The Dark Matter Programme of the Cherenkov Telescope Array

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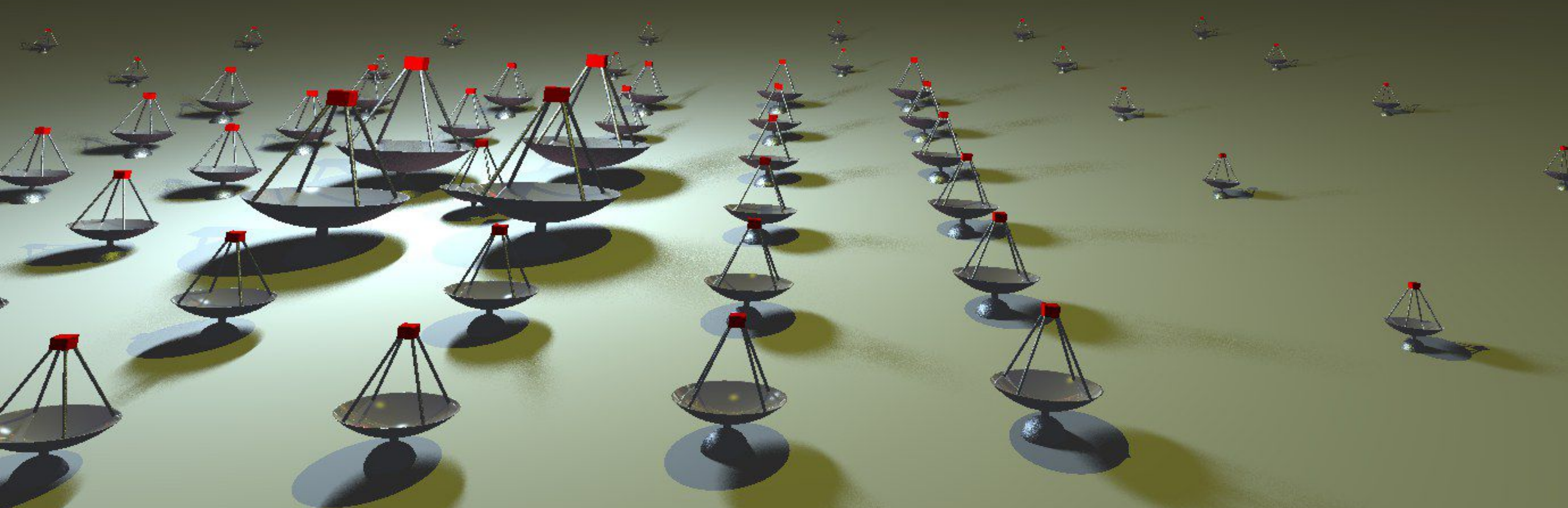
INFN Roma Tor Vergata
in collaboration with M.Doro, G. Rodríguez-Fernández and F. G. Saturni



Virtual Meeting CTA-INFN on analysis and science, 30th June 2020

Dark Matter Search: Targets and Strategies

Satellites

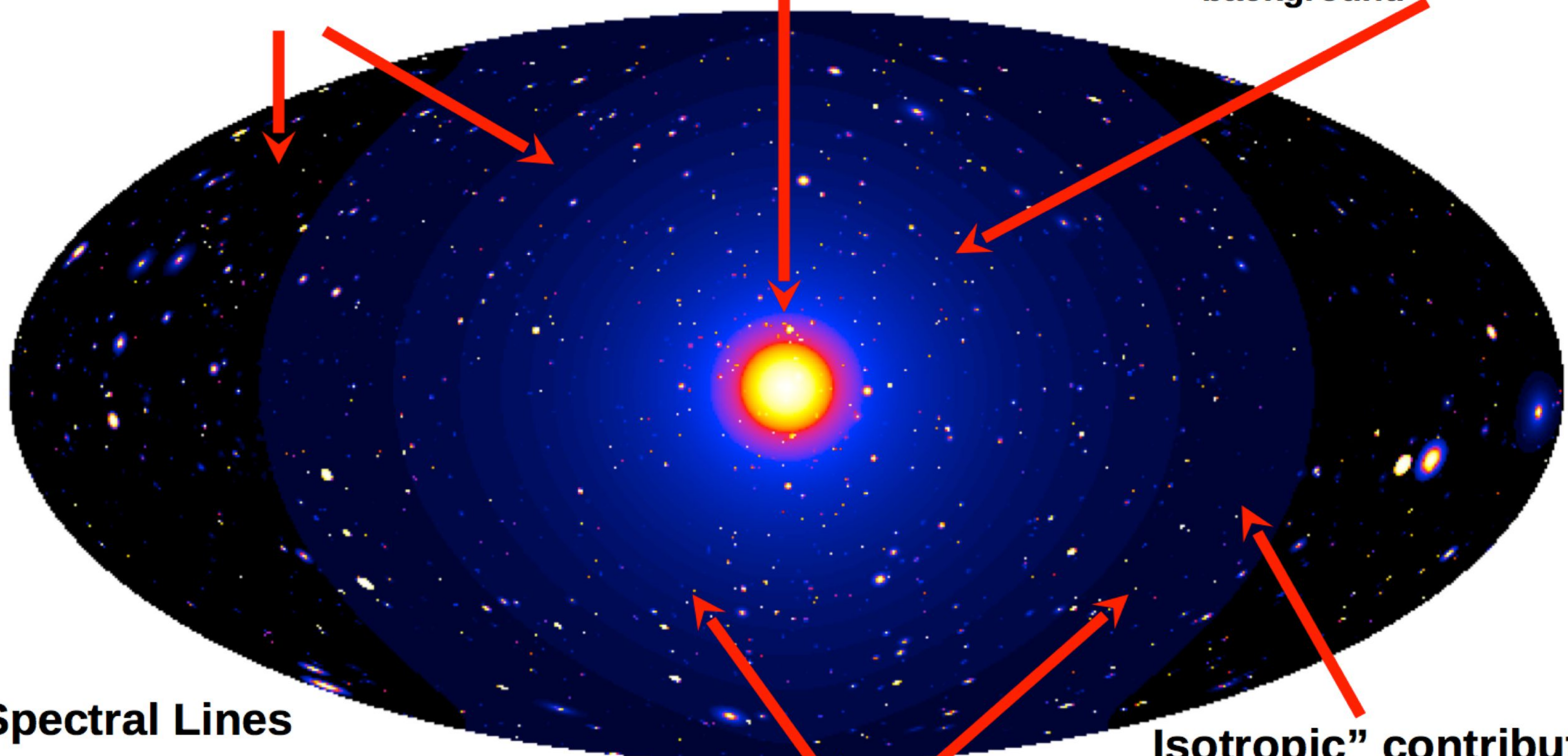
Low background and good source id, but low statistics

Galactic Center

Good Statistics, but source confusion/diffuse background

Milky Way Halo

Large statistics, but diffuse background



Spectral Lines

Little or no astrophysical uncertainties, but low sensitivity because of expected small branching ratio

