Accelerator Technical and Operational Review – ATC/ABOC Days 2007

Session 5: AD Machine and Exp. Areas – nTOF Facility

Conveners: I. Efthymiopoulos
T. Eriksson

- Highlights from the presentations
- Summary notes

Ilias Efthymiopoulos – AB/ATB-EA
ATC/ABOC Days – Summary Meeting
February 9, 2007

Backup slides

AD – Physics in 2006 and Beyond (W.Oelert – PH/DI)

QCD Physics at FAIR:
unpolarized Antiprotons in HESR

PAX → Polarized Antiprotons

Central PAX Physics Case:

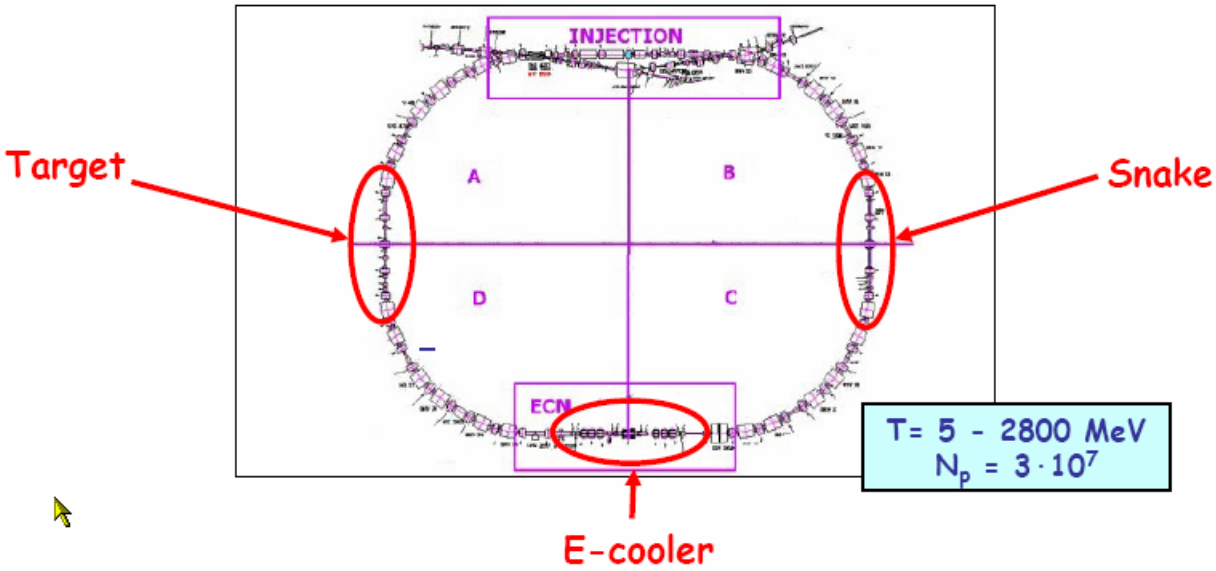
Transversity distribution of the nucleon in Drell-Yan processes:
→ FAIR

- last missing piece of the QCD description for the partonic structure of the nucleon
- observation of the structure of the valence quarks of the proton
  ($h_1^q(x,Q^2)$ A_{TT} in Drell-Yan >0.2)
  - transversely polarized proton beam or target (✓)
  - transversely polarized antiproton beam (×)

AD – Physics in 2006 and Beyond (W.Oelert – PH/DI)

AD Ring at CERN

Study of spin filtering in pbar-p (pbar-d) scattering



Measurement of effective polarization build-up cross-section

- Measure both transverse and longitudinal build-up
- Variable acceptance at target
- Utilize also polarized D target

First measurement for spin correlations in pbar-p (and pbar-d)

AD Machine & Exp. Areas

Timeline

Fall 2005	LOI to SPSC for Spin-Filtering Studies (✓)
Fall 2006	Submission of Proposal to COSY-PAC (✓)
	Beam depolarization & lifetime studies
2006 - 2008	Design and Construction Phase
	Dec 2006: Technical Boundaries, AD visit
	early 2008: ~ Pioneering Experiment (Proposal)
Fall 2007	Technical proposal to COSY-PAC for Spin Filtering
	Technical proposal to SPSC for Spin Filtering at AD
2009	Spin-Filtering Studies at COSY
2010	Installation and Commissioning of AD experiment
	Spin-Filtering Studies at AD

AD Machine & Exp. Areas

AD startup after 18 months….

