Concluding Remarks
VLVνT Workshop
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Uli Katz, Univ. Erlangen

This is NOT thought to be the summary of summaries!

1) Where we are, where we want to go

- After almost 20 years: first νT's in sea water "ante portas"
- Everybody is enthusiastically anticipating the future
- But: until recently lack of coherence, no united effort
  - no backup by politics and funding agencies
  - no realistic roadmap to "the KM3 project"
  - support by astroparticle community subject to conditions
  - no chance to obtain world-wide consensus on

NEED FOR A CUBIC KILOMETER νT
IN THE MEDITERRANEAN

§ NOW: the FP6 program has triggered a "unification process"

- Ø common effort to obtain funding
- Ø will it develop to a common effort to design and construct KM3?

§ Time scale: given by "community lifetime" and competition with ice detectors

- Ø interest fades away if KM3 comes much later than IceCube
- Ø remember: IceCube ready by 2010
- Ø we better start NOW (even without EU money?!) . . .

Imagine we fail at this point: What would it mean?

A FUTURE WITHOUT A NORTHERN-HEMISPHERE νT?

HOW DULL !!!

2) Physics Objectives and Implications for KM3

Physics objectives of current & future νTs:

importance for KM3

§ astrophysics: diffuse fluxes, point sources ***

- Ø point sources: need good angular resolution, medium energies
- Ø diffuse fluxes: large energies

§ dark matter ("low energies") **

- Ø What happens, if LHC discovers something?

§ neutrino oscillations (*)

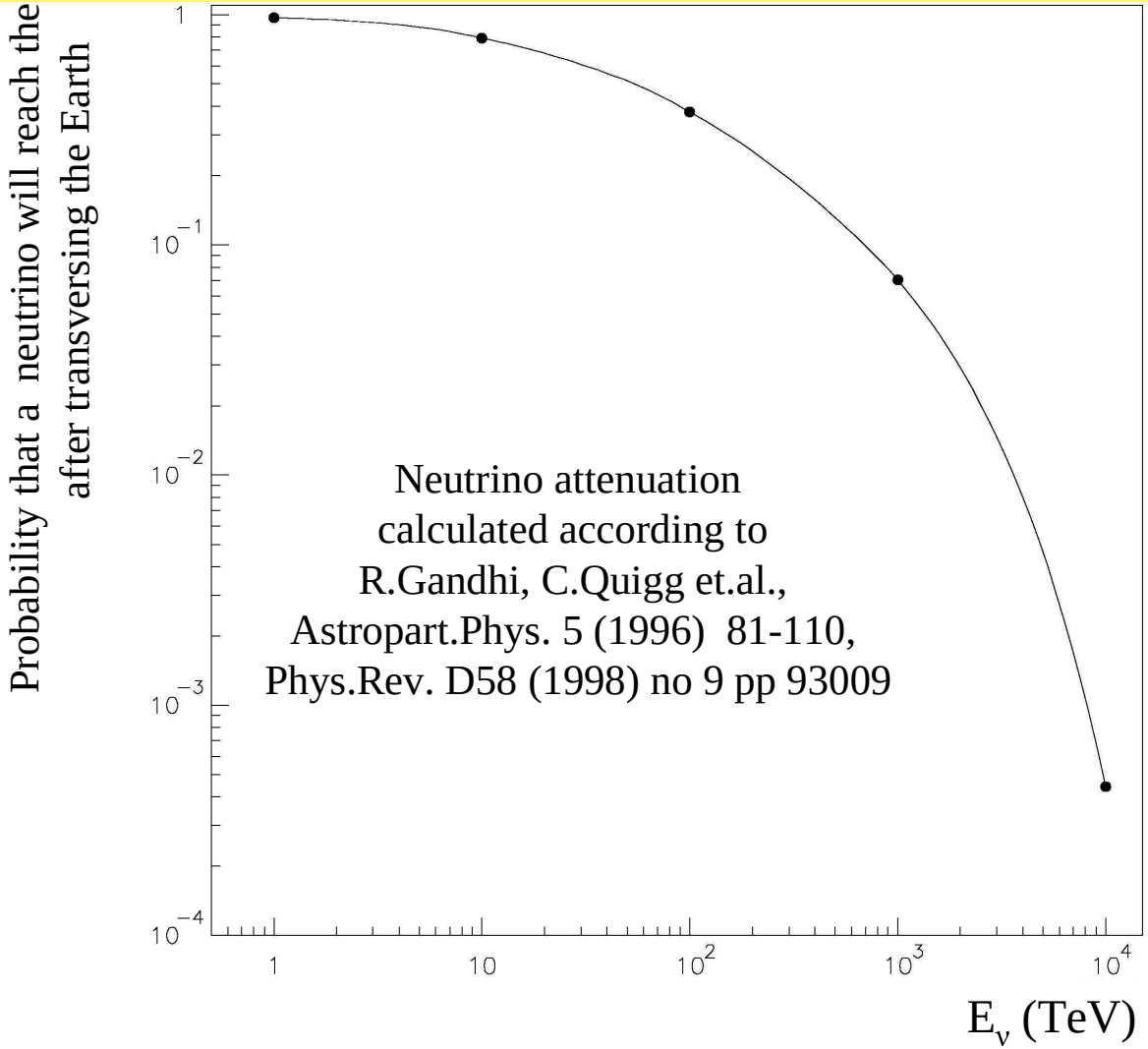
- Ø Probably covered by dedicated experiments

