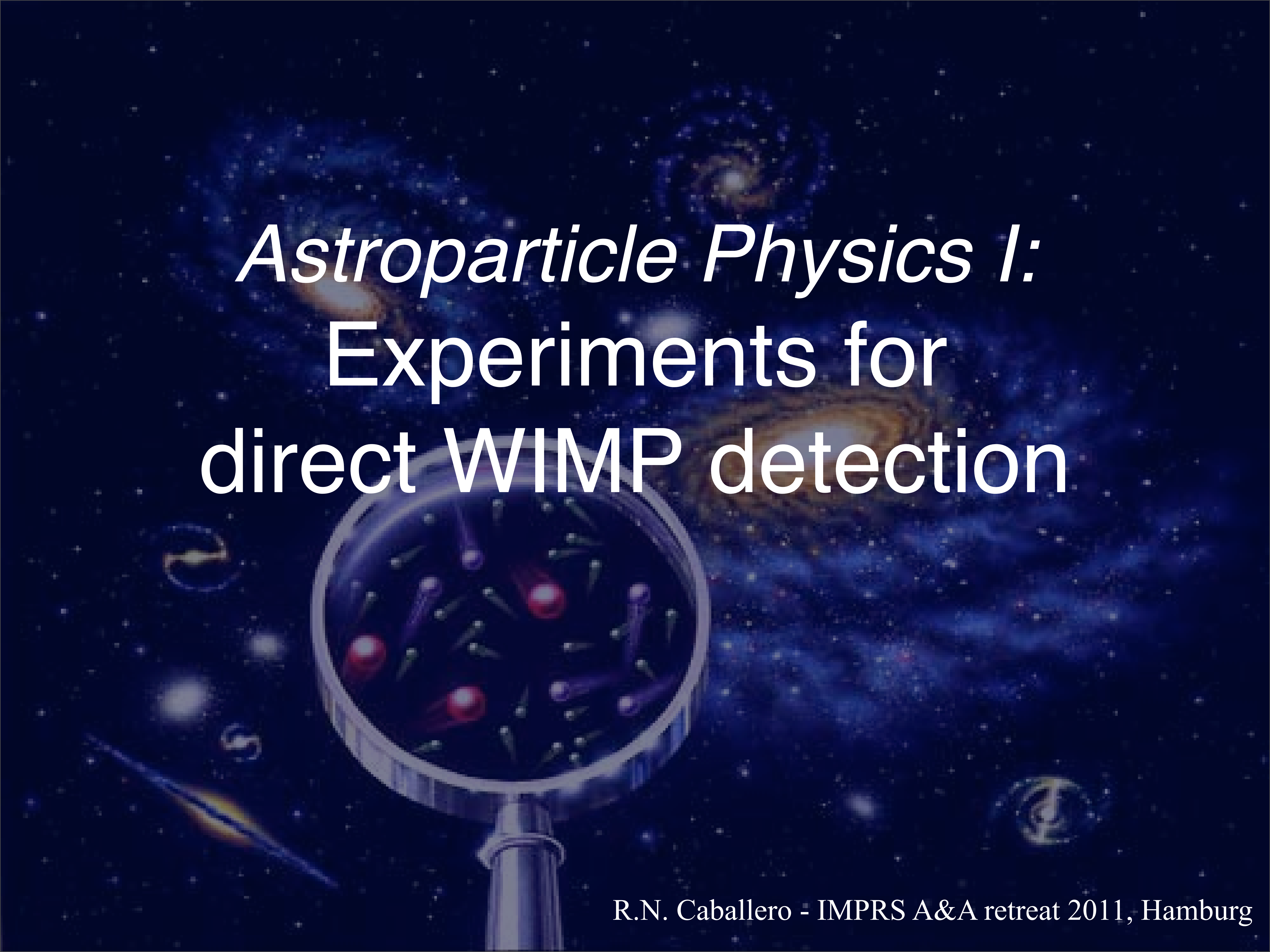
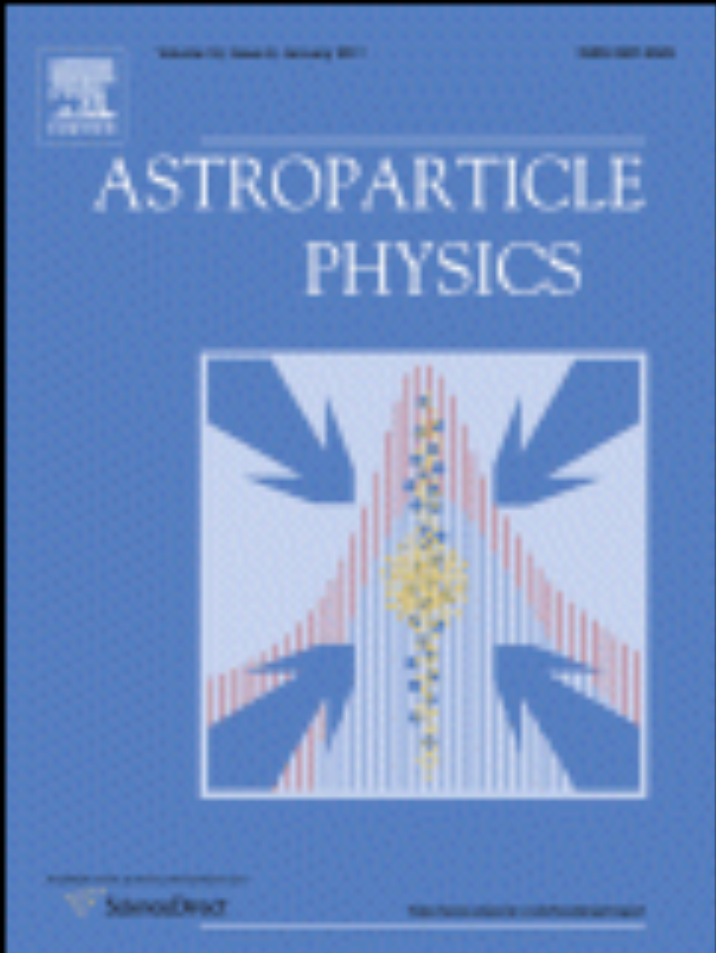
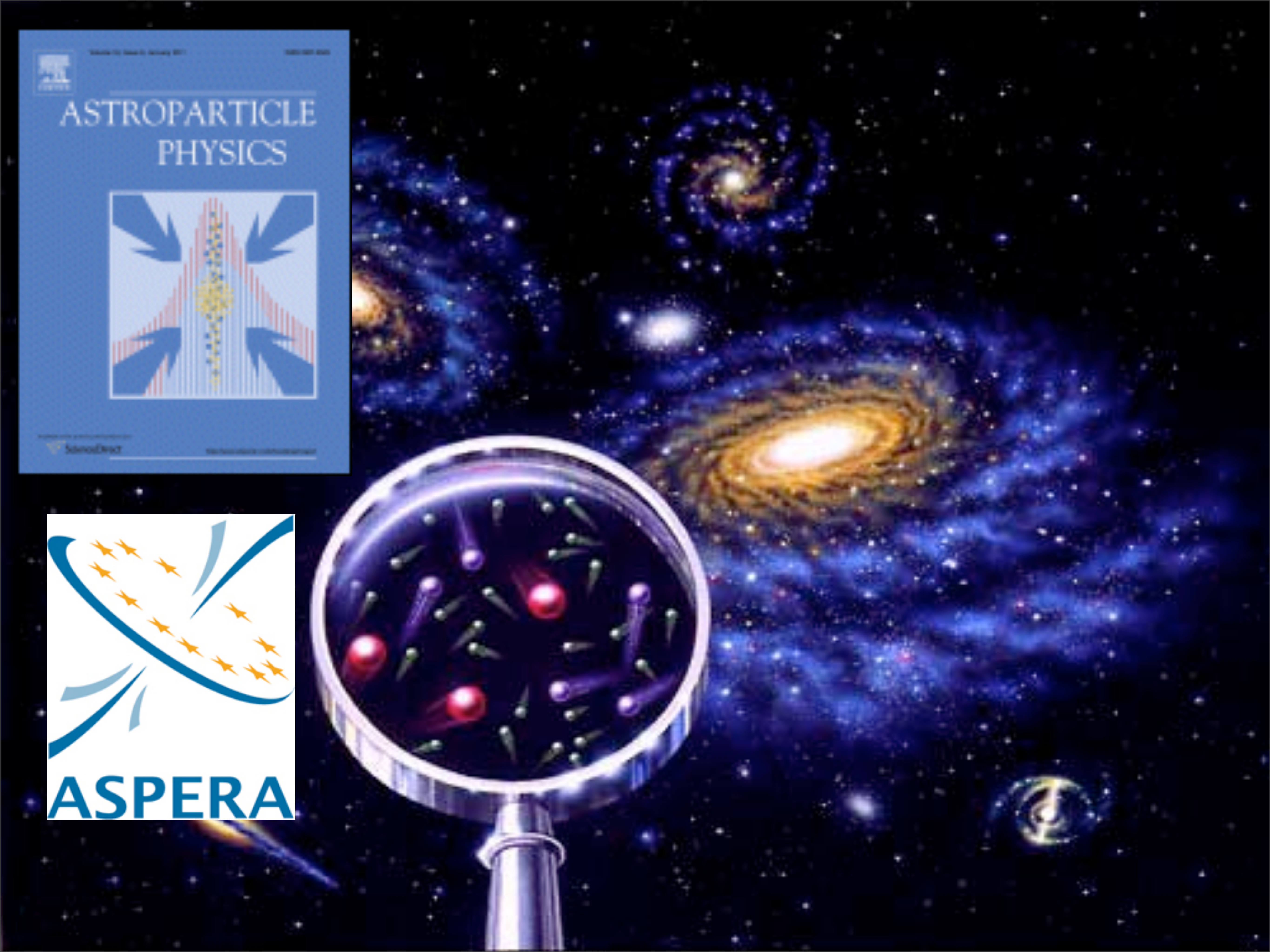


Astroparticle Physics I: Experiments for direct WIMP detection

R.N. Caballero - IMPRS A&A retreat 2011, Hamburg


ASTROPARTICLE
PHYSICS



ASTROPARTICLE
PHYSICS
ASPERA

- Part I (Nicolas) : Experiments for direct detection of WIMPs

- Part II (Jana): Cosmic Rays Observations

- Part III (Cherry):
- Astroparticle physics and pulsars

Weakly Interacting Massive Particles (WIMPs)

- Interaction through weak force
- Mass: 1 Kev$\leq$ M $\leq$ 300 TeV (~100 GeV)

(M_{H_2}=1GeV, M_U~240 GeV)

- Velocity (Galactic WIMPs): ~300 km s^{-1}

Weakly Interacting Massive Particles (WIMPs)

•Principle: WIMP/detector particle elastic collision

Energy transfer to medium

•Important: cross-sections, expected event rates

•Tests with neutron collisions

Cryogenic Dark Matter Search (CDMS)

• Direct Detection: WIMP interaction with fermions in detector

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• Cross-section (elastic scattering with fermions, today)

10^{-38} cm^2

• Event Rate ~ 0.1 kg^{-1} day^{-1}

• ⇒ Needs :

Large detector mass,

Extremely low rate of background noise (low T)

Cryogenic Dark Matter Search (CDMS)

The CDMS experiments:

Detector: Cryogenic Ge/Si crystals

Cryogen: $^{3}He/^{4}He$ Dilution Refrigerator (5-10 mK)

Physical Quantity Measured : Energy deposited in crystal by interaction

Means of Measurement: Change in conductivity of

Matter Search
MS)

periments:

tals

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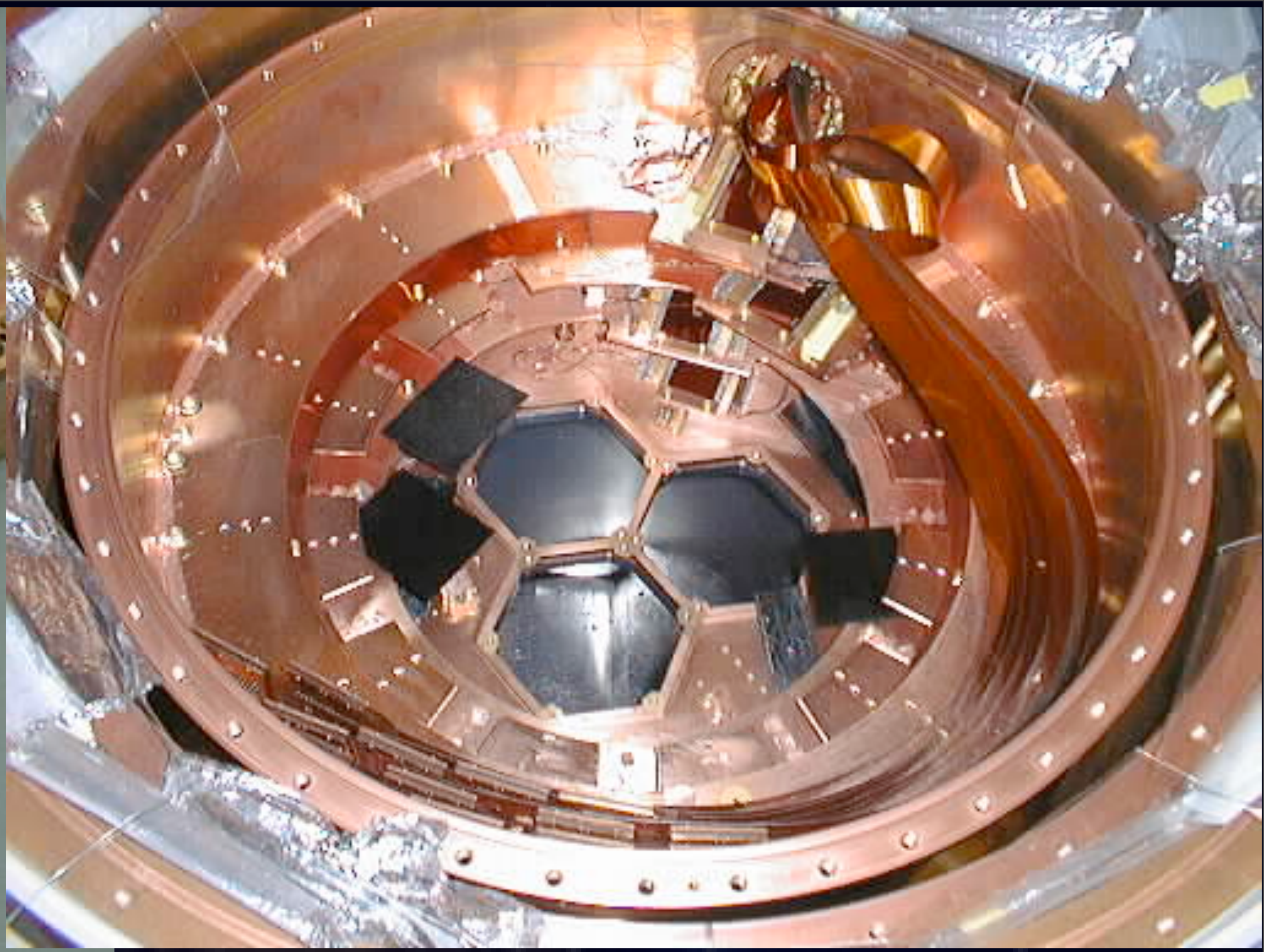

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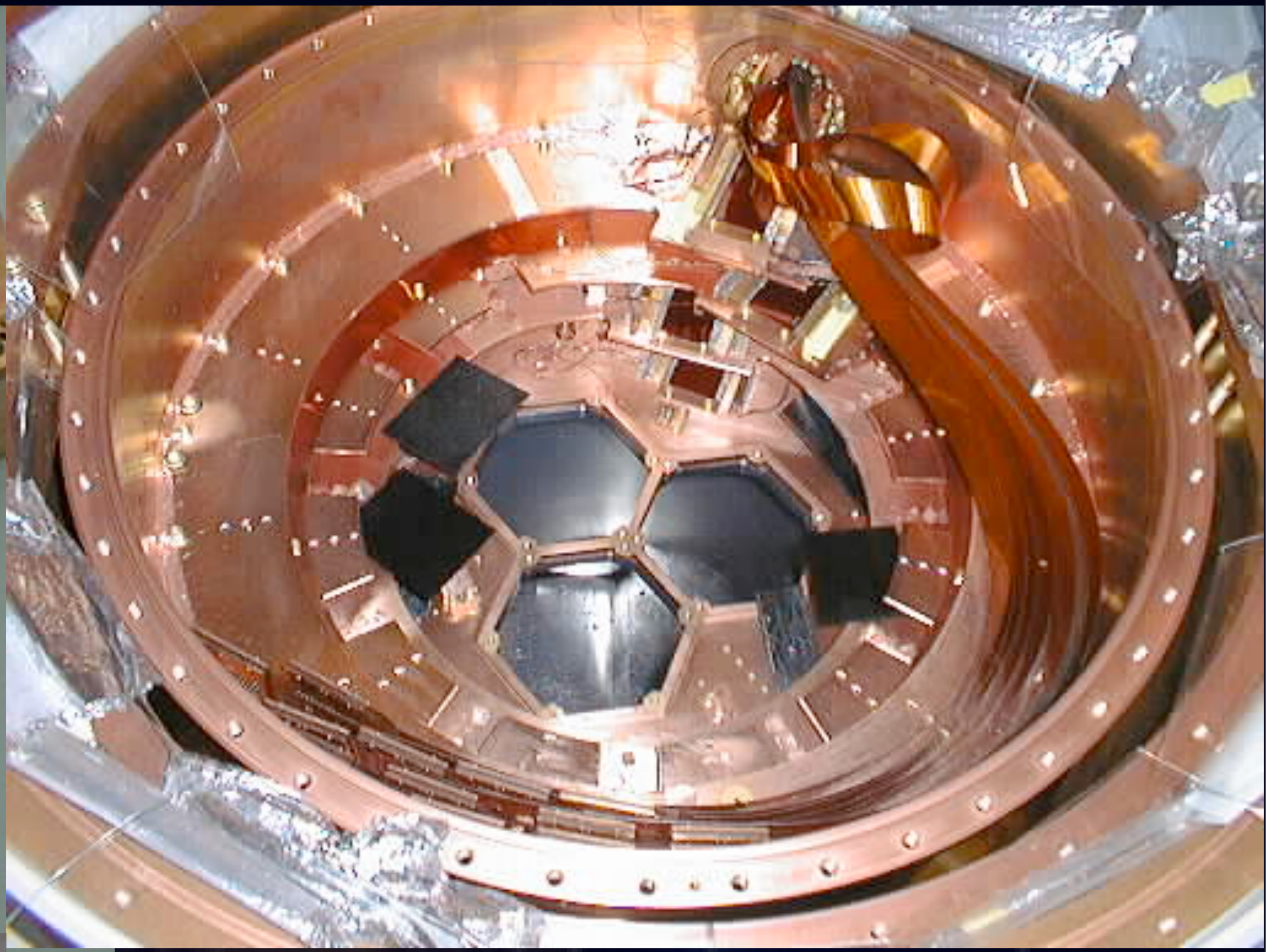
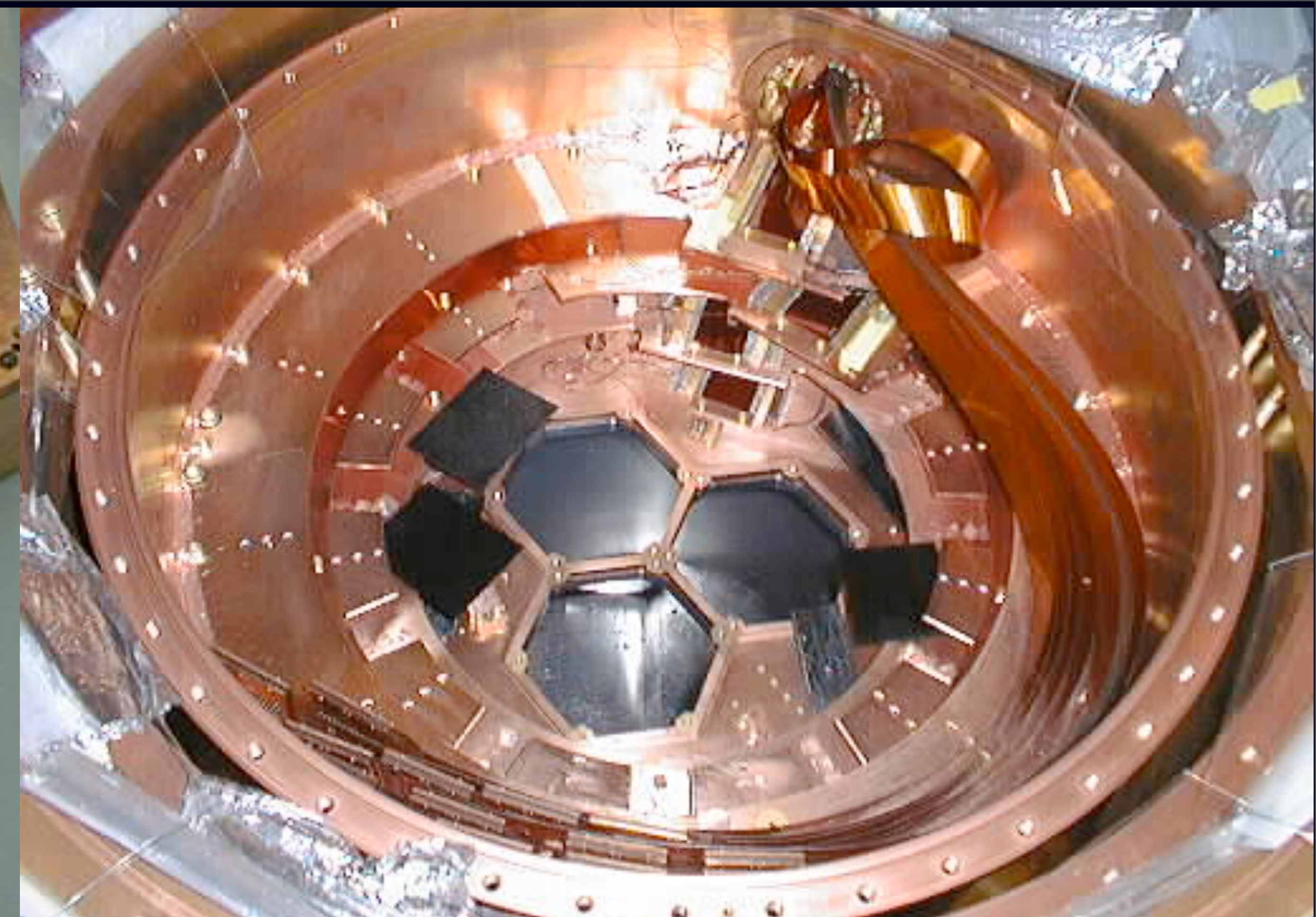