Extremely difficult startup:

- **PS-complex schedule delayed 6 weeks due to PS rotor (☺)**
- **3 weeks planned for AD startup – needed 8 weeks !! ☹**
  - **Problems in setting up electron cooler (19 days) ☹**
  - **PS injection septum failure (6 days) ☹**
  - **CERN general power distribution failure (4 days) ☹**
  - **Difficulties in finding correct trajectory for ALPHA line (8 days) ☹**
- **Physics finally started 22/8 instead of 18/7(all beamlines ok) ☺ ……**
- **…but with lower rep. rate and somewhat lower intensity ☹**

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AD Machine & Exp. Areas

The 2006 run

- Increased losses PS – AD target
- Increased deceleration losses
- Slower beam cooling at low energies
- Higher long. emittance

Parameter (at extraction)	Design	Achieved 2004				Achieved 2006		
	100 MeV/c	100 MeV/c	300 MeV/c	100MeV/c, multiej.		100 MeV/c	500 MeV/c	100MeV/c multiej.
Total energy spread [4s] [10^{-3}]	1 – 0.1	0.8 – 0.4	0.15			>1	2	>1
Bunch length [ns]	200-500	90-200	300			120-500	500	50
Number of antiprotons [107]	1.2	3.0/4.2	3.3/4.0	1.0*3	0.4*6	2.5	3.0	0.4*6
Cycle time [s]	60	84	84	89	96	100	95	112

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AD Machine & Exp. Areas

The 2006 run

- **All beamlines operational as of 22/8 (5weeks late): Run extended until 20/11 to compensate**

Run time (h)	2000	2001	2002	2003	2004	2006
Total	3600	3050	2800	2800	3400	2925
Physics	1550	2250	2100	2300	3090	2765
md	2050	800	700	500	310	160
uptime	86%	89%	90%	90%	71%	65%

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AD Machine & Exp. Areas

2007 startup

- Extra HW-test time requested by AB/PO: 4 weeks in total
- Start with production beam 7/5
- 4 weeks for startup/md
  - Thorough study of e- vs. Pbar alignment for e-cooling
  - Set-up of new optics in DE0, DE3/4, DE2
- No plans for tst protons, but it might be needed
- And:
  - *Study of PS to AD line optics desirable*
  - *5-bunch production beam – is it far away?????*

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AD Machine & Exp. Areas

2007 startup

- Physics run: 4/6 – 22/10
- Plan to continue running during weekends
- AD operation:
  - 2 shifts/day during startup, then:
  - 1 specialist on-call/week
  - 1 backup/week
  - ccc looks after AD during nights/weekends
- The same team also runs LEIR

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AD Machine & Exp. Areas

CCC

- *Running AD from ccc reinforces the need for:*
- *Improved machine stability =*
  - *Electron cooler stability/performance*
  - *Need improved correction of ecool trajectories*
- *Better tools for ejection beamline tuning =*
  - *Need new monitors for fast, non-destructive measurements and corrections*

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AD Machine & Exp. Areas

AD Consolidation

- AD is now included in the general consolidation program….
- ….at the bottom of the list….
- Let's look at only RS…and see what can be done

Item	RS	Material budget 2007-2010 kCHF	Staff requirements 2007-2010 MY
C10/C02 Cavity upgrade	12	380	3.3
Stochastic cooling Pickup/kicker movement	12	150	1.0
Horn pulser ignitron phaseout	9	230	0.35
Stochastic cooling controls/instrumentation	8	200	2.0
Horn pulser electronics	6	175	1.30
Ej.line trajectory instrumentation	2	300	0.6
(RF low level migration to DSP)	6	150	1.0