Galaxy Clusters

Low background, but low statistics

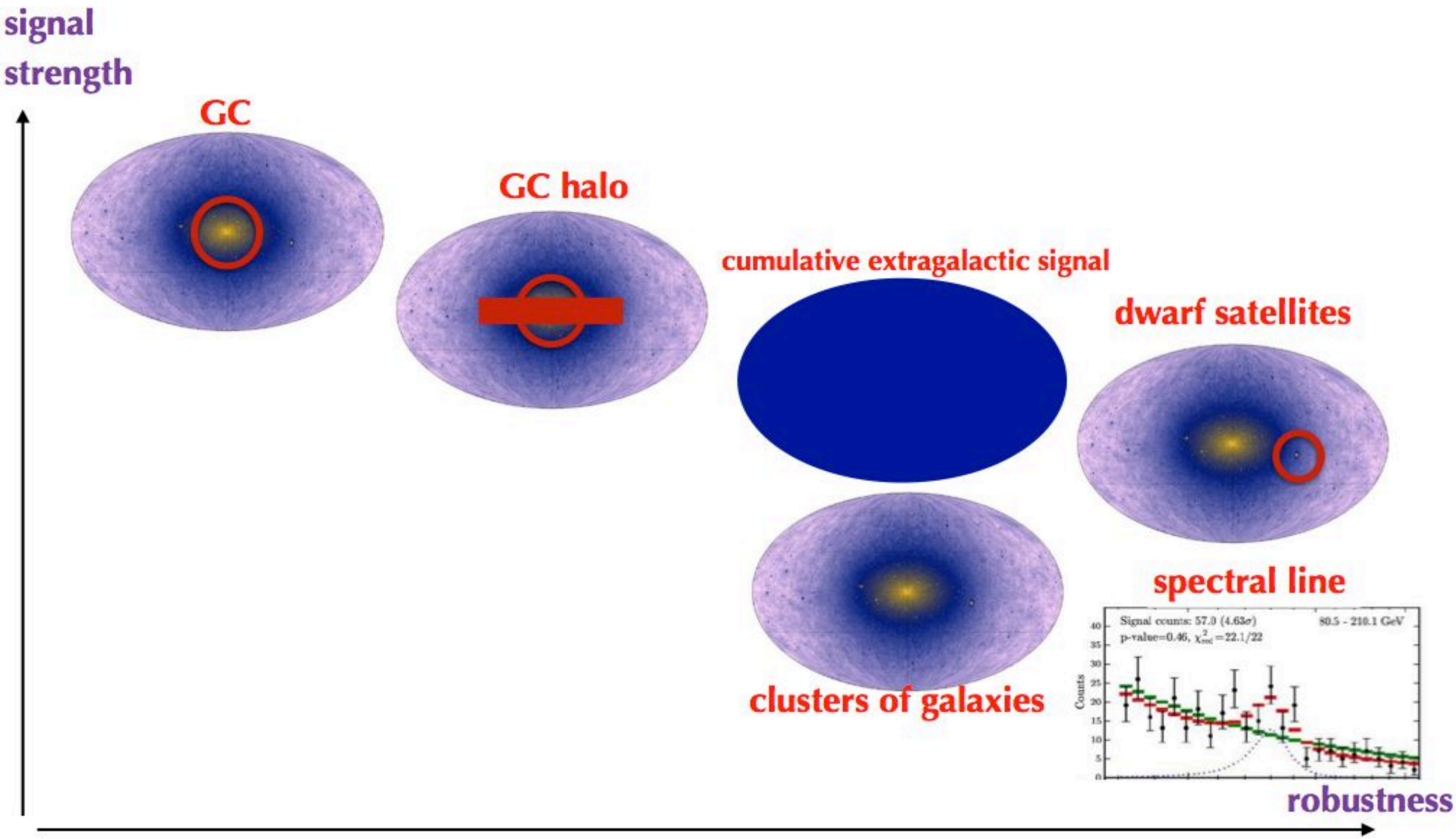
Isotropic" contributions

Large statistics, but astrophysics, galactic diffuse background

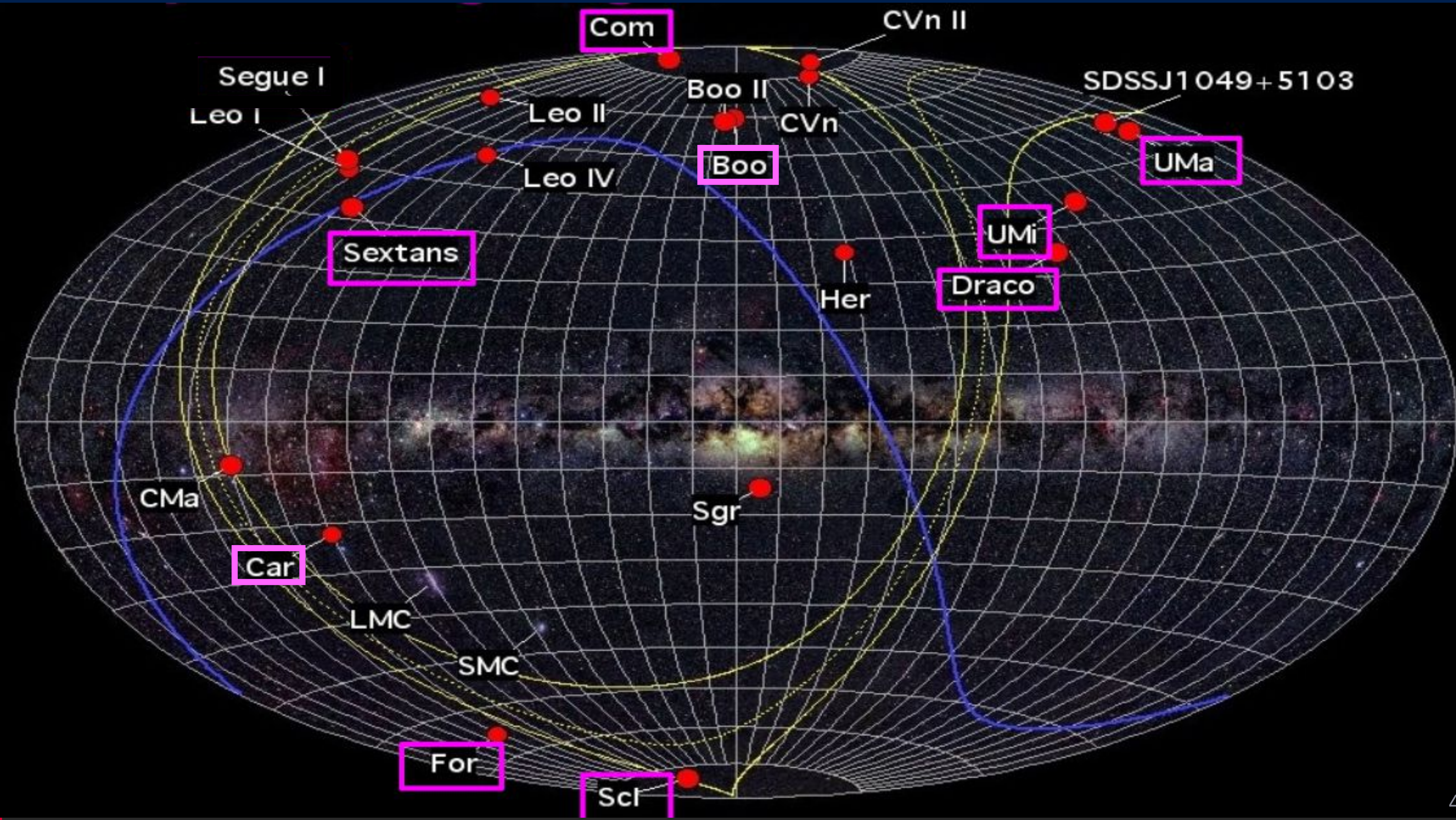
Dark Matter simulation: Pieri+(2009) arXiv:0908.0195

Dark Matter Search: Targets and Strategies

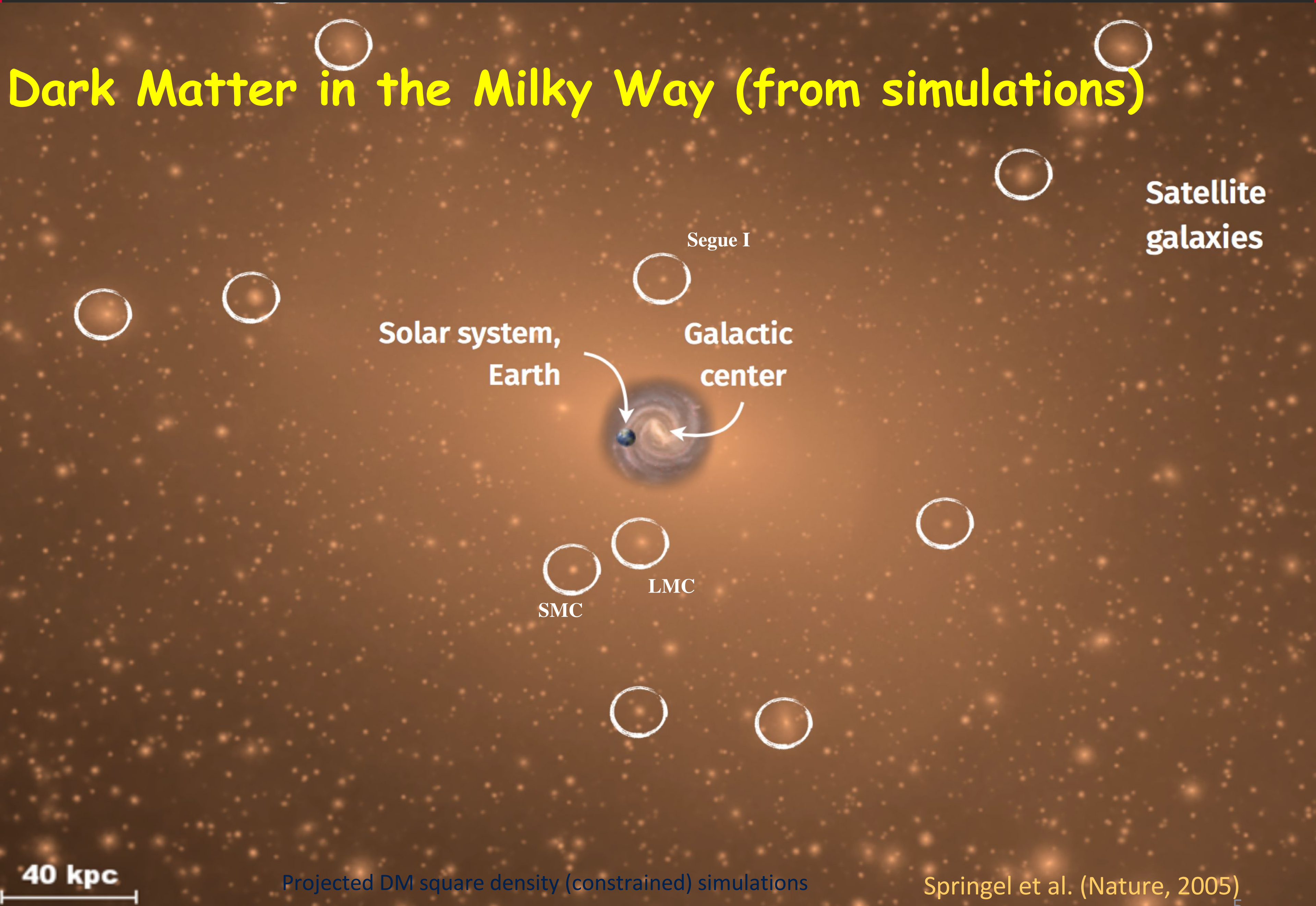
(Another way to see it)



Classical Dwarf spheroidal galaxies: promising targets for DM detection



Dark Matter in the Milky Way (from simulations)



Projected DM square density (constrained) simulations

Springel et al. (Nature, 2005)

CTA DM Detection Strategy

Year	1	2	3	4	5	6	7	8	9	10
Galactic halo	175 h	175 h	175 h							
Best dSph	100 h	100 h	100 h							
				in case of detection at GC, large σv						
Best dSph				150 h	150 h	150 h	150 h	150 h	150 h	150 h
Galactic halo				100 h	100 h	100 h	100 h	100 h	100 h	100 h
				in case of detection at GC, small σv						
Galactic halo				100 h	100 h	100 h	100 h	100 h	100 h	100 h
				in case of no detection at GC						
Best Target				100 h	100 h	100 h	100 h	100 h	100 h	100 h