Refrigerator (5-10 mK)

: Energy deposited in

ange in conductivity of

Cryogenic Dark Matter Search (CDMS)

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(1) WIMP collides with detector nucleus

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(2) Vibration: Phonons propagation through crystal

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(3) Some phonos reach the detector surface

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(4) Phonos absorbed by Al collector fins

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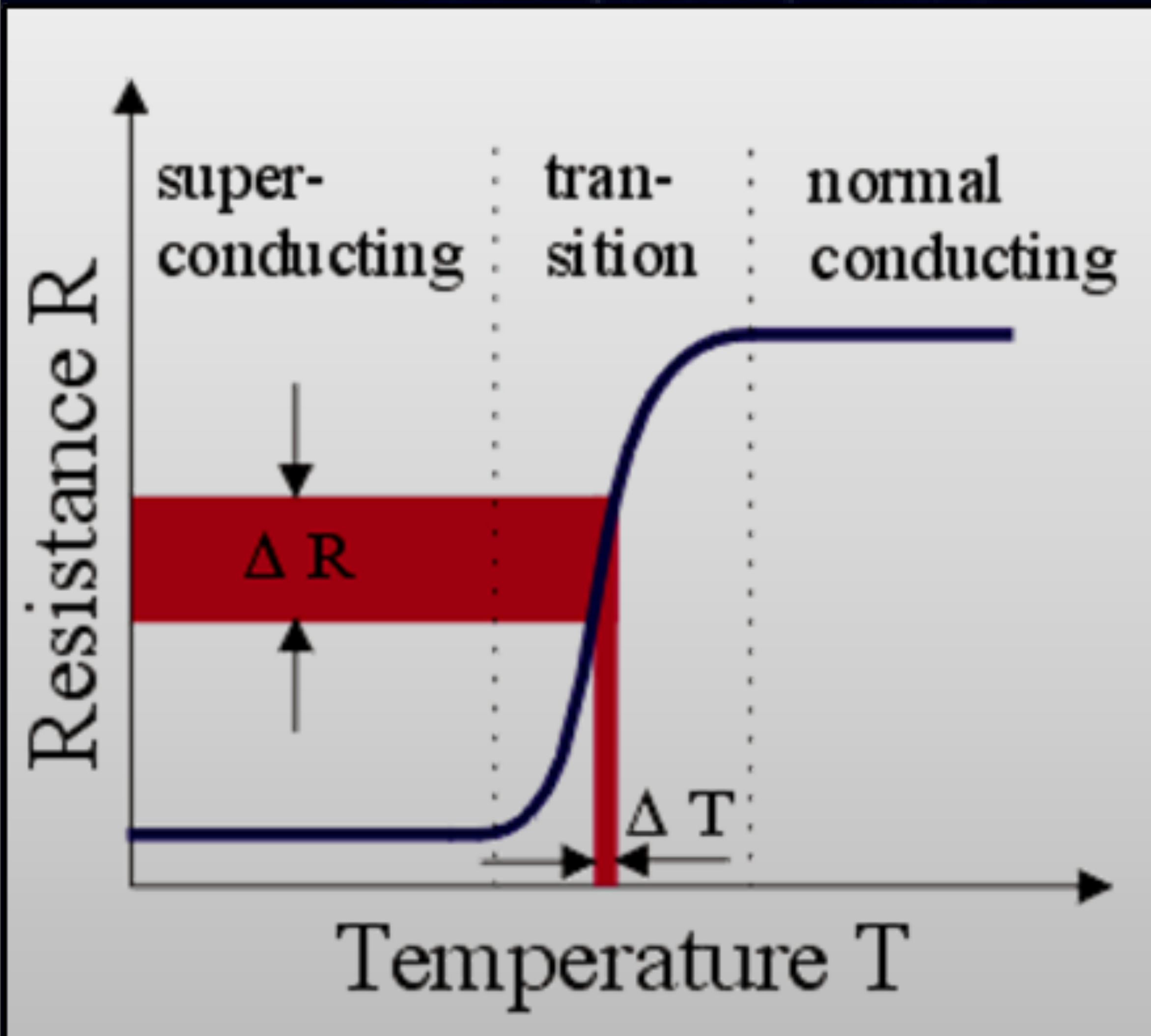

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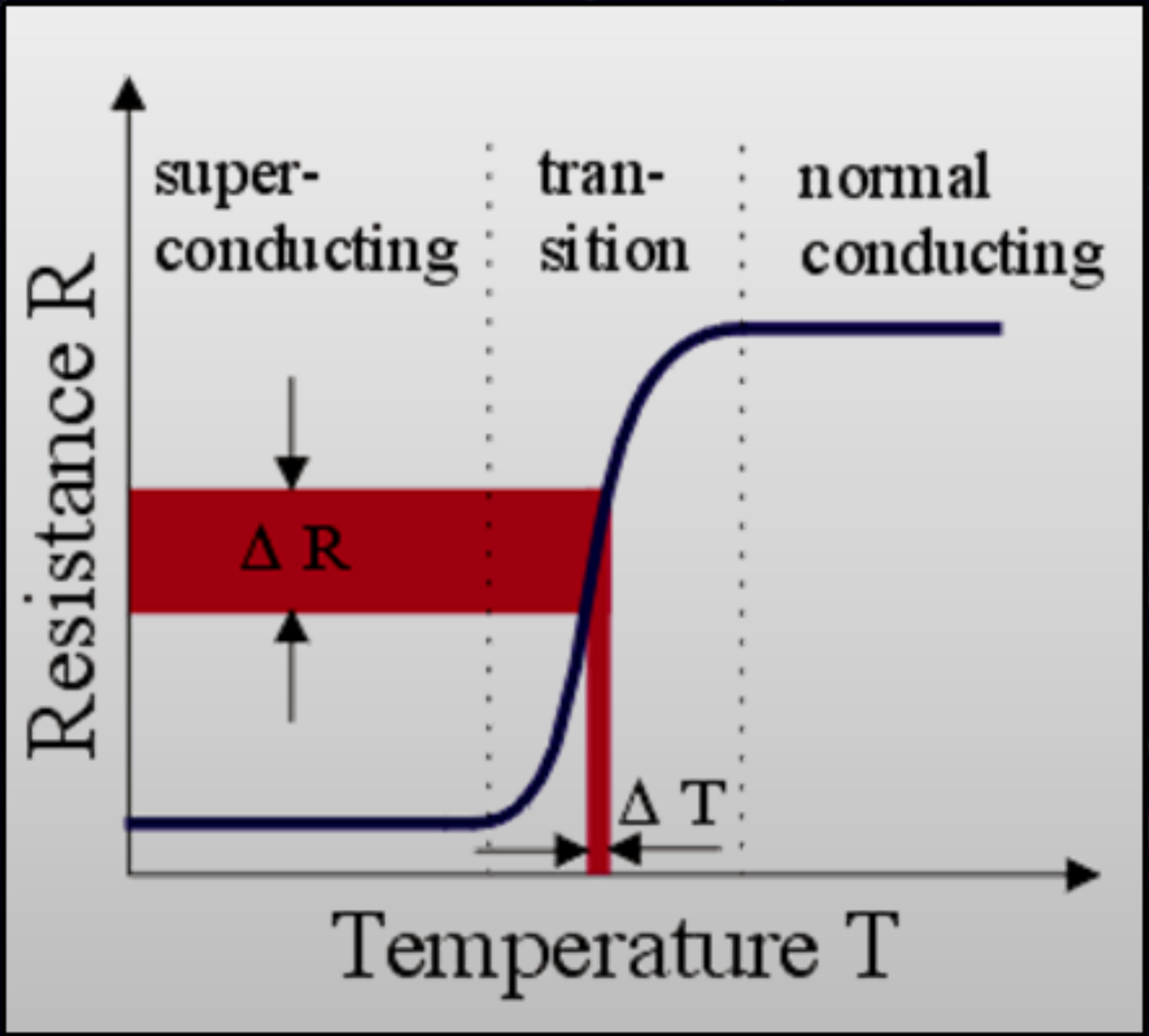

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(6) e^- migrate to W strip
(7) Excess current pushes W from superconductor state back to conductor ⇒ dramatic change in the W electrical resistance

Directional Recoil Identification from Tracks (DRIFT)

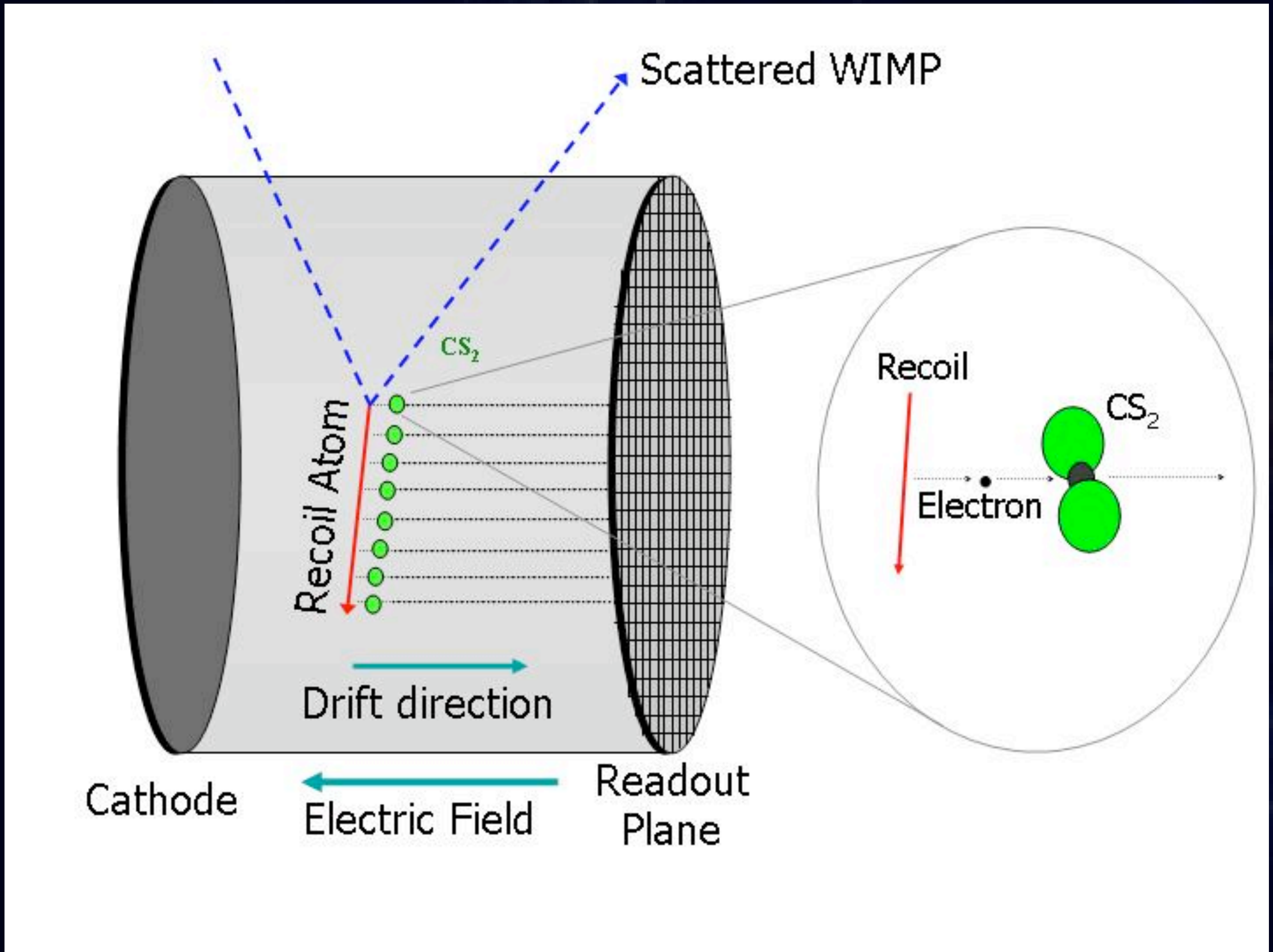
- Direct Detection: WIMP interaction with low pressure gas molecules in detector (e.g. CF_4 /CS_2 mixture)

