Dark Matter Working Group

A unified community: Dark Matter program definition

Scientific roadmap
Timeline

Experimental program R&D

Facilities requirement
individual experiments will send their response to DEDC/Facility

Unified Community

Strong community in strong position

4 S4 approved ≈$9M out ≈$21M in Physics
+ CLEAN: study with other resources

One of the most important questions in science

e.g. Science Magazine ranking "Composition of the Universe" 1/179
If timely, DUSEL can be a world leader: one of the key justifications

Intensely competitive

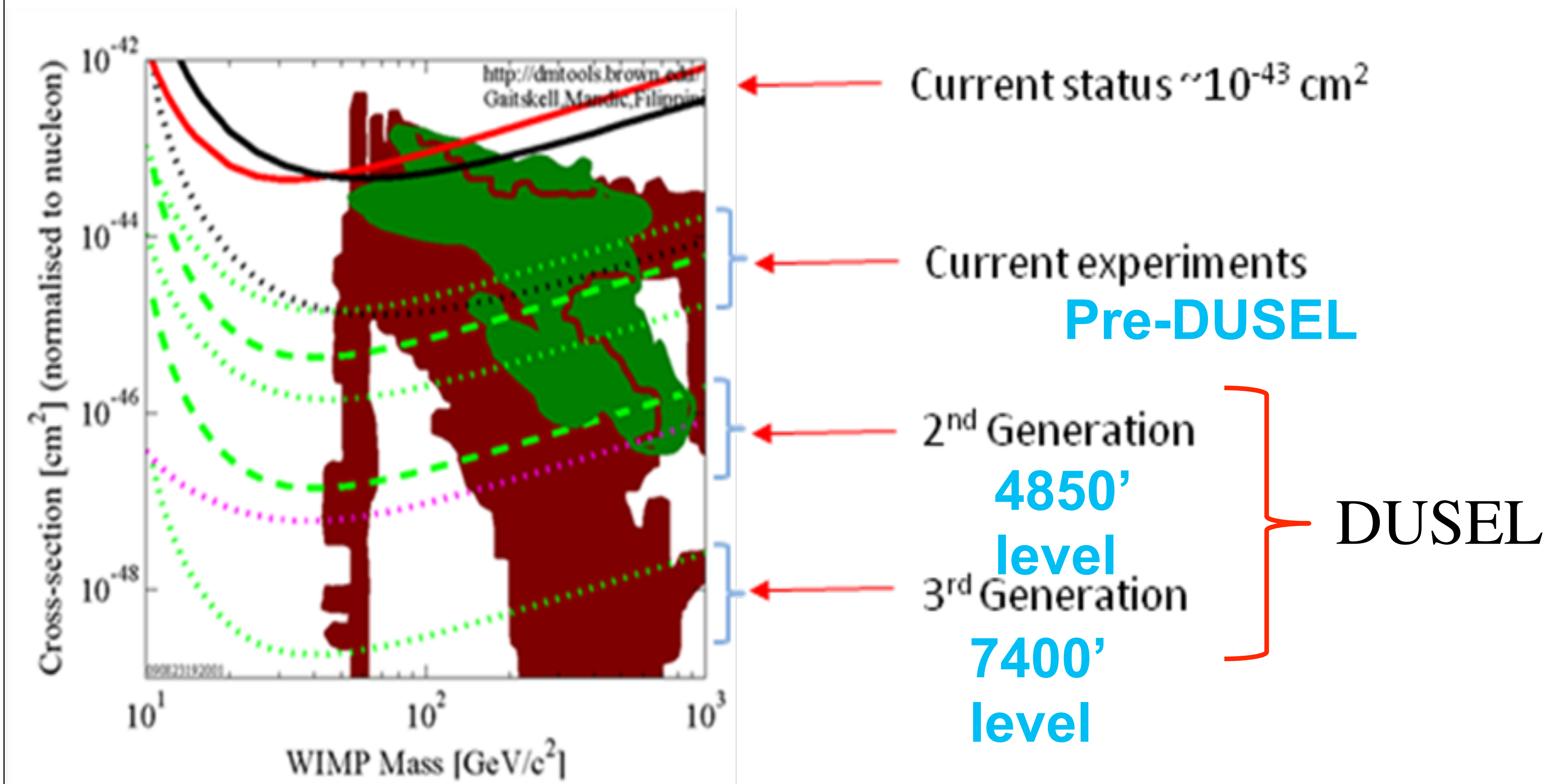
Main decision of this meeting:

A proactive & unified input into the MREFC definition

We would like to go to the MREFC defining team as a unified community with a common roadmap with solid justifications:

- Science (strong consensus)
- Technical/engineering (built on the pre-DUSEL program and the S4 studies)
- Financial -> Envelope (built on the pre-DUSEL program and the S4 studies)

Experimental Program



Why ≥2 Experiments?

