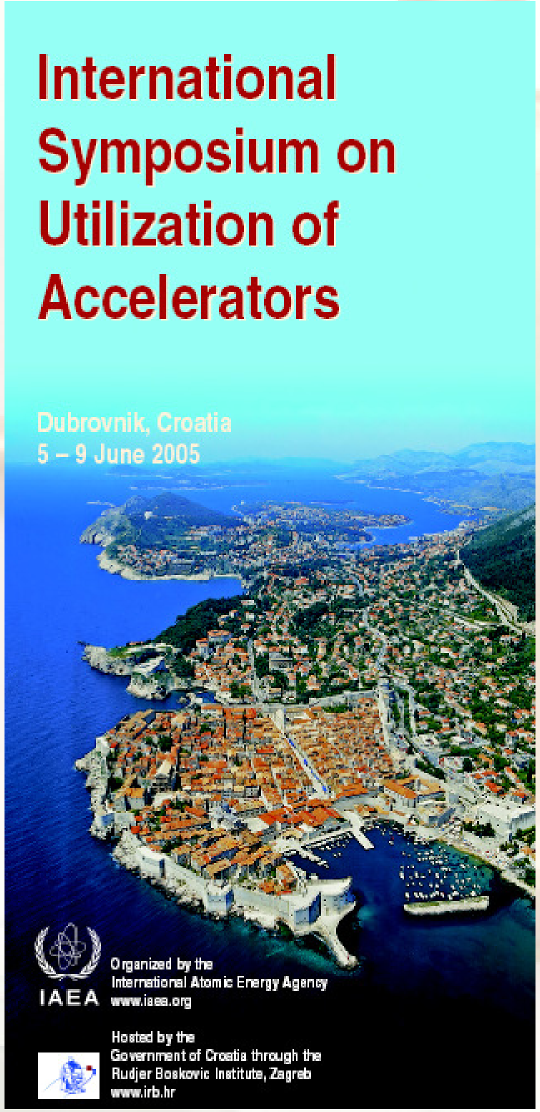

A REFERENCE CONCEPT FOR ADS ACCELERATORS*

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France

*Work accomplished within the
European Commission Contract N° FIKW-CT-2001-00179, "PDS-XADS"

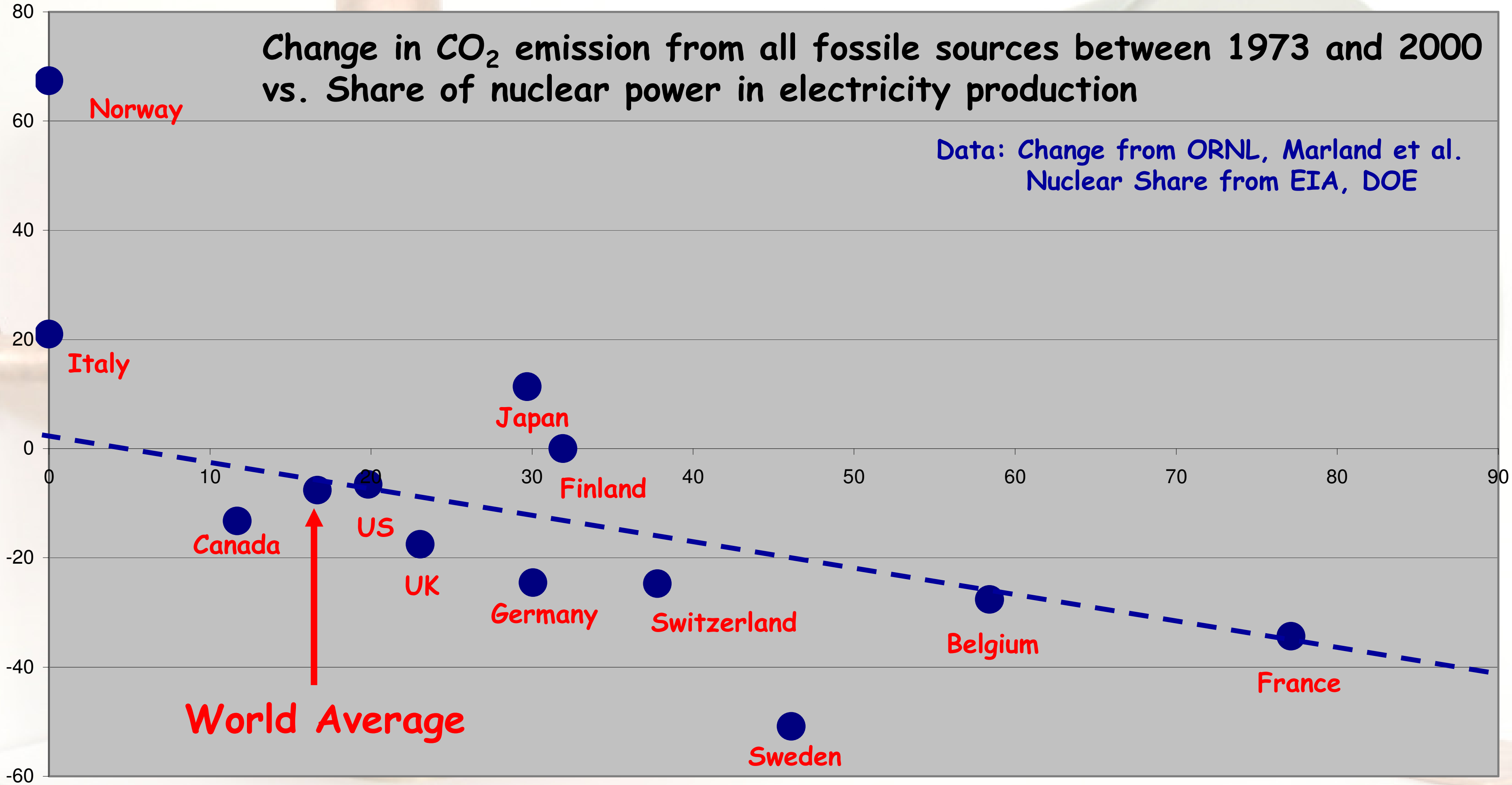
Cumulated CO_2 emissions from different means of electricity production

Production Mode	grams CO_2 /kWh
• Hydro-electricity	4
• Nuclear	6
• Wind	3-22
• Photovoltaic	60-150
• Combined-cycle gas turbine	427
• Natural gas direct-cycle	883
• Fuel	891
• Coal	978

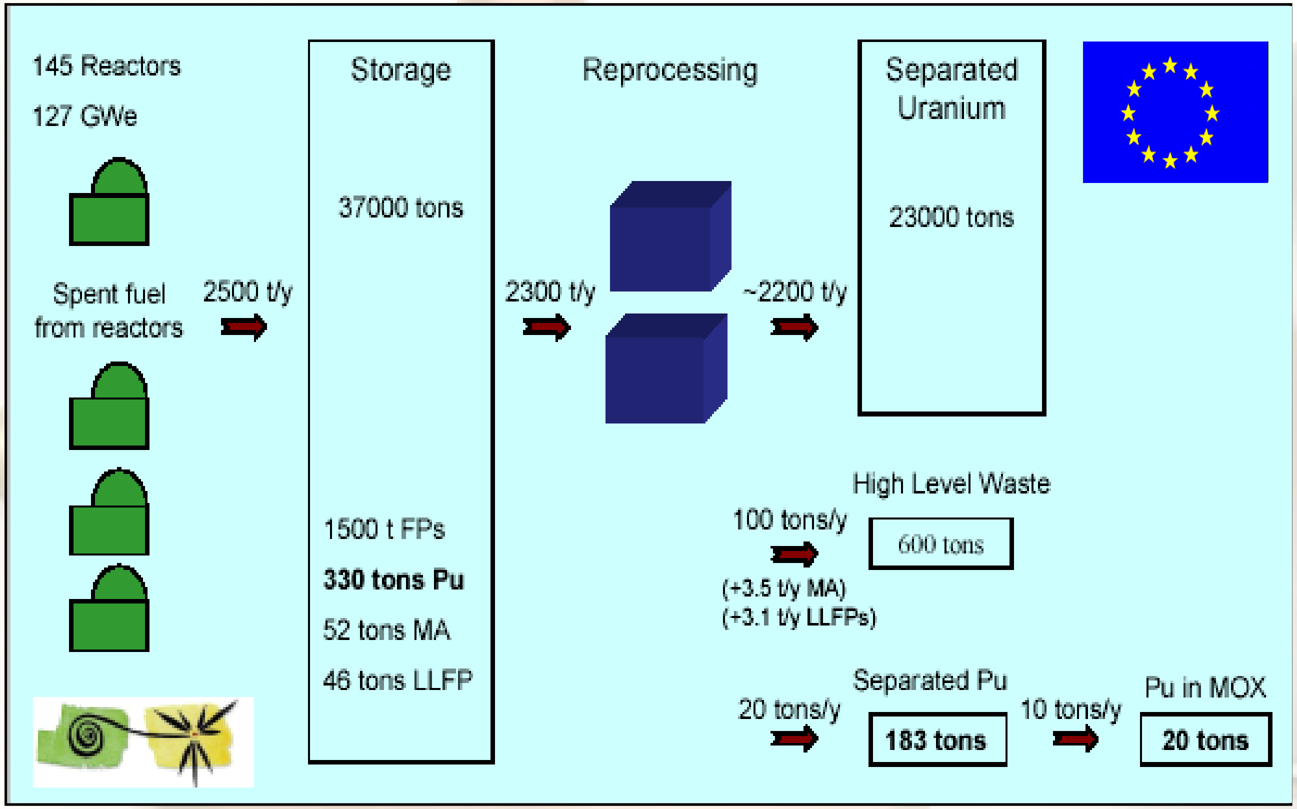
Range reflects the assumption on how the large amount of energy for making the systems are generated!! (Wind, Photovoltaic)

Source: SFEN, ACV-DRD Study

Introduction of Nuclear Power and Reduction of CO_2-emission



Nuclear energy makes 880 TWh/y (35% of EU's electricity), but LWR produce important amounts of high level waste



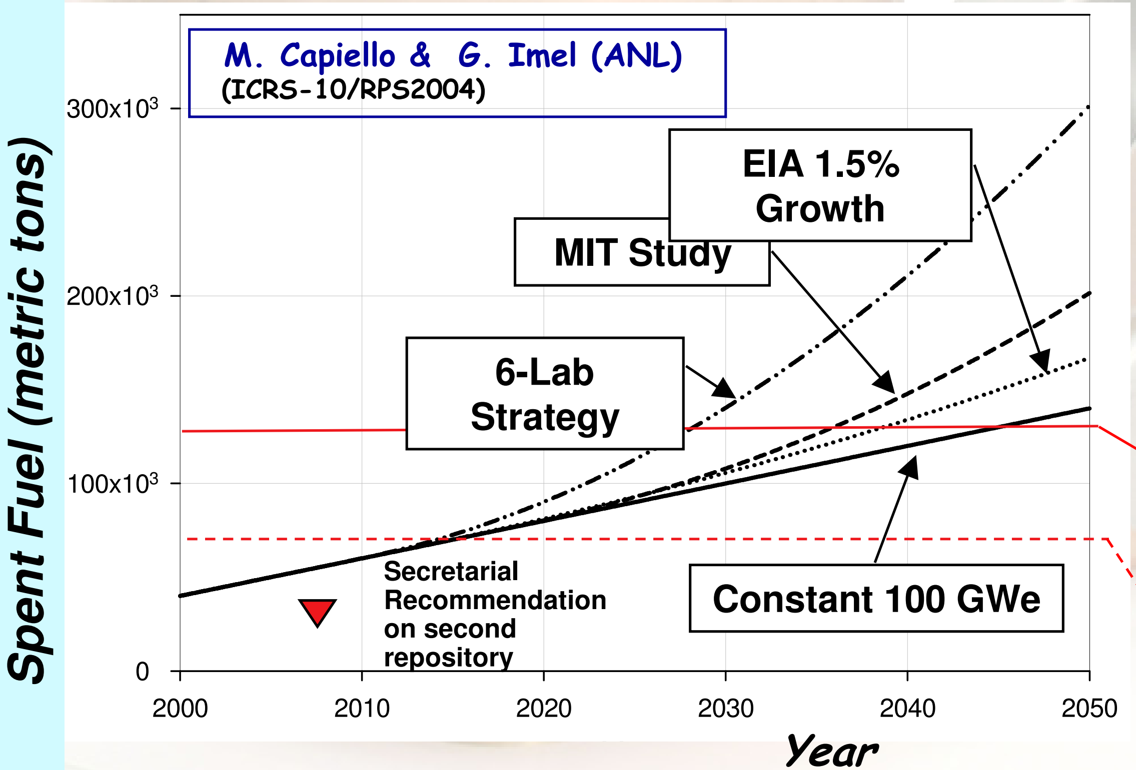
Nuclear Waste from present LWR's (Light Water Reactors)

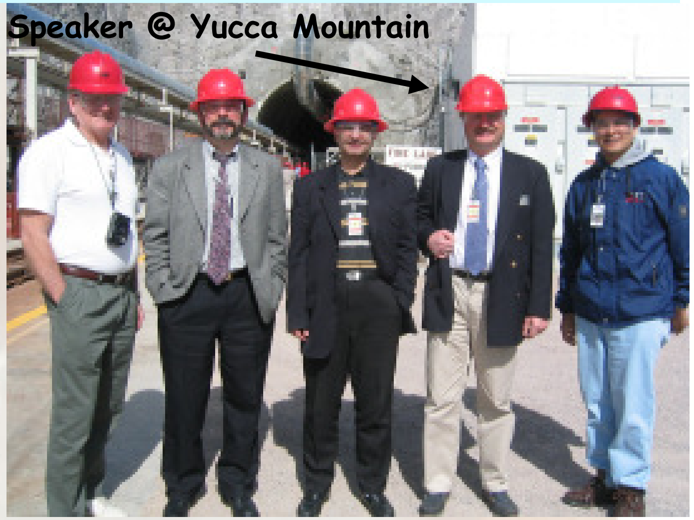
- ➔ is highly radiotoxic (10^8 Sv/ton)
- ➔ at the end of present-type nuclear deployment about 0.3 Mtons, or 3×10^{13} Sv, compare to radiation workers limiting dose of 20mSv
- ➔ the initial radiotoxicity level of the mine is reached after more than 1 Mio years
- ➔ worldwide, at present 370 "1GW_{el} equiv. LWR" produce 16% of the net electricity

- **Geologic time storage of spent fuel is heavily debated**
  - ➔ leakage in the biosphère ?
  - ➔ expensive (1000 €/kg), sites? (Yucca mountain would hold 0.07 Mio tons!!)
  - ➔ public opposition
- **Long term Energy Concerns**
  - ➔ availability of oil, gas, coal (and uranium!)
  - ➔ global warming induced by fossile fuels

The Yucca Mountain Dilemma

- In the United States, the current plan is to send all spent nuclear fuel to the Yucca Mountain Repository. The challenge they are faced with is that new repositories will be needed as nuclear energy continues or grows.