Needs :

Large detector mass,

Extremely low rate of background noise (low T)

Directional Recoil Identification from Tracks (DRIFT)



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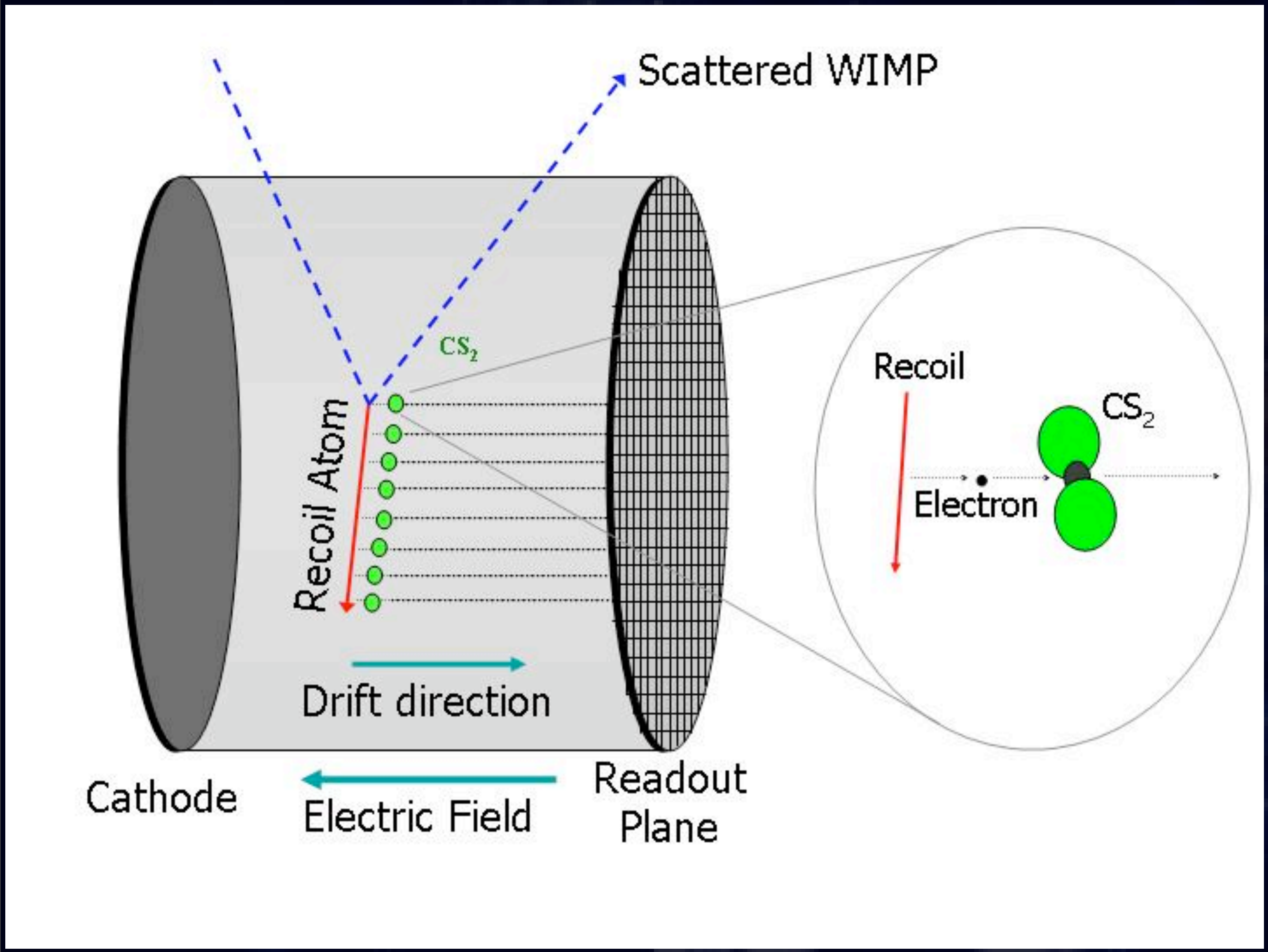

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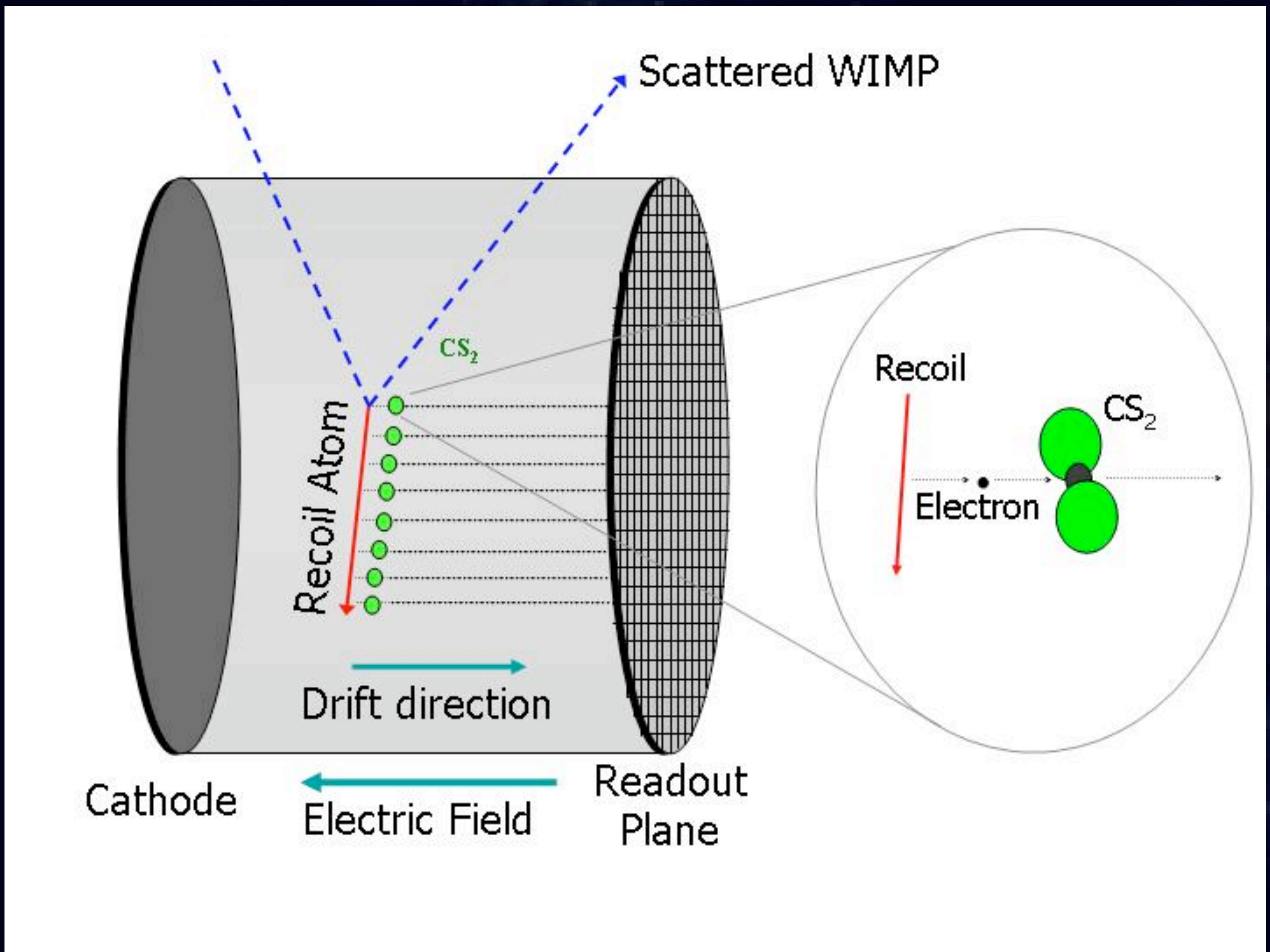

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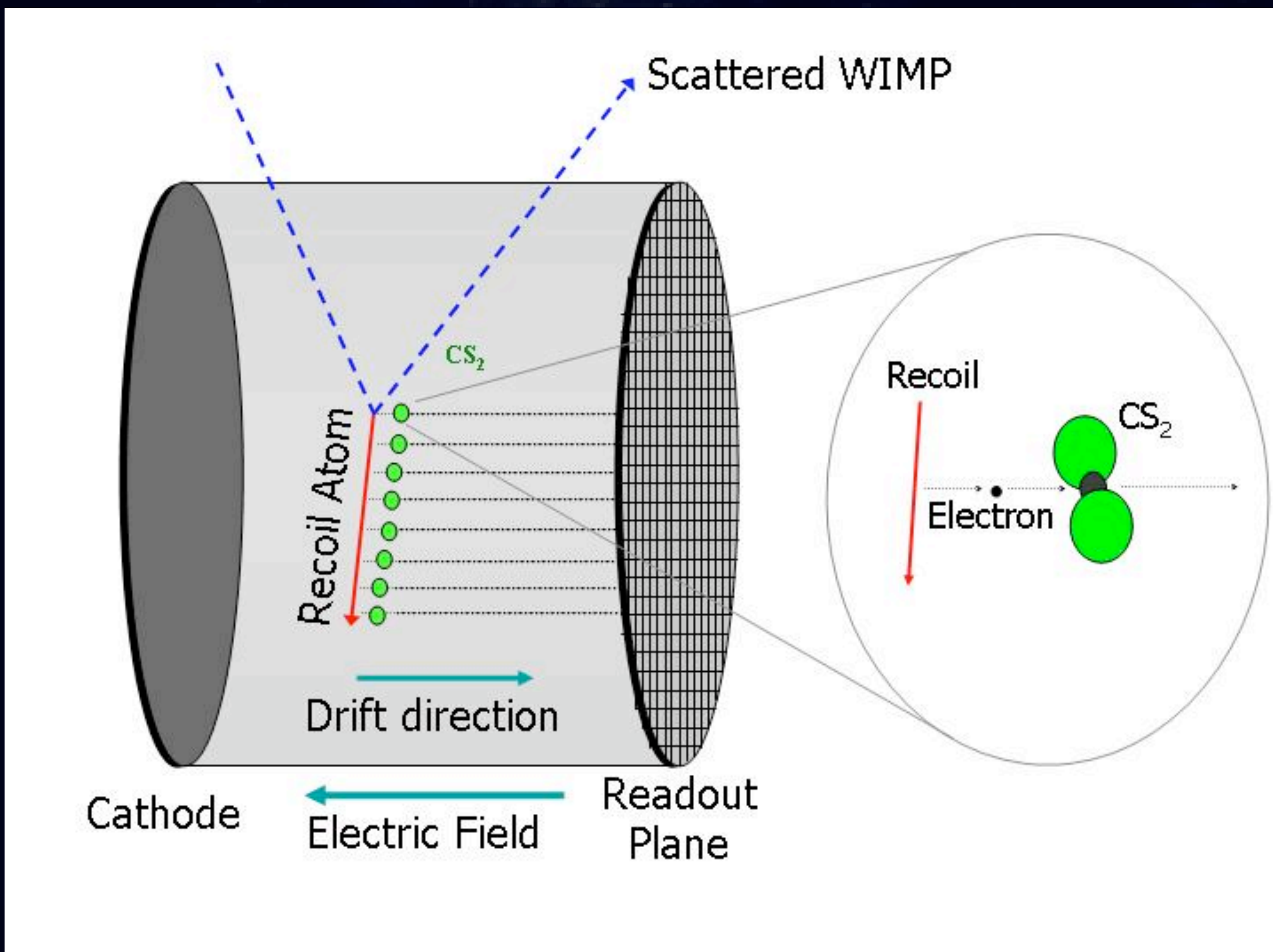

