RFX /ENEA Studies

M. Valisa and the RFX group

ADAS Workshop , 10-12 October 2007

The RFX Group

*M. Agostini, L. Carraro, E Gazza, L. Lauro Taroni *, M. Mattioli *, I. Predebon, M.E. Puiatti, P.Scarin,, B.Zaniol and M. Valisa*

Main ADAS-related activities

- Spectroscopy and impurity transport studies on RFX

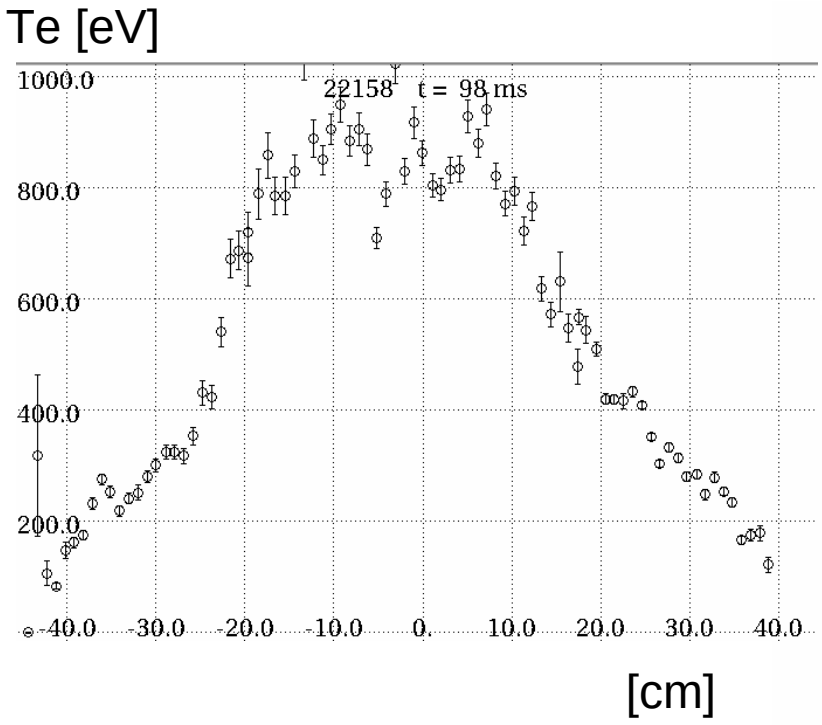
- Impurity transport studies on JET

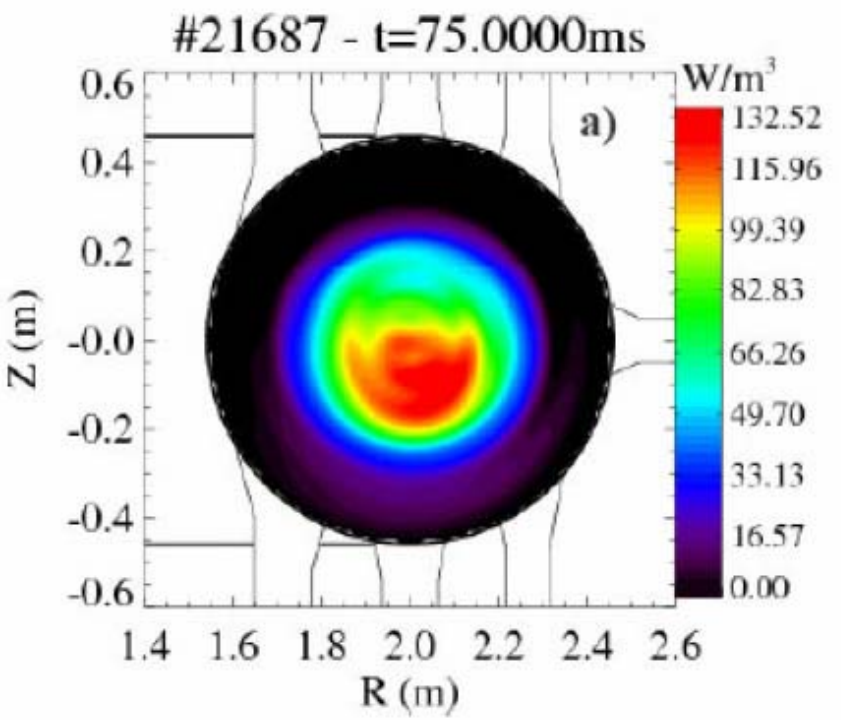
- Atomic physics updating for transport codes (M.Mattioli)
  See M. Mattioli later this workshop

- Superstates implementation on Sanco/ JETTO(L.LauroTaroni)
  See Lauro Taroni Later this workshop

(*) collaborators

Latest from RFX





Sophisticated Feedback Control of the magnetic boundary has led RFX to reach 1.5 MA of plasma current.