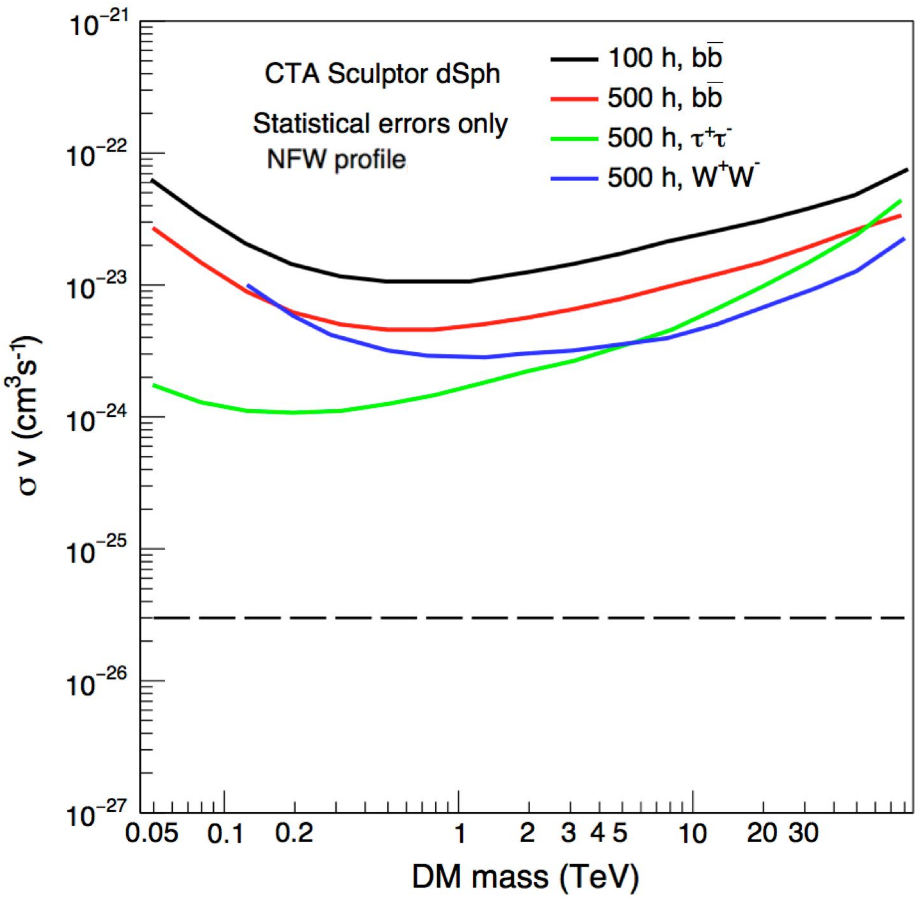
First 3 years

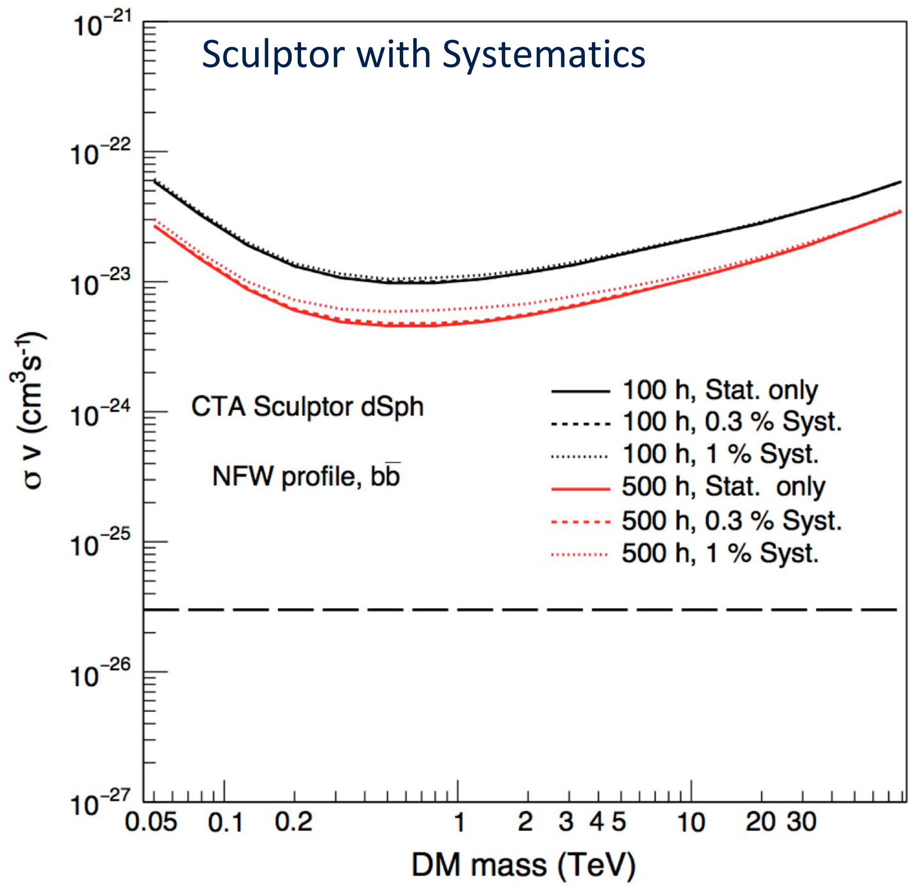
- The principal target is the Galactic Center Halo (most intense diffuse emission regions removed)
- Best dSph as “cleaner” environment for cross-checks and verification (if hint of strong signal)

Next 7 years

- If there is detection in GC halo data set (525h)
  - Strong signal: continue with GC halo in parallel with best dSph to provide robust detection
  - Weak signal: focus on GC focus to increase data set until systematic errors can be kept under control
- If no detection in GC halo data set
  - Focus observation on the best target at that time to produce legacy limits.

Dwarf Spheroidal Galaxies: CTA Sensitivity

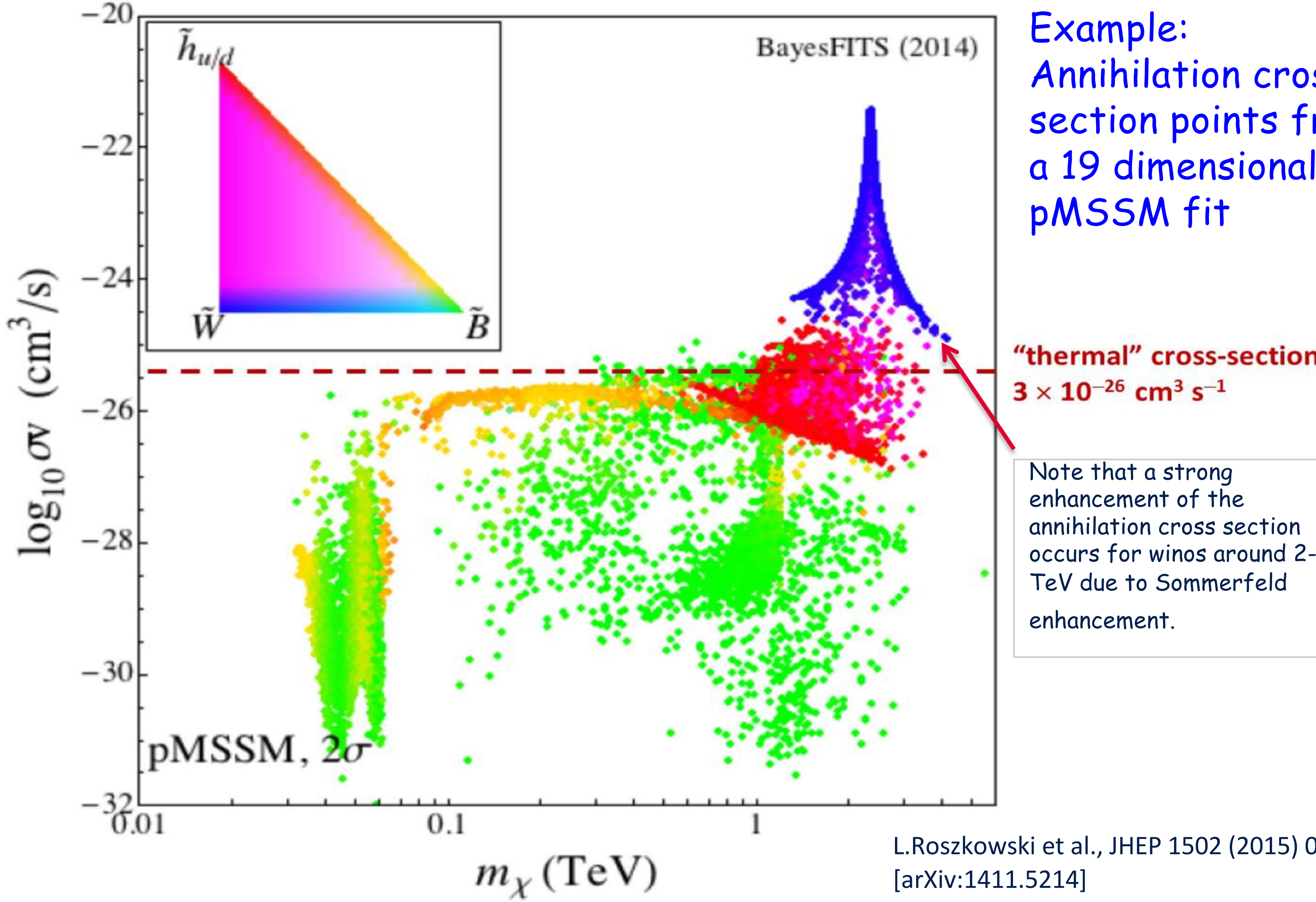




There are several of the newly discovered dSph that have a better case for being a promising target,

Will choose most promising targets before observations with the latest knowledge.

note:the "thermal" cross section is only a reference value. The real cross section can be higher or lower



Example: Annihilation cross-section points from a 19 dimensional pMSSM fit

Note that a strong enhancement of the annihilation cross section occurs for winos around 2-3 TeV due to Sommerfeld enhancement.