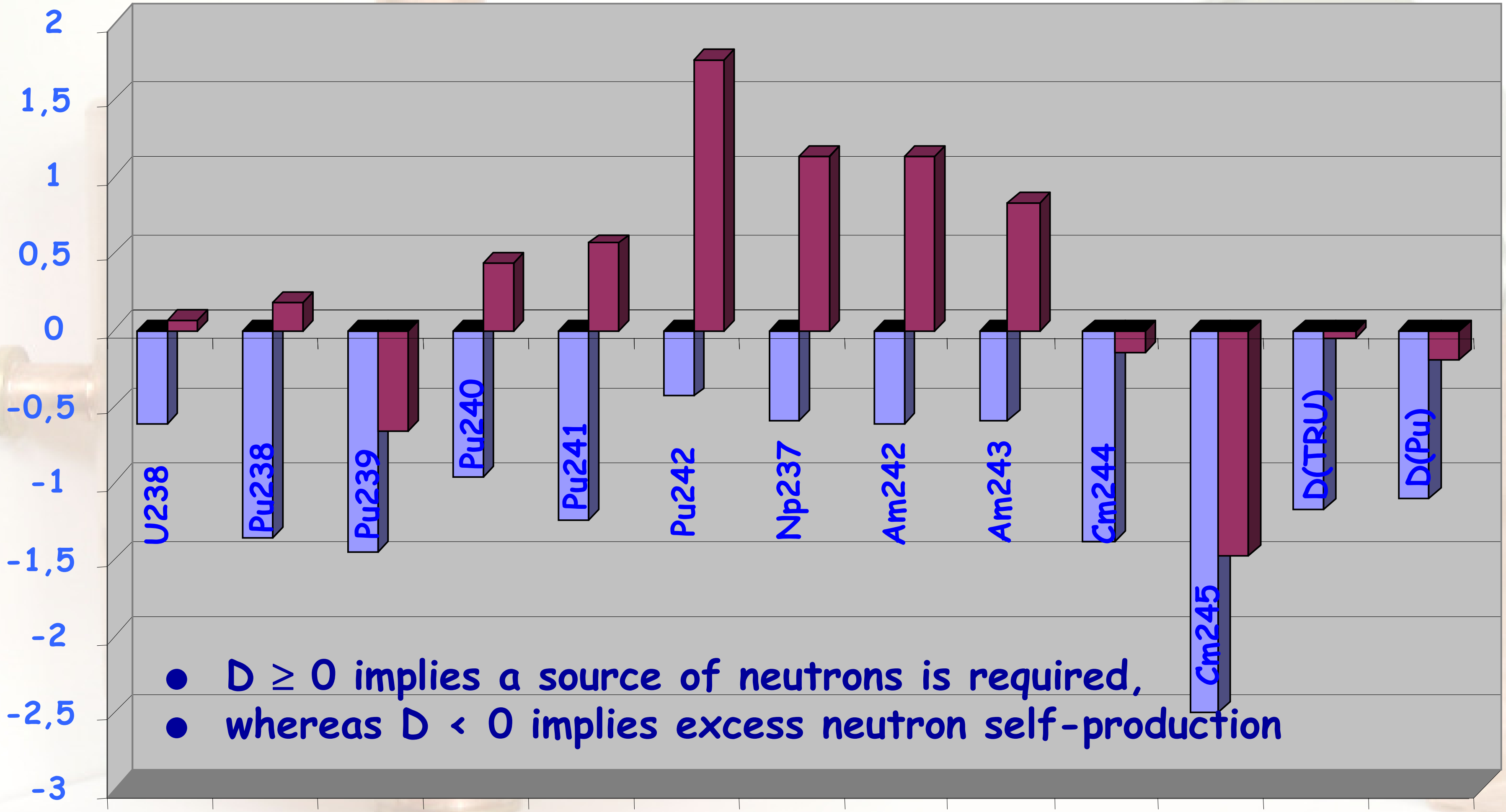




Legislated capacity

Capacity based on limited exploration

Neutron consumption per fission ("D-factor") for thermal (red) and fast (blue) neutron spectra



- D ≥ 0 implies a source of neutrons is required,
- whereas D < 0 implies excess neutron self-production

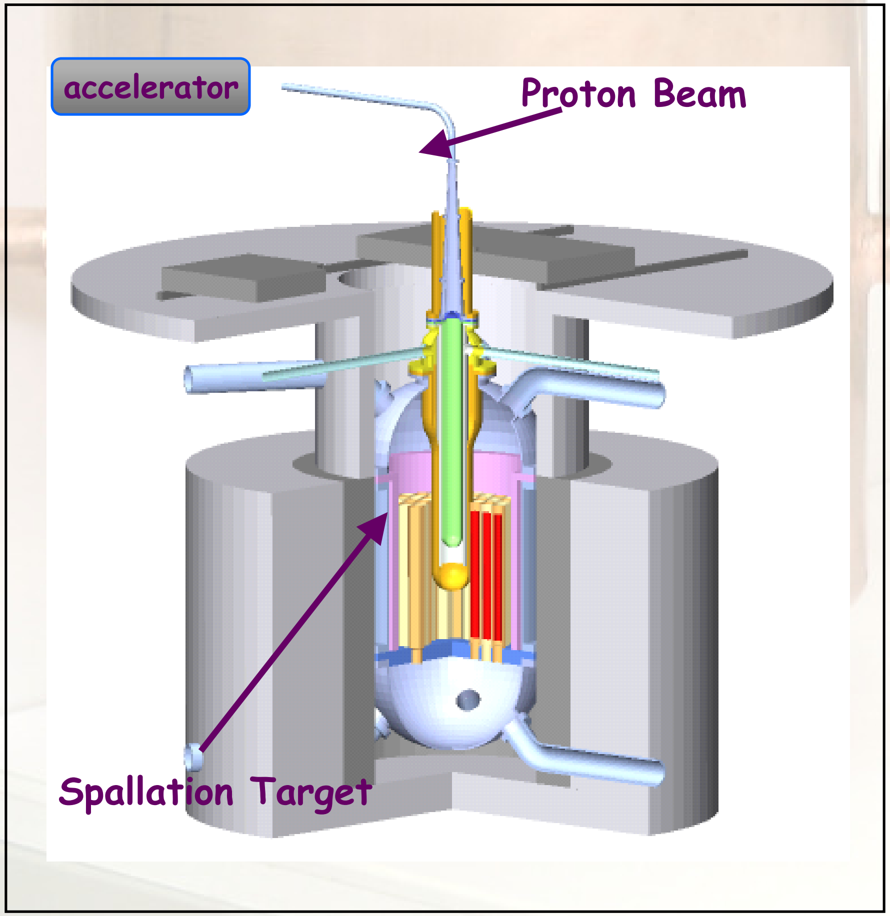
Where should we buy the needed fast neutrons?

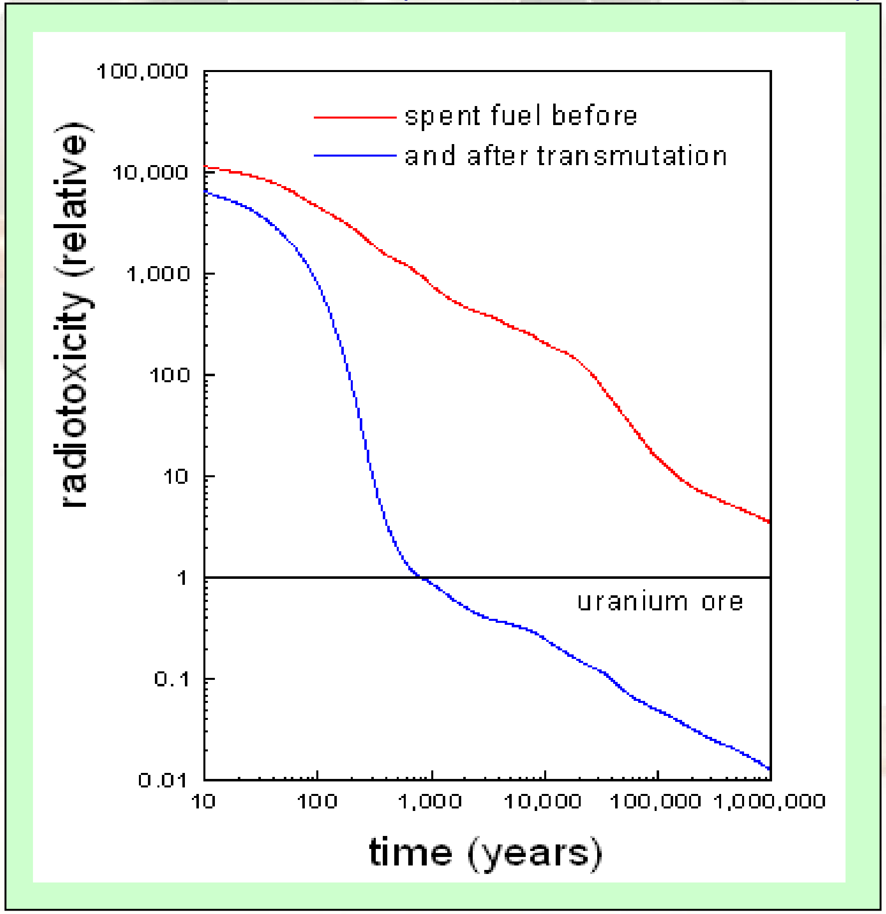
ADS: Accelerator Driven (subcritical) System for transmutation

Both critical reactors and sub-critical Accelerator Driven Systems (ADS) are potential candidates as dedicated transmutation systems.

Critical reactors, however, loaded with fuel containing large amounts of MA pose safety problems caused by unfavourable reactivity coefficients and small delayed neutron fraction.

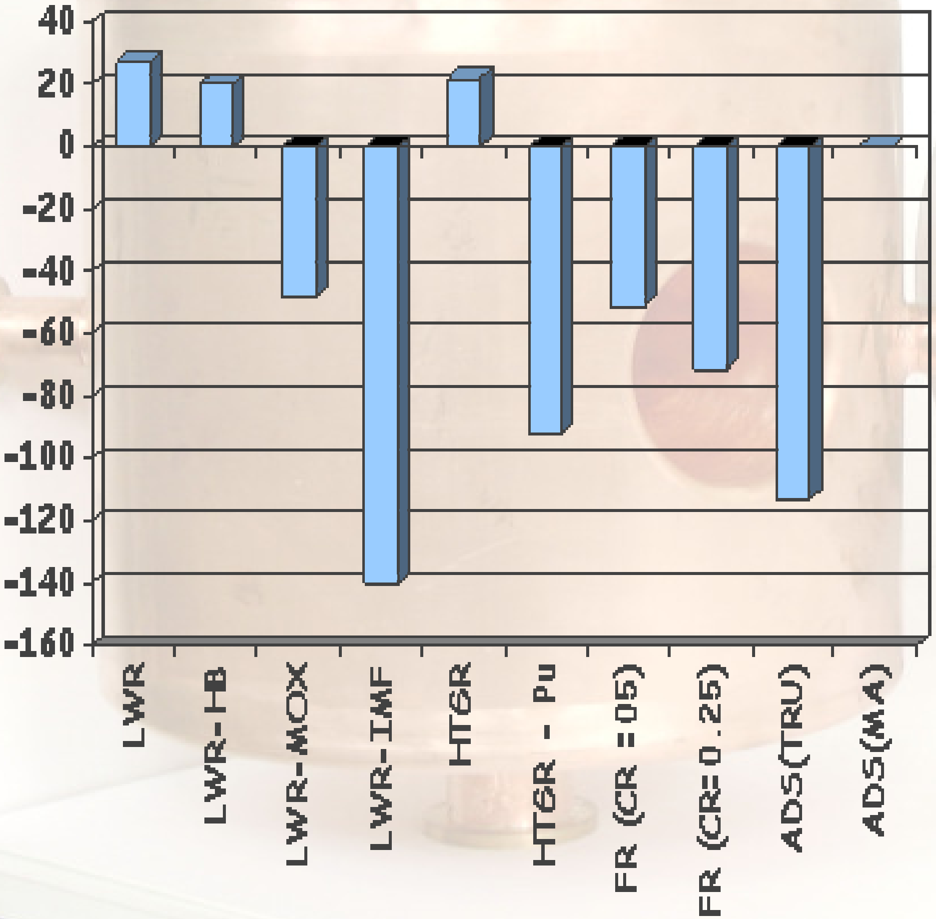
ADS operates flexible and safe at high transmutation rate (sub-criticality not virtue but necessity!)