Electron Temperature now reach (transiently) 1 keV.

Spectroscopy on RFX

Standard plasma monitoring XUV- VUV (High res . Czerny-Turner) and VIS (High res. high throuhput).

Diagnostic Neutral Beam Injector

Thermal He beam for electron density and temperature edge profiles

Impurities studied : He, B, C, O, Ne, Ni – Impurity transport of oxygen and carbon dominated by e.m. turbulence

Spectroscopy on RFX

Laser Blow Off system Almost ready – Lab tests OK.

Aim : to probe metals transport in magnetic turbulence dominated plasma vs situations with conserved magnetic surfaces (i.e. Quasi Single Helicity states)

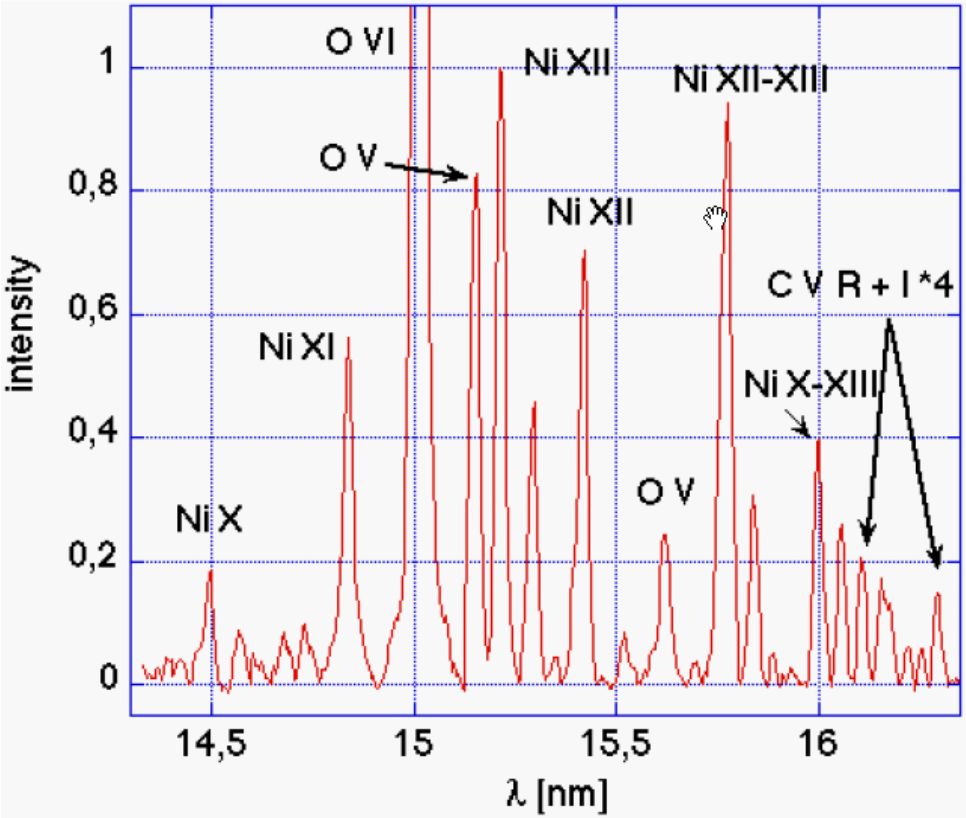
Probe Ni, Fe , Mo and W

Doped cryo-pellets and solid pellets for other impurities (Ne, Ar, C, Li etc)

