DARWIN

DARk matter WImp search with Noble liquids

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(on behalf of the DARWIN Consortium)

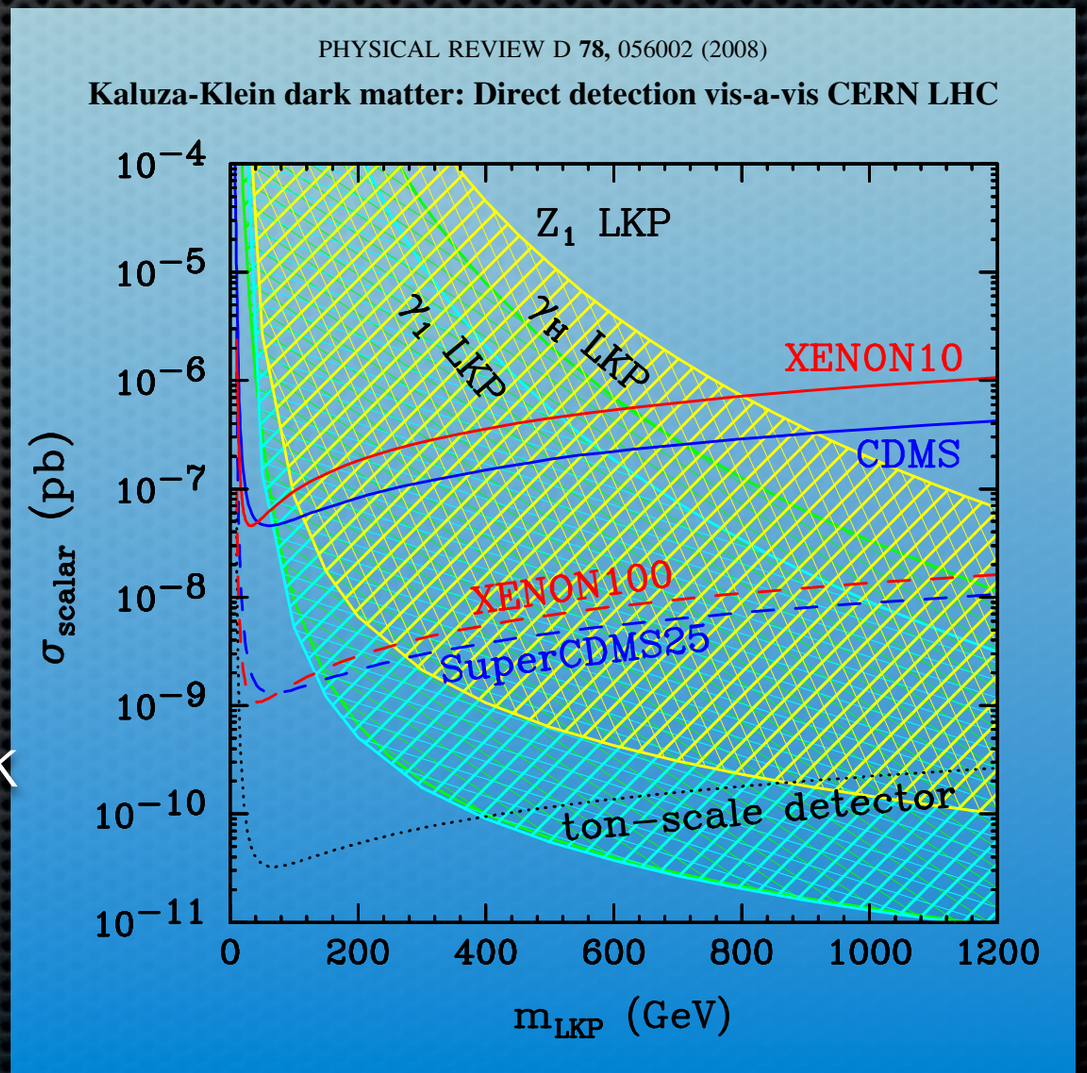
DARWIN

darwin.physik.uzh.ch

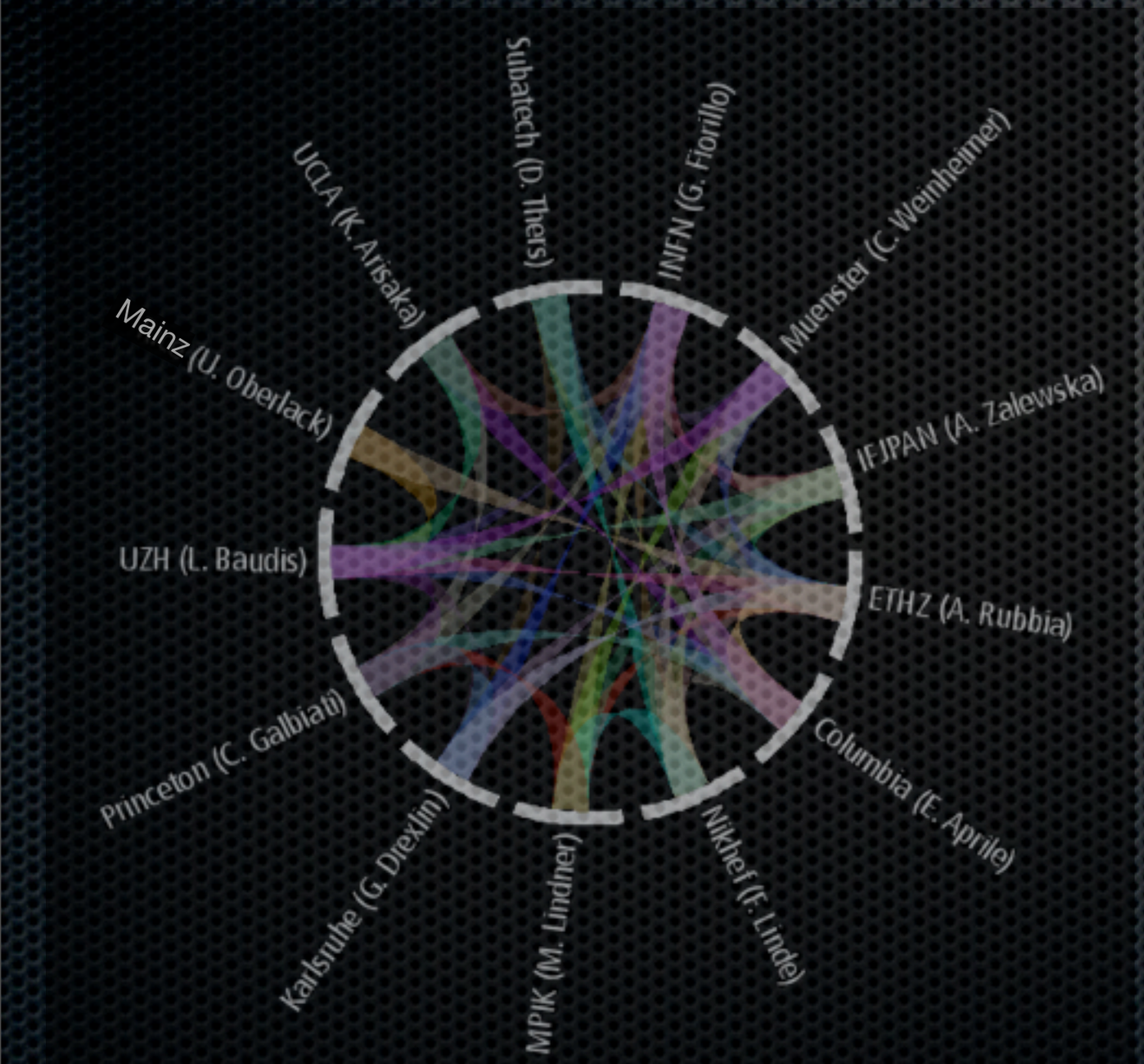
IDM2010
