

DARWIN

DARk matter WImp search with Noble liquids

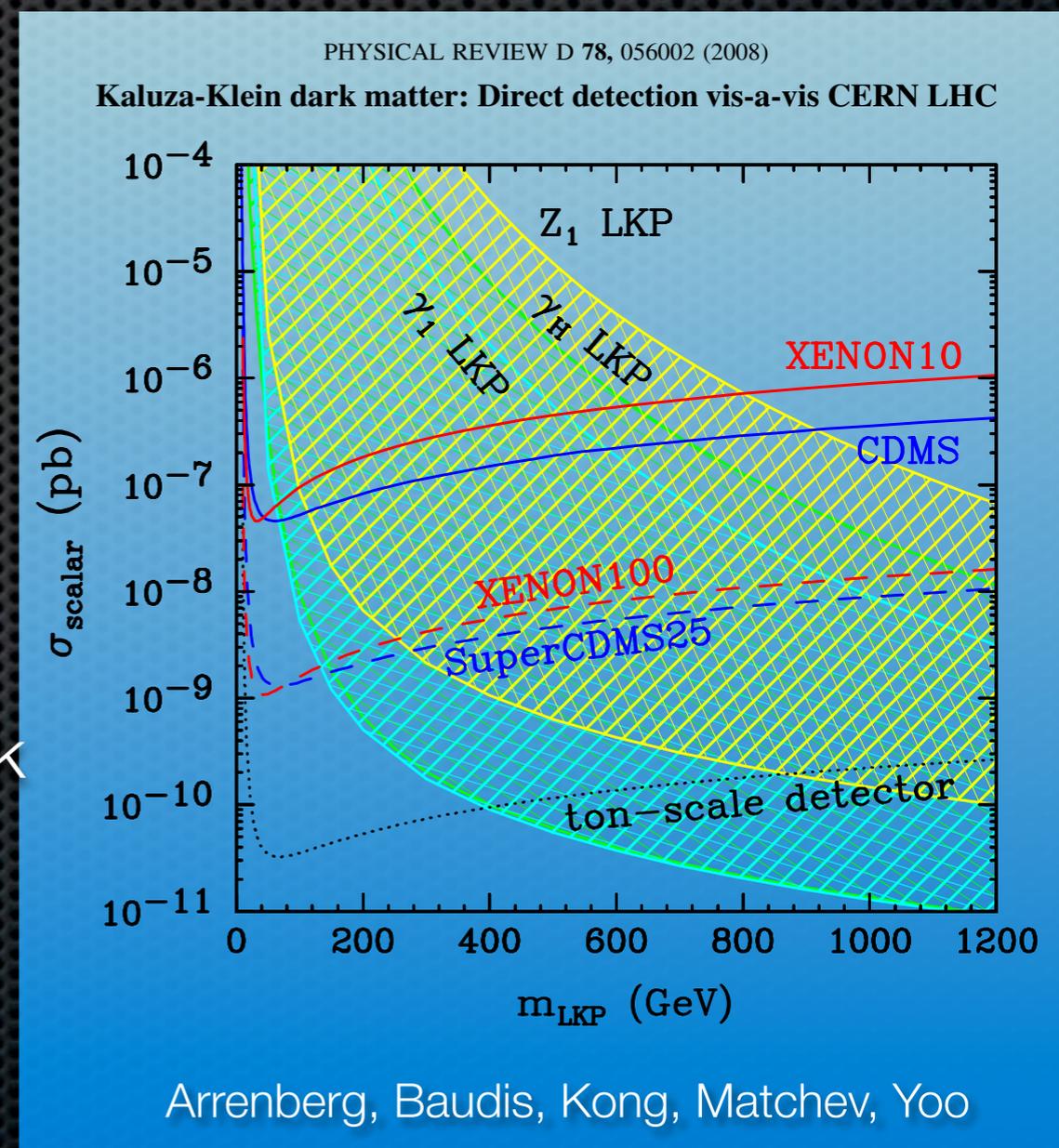
Laura Baudis
University of Zurich
(on behalf of the DARWIN Consortium)