RFX data useful for SOL and Divertor Region of Tokamaks

Spectroscopy on RFX

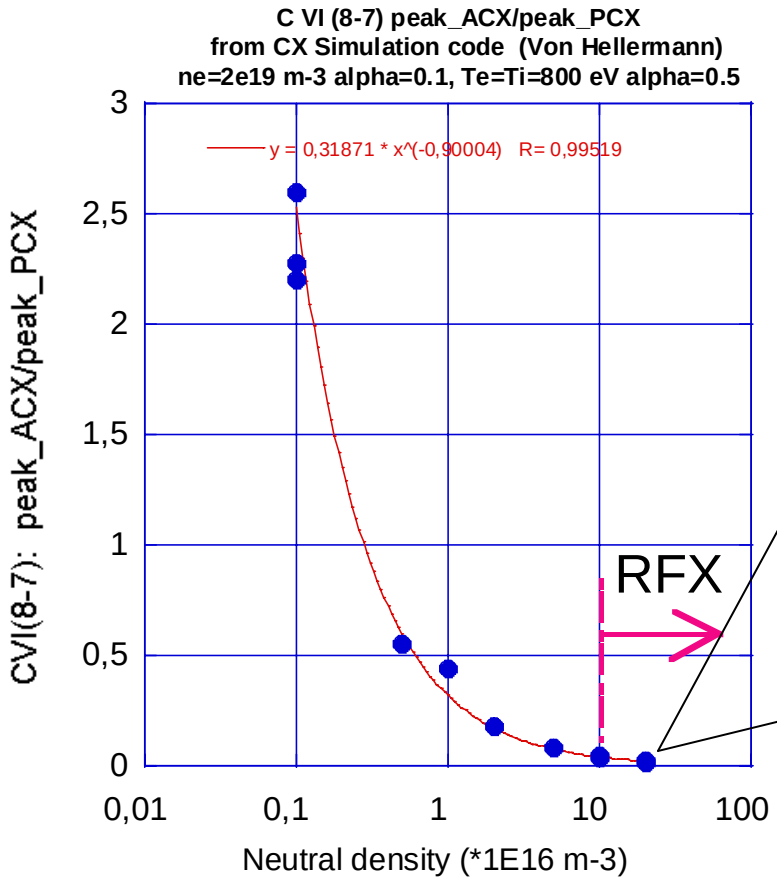
So far Ni seen only in few shots with strong Plasma Wall interactions. Seen intermediate ionisations states (Ni XI-NiXIII)