University of Montpellier, July 30, 2010

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



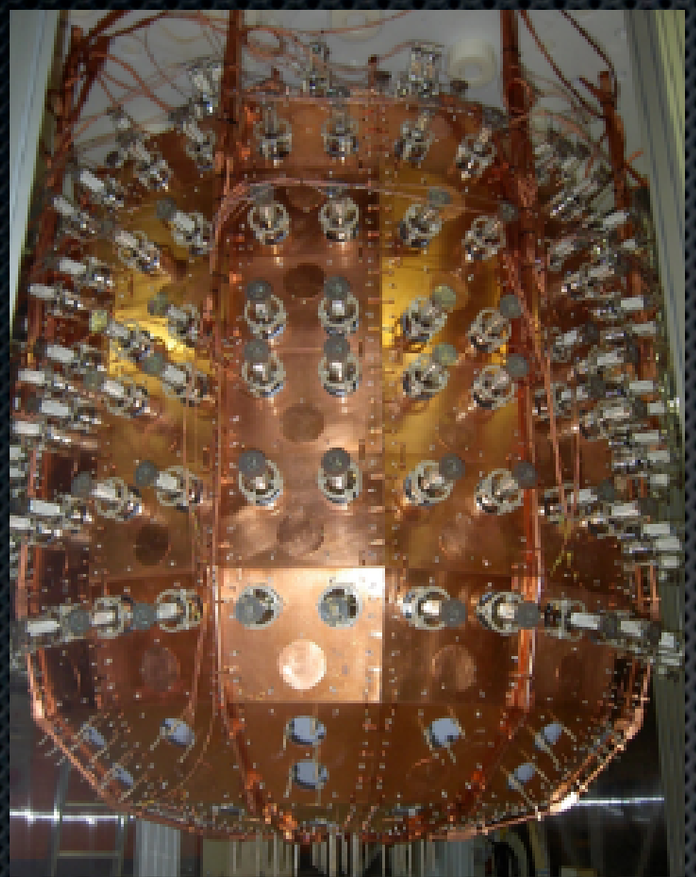
- **A total of 22 groups from:**

  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

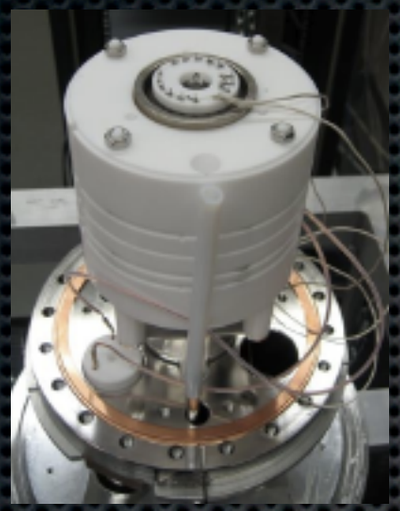
XENON100
(161 kg of LXe)