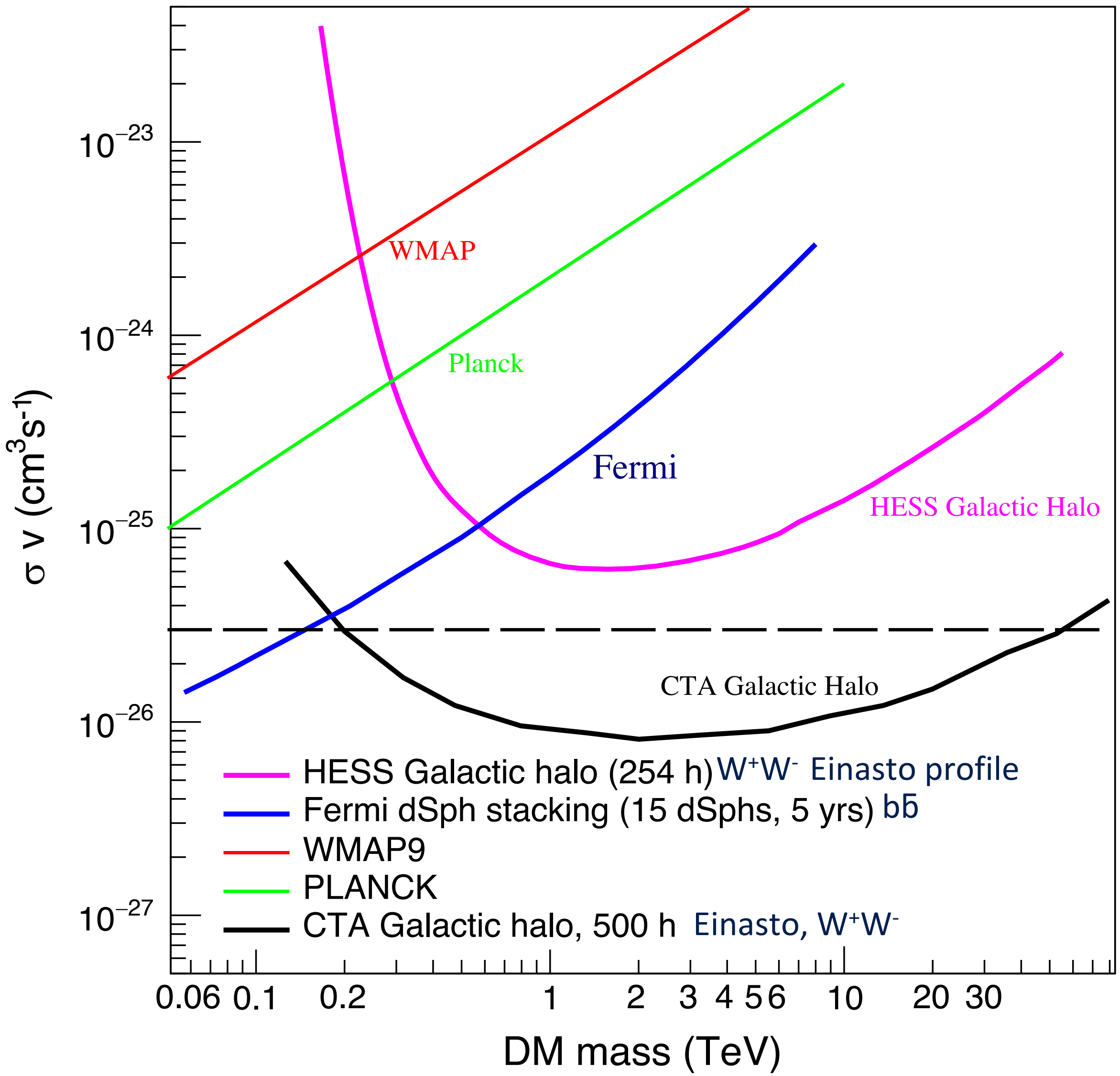
L.Roszkowski et al., JHEP 1502 (2015) 014 [arXiv:1411.5214]

CTA, HESS, FERMI, PLANK DM upper-limits

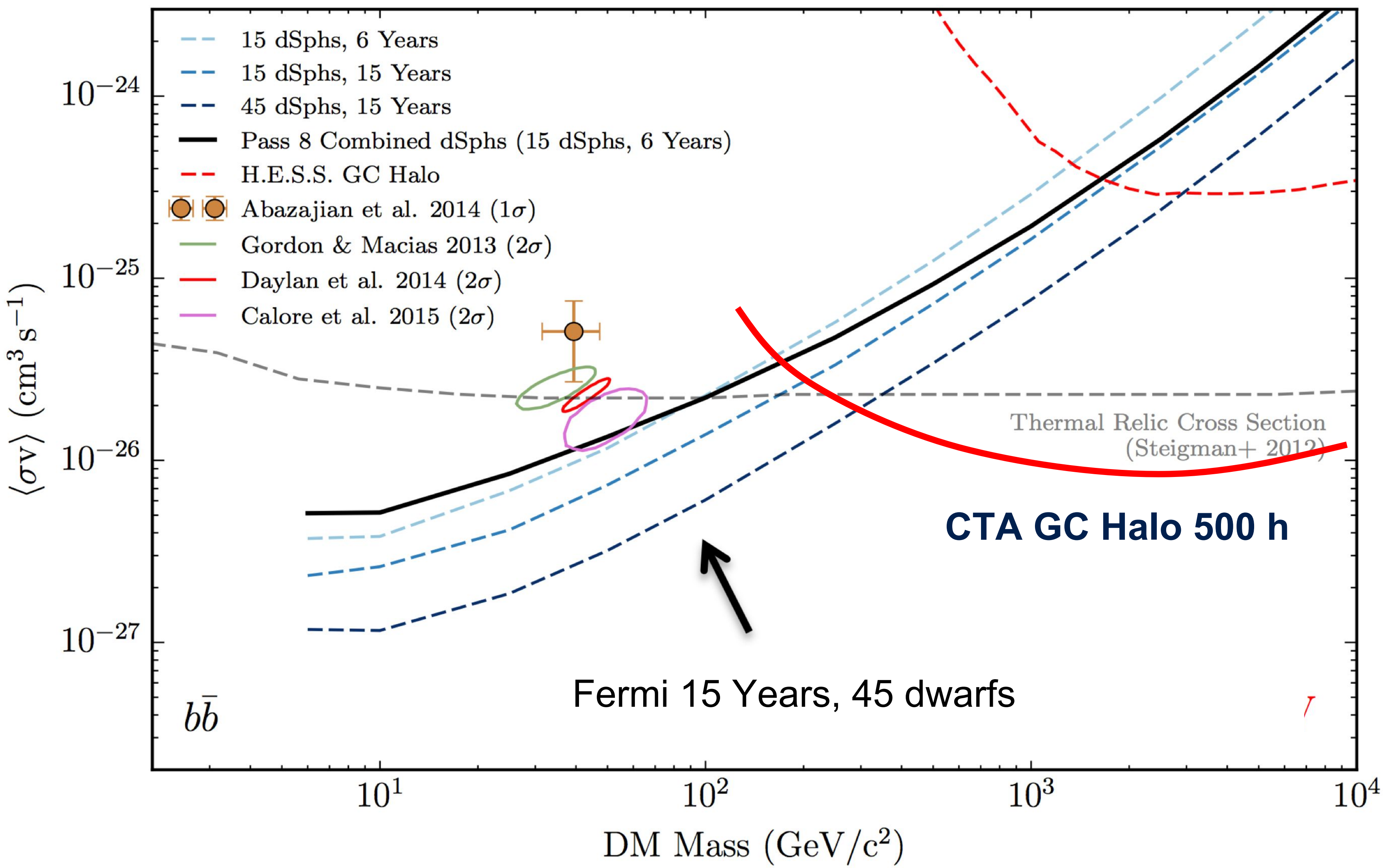
Together Fermi and CTA will probe most of the space of WIMP models with thermal relic annihilation cross section

The expectation for CTA is for the Einasto profile and is optimistic as includes only statistical errors.

The effect of the Galactic diffuse emission can affect the results by ~ 50%



DM limit improvement estimate in 15 years (2008- 2023)



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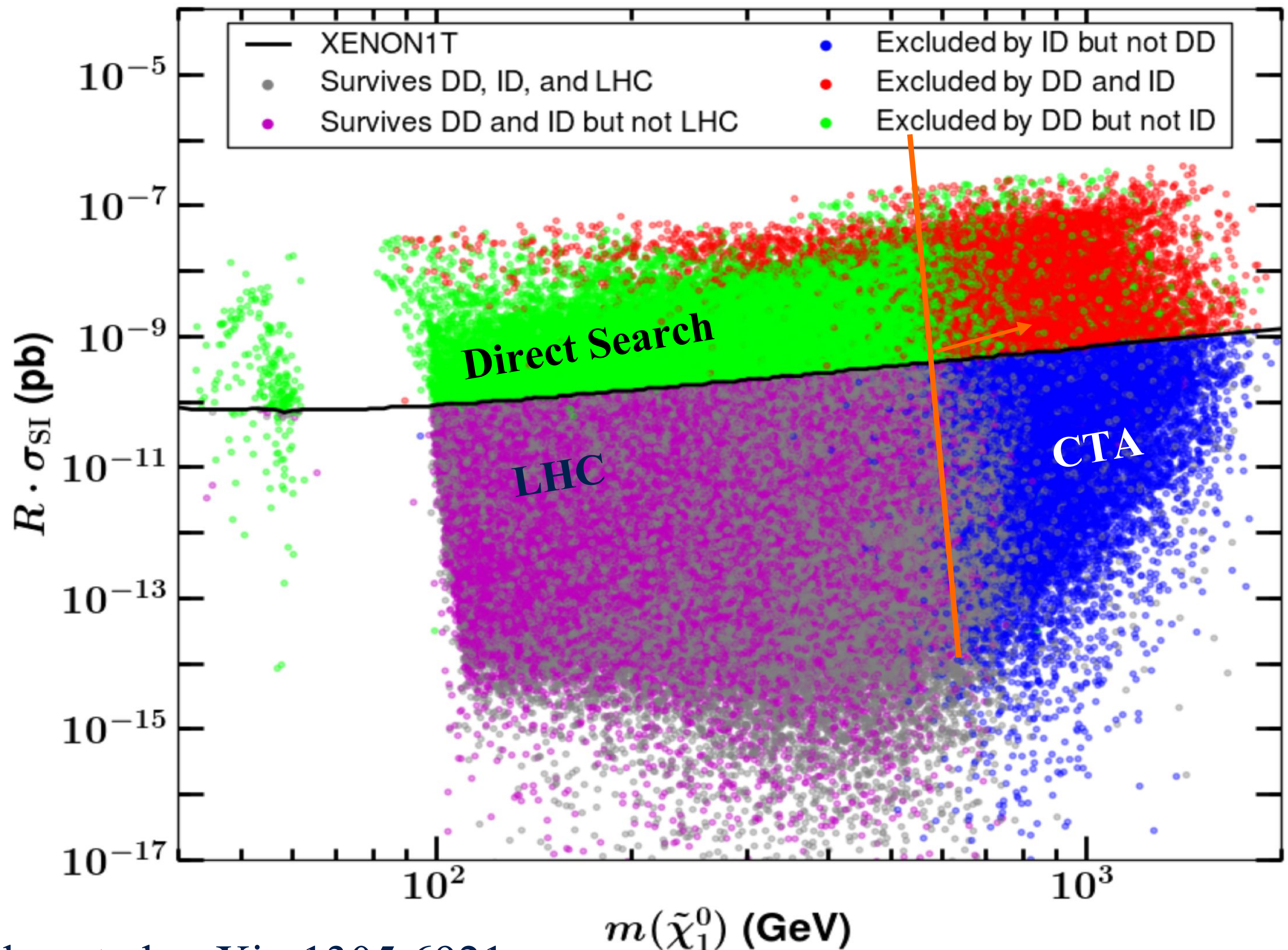
Complementarity and Searches for Dark Matter in the pMSSM