§ others: t.b.worked out

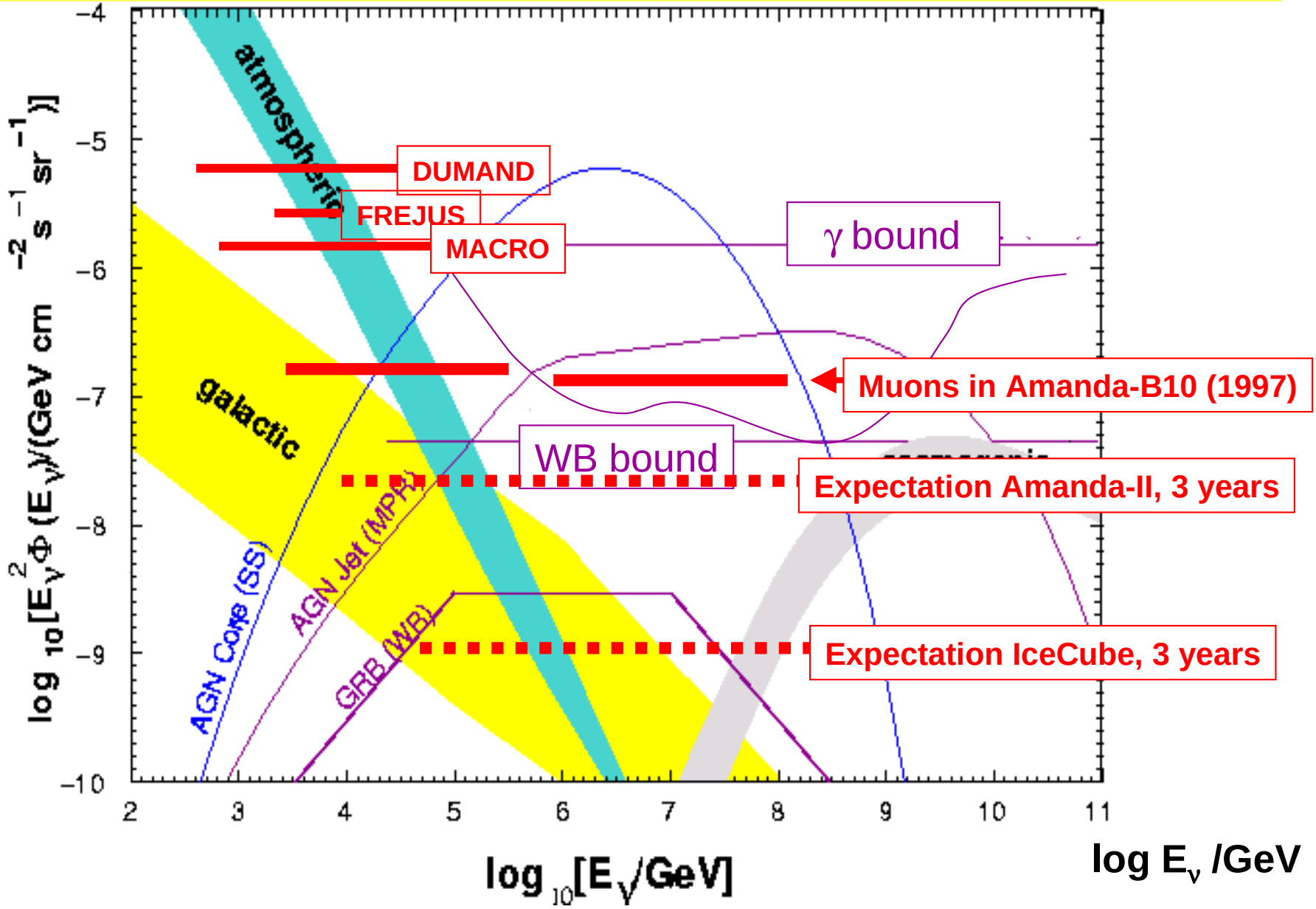
NEEDS DISCUSSION, ENERGY RANGE CRUCIAL FOR DESIGN !

=> Basic requirements:

- Ø affordable !
- Ø 4 pi acceptance ?