under operation at
LNGS

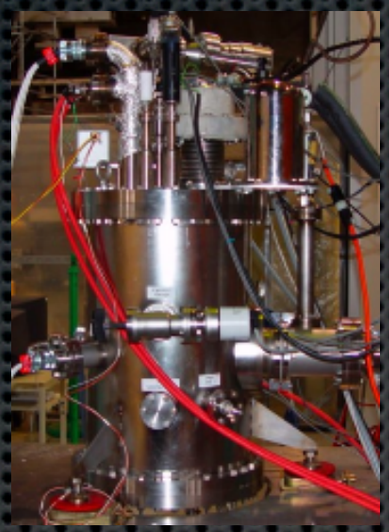
XENON/ArDM/WARP evolution

DARWIN

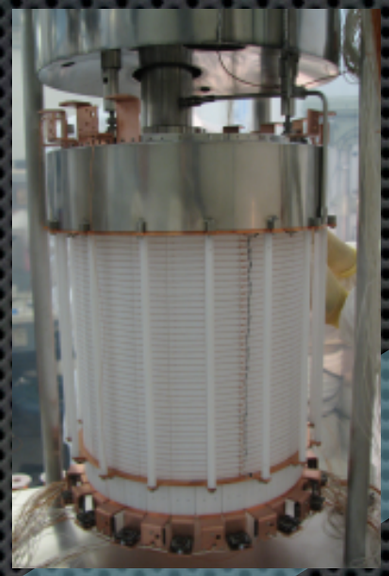
XENON R&D
ongoing



XENON10
2005-2007



XENON100
2008-2010



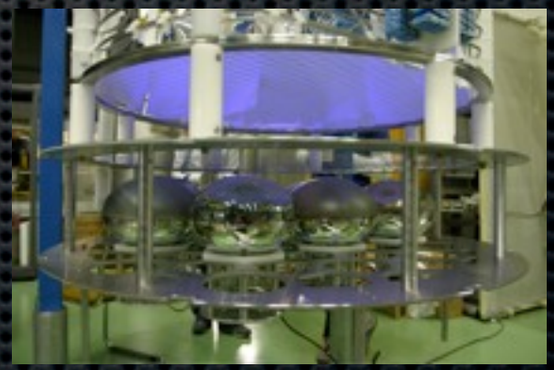
XENON1t
2011-2015

WARP R&D

WARP 2.3 l

WARP-140

ArDM-1 ton

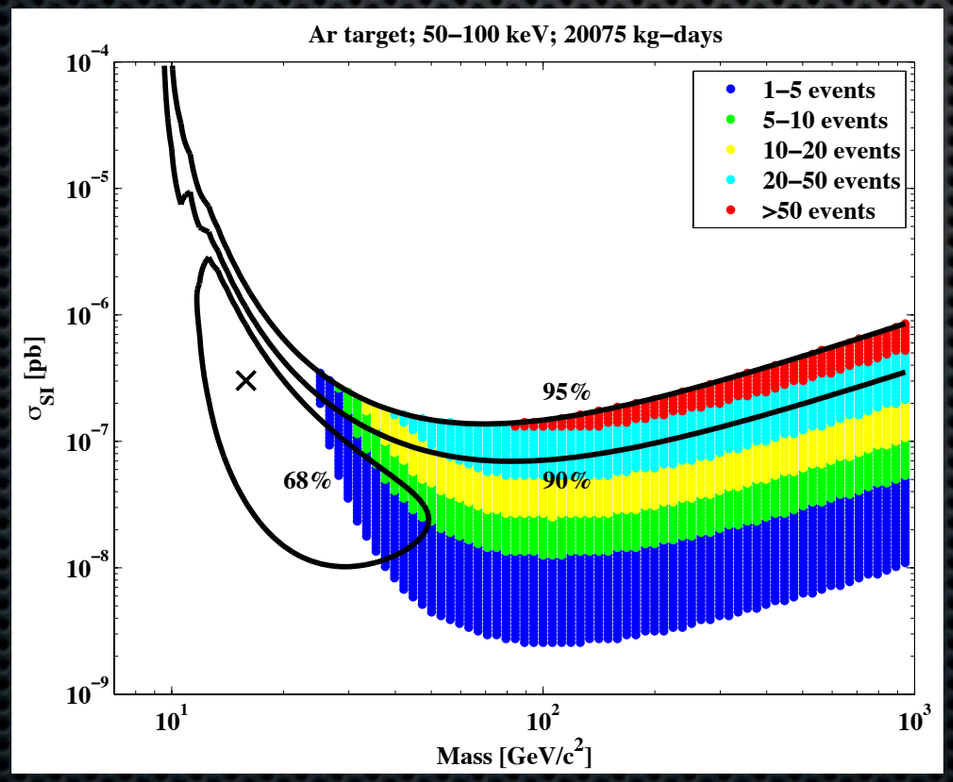


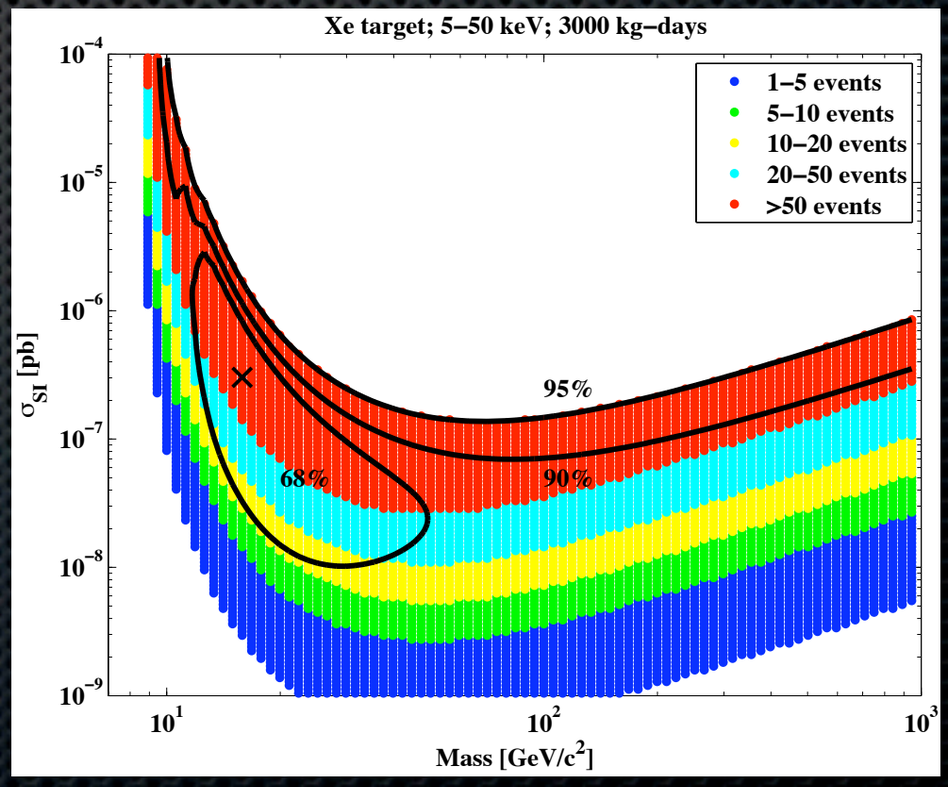
Motivation (I)