IDM2010
University of Montpellier, July 30, 2010

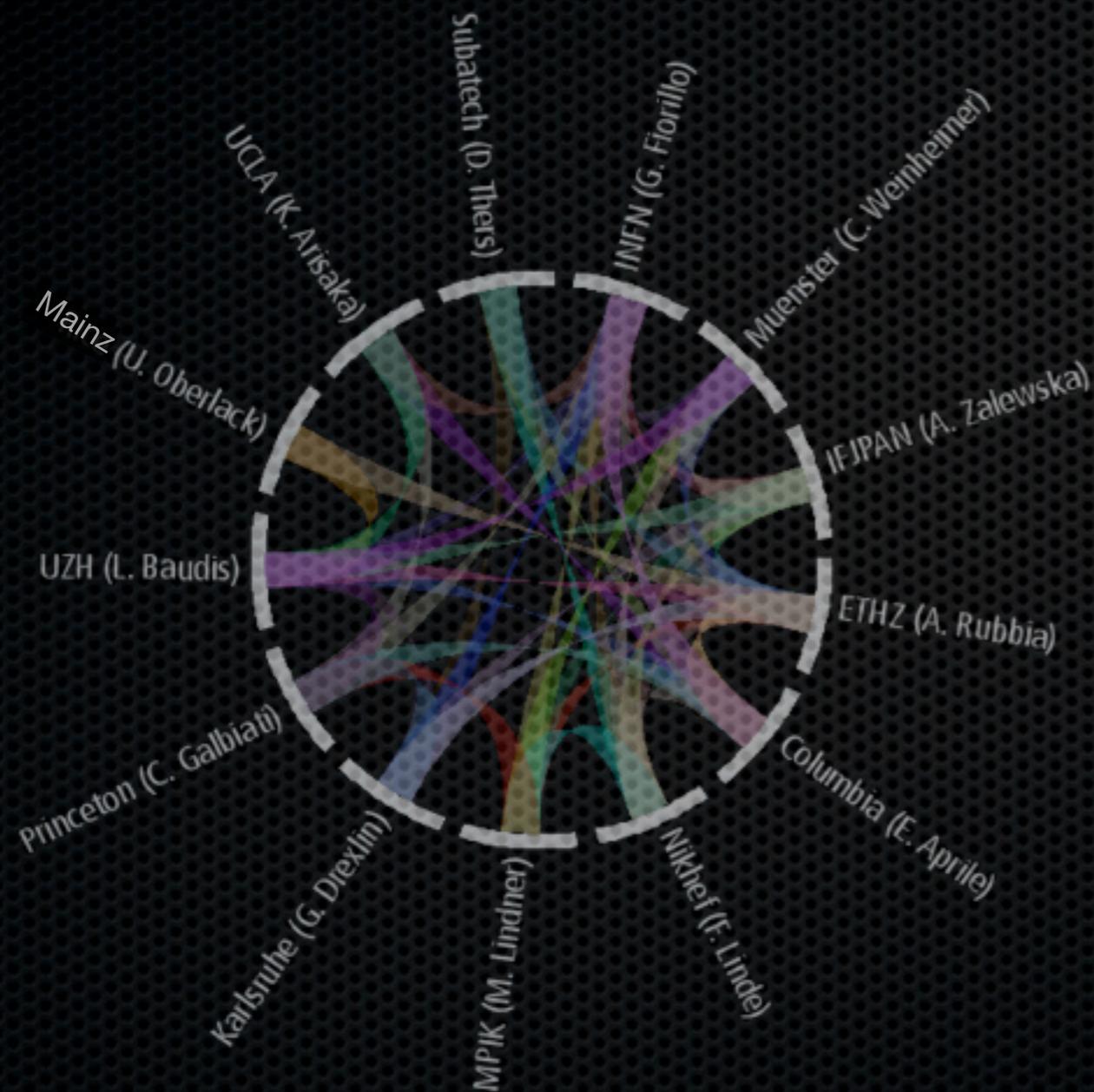


What is DARWIN?

- ✦ **R&D and design** study for a next-generation noble liquid facility in Europe
- ✦ Approved by ASPERA (ASTroParticle ERAnet) in late 2009
- ✦ **Focus:** coordinate existing European activities in liquid argon and liquid xenon towards the construction of a multi ton dark matter facility (using argon and/or xenon)
- ✦ **Physics goal:** probe WIMP nucleon (SI) cross sections well below 10^{-47} cm^2



DARWIN Institution and Connections



✦ A total of 22 groups from:

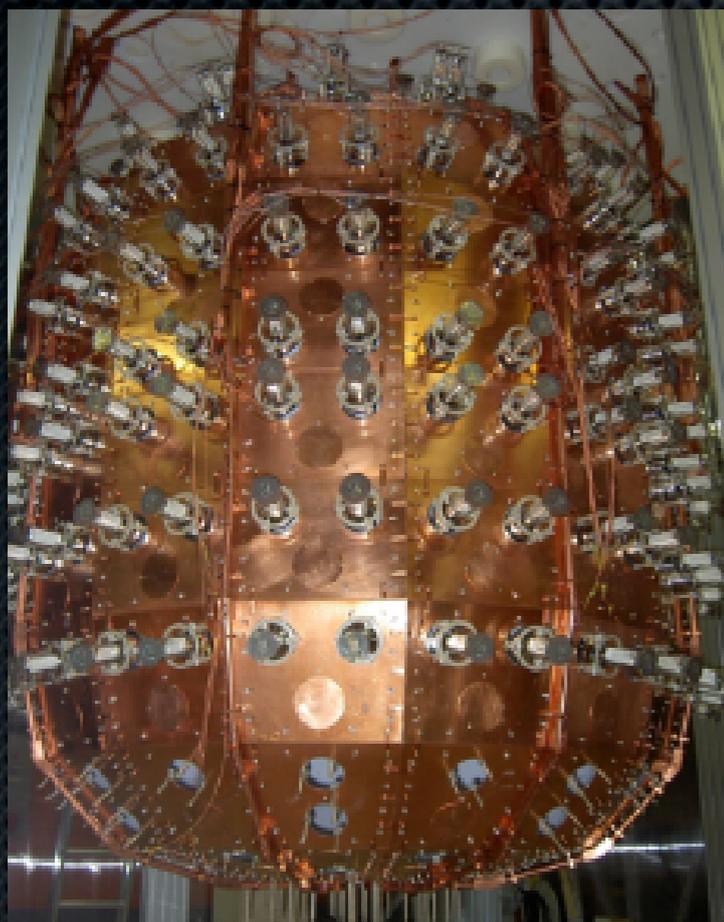
ArDM and **WARP** for LAr
XENON for LXe

Europe: UZH, INFN, ETHZ, Subatech, Mainz, MPIK, Münster, Nikhef, KIT, IFJPAN

USA: Columbia, Princeton, UCLA

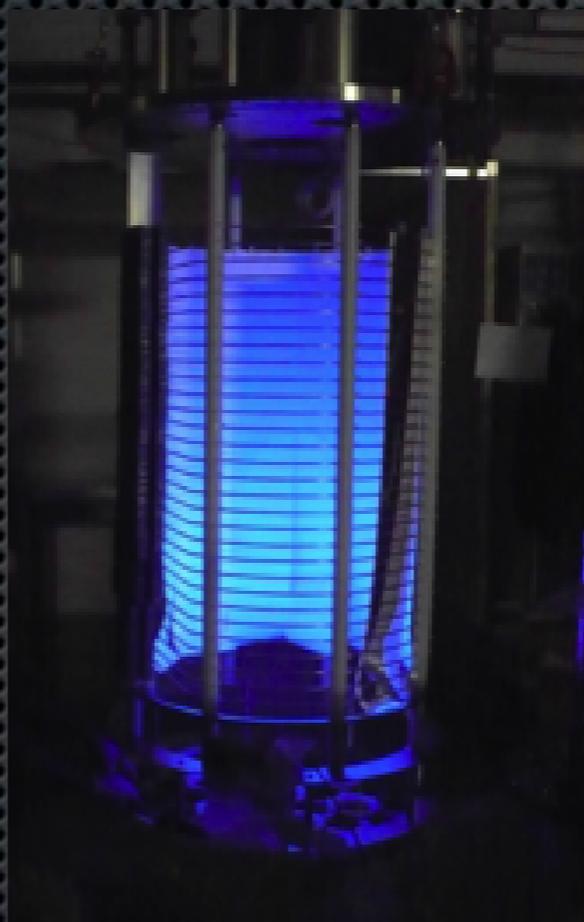


DARWIN Prototypes



WARP-140
(140 kg of LAr)

under commissioning
at LNGS



ArDM (~1 ton of LAr)