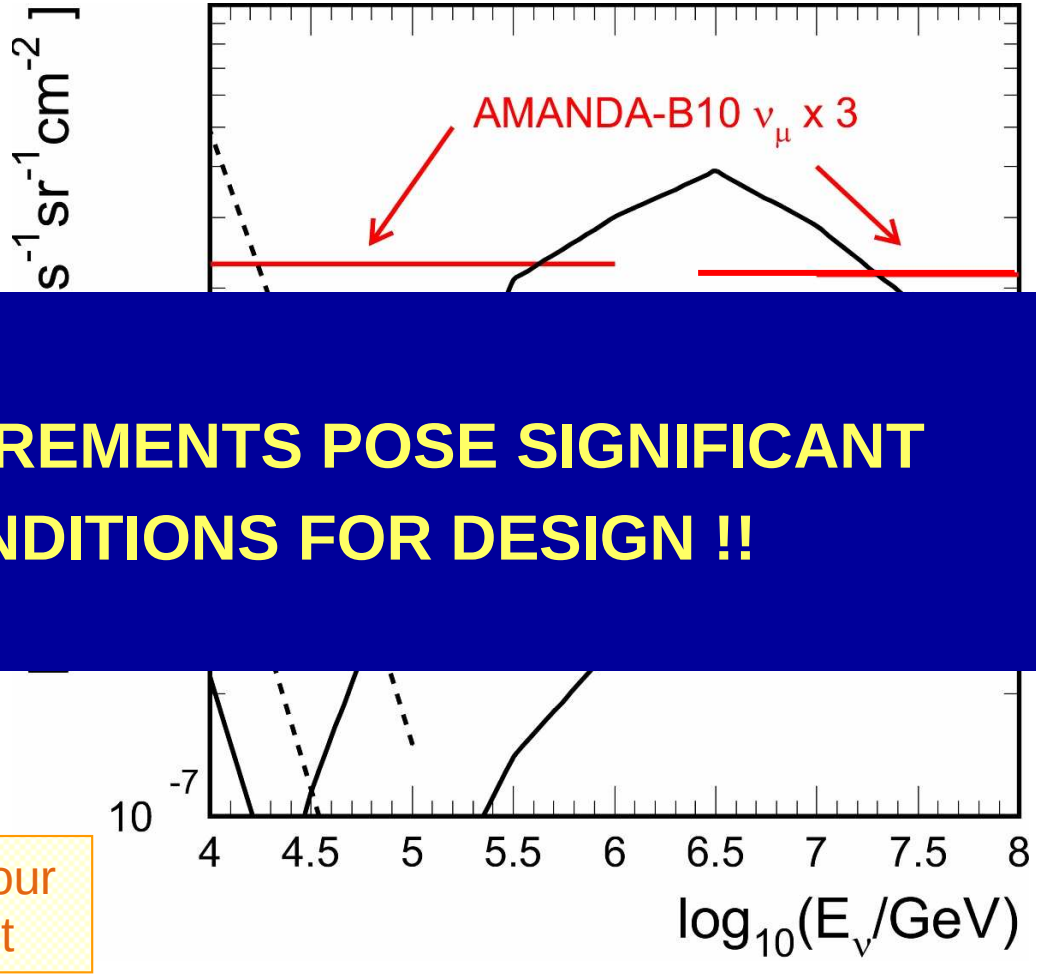
Ø extendable ? (must be able to react to new developments)



Ø sensitivity to muons AND to showers !
(also gains from "looking upward")

assuming $\nu_e:\nu_\mu:\nu_\tau = 1:1:1$ @ Earth

- multiplicative factor 3 applied for single ν_μ channel



=> ALL THESE REQUIREMENTS POSE SIGNIFICANT BOUNDARY CONDITIONS FOR DESIGN !!

2000 ν_μ analysis will yield all-flavour limit comparable to cascade limit

3) Lessons to be learned from current projects

§ Lots of tested technological solutions

Ø which of them can be used "as are"?

Needs critical review !

Ø offer basis for (some? many?) future developments

Ø WARNING: existing solutions are well-tested, low-risk ...

BUT may reduce acceptance for new, better approaches

§ Make best use of experience gained!

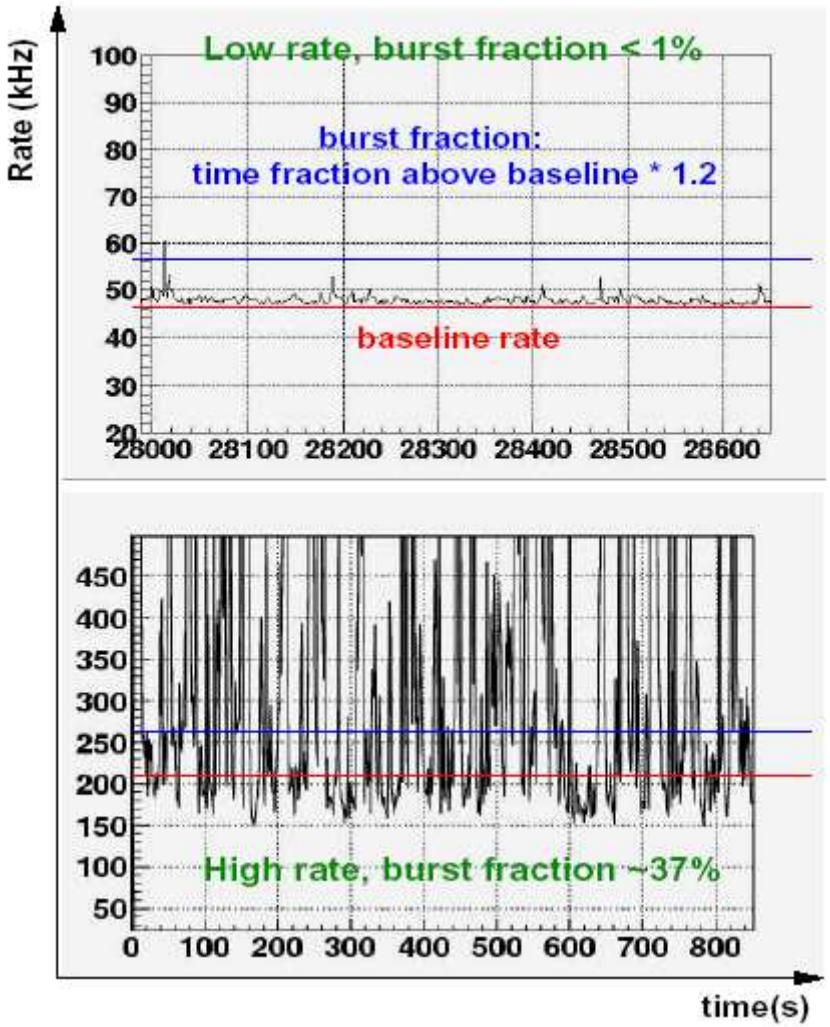
Ø crucial failures may appear where they are the least expected