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AD Machine & Exp. Areas

Conclusion
General remarks

- AD downtime is increasing
- e-cooler is getting more and more difficult to set-up correctly
- Some equipment (eg. target area) has been operational for a very long time without intervention: know-how is disappearing
- Keen interest from users

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nTOF Facility – what needs to be done

SC-RP Resources (1)

- At present:
  - Until 2004 n-TOF has been operated by CERN as an "insignificant activity" and no additional resources had been allocated
  - For ISOLDE, n-TOF and MERIT:
    - < 1.5 FTE RP engineers for monitoring
    - 0.2 FTE RP physicist for studies and authorisations
- Start of a new n-TOF physics programme
  - Additional manpower required for state-of-the-art radiation protection programme:
    - (part of) physicist/ senior engineer for studies and authorisations
    - (part of) technician/ tech. engineer for monitoring work with potentially dangerous radioactive targets

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nTOF Facility – what needs to be done

SC-RP Resources (2)

- LHC start-up/ commissioning/ first years:
  - nearly all present RP physicist resources bound to LHC until at least 2011 (nominal intensity in LHC)
  - numerous additional RP technicians/ engineers are required for LHC operation
- APT:
  1 physicist/ senior engineer &
  1 technician/engineer requested for
  injectors and "low-energy" programme,
  shared with CTF-3, Linac-4, PS, PSB, East hall...
- Present SC-RP resources are insufficient for monitoring the operation of n-TOF

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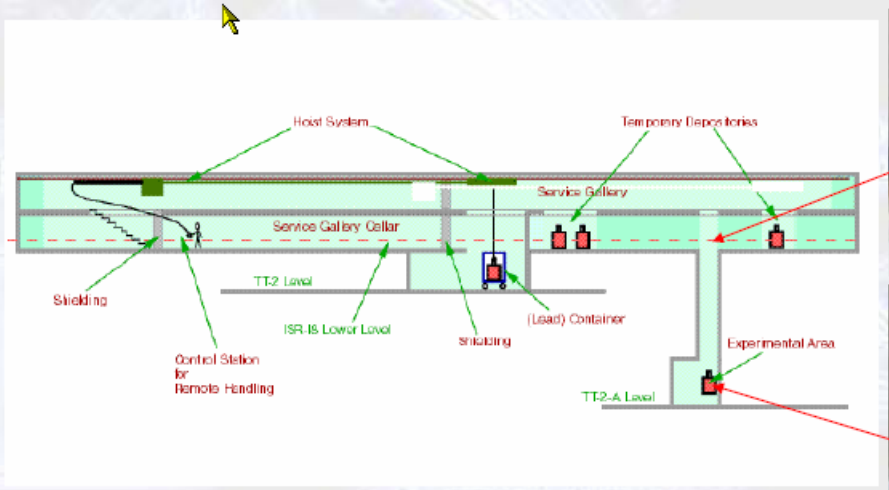
nTOF Facility – what it implies

Target Handling



- The Target must be moved from TT2-A to the Depository in the Service Gallery.
- This operation is done through the Shaft by using the Hoist System.
- A system using several video cameras is used for the remote control.