- **Question:** what would XENON100 and WARP140 see, if the two CDMS events were WIMPs?
- **Assumptions:**

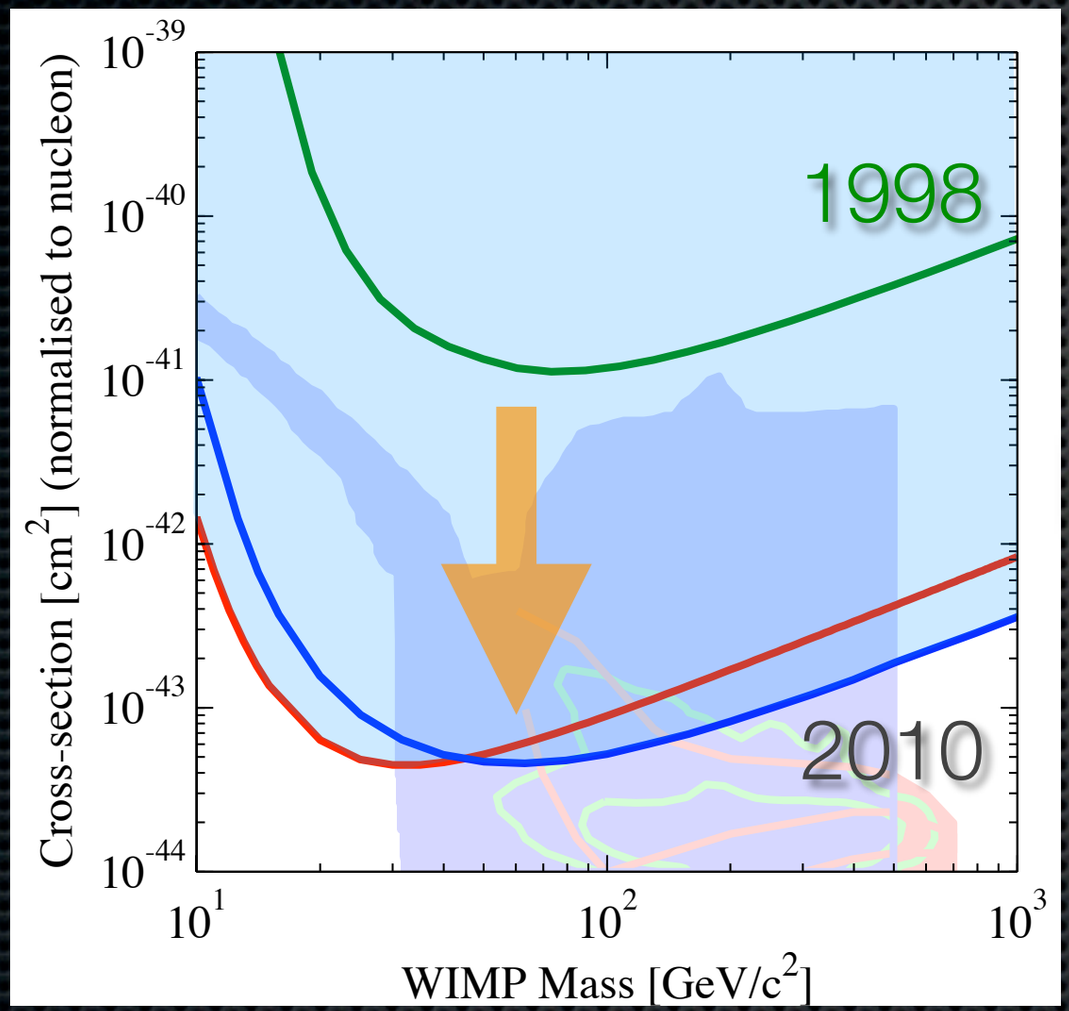
➡110 kg x 1 year x 50% signal acceptance = 20’075 kg days exposure (WARP-140)

