What's new in ALPS-II.

Overview & update with respect to goals, experiment and politics

B. Döbrich for the collaboration
9th Patras workshop
Mainz, Schloss Waldthausen, June 24th 2013

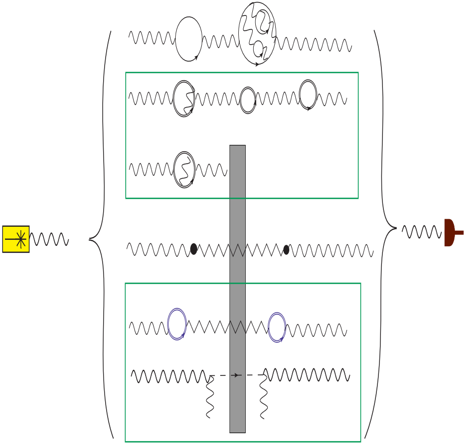
HELMHOLTZ GEMEINSCHAFT

DESY

A biased list of (astro-)particle questions

	rather massive particles?	low mass but very weakly coupled?
Fundamental (pseudo-) scalar particles?	✓	✗
Finetuning/Hierarchy?	✗	✗
What appears in UV-completions of the Standard Model?	✗	✗
Observational puzzles in astroparticle physics	?	✗
What is the nature Dark Matter/Dark Energy?	✗, ?	✗
	high energy →	Weakly Interacting Slim Particles
	Accelerators, Direct Dark Matter WIMP detection	High intensity → laser photons
		Light-shining-through-a-wall

The Light-shining-through-a-wall principle

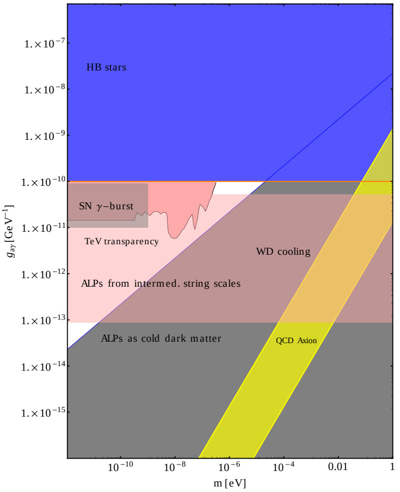


- shine laser onto opaque barrier [theory: Sikivie '83, v. Bibber '87]

  [cf. also talk by M. Sulc]

- wall blocks essentially all SM processes, but WISPs traverse wall (weak coupling), reconvert to γ
- particle content: hidden photons $\mathcal{L}_{\rm int} \sim \frac{1}{2}\chi F_{\mu\nu}X^{\mu\nu}$, axion-like particles (pseudoscalar pseudo-GSBs) $\mathcal{L}_{\rm int} \sim \, g\,\phi\,F_{\mu\nu}\tilde{F}^{\mu\nu}$, minicharged particles $\mathcal{L}_{ferm} \sim e\bar{\psi}\not{A}\psi + e_{\rm h}\bar{h}\not{X}h$

Axion-like-particle-reach with ALPS-II



- QCD Axion is a hard nut to crack
- (m, g)-plane: axion-*like* particles
  - astrophysics indic.: TeV γs [1302.1208], cf. also talks on friday + White Dwarf cooling hint [1204.3565]
  - moduli stab. in intermediate string scale scenarios [1209.2299]
  - Dark Matter candidate [1201.5902]

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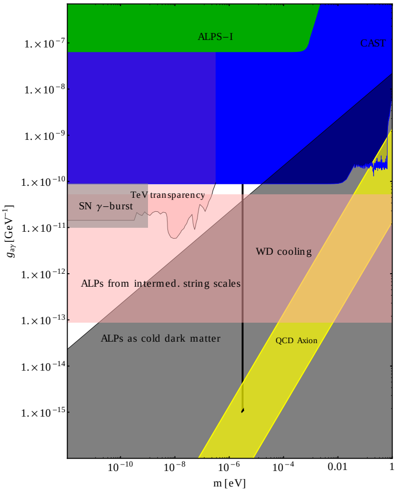