under commissioning
at CERN; underground
operation planned for
2011

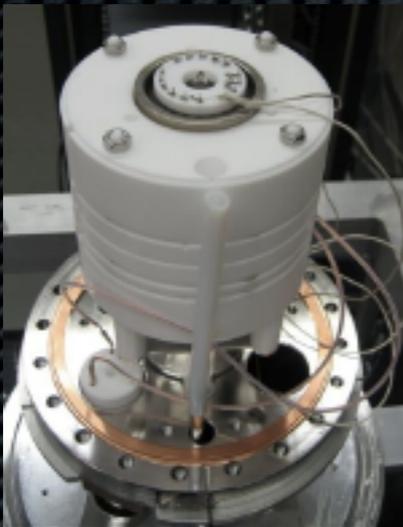


XENON100
(161 kg of LXe)

under operation at
LNGS

XENON/ArDM/WARP evolution

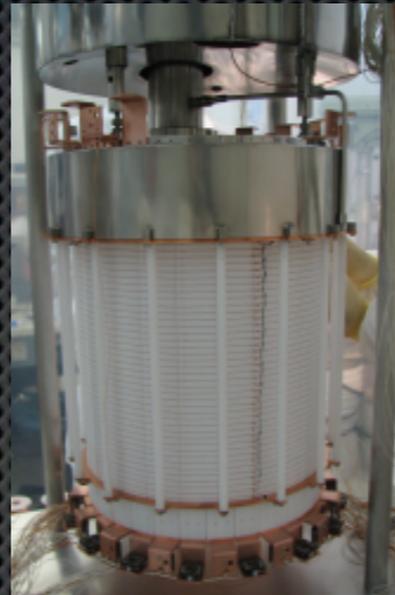
XENON R&D
ongoing



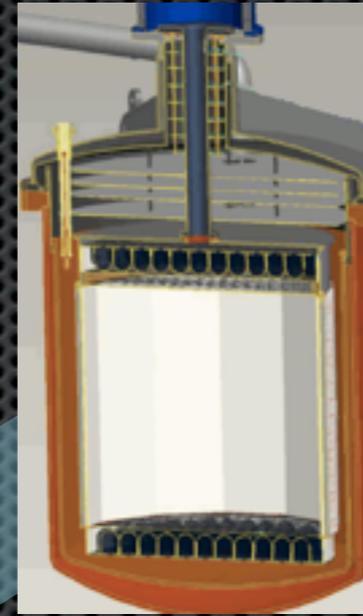
XENON10
2005-2007



XENON100
2008-2010



XENON1t
2011-2015



WARP 2.3 l



WARP-140



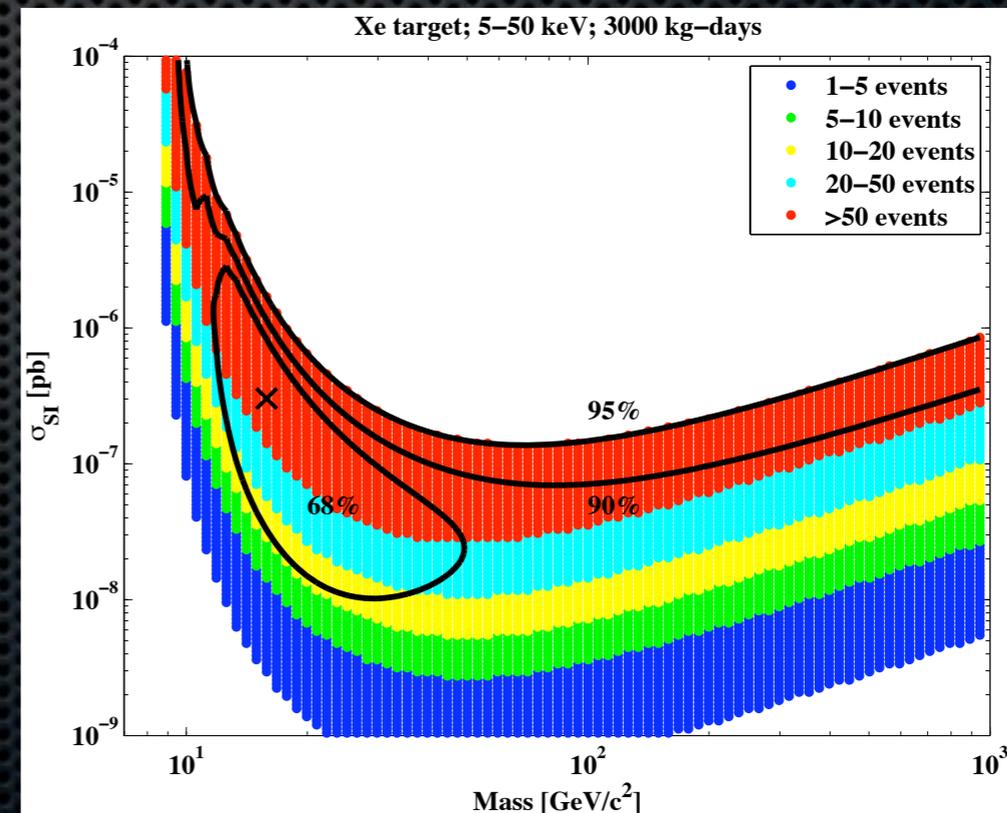
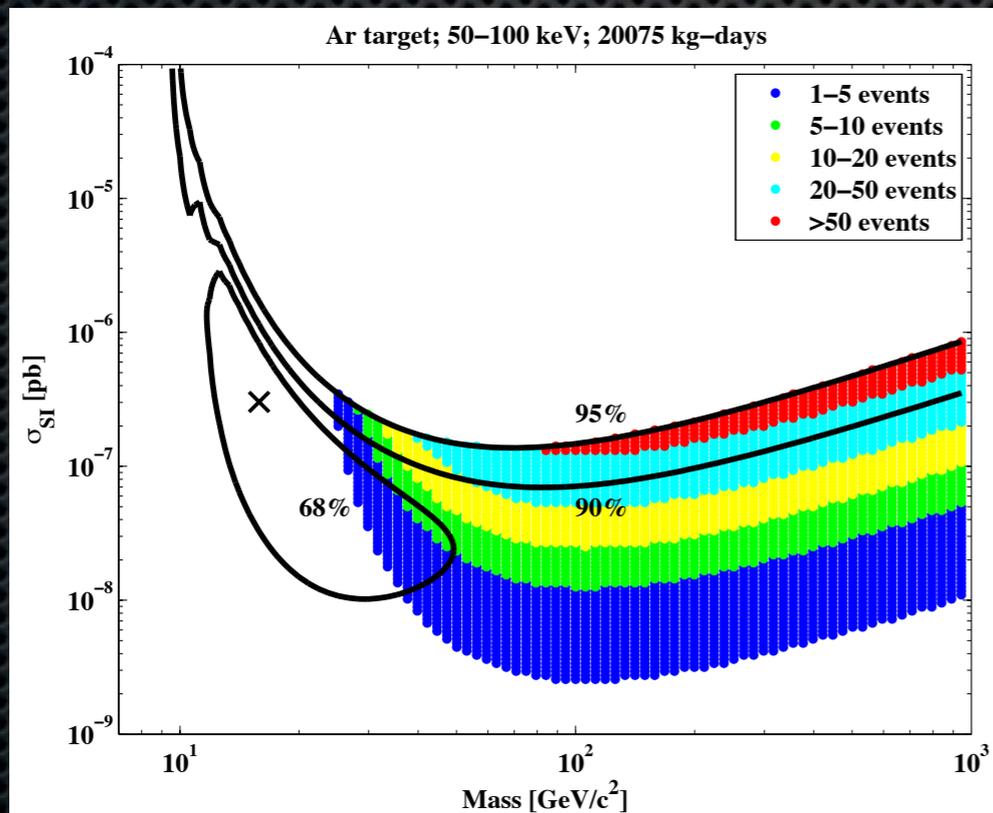
ArDM-1 ton