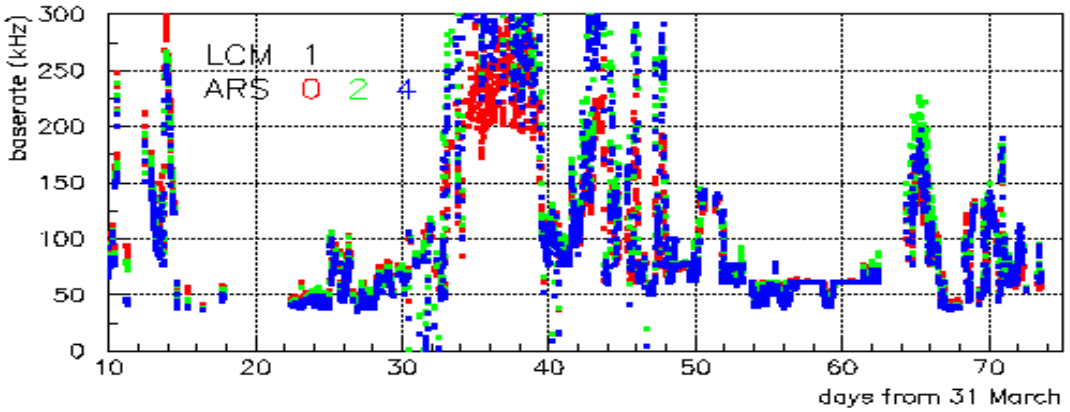
- **complexity of detectors must be reduced**
- **quality control and assurance will be a central topic**

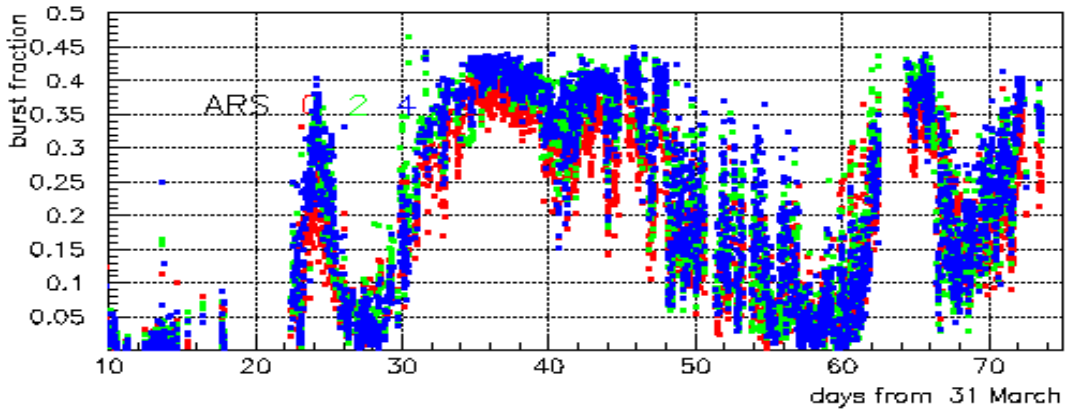
Ø time schedules are difficult to control
but are crucial for the KM3 project

- Imagine **construction and deployment take longer than the detector lifetime!** (IceCube: ~50%)
- DANGER: **technical solutions outdated by ~10 years at construction time**
(imagine building km3 with technology from 1990).

