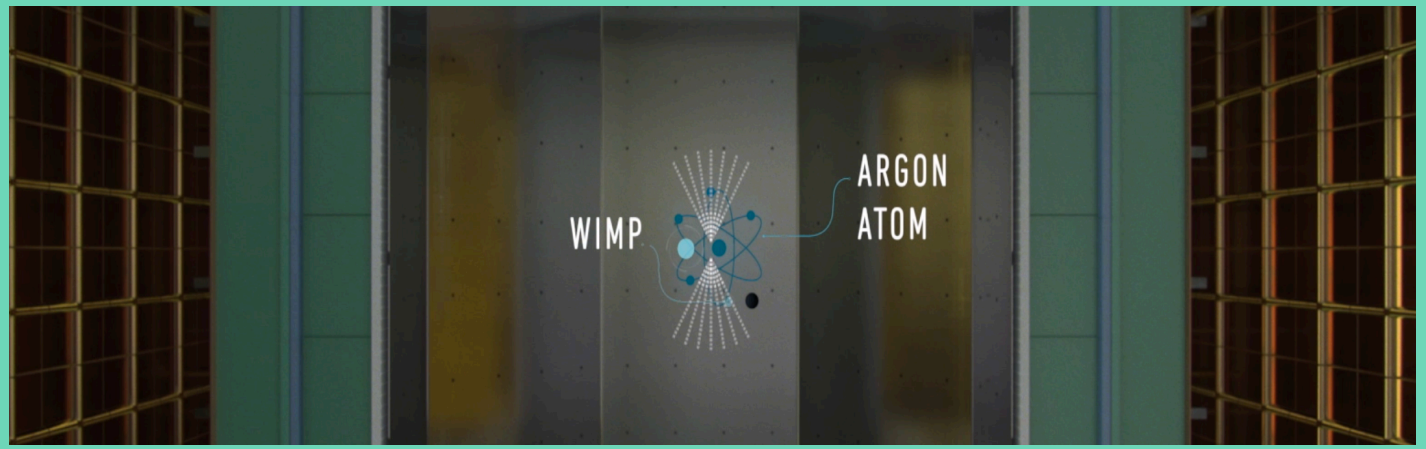
DarkSide Masterclass

Results – Group 6 Liceo Luigi Galvani

Isabella Merli
Greta Pagliani
Tommaso Taliani
Manfredi Tambella
Maisha Alam Tasnova

Bologna,
12\11\2020



Theory Overview

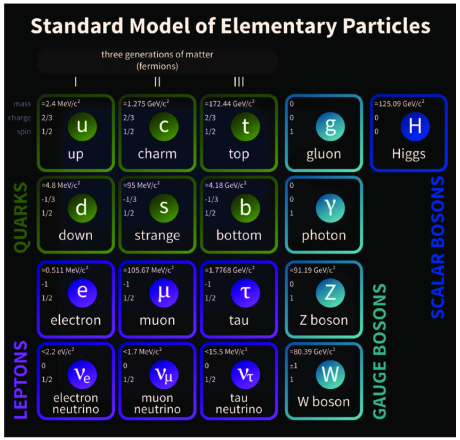
About **85%** of the universe is made up of dark matter:

Where does this hypothesis come from?

1. The first scientist to observe the galaxies was *Fritz Zwicky*
2. In 1970, *Vera Rubin* confirms the presence of dark matter, making measurements of rotation in galaxies.
3. *Bullet cluster* theory

1

WHAT IS THE DARK MATTER?



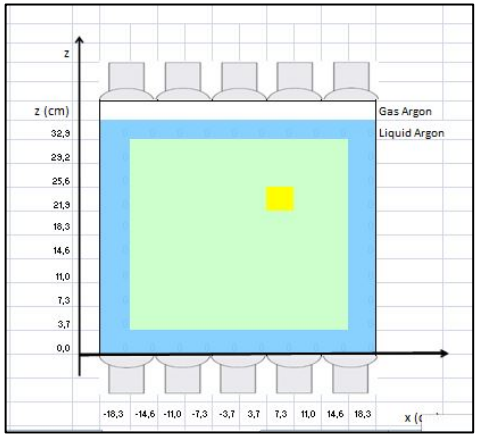
We are looking for particles that have these characteristics:

- They do not feel electromagnetic force, in fact they have no charge
- They do not feel strong force, in fact they interact very weakly
- Stable
- Non-baryonic (not ordinary matter)
- Cold and slow
- Massive

Initially, scientists have tried to match dark matter to the known baryonic particle without obtaining any results. There is no alternative but to admit existence of unknown matter. One leading explanation, motivated by super symmetry theory, is that dark matter is made of Weakly Interacting Massive Particles (**WIMPs**).