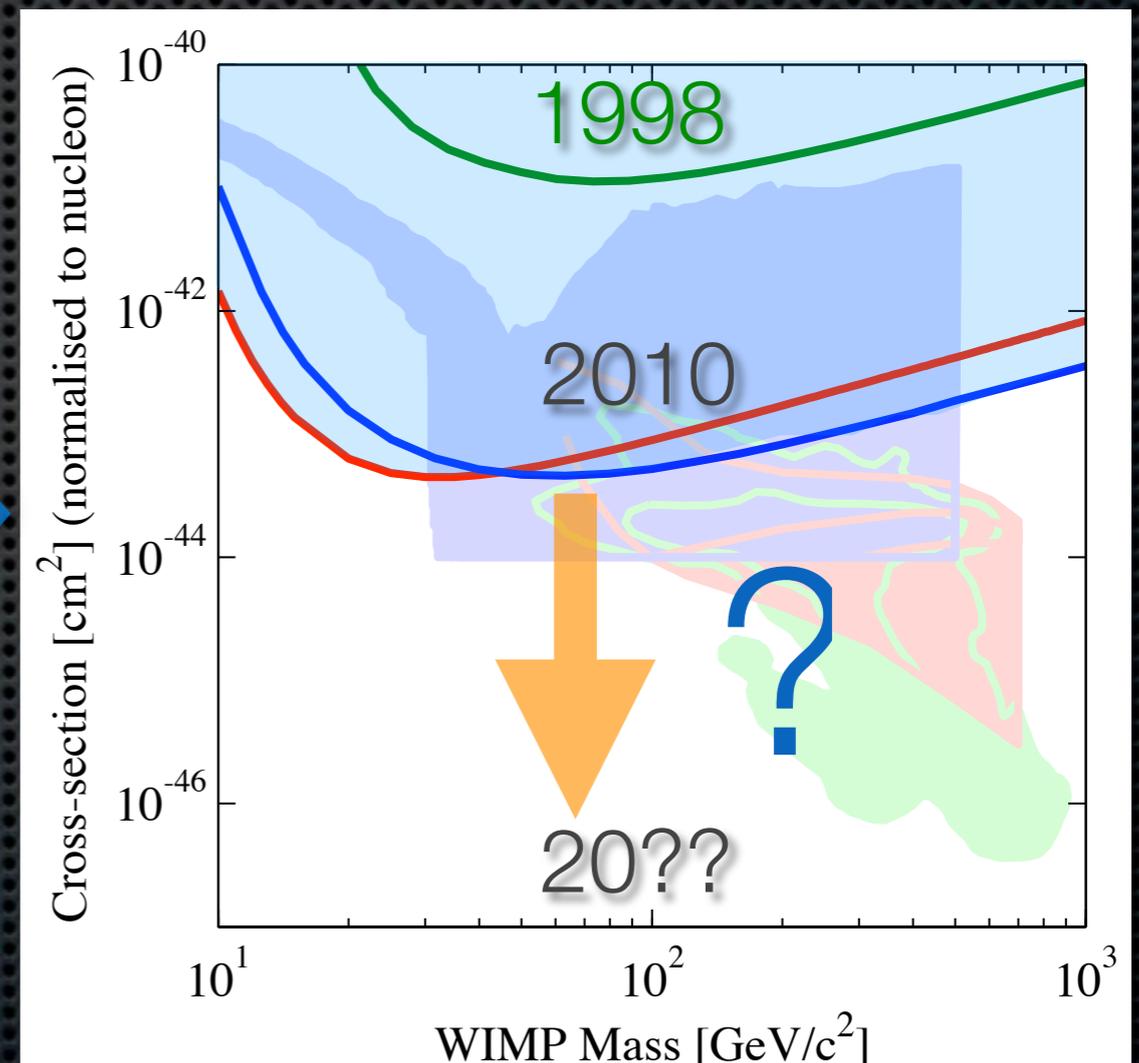
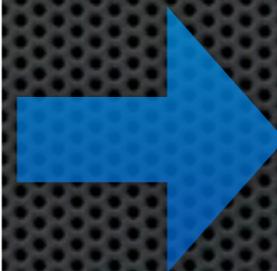
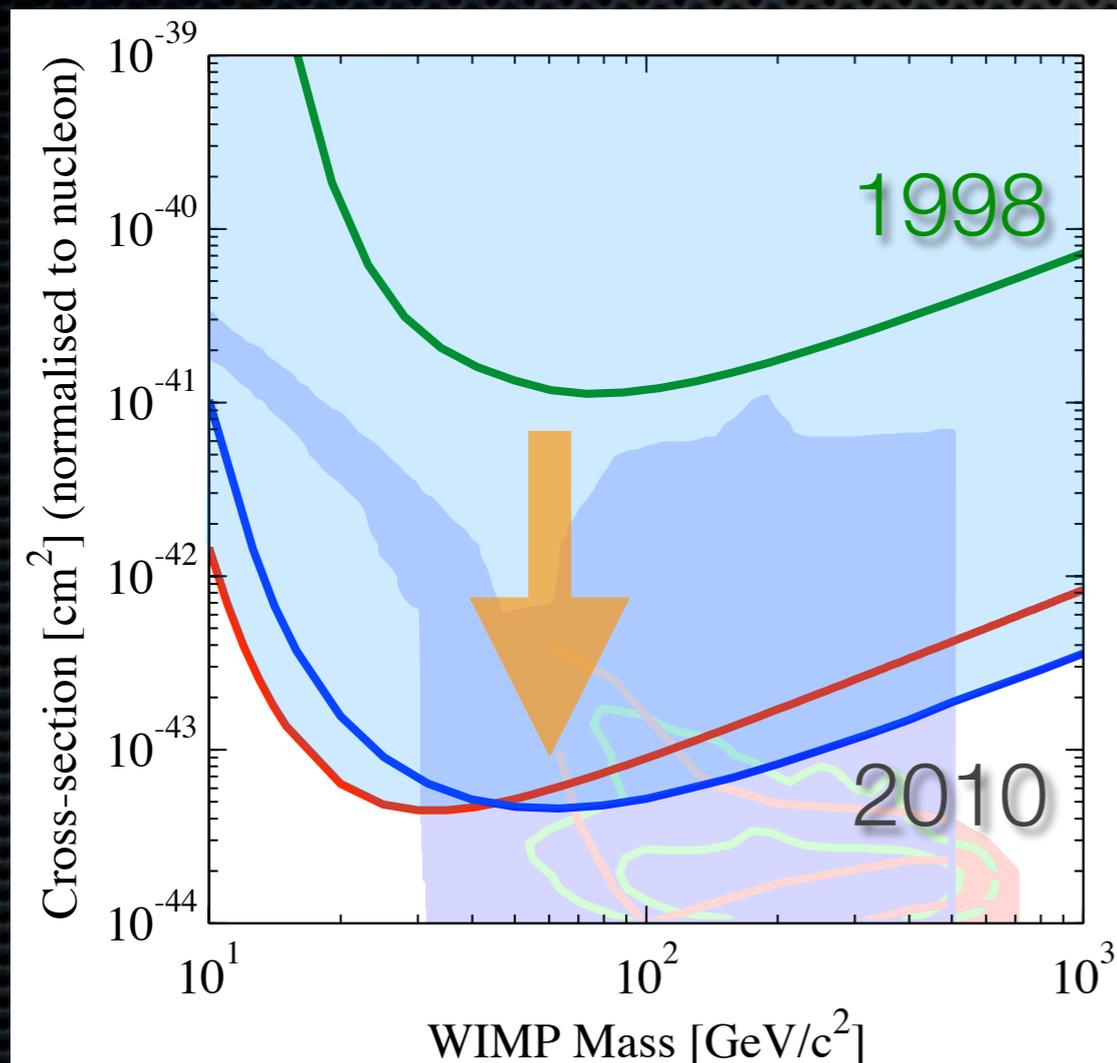
WARP R&D