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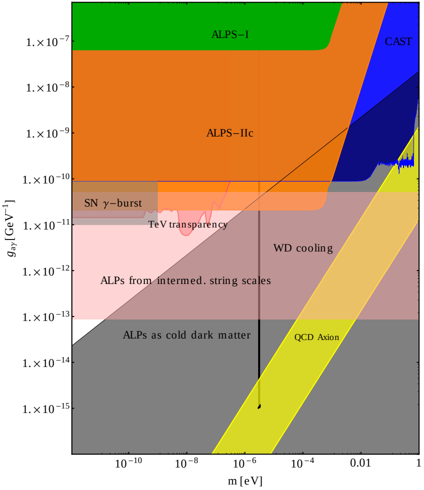

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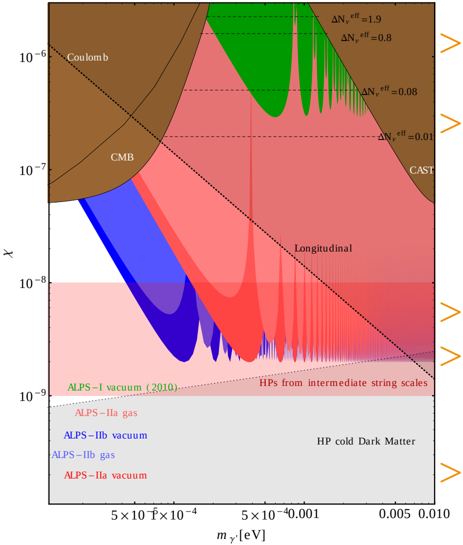
- ALPS-IIc should compete with CAST, cover hints as much as possible

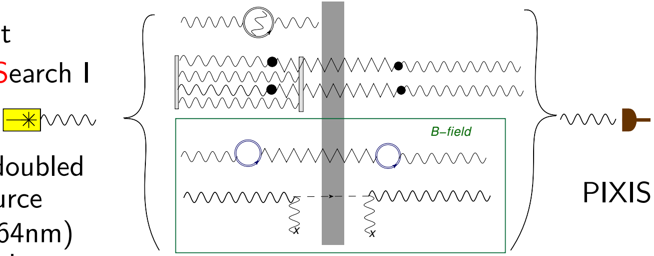
Case for hidden photons and others



- experimentally no need for B-fields, oscillation process
- HPs e.g. from intermediate string scale scenarios [arXiv:1206.0819], Dark Matter candidate & ~~possibly Dark Radiation [0804.4157]~~, but! new solar constr' [1302.3884 → Pradler and 1305.2920]
- ALPS-I, ALPS-IIa, ALPS-IIb
- if B-field applied, also sensitive to minicharged particles (fractionally charged hidden matter)
- also sensitive to scalar fields of massive gravity theories [1206.1809]

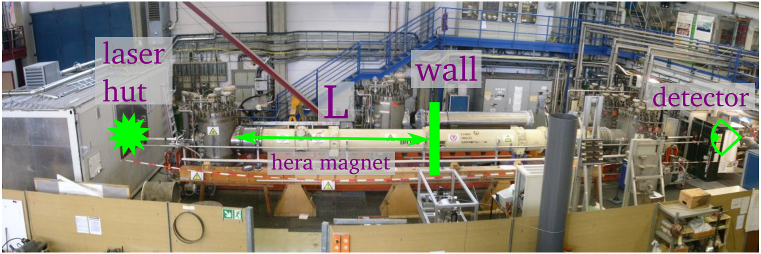
ALPS-I (2010) and upgrades towards ALPS-II

Any Light
Particle Search I



frequency doubled infrared source ('35W', 1064nm) +Resonator!

PIXIS CCD



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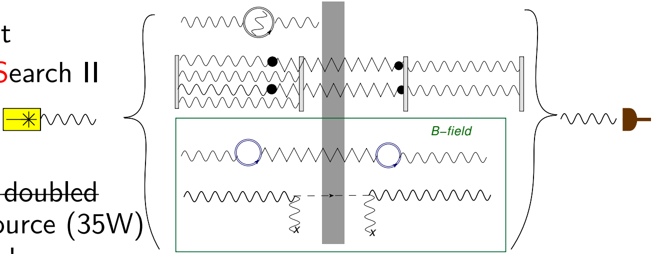
Particle Search II



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Possible upgrades

- (Even) More photons → enhanced probability
- better single photon detection

Technical realization

- *coupled* cavities on both sides of the wall
- Transition edge sensor (CCD low Q.E. for inrared)