2

HOW CAN WE DETECT WIMPS?



1. Choice of materials: Argon is chosen thanks to its luminosity properties
2. Photo detectors are positioned to reveal the luminous signal
3. Preparation of the electric field chambers: at liquid Argon and gas Argon → there will be a double interaction

TWO SIGNALS

1) *Collision signal* of photons freed by the interaction between WIMPS and the atomic nucleus of argon
2) *Second signal* given by the rising electrons to gas Argon

The time between the two signals is called **drift time** and it allows us to ascertain where the collision happened in the chamber

3

HOW CAN WE REDUCE THE BACKGROUND?

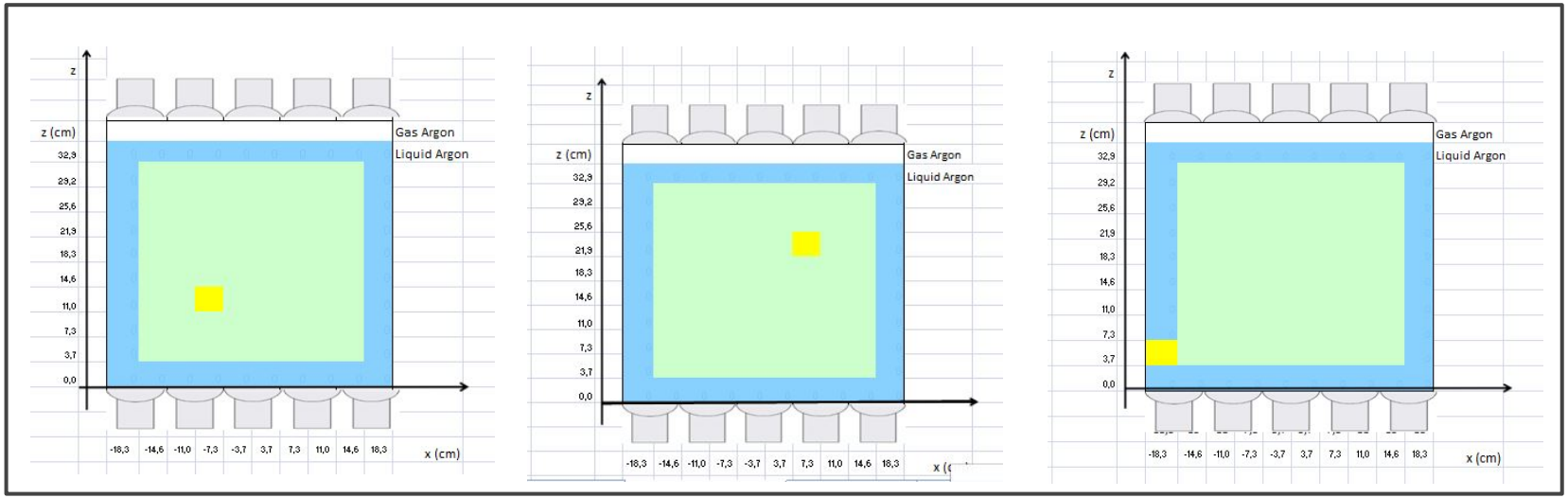
It is essential to reduce the background to avoid confusing the WIMPS with other particles. The solutions are:

1. Locate the experiment in deep underground sites
2. Use materials which are radio pure
3. Set low background, high-quantum-efficiency Qupid photo detectors
4. Put Time Projection Chamber (TPC) into a compact high-efficiency external water veto for neutrons
5. Apply a positional cut, excluding the signals near the edges
6. Select scintillation signals based on the amount of light present in the first ones 90 ns. Eliminate the slowest ones.

Analysis part 1:

exercise on reconstruct position and cut

1. We analysed 3 events: number 4; 474 and 19383.
2. We used the “Position Cut sheet” to learn how to reconstruct the position (x,y,z,r) of the particle and when to reject an event (based on the position).