Motivation (I)

- **Question:** what would XENON100 and WARP140 see, if the two CDMS events were WIMPs?
- **Assumptions:**
 - ➔ 110 kg x 1 year x 50% signal acceptance = 20'075 kg days exposure (WARP-140)
 - ➔ 30 kg x 200 days x 50% signal acceptance = 3'000 kg days exposure (XENON100)



Motivation (II): progress in the last decade



Larger detectors with improved backgrounds will be needed for WIMP (astro)physics!

Components of DARWIN

- **Detector infrastructure:**

- ➔ cryostat and inner TPC vessel
- ➔ cryogenic systems
- ➔ liquid handling and purification
- ➔ HV systems

- **Light readout**

- ➔ photo detectors
- ➔ UV light collection
- ➔ light yield of low-energy NRs in LAr/LXe

- **Alternative charge readout**

- ➔ large area thick GEMS
- ➔ gaseous photomultipliers
- ➔ GridPix

- **Electronics and DAQ**

- ➔ low-noise electronics
- ➔ DAQ/trigger schemes
- ➔ common computing centre

- **Underground site and shielding**

- ➔ LNGS investigations
- ➔ ULISSE (LSM extension) investigations
- ➔ external backgrounds and shields
- ➔ coordination and supply of large amounts of liquid argon and xenon

- **Material screening and backgrounds**

- ➔ material screening
- ➔ cryogenic purification
- ➔ database and MC simulations

Structure of DARWIN

Work package title	Lead participant
Management	UZH, Switzerland (Laura Baudis)
Detector infrastructure	Münster, Germany (Christian Weinheimer)
Light read-out	INFN, Italy (Giuliana Fiorillo)
Alternative charge read-out	ETHZ, Switzerland (Andre Rubbia)
Electronics and DAQ	Subatech, France (Dominique Thers)
Underground and shielding infrastructure	Mainz, Germany (Uwe Oberlack)
Material screening and background modeling	MPIK, Germany (Hardy Simgen)
Science impact	Nikhef, Netherlands (Patrick Decowski)

Overall Physics Goals

- **5 t and 10 t of fiducial mass for LXe and LAr** (to be optimized by this study!)

