

Darkside, The Quest for Dark Matter Detection

Short Treatment

di **Matias Guerra, Matteo Corbi**

Director Notes

An analytical view of the quest to find Dark Matter through the lives of five of the protagonists of the Darkside collaboration, who will intersect and reveal the scientific challenges at stake. We have a narrating baseline thanks to Nobel Prize Art McDonald representing the voice of “Cosmos”.

Four leading scientists Eugenio Scapparone, Christian Galbiati, Hanguo Wang and Giuliana Fiorillo, who represents our “Virgil” by leading us to the most important locations, create four storylines, each led by one of the scientists and meet under the Gran Sasso mountain to explain the experiment. **Each storyline follows a macro topic of the experiment**, Scapparone: the **politics** and repercussions on everyday life, located in Abruzzo at the NOA lab; Galbiati: **chemical and biological aspects** of the experiment, located in the Seruci mines of Sardinia; Wang: the **engineering and technological** aspects of the cryostat, located in Geneva at CERN; Fiorillo: **electronics** and technology, located in Naples at the INFN lab.

We focus on the stories told by the protagonists, their hopes and expectations and therefore revealing the quest for Dark Matter.

ACT I

We see four different starry night skies from Sardinia, Geneva, Naples and Gran Sasso, Art McDonald in voice over interrogates himself on several cosmological broad questions.

Why are the stars where they are, why is space the way it is?

From the establishing shot of the sky a camera movement reveals our main characters in their own cities.

Art's voice leads us to a new day, we follow individually our characters in their daily routine, a coffee, a phone call, heading to their labs. Scientist Christian Galbiati whilst speaking briefly tells us his story and mentions one of the leading scientific topics. We jump from one character introduction to another by also following his or her day. Giuliana Fiorillo presents herself and starts talking more in depth about Dark Matter.

Art McDonald covers shortly high cosmological concepts leading to Dark Matter and Dark Energy - why we think it is 85% of the universe versus the 15% of visible matter, we see how indirect proof is obtained, shown by graphical simulations of the Scuola Normale Superiore of Pisa.

Giuliana Fiorillo takes us back to the history of Dark Matter research from Zwicky to the most recent theories introducing concepts such as Rotational Curves and Gravitational Lenses that we see explained thanks to visual supports. Giuliana starts to unfold better the theories leading to why we think Dark Matter exists and why it could be found with the experiment she is involved in, showing what we're looking for and how we got to this point, what other experiments had been done in the past and why they failed, why is her experiment *Darkside* one of the most probable candidates for success.

What do we need to be able to identify Dark Matter?

Giuliana with more scientific details tells us they are looking for a particle of major importance that would confirm the existence of Dark Matter, the WIMP aka Weakly Interacting Massive Particle.

She shows how strongly she believes that they will find it and that it is the key for success. Narrating also a lifetime of conviction and hard work to find the right candidate particle for Dark Matter detection, a bet involving the whole life of these scientists and researchers.

ACT II

The WIMP to be found, if it can be found, needs a special element to interact with, an element that Christian Galbiati starts to passionately explain, an isotope of Argon, Argon40. We see where the Argon comes from, how it is taken from Colorado to Sardinia and how it's used in the prototype of the experiment. We follow Christian in the Sardinia laboratories, he explains why *Darkside* uses Argon40, how we obtain it in the world's deepest mine shaft located in Seruci, which we see from above (drone) and in detail, the Argon is purified and stabilized with a sophisticated and advanced process.

Hanguo Wang is in his Geneva laboratory at CERN working with his team on the *Darkside* prototype, he tells us what issues and tasks he was asked to resolve.

How do we use Argon at its best? Why do we need extremely low temperatures for the experiment and how to obtain them?

He shows us some of the components of the Cryostat of which he is responsible for. Nevertheless Argon and WIMP aren't the only candidates for a revealing Dark Matter and Christian indicates the diversity and multitude of experiments being held in the world - of which we see a fast group sequence - focusing on their major adversary, Xenon, an experiment built in the same warehouse at Laboratorio Nazionale del Gran Sasso that makes the race for discovery even more pressing. The winner of this race will certainly be a candidate for the Nobel Prize and for sure will have a seat reserved in humanity's history.

By looking at visual supports Art McDonald explains what can change in the Standard Model of particle physics thanks to Dark Matter comprehension.

Eugenio Scapparone sits in his office talking about a possible Nobel Prize candidacy for the collaboration, but mainly the scientific importance of the *Darkside* experiment, and the positive repercussions it will have for Italy and its technological development.

How can we reveal an invisible matter for which there is no certainty of existence?

We are in the laboratories of Naples where Giuliana is testing a Silicon PM, the device built to detect the collisions between a Weakly Interacting Massive Particle and an Argon atom. She shows us this unique laboratory, the only *radeon* free lab in the world that reflects all her efforts in this field, whilst holding the Silicon PM in her hand, a small high-tech device built at Nuove Officine Abruzzo (NOA). Giuliana takes us now in Abruzzo to meet Eugenio Scapparone who introduces the NOA laboratories, built to develop this fundamental part of *Darkside*, a tech development which will also serve multiple purposes in daily applications. Giuliana and Eugenio have a conversation revolving around these topics and other aspects of *Darkside*.



ACT III

We see the landscapes of the Abruzzo Gran Sasso mountains, right above the laboratory, Art narrates his experience with the *Darkside* collaboration through the various generations, telling us how countries with totally different cultures can unite thanks to a common scientific goal. He introduces at a high level the experiment we are about to see.

Giuliana and a researcher travel into the tunnel that leads to the laboratory of Gran Sasso, she awaits the opening of the gate whilst explaining what is coming. We follow Giuliana into the tunnels that lead to the main hangar of the experiment where the *Darkside* structure will be built in 2024, with the support of CGI we see the whole structure of *Darkside* as if it were there. Thanks to CGI we see the various elements of the structure and its workings, and by opening it up with the camera we focus on certain areas and see how the experiment evolves inside this huge cryostat. We see what happens at a subatomic level with visual explanations and projections of what they hope will eventually reveal the Weakly Interacting Massive Particle. *What happens when Darkside will be working at full regime? What are the possibilities of success? what happens in case of failure?*

The four scientists virtually dialogue prospecting their hopes and fears whilst pondering on the 2024 milestone versus their life goals and expectations. We are in space where Art, following the considerations of the scientist, projects us into the future whilst synthesizing the journey we have just completed and the journey yet to come for humanity.

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- Scientific Direction and Treatment: Marcos Valdes