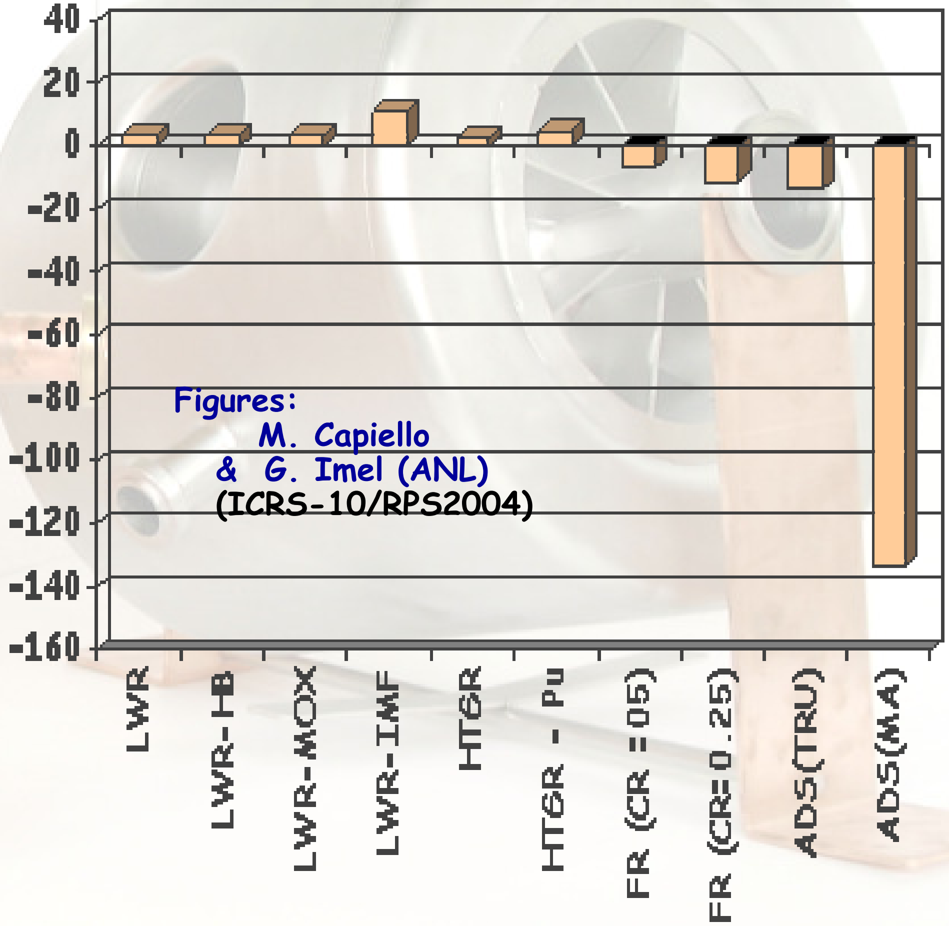


Burning and breeding efficiency of different reactor types

- The ADS is most efficient at Minor Actinide Transmutation

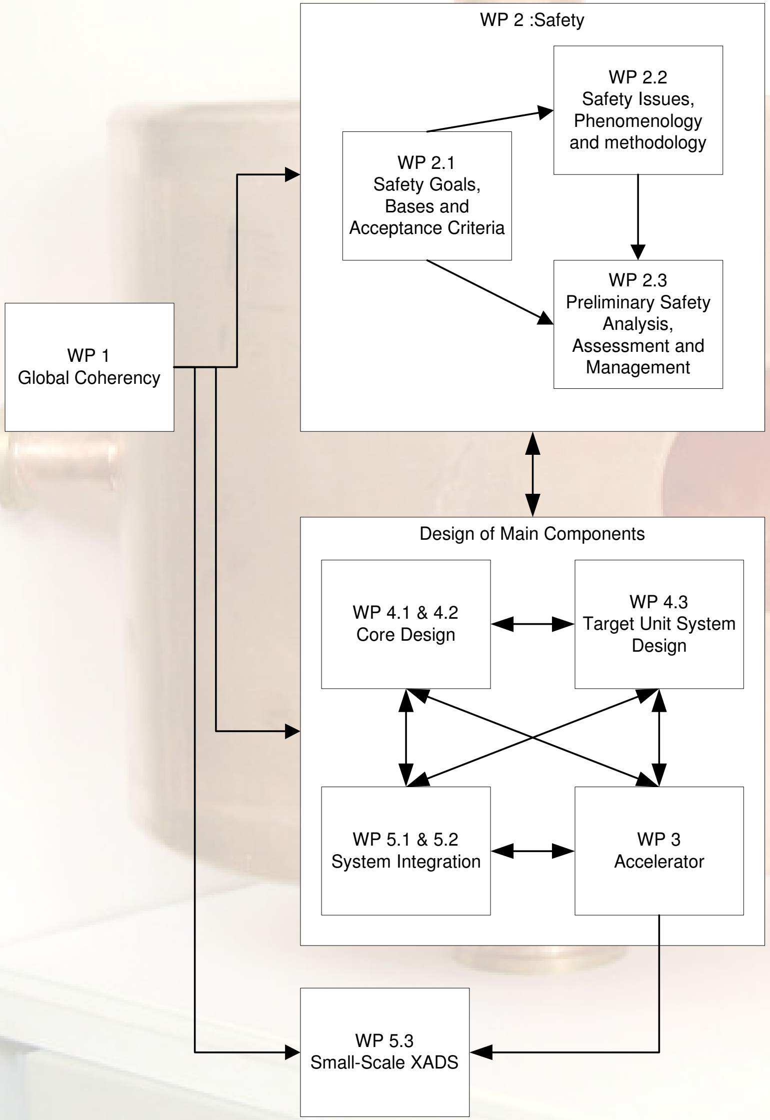


Pu Production Rate (grams / GWh)



MA Production Rate (grams / GWh)

FP5 PDS-XADS*: Working Packages



*Contract N° FIKW-CT-2001-00179 (2001-2004)

A collaboration between Industrial Partners and Research Organisations

F: Framatome-F CNRS CEA
I: Ansaldo INFN ENEA CRS4
RFA: Framatome-D FZK FZJ UFra
Esp: CIEMAT Empresarios UPM
B: SCK IBA Tractebel
UK: NNC BNFL
Pt: ITN
S: KTH
Sui: PSI
Pl: UMM
NL: NRJ
Eur: JRC

coordinateur général : Framatome (B.Carluec, B.Giraud)
coordinateur accélérateurs: CNRS-IN2P3 (A.C. Mueller)

The PDS-XADS Accelerator Group (WP3)

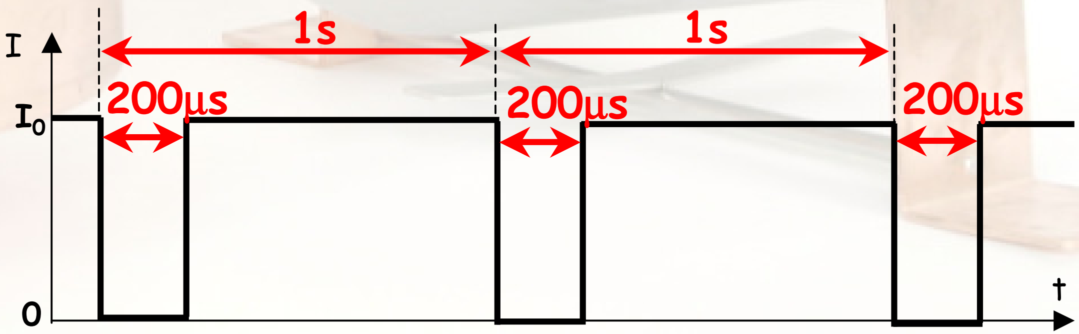
- **WP3 partners**
  - Coordinator: CNRS-IN2P3 (F)
  - Participants: Ansaldo (I), CEA (F), ENEA (I), FANP (F), F GmbH (D), IBA (B), INFN (I), ITN (P), U. Frankfurt (D)
- **Main WP3 objectives**
  - Investigation of linac and cyclotron types with the main emphasis on the XADS requirements
  - Examination of the XADS accelerator characteristics: reliability, availability, stability, power control & maintainability
  - Definition of the R&D needs
  - Choice of the reference accelerator type for XADS and for a long-term extrapolated industrial transmuter
  - Definition of the road mapping of the ADS-class accelerators
- **6 Deliverables written**
  - D9 – D47 – D48 – D57 – D63 – D80

XADS Accelerator Requirements

- **Proton Beam Specifications**
  - Defined by WP1
  - **600 MeV, 6 mA max**. for operation
  - 10 mA for the demonstration of concept
  - 350 MeV for the smaller scale XADS MYRRHA
  - **High reliability requirement**: less than 5 beam trips > 1 sec per year

Accelerator requirements	
Max. Beam Intensity	6 mA
Proton Energy	600 MeV
Beam entry	To be defined
Beam trip number	Less than 5 per year for the accelerator design Less than 50 per year for the reactor design
Beam type	CW, best solution Pulsed, back-up solution
Beam power stability	± 2 %;
Beam energy stability	± 1 %;
Beam intensity stability	± 2 %;
Beam footprint dimensions	± 10 %.

- **Additional requirements**
  - 200 µs beam « holes » for on-line sub-criticality measurements
  - Safety grade shutdown

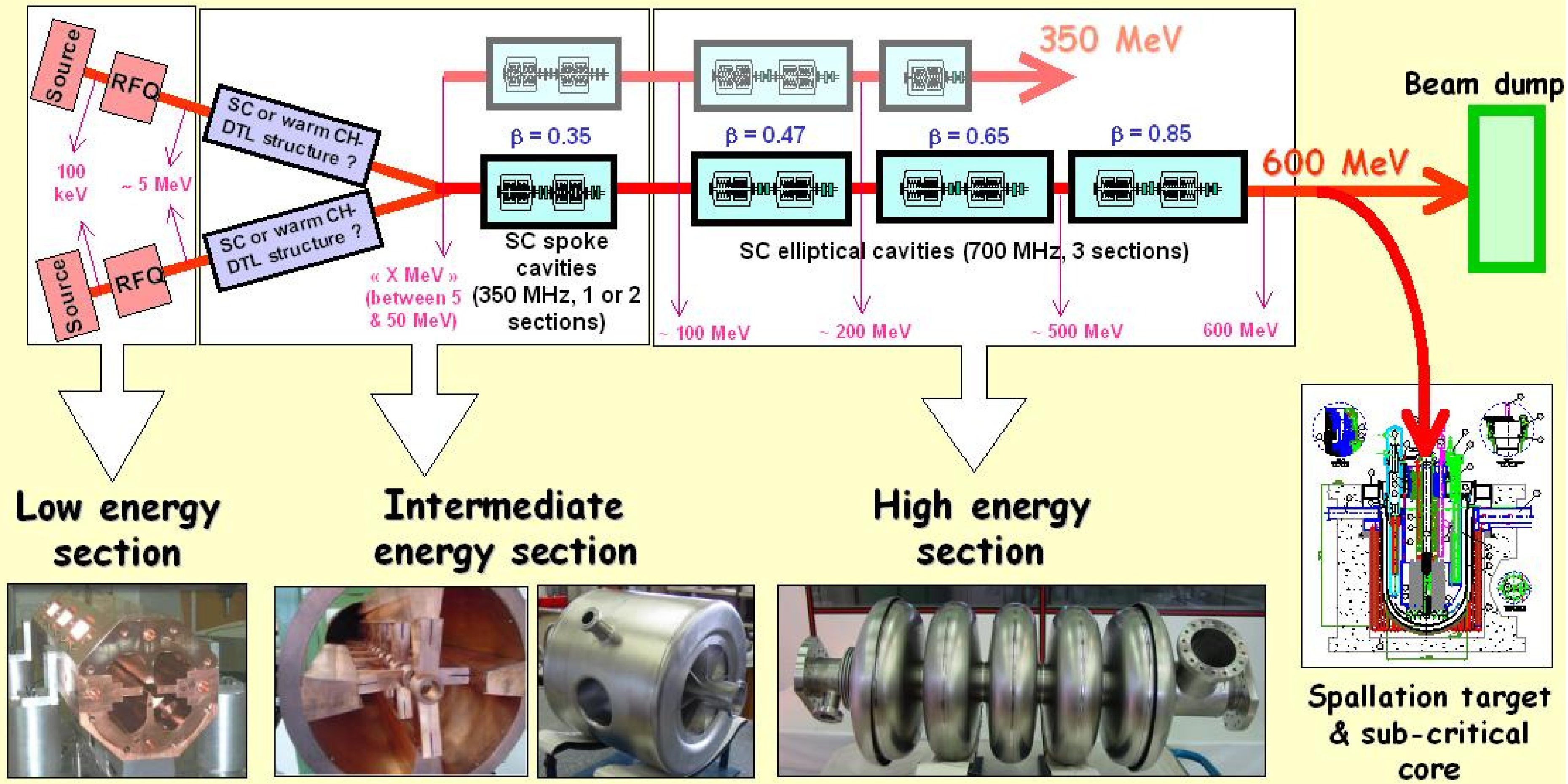


Choice of the Generic Accelerator Type

- **Main technical answers**
  - Superconducting linac
    - No limitation in energy & in intensity
    - Highly modular and upgradeable (industrial transmuter)
    - Excellent potential for reliability (fault-tolerance)
    - High efficiency (optimized operation cost)
  - Cyclotron
    - Attractive (construction) cost
    - Required parameters at limits of feasibility ("dream machine")
    - Compact, but therefore not modular

- **In complete agreement with findings of the NEA report:**
  - **Cyclotrons of the PSI type** should be considered as the natural and cost-effective choice **for preliminary low power experiments**, where availability and reliability requirements are less stringent.
  - **CW linear accelerators must be chosen for demonstrators and full scale plants**, because of their potentiality, once properly designed, in term of availability, reliability and power upgrading capability.