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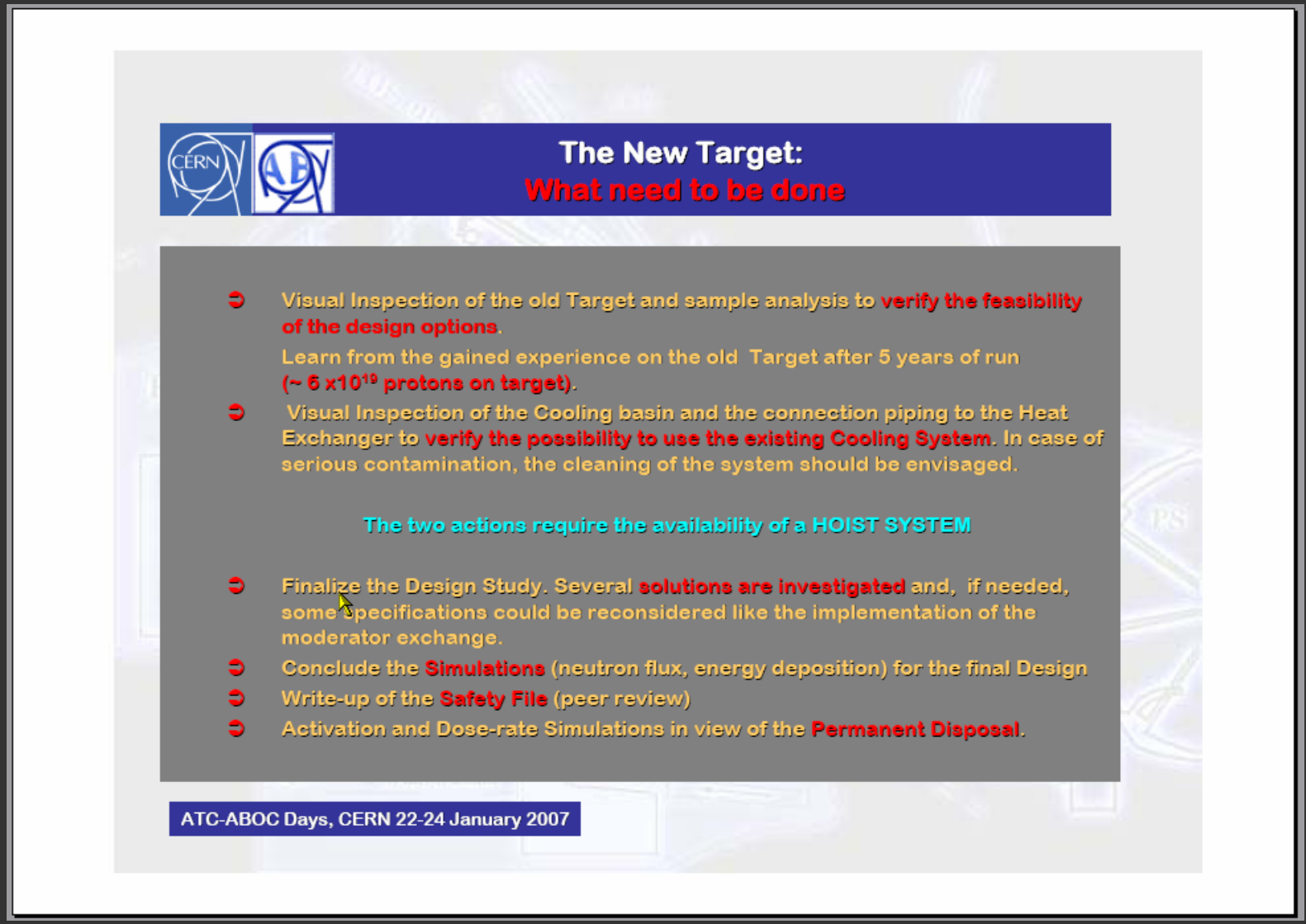
nTOF Facility – what it implies



nTOF Facility – what it implies

Introduction

Old Target

- Lead blocks directly in contact with cooling water
- Target mass > 4 tons
- Support structure entirely stainless steel (water basin in aluminium → corrosion risk)

New Target

- No direct contact between target lead & water circuit
- Smaller target (~1 ton)
- Optimised support structure (corrosion, activation, etc.)

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nTOF Facility – what it implies

Design issues: Radiation Safety

Target Cladding

Metal(*) clad lead target with lead core

Consequences of cladding:

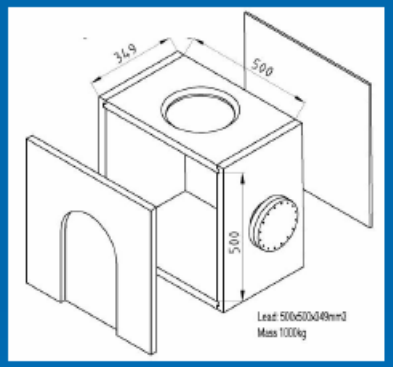
1. Thermal contact resistance between lead and cladding. Need for good contact pressure between core and shell.

2. Core and shell will have different temperatures → different expansion → large forces on shell

Proposal: Introduce initial [illegible] gap, to have contact at nominal working temperature. Needs to be studied!