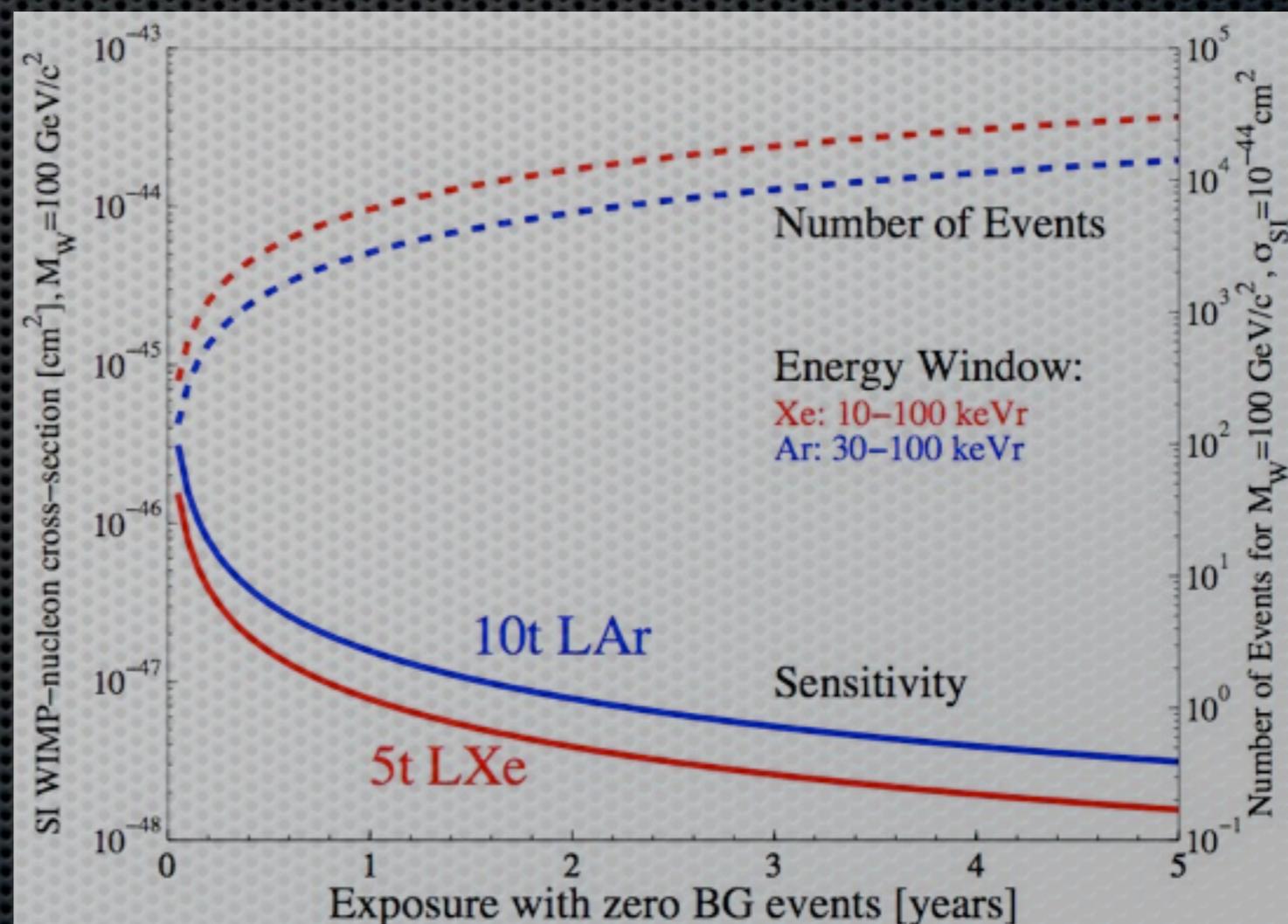
- **raw BG: 0.1 mdru in LXe**, with 99.9% rejection of ERs, based on the S2/S1-ratio (factor 100 better than current XENON100 background of ~ 10 mdru)

- **raw BG: 0.45 dru in LAr**, with 10^8 rejection of ERs, based on PSA and on the S2/S1-ratio (reduction of the ^{39}Ar rate by a factor 25 relative to $^{\text{atm}}\text{Ar}$, corresp. to an activity of 40 mBq/kg for ^{39}Ar)

- a NR acceptance of 50% for LXe and of 80% for LAr

- thus, zero BG events (< 1 event) for the given exposure

Assumptions



Time Schedule

January 2010



First general meeting (UZH)

WPs have been set up

Website (public and internal)

September 14-15, 2010



Second meeting (UZH)

Interim reports from WPs

September 2011



Third general meeting (Nikhef)