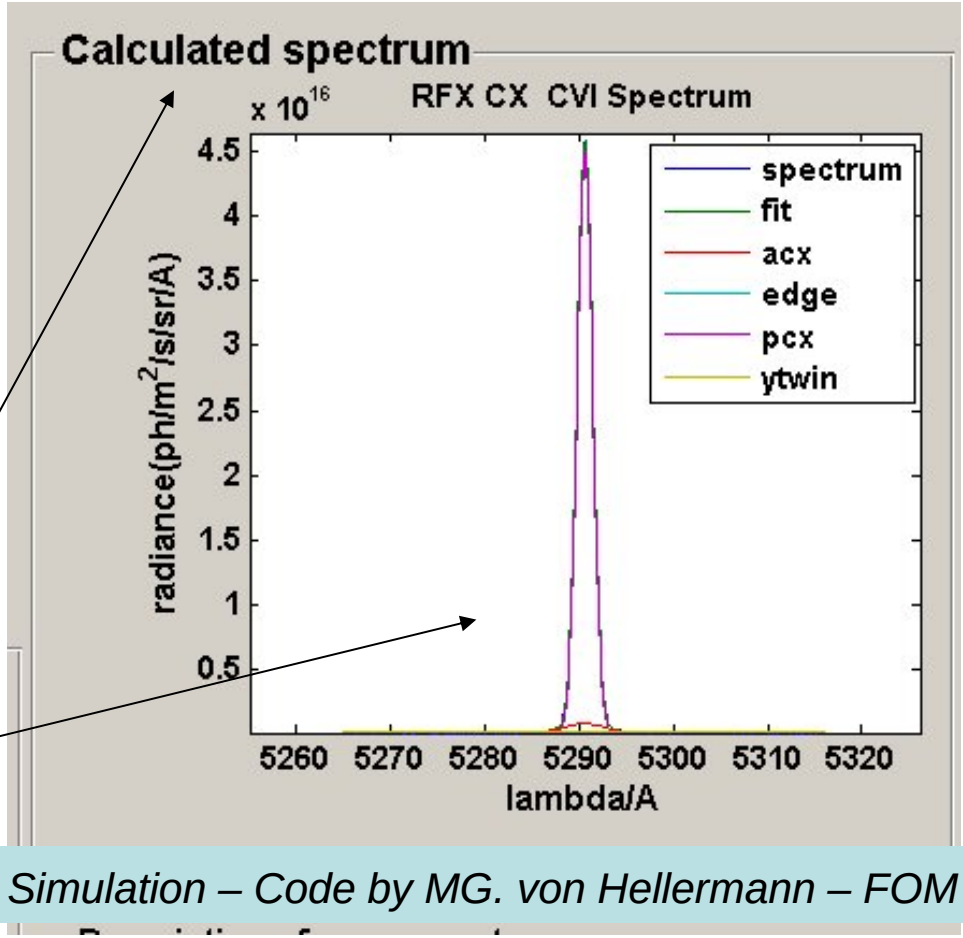


Experimental and simulated M-shell nickel spectra in the 14.4–18.0 nm region from magnetic fusion devices
Mattioli et al. J. Phys. B: At. Mol. Opt. Phys. 37 (2004) 13–40

Spectroscopy on RFX/ Diagnostic Neutral Beam

Severe problems so far to get a useful CX signal out of a 2A of equivalent current. Some technical issues have introduced delays. Intrinsic physical aspects are under investigation. Role of neutral density? Looking for low recycling conditions and most favourable plasma conditions.

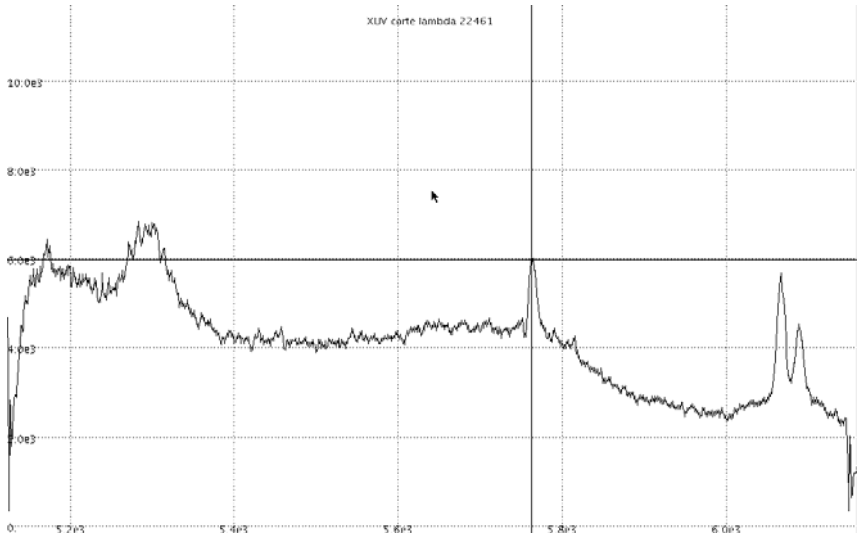


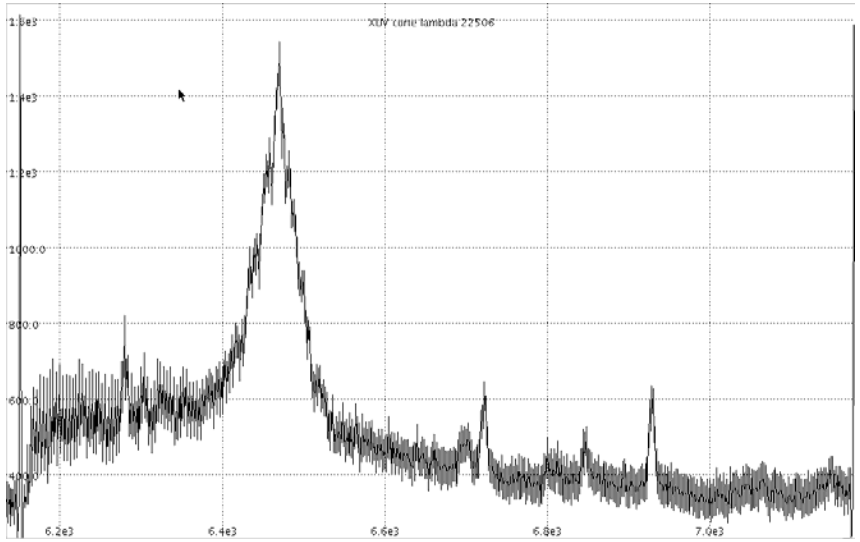


CX Simulation – Code by MG. von Hellermann – FOM

Spectroscopy on RFX

Structures found in the spectra @ ~22 and, with Ne, @~88 Ang





Instrument artifact?
Satellite lines of oxygen and neon?