Ø understand well (better?) the environmental conditions







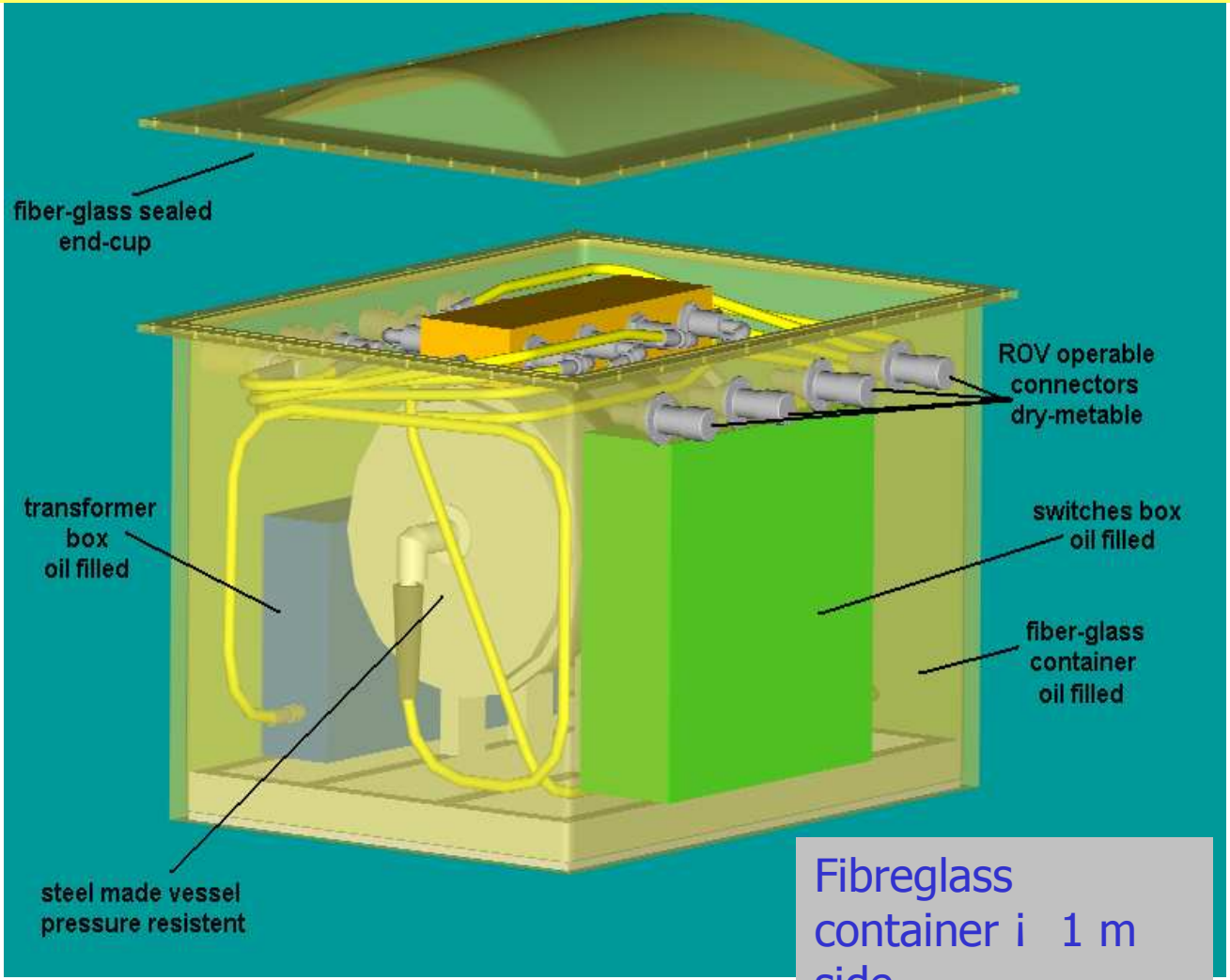
Large variability of rates and burst fraction

Essentially bioluminescence

More than 90% of time below 200 kHz

JB i

§ a lot of interesting developments are under way, e.g. by NEMO



Fibreglass container i 1 m side

4) Asking Questions and Collecting Options ...

§ **... is the most important task right now**

since it helps us to identify problems, find solutions
and to initiate / continue / intensify the necessary R&D steps

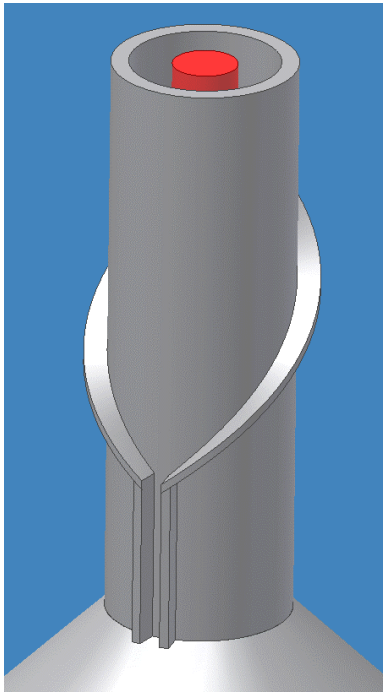
§ **a selection of such questions/options (strongly interrelated!):**

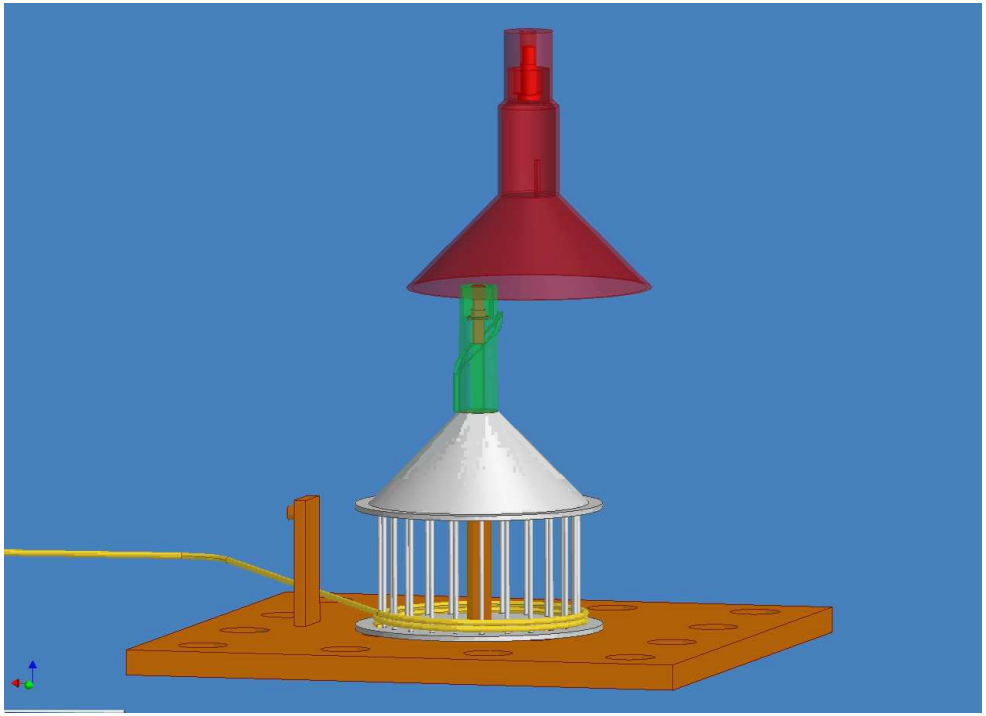
=> How will the detector look like?