Cahill-Rowley et al. arXiv:1305.6921

Dark Matter Searches in Dwarf Spheroidal Galaxies with CTA

In-house calculation of the astrophysical factors for the dSph halos

— Selection of final sample of dSphs
— Derivation of input quantities for Jeans analysis
— Calculation of astrophysical factor profiles and 2D maps

2020 May

- In-house calculation of astrophysical factors for DM annihilation and decay in dSphs
  - Selection of optimal candidates for both CTA sites made on distance and minimum zenith angle:

    ***D* < 100 pc**
    ZA_{min} < 30º

  - Selected sample:

    10 Northern dSphs (BoöI, BoöII, BoöIII, CBe, DraI, Lae3, Seg1, Seg2, TriII, Wil1)
    11 Southern dSphs (CetII, EriIII, GruII, HorI, IndI, PheII, RetII, SgrI, SgrII, Scl, Sex)

Table 2: Basic properties of the dSphs belonging to the MW subgroup and those of the LG not associated to major galaxies, ranked in alphabetical order. The dSphs from the M31 subgroup are not included. Objects indicated with "cls" are "classical" dSphs, whereas "uft" stands for "ultra-faint". Dashes in the culmination columns indicate objects that do not rise above the horizon in the relevant hemisphere. The names of targets within ~100 kpc with culmination zenith angles ZA $\lesssim 30°$ are highlighted in **boldface** for the Northern hemisphere and in *italic* for the Southern hemisphere respectively, for a total of 10 Northern and 11 Southern dSphs.

Name	Abbr.	Type	R.A. (hh mm ss)	dec. (dd mm ss)	Distance (kpc)	ZA_{culm} N (deg)	ZA_{culm} S (deg)	Month	Ref.
Andromeda XVIII	AndXVIII	uft	00 02 14.5	+45 05 20	1330 ± 104	14.62	70.00	Sep	1,2
Aquarius	Aqr	uft	20 46 51.8	−12 50 53	1030 ± 57	41.54	11.54	Aug	1,3
Boötes I	BoöI	uft	14 00 06.0	+14 30 00	65 ± 3	13.85	38.46	Apr	1,4
Boötes II	BoöII	uft	13 58 00.0	+12 51 00	39 ± 2	16.15	36.92	Apr	1,5
Boötes III	BoöIII	uft	13 57 12.0	+26 48 00	46 ± 2	1.54	40.77	Apr	1,5
Canes Venatici I	CVnI	uft	13 28 03.5	+33 33 21	216 ± 8	4.62	57.69	Apr	1,4
Canes Venatici II	CVnII	uft	12 57 10.0	+34 19 15	159 ± 8	6.15	59.23	Apr	1,4
Carina	Car	cls	06 41 36.7	−50 57 58	106 ± 1	80.00	26.92	Dec	1,6
Cetus I	CetI	uft	00 26 11.0	−11 02 40	748 ± 31	39.23	13.85	Sep	1,7
Cetus II	CetII	uft	01 17 52.8	−17 25 12	30 ± 3	45.38	6.91	Oct	23
Columba I	ColI	uft	05 31 26.4	−28 01 48	182 ± 18	56.15	3.08	Dec	23
Coma Berenices	CBe	uft	12 26 59.0	+23 54 15	42 ± 2	5.38	47.69	Mar	1,8
Draco I	DraI	cls	17 20 12.4	+57 54 55	75 ± 4	29.23	83.08	Jun	1,9
Draco II	DraII	uft	15 52 47.6	+64 33 55	20 ± 3	34.62	88.46	May	24
Eridanus II	EriII	uft	03 44 21.5	−43 31 48	330 ± 16	72.31	18.46	Nov	25
Eridanus III	EriIII	uft	02 22 45.5	−52 16 48	95 ± 27	80.77	27.69	Oct	25
Fornax	For	cls	02 39 59.3	−34 26 57	146 ± 1	63.08	10.00	Oct	1,6
Grus I	GruI	uft	22 56 42.4	−50 09 48	120 ± 17	78.46	25.38	Sep	26
Grus II	GruII	uft	22 04 04.8	−46 26 24	53 ± 5	75.38	22.31	Aug	23
Hercules	Her	uft	16 31 02.0	+12 47 30	137 ± 11	16.15	36.92	May	1,10
Horologium I	HorI	uft	02 55 28.9	−54 06 36	87 ± 13	83.08	29.23	Oct	25
Hydra II	HyaII	uft	12 21 42.1	−31 59 07	134 ± 10	60.77	6.92	Mar	27
Indus I	IndI	uft	21 08 48.1	−51 09 36	69 ± 16	80.00	26.92	Aug	25
Indus II	IndII	uft	20 38 52.8	−46 09 36	214 ± 16	75.38	22.31	Aug	23
Laevens 3	Lae3	uft	21 06 54.3	+14 58 48	67 ± 3	13.85	39.23	Aug	24
Leo I	LeoI	cls	10 08 28.1	+12 18 23	272 ± 10	16.15	35.38	Feb	1,11
Leo II	LeoII	cls	11 13 28.8	+22 09 06	240 ± 9	6.92	46.92	Mar	1,12
Leo IV	LeoIV	uft	11 32 57.0	−00 32 00	151 ± 4	29.23	23.85	Mar	1,13
Leo V	LeoV	uft	11 31 09.6	+02 13 12	169 ± 5	26.15	26.92	Mar	1,13
Leo T	LeoT	uft	09 34 53.4	+17 03 05	377 ± 28	12.31	42.31	Feb	1,14
Phoenix I	PheI	uft	01 51 06.3	−44 26 41	427 ± 31	73.85	20.00	Oct	1,14
Phoenix II	PheII	uft	23 39 57.6	−54 24 36	95 ± 18	83.08	30.00	Sep	25
Pictor I	PicI	uft	04 43 48.0	−50 16 48	126 ± 24	78.46	26.15	Nov	25
Pisces II	PscII	uft	22 58 31.0	+05 57 09	182 ± 13	23.08	30.77	Sep	1,15
Reticulum II	RetII	uft	03 35 40.9	−54 03 00	32 ± 2	83.08	29.23	Nov	25
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Sagittarius I	SgrI	uft	18 55 19.5	−30 32 43	31 ± 1	59.23	6.15	Jul	1,16
Sagittarius II	SgrII	uft	19 52 40.5	−22 04 05	67 ± 5	51.54	2.31	Jul	24
Sculptor	Scl	cls	01 00 09.4	−33 42 33	84 ± 2	63.08	9.23	Oct	1,17
Segue 1	Seg1	uft	10 07 04.0	+16 04 55	23 ± 2	12.31	40.77	Feb	1,18
Segue 2	Seg2	uft	02 19 16.0	+20 10 31	36 ± 2	8.46	44.62	Oct	1,19
Sextans	Sex	cls	10 13 03.0	−01 36 53	84 ± 3	30.77	23.07	Feb	1,13
Triangulum II	TriII	uft	02 13 17.4	+36 10 42	30 ± 2	6.92	60.77	Oct	28
Tucana I	TucI	uft	22 41 49.6	−64 25 10	855 ± 35	—	40.00	Sep	1,7
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Tucana IV	TucIV	uft	00 02 55.3	−60 51 00	48 ± 4	89.23	35.38	Sep	23
Ursa Major I	UMaI	uft	10 34 52.8	+51 55 12	105 ± 2	23.08	76.15	Mar	1,20
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Ursa Minor	UMi	cls	15 09 08.5	+67 13 21	68 ± 2	38.46	—	May	1,22
Willman 1	Wil1	uft	10 49 21.0	+51 03 00	38 ± 7	22.31	75.38	Mar	1,18

References: (1, coordinates only) [?]; (2–22, distances only) [4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24]; (23–28, both data) [25, 26, 27, 28? ?].