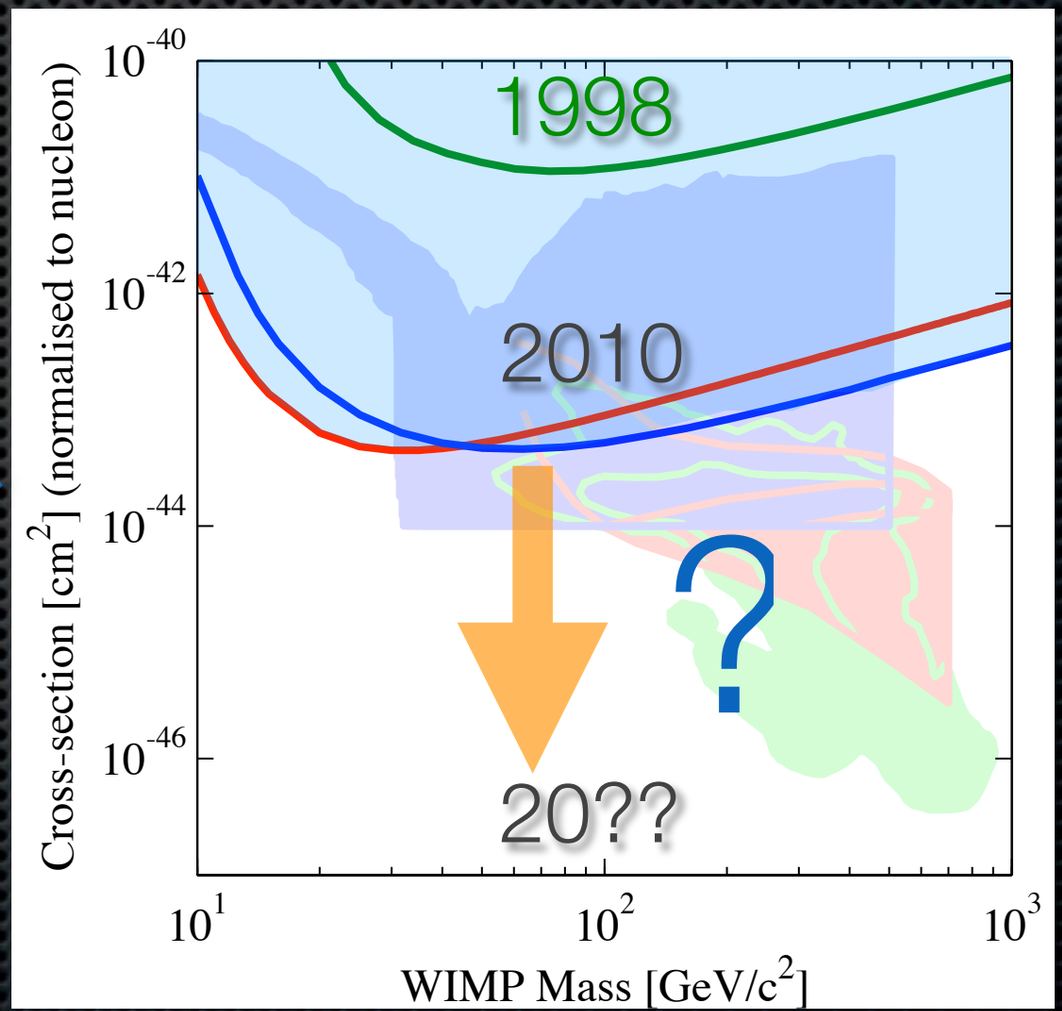
➡30 kg x 200 days x 50% signal acceptance = 3’000 kg days exposure (XENON100)





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!)

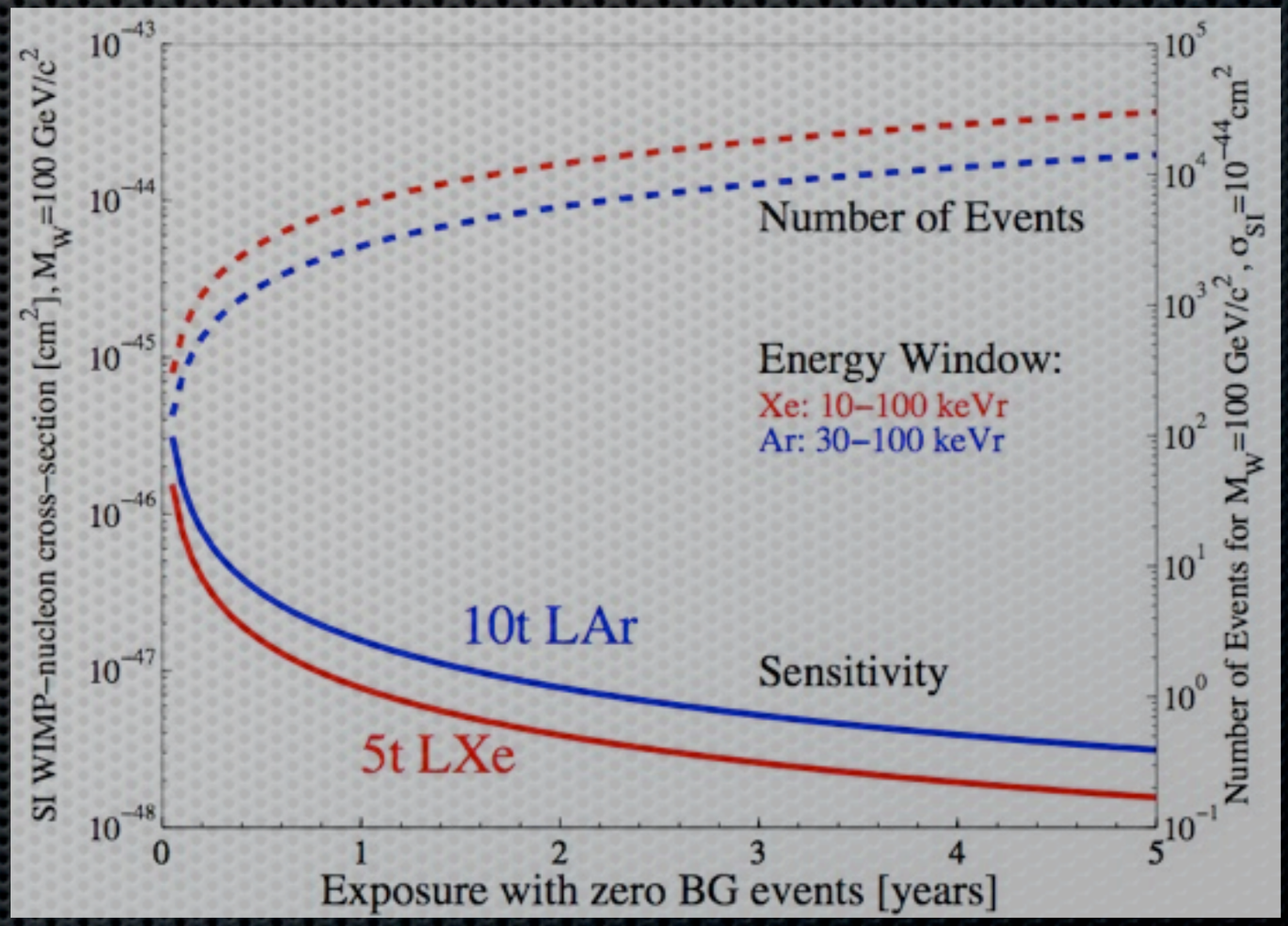
- raw BG: 0.1 mdru in LXe, with 99.9% rejection of ERs, based on the S2/S1-ratio (factor 100 better than current XENON100 background of ~10 mdru)