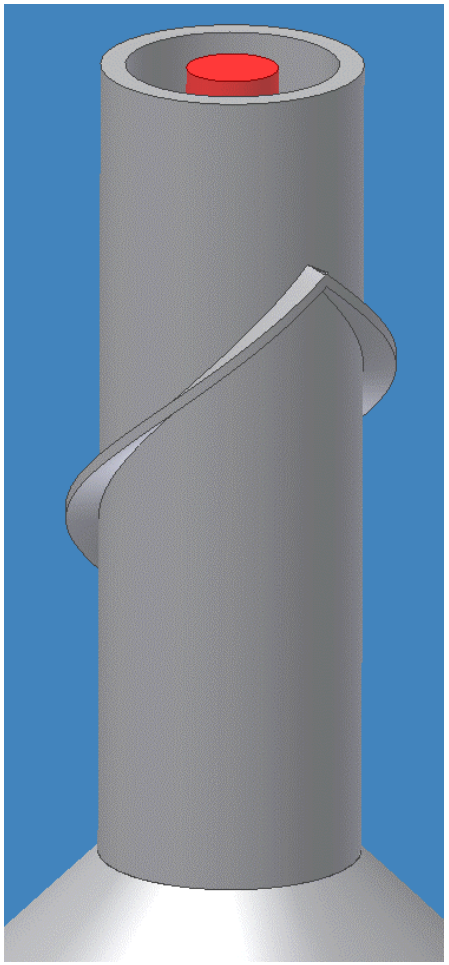
- Ø which structures are optimal?
- Ø dry or wet connections, or wet from top, or ...?
- Ø how to avoid single point failures?
- Ø star or linear or circular interconnection topologies or **. . .** ?
- Ø how to optimize architecture? - **needs thorough simulation!**

=> Sea operations are a major part of the project and
must be considered from the very beginning

=> Dry or wet connections, or wet from top, or . . . ?







=> What materials to use?

- Ø replacement(s) for titanium?
- Ø composite solutions
- Ø polyurethane encapsulation (as for hydrophones)?

=> Cables and connectors?

- Ø connectors are extremely expensive –
  how to reduce number, in particular wet-matable ones
- Ø reliability is crucial !

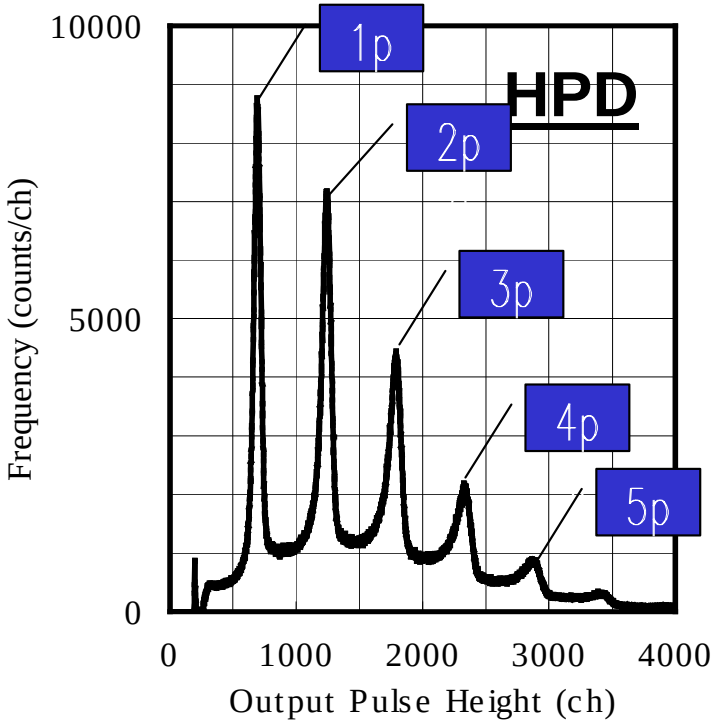
=> Which photodetectors?

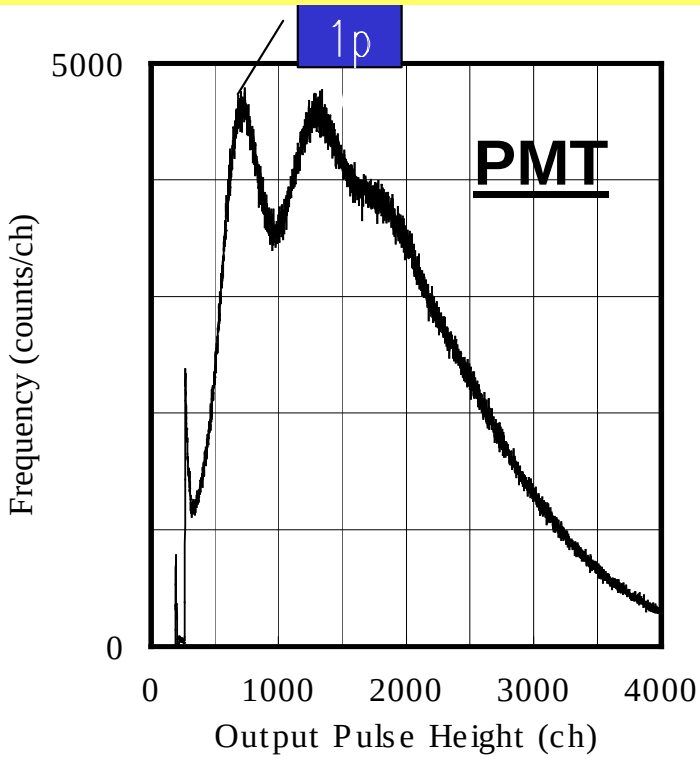
can we improve on:

quantum efficiency * sensitive area / cost ?

time resolution?