2020 May

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2020 May

- In-house calculation of astrophysical factors for DM annihilation and decay in dSphs
  - Exclusion of targets without or with too poor brightness/kinematic data available in the literature:

    BoöII (only 5 member stars)
    CetII (no kinematic data)
    EriII (no kinematic data)
    HorI (only 5 member stars)
    IndI (no kinematic data)
    Lae3 (no kinematic data)
    PheII (no kinematic data)
    Seg2 (no brightness data)

  - Surviving sample:

    7 Northern dSphs
    6 Southern dSphs

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Draco I	DraI	cls	17 20 12.4	+57 54 55	75 ± 4	29.23	83.08	Jun	1,9
Draco II	DraII	uft	15 52 47.6	+64 33 55	20 ± 3	34.62	88.46	May	24
Eridanus II	EriII	uft	03 44 21.5	−43 31 48	330 ± 16	72.31	18.46	Nov	25
Eridanus III	EriIII	uft	02 22 45.5	−52 16 48	95 ± 27	80.77	27.69	Oct	25
Fornax	For	cls	02 39 59.3	−34 26 57	146 ± 1	63.08	10.00	Oct	1,6
Grus I	GruI	uft	22 56 42.4	−50 09 48	120 ± 17	78.46	25.38	Sep	26
Grus II	GruII	uft	22 04 04.8	−46 26 24	53 ± 5	75.38	22.31	Aug	23
Hercules	Her	uft	16 31 02.0	+12 47 30	137 ± 11	16.15	36.92	May	1,10
Horologium I	HorI	uft	02 55 28.9	−54 06 36	87 ± 13	83.08	29.23	Oct	25
Hydra II	HyaII	uft	12 21 42.1	−31 59 07	134 ± 10	60.77	6.92	Mar	27
Indus I	IndI	uft	21 08 48.1	−51 09 36	69 ± 16	80.00	26.92	Aug	25
Indus II	IndII	uft	20 38 52.8	−46 09 36	214 ± 16	75.38	22.31	Aug	23
Laevens 3	Lae3	uft	21 06 54.3	+14 58 48	67 ± 3	13.85	39.23	Aug	24
Leo I	LeoI	cls	10 08 28.1	+12 18 23	272 ± 10	16.15	35.38	Feb	1,11
Leo II	LeoII	cls	11 13 28.8	+22 09 06	240 ± 9	6.92	46.92	Mar	1,12
Leo IV	LeoIV	uft	11 32 57.0	−00 32 00	151 ± 4	29.23	23.85	Mar	1,13
Leo V	LeoV	uft	11 31 09.6	+02 13 12	169 ± 5	26.15	26.92	Mar	1,13
Leo T	LeoT	uft	09 34 53.4	+17 03 05	377 ± 28	12.31	42.31	Feb	1,14
Phoenix I	PheI	uft	01 51 06.3	−44 26 41	427 ± 31	73.85	20.00	Oct	1,14
Phoenix II	PheII	uft	23 39 57.6	−54 24 36	95 ± 18	83.08	30.00	Sep	25
Pictor I	PicI	uft	04 43 48.0	−50 16 48	126 ± 24	78.46	26.15	Nov	25
Pisces II	PscII	uft	22 58 31.0	+05 57 09	182 ± 13	23.08	30.77	Sep	1,15
Reticulum II	RetII	uft	03 35 40.9	−54 03 00	32 ± 2	83.08	29.23	Nov	25
Reticulum III	RetIII	uft	03 45 26.3	−60 27 00	92 ± 13	88.46	35.38	Nov	23
Sagittarius I	SgrI	uft	18 55 19.5	−30 32 43	31 ± 1	59.23	6.15	Jul	1,16
Sagittarius II	SgrII	uft	19 52 40.5	−22 04 05	67 ± 5	51.54	2.31	Jul	24
Sculptor	Scl	cls	01 00 09.4	−33 42 33	84 ± 2	63.08	9.23	Oct	1,17
Segue 1	Seg1	uft	10 07 04.0	+16 04 55	23 ± 2	12.31	40.77	Feb	1,18
Segue 2	Seg2	uft	02 19 16.0	+20 10 31	36 ± 2	8.46	44.62	Oct	1,19
Sextans	Sex	cls	10 13 03.0	−01 36 53	84 ± 3	30.77	23.07	Feb	1,13
Triangulum II	TriII	uft	02 13 17.4	+36 10 42	30 ± 2	6.92	60.77	Oct	28
Tucana I	TucI	uft	22 41 49.6	−64 25 10	855 ± 35	—	40.00	Sep	1,7
Tucana II	TucII	uft	22 52 16.7	−58 33 36	58 ± 6	86.92	33.85	Sep	25
Tucana III	TucIII	uft	23 56 35.9	−59 36 00	25 ± 2	87.69	34.62	Sep	23
Tucana IV	TucIV	uft	00 02 55.3	−60 51 00	48 ± 4	89.23	35.38	Sep	23
Ursa Major I	UMaI	uft	10 34 52.8	+51 55 12	105 ± 2	23.08	76.15	Mar	1,20
Ursa Major II	UMaII	uft	08 51 30.0	+63 07 48	35 ± 2	34.62	87.69	Feb	1,21
Ursa Minor	UMi	cls	15 09 08.5	+67 13 21	68 ± 2	38.46	—	May	1,22
Willman 1	Wil1	uft	10 49 21.0	+51 03 00	38 ± 7	22.31	75.38	Mar	1,18

References: (1, coordinates only) [?]; (2–22, distances only) [4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24]; (23–28, both data) [25, 26, 27, 28? ?].

2020 May

- In-house calculation of astrophysical factors for DM annihilation and decay in dSphs
  - Exclusion of targets without or with too poor brightness/kinematic data available in the literature:

    BoöII (only 5 member stars)
    CetII (no kinematic data)
    EriII (no kinematic data)
    HorI (only 5 member stars)
    IndI (no kinematic data)
    Lae3 (no kinematic data)
    PheII (no kinematic data)
    Seg2 (no brightness data)

  - Surviving sample:

    7 Northern dSphs
    6 Southern dSphs

Table 2: Basic properties of the dSphs belonging to the MW subgroup and those of the LG not associated to major galaxies, ranked in alphabetical order. The dSphs from the M31 subgroup are not included. Objects indicated with "cls" are "classical" dSphs, whereas "uft" stands for "ultra-faint". Dashes in the culmination columns indicate objects that do not rise above the horizon in the relevant hemisphere. The names of targets within ~100 kpc with culmination zenith angles ZA $\lesssim 30°$ are highlighted in **boldface** for the Northern hemisphere and in *italic* for the Southern hemisphere respectively, for a total of 10 Northern and 11 Southern dSphs.

Name	Abbr.	Type	R.A. (hh mm ss)	dec. (dd mm ss)	Distance (kpc)	ZA_{culm} N (deg)	ZA_{culm} S (deg)	Month	Ref.
Andromeda XVIII	AndXVIII	uft	00 02 14.5	+45 05 20	1330 ± 104	14.62	70.00	Sep	1,2
Aquarius	Aqr	uft	20 46 51.8	−12 50 53	1030 ± 57	41.54	11.54	Aug	1,3
Boötes I	BooI	uft	14 00 06.0	+14 30 00	65 ± 3	13.85	38.46	Apr	1,4
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Boötes III	BoöIII	uft	13 57 12.0	+26 48 00	46 ± 2	1.54	40.77	Apr	1,5
Canes Venatici I	CVnI	uft	13 28 03.5	+33 33 21	216 ± 8	4.62	57.69	Apr	1,4
Canes Venatici II	CVnII	uft	12 57 10.0	+34 19 15	159 ± 8	6.15	59.23	Apr	1,4
Carina	Car	cls	06 41 36.7	−50 57 58	106 ± 1	80.00	26.92	Dec	1,6
Cetus I	CetI	uft	00 26 11.0	−11 02 40	748 ± 31	39.23	13.85	Sep	1,7
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Columba I	ColI	uft	05 31 26.4	−28 01 48	182 ± 18	56.15	3.08	Dec	23
Coma Berenices	CBe	uft	12 26 59.0	+23 54 15	42 ± 2	5.38	47.69	Mar	1,8
Draco I	DraI	cls	17 20 12.4	+57 54 55	75 ± 4	29.23	83.08	Jun	1,9
Draco II	DraII	uft	15 52 47.6	+64 33 55	20 ± 3	34.62	88.46	May	24
Eridanus II	EriII	uft	03 44 21.5	−43 31 48	330 ± 16	72.31	18.46	Nov	25
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Fornax	For	cls	02 39 59.3	−34 26 57	146 ± 1	63.08	10.00	Oct	1,6
Grus I	GruI	uft	22 56 42.4	−50 09 48	120 ± 17	78.46	25.38	Sep	26
Grus II	GruII	uft	22 04 04.8	−46 26 24	53 ± 5	75.38	22.31	Aug	23
Hercules	Her	uft	16 31 02.0	+12 47 30	137 ± 11	16.15	36.92	May	1,10
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Hydra II	HyaII	uft	12 21 42.1	−31 59 07	134 ± 10	60.77	6.92	Mar	27
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Indus II	IndII	uft	20 38 52.8	−46 09 36	214 ± 16	75.38	22.31	Aug	23
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Leo I	LeoI	cls	10 08 28.1	+12 18 23	272 ± 10	16.15	35.38	Feb	1,11
Leo II	LeoII	cls	11 13 28.8	+22 09 06	240 ± 9	6.92	46.92	Mar	1,12
Leo IV	LeoIV	uft	11 32 57.0	−00 32 00	151 ± 4	29.23	23.85	Mar	1,13
Leo V	LeoV	uft	11 31 09.6	+02 13 12	169 ± 5	26.15	26.92	Mar	1,13
Leo T	LeoT	uft	09 34 53.4	+17 03 05	377 ± 28	12.31	42.31	Feb	1,14
Phoenix I	PheI	uft	01 51 06.3	−44 26 41	427 ± 31	73.85	20.00	Oct	1,14
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Pictor I	PicI	uft	04 43 48.0	−50 16 48	126 ± 24	78.46	26.15	Nov	25
Pisces II	PscII	uft	22 58 31.0	+05 57 09	182 ± 13	23.08	30.77	Sep	1,15
Reticulum II	RetII	uft	03 35 40.9	−54 03 00	32 ± 2	83.08	29.23	Nov	25
Reticulum III	RetIII	uft	03 45 26.3	−60 27 00	92 ± 13	88.46	35.38	Nov	23
Sagittarius I	SgrI	uft	18 55 19.5	−30 32 43	31 ± 1	59.23	6.15	Jul	1,16
Sagittarius II	SgrII	uft	19 52 40.5	−22 04 05	67 ± 5	51.54	2.31	Jul	24
Sculptor	Scl	cls	01 00 09.4	−33 42 33	84 ± 2	63.08	9.23	Oct	1,17
Segue 1	Seg1	uft	10 07 04.0	+16 04 55	23 ± 2	12.31	40.77	Feb	1,18
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Sextans	Sex	cls	10 13 03.0	−01 36 53	84 ± 3	30.77	23.07	Feb	1,13
Triangulum II	TriII	uft	02 13 17.4	+36 10 42	30 ± 2	6.92	60.77	Oct	28
Tucana I	TucI	uft	22 41 49.6	−64 25 10	855 ± 35	—	40.00	Sep	1,7
Tucana II	TucII	uft	22 52 16.7	−58 33 36	58 ± 6	86.92	33.85	Sep	25
Tucana III	TucIII	uft	23 56 35.9	−59 36 00	25 ± 2	87.69	34.62	Sep	23
Tucana IV	TucIV	uft	00 02 55.3	−60 51 00	48 ± 4	89.23	35.38	Sep	23
Ursa Major I	UMaI	uft	10 34 52.8	+51 55 12	105 ± 2	23.08	76.15	Mar	1,20
Ursa Major II	UMaII	uft	08 51 30.0	+63 07 48	35 ± 2	34.62	87.69	Feb	1,21
Ursa Minor	UMi	cls	15 09 08.5	+67 13 21	68 ± 2	38.46	—	May	1,22
Willman 1	Wil1	uft	10 49 21.0	+51 03 00	38 ± 7	22.31	75.38	Mar	1,18

References: (1, coordinates only) [?]; (2–22, distances only) [4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24]; (23–28, both data) [25, 26, 27, 28? ?].