PDS-XADS Reference Accelerator Layout
(n.B. note similatity to EURISOL-driver)

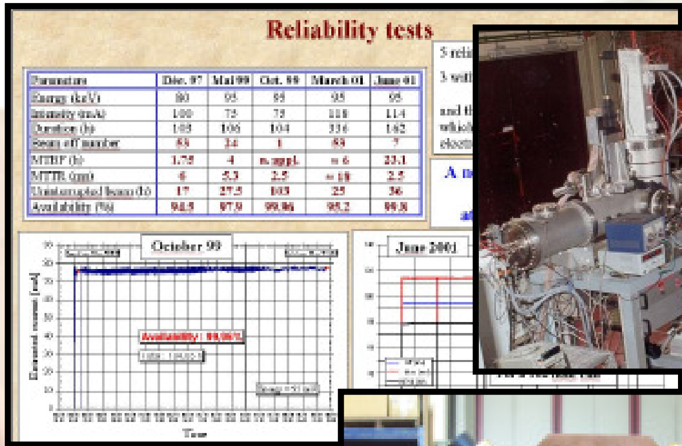


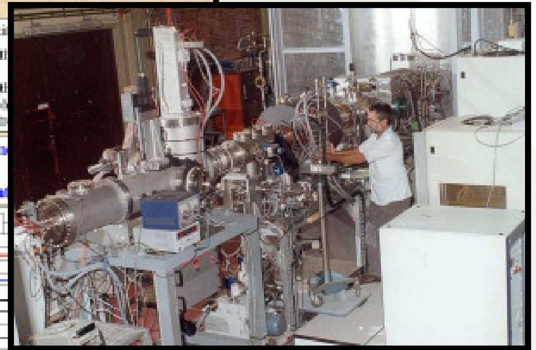
Strong R&D & construction programs for LINACs underway worldwide for many applications

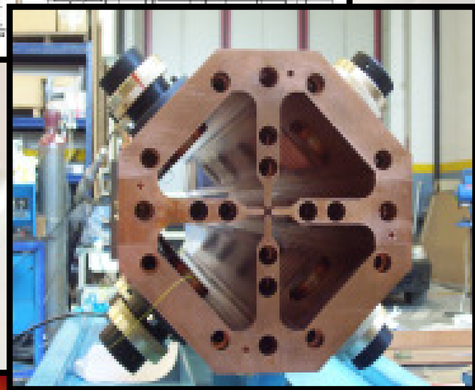
(Spallation Sources for Neutron Science, Radioactive Ions & Neutrino Beam Facilities, Irradiation Facilities)

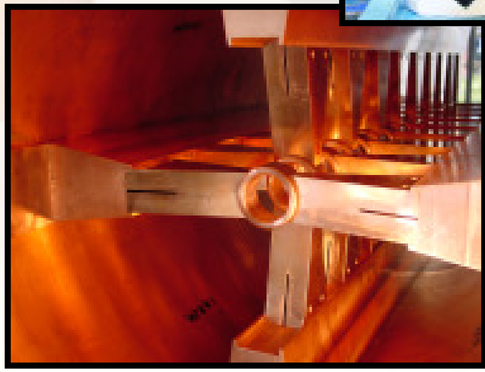
Reference Accelerator: Low Energy Section

- **R&D on the injector part by the WP3 partners**
  - « IPHI » ECR Source & Normal Conducting RFQ (CEA-CNRS)
  - « TRASCO » ECR Source & Normal Conducting RFQ (INFN)
  - Normal Conducting IH-DTL Structure (IBA)
  - Superconducting CH-DTL Structure (U. Frankfurt)



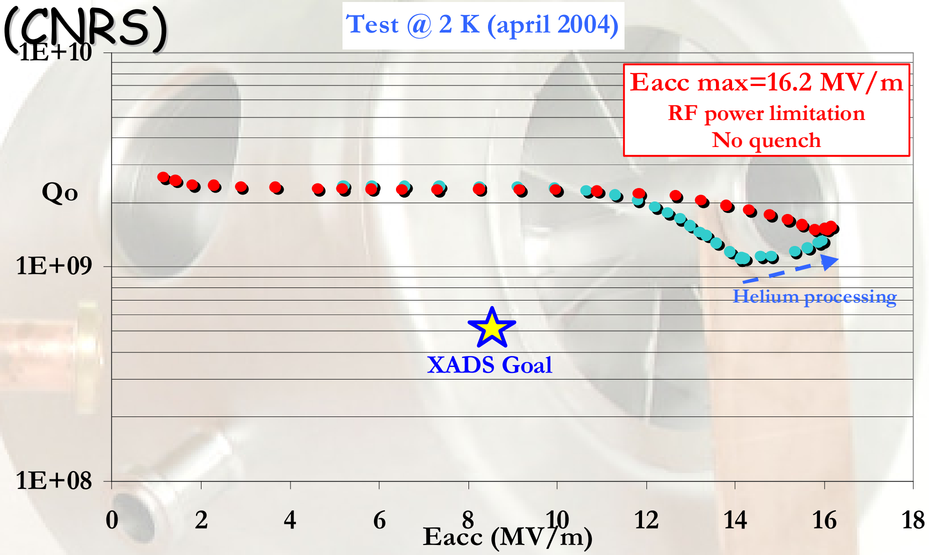




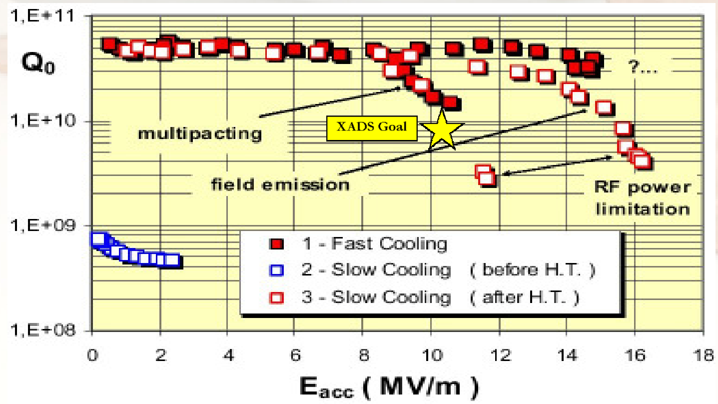


Reference Accelerator: High Energy Section

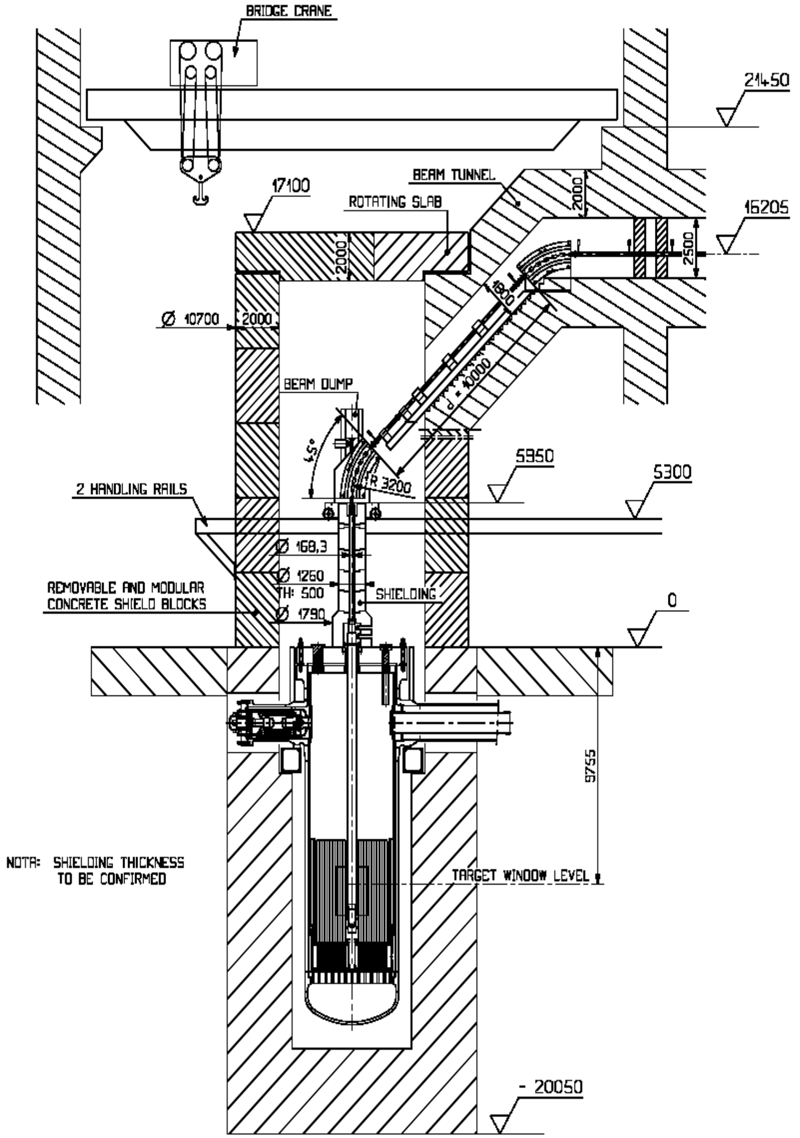
- R&D on SC prototypical cavities by the WP3 partners
  - Spoke cavities β = 0.15 & β = 0.35 (CNRS)



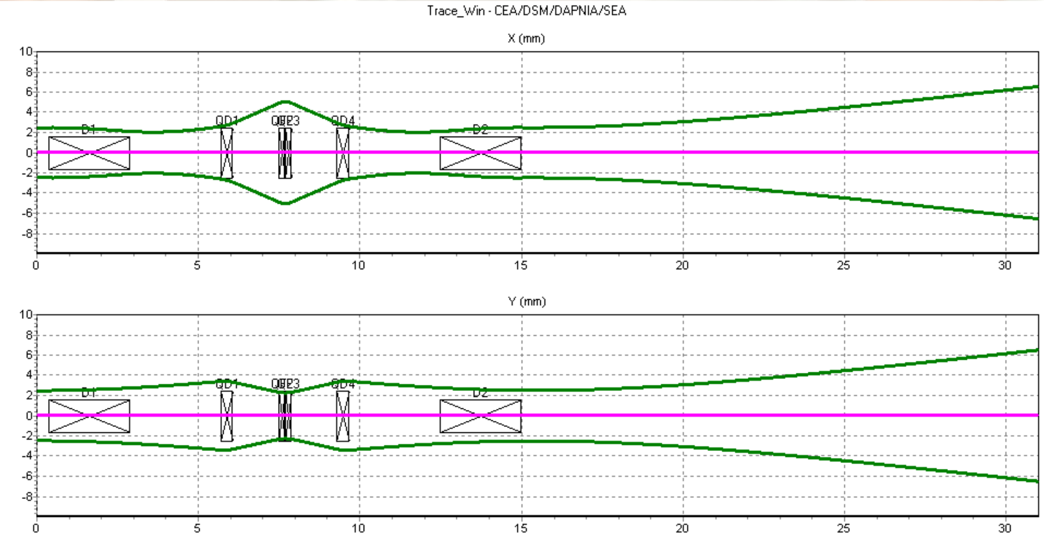
  - Elliptical cavities β = 0.5 & β = 0.65 (CEA-CNRS-INFN)



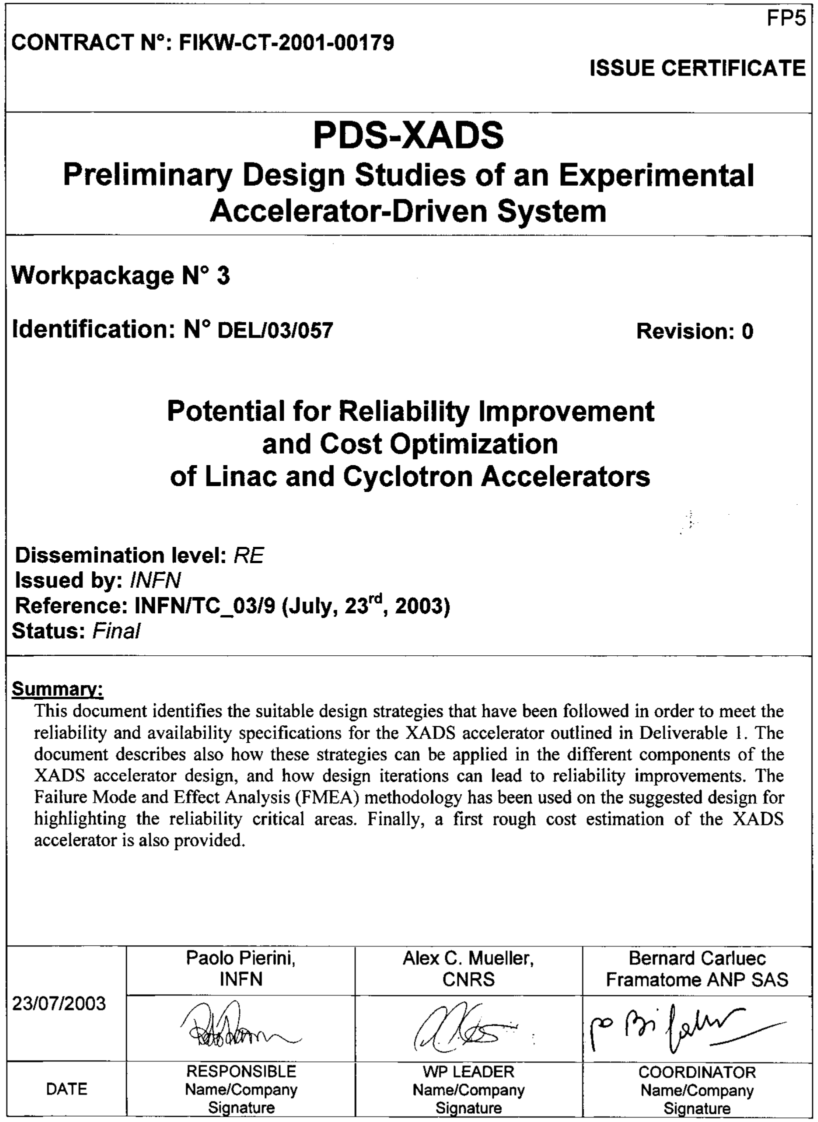
Reference Accelerator: Beam Line Transport