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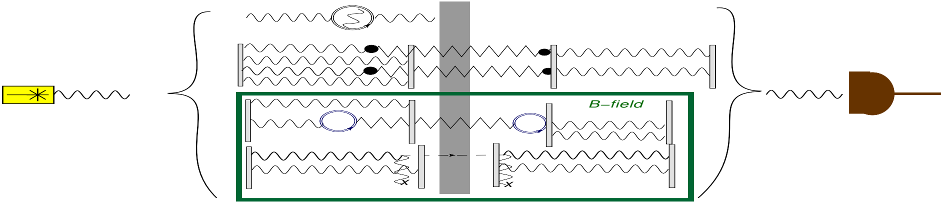

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- More (magnetic) length

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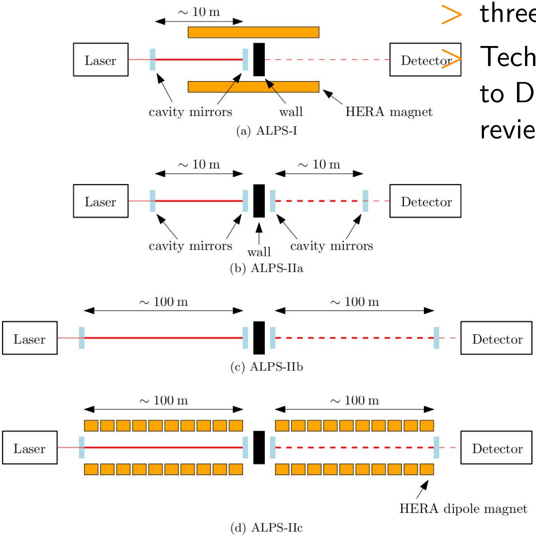
- Transition edge sensor (CCD low Q.E. for inrared)
- more HERA dipoles! enhance length → tunnel

Status & Organizational matters



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- Technical design report submitted to DESY PRC in August 2012, review in November 2012

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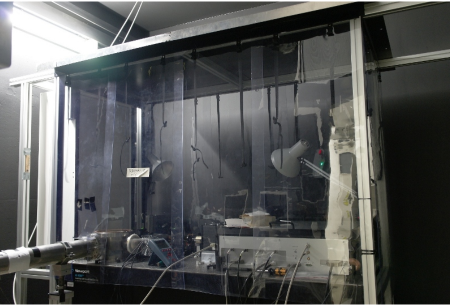

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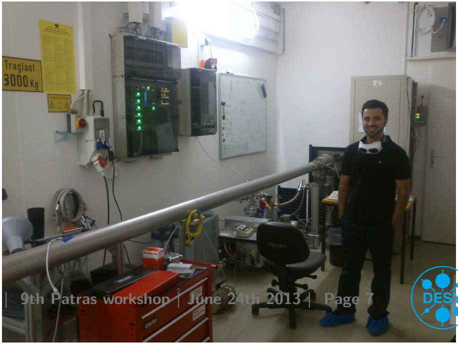

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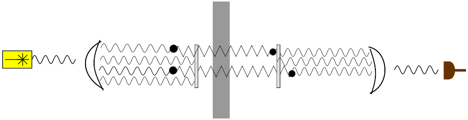
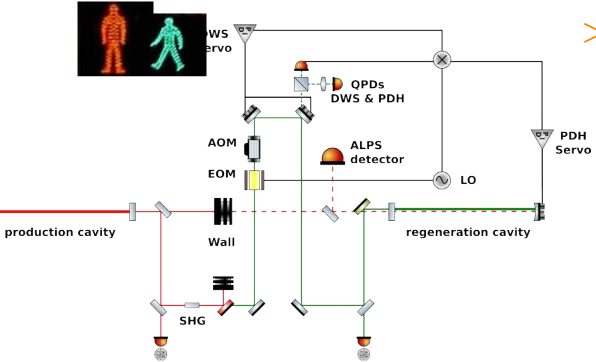
- People and collaborators
  - 3 institutions (DESY, UHH, AEI)
  - 4 (part-time) scientists, 3 retired, 2 postdocs, 4 PhD students
  - tentative expansion!
- $\lesssim$ 2M running and invest for 5 yr thereof $\approx$ 1M already spent

Albert-Einstein-Institut Hannover

Resonant regeneration





- "photon selfinterference"