- 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 ^{atm}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

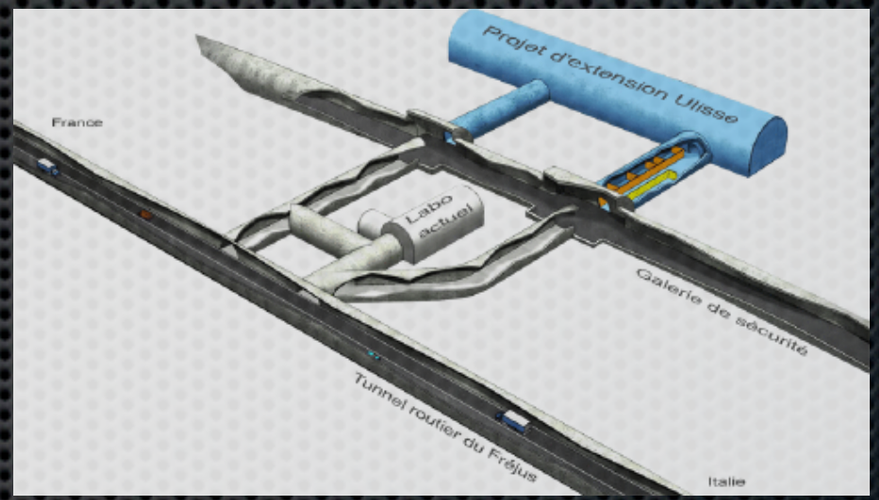
Final report

Technical Design Study

Rough time schedule after 2012

2010 - 2012:
R&D and Design Study

2013: Submission of LoI