- **The doubly achromatic beam line concept + beam scanning method meets the specifications:**
  - of the Gas-cooled XADS
    (circular footprint, ∅160)
  - of the LBE-cooled XADS
    (rectangular footprint, 10×80)
  - of MYRRHA
    (quasi-circular footprint, ∅72)



Reliability Analysis



FP5

CONTRACT N°: FIKW-CT-2001-00179

ISSUE CERTIFICATE

PDS-XADS
Preliminary Design Studies of an Experimental Accelerator-Driven System

Workpackage N° 3

Identification: N° DEL/03/057 **Revision: 0**

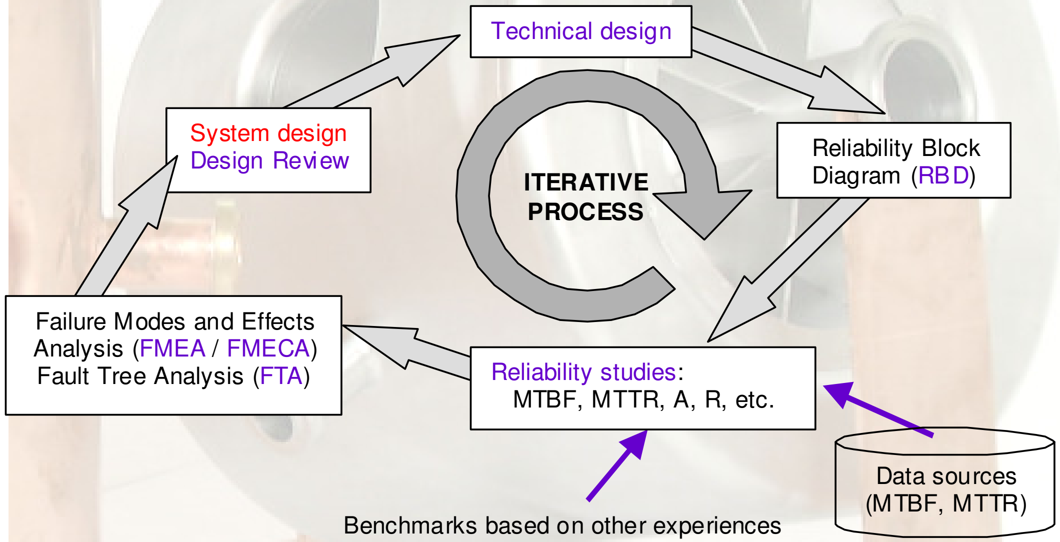
Potential for Reliability Improvement and Cost Optimization of Linac and Cyclotron Accelerators

Dissemination level: *RE*
Issued by: *INFN*
Reference: INFN/TC_03/9 (July, 23rd, 2003)
Status: *Final*

Summary:
This document identifies the suitable design strategies that have been followed in order to meet the reliability and availability specifications for the XADS accelerator outlined in Deliverable 1. The document describes also how these strategies can be applied in the different components of the XADS accelerator design, and how design iterations can lead to reliability improvements. The Failure Mode and Effect Analysis (FMEA) methodology has been used on the suggested design for highlighting the reliability critical areas. Finally, a first rough cost estimation of the XADS accelerator is also provided.

23/07/2003	Paolo Pierini, INFN	Alex C. Mueller, CNRS	Bernard Carluec Framatome ANP SAS
	[signature]	[signature]	[signature]
DATE	RESPONSIBLE Name/Company Signature	WP LEADER Name/Company Signature	COORDINATOR Name/Company Signature

- Assessments using the « Failure Modes and Effects Analysis » (FMEA) method



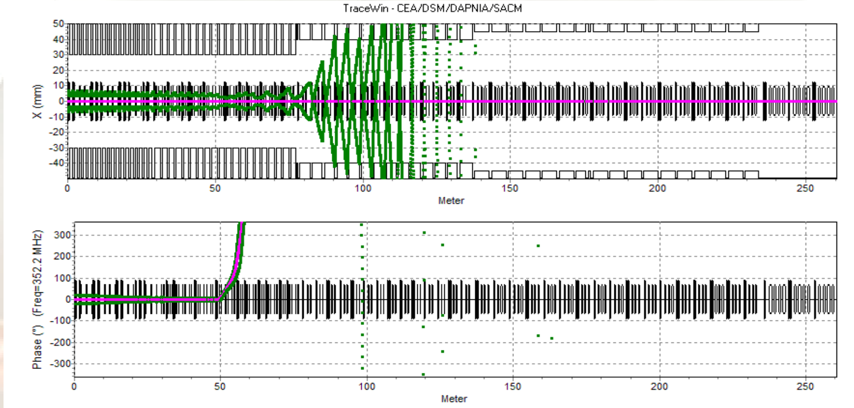
- Reliability engineering is a discipline for estimating, predicting and controlling the probability of occurrence of system faults

Main Conclusions on Reliability

- The cyclotron option for PDS-XADS does not seem to offer a sufficient perspective of reaching the requested reliability level
- No showstopper to reach high availability & high reliability with the XADS reference linac if over-design & redundancy are used
- Fault tolerance has been identified as key element in order to guarantee reliability by design and operation
  - Identification of the main component faults & estimate of their effect on the beam (not always straightforward)
  - Identification of strategies (and proper hardware systems) to deal with faults
  - Plans for the accelerator commissioning and maintenance
  - Reliability/availability allocation need to be examined with the constraints of legislation (safety aspects) & radioprotection

Fault scenarios and recovery → see talk Lucija Lukovac

Fault tolerance in the independently phased SC sections is a crucial point because a few tens of RF systems failures are foreseen per year.



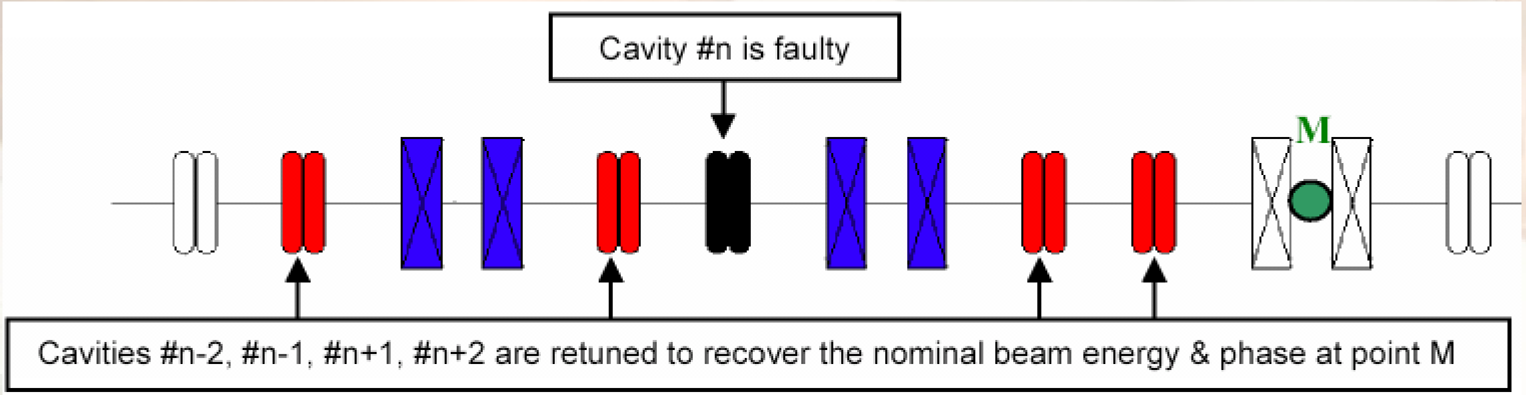
1. Consequences of the failure of a superconducting RF cavity

→ A RF system failure induces phase slip (non relativistic beam)

→ If nothing is done, the beam is always LOST

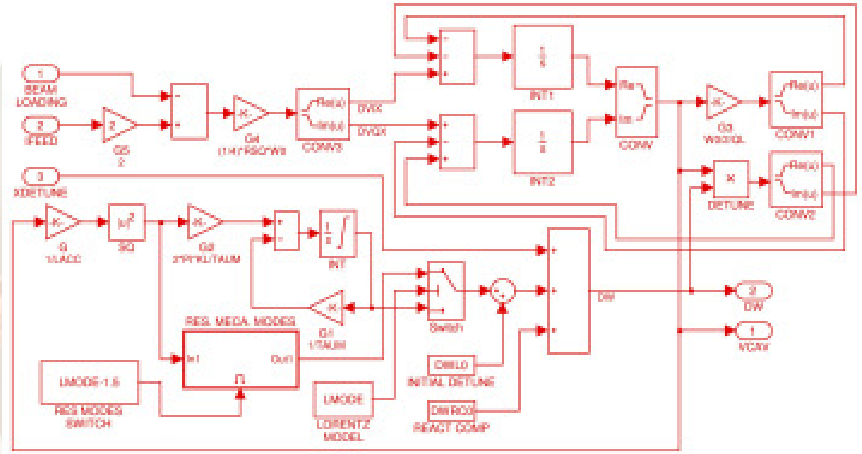
2. Linac retuning after the failure of a RF cavity or of a quadrupole

→ Local compensation philosophy is used
→ In every case, the beam can be transported up to the high energy end without beam loss



Reliability, Feedback Systems & Maintenance

- **The feedback systems has to provide the necessary energy stability, dealing with faults in order to reach the project goals** *(less than 5 beam trips per year)*
  - **Fast digital RF system** can implement fault tolerance with respect to cavity fault by dealing fault set tables
  - **Beam diagnostics** is also an area of prime importance



- **The maintenance strategy has to guarantee the reliability of the machine for more than 20 years**
  - It should guarantee the long-term validity of the linac prime criteria:
    - Over-Design / Redundancy / Fault Tolerance
  - Need for an expert system :
    - Detecting faulty or out-of-order equipment
    - Planning of subsequent maintenance & management of the intervention time according to radioprotection

Reliability & Maintenance

- **The maintenance strategy is presently under investigation, assuming 3 months of operation / 1 month of maintenance**

PDS-XADS-WP3	Severity Ranking Tables	
Deliverable 48	Local effect	Effect on beam
Chapter 4	0: No effect	0: Beam with nominal parameters on targ
4.3.1 H+ source	1: Functionning with reduc	1: Beam with wrong parameters on target
	2: Loss of function	2: No beam on target

Main Items	Function	Failure Mode	verity rank		Preventive action			Curative action		Rem.
			local	beam	action	freq.	time of int.	action	time of int.	
Boron nitride discs		Wear	1	1	Replace	6 months	24 H	Replace	24H	
Vacuum pumps		Wear	1	2	Regenerate	24 months				
		Out of order	2	2	-			Replace	8H	
Power supply filters		Get dirty	0	0	Clean	3 months	few min			
Power supply		Aging	0	0	Overhaul	24 months	few weeks			Use spare while overhauling
Cooling (water): filters, pumps...		Wear / dirty	0	0	Clean					
Plasma electrode		Aging	1	1	Replace	12 months	24H			
Magnetron		Out of order	2	2	Replace	24 months	2H	Replace	2H	Replace "before MTBF"
HV power supply		Out of order	2	2	Oil changing	24 months	8H	Replace	8H	
Extraction electrodes		Aging	1	1	Replace	24 months	48H			
Security devices :										
Water flow controller		get dirty			cleaning	12 months	30 min	Replace	2H	
Temperature controller		Out of order			Systematic tests	12 months	few min	Replace	8H	could be doubled
Emergency stop		Out of order			Systematic tests	12 months	1 H	Replace	1 H	
DGPT		Out of order			Systematic tests	12 months	1 H	Replace	8 H	

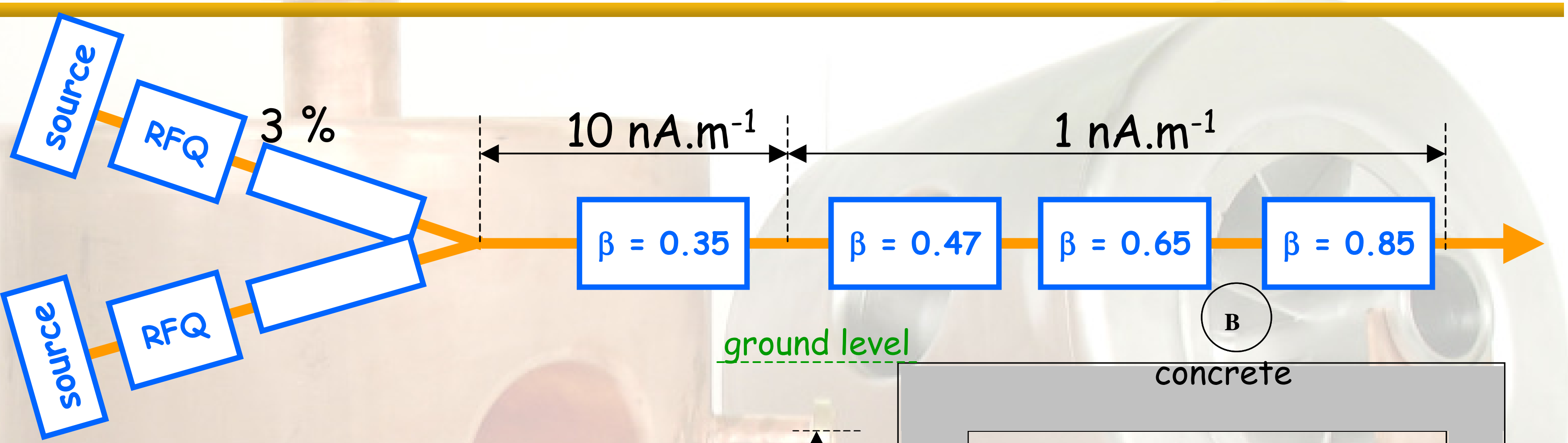
XADS: Safety Aspects & Radioprotection*

- **Legal framework**
  - Recommendations: ICRP publication 60
  - European Directive 96/29/Euratom
  - European Union: analysis of national legislations
    - Belgium
    - France
    - Germany
  - Very similar requirements from national legislations for an XADS facility, in particular:
    - Public enquiry
    - Decommissioning plan
  - Belgium: more restrictive definition of « radiation worker »