JET : Impurity transport issues

- Effect of central ICRH electron heating on transport of Ni , Mo , Ar and Ne.

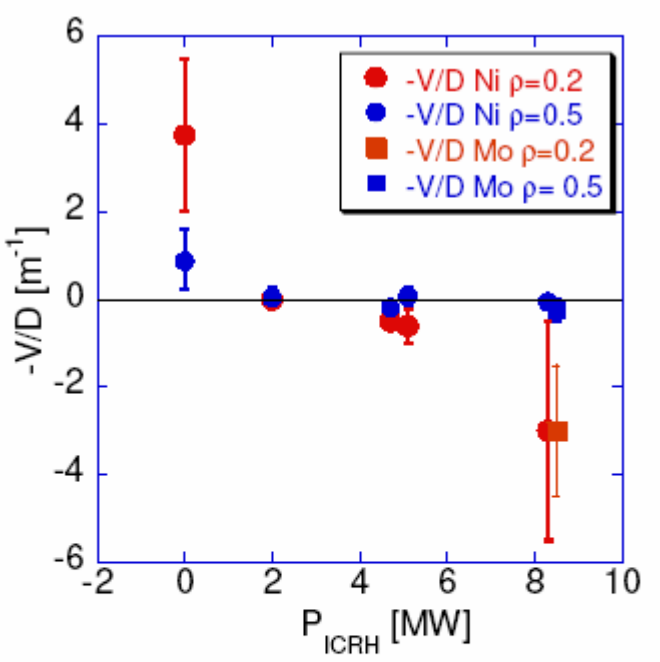


Fig.4 Ni peaking factors at ρ=0.2 and ρ=0.5 versus ICRF powers for the 6 discharges, Mo peaking factors for shot #68381.

New proposals for 2008:
- look for a power threshold for the pinch inversion
- include W
- compare data with first principle models

Impurity profile control in JET plasmas with radio-frequency power injection.
L. Carraro et al, EPS Conf .Warsaw 2007

Mo data not from ADAS

Main references for Atomic data used so far for analysis of JET and FTU discharges come from [*]

Comparison with ADAS should be pursued, since Mo is an actractive element for impurity transport studies. Adopted in various machines as first wall component is also of relevance as heavy metal(LBO experiments).

(*)

M Mattioli1, G Mazzitelli2, K B et al J. Phys. B: At. Mol. Opt. Phys. 39 (2006) 4457
Mattioli et al. EPS Conf London 2004
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D.Mitnik, PhD Thesis, Hebrew University, Jerusalem, Israel (1996)

Atomic Physics: updating ionization data

Updating of ionization data for ionization balance evaluations of atoms and ions for the elements hydrogen to germanium

M Mattioli, G Mazzitelli, M Finkenthal, P Mazzotta, K B Fournier, J Kaastra and M E Puiatti

J. Phys. B: At. Mol. Opt. Phys. 40 (2007) 3569–3599

See M. Mattioli later this workshop

JET- Superstates implementation on Sanco/ JETTO (L.LauroTaroni)

Implementation of ADAS atomic physics packages for the treatment of heavy impurity in SANCO .

Rationalization of ADAS access routines in SANCO and EDGE2D for COCONUT.

Tests with Nickel are being carried out, aiming at an implementation of the database for W.

See L: lauro Taroni later this workshop

Summary and future plans

- *impurity transport studies on RFX and JET of "traditional impurities "*

- *compare Ni and Mo with W transport in different temperature regimes in RFX and JET (both high and low ionization states)*

- *update CR models of He*

- *more studies on the role on neutrals on the CERS signal to background ratio and plasma perfomance on RFX*

- *modelling of low temperature plasmas (ion sources for ITER beam – H2 , Cs)*

- *Modelling of beam plasma interaction (ITER BEAM)*

- *extend RFX spectrum monitoring to higher energies (5-20 Ang.)*

The end

INSTITUTE OF PHYSICS PUBLISHING JOURNAL OF PHYSICS B: ATOMIC, MOLECULAR AND OPTICAL PHYSICS

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Updating of atomic data needed for ionization balance evaluations of krypton and molybdenum

M Mattioli[1], G Mazzitelli[2], K B Fournier[3], M Finkenthal[4] and L Carraro[1]