Science

Several targets: A dependence, spin dependence => ≥3
Mass measurement
Cross check of a discovery

Mitigate technical risk

Unexpected background
Instrumental difficulties and background rejection surprises
Cost drift / significant descoping

DUSEL Initial Suite fits into wider context

Pre-DUSEL program
Push science frontier $\approx 10^{-46}$ cm^2
Demonstrate technologies for DUSEL: key in choice of specific expts.

International competition/collaboration
Strong international participation at DUSEL
Coordination of large detectors worldwide

Future DUSEL program
e.g. directional, larger statistics, new ideas
Need for strong R&D

Documents to MREFC team

Overall Dark Matter Program

≈ 20 pages

Scientific goals: Dark Matter

Scientific justification of the program

variety of targets, technologies, deployment dates

Existing techniques, summary R&D

Required demonstration

Requirements from the facility

Common and summary of specific

Range of costs and proposed envelope

Rigorous

The MREFC defining team would welcome such input

First draft by January 2010

Final by July 2010

S4 expt specific

detailed documents

as specified in S4 Cooperative agreement with NSF

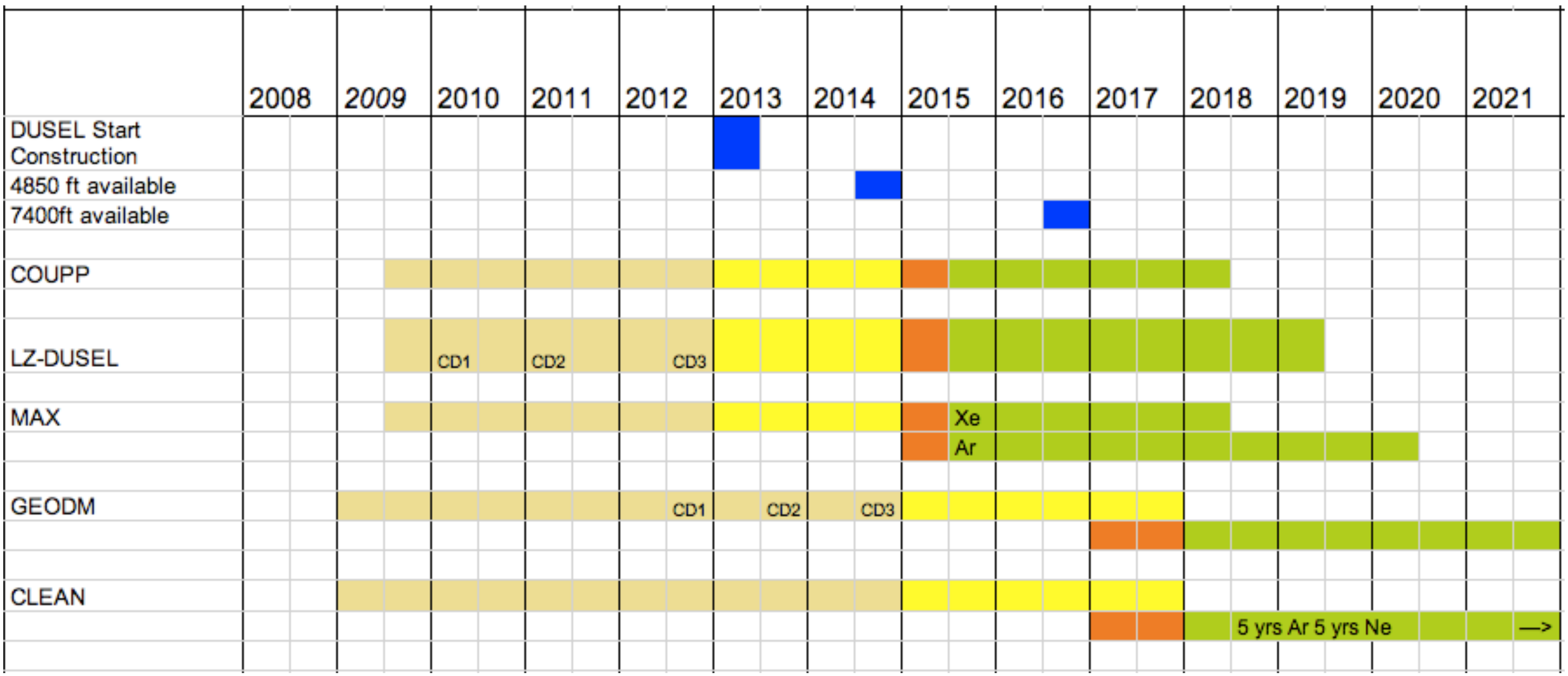
as close as PDF as possible

CLEAN will also provide these documents

DUSEL Dark Matter Experiments

Experiment	Mass Target	Sensitivity Scalar cm^2	Location Install. Date	Strengths	Challenges R&D	Estimated Costs
COUPP	nx500kg CF3I bubble ch.	dependent on α contamination	4850 ft 2015	γ rejection Cheap SD target	α Threshold detector	n x$1M
LZD	5-20t Xe dual phase	10^{-48}	4850 ft 2015	3D imaging Self shielding Scalable	Liquid purity HV	$32-48M
Max	5t Ar 2.5t Xe dual phase	10^{-47}	4850 ft 2015 -> 7400ft	3D imaging Self Shielding QUPID Pulse shape rejection (Ar)	Liquid purity HV ^{39}Ar depletion	$16M+ $18M
GEODM	1.5 t Ge phonons +ionization	2 10^{-47}	7400 ft 2017	Rejection + Background demonstrated 3D imaging	Cost/yield for large # of detectors high Ø Ge	$50M
CLEAN	50 t Ar single phase	few 10^{-47}	7400 ft 2017	Pulse shape rejection n self shielding Scalable	Rn contamin. Liquid purity	$60-80M

Roadmap



2 phases based on depth
Desired timeline shorter than facility first estimates

Pressure of the science
Technical readiness
International competition

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Dimensions

Experiment	Location Install. Date	Dimensions	Shield	Crane	Access	Hoist capacity
COUPP	4850 ft 2015	1/2 standard L= 35m wxh=20x20m	Water	20t	24/7/365 in emergency	20t