2020 May

- In-house calculation of astrophysical factors for DM annihilation and decay in dSphs — ***IN PROGRESS***
  - Jeans analysis with CLUMPY v3.0.1 (Hütten+ 2019)
  - Input data: dSph surface brightness profile + kinematics of dSph member stars

$$\frac{1}{n^*(r)}\left\{\frac{d}{dr}\left[n^*(r)\overline{v_r^2}\right]\right\}+\frac{2}{r}\beta_{\text{ani}}(r)\overline{v_r^2}=-\frac{G[M_{\text{DM}}(r)+M_*(r)]}{r^2}$$

$$n^*(r)=\frac{n_s^*}{\left(\frac{r}{r_s^*}\right)^{\gamma^*}\left[1+\left(\frac{r}{r_s^*}\right)^{\alpha^*}\right]^{\frac{\beta^*-\gamma^*}{\alpha^*}}}$$

$$p_{\text{mem}}(v_i,W_i)=\frac{\exp\left\{-\frac{1}{2}\left[\frac{(v_i-\langle v_{\text{mem}}\rangle)^2}{\sigma_{\text{mem}}^2+\sigma_i^2}+\frac{(W_i-\langle W_{\text{mem}}\rangle)^2}{\Delta W_{\text{mem}}^2+\Delta W_i^2}\right]\right\}}{2\pi\sqrt{(\sigma_{\text{mem}}^2+\sigma_i^2)(\Delta W_{\text{mem}}^2+\Delta W_i^2)}}$$

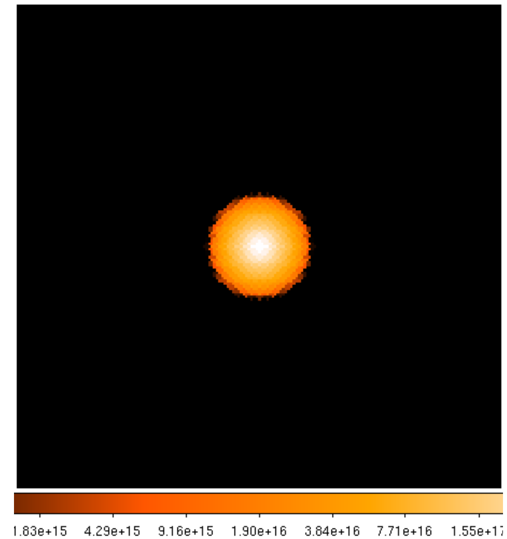
2020 May

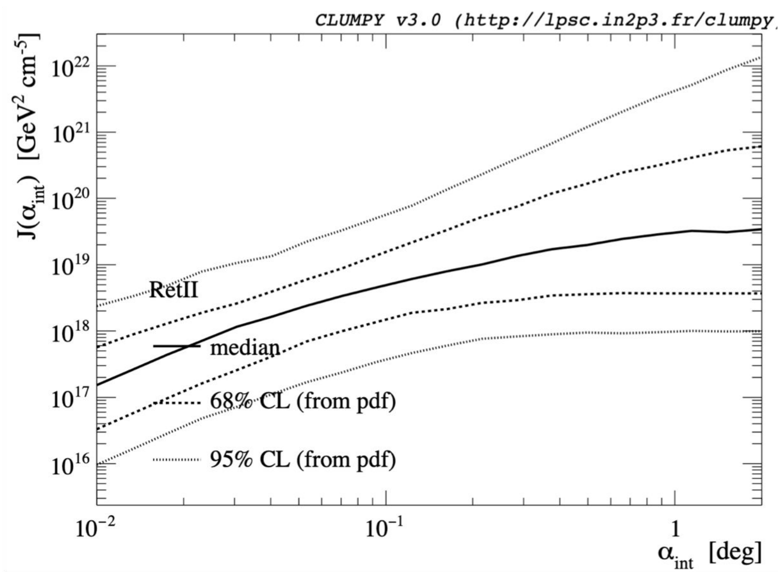
- In-house calculation of astrophysical factors for DM annihilation and decay in dSphs — ***IN PROGRESS***
  - dSph surface brightness parameters computed for the whole selected sample

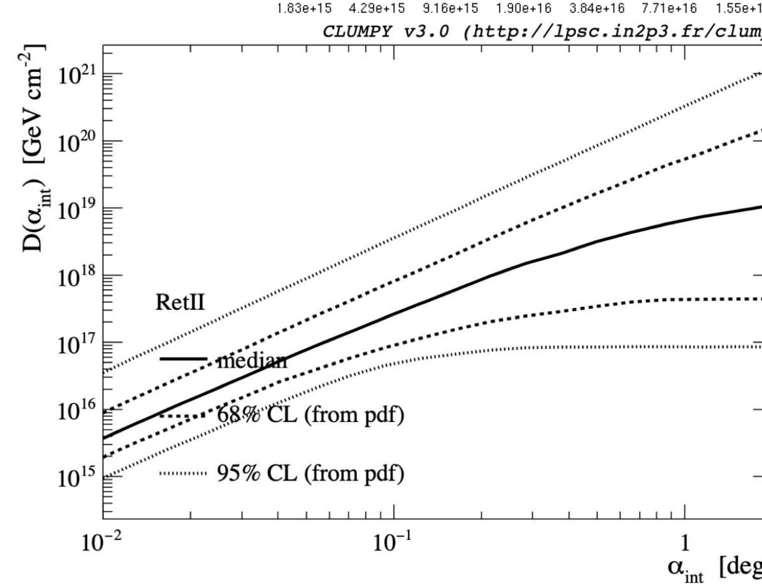
	ρ^*_s (10^7 L⊙/kpc^3)	r^*_s (pc)	α^*	β^*	γ^*
BoöI	0.287 ± 0.053	176.1 ± 5.3	0.6	3.2	0.6
BoöIII	0.23 ± 0.10	3.91 ± 0.17	0.4	1.0	3.6
CBe	1.53 ± 0.70	85.1 ± 7.7	0.4	3.4	1.2
DraI	102 ± 28	58.0 ± 4.6	0.6	2.6	0.0
GruII	0.190 ± 0.035	75.6 ± 7.1	0.6	2.8	0.6
RetII	2.98 ± 0.27	25.0 ± 1.6	0.6	3.0	1.0
Scl	770 ± 360	31.5 ± 2.2	0.2	2.4	1.0
Seg1	35 ± 26	5.92 ± 0.51	0.6	3.2	0.2
Sex	0.41 ± 0.19	255 ± 12	0.8	3.0	0.2
SgrI	6.6 ± 1.8	473 ± 36	0.2	3.0	1.6
SgrII	123 ± 11	7.97 ± 0.57	0.4	2.4	0.2
TriII	13.1 ± 6.0	30.8 ± 2.1	0.2	2.6	1.6
Wil1	73 ± 54	8.1 ± 1.5	0.4	2.8	0.2

2020 May

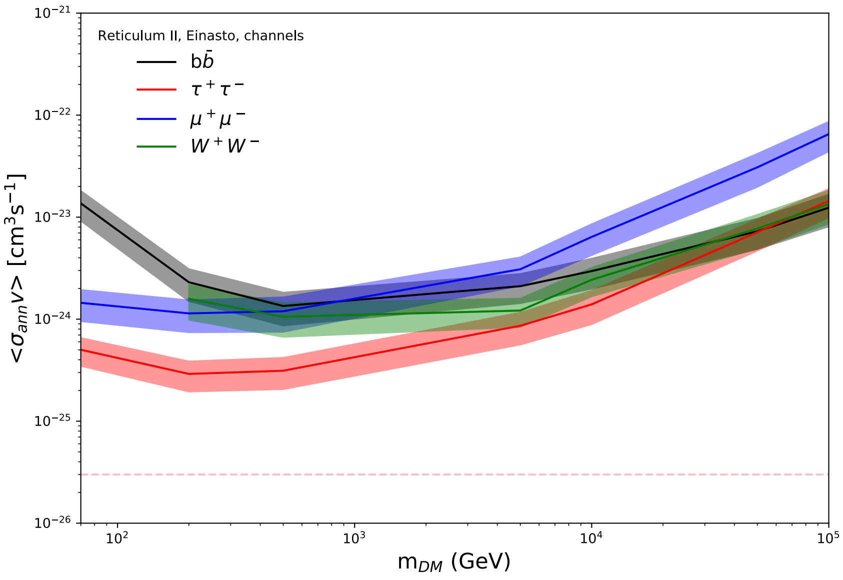
- In-house calculation of astrophysical factors for DM annihilation and decay in dSphs — ***IN PROGRESS***
  - *J*/*D*-factor profiles to be computed as a function of the integration angle up to 2º for both cuspy (Einasto) and cored (Burkert) DM density profiles
  - 2D maps of *J*/*D*-factors to be computed up to 10º FoV for both DM density profiles