[1] Consorzio RFX, Associazione Euratom-Enea sulla Fusione, Corso Stati Uniti 4, Padova, I-35127, Italy
[2] Associazione Euratom-Enea sulla Fusione, C R Frascati, CP 65-00044, Frascati Roma, Italy
[3] Lawrence Livermore National Laboratory, PO Box 808, L-41 Livermore, CA 94550, USA
[4] Plasma Spectroscopy Group, The Johns Hopkins University, Baltimore, MD 21218, USA

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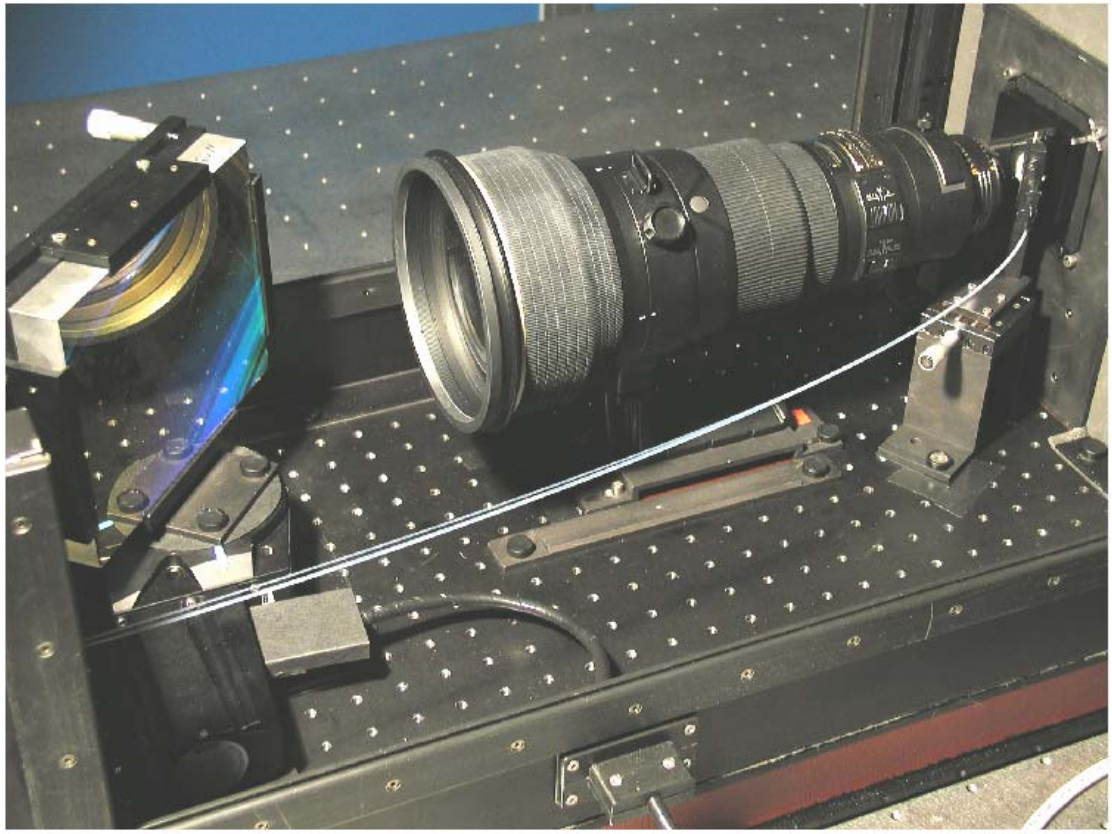
Abstract

Atomic data for both ionization and recombination of Kr and Mo ions are reviewed, the rates for these processes needing to be regularly updated following the publication of new theoretical calculations and new experimental data. Kr is used in magnetic-confinement fusion devices to produce a peripheral radiating mantle meant to spread the heat load on the plasma-facing components. In a few tokamaks Mo tiles cover the plasma-facing surfaces, acting in most cases as a plasma-column limiter. The collected atomic data represent the state of the art on the ionization and recombination data for the two considered elements. Samples of rates are proposed for both ionization and recombination along with tables of the fractional abundances at ionization equilibrium. The proposed rates should be included in codes that simulate the impurity behaviour in magnetic-confinement fusion devices, i.e., when radial transport is added to ionization and recombination to predict spatially resolved charge-state distributions to be compared with experimental results. As an example, the simulation of a Mo laser blow-off injection on the JET tokamak is re-analysed with the revised rates and multiplicative correction factors are obtained for the rate ratios recombination over ionization for L-shell ions.



Littrow Spectrometer – 400 mm / 3000 g/mm grating / true f/3
Unpublished