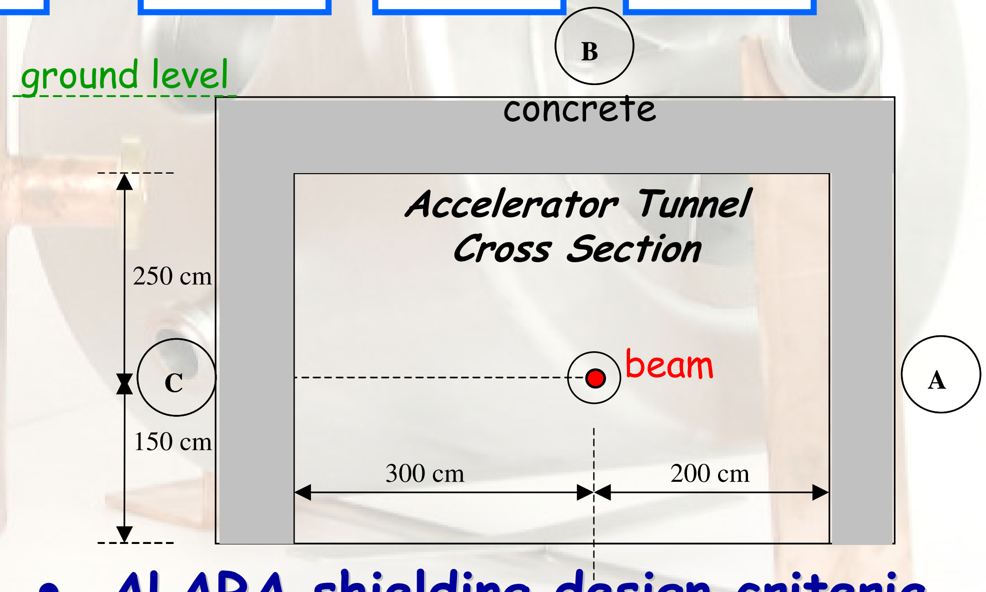
- **Accelerator shielding philosophy based on the ALARA principle**
  - As Low As Reasonably Achievable

**study performed within "Deliverable D48" by Paul Berkvens and S.Palanque relying on Moyer's model*

XADS-Accelerator Shielding Design



- **Conservative beam losses assumptions**
  - Normal beam losses
    - RFQ: 3%
    - Intermediate energy: 10 nA/m
    - High energy: 1 nA/m
  - Unwanted beam trips
    - P > 1. 10^{-2} $year^{-1}$ → included in the normal beam losses
    - P < 1. 10^{-2} $year^{-1}$ → "accidental beam losses" case



- **ALARA shielding design criteria**
  - < 1 mSv/year
  - I.e. **< 0.5 µSv/h** (2000 h/year)
  - Occupancy factor = 1

600 MeV XADS:
Shielding for Normal Operation and for Commissioning

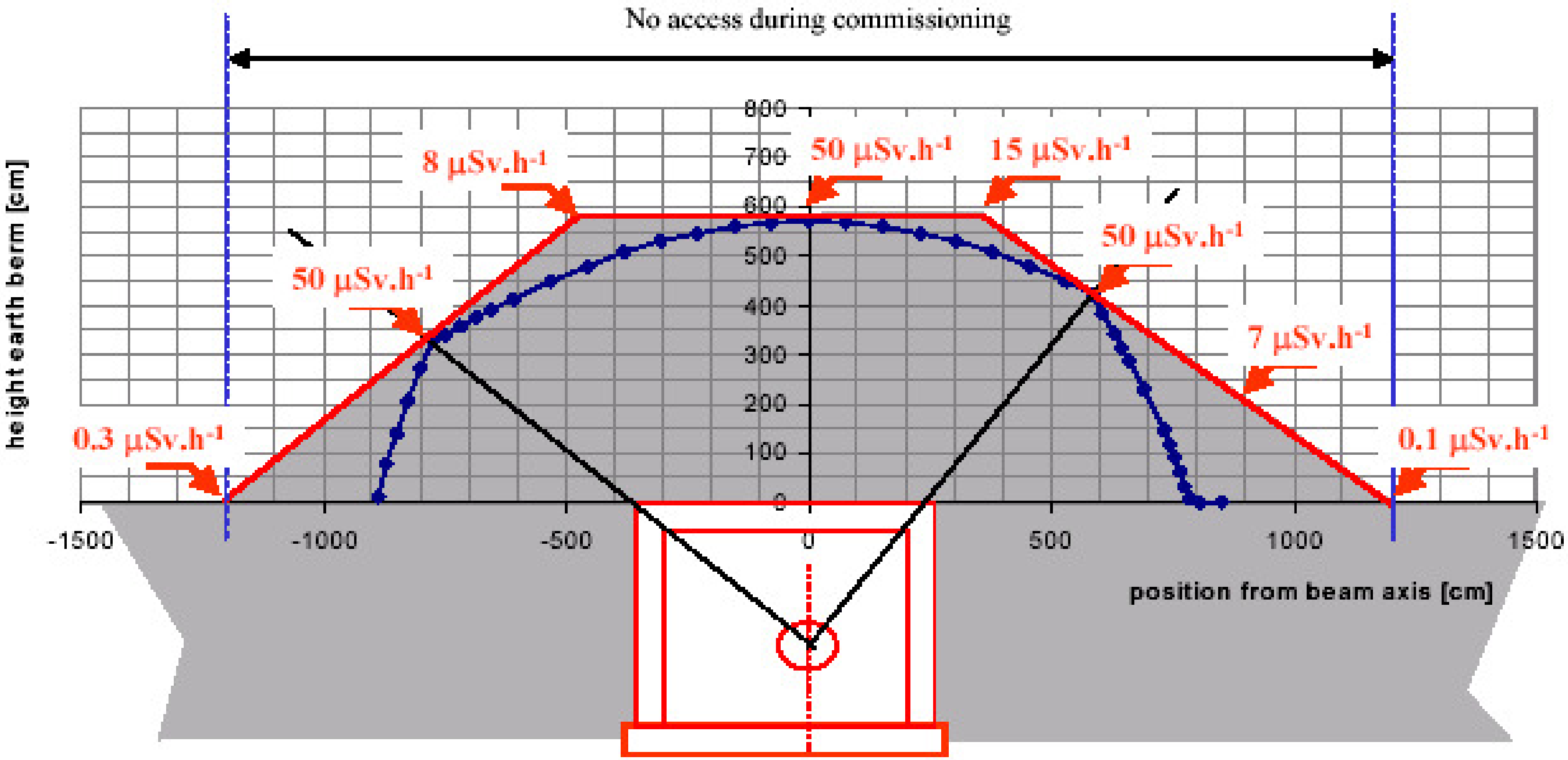
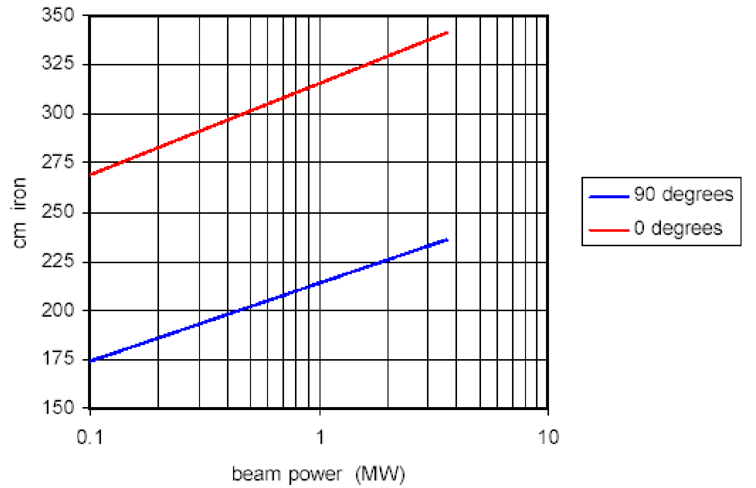
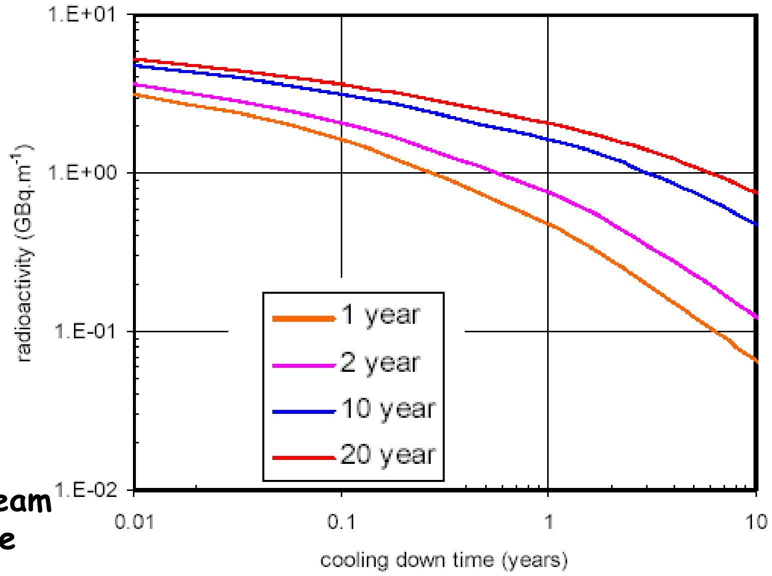


Figure 6.1 – Minimum earth profile above a 60 cm concrete tunnel (blue curve) corresponding to a beam loss rate of 1 nA.m^{-1} at 600 MeV for a residual dose rate of 0.5 □Sv.h^{-1}. Red curve: corresponding realistic earth profile. Dose rates are calculated for a beam loss rate of 100 nA.m^{-1} at 600 MeV.

Beam Stop and Accelerator Activation

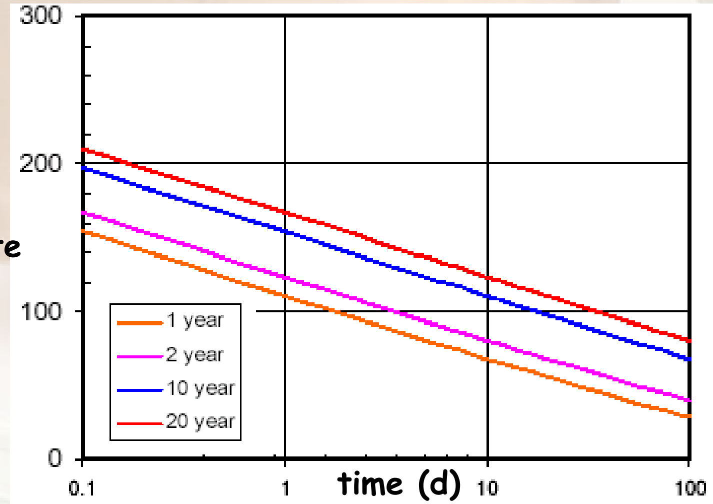


Iron shielding for a 600 MeV beam dump as a function of the beam power,required to reduce the dose rate outside a 60 cm concrete building, covered with 550cm of earth, below 0.5 $\mu Sv.h^{-1}$.



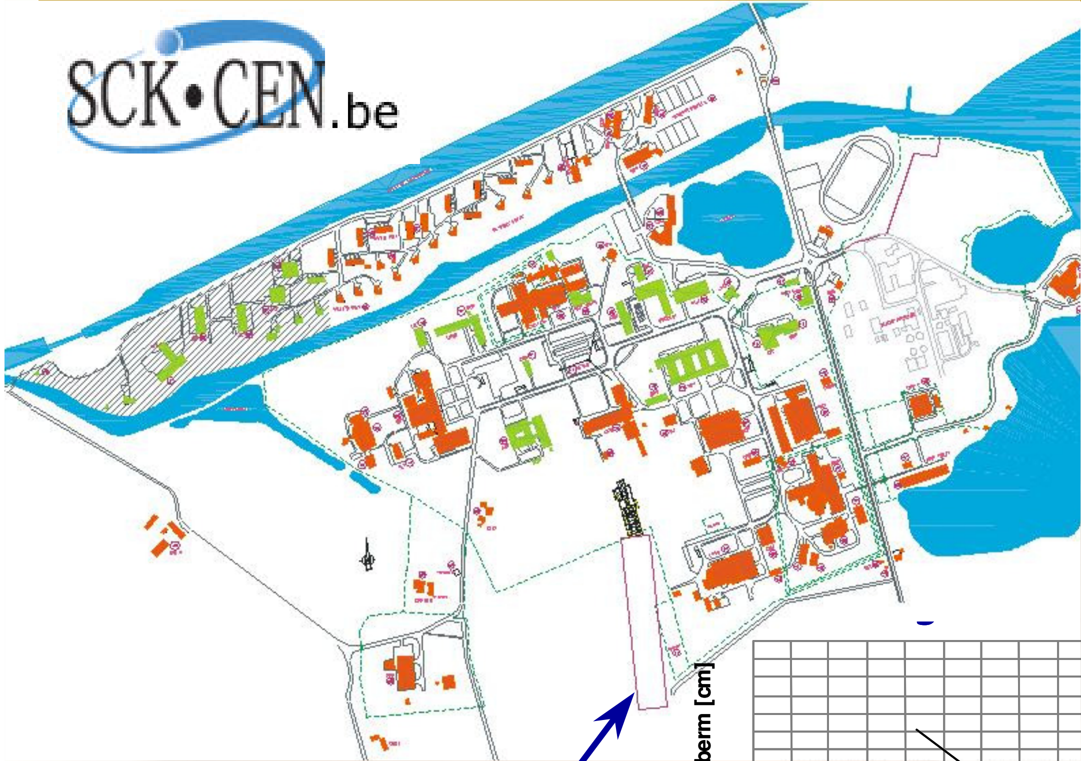
Radioactivity produced per meter along the high-energy part of the accelerator for a 1 $nA.m^{-1}$ beam loss, as a function of the decay time, for 4 different values of the irradiation time.