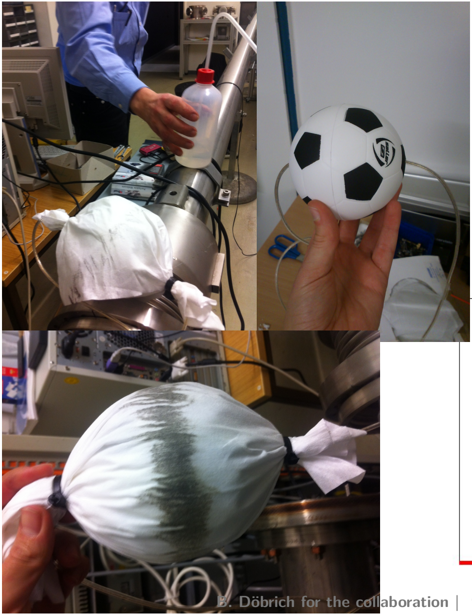
  experiment w. microwave:

  arXiv:1101.4089, theory:

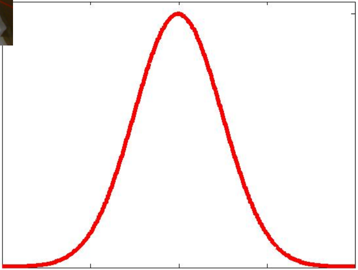
  Hoogeveen/Ziegenhagen

- momentum conservation → frequency-lock the two cavities with different colors (infrared, green) → talk by R. Bähre on wednesday

Aperture constraints



- $PB_{PC} = 5000,$
  $PB_{RC} = 40000$
- pipe aperture limits PB due to clipping
- **large** aperture for ALPS-IIa and b (HERA straight)



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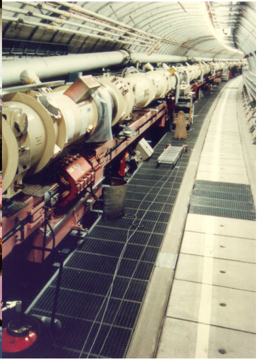

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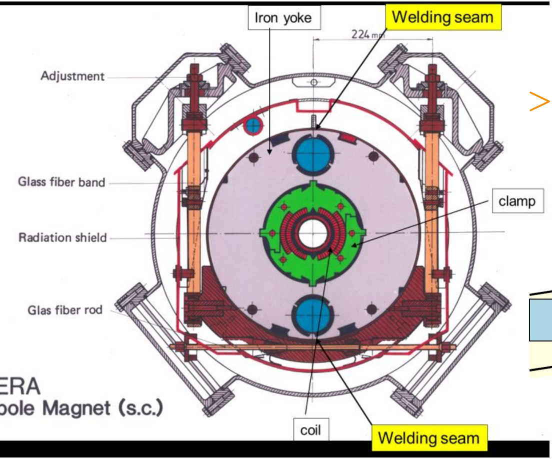
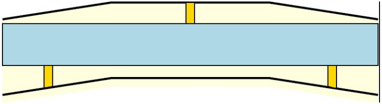
- reestablish “true aperture”?

Magnet straightening in a (very small) nutshell



- howto
  - force on cold mass
  - pressure prop at middle and ends



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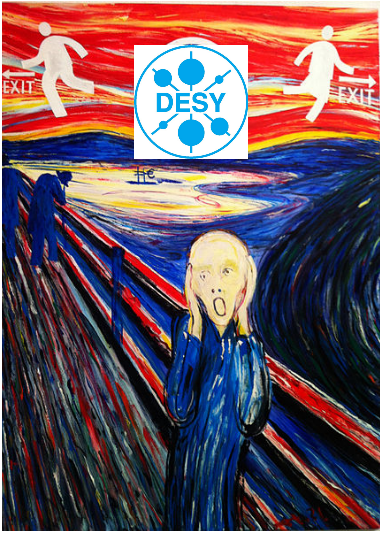

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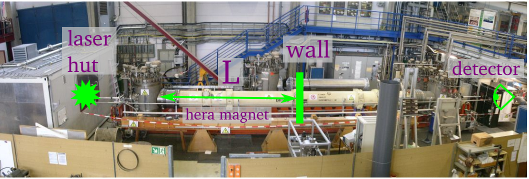