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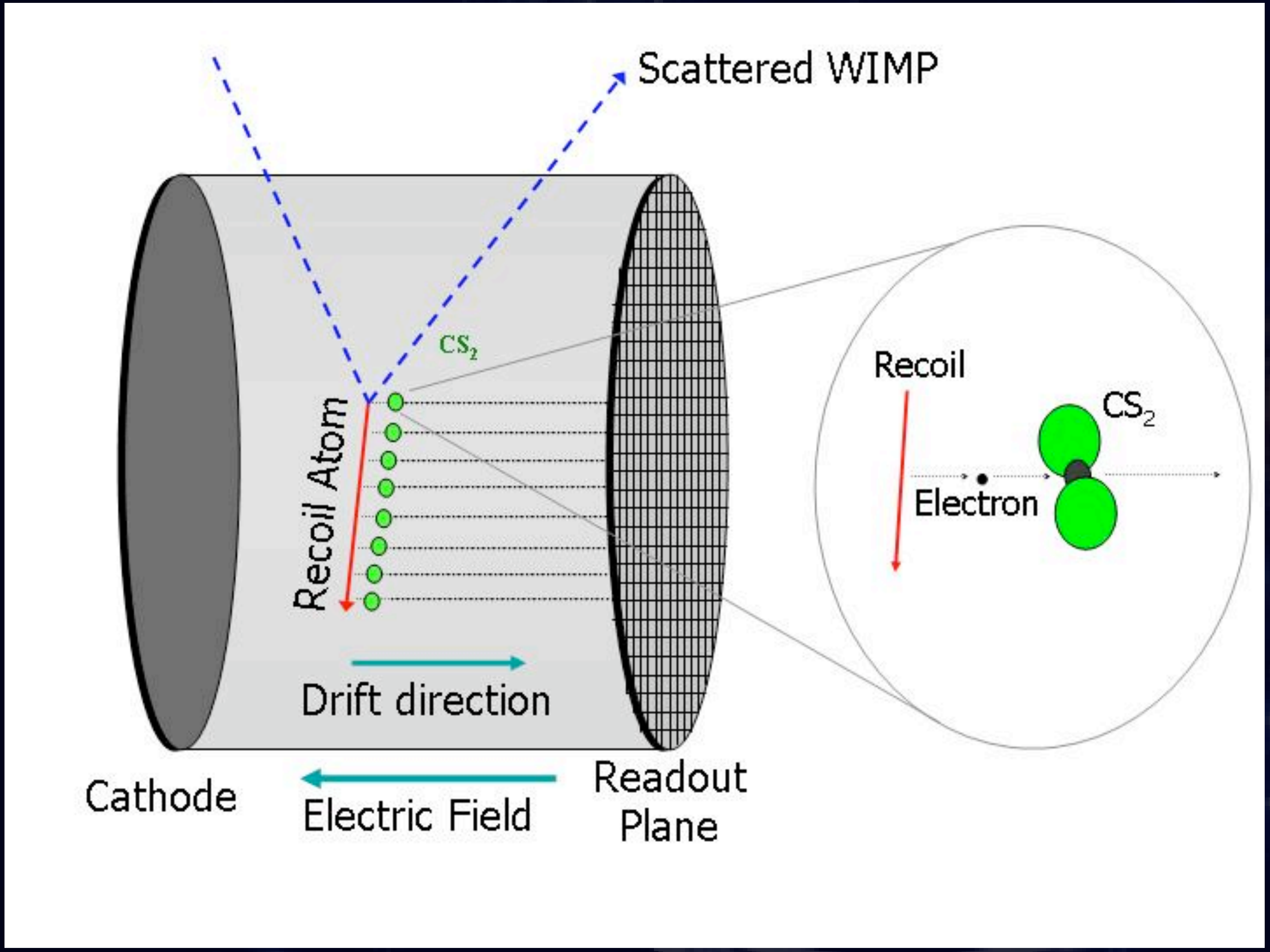

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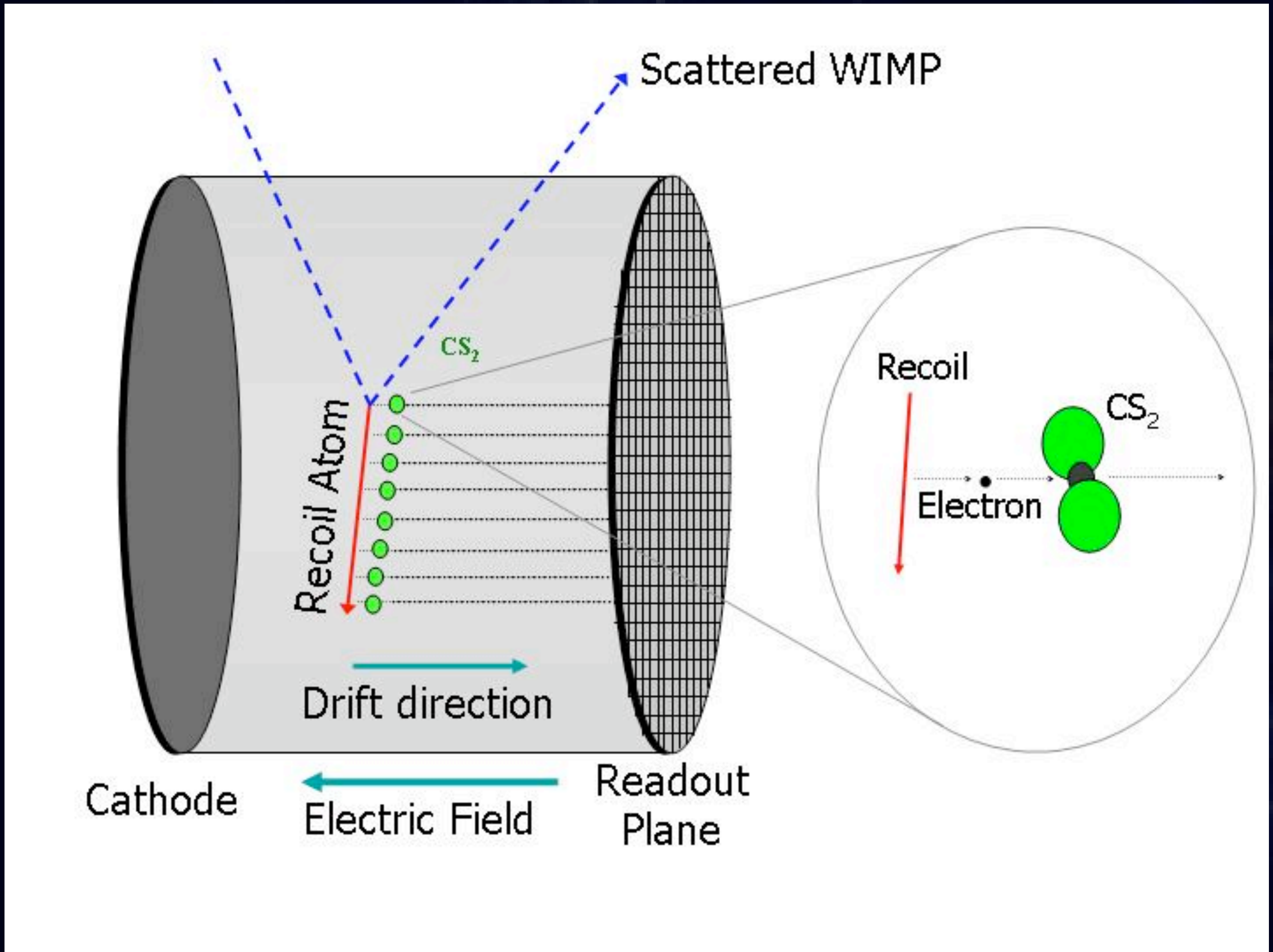