Dose Rate
(µSv/h)



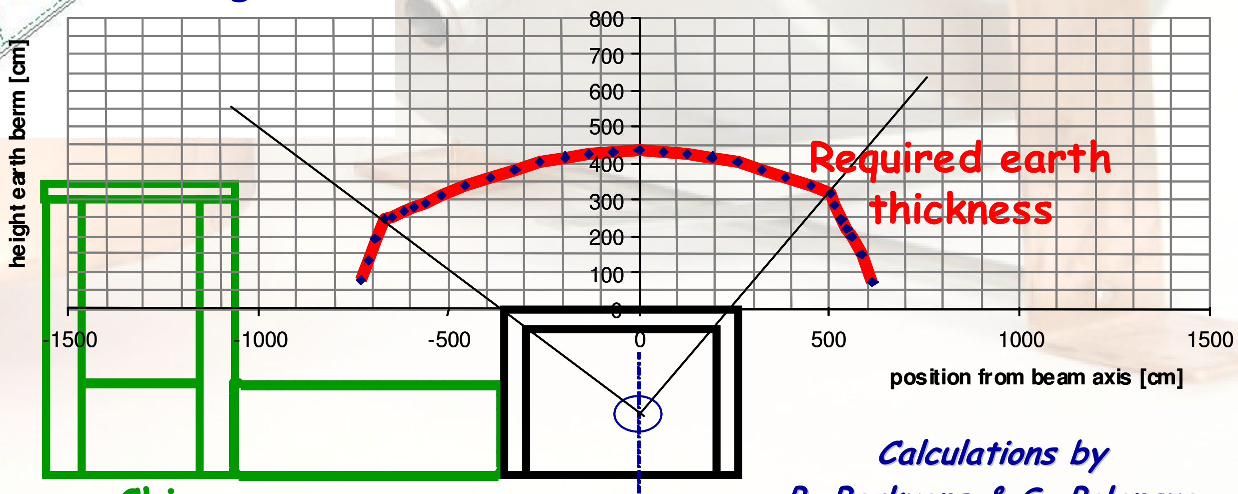
Dose rates at 50 cm from the beam axis, along the high-energy part of the accelerator for a 1 $nA.m^{-1}$ beam loss, as a function of the decay time, for 4 different values of the irradiation time.

Safety Aspects: Application to MYRRHA @ Mol



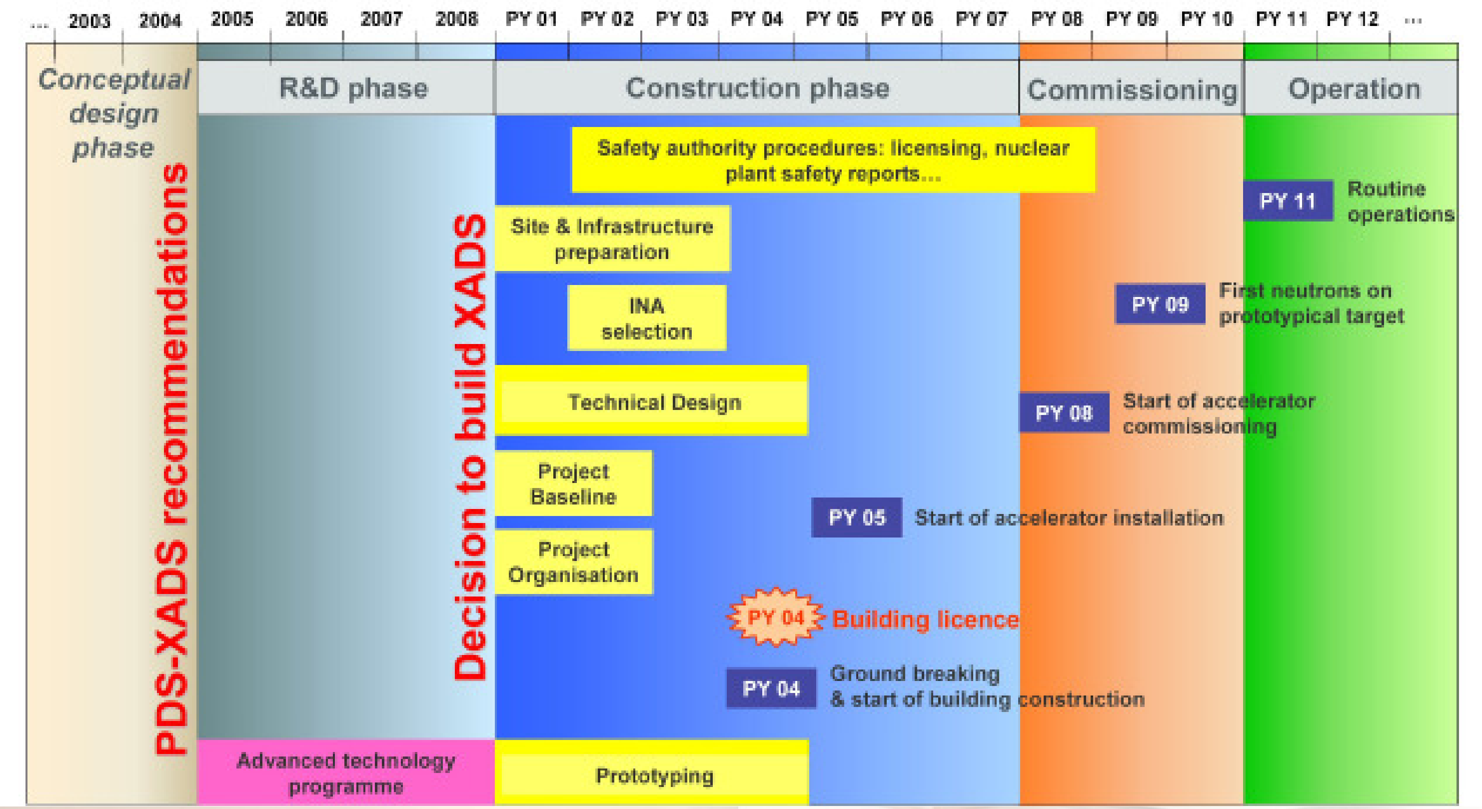
- **The 350 MeV MYRRHA machine**
  - Location on the SCK•CEN site, Mol, Belgium

- **Tunnel design for a 350 MeV XADS linac**
  - **Shielding calculations @ 350 MeV**, 1 nA/m, 0.5 µSv/h
  - Chicane access design
  - Shielding for normal losses also copes with « accidental losses »



Calculations by P. Berkvens & S. Palanque

XADS Accelerator Roadmap and advanced technology programme



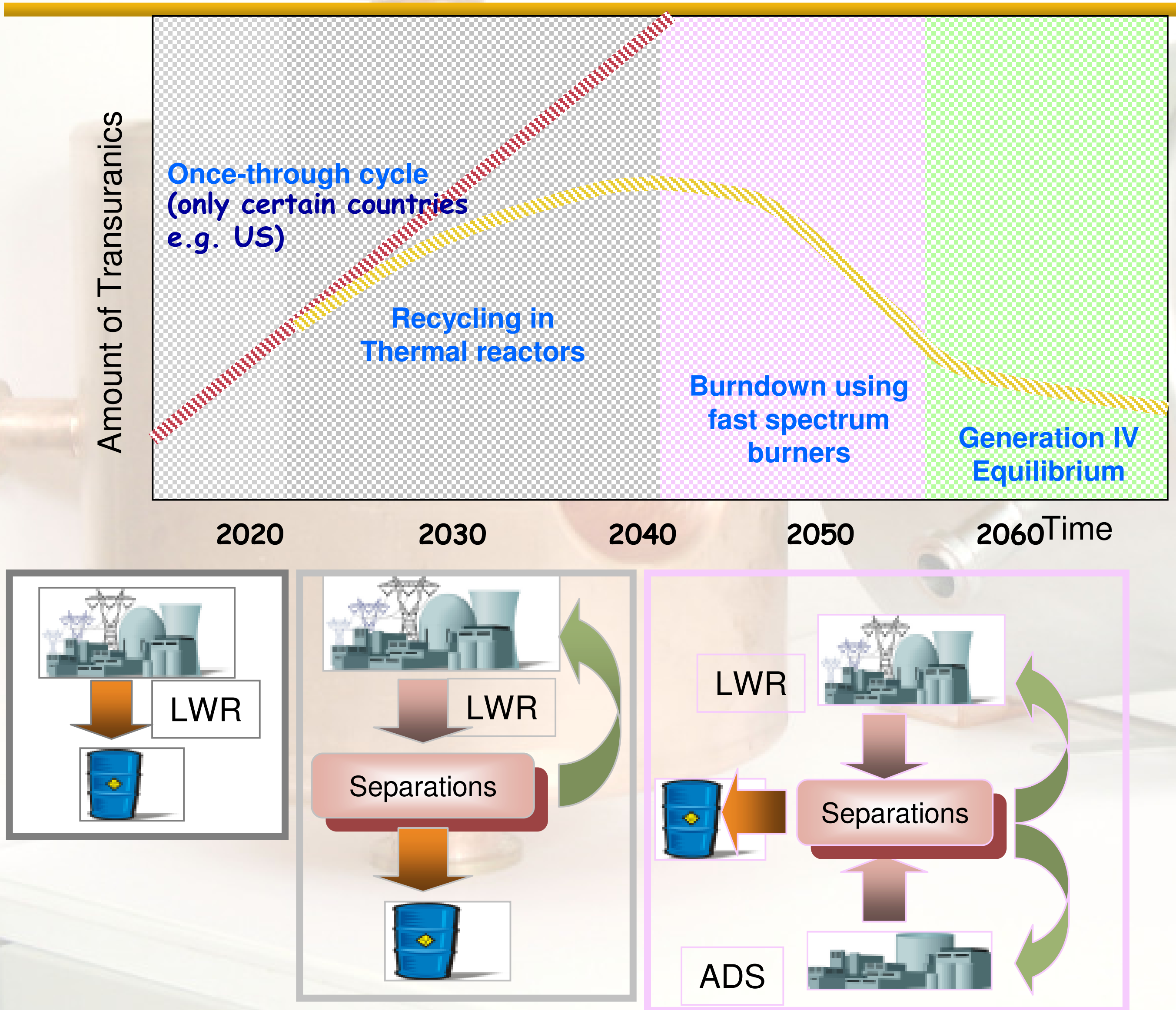
Long-term operation of the injector

Construction & test of intermediate energy cavities

Full demonstration of the high energy section cryomodule

Fault tolerance: numerical simulation code & digital RF control system design

A possible Scenario using ADS to support Generation-III (and even Gen-IV !) reactors



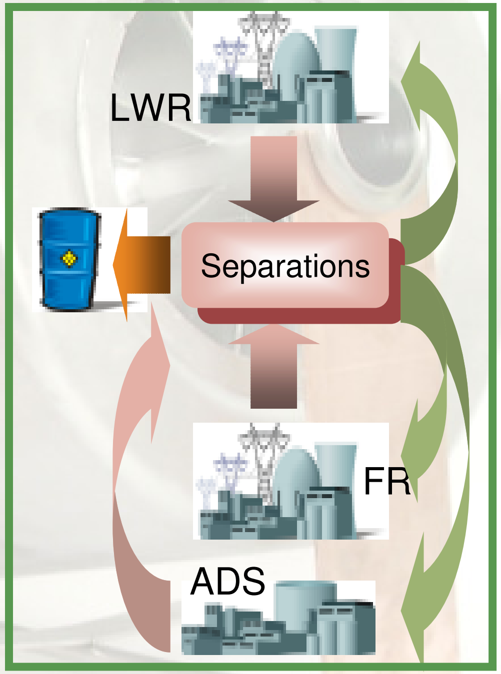
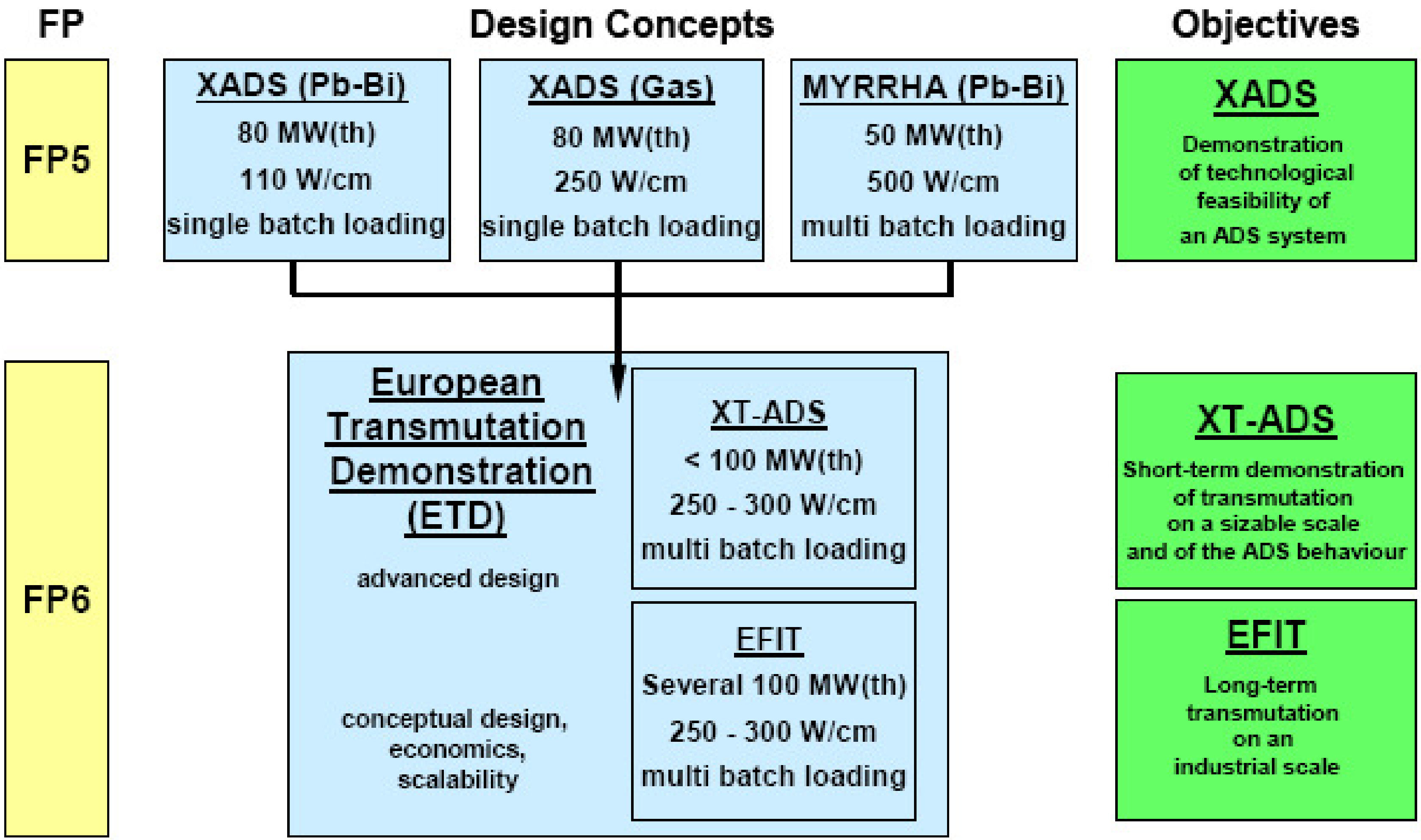