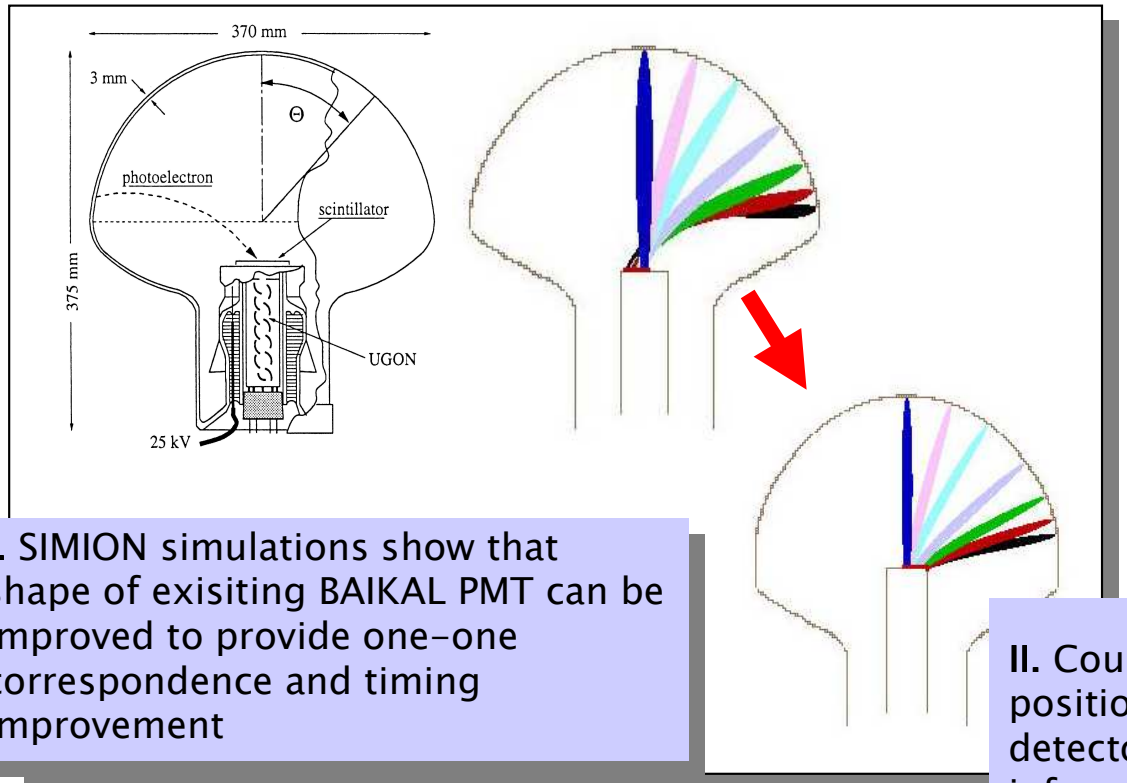
single photon electron resolution?





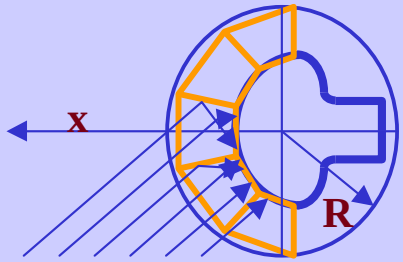
Remember: 10% larger PM distance @ same efficiency
=> ~ 30% more detector volume !

=> is directional sensitivity possible?

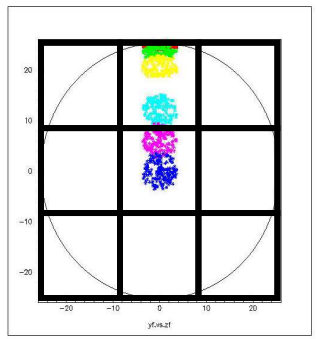


I. SIMION simulations show that shape of exisiting BAIKAL PMT can be improved to provide one-one correspondence and timing improvement

III. Coupling to a light guide system also provides information on the detected light direction



II. Coupling to a position sensitive detector provides information on the photoelectron emission point



=> How to get data to shore (and from shore to detector)?

- Ø needs integrated concept for

  sensor – frontend electronics – data transport – technology on shore

- Ø Promising approach using commercial optical solutions
- Ø Can we send analogue signals to shore?

=> How do we calibrate the detector?

Ø are current calibration tools adequate/scalable/reasonable?

Ø is it feasible/helpful to separate detection and calibration units?

Ø do we need a surface array? How to decide and design it?