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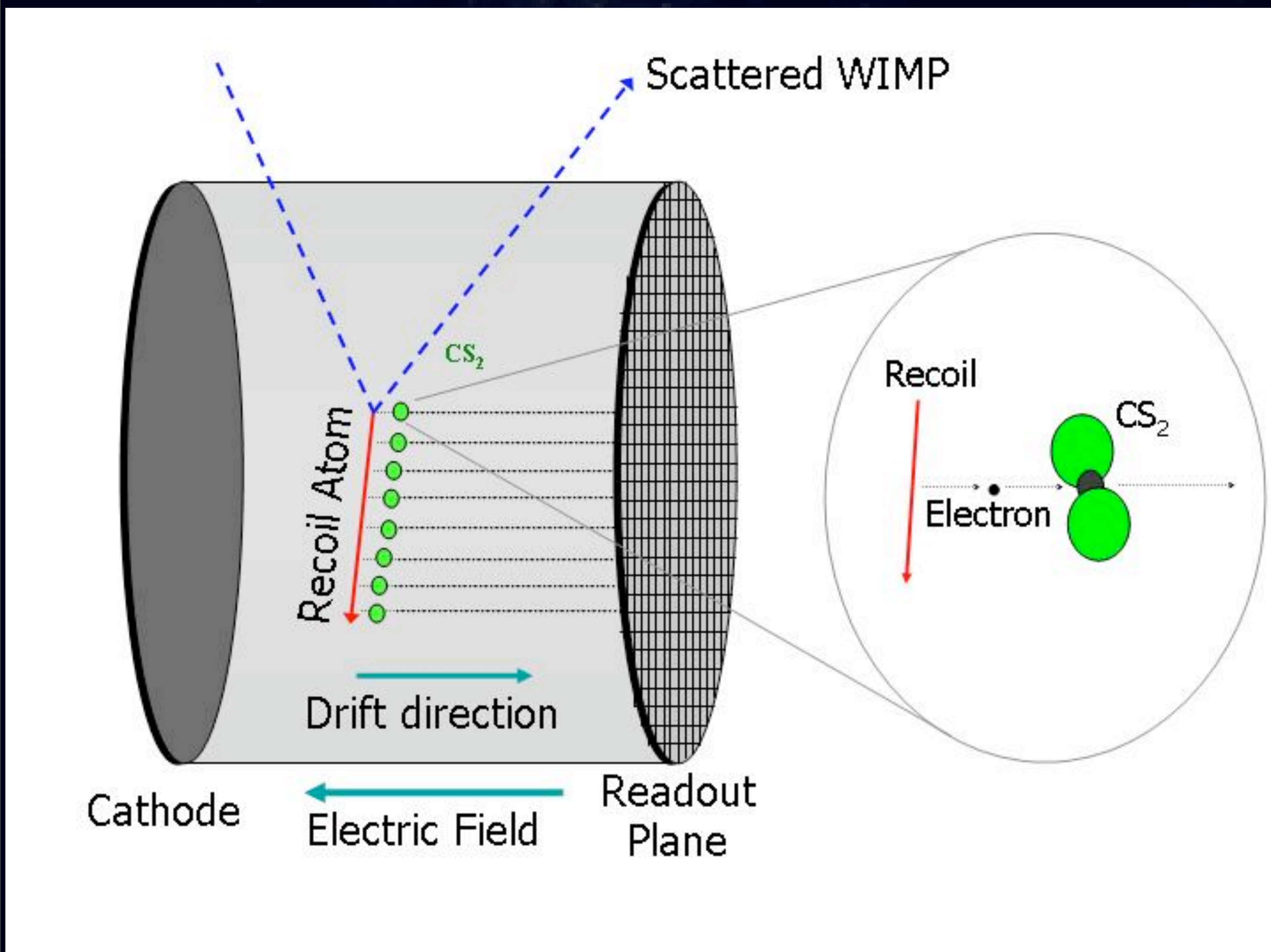

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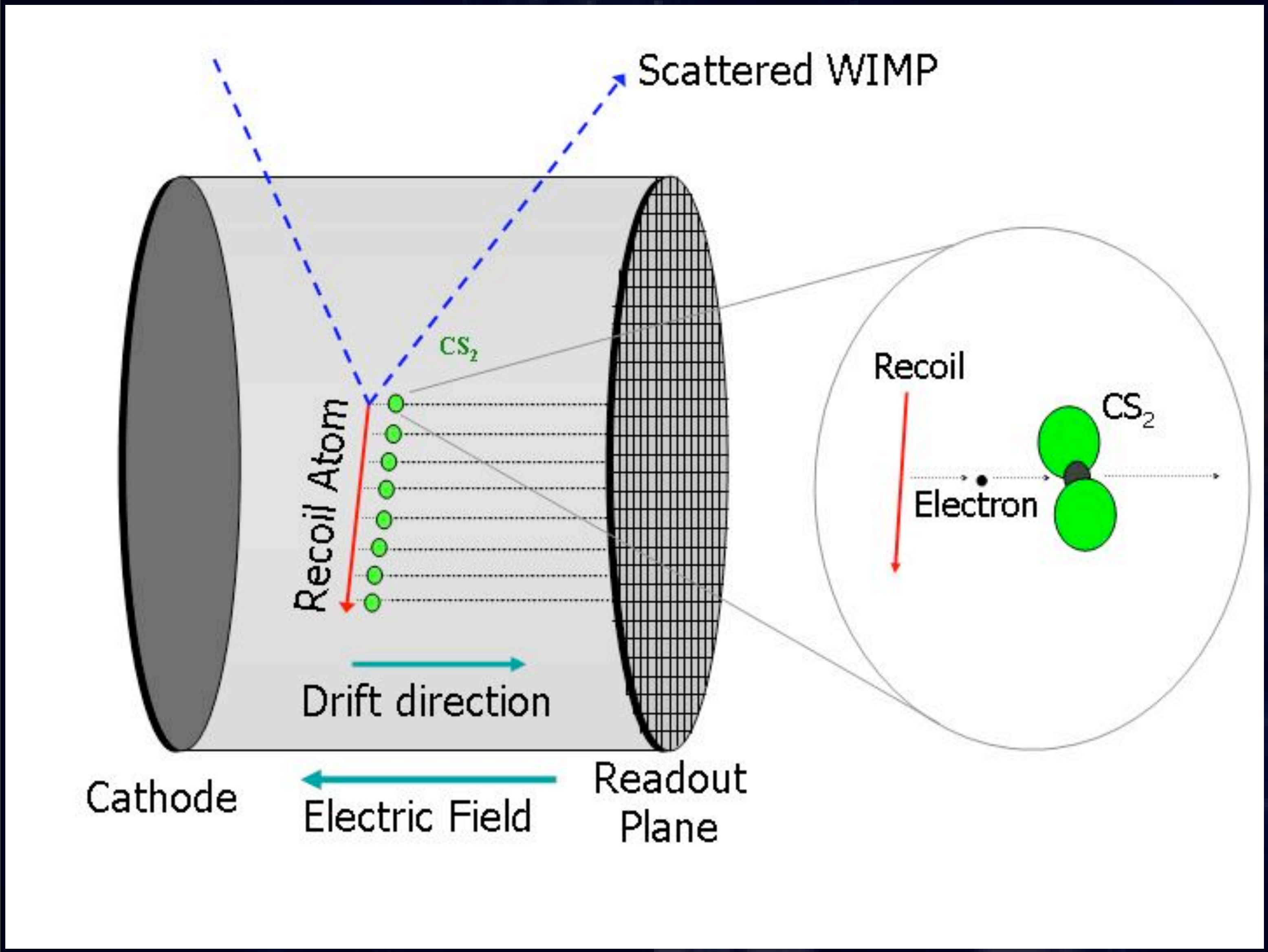

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(5) Applied E field makes CS_2^- ions drift to the readout plane
(6) Large mass of ion (vs e^- mass) ⇒ the original track structure maintained
(7) High directional sensitivity

WIMP Argon Programme (WARP)

Dark matter detection through scintillation:

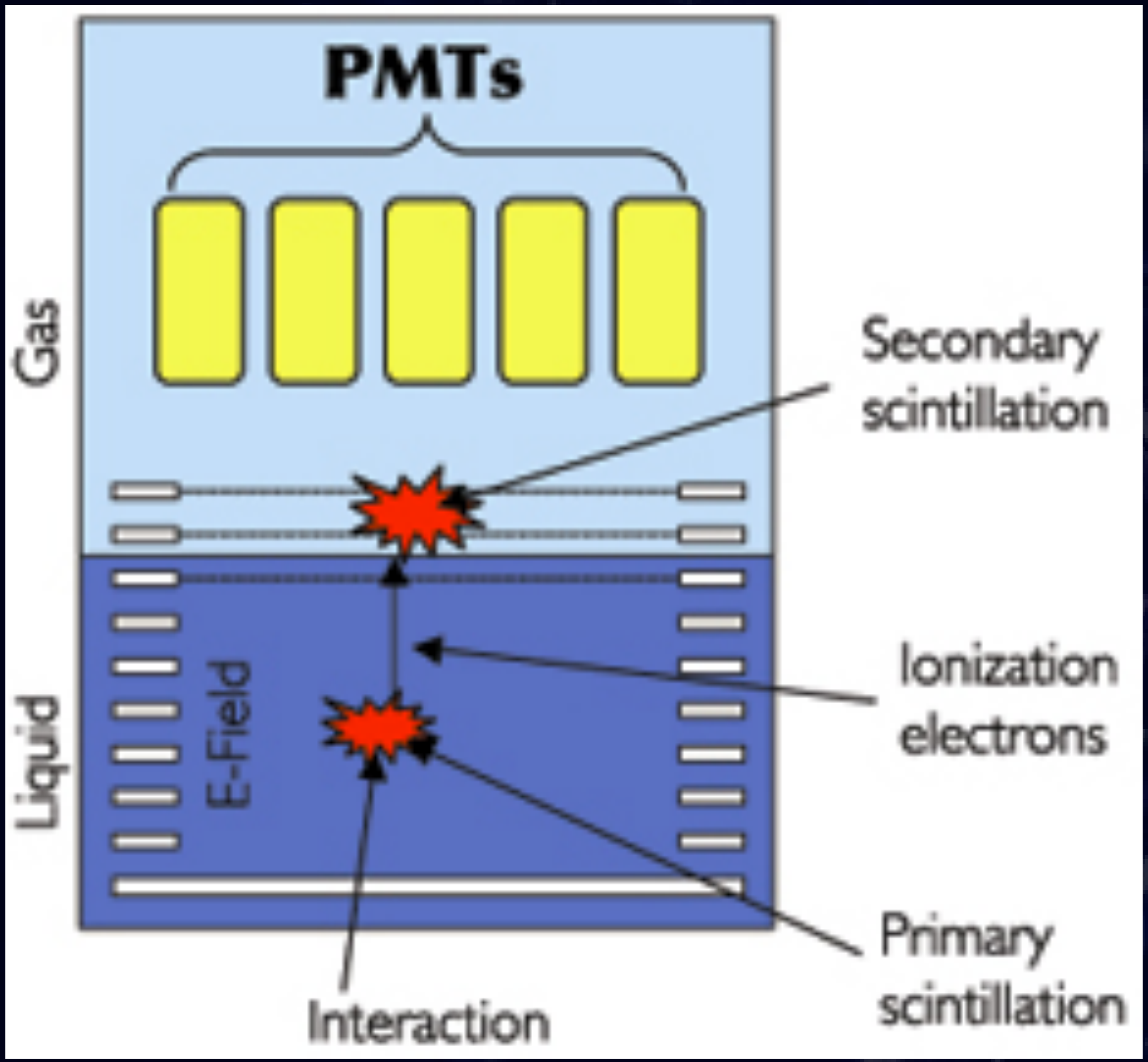
Detector: cryogenic noble liquid (Ar, Xe)
Allows ionisation & scintillation detection

Cryogen: external liquid Argon bath (~ 87 K)

Physical Quantity Measured : energy diposited in medium by recoil

Means of Measurement: Scintillation light

WIMP Argon Programme (WARP)