Event 4

Event 19383

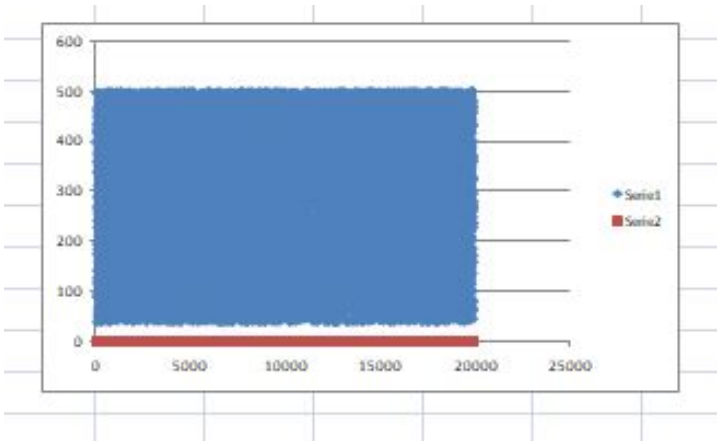
Event 474

Analysis part 2:

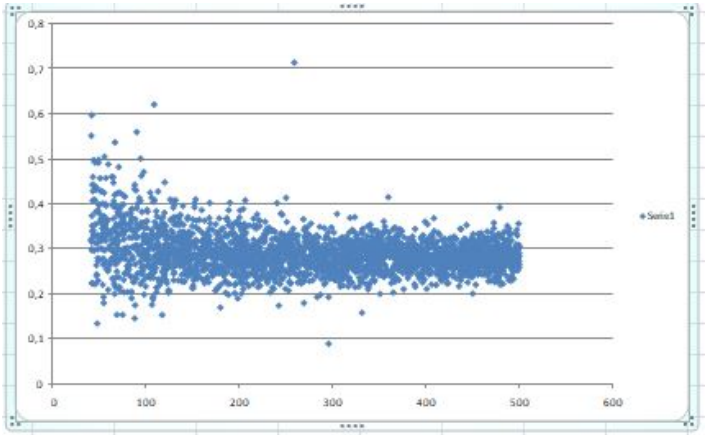
exercise on f90 vs S1

We analyzed a set of data from the existing DS-50 experiment in terms of f90 vs S1:
f90 is expected to be roughly > 0.7 for DM interaction.
To remove the background we applied:

1. **Position cut** (r< 15cm and 4,352cm< z <31,88cm)
2. **Veto signal** (veto<6 pe)
3. At least **70% of light emission** in the first 90ns



Before filters



After filters

It is possible to trace a few DM events

RESULTS

01

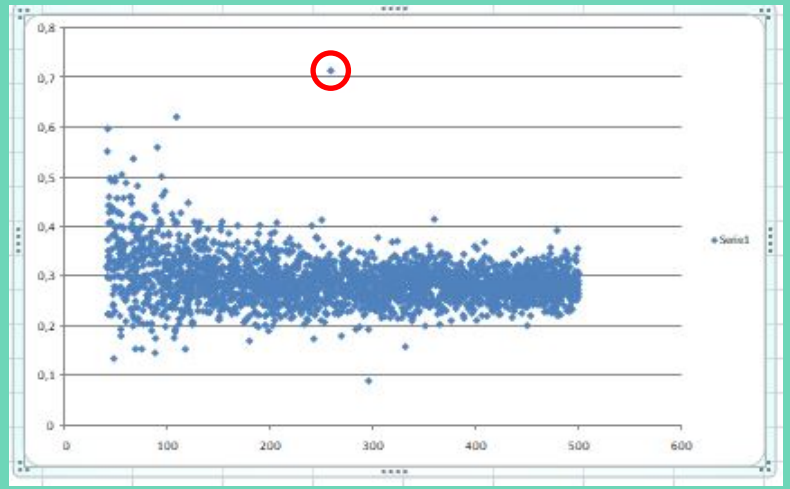
DID YOU FIND A WIMP SIGNAL?

We detected one WIMP signal

02

AT WHICH EVENT NUMBER?

•Event 474



03

WHY DO YOU THINK THAT IT IS A WIMP EVENT?

It respects all the filters that we have applied
•Position cut
•Veto signal
•Light emission

CONCLUSIONS

1. **We calculated:**
   - f90
   - r
   - drift distance
   - z
2. **We created a scatter plot graph, selecting a defined range of data to be analysed**
3. **We applied the cuts to reduce the background**
   - r< 15 cm
   - 4.352 cm< z < 31.88 cm
   - Veto signal < 6 pe
4. **We compared our graph with the official graph of DarkSide-50**
5. **We found a WIMP signal at the event number 19963**