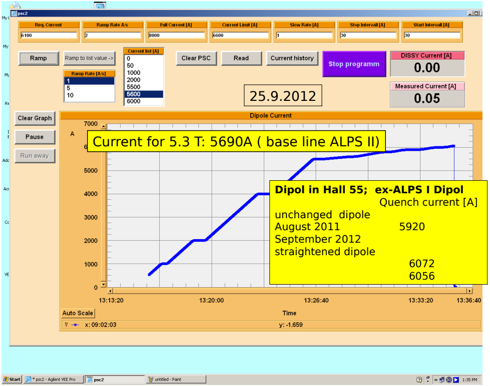

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  > first tests with “PR” magnet (non-functional)
  > real-life tests with ALPS-I magnet

DESY

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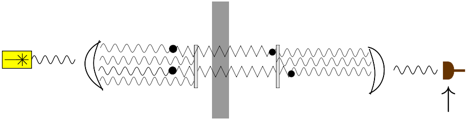
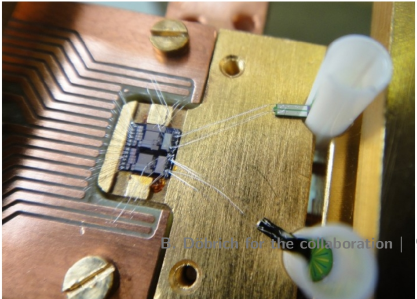
- good to know
  - first tests with “PR” magnet (non-functional)
  - real-life tests with ALPS-I magnet
  - ultimate setup: 24 spare magnets (unused)
  - even reversible

Detector requirements and TES option





- Experimental needs
  - low rates of single infrared photons (<1/h)
  - high quantum efficiency
  - low background
- CCD still available but low Q.E., other single photon options → talk by J.-E. v. Seggern wednesday
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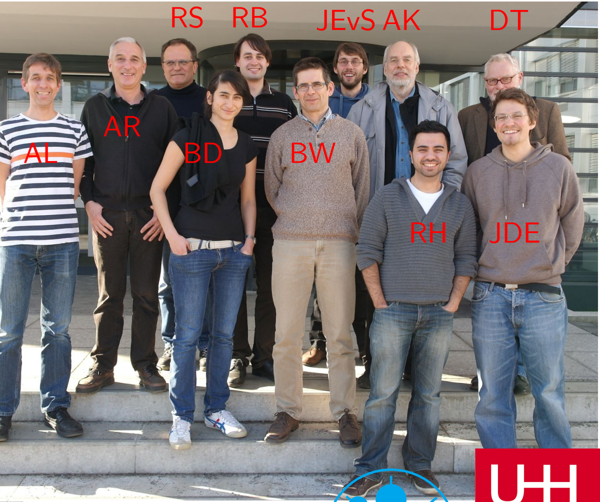
- withstands even theorists' karma

More here: arXiv:1302.5647, or ask people below



- *Optics:* Benno Willke (staff AEI) Robin Bähre (PhD, AEI), Reza Hodajerdi (PhD, DESY), Samvel Ghazaryan (staff)
- *Magnet/Site:* Dieter Trines + team
- *Detector:* Dieter Horns (staff HH), Friederike Januschek (Postdoc), Jan Dreyling-Eschweiler, Jan-Eike von Seggern (PhD)
- *Safety/Eng.:* Richard Stromhagen
- *Howto:* Ernst-Axel Knabbe (staff)
- *Science case & miscellanea:* Axel Lindner, Andreas Ringwald (staff), Babette Döbrich (Postdoc)

Albert-Einstein-Institut Hannover

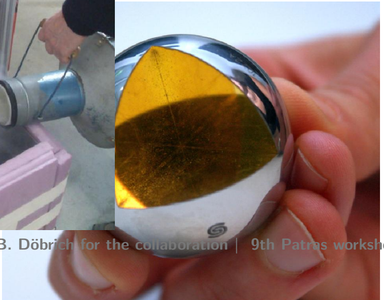
DESY

UHH

More?