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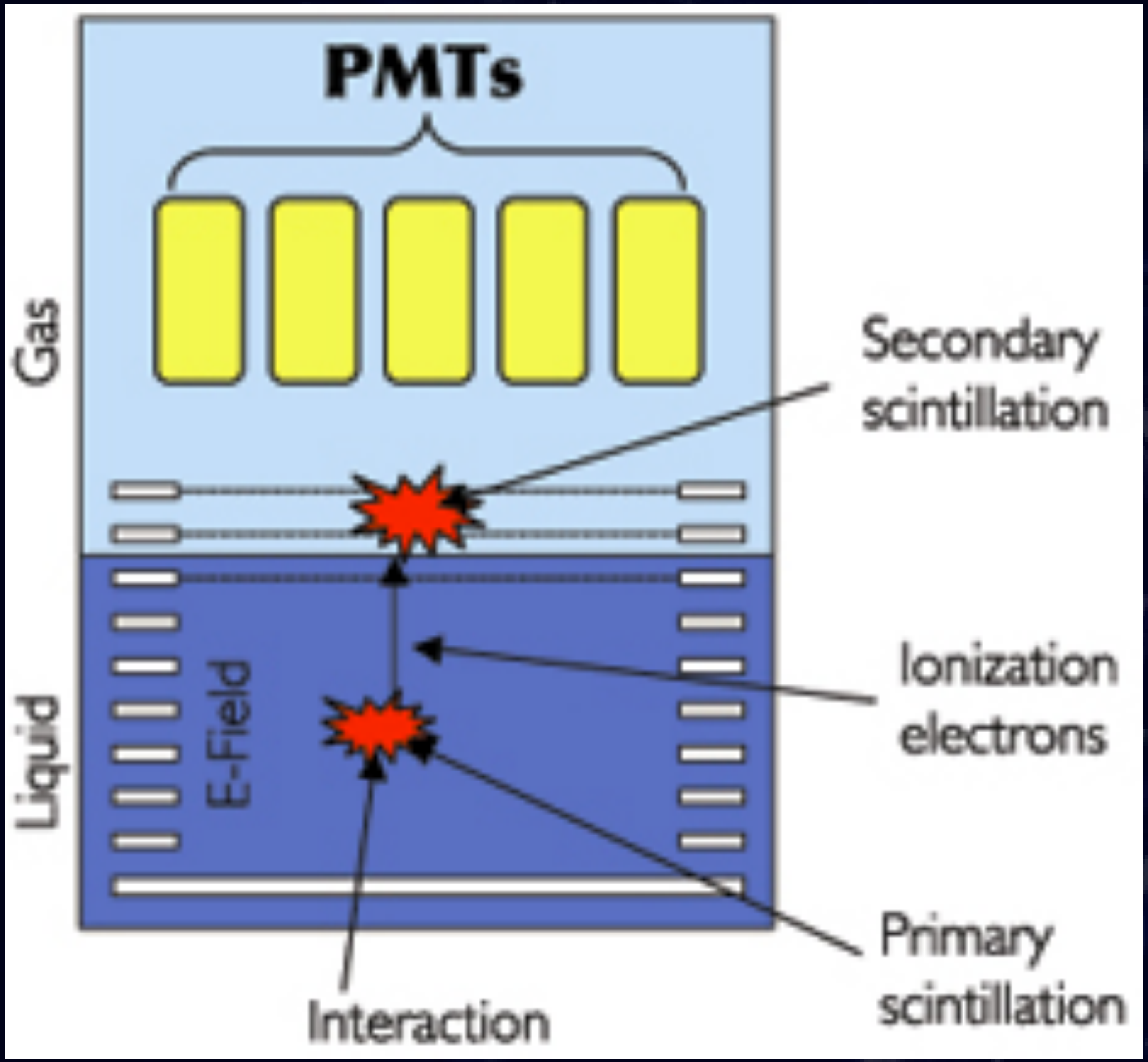

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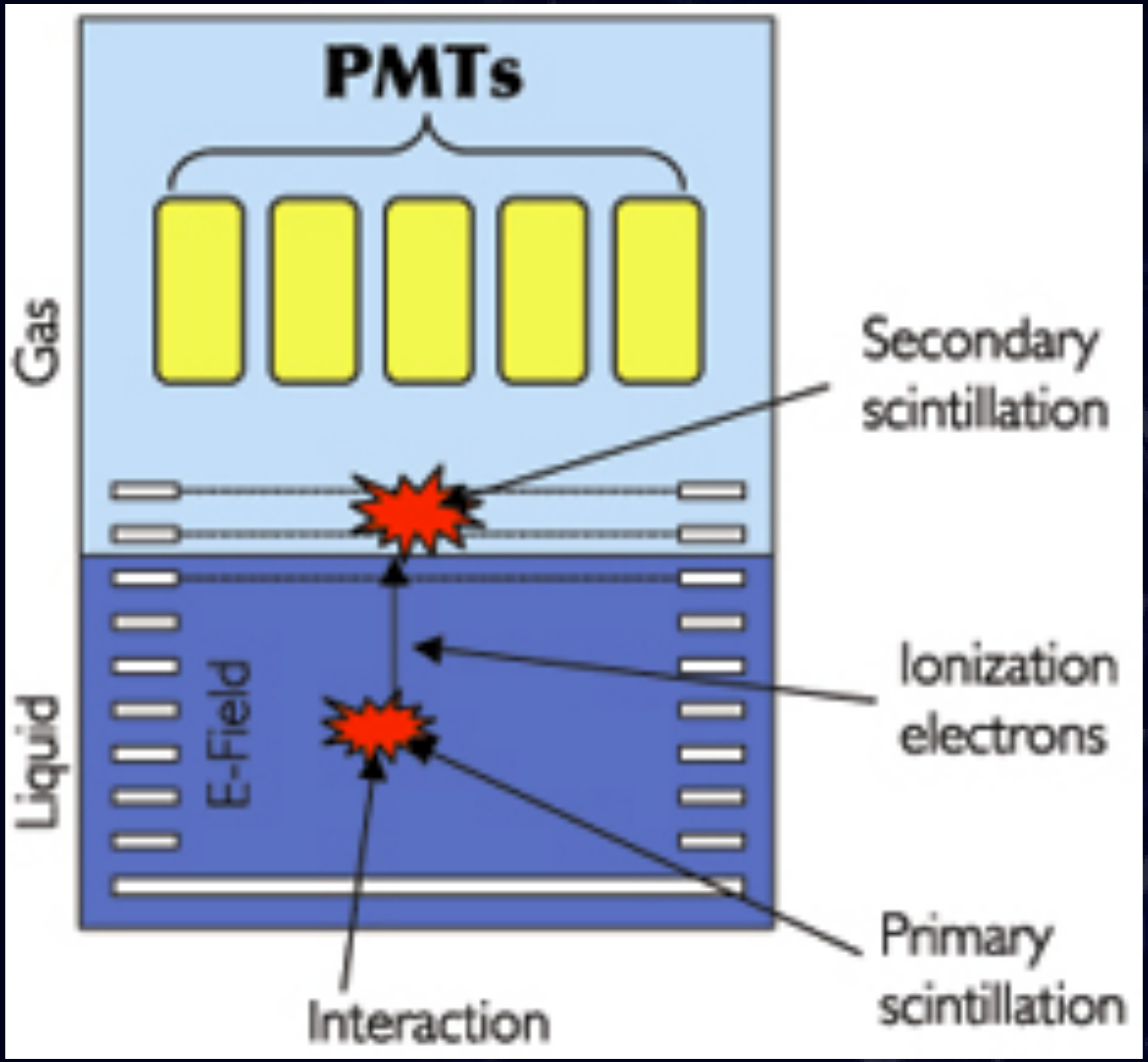

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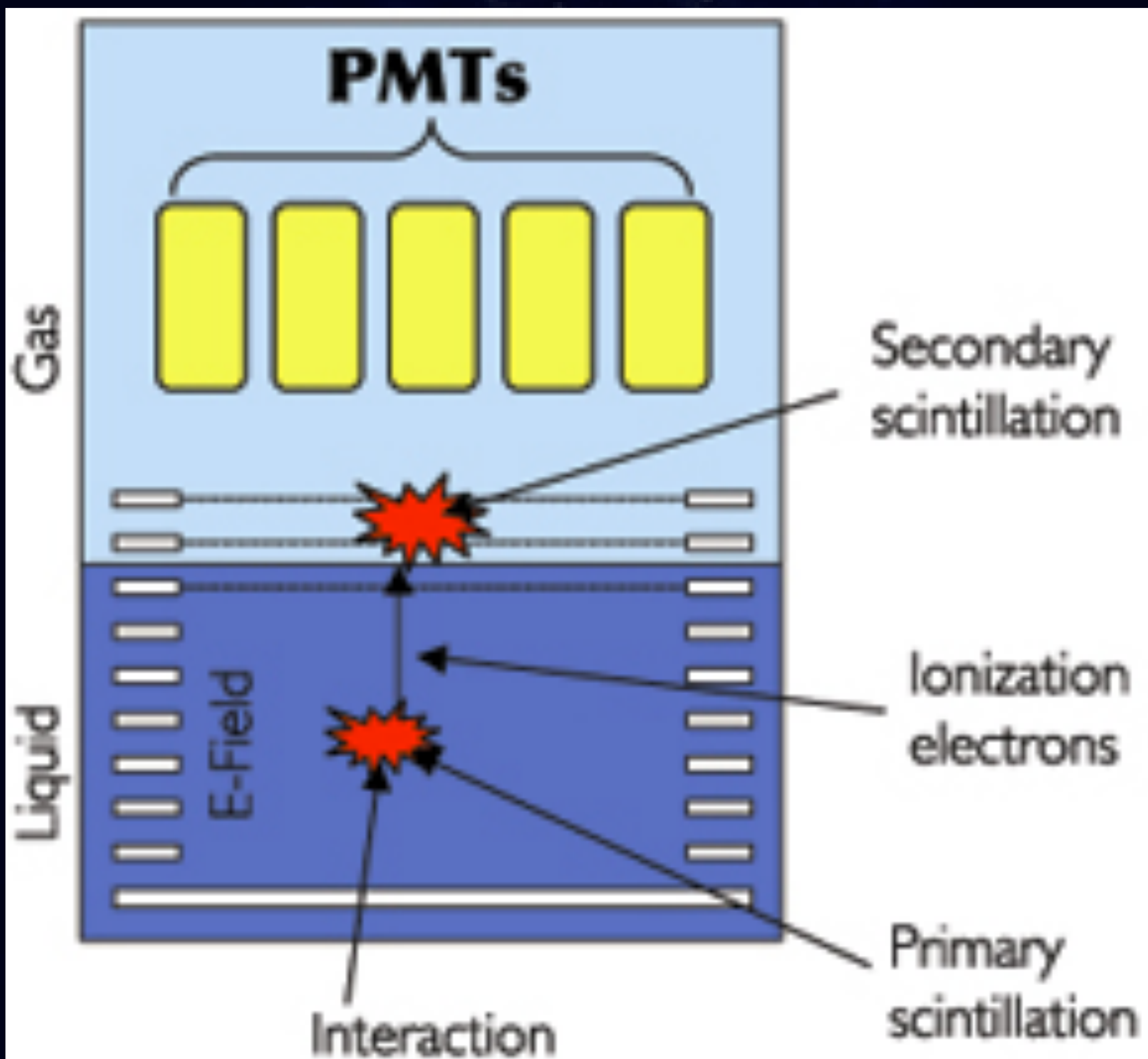

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(3) De-excitations ,re-combinations ⇒ primary scintillation signal