Technical report

September 2012



Fourth general meeting

Final report

Technical Design Study

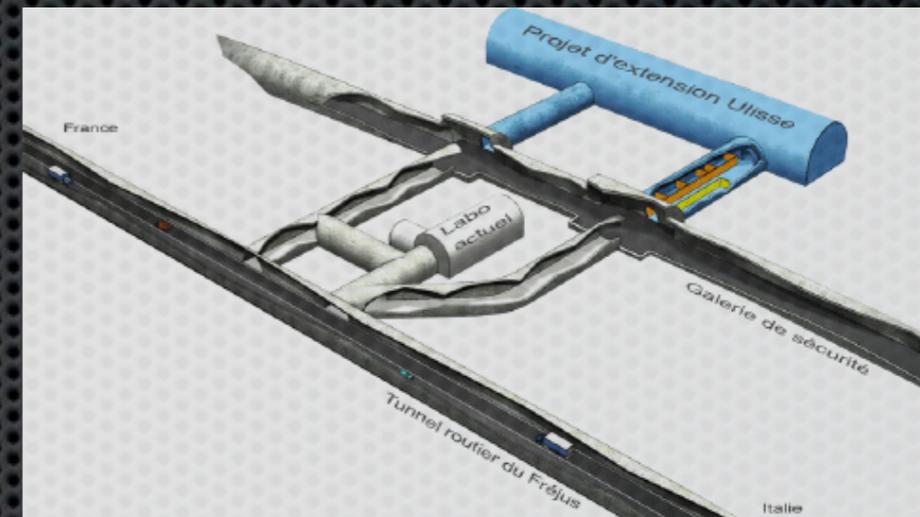


Rough time schedule after 2012

2010 - 2012:
R&D and Design Study



2013: Submission of Lol engineering studies



2014 - 2015:
Construction and commissioning



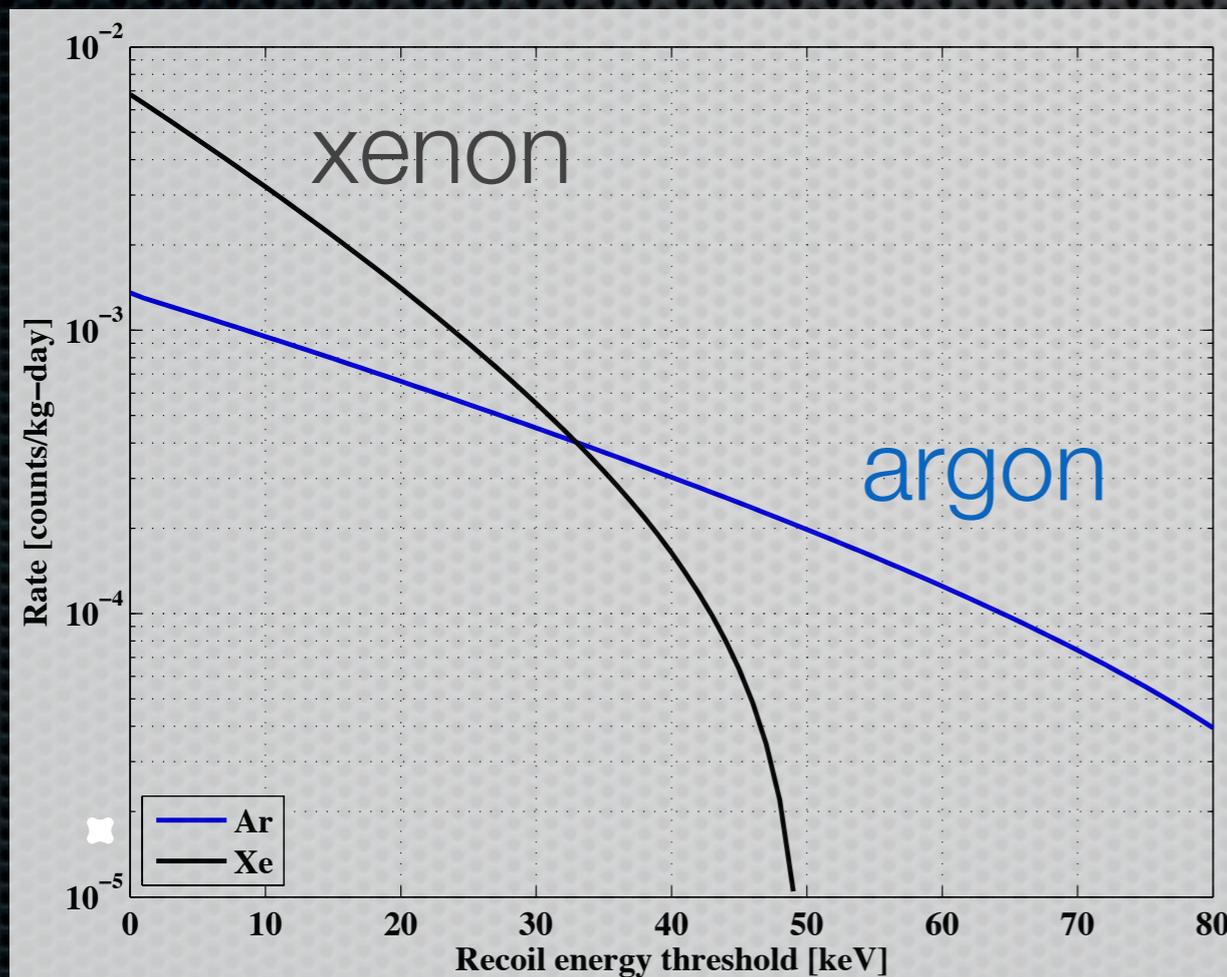
2016 - 2020:
Operation, physics data



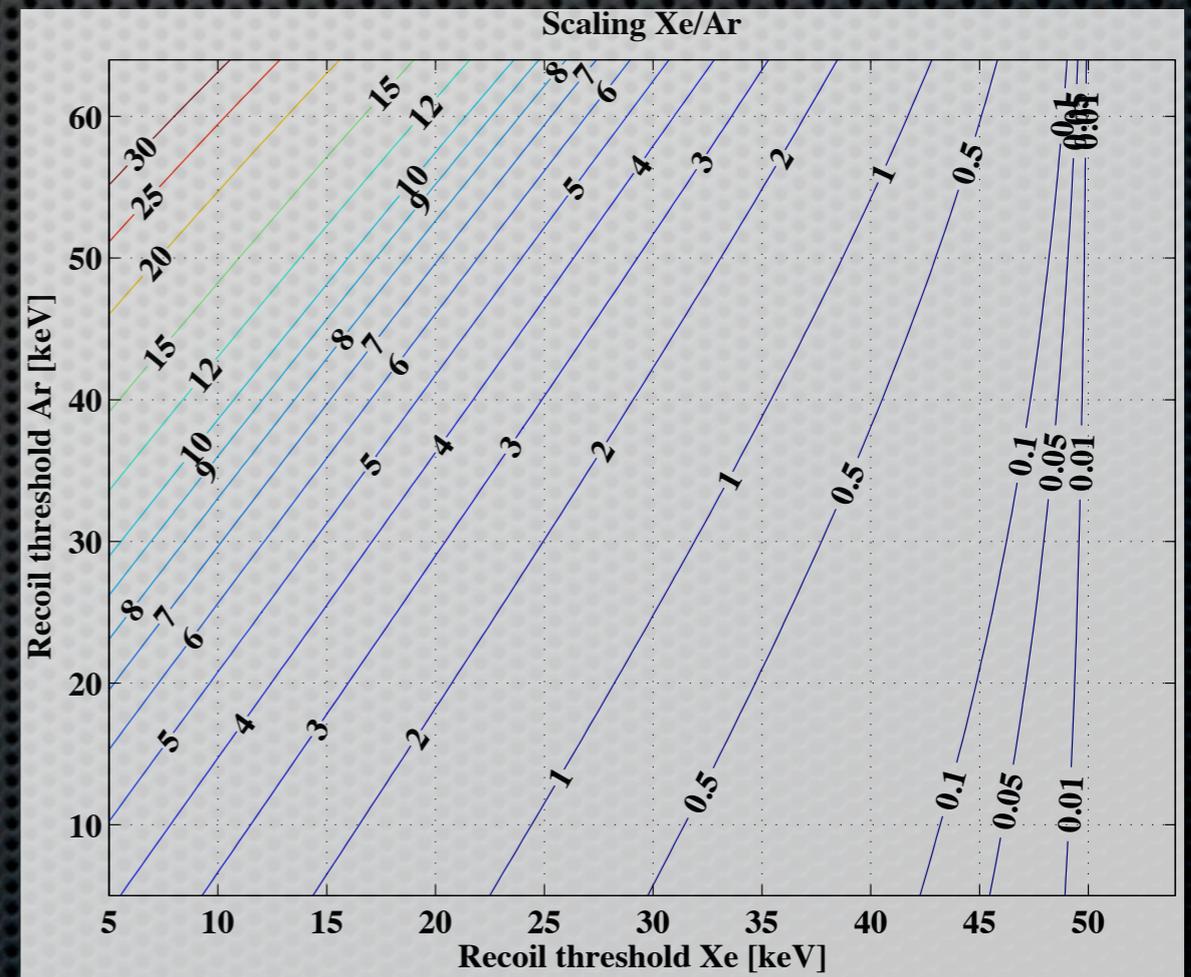
Sensitivity comparison between LAr and LXe