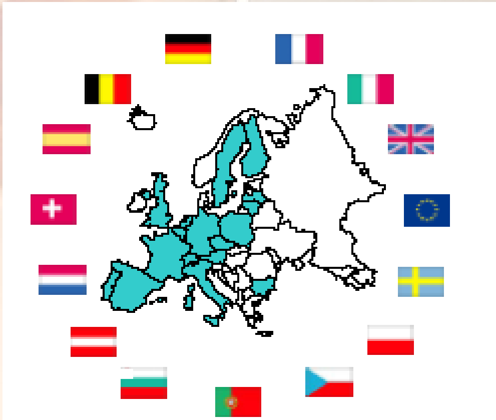
Figure:
M. Capiello
& G. Imel (ANL)
(ICRS-10/RPS2004)

From FP5 PDS-XADS to FP6 EUROTRANS



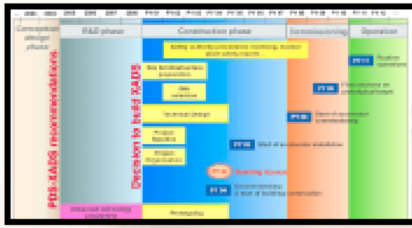
EURopean Research Programme for the TRANSmutation of High Level Nuclear Waste in an Accelerator Driven System

- FZK
- AAA
- ANSALDO
- Nexia Solutions
- CEA
- CIEMAT
- CNRS
- CRS4
- CSIC
- EA
- ENEA
- ENEN
- FANP SAS
- FZJ
- FZR



- GSI
- IBA
- INFN
- INRNE
- ITN
- JRC
- NRG
- NRI
- OTL
- PSI
- SCK-CEN
- Suez-Tractebel
- FANP GmbH
- NNC

The accelerator within EUROTRANS-DM1



WP1.3: ACCELERATOR

GOAL:

HPPA development, and in particular, qualification of the reliability of the prototypical components

CO-ORDINATING CONTRACTOR:

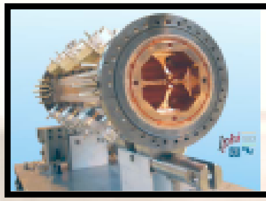
CNRS (F) – *Alex C. Mueller*

DM1 DESIGN WP1.3 - Accelerator	TOTAL WP1.3			
	Cons. k€	PM	Total k€	*EU request k€*
P5-CEA (F)	170	67	840	*420.0*
P8-CNRS (F)	180	138	1560	*780.0*
P13.4-IAP-FU (D)	75	27	345	*172.5*
P13.12-UPM (SP)	3	4	43	*21.5*
P18-IBA (B)	182	20	382	*191.0*
P19-INFN (I)	480	65	1130	*565.0*
P21-ITN (P)	10	10	110	*55.0*
P31-FANP GmbH (D)	3	2	23	*11.5*
Total WP1.3	1103	333	4433	*2216.5*

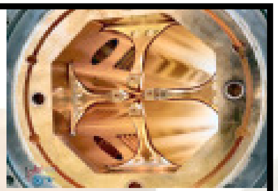
1 PM = 10k€

RED: *Leading Organization in this Work Package*

Injector Reliability



TASK 1.3.1



DM1 DESIGN WP1.3 - Accelerator	Task 1.3.1 Experimental evaluation of the proton injector reliability		
	Cons. k€	PM	Total k€
P5-CEA (F)	140	38	520
P8-CNRS (F)	0	15	150
P13.4-IAP-FU (D)	0	0	0
P13.12-UPM (SP)	0	0	0
P18-IBA (B)	0	0	0
P19-INFN (I)	0	0	0
P21-ITN (P)	0	0	0
P31-FANP GmbH (D)	0	0	0
Total WP1.3	140	53	670

GOAL:

The injector IPHI, developed by CEA and CNRS, will be used for a long run test to demonstrate on a real scale the reliability of the injector part.

CO-ORDINATING CONTRACTOR:

CEA (F) – *Raphaël Gobin*

MILESTONES:

M1.3.1: Specifications for the long test run (+9)

M1.3.2: Injector operational for test (+18)

M1.3.3: Experimental tests accomplished (+36)

M1.3.4: Final report: results and analysis (+39)

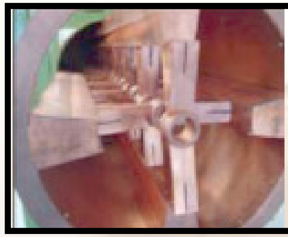
DELIVERABLES:

D1.3.1: Preliminary short report. Specifications of the long test runs (CEA, +9)

D1.3.2: Intermediate progress report on injector status and proposed test schedule (CEA, +18)

D1.3.3: Final report on results and analysis (CEA, +39)

Intermediate-energy Section



TASK 1.3.2

DM1 DESIGN WP1.3 - Accelerator	Task 1.3.2 Assessment of the reliability performances of the intermediate energy accelerating components		
	Cons. k€	PM	Total k€
P5-CEA (F)	0	1	10
P8-CNRS (F)	50	24	290
P13.4-IAP-FU (D)	70	24	310
P13.12-UPM (SP)	0	0	0
P18-IBA (B)	170	15	320
P19-INFN (I)	0	0	0
P21-ITN (P)	0	0	0
P31-FANP GmbH (D)	0	0	0
Total WP1.3	**290**	**64**	**930**

GOAL:

Evaluation of room-temperature cavities and superconducting cavities performances, reliability and cost. Determination of the energy transition from where on doubling of the injector is no longer required for reliability.

CO-ORDINATING CONTRACTOR:

CNRS (F) – *Tomas Junquera*

MILESTONES:

M1.3.5: Specifications for prototypes (+6)

M1.3.6: Prototypes ready for test (+27)

M1.3.7: Experimental results of prototypes performances (+39)

M1.3.8: Final report: synthesis and design proposals (+42)

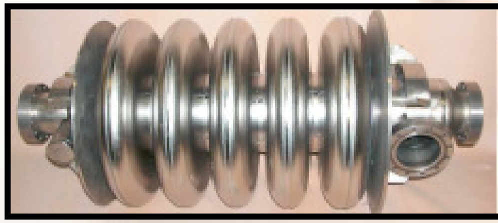
DELIVERABLES:

D1.3.4: Preliminary report. Specifications of the prototypes (IAP_FU, +6)

D1.3.5: Intermediate report on prototype test schedules (IBA, +18)

D1.3.6: Final report: tests results, synthesis and design proposals (CNRS, +42)

High-energy Section



TASK 1.3.3

GOAL:

Design, construction and test of a full prototypical cryomodule of the high energy section of the proton linac.

CO-ORDINATING CONTRACTOR:

INFN (I) – *Paolo Pierini*

DM1 DESIGN WP1.3 - Accelerator	Task 1.3.3 Qualification of the reliability performances of a high energy cryomodule at full power and nominal temperature		
	Cons. k€	PM	Total k€
P5-CEA (F)	0	1	10
P8-CNRS (F)	100	80	900
P13.4-IAP-FU (D)	0	0	0
P13.12-UPM (SP)	0	0	0
P18-IBA (B)	0	0	0
P19-INFN (I)	440	60	1040
P21-ITN (P)	0	5	50
P31-FANP GmbH (D)	0	0	0
Total WP1.3	540	146	2000

MILESTONES:

M1.3.9: Preliminary cryomodule specifications (+9)

M1.3.10: Cryomodule design finalized (+15)

M1.3.11: Cryomodule is ready for test (+30)

M1.3.12: Exptl. results of cryomodule performances (+39)

M1.3.13: Final report: synthesis and design proposals (+42)

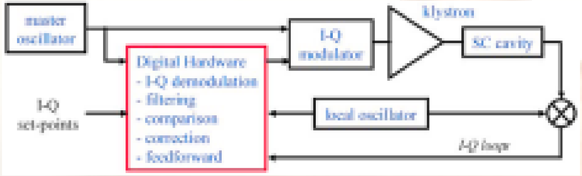
DELIVERABLES:

D1.3.7: Preliminary report: specifications for the cryomodule (INFN, +9)

D1.3.8: Report on cryomodule design and schedule (CNRS, +15)

D1.3.9: Final report: test results, synthesis and design proposals (INFN, +42)

Digital RF Control



TASK 1.3.4

DM1 DESIGN WP1.3 - Accelerator	Task 1.3.4 Conceptual design of an RF control system for fault tolerant operation of the linear accelerator		
	Cons. k€	PM	Total k€
P5-CEA (F)	10	15	160
P8-CNRS (F)	0	5	50
P13.4-IAP-FU (D)	0	0	0
P13.12-UPM (SP)	0	0	0
P18-IBA (B)	0	1	10
P19-INFN (I)	10	0	10
P21-ITN (P)	0	0	0
P31-FANP GmbH (D)	0	0	0
Total WP1.3	**20**	**21**	**230**

GOAL:

Modelling and VHDL analysis of a digital RF control system for fault tolerant operation of the linear accelerator. *(Prototyping of an RF control unit is strongly recommended)*

CO-ORDINATING CONTRACTOR:

CEA (F) – *Michel Luong*

MILESTONES:

M1.3.14: Preliminary RF control system specifications (+6)

M1.3.15: RF control system modelling (+24)

M1.3.16: Final report: VHDL architecture and synthesis (+42)

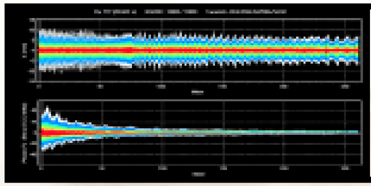
DELIVERABLES:

D1.3.10: Preliminary specifications of the RF control system (CEA, +6)

D1.3.11: Report on RF control system modelling (CEA, +24)

D1.3.12: Final report: VHDL architectures and synthesis (CEA, +42)

Beam Dynamics and Overall Coherence



TASK 1.3.5

DM1 DESIGN WP1.3 - Accelerator	Task 1.3.5 Overall coherence of the accelerator design, final reliability analysis, cost estimation of XT-ADS and EFIT		
	Cons. k€	PM	Total k€
P5-CEA (F)	20	12	140
P8-CNRS (F)	30	14	170
P13.4-IAP-FU (D)	5	3	35
P13.12-UPM (SP)	3	4	43
P18-IBA (B)	12	4	52
P19-INFN (I)	30	5	80
P21-ITN (P)	10	5	60
P31-FANP GmbH (D)	3	2	23
Total WP1.3	113	49	603

GOAL:

Overall coherence of the accelerator design, including beam dynamics simulations, integrated reliability analysis, and cost estimation.

CO-ORDINATING CONTRACTOR:

CNRS (F) – *Jean-Luc Biarrotte*

MILESTONES:

M1.3.17: General specifications (+6)
M1.3.18: WP1.3 overall task review (+18)
M1.3.19: Results of beam dynamic simulations (+30)
M1.3.20: Reliability study experimental results (+39)
M1.3.21: Integrated reliability analysis (+45)
M1.3.22: Cost Analysis (+45)
M1.3.23: Final report (+48)

DELIVERABLES:

D1.3.13: General specifications for all the tasks (CNRS, +6)

D1.3.14: Beam dynamics simulations for fault tolerance (CNRS, +30)

D1.3.15: Report on integrated reliability analysis of the accelerator (INFN, +48)

D1.3.16: Final report: accelerator design, performances, costs for XT-ADS and EFIT and associated road map (CNRS, +48)

CONCLUSION

With the reliability-focused R&D programme within the EUROTRANS project,

the Accelerator for a EUROPEAN ADS Demonstrator XT-ADS is on the projected roadmap