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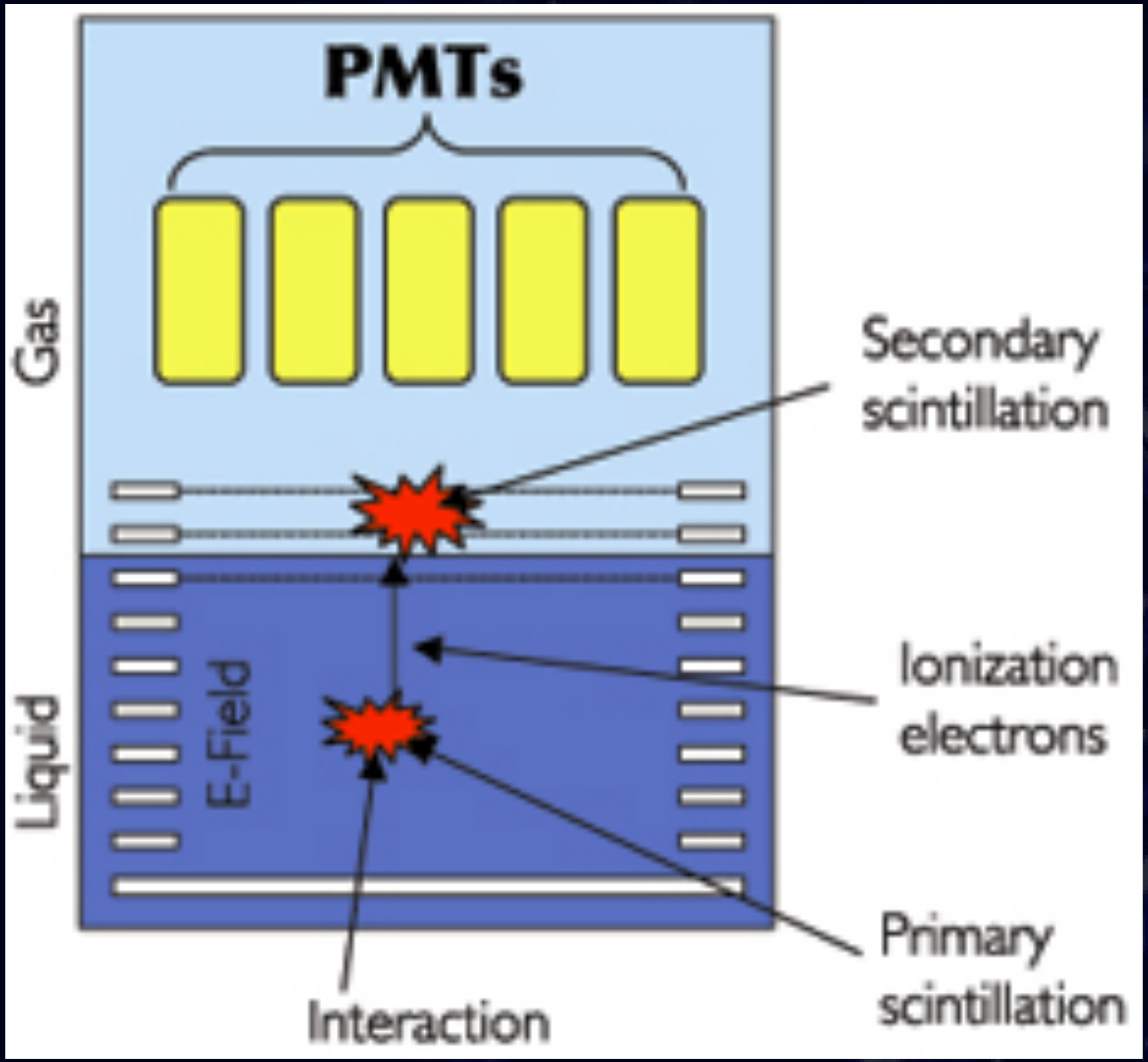

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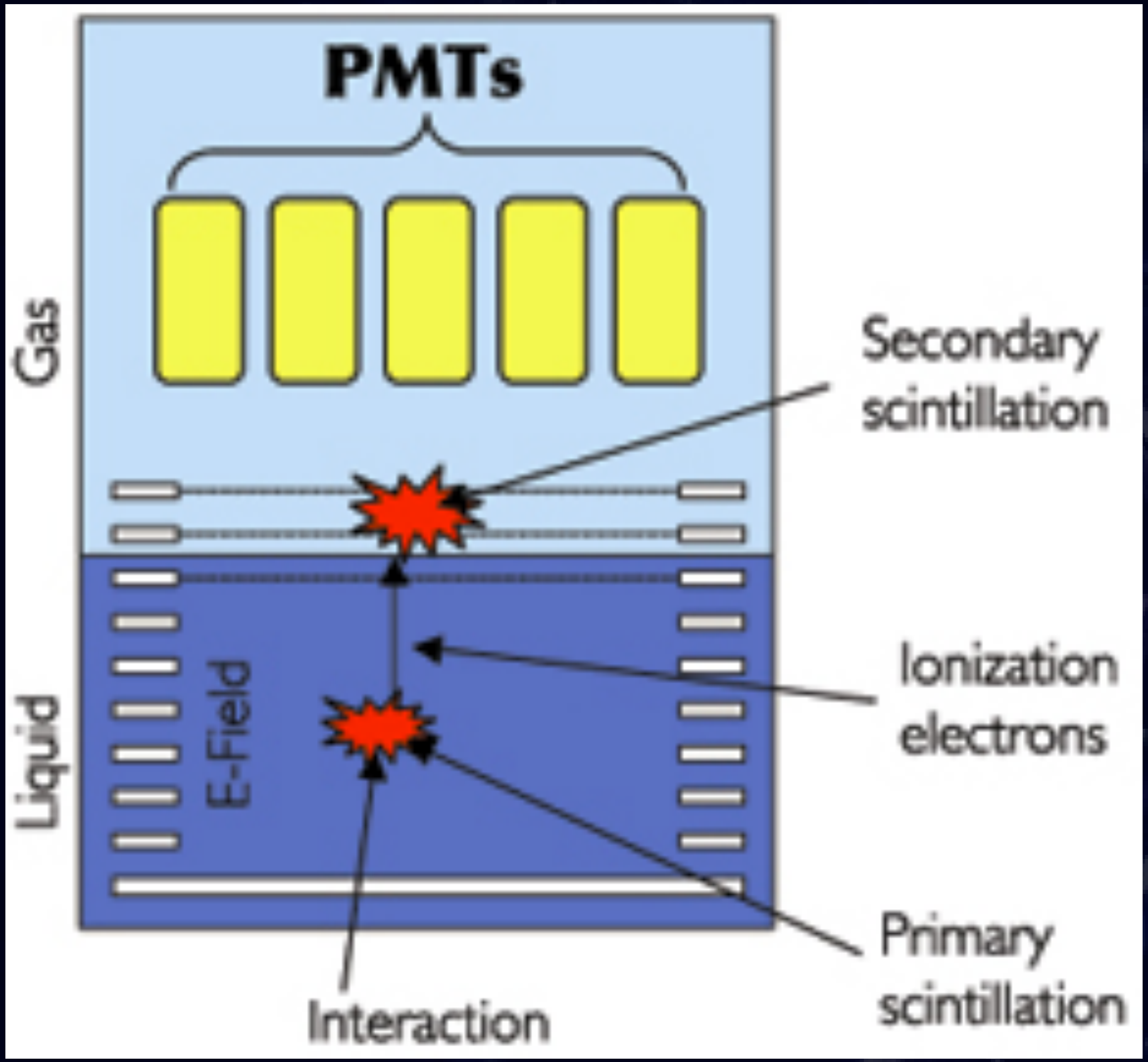

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(5) e^- accelerated, collide with gas atoms ⇒ secondary scintillation signal

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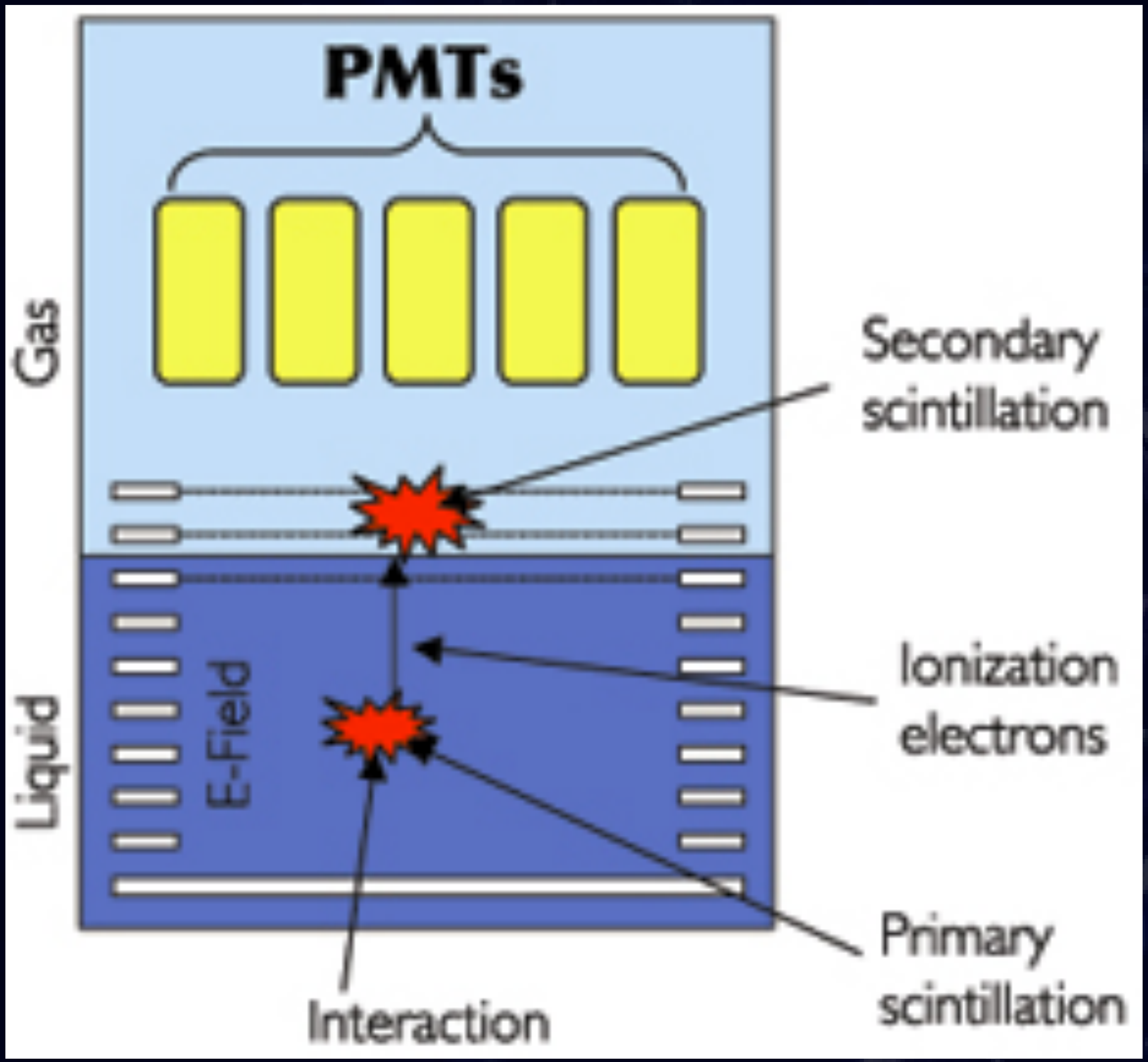

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(3) De-excitations ,re-combinations ⇒ primary scintillation signal
(4) Applied E field⇒ free e^- go to gas
(5) e^- accelerated, collide with gas atoms ⇒ secondary scintillation signal
(6) primary/secondary are dependent on the nature of the kind of impinging particle.

Results so far

?

Also, Axions are searched...

CAST (CERN)

ADMX (Washington)


Thanks!