- the relative sensitivity depends highly on the energy threshold

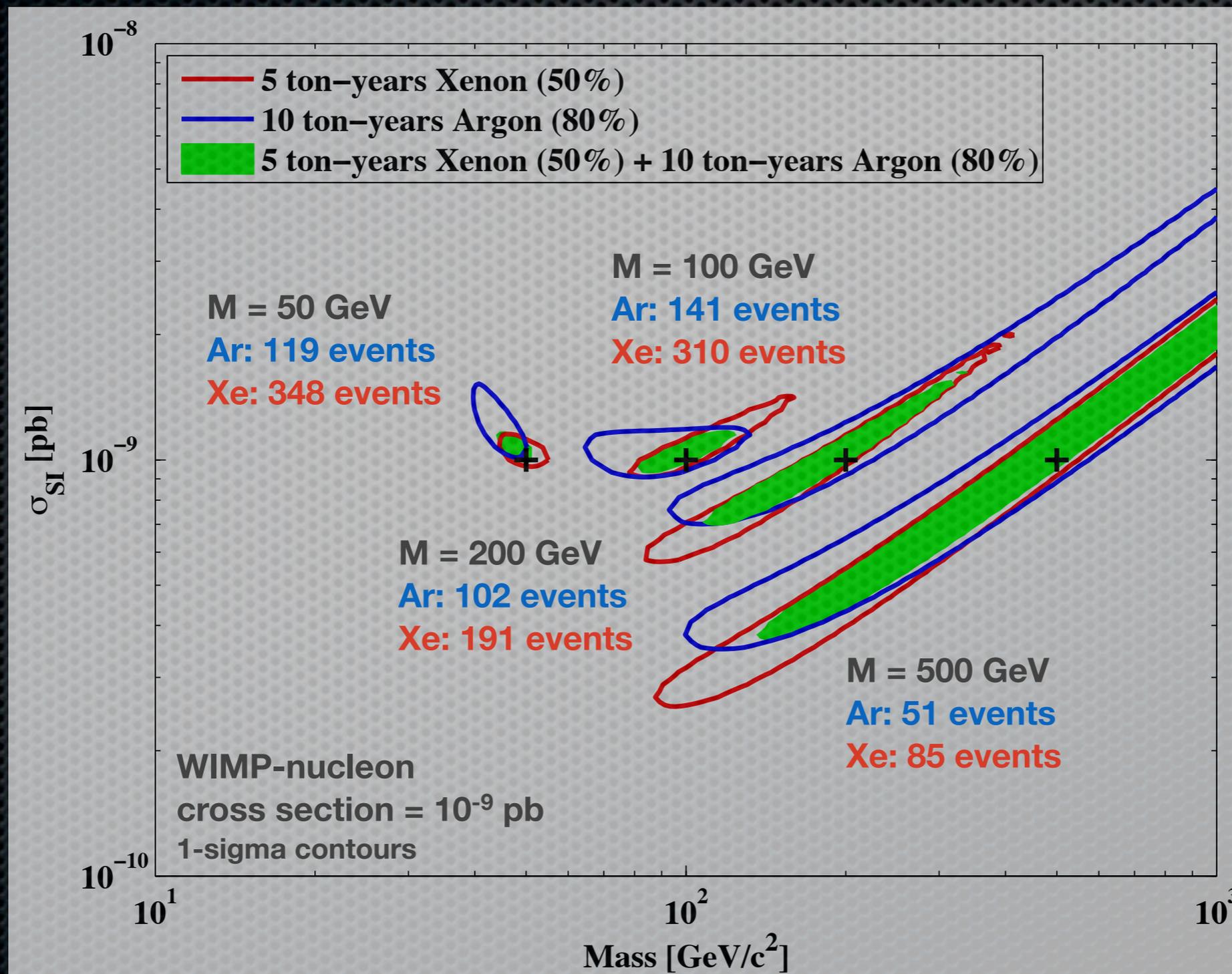


Integrated rate in Xe and Ar



Scaling factor between Xe and Ar

Complementarity between LAr and LXe



DARWIN Website

(darwin.physik.uzh.ch)



▪ stay
tuned...

dark matter wimp search in noble liquids

DARWIN

DARWIN home

[:: internal ::](#) [:: dark matter ::](#) [DARWIN](#) [:: collaboration ::](#) [news ::](#)



Welcome to the homepage of the DARWIN project

DARWIN is a design study towards the realisation of future astroparticle infrastructure in Europe as identified in the **ASPERA Roadmap**. The proposal was funded through the first ASPERA common call, from the virtual pot created from contributions from the national funding agencies participating in the call.

The aim of DARWIN is to complete the necessary research for the construction of a ton-scale liquid xenon detector and a multi-ton scale liquid argon detector for the direct detection of particle dark matter with a sensitivity which is three orders of magnitudes beyond the one of existing experiments. Such a detector would not only have a realistic chance of discovering the nature of dark matter, but would also be able to study its properties such as mass, interaction strength and its local distribution in our galaxy.

DARWIN brings together several European and American groups working in the existing XENON, WARP and ArDM collaborations and unites expertise on liquid noble gas detectors, low-background techniques, cryogenic infrastructure, shielding and astroparticle physics phenomenology. Even though noble liquid detectors are a relative newcomer in the field of direct dark matter detection, they have been shown to be highly competitive to the other main technologies in this area. They offer low-threshold, ultra-low background and position-sensitive detectors which can be scaled to large target masses which are required to detect weakly interacting massive particles.

On these pages, you can find more information about Dark Matter in the Universe, the DARWIN project, and the DARWIN collaboration.

:: what's new... ::

[26.01.2010] The first DARWIN collaboration meeting was held at Zurich University from Jan 25-26, 2010.
[read more...](#)

[30.10.2009] The DARWIN proposal has been funded.
[read more...](#)

[:: modified 29.01.2010 by MS ::](#)

Backup slides

XENON1t reach