Cooperation with Industry

- **ν telescopes do and will need industrial partners for various components**
  - cables and connectors
  - IT solutions for data transport
  - photo sensors
  - glass spheres
  - deep-sea technology, . . .
- **Many companies followed invitation to VLVνT workshop**
  - mutual interest !?
  - we must find / maintain suitable “interfaces” to describe needs and problems
  - we astroparticle physicists must not re-invent the wheel, even if we are capable of doing so !
- **Integration of SME’s in Design Study is of strategic value and politically adequate**

Cooperation with other Scientific Partners

- **ESONET (biology, oceanography, environment, . . .)**
  - there seems to be a lot of potential for synergetic cooperation
  - we'll have to understand how to combine our interests without compromising our scientific goals

- **GRID**
  - mutual interest in cooperation !?
  - may provide solutions for a data analysis and reconstruction

VLVνT Reconstruction Model

Grid data model applicable, but maybe not computational model …

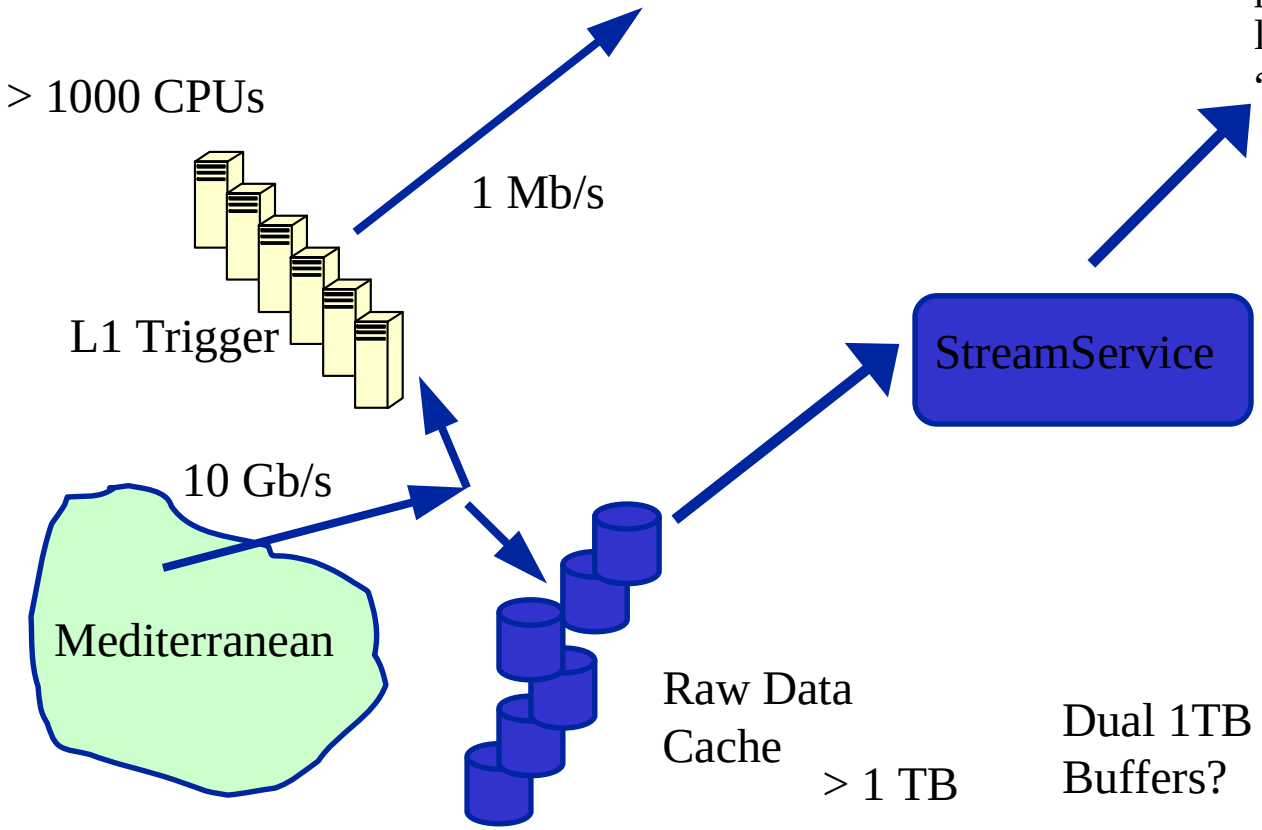
ØDistributed Event Database?

ØAuto Distributed Files?

ØSingle Mass Store + “Thermal Grid”?

Grid useful here – get a lot but only when you need it!

All connections through single pipe probably bad. Dedicated line to better-connected “redistribution center”?



This needs work!! 2 Gbit/s is not a problem but you want many x 80 Gbit/s!

Dual 1TB Circular Buffers?

The Future

Design Study:

Call expected by 11.11.2003

Brussels deadline for proposal: 4. March 2004

ApPEC will review astroparticle proposal for DS's and possibly issue recommendations / priority list (meeting in Munich, 25.11.2003)

Jos Engelen: "KM3 project fits very well into DS frame"

If successful: provides funding for R&D studies (3 – 4 years)

Result can / should / must be a **technical design report**

=> start construction of detector thereafter

Site Decision

- decouple site decision from R&D work towards KM3

- for simulations, use "site" as "mathematical symbol" including
  - depth
  - distance to shore
  - water transparency
  - bioluminescence
  - sedimentation
  - . . .

- However, the final detector design needs the site decision
  => this sets the/a time scale !

We NOW have the HISTORICAL chance to realize KM3

No guarantee – but realistic possibility

LET ’S GO FOR IT !

Ø be open to all ideas and options
Ø solve open questions on scientific basis

Thanks to all who contributed to the workshop and will carry on the efforts towards KM3 !

ØVLVνT Workshop was first in a series
=> next location and date to be announced soon

See you all there !