engineering studies

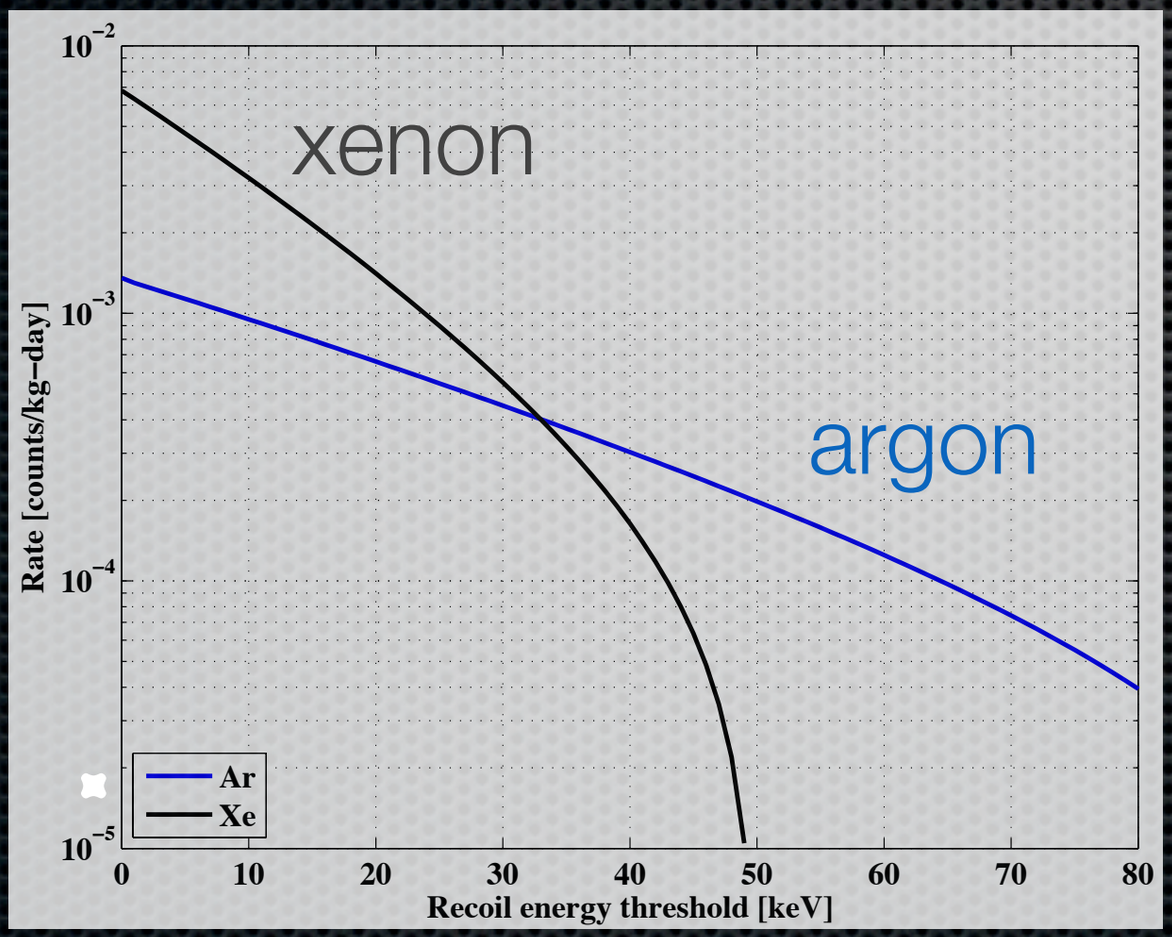


2014 - 2015:
Construction and commissioning

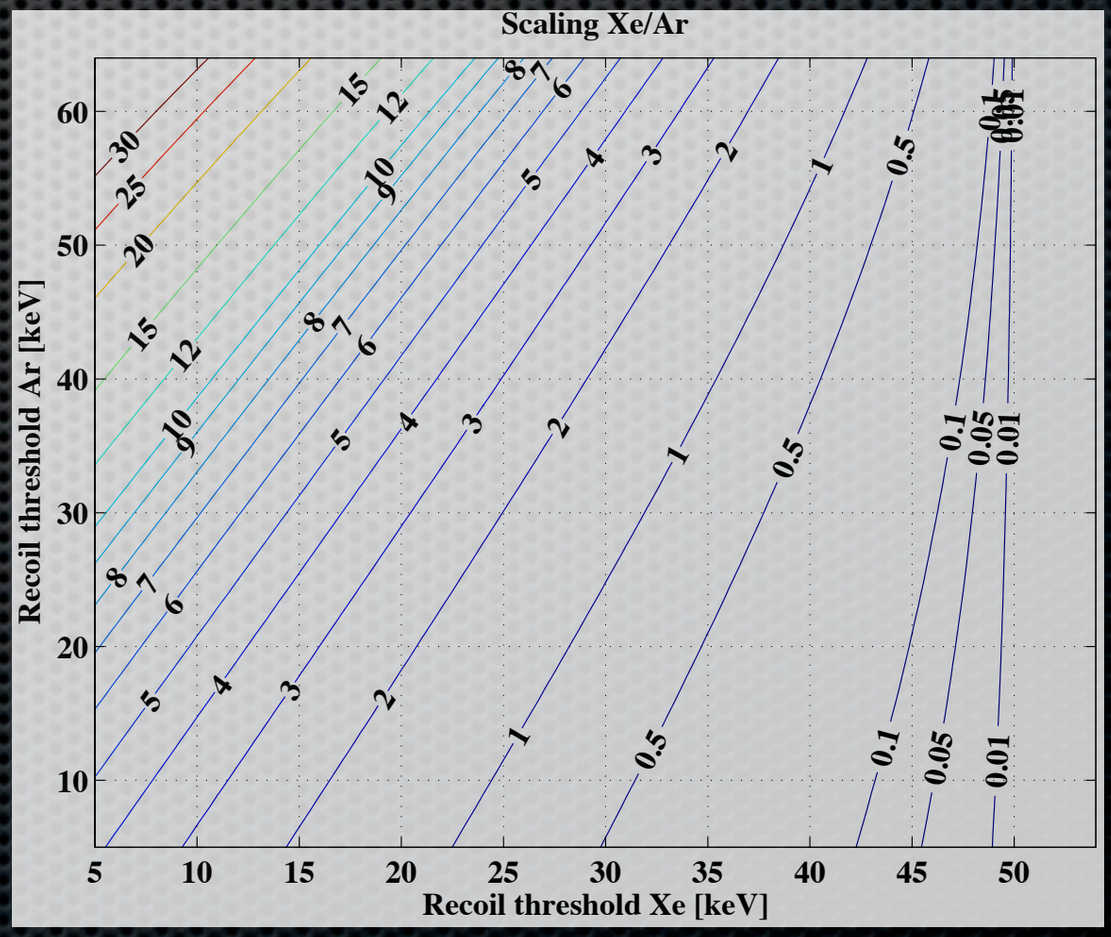
2016 - 2020:
Operation, physics data

Sensitivity comparison between LAr and LXe

- the relative sensitivity depends highly on the energy threshold