Challenge

Possible production method



(*) Aluminium is used in the calculations. Material may have to change for reasons of radioactive waste disposal (see talk Luisa ULRICI, today at 12:00)

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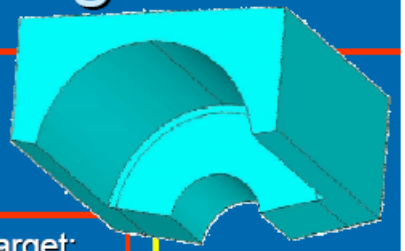
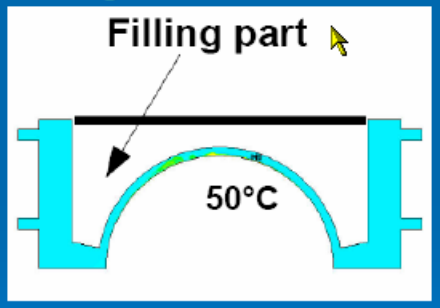
nTOF Facility – what it implies

Optimized for cooling

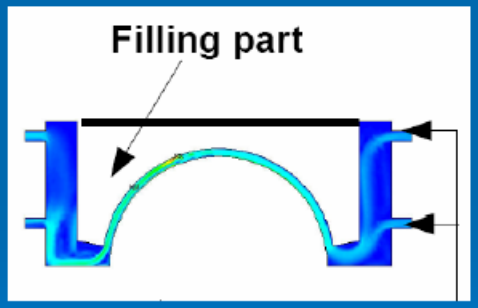
Proposal: Filling part to help guide the water and increase local velocity



Water temperature:
Average: 22°C - Local:50°C



Water velocity around target:
Average: 0.02 m/s - Local: 0.1m/s



Filling parts are efficient

- Filling parts: complex geometry, minimize mass
- Support structure to be adapted
- Impact on target integration to be evaluated

Challenge

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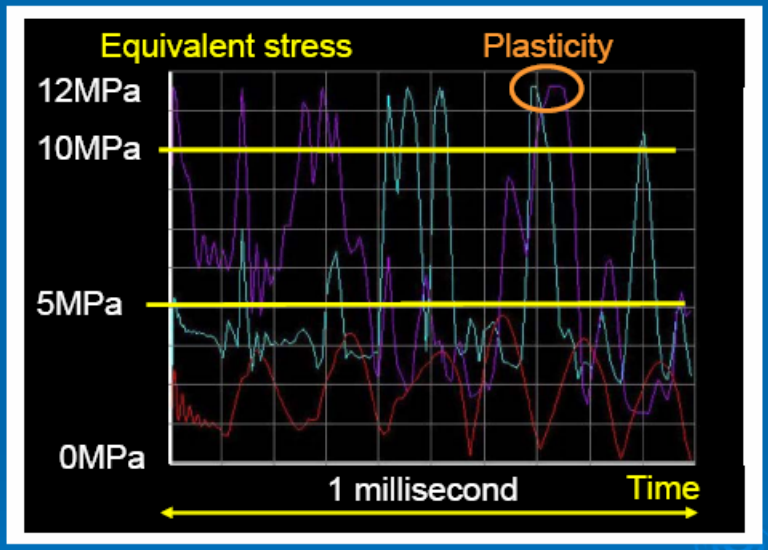
nTOF Facility – what it implies

Transient elasto-plastic behaviour

First results:

- Presence of plasticity
- Fatigue driven failure of the material will occur in central region (number of cycles to be determined).