LZD	4850 ft 2015	1/2 standard L= 35m wxh=20x20m	Water 12mØ	20t	24/7/365 in emergency	20t
Max	4850 ft 2015 -> 7400ft	1 standard L= 75m wxh=20x20m	Water Water 15 mØ	20t	24/7/365 in emergency	20t
GEODM	7400 ft 2017	1/2 standard L= 35m wxh=20x20m	Pb/CH4 or Water 10mØ	20t	24/7/365 in emergency no long shutdown	20t 4mx4m
CLEAN	7400 ft 2017	1/2 standard L= 35m wxh=20x20m	Water 12m Ø	20t	24/7/365 in emergency	20t

Facility requirements

Experiment	Shield	Main Safety Issues	Air Ventilation Cleanliness Rn	Electric power /Cooling	Communications	Special requirements
COUPP	Water	mild toxicity CF3I ($5m^3$)	Class 10000 100 assembly $100Bq/m^3$	100kW 25kW UPS	Gb internet GPS time Environmental data	Blast warning
LZD	Water Liquid Sc	$7m^3$ liq Xe Mix Xe water 40 t liq. Scint	Class 10000 100 assembly $100Bq/m^3$	100kW 25kW UPS	Gb internet GPS time Environmental data	Blast warning
Max	Water Liquid Sc	$5m^3$ liq. Ar $1m^3$ liq. Xe Mix cryo water	Class 10000 100 assembly $100Bq/m^3$	100kW 25kW UPS	Gb internet GPS time Environmental data	Blast warning
GEODM	Pb/CH4 or Water	none signific. cryogenic liquid=small	Class 10000 100 assembly $100Bq/m^3$	100kW 25kW UPS	Gb internet GPS time Environmental data	RF shielding Blast warning
CLEAN	Water	70 m^3 Ar Mix Ar water	Class 10000 100 assembly $100Bq/m^3$	100kW 25kW UPS	Gb internet GPS time Environmental data	Blast warning

Facility Drivers

Cryogenic liquids 5-70m3

- emergency ventilation
- fast liquid transfer to cryogenic vessel
- gas exhaust or capture (Xe, depleted Ar)

Rn

- 100Bq/m^3 for the halls
  - Pipe from the surface?
- 100mBq/m^3 for detector assembly / clean room
  - Common Rn scrubber? What flow rate?

UPS

- how long? >10 minutes
- Diesel Generator

Cooling

- Maintain comfortable temperature ≈22C
- Temperature stability mild to be determined
- Water cooling (e.g. electronics, cryocoolers), chilled water

Vibration

- Blast warning, potential rock bursts/earthquakes
  - need estimate of acceleration

Facility Drivers

Common Water purification plant

flow rate to be determined
SK, SNO type purity

Common liquid nitrogen production plant+ storage vessel

few m3/day, to be refined

Access

Yates 4x4m 20 tons adequate, but worries about timing (2017 late)
Winze 7400 similar
Dust environment for component transport, cleaning

Contacts

Experiment	PI/ Spokesperson	Engineer	E&O
COUPP	J. Collar	R. Rucinski	TBD
LZD	T. Shutt/ R. Gaitskell	H. von der Lippe	TBD
Max	C. Galbiati	R. Parsells	TBD
GEODM	S. Golwala	TBD/SLAC	R. Winheld
CLEAN	A. Hime / D. McKinsey	J. Oertel LANL	TBD