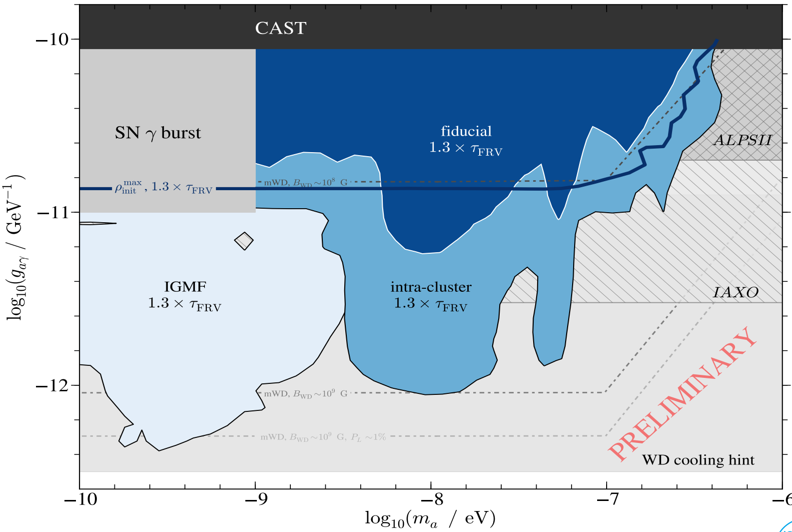
Bonus material

How straight are the magnets?



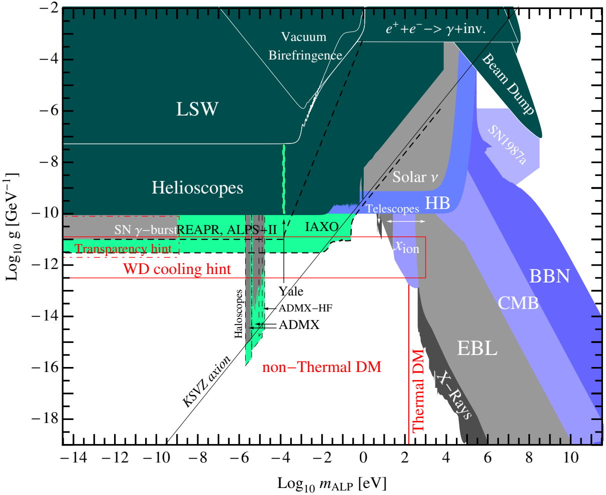
> achieved ∼50mm, Measurement at cold forseen, but details to be worked out

TeV transparency recent data [arXiv:1302.1208]



Comprehensive ALP exclusion plot

whole story see e.g. [arXiv:1205.2671]

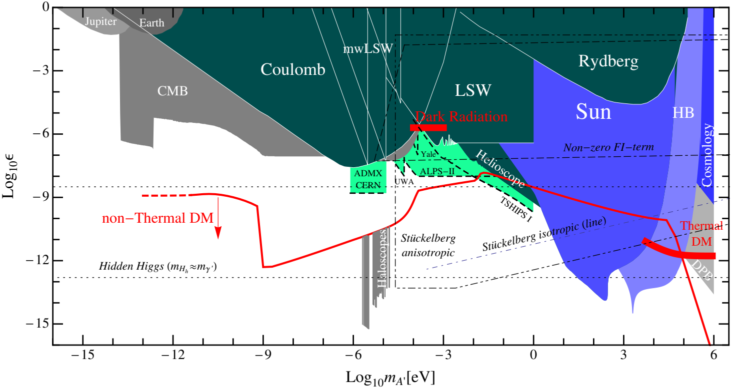


colored regions:

- Dark green = experiments
- blue: astrophysical/cosmological
- gray: astronomical
- light green: planned exp.
- red: favored parameter regions

Comprehensive HP exclusion plot

whole story see e.g. [arXiv:1205.2671]



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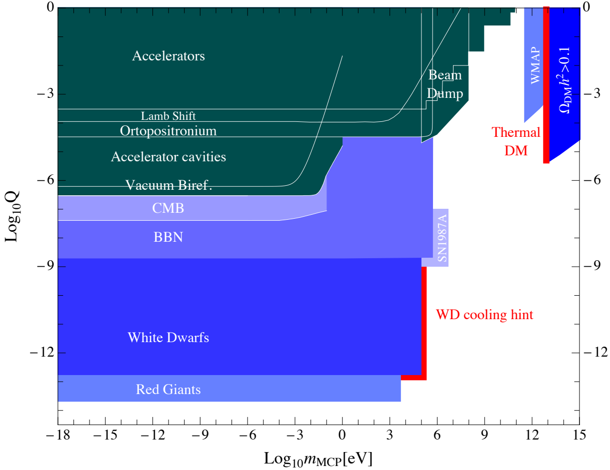

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