Next steps:

- Get detailed material properties (literature / experiment)
- Take into account the initial gap and the cladding mat[illegible]
- Fatigue analysis of both lead and cladding m[illegible]

Challenge

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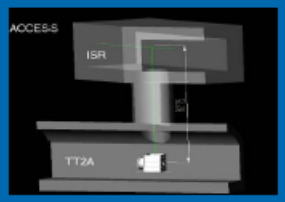
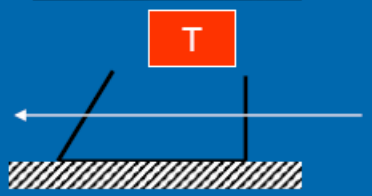
nTOF Facility – what it implies

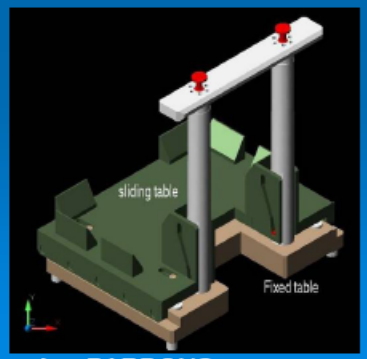
Design issues: Integration

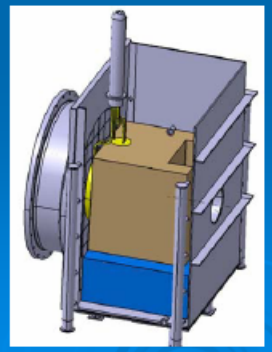
- Supports and guiding system
  - Need for precise positioning (access!)
  - Limited space available
  - Integrate “filling parts”
  - Installation vertical + horizontal (moderator)

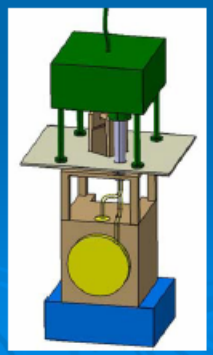




First ideas: remotely actuated sliding table, tubes for moderator







To do:

- Design
- Prototyp[illegible]

Challenge

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Slide 12 of 14

nTOF Facility – what it implies

What need to be done to restart n_TOF
Summary

Title	Description	Group	FTE	kCHF
Old Target Removal	New Crane Purchase	AB-ATB		320
	Video Remote Control	AB-ATB	0.05	50
Old Target Removal	Modification Existing Crane	AB-ATB SC-GS TS-IC	0.1	50
Target Area Ventilation (full scenario)	Civil Engineering	TS-CE		40
	Ventilation System Design	TS-CV		
	Air Recirculation System	TS-CV		35
	Air Extraction System	TS-CV		35
	Environmental Monitoring	SC-RP		90
New Target	Design & Production	AB-ATB	1.5	230
	Simulations (neutronics)	AB-ATB	0.5	
New target Disposal (CERN)	Repository Construction	TS-CE		100
Target Permanent Disposal	Infrastructure Design	AB-ATB	0.3	150
	Radioprotection	SC-RP	0.2	
	Simulations	AB-ATB	0.2	
Experimental Area	Alignment System	AB-ATB	0.25	30
	Total	AB-ATB	2.8 (2.55)	1080 (630)

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nTOF Facility – what it implies

What need to be done to restart n_TOF
Summary

Title	Description	Group	FTE	kCHF
Operation	Re-Installation n_TOF Beam	AB-ATB	0.3	
		AT-VAC	0.15	5
		TS-IC	0.3	15
		TS-CV	0.05	
		TS-SU	0.05	
	Radioprotection	SC-RP	0.3	
	Total	AB-ATB	0.3	20

Option 1 - New Crane, New Target, New Target Repository, Ventilation, Old Target Definitive Disposal, Alignment System:
FTEs AB-ATB 3.1, Budget 1100 kCHF

Option 2 - Modification Old Crane, New target, Ventilation, Old Target Definitive Disposal:
FTEs AB-ATB 2.95, Budget 650 kCHF