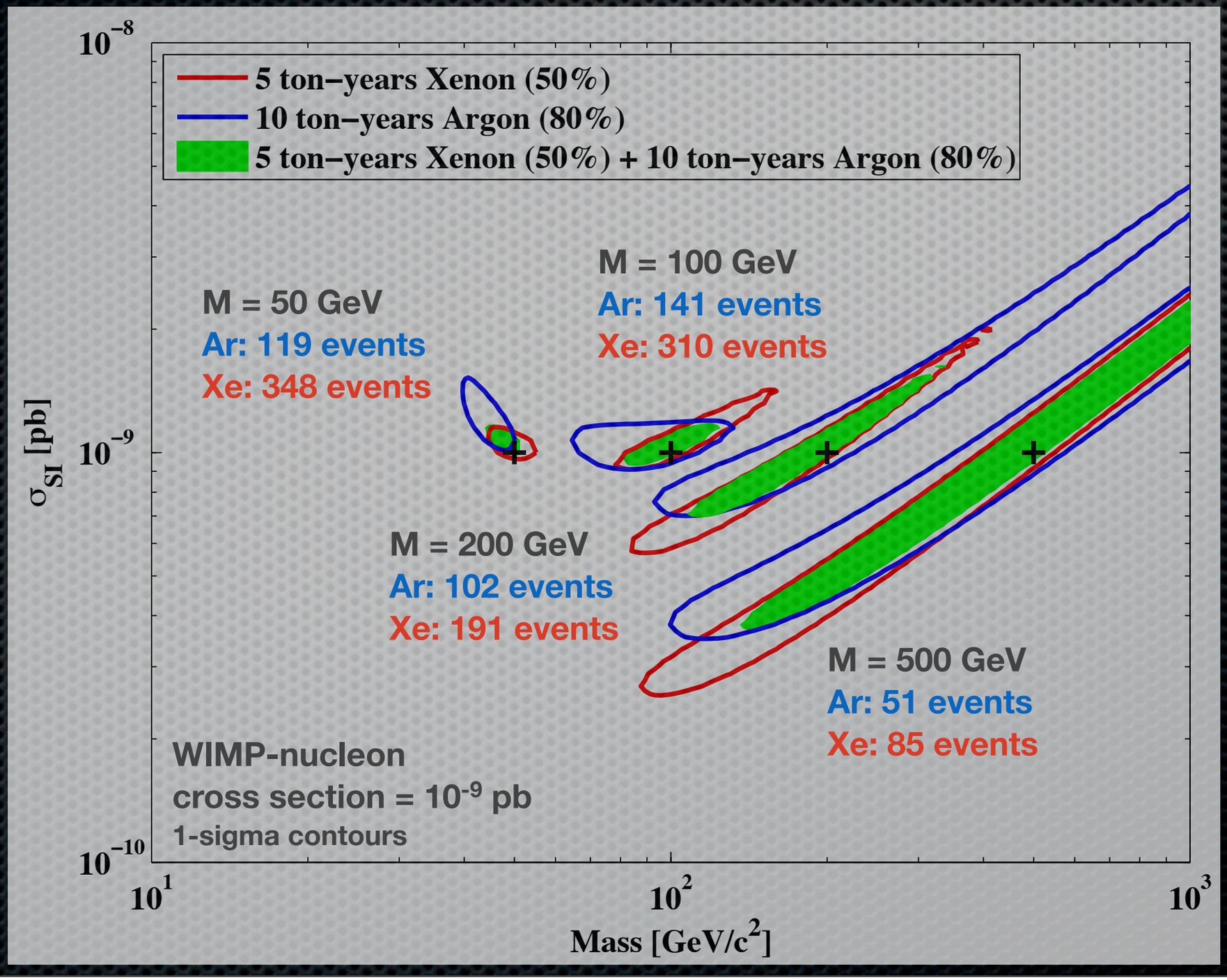


Integrated rate in Xe and Ar



Scaling factor between Xe and Ar

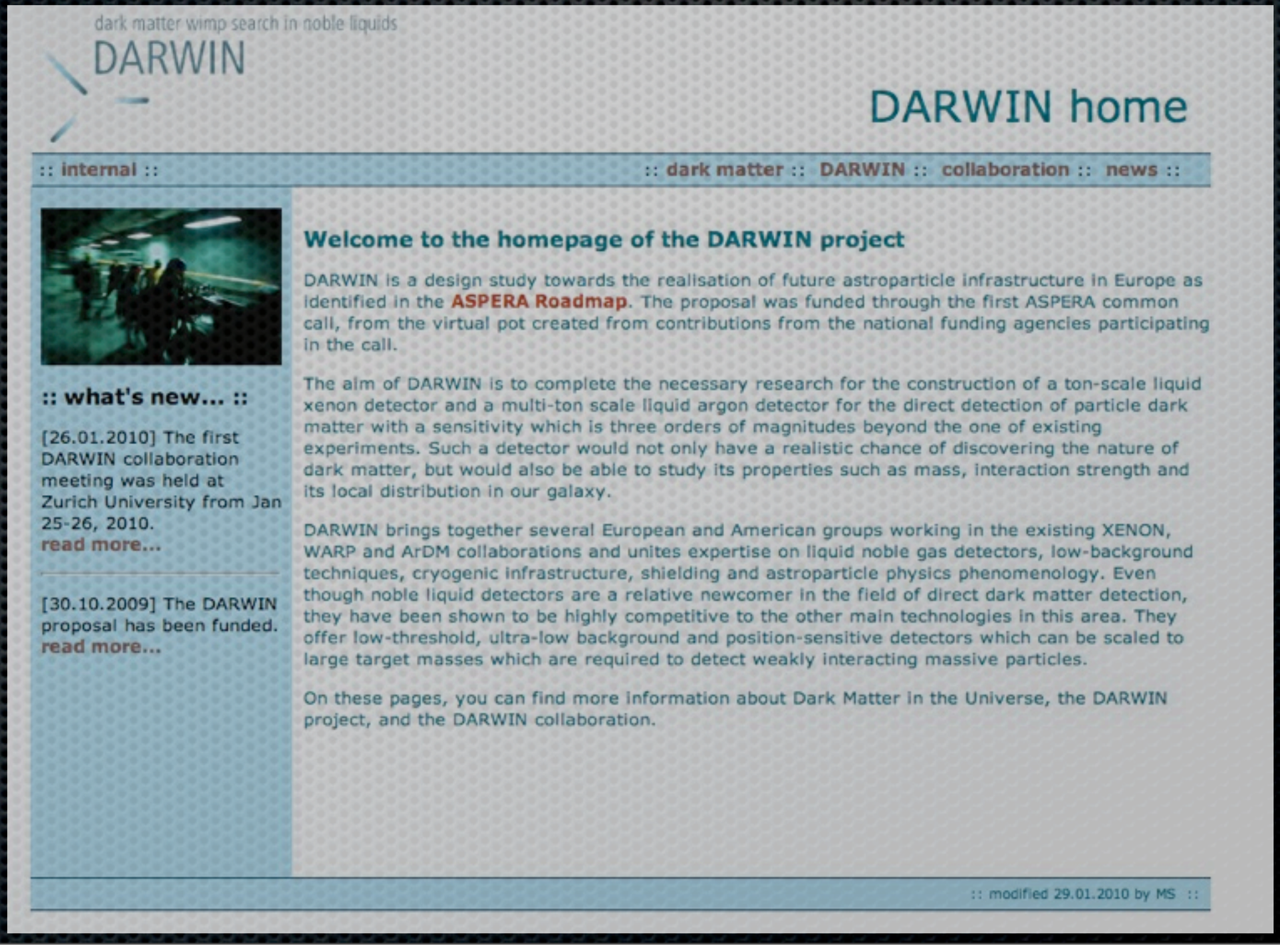
Complementarity between LAr and LXe



DARWIN Website

(darwin.physik.uzh.ch)

- stay tuned...



Backup slides

XENON1t reach