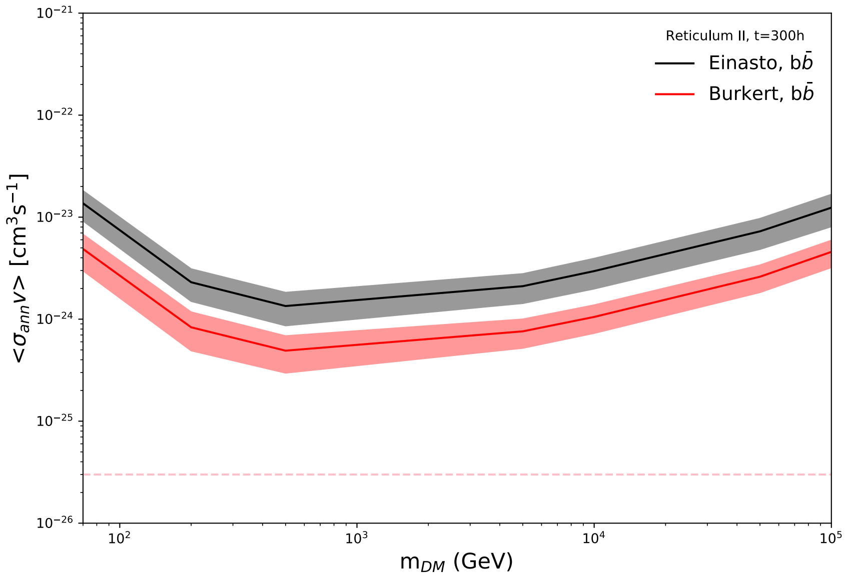






Upper Limits 95% CL CTOOLS v1.5.1:

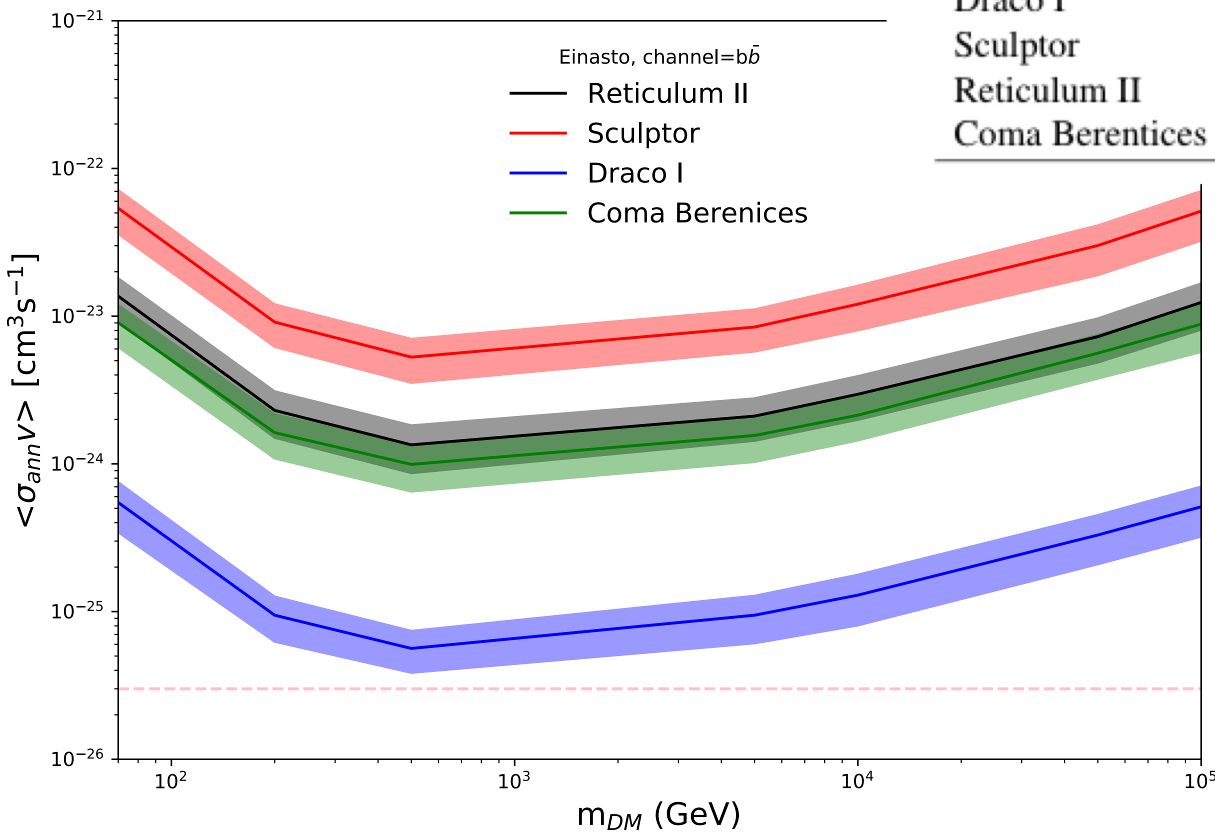




Upper Limits 95% CL CTOOLS v1.5.1:

Integrated values J(alpha_int = 10º)

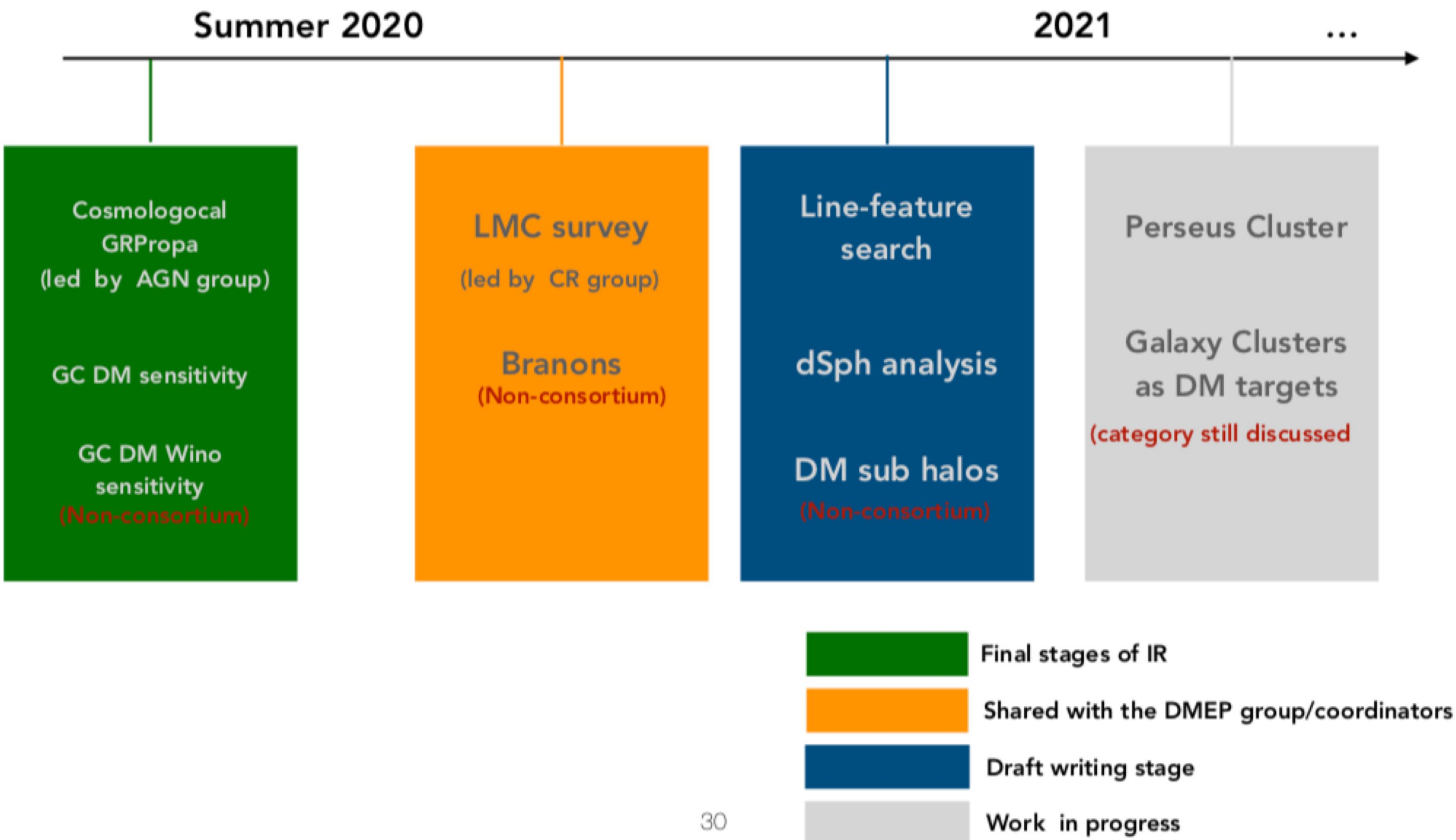
Name	Einasto	Burkert
Draco I	8.73e20	8.84e20
Sculptor	7.96e18	6.62e18
Reticulum II	3.27e19	8.99e19
Coma Berentices	5.17e19	6.64e19



Summary

- We will include the limits for extended Sources in the paper
- We are calculating upper limits for all the selected targets
- Compatibility with gammapy is under study.
- Update to the last IRFs
- Study IRF systematics.
- We are updating the final draft of the document

CTA CONTRIBUTION TO DM RESEARCH



CTA CONTRIBUTION TO DM RESEARCH (SUMMARY)

- CTA has good prospects to probe for the first time WIMP models with thermal relic cross-section and masses above 200 GeV;
- Together with Fermi CTA will be able to exclude thermal WIMPs within the mass range from a few GeV up to a few tens of TeV.
- For heavy WIMPs (>TeV) CTA will provide unique observational data to probe parameter space not reachable by the other experiments.
- CTA is complementary instrument to LHC and direct DM searches probing some non-overlapping regions of DM particle parameter space.
- If DM is detected by CTA, it will also be possible to explore some properties of DM particle through the study of annihilation channels, etc.
- Control of systematics in deep observations of GC halo and dSph(s) is critical for the success of these studies and will require full knowledge of the instrumentation (hence CTA KSP)
- Better understanding of J factors is essential for interpretation of observational data and derivation of limits.