Estimations presented to the ATC 08.12.2006

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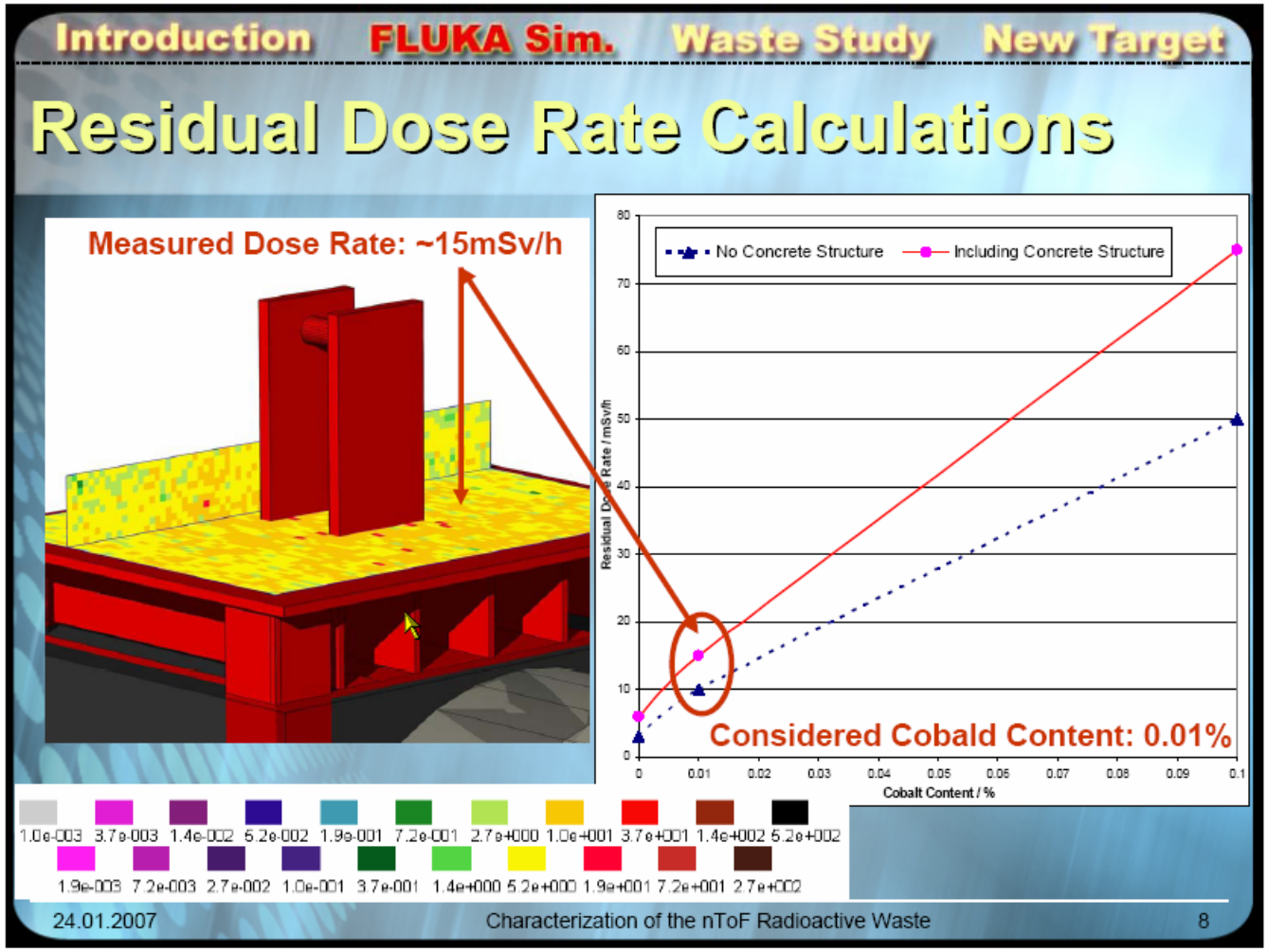
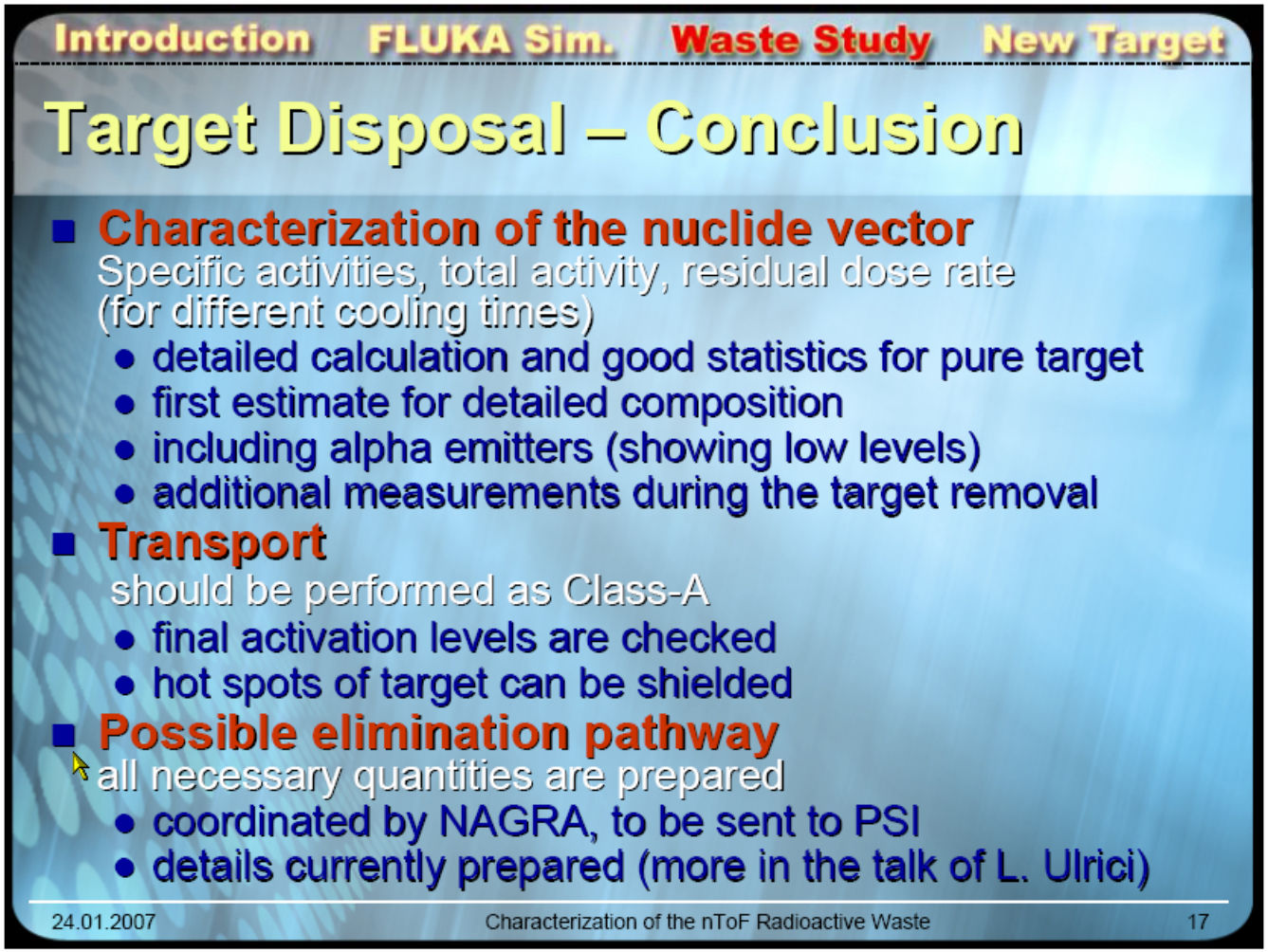
nTOF Facility – radioactive waste



nTOF Facility – radioactive waste



nTOF Facility – radioactive waste

nTOF OLD TARGET

- OFSP agreed to the final disposal of the old target in Switzerland
- NAGRA calculated the total content in alpha-emitters. From these results the target could, in principle, be accepted in the temporary storage (PSI) and in the final repository.
- PSI asked for a visit of n-TOF in order to get familiar with the installation and its radioactive waste. During the visit, an analysis of the radiological risks of the old target will be performed in order to define the conditioning for the delivery to the temporary storage.
- The delivery is subject to some technical requirements
  - Maximum dose rate at the surface of the waste container 2 mSv/h
  - No volatile contamination (container needed)
  - Dimensions adapted to fit in the final container for waste conditioning

Luisa Ulrici, SC/RP January 24, 2007 ATC-ABOC - 5

nTOF